ELECTRONICS COMPUTING COMMUNICATIONS BROADCASTING AUDIO AND VIDEO

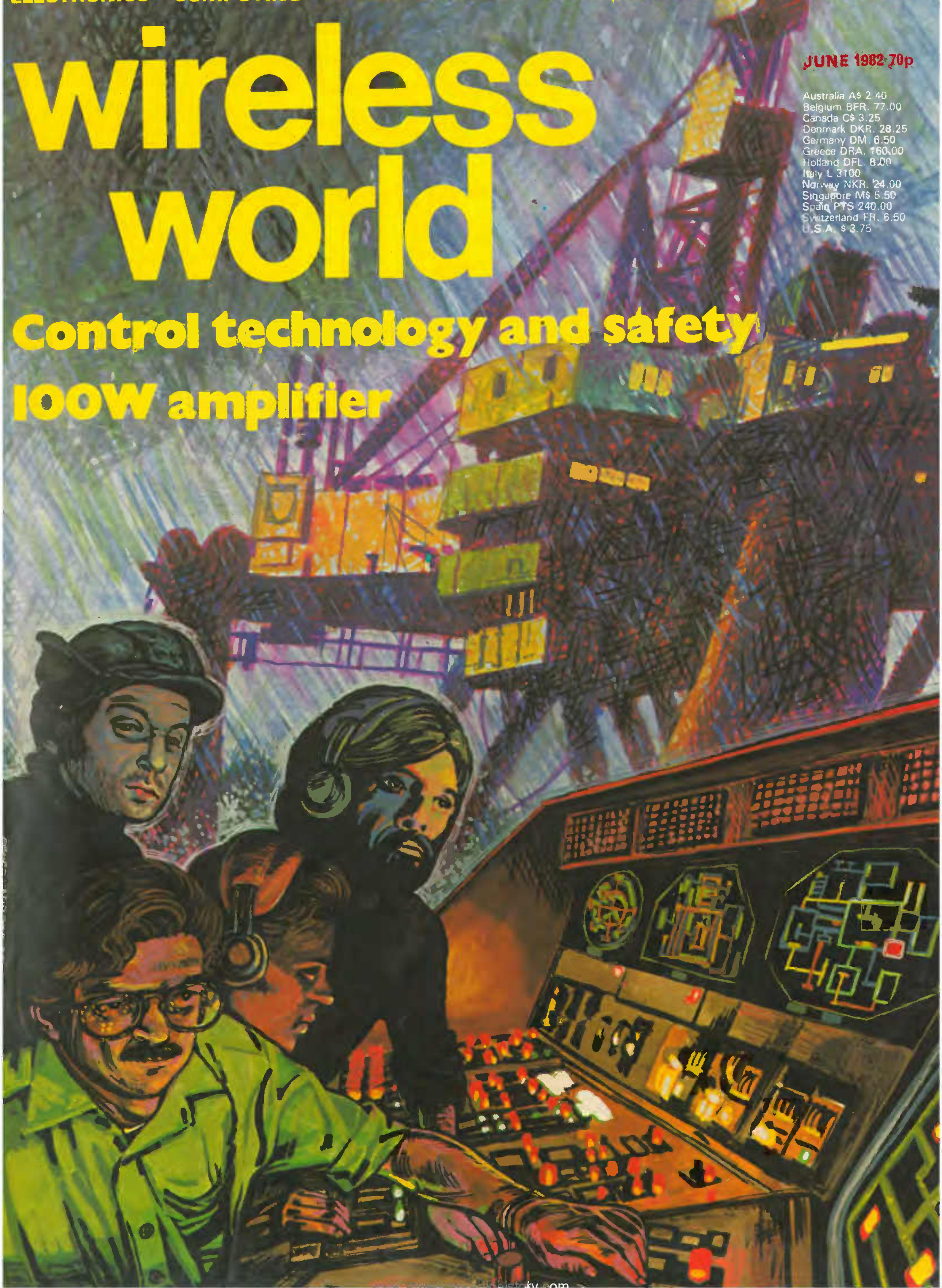
wireless world

JUNE 1982 70p

Australia A$ 2 40
Belgium BFR. 77.00
Canada C$ 3.25
Denmark DKR. 28.25
Germany DM. 6.50
Greece DRA. 160.00
Holland DFL. 8.00
Italy L 3100
Norway NKR. 24.00
Singapore M$ 5.50
Spain PTS 240.00
Switzerland FR. 6.50
U.S.A. $ 3.75

Control technology and safety

100W amplifier



ORYX

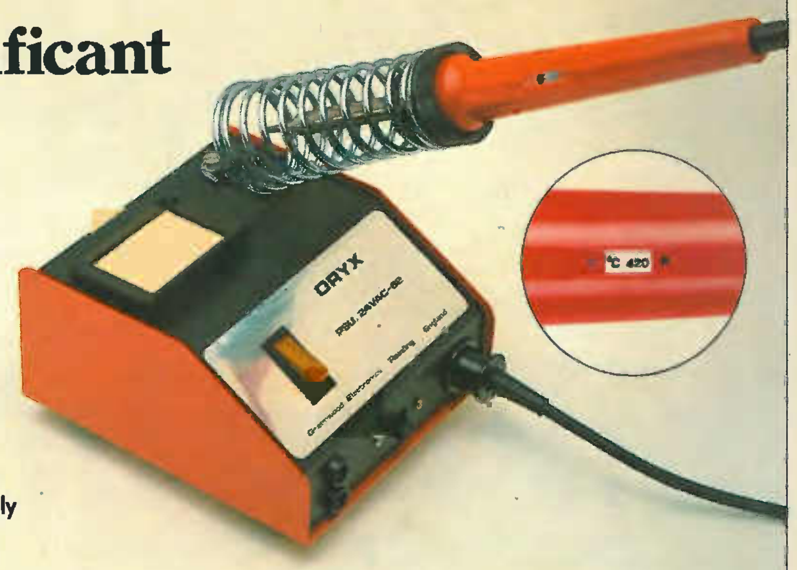
the new name in quality solder

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 TC 82 has features unique to any temperature controlled precision soldering iron. Available in 24 V, 50 V, 115 V and 210/240 V models, the TC 82 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 TC 82 is also **extra-safe.** Removing the handle automatically disconnects the iron from power source.
Other TC 82 features include: Power-on Neon indicator in handle; burn proof cable; choice of 13 tip styles.

And more good news

The Oryx TC 82 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 £3.95 (+VAT).

Greenwood Electronics

Greenwood Electronics Limited, Portman Road, Reading, Berkshire RG3 1NE. Telephone: (0734) 595844. Telex: 848659

WW—003 FOR FURTHER DETAILS

WIRELESS WORLD JUNE 1982 VOL 88 NO 1557

ELECTRONICS COMPUTING COMMUNICATIONS BROADCASTING AUDIO AND VIDEO

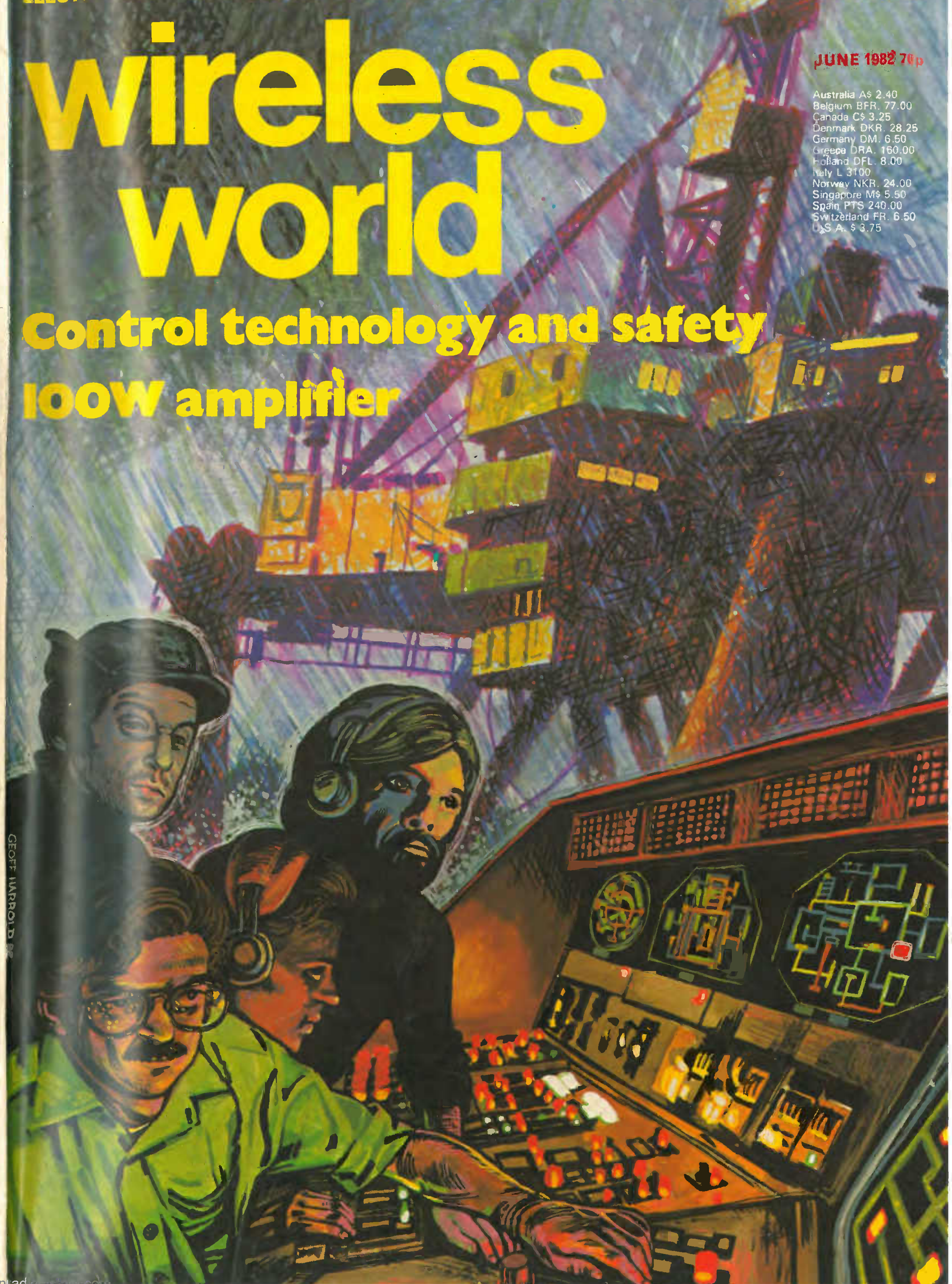
wireless world

JUNE 1982 70p

Australia A$ 2.40
Belgium BFR. 77.00
Canada C$ 3.25
Denmark DKR. 28.25
Germany DM. 6.50
Greece DRA. 160.00
Holland DFL. 8.00
Italy L 3100
Norway NKR. 24.00
Singapore M$ 5.50
Spain PTS 240.00
Switzerland FR. 6.50
U.S.A. $ 3.75

Control technology and safety

100W amplifier



GOULD OSCILLOSCOPES SET A HIGHER STANDARD

THE NEW GOULD OS300 DUAL-TRACE 20MHz 'SCOPE

The OS300: as tough as the environment you use it in, e.g. measuring vibration characteristics of rotating machinery and mechanical structures on site.

A tough, professional instrument you can trust – at a price you can afford! Built to do more – safely, reliably and longer.

Complete with a 2-year guarantee. This robust and highly portable oscilloscope has obvious applications in test, production, service and R & D areas.

As some of the specification highlights make clear: ★True 20MHz operation – compare its maximum display amplitude at full bandwidth with competitors; ★Continuously variable amplifier sensitivity with no loss of bandwidth from 2mV/cm to 25V/cm; ★Differential measurements can be made using the channel 2 'add' and 'invert' controls; ★X-Y operation for frequency and phase shift measurements; ★New type CRT with quick-heat cathode to reduce operational delays and P43 phosphor for a brighter display.

And many other features designed specifically for you!

Comprehensive data is yours for the asking. On this tough little 'scope.

Gould Instruments Division, Roebuck Road, Hainault, Ilford, Essex IG6 3UE. Telephone: 01-500 1000.

GOULD

Electronics & Electrical Products

10614

WW – 001 FOR FURTHER DETAILS

An impression of crisis control, created by Geoff Barrold, linked with R. E. Young's article on the subject in this issue.

NEXT MONTH

Line printer – an interface for driving a 40-column, dot-matrix, mechanism from a 28D based computer.

GPIB/serial interface – Chris Jay demonstrates an 'economical and practical' solution with talker/listener capability.

Light pen – reads screen characters, in memory-mapped display microcomputer systems, and returns address. Design uses fibre-optic cable.

Current issue price 70p, back issues (if available) £1, 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 £1.6p, back issues (if available) £1.50, order and payments to EEP General Sales Dept., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Editorial & Advertising offices: Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Telephones: Editorial 01-661 3500. Advertising 01-661 3130.

Telegrams/Telex: 892084 BISPRS G.

Subscription rates: 1 year £12 UK and £15 outside UK.

Student rates: 1 year £8 UK and £10 outside UK.

Distribution: Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Telephone 01-661 3500.

Subscriptions: Oakfield House, Perrymount Road, Haywards Heath, Sussex RH16 3DH. Telephone 0444 59188. 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.

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

© IPC Business Press Ltd, 1982

ISSN 0043 6062

wireless world

ELECTRONICS
TELEVISION
RADIO
AUDIO

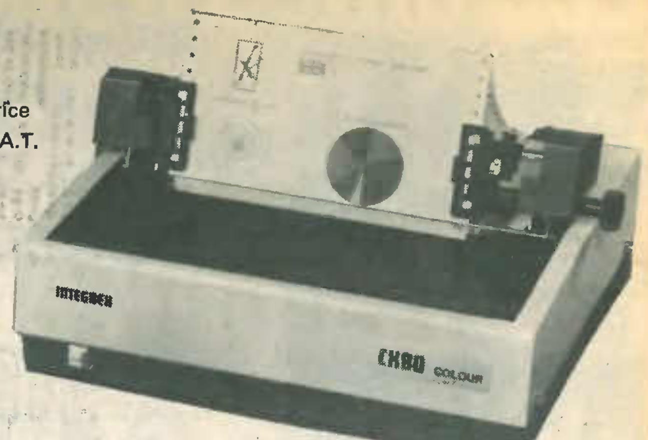
JUNE 1982 Vol 88 No 1557

www.americanradiohistory.com

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.

Dot Addressable + 15 user programmable characters, 96 ASCII and 64 graphics characters in rom. Centronics interface with RS232 and IEEE488 options. Apple II interface gives dot for dot colour dump. New viewdata interface prints out two pages side by side in full colour. See Prestel 200650.

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

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, Kingsville Road, Kingsditch Trading Estate, Cheltenham GL51 9NX

Tel: 0242-41313 Telex: 897106

WW – 087 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 oxydised) and specially sensitive contacts. An excellent lubricant for all electrical and electro 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 Cold Spray, K70 Plastic Spray, K88 Oil Spray, K701 Vaseline Spray, K90 Video Spray, K33 Graphite Spray, K100 Antistatic Spray, K101 Fluid Spray and, of course, Positiv 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: Speciprod, London, W1

WW – 083 FOR FURTHER DETAILS

Electronic Brokers Second User Test Equipment. Makes engineers smile without making accountants cry.

Electronic Brokers are 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.

ANALOGUE VOLTMETERS

Avo
EA113 Electronic Multimeter £115.00

Bruel and Kjaer
2409 TRUE RMS. Average and Peak 2Hz-200KHz £250.00

Hewlett Packard
3400A True RMS 1mV-300V 10Hz-10MHz £600.00
3406A 1mV-3V FSD 10KHz-1.2GHz .. £850.00

Marconi.
TF2600A 1mV-100V FSD 10Hz-10MHz £245.00
TF2603 RF Millivoltmeter 300μV Sensitivity. 50KHz-1.5GHz £525.00

Racal
9301A RF Millivoltmeter £525.00

Rohde & Schwarz.
URV RF-DC Millivoltmeter DC 50μV-1050V RF 10KHz-2GHz £950.00

ANALYSERS

Hewlett Packard
3580A Spectrum Analyser 5Hz-50KHz £2950.00
141T/8552B/8555A 10MHz-18GHz . £9750.00
332A Distortion Meter 5Hz-600KHz ... £495.00
333A Distortion Meter with Auto null £675.00
8407A/8412A Network Analyser £1950.00
8555A Plug in. 10MHz-18GHz £5000.00

Marconi
TF2370 Spectrum Analyser 30Hz-110MHz. 0.1dB and 5Hz resolution £6500.00
TK2374 Zero loss probe for TF2370 ... £375.00
TF 2300B Modulation Meter £1200.00

Solartron
JM 1172 TFA £4000.00

Sound Technology
1700A measures distortion down to 0.002%. AC voltage 30μV-300V. S/N Ratio 100dB Dynamic range, power into 8Ω. 0.001% distortion Oscillator £950.00

Tektronix
R491 Spectrum Analyser 10MHz-40GHz AS NEW £3500.00

BRIDGES

Marconi
TM4520 Set of Inductors £350.00

Rohde & Schwarz.
LRT (BN6100) Inductance Meter. 1pH-100μH. 2.2-285KHz £395.00

Wayne Kerr

B642 LCR 0.1% £795.00
SR 268 Source & Detector £875.00

DVM's AND DMM's

Fluke
8300A 5½ Digit DC only 1μV sensitivity 5 ranges to 1100V £750.00

Philips
PM 2523-01 LED 3½ Digit DMM £95.00

Solartron.
7055 Microprocessor DMM. Scale Length 20,000. AC/DC volts, resistance. 1μV resolution £495.00

FREQUENCY COUNTERS

Fluke
1920A with Option 13 9 Digit 1GHz .. £750.00
1925A Multifunction, EMI Proof 9 Digit 125MHz £625.00

Hewlett Packard
5340A 8 Digit 10Hz-18GHz £3750.00

Marconi.
2432A 8 digit 10Hz-560MHz Battery/Mains £650.00

OSCILLOSCOPES

Marconi.
TF2213/1 + TK2214 X-Y Display and memory £550.00

Philips
PM 3234 True Dual Beam Storage Oscilloscope 10MHz New CRT £1750.00
PM 3244 50MHz 4 Channel Delay T'Base £1500.00

Tektronix.
453A Dual Trace DC-60MHz Portable Sweep Delay £750.00
465 Dual Trace Portable Oscilloscope. DC — 100MHz. 5mV-5V/div. Full delayed sweep £1395.00
465 with DM40 .... £1450.00
475 Dual Trace 200MHz Portable £2000.00
7603 100MHz Mainframe with 7A18N and 7B53N £3000.00
7704A 200MHz Mainframe c/w 7A22 Diff. Amplifier, 7A26 Dual Channel, 7B80 Timebase and 7B85 Delaying Timebase £4610.00
S1 Sampling Head. As New £450.00
7D14 Digital Counter plug-in 525MHz £850.00
434 Option 01 Storage Oscilloscope 25MHz £2250.00
1502 TDR £3500.00
P6015 HV Probe £295.00

Telequipment
DM63 Storage Oscilloscope Fitted with 2 x V4 Plug-ins to give 4 Trace 15MHz £1350.00
CT 71 Curve Tracer £450.00

Texscan.
DU120 12" Display £425.00

RECORDERS

Hewlett Packard
7045A X-Y Plotter T'Base Metric £1150.00

Watenabe.
MC641 6 Channel 250mm Chart Recorder £1495.00

Yokagawa
3047 2 Channel 2 cm/HR — 60cm/MIN £550.00

SIGNAL SOURCES

Hewlett Packard.
4204A Decade LF Oscillator. 10Hz-1MHz. 1mV-10V into 600Ω £695.00
606B AM Signal Generator. 50KHz-65MHz. AM 0-95% £850.00
608F 10-455MHz AM/PCM Modulation 0.1μV-1V output £600.00
616B 1.8-4.2GHz int or ext PCM/FM 0.1μV-0.224V £1000.00
616B UHF Signal Generator. 1.8 to 4.2GHz. Int pulse Mod £1000.00
651B Test Oscillator. 10Hz-10MHz. 0.1mV-3.16V £415.00
3200B 10-500MHz Signal Source £475.00
3320A Frequency Synthesizer. 0.01Hz-13MHz. £995.00
8640B c/w options 001, 002, 003 500KHz-1024MHz £4850.00

Marconi.
TF144H/4 AM Signal Generator. 10KHz-72MHz. 2μV-2V £750.00
TF2002B AM/FM 10KHz-88MHz £1200.00
TF2170B Synchronizer for TF2002B ... £450.00
TF995B/2 AM/FM 200KHz-200MHz ... £695.00
TF2005R 2 Tone Signal Source. 20Hz-20KHz. 0-111dB in 0.1dB steps £295.00
TF2008 AM/FM 10KHz-510MHz built in sweeper. Output 0.2μV-200mV £3500.00
TF2016 + TF2173 Synchroniser AM/FM 10KHz-102MHz £2000.00
TF2169 Pulse Modulator for use with TF2015 or TF2016 .... £200.00
TF 2000 AF Signal Source £365.00
TF 2015 AM/FM Generator 10-520MHz £1100.00
TF 2015 + TF 2171 Generator & Synchroniser £1850.00

Philips.
PM5715 Pulse Generator 1Hz-50MHz £675.00
PM6456 Stereo Generator. £250.00

Racal
9081 Synthesized AM/FM, Phase and Pulse modulation 5-520MHz £2200.00

Radiometer
SMG1 Stereo Generator £375.00

TRANSMISSION MEASURING EQUIPMENT

Siemens.
D2040 Selective Level Analyser and Voltmeter. 10Hz-60KHz. £1200.00
D2072 + W2072 Level Meter and Oscillator. 50KHz-100MHz. £2200.00
W2006 + D2006 Carrier Level Test Set. 10KHz-17MHz. —100 to + 10dB £1650.00
W2007 + D2007 Carrier Level Test Set. 6KHz-18.6MHz. —120 to + 20dB .. £1800.00

Wandel and Golterman.
PF-1 Digital Error Rate Measuring Set. Consisting of PFM-1 Digital Error Rate Meter and PFG-1 Pettern Generator £2490.00
SPM-6 and PS-6 Level Measuring Set. 6KHz-18.6MHz. —110dB to + 20dB. Mains / battery operation £2150.00
PCM-1 PCM Test Set, PDA-64 PCM Signalling Analyser, PSM-4 Level Measuring Set Scanner. PDG-1 Digital Signal Generator, PDA-1 PCM Digital Signal Analyser .... P.O.A.

MISCELLANEOUS

Bruel & Kjaer
2209 Sound Level Meter £975.00

Dymar
2085 AF Power meter 20Hz-30KHz 10μW-50W input imp 1.2-1000Ω £250.00

Ferrograph
RTS 2 Test Set £355.00

Fluke
3010A Logictester. Self Contained. Portable. Full Spec. on Request £8500.00

Hewlett Packard.
355E 12dB Programmable Attenuator unused £90.00
8403A Modulator Fitted With 8732B PIN MODULATOR £1500.00
8412A Phase Magnitude CRT display for network analyser £1500.00
8482H Power Sensor 100KHz-4.2GHz. AS NEW £250.00
8745A S Parameter Test Set. Fitted with 11604A Universal Arms 0.1-2GHz ... £2750.00
59308A HP-IB Timing Generator £300.00

Marconi.
TF2162 M.F. Attenuator. 0-111dB £135.00
TF 2502 RF Power Meter DC — 1GHz 10W £525.00
TF2331 AF Distortion Meter 20Hz-20KHz. £395.00
TF2500 AF Power Meter. 7 ranges 100μ watts to 25 watts £275.00
TM8339 AC/DC mixer for use with TF2702 .... £250.00

Philips
PM9380 Camera and Accessories (as new) £200.00

Rohde and Schwarz.
MSC Stereo Coder. 30Hz-15KHz £500.00

Schaffner
NSG 509 Test Generator £785.00

Tektronix
141A PAL Test Signal Generator £1750.00
1481C PAL TV Waveform Monitor .. £2375.00
191 Constant Amplitude Sig. Gen. 350KHz-100MHz 5mV-5.5V £250.00
106 Square Wave Generator 1nS risetime 10Hz-1MHz without accessories £175.00
284 Pulse Generator 70pS risetime .. £1250.00
2901 Time-Mark Generator £195.00

Please note: Prices shown do not include VAT or carriage.

Electronic Brokers

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

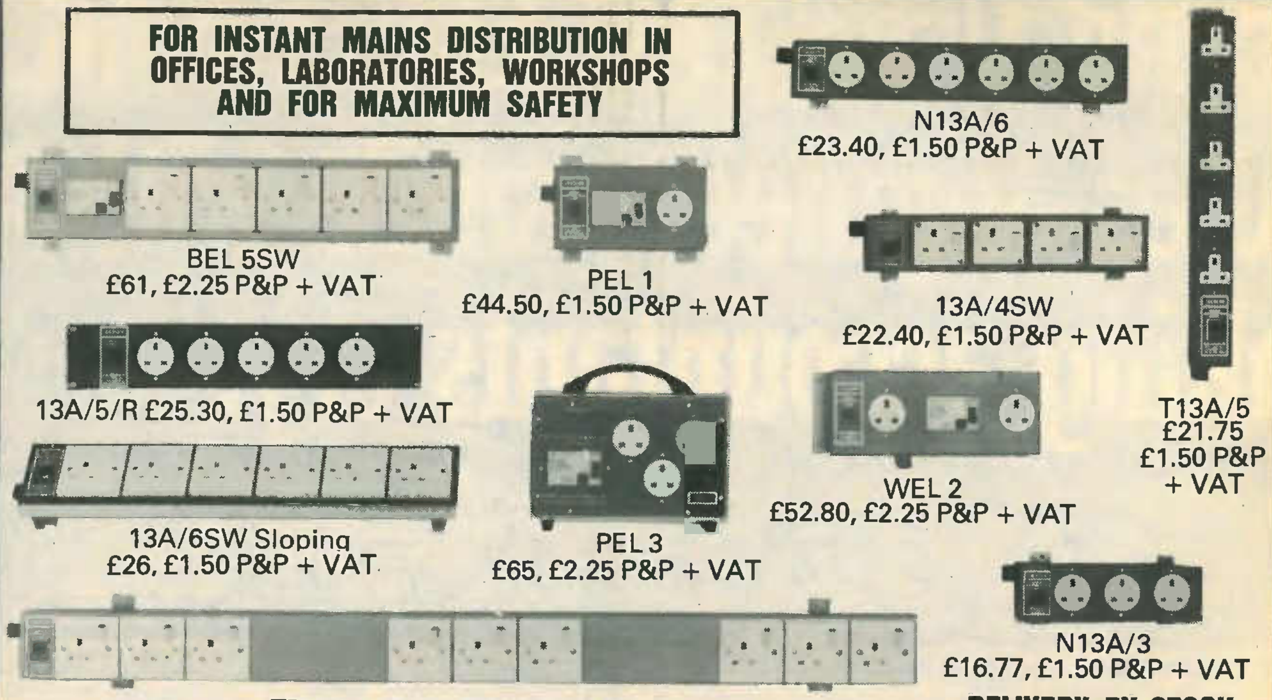
WW – 200 FOR FURTHER DETAILS

www.americanradiohistory.com

PORTABLE MAINS DISTRIBUTION NOW WITH EARTH LEAKAGE

OLSON

FOR INSTANT MAINS DISTRIBUTION IN OFFICES, LABORATORIES, WORKSHOPS AND FOR MAXIMUM SAFETY



N13A/6 £23.40, £1.50 P&P + VAT

BEL 5SW £61, £2.25 P&P + VAT

PEL 1 £44.50, £1.50 P&P + VAT

13A/4SW £22.40, £1.50 P&P + VAT

13A/5/R £25.30, £1.50 P&P + VAT

T13A/5 £21.75 £1.50 P&P + VAT

WEL 2 £52.80, £2.25 P&P + VAT

13A/6SW Sloping £26, £1.50 P&P + VAT

PEL 3 £65, £2.25 P&P + VAT

N13A/3 £16.77, £1.50 P&P + VAT

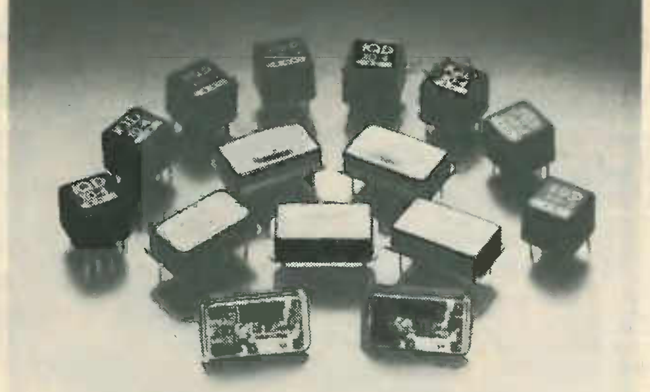
TR9 £38.75, £2.50 P&P + VAT

DELIVERY EX-STOCK

OLSON Electronics Ltd. FACTORY NO. 8, 5-7 LONG STREET LONDON E2 8HJ Tel: 01-739 2343

WW – 068 FOR FURTHER DETAILS

Quartz Oscillators



DIL compatible configurations
CMOS and TTL outputs
Wide temperature ranges
Frequencies one pulse per day to 60 MHz
Many standard frequencies from stock

More details of specifications from

Interface Quartz Devices Limited

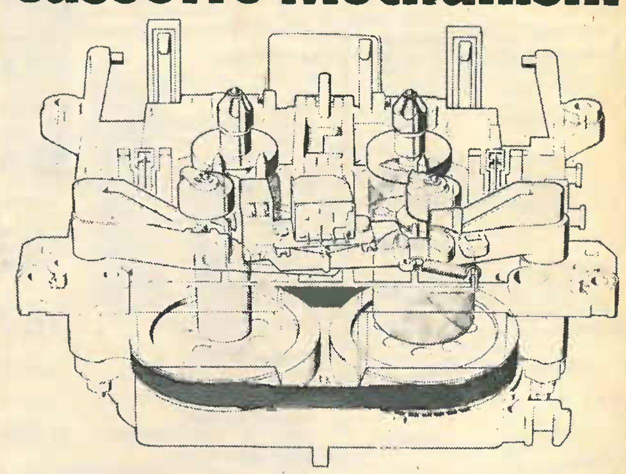
IQD

29 Market Street
Crewkerne
Somerset TA18 7JU

Crewkerne (0460) 74433
Telex 46283 inface g

WW – 090 FOR FURTHER DETAILS

Multi Direct Drive Cassette Mechanism



3 Motor Direct Drive • High Reliability • Wide Speed Range, 1.2-19cm/s • Designed for Full Remote Control
Dual Capstan: 0.16% Wideband Wow/Flutter 0.07% DIN Pk Wtd.Wow/Flutter
Motion Sensors and Tachogenerator: Intelligent Control of Unit
Applications: Studio Quality Recording Equipment • Compact Transportable Equipment • Industrial Recording and Monitoring

PAPST

PAPST MOTORS LIMITED, PARNELL COURT, EAST PORTWAY INDUSTRIAL ESTATE, ANDOVER, HAMPSHIRE. TEL. ANDOVER (0264) 53655 TELEX: 477512

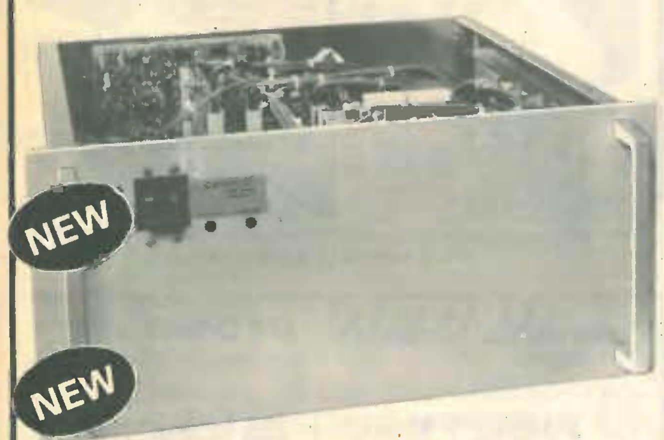
WW – 088 FOR FURTHER DETAILS

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 obsolescent 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

We supply FLUKE for industry

STOP PRESS
New Fluke 4½ Digit Hand-held D.M.M.s Now in Stock.
8060A £275
8062A £210
Phone for details!

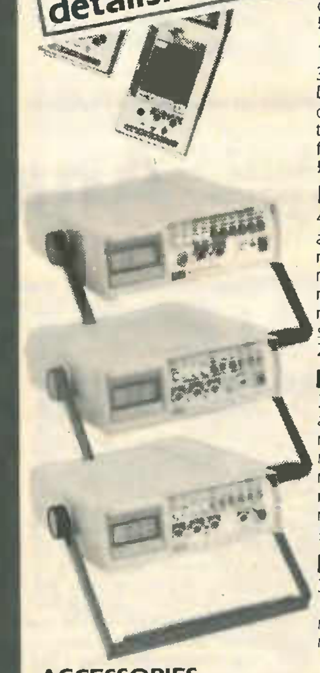
* NOW WITH A 2 YEAR WARRANTY

*** Fluke 8022B**
3½ Digit hand held LCD, DMM, AC/DC volts, DC/AC current, resistance, diode test. 0.25% basic DC accuracy. Overload protection. Vinyl carrying case C90 £8.00 .... **£85.00**

*** Fluke 8021B.**
Same spec as 8022B with additional audio tone for continuity. Vinyl case C90 £8.00 .... **£95.00**

***Fluke 8020B**
3½ digit 0.1% basic DC accuracy. DC/AC volts, DC/AC current, resistance, diode test and conductance. Continuity beeper. Vinyl case C90 £8.00 .... **£125.00**

***Fluke 8024B**
3½ digit. 0.1% basic DC accuracy. DC/AC volts, DC/AC current, resistance. Diode test, conductance, logic + continuity detect + temperature. Peak hold on voltage and current functions, continuity beeper. Vinyl case C90 £8.00 .... **£155.00**



FLUKE 8050A
4½ Digit LCD DMM with true RMS on AC volts and current DC volts 200mV-1KV, 10μV resolution AC volts, 200mV-750V, 10μV resolution. DC/AC current 200μA-2A, 0.01μA resolution resistance 200Ω-20MΩ, 0.01Ω resolution. Also reads dB direct referenced to 16 stored impedances. Conductance ranges 2mS and 200nS. **£255** mains model **£285** mains battery.

FLUKE 8012A
3½ Digit LCD DMM with true RMS on AC volts and current. DC volts 200mV-1KV, 100μV resolution. AC volts 200mV-750V, 100μV resolution. DC/AC current 200μA-2A, 0.1μA resolution. Resistance 200Ω-20MΩ, 0.1Ω resolution Low resistance 2Ω and 20Ω, 1mΩ resolution Conductance ranges 2mS-20μS-200nS **£229.00** mains model **£259.00** mains battery.

FLUKE 8010A
3½ Digit LCD DMM Same spec as 8012A plus a 10Amp AC/DC current range, but not low resistance range. **£175.00** mains model **£203.00** mains battery.

ACCESSORIES

A81-230 Battery eliminator	£14.00
C90 Carry case for hand held	£10.00
801-600 Amp clamp	£68.00
80J-10 Current shunt 10A	£22.00
80K-40 H.V. probe 40kV	£56.00
80K-6 H.V. probe 6kV	£40.00
80T-150 Temperature probe	£72.00
80T-H Touch hold probe	£36.00
83RF R.F. probe 100MHz	£40.00
85RF R.F. probe 500MHz	£69.00
Y8102 Thermocouple probe	£41.00
Y8103 Bead thermocouple	£18.00
Y8104 K type thermocouple termination	£8.00
Y8133 Deluxe test leads	£13.00

Full Specs. on Request.
The above prices do not include carriage or VAT (15%).

EXPRESS DELIVERY SERVICE

Simply Phone or Telex your order for immediate dispatch.

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

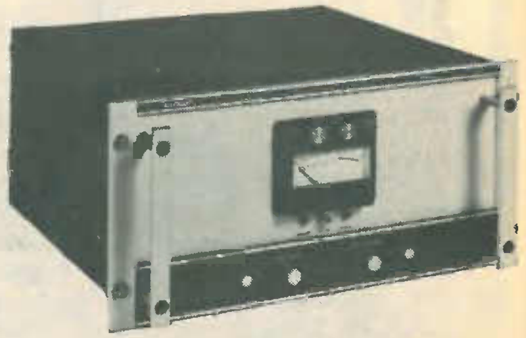
WW – 201 FOR FURTHER DETAILS

Electronic Brokers

www.americanradiohistory.com

amcron INDUSTRIAL MUSCLE

★ POWER RESPONSE DC – 45KHz ± 1dB.
★ OUTPUT POWER IN EXCESS OF 1.5KW INTO 2.75 Ohm LOAD (CONTINUOUS R.M.S.)
★ D.C. OUTPUT 20 AMPS AT 100 VOLTS OR 2KVA.
★ HARMONIC DISTORTION LESS THAN 0.05% DC-20KHz AT 1kW INTO 6 OHMS.
★ PLUG-IN MODULES: CONSTANT VOLTAGE/CURRENT, PRECISION OSCILLATORS.
★ UNIPOLAR AND BIPOLAR DIGITAL INTERFACES, FUNCTION GENERATORS, AND MANY OTHERS.
★ OUTPUT MATCHING TRANSFORMERS AVAILABLE TO MATCH VIRTUALLY ANY LOAD.
★ FULL OPEN AND SHORT CIRCUIT PROTECTION GUARANTEED STABLE INTO ANY LOAD.
★ TWO UNITS MAY BE CONNECTED TO PROVIDE UP TO 4kW.
★ INTERLOCK CAPABILITY FOR UP TO EIGHT UNITS.
★ 3-YEAR PARTS AND LABOUR WARRANTY.
★ UNITS AVAILABLE FROM 100VA-12KVA.



Model — M600

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

P.O. BOX 3
ATTLEBOROUGH
NORFOLK NR17 2PF
Tel: 0953-452477

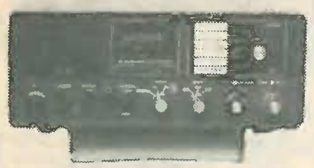
Analogue Associates

PROFESSIONAL INDUSTRIAL ELECTRONICS

WW – 065 FOR FURTHER DETAILS

COMMUNICATIONS EQUIPMENT

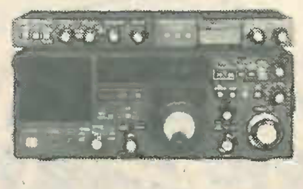
PIONEER HF TX/RX



"Pioneer": HF SSB mobile or base station transceivers operating between 1.6 and 18 Mhz with 100 watts RF output. Features, 6 simplex or 3 semi-duplex channel operation with squelch facility available on all modes. Requires only a 12 VDC source and a 50 ohm aerial to complete the installation. For mobile installations, we recommend our HW4 single channel whip and for base stations our range of trap dipoles. Complete station prices from £600 plus VAT.

GENERAL COVERAGE RECEIVER

FRG7700: 150 KHz to 29.999 MHz general coverage receiver featuring all-mode reception (AM, USB, LSB and FM) with an optional 12-channel memory unit for instant frequency recall. When used in conjunction with the optional memory unit this receiver lends itself admirably to channel monitoring, for example, on 2182, 4125 and up to 10 other frequencies. To complete the installation VHF convertor units are available covering amateur, marine and PMR frequencies. Prices from £329 including VAT.



SMC

SOUTH MIDLANDS COMMUNICATIONS LIMITED
SM HOUSE, OSBORNE ROAD
TOTTON SO4 4DN, SOUTHAMPTON
ENGLAND
TELEX: 477351 SMCOMMG
TEL: 0703 867333

WW–019 FOR FURTHER DETAILS

CLEF ELECTRONIC MUSIC

PIANOS

SPECIALISTS SINCE 1972
DOMESTIC OR STAGE
SIX OR 7¼ OCTAVES
KITS OR MANUFACTURED

The most advanced form of touch-sensitive action simulating piano key inertia by patented technique.

Four mixable voices for serious tone variation plus electronic chorus and flanger effects.

Component Kits include Keyboard.

Full Kits further contain: Cabinets, Harness, Power Amp and Speaker.

DOMESTIC PRICES

£	SIX	7¼
Comp	217	244
Full	363.90	399.90
MFD	595	675

Kit £289
Mfd £399

VOCAL & INSTRUMENTAL SOLOISTS!

BAND-BOX
An Electronic Backing TRIO. Drums, Bass & Chord Instrument. User Programmable for 50-100 scores, using microprocessor.

MASTER RHYTHM
User Programmable DRUM MACHINE. Twenty-four patterns. Eight parallel tracks. Twelve instruments sequence operation.

£79 KIT £119 BUILT

Write or Phone for full details of our range of high quality Kit and manufactured Electronic Musical Instruments. Prices include V.A.T., Carr., & Ins. and we operate Telephone BARCLAYCARD/ACCESS
Competitive EXPORT Quotations given.

CLEF PRODUCTS (ELECTRONICS) LIMITED
Dept. W, 44a Bramhall Lane South
Bramhall, Stockport, Cheshire SK7 1AH
061-439 3297

WW – 038 FOR FURTHER DETAILS

SWITCHCRAFT XLR CONNECTORS

Line Female A3F £1.59
Line Male A3M £1.36
Chassis Female D3F £2.04
Chassis Male D3M £1.19

4, 5, 6 and 7-pin versions and large selection audio adaptors available

NEUTRIK XLR CONNECTORS

Latchless Chassis NC3-FZ £0.67
Line Female NC3-FCC £1.34
Female Chassis NC3-FP £1.65
Latchless Chassis Male NC3-MZ £0.59
Line Male NC3-MC £1.15
Chassis Male NC3-MP £0.87

4,5-pin, PCB and black versions and large selection of audio adaptors available

XLR LNE MAIN SERIES

XLR LNE 11C £3.87
XLR LNE 32 .... £2.89
XLR LNE 12C £3.76
XLR LNE 31 .... £4.14

BELCLERE AUDIO TRANSFORMERS

EN6422 Ratio + 1.2 + 2. Freq. 40Hz-35KHz. PRI 150/600Ω, sec. 600/2.4KΩ £3.64
EN6423 Ratio 1 + 1:6.45 + 6.45. Freq. 40HZ-25KHz. PRI 150/600Ω. sec. 6.25K/25KΩ £3.64
SKT-723 MuMetal Screening can, 39dB reduction 50Hz ext. field £1.15

Trade enquiries welcome; quantity discounts available. All prices subject to V.A.T. Call, write or phone. Min. order £10. Please add £1 postage. Access, Amex, Barclaycard.

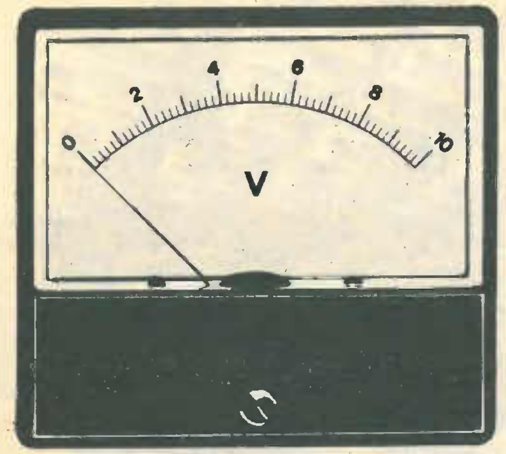
Buy it with Access

KELSEY ACOUSTICS LTD.
28 POWIS TERRACE, LONDON W11 1JH
01-727 1046/0780

BARCLAYCARD

WW – 042 FOR FURTHER DETAILS

METER PROBLEMS?



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

Full information from:
HARRIS ELECTRONICS (London)
138 GRAYS INN ROAD, W.C.1 Phone: 01/837/7937
Telex: 892301 HARTRO G.

WW – 079 FOR FURTHER DETAILS

Croydon Micros

★★★ IN STOCK ★★★

£477

ELECTRONIC MAGNIFICENCE
Personal Computer

Over £50 worth of FREE progs. including BASIC tutorial, 10 games, home finance, and GEMINI tape database.

01-689 4349

★★ Now in our new premises ★★
20-28 Whitehorse Rd., Croydon CR9 2NA

ALSO – PC1500 Pocket Computer – £145

Prices include VAT **FRONTREALM LTD. (T/A)**

WW – 061 FOR FURTHER DETAILS

We supply HAMEG for Industry

HM 307 OSCILLOSCOPE

Single trace. DC to 10MHz. Risetime 35nS. 5mV/cm to 20V/cm. Timebase 0.5μS-0.2S. Built in component tester. LPS technique provides stable and reliable triggering up to 30MHz **£138.00**

HM 203 PORTABLE OSCILLOSCOPE

Dual Trace. DC to 20MHz. 8 × 10cm display. Risetime 17.5nS. Sensitivity 5mV/cm-20V/cm. Timebase 0.5μS-0.2S. × 5 magnifier. X-Y operation. Auto or variable trigger. Channel 1. Channel 2, line and external. Coupling AC, or TV low pass filter. Weighs only 6Kg. Size (m.m.) H. 145. W. 285. D. 380 **£220.00**

HM412-5

Dual Trace. DC to 20MHz 8 × 10cm display with internal graticule. Rise time 17.5nS. Variable input 2mV-20V/cm. Add and invert modes. Timebase 0.5μS-0.2S with sweep delay 100nS-1S × 5 expansion. X-Y operation Z modulation. Trigger CH1, CH2, CH1/2, Line or EXT **£350.00**

HM705

Dual Trace DC-70MHz 8 × 10cm display with internal graticule. Risetime 5nS. Variable input 2mV-20V. Add and invert modes. 95nS Signal Delay Line. Timebase 50nS-1S/cm with Sweep delay 100nS-1S × 10 expansion. XY operation. Z modulation, Trigger CH1, CH2, CH1/2 line or EXT **£580.00**

The above prices do not include carriage or VAT (15%).

EXPRESS DELIVERY SERVICE

Simple Phone or Telex your order for immediate dispatch.

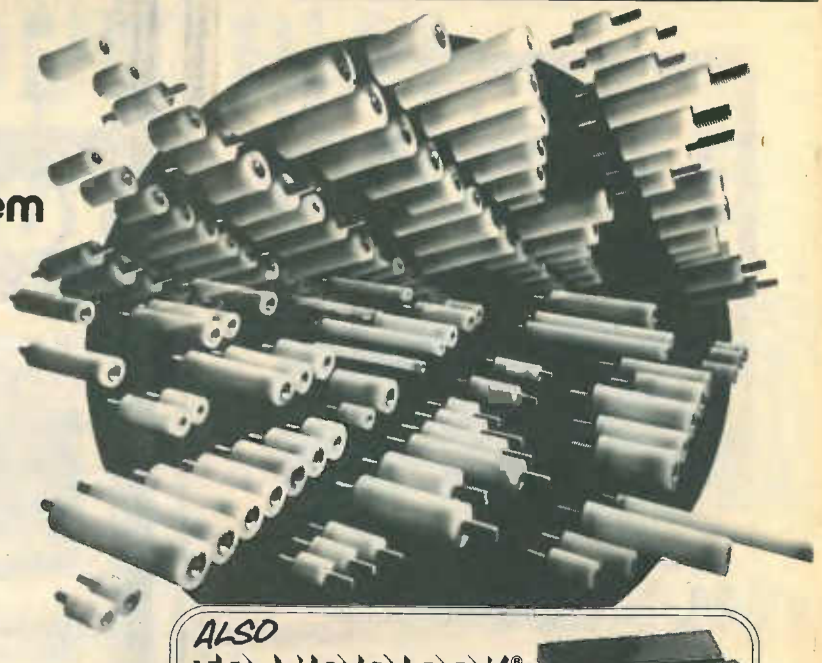
Electronic Brokers Ltd
61/65 Kings Cross Road
London WC1X 9LN
Telephone: 01-278 3461
Telex: 298694 Elebro G

WW – 202 FOR FURTHER DETAILS

Electronic Brokers

www.americanradiohistory.com

moulded nylon TRANSIPILLARS®



probably the most versatile and rugged insulating mounting system ever developed

Transipillar insulating mounts hold heavy sub-assemblies totally secure. Because they're precision moulded from very tough Nylon.

Metric or Imperial versions are available, with insulator lengths from ½ in to 2¾ in, and a choice of metal screw or threaded insert end fittings from 0 to 6BA.

If one of the preferred sizes won't suit your application, the chances are we can make one that will.

Write today for samples, full technical details and prices of TRANSIPILLARS.

ALSO **TRANSIBLOCK®**

the patented insulating mount for ³⁄₁₆ in thick heatsinks. Eliminates the need for power transistor mica washers.

WK ELECTRONICS LTD
Napier Road Bromley Kent BR2 9JA
Telephone: 01-464 4346 Telex: 896691 Extn WKE.

WW – 052 FOR FURTHER DETAILS

MINI-DISK DRIVE TEST BOX

A simple aid to test and alignment of drives without tying up valuable system time.
Neatly presented in handy case with leads and connectors for 2 drives. Needs +12V and +5V through standard drive connectors (provided).
Circle number for further details.

Price £135 + carriage and VAT

MELKUIST LTD.

35A Guildford Street, Luton LU1 2NQ
Tel: 0582/416028
Telex: 825828 MELKST G

WW – 048 FOR FURTHER DETAILS

PRINTED CIRCUITS
FOR WIRELESS WORLD PROJECTS

Audio compressor/limiter—Dec. 1975—1 s.s. (stereo)	£4.25
Cassette recorder—May 1976—1 s.s.	£5.00
Audio compander—July 1976—1 s.s.	£4.25
Audio preamplifier—November 1976—2 s.s.	£8.50
Additional circuits—October 1977—1 s.s.	£4.00
Stereo coder—April 1977—1 d.s. 2 s.s.	£8.50
Low distortion disc amplifier (stereo)—September 1977—1 s.s.	£2.00
Low distortion audio oscillator—September 1977—1 s.s.	£3.50
Synthesized f.m. transceiver—November 1977—2 d.s. 1 s.s.	£12.00
Morsemaker—June 1978—1 d.s.	£4.50
Metal detector—July 1978—1 d.s.	£3.75
Oscilloscope waveform store—October 1978—4 d.s.	£18.00
Regulator for car alternator—August 1978—1 s.s.	£2.00
Wideband noise reducer—November 1978—1 d.s.	£5.00
Versatile noise generator—January 1979—1 s.s.	£5.00
200MHz frequency meter—January 1979—1 d.s.	£7.00
High performance preamplifier—February 1979—1 s.s.	£5.50
Distortion meter and oscillator—July 1979—2 s.s.	£5.50
Moving coil preamplifier—August 1979—1 s.s.	£3.50
Multi-mode transceiver—October 1979—10 d.s.	£35.00
Amplification system—Oct. 1979—3 preamp 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 6802 or 6809 – 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. – 1 d.s.	£6.00
Electronic ignition – March, 1982 – 1 s.s.	£4.00

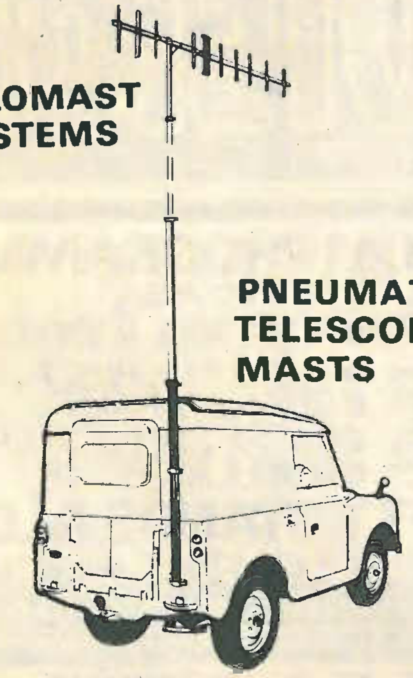
Boards and glassfibre roller-tinned and drilled. Prices include VAT and UK postage. Airmail add 30%, Europe add 10%. Insurance 10%. Remittance with order to:

M. R. SAGIN, NANCARRAS MILL, THE LEVEL CONSTANTINE, FALMOUTH, CORNWALL

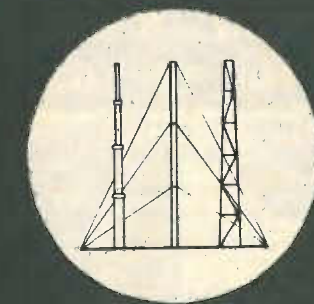
WW – 082 FOR FURTHER DETAILS

Hilomast Ltd

HILOMAST SYSTEMS



PNEUMATIC TELESCOPIC MASTS



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

WW – 054 FOR FURTHER DETAILS

Electronic Brokers
DEC SALE
a selection from our huge stocks

PROCESSORS

PDP8A 10½" 32KW MOS [NEW]	£1,750
PDP11/34A, 128KB MOS	£5,000
PDP11X44-CB 256KB CPU, Dual TU58, H9642 Cabinet	£12,750
PDP11/45 CPU, 96KW Core, Cab	£7,450
PDP11/70 CPU, 512KB MOS, Dual Cab	P.O.A.

PERIPHERALS & OPTIONS

BC06-S-10 Massbus Cable	£250
BC06-S-15 Massbus Cable	£325
BC11A-08 Unibus Cable	£70
DU11 Synchronous Interface	£525
KMC11A Auxiliary Processor [NEW]	£925
KW11L Real Time Clock	£195
KW11P Programmable Clock	£345
LA34DA KSR Terminal E1A	£425
LA36CJ KSR Terminal 20mA	£450
LA36HJ KSR Terminal E1A	£495
LA120DA KSR Terminal [NEW]	£1,225
LA120RA RO Terminal [NEW]	£895
LA180-ED RO Printer E1A [NEW]	£670
LA180-PD RO Printer-Parallel [NEW]	£495
LP04 900 1pm Drum Printer [NEW]	£5,500
MM8AB 16KW Core [NEW]	£995
PC11A Reader/Punch and control	£925
RK06 Add-on Disk Drive [NEW]	£2,200
RM80-AD Add-on Disk Drive [NEW]	£10,500
RX11-BD Dual Floppy Disk Drive and ctl [NEW]	£995
VT50 DECscope Terminal 20mA	£250
VT50 DECscope Terminal E1A	£275
VT52 DECscope Terminal (E1A or 20mA)	£395
VT52 DECscope Terminal [NEW]	£525
VT55 Graphics Terminal	£650

SYSTEMS

SMFX-MMA-DN 11/24 CPU 256KB, H9645 CAB, 2 x RL02 Disk, KT24, VT100 Console, RSX11M [NEW]	£17,000
11/34 CPU 128KB MOS, RL11A 5MB Disk & Ctl, RL01A 5MB Disk, H960 Cab, LA36 Console, RSX11M Licence	£8,750
11/44 CPU 256KB MOS, Dual TU58, H9642 Cab, RK711 28MB Disk & Ctl, RK07 28MB Disk, LA120 Console, RSX11M Licence	£26,300
11/44 UPGRADES complete service offered including supply and installation of 11/44 CPU and trade-in of redundant processor	P.O.A.
11/70 CPU, 512KB MOS, RWM05 Disk Drive and Ctl, TWU77 mag tape and ctl, LA120 Console [NEW]	£78,000

HAZELTINE VDUs NEW SCOOP PURCHASE

Special purchase of Hazeltine 1500 series VDUs — manufacturer's surplus — ALL BRAND NEW BOXED

HAZELTINE 1510 - SAVE £330

- ★ 24 x 80 Upper/Lower case ASCII
- ★ 7 x 10 dot matrix ★ Dual intensity
- ★ 8 Switch-Selectable baud rates 110/9600 baud
- ★ Full/Half duplex plus format mode
- ★ Remote XY Cursor addressing
- ★ 12" non-glare screen ★ EIA/20mA Interface

Manufacturer's list price £880
OUR PRICE £550

HAZELTINE 1520 — SAVE £425

All the features of the 1510 plus buffered serial/parallel printer interface. Manufacturer's list price £1050
OUR PRICE £625

Also available — Reconditioned Hazeltine H2000 VDUs @ **£299** while stocks last

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

Electronic Brokers

WW – 203 FOR FURTHER DETAILS

www.americanradiohistory.com

DISCS ARE HERE!

The long-awaited Philips LaserVision video disc system is now being launched in the UK. To mark this historic event, we start a detailed account of the discs, how the signals are recorded and processed and how the player operates.

READY FOR CHANNEL 4?
The Channel 4 service starts this autumn. We describe the steps in the introduction of the service and comment on aerial requirements.

PLUS!
- Testing procedures on GEC Hybrid colour sets.
- VCR modifications.
- Service Notebook.

JUNE ISSUE
ON SALE NOW
Well worth a closer look!!

TELEVISION

BROADCAST MONITOR RECEIVER 150kHz-30MHz

APRS STAND 35 JUNE 23-25th

We have taken the synthesised all mode FRG7700M communications receiver and made several well-thought-out modifications to provide a receiver for re-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 −2dBm (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 envelope 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 and time display, timer for unattended recordings or external switching, advanced noise blanker, all modes including NBFM with squelch. From £418+VAT.
Stereo Disc Amplifier 2 and 3 ★ Peak Deviation Meter ★ Programme and Deviation Chart Recorders ★ Stabilizer ★ Frequency Shift Circuit Boards ★ 10 Outlet Distribution Amplifier ★ Peak Programme Meter Illuminated Boxes, Circuit Boards and Ernest Turner Movements.

SURREY ELECTRONICS
The Forge, Lucks Green, Cranleigh, Surrey GU6 7BG. Tel: 04866 5997

EPROM PROGRAMMER

2716 ● HEX KEY PAD ● POWERFUL EDITOR
2732 ● TV (MONITOR) DISPLAY ● SERIAL/PARALLEL I/O
2532 ● CASSETTE BACK-UP ● ROMULATOR

SOFTY STANDS ALONE
£169+VAT, EX-STOCK, BY RETURN

DATAMAN DESIGNS, LOMBARD HOUSE, DORCHESTER, DORSET, DT1 1RX. (0305) 68066

WW – 039 FOR FURTHER DETAILS

Hitachi Oscilloscopes

performance, reliability, exceptional value and immediate delivery!

Hitachi Oscilloscopes provide the quality and performance that you'd expect from such a famous name, in a range that represents the best value for money available anywhere.

		newly released	
V-152	15MHz Dual Trace	V-650	60MHz Dual Trace, Dual Timebase
V-202	20MHz Dual Trace (illustrated)	V-1050	100MHz Quad Trace, Dual Timebase
V-302	30MHz Dual Trace	V-209	20MHz Dual Trace, Battery Portable
V-352	35MHz Dual Trace	V-509	50MHz Dual Timebase, Portable

Prices start from around £230 and we hold the range in stock for immediate delivery.
For colour brochures giving detailed specifications and prices, ring 0480 63570.

Reltech Instruments 46 High St., Solihull, W. Midlands. B91 3TB

WW – 058 FOR FURTHER DETAILS

The MICRO PROFESSOR solves the 'mystery' of micro-processors.

Micro-Professor is a low-cost Z80A based microcomputer which provides you with an interesting and inexpensive way to understand the world of microprocessors.
Micro-Professor is a microprocessor learning tool for students, hobbyists and engineers. It is also an ideal educational tool for teaching in schools and universities.
The main object of **Micro-Professor** is for the user to understand the software and hardware of a microcomputer easily and conveniently. Besides the complete hardware/software system you have the users experimental manual. It includes self-learning text with 20 experiments which range from simple, software programming to designing a complex electronic game. Completed programes can be stored and re-read via the cassette interface. 2K bytes of monitor source program with documentation is also provided in the manual.
Micro-Professor provides a wide range of other applications: Low cost prototyping tool ● Low cost development tool ● Process controller ● Electronic music box ● Timer ● Noise generator ● Home appliance control ● Burglar alarm ● System control simulation Tester ... and much more!

New Add on products Speech synthesiser EPROM programmer board

TECHNICAL SPECIFICATION

CPU Z80A CPU high performance microprocessor with 158 instructions.
SOFTWARE COMPATIBILITY Capable of executing Z80/8080/8085 machine language program.
RAM 2K bytes expandable to 4K bytes.
ROM 2K bytes of sophisticated monitor expandable to 8K bytes.
INPUT/OUTPUT 24 system I/O lines.
DISPLAY 6 digit 0.5" red LED display.
AUDIO CASSETTE INTERFACE 165 bit per second average rate for data transfer between memory and cassette tape.
EXTENSION CONNECTORS Provides all buses of CPU, channel signals of CTC and I/O port bus of PIO for user's expansion.
COUNTER TIMER CIRCUITS Socket is provided. Z80-CTC IC extra.
PARALLEL I/O CIRCUITS Socket is provided. Z80-P10 IC extra.
SPEAKER AND SPEAKER DRIVER CIRCUITS A 2.25" – diameter speaker is provided for user's applications.
USER'S AND EXPERIMENT MANUAL Complete self-learning text with experiments and applications.
OPTIONS (Prices on application) Z80-CTC. EPROM programmer board. Prototyping Board. Z80-PIO. Speech synthesiser board. Audio Cassette. 2K Ram.
KEYBOARD 36 keys including 19 function keys, 16 hex-digit keys and 1 user defined key.

A 9V, 0.5A adaptor and 350 page manual is provided.
Formal orders requiring
Acc & 30 days credit.
Please ask for price list.

New "BASIC" EPROM & Keyboard Overlay £9.95

Use the unique Micro-Computer to truly understand the inside workings of microprocessors, or simply use as a Z80A evaluation system.

FLIGHT

£69.95* + p&p

Flight Electronics Ltd. * Mail Order only

MICRO-PROFESSOR is a trade mark of Multitech Industrial Corporation. Z80 is a trade mark of Zilog Inc.

To receive your MICRO-PROFESSOR Complete the coupon today!
Please send me .... MICRO-PROFESSOR(S) (+ £2.95 p & p)
I enclose cheque/P.O. for £........
Name........
Address........
Please allow 28 days for delivery
Flight Electronics Ltd. Flight House
Quayside Road, Southampton
Hants SO2 4AD.
Tel: (0703) 34003/27721
Telex: 477793

WW6/82

WW – 021 FOR FURTHER DETAILS

www.americanradiohistory.com

Carstonbuy Carstonsell Carstonbuy Carstonsell Carstonbuy Carstonsell Carstonbuy Carstonsell Carstonbuy

Carstonsell

Used test equipment, calibrated to Manufacturer's original specification.

Prices from £

ACOUSTIC & VIBRATION

BRUEL & KJAER
1621 Tunable Band Pass Filter 550
2113 Audio Frequency Spectrometer 1400
2203 Sound Level Meter 450
2215 Sound Level Meter inc. Oct. Filter 1050
2218 Sound Level Meter inc. Leq. 1475
2305B Level Recorder inc. 50 dB pot. 1350
2625 Vibration pick-up amplifier 350
2808 Power Supply/Mains Adapter 90
2972 Tape Signal Gate 200
4230 Sound Level Calibrator 120
4423 Noise Dosemeter 350
4424 Noise Dosemeter 375

CASTLE ACOUSTICS
CS181 Sound Level Meter & Calibrator 295

C.E.L.
112 Environmental Noise Analyser 300
144 Environmental Noise Analyser 500

DAWE
419C Audio White Noise Generator 190
1461CV Vibration Analyser 350
1463B ½ Octave Filter 200
1465 Octave Band Filter 150

KISTLER
504A Charge Amplifier 200

WAYNE KERR
B731B Vibration Meter inc. probe 270

BRIDGES & V and I STANDARDS

CINTEL
2773 Inductance Bridge 160

HEWLETT PACKARD
4261A Digital Automatic LCR Bridge 975
4342 QLC Meter 22 KHz-70 MHz 2600

MARCONI
TF868A Universal LCR Bridge 250

MUIRHEAD
D30A DC Bridge 0.15% 180

PHILIPS
PM6302 RCL Bridge — direct reading 395

WAYNE KERR
B224 RCL Bridge 0.1% 500
B521 LCR Bridge 115
B801/CU681/Q801/SR268 VHF Admittance Bridge with source and detector transistor adapter & D.C. Control Unit for transistor measurements 750

COMMS & CABLE TEST EQUIPMENT

DYMAR
BC282 Battery charger for 883 Radio Telephone 80
883 Radio Telephone — VHF band — hand held 245

HEWLETT PACKARD
3556A Psophometer 20 Hz-20 KHz 250

MARCONI
TF2091 White Noise Generator (exc. filters) 1000
TF2092 White Noise Receiver (exc. filters) 1000
TF2809 Data Line Analyser 600

NORTHEAST ELECTRONICS
TT537B Psophometer/VU Meter 200

SEIMENS
U2033 Psophmeter 475

S.T.C.
74106 Bridge Unit 135

74184B Selective Level Measuring Set 600
74216A Noise Generator 300
74261A Psophometer 300
74262B White Noise Generator & Receiver 2000
74307C Level Measuring Set 175
74834C Distortion Measuring Set 500
96016 Selective Null Detector 200
GTA-2 Quantization Distortion Tester 800
GTA4B Pattern Generator 900

COMPUTER EQUIPMENT
(90 day guarantee)

CENTRONICS
702 matrix printer 500

HEWLETT PACKARD
9835A Desktop Computer 64K + expanded I/O ROM + HP — IB interface. Includes C.R.T. Cartridge Tape Drive — Full documentation test tapes etc. 5900

TEKTRONIX
4610-1 Hard copy printer for 4010 series computer display terminals 1500

COUNTERS & TIMERS

FLUKE
1912 520 MHz 7 digit Counter 375

9520 10 MHz 4 Digit 96
9905 200 MHz 8 digit Counter Timer 380

SYSTRON DONNER
6053 3 GHz 9 digit Counter BCD O/P 790
5103B Strip Printer for 6053/6054 375

TEKTRONIX
DC501 7 Digit 100 MHz Counter — TM500 Plug-in 180

VENNER
1000F 32 MHz 7 digit counter/timer 190

DIGITAL TESTING EQUIPMENT

HEWLETT PACKARD
1600A Logic Analyser 16 ch 20 MHz 1150
1600S Logic Analyser 32 ch 20 MHz 2250
1602A Logic Analyser 16 ch 10 MHz 900

TEKTRONIX
832 Datacomm Tester RS232/V24 1150
833 As 832 plus BERT/BLERT feature 1300

MAINS TEST EQUIPMENT

DATALAB
DL019 Mains Interface for DL905 300

DRANETZ
606 3ch Volts Av/Spike/Time/Printer 2950

SPECIAL OFFER

MARCONI TF2432
560 MHz Frequency Counter
10 Hz-560 MHz, 0.1 Hz Resolution. 8 digit L.E.D. readout. 10 mV sensitivity, automatic a.g.c. on input. Display hold facility.
£275

PHILIPS PM6456
Stereo F.M. Generator
For testing and aligning FM tuners and receivers. Separate L & R signals. Internal and External modulation facilities. X-tal controlled pilot signal. Adjustable multiplex signal. Tunable 100 MHz R.F. signal.
£230

1912A01 As 1912A but inc. re-charging batteries 430
1920A 520 MHz 9 digit Counter inc. Brst. mode 575
1920A14 1250 MHz otherwise as 1920A 750

HEWLETT PACKARD
5300A/5305B 1300 MHz 6 Digit Counter 425
5345 500 MHz 11 Digit Counter Timer 2000

MARCONI
TF 2432 560 MHz 8 digit Counter 350

RACAL-DANA (E.I.P.)
371 18 GHz 11 digit Counter with Source Locking facility 4950
371 18 GHz 11 Digit Counter with high stab xtel option. Source Locking facility. HP-IB opt 5500
8110 50 MHz 8 Digit Counter Timer 320
9024 600 MHz 7½ digit Counter 220
9025 1 GHz 8 digit Counter 450

616 2ch AC 1ch DC Volts/Av/Spike/Time/Printer 3300

GAY
LDM AC/DC/Spike/Time inc. Printer 900

MISCELLANEOUS

A.I. INDUSTRIES
TCS General Purpose Gas Leak Detector — intrinsically safe 290

BRADLEY
192 Oscilloscope Calibrator 825

COMARK
1601BLS Thermom 10ch 87 + 1000°C type K 50
N.B. Thermocouples not included

CROWCON
71P Inflammable Gas Detector/Alarm 125

DATALAB
DL905 Digital Transient Recorder/Display Storage 1050

FLANN
16/11 Rotary Vane Attenuator WG16

HEWLETT PACKARD
342A Noise Figure Meter
X382A Rotary Vane Attenuator WG16

MULTIMETRICS
AF120 Dual H/Pass L/Pass active filter 20 Hz – 2 MHz

PHILIPS
PM 5501 Colour TV Pattern Generator
PM 6456 Stereo FM Generator

RADIOMETER
SMG1 Stereo FM Generator

ROHDE & SCHWARZ
BN252 Transistor Y Parameter Test Set

S.T.C.
74600J Attenuator 0-9 dB 50Ω in 1 dB steps
74616A Attenuator 0-100 dB 600Ω in 0.1 dB steps

TEKTRONIX
184 Time Mark Generator
521PAL Vectorscope
528 TV Waveform Monitor
575 Semiconductor Curve Tracer
1485C TV Waveform Monitor PAL/NTSC

TELONIC
6001 RF Detector with Log Amplifier — Analogue display & recorder O/P. 0.4-130 MHz — 80 dB range

YELLOW SPRINGS
YS157 Water Pollution Measurement System

NETWORK ANALYSERS/ PHASEMETERS

DRANETZ
301A Analogue Phasemeter 5 Hz-500 KHz

GENERAL RADIO
1710/11/12/14 0.4-500 MHz 115 dB range

HEWLETT PACKARD
8405A Vector Voltmeter 1–1000 MHz
8407A/8412A/8601A 100 KHz-110 MHz complete Network Analyser system comprising Analyser, Phase/Magnitude display and Swept Generator. 50Ω or 75Ω system available. 80 dB dynamic range
8414A Polar Display for 8410 N.W.A.
8745A S Parameter Test Set 0.1-2 GHz
11570A Accessory Kit for 8405A
11600A Transistor Test Fixtures TO18/TO-72
11602A Transistor Test Fixtures TO5/TO-12
11604A Universal extension arm for 8745A
11605A Flexible arm for 8743A

OSCILLOSCOPES & ACCESSORIES

CROTECH *These are brand-new instruments*
3030 15 MHz 1 Trace 5mV built-in component tester
3033 15 MHz 1 Trace 5mV battery operation
3034 15 MHz 2 Trace 5mV battery operation
3131 15 MHz 2 Trace 5mV built-in component tester
3337 30 MHz 2 Trace 5mV with signal delay

BIOMATION
350 Compact XYZ Display

GOULD ADVANCE
OS1000B 20 MHz 5mV 2 Trace

HEWLETT PACKARD
182C 100 MHz Mainframe
182T 100 MHz Mainframe with digital normaliser interface
1804A 50 MHz 20mV 4 Trace Plug-in
1825A Dual Timebase Plug-in
1805A 100 MHz 5mV 2 Trace Plug-in

PHILIPS
PM3207 15 MHz 5mV 2 Trace TV trig
PM3211 15 MHz 2mV 2 Trace TV trig
PM3212 25 MHz 2mV 2 Trace TV trig
PM3233 10 MHz 2mV 2Ch fixed delay Dual Beam
PM3244 50 MHz 5mV 4 Trace 2T base
PM3260 120 MHz 5mV 2 Trace 2T base
PM3262 100 MHz 5mV 2 Trace 2T base
Tr View

TEKTRONIX
465B 100 MHz 5mV 2 Trace 2TB, inc Probes 1685
475 200 MHz 2mV 2 Trace 2T base 1750
475A 250 MHz 2mV 2 Trace 2T base 2100
485 350 MHz 5mV 2 Trace 2T base 3600
5B42 2 T/base plug-in 50 MHz Trig for 5000 series Mainframe 325
661/4S3/5T1A 1 GHz Sampling scope 595
7A18 75 MHz 5mV 2 Trace Plug-in 420
7A22 1 MHz 10μV Differential Plug-in 595
7A26 200 MHz 5mV 2 Trace Plug-in 655
7B53A 2 Timebase Plug-in 100 MHz Trig 350
7403N 75 MHz 3 slot M/Frame 990
7603 100 MHz CRT r/out 3 slot M/Frame 1350

TELEQUIPMENT
D63/V1/V1 15 MHz 2 Trace 1mV 425
D63/V5/V5 15 MHz 5mV 2 Trace & fixed delay 440
S61 5 MHz 5mV 1 Trace 135

TEXSCAN
DU120 Large CRT XY Display with z modulation 280
Note: we hold a range of cameras P.O.A.

OSCILLOSCOPES (STORAGE)

HEWLETT PACKARD
181A 100 MHz Mainframe 5cm/μs 2500
1703A 35 MHz 10mV 2 Tr 2TB 1000 Div/ms 1400

TEKTRONIX
466 100 MHz 5mV 2 Tr 2TB 1350cm/μs 2950
7313 25 MHz 3 slot M/frame split screen 5cm/μs 1700
7613 100 MHz 3 slot M/frame 4.5cm/μs 2700

POWER MEASUREMENT

HEWLETT PACKARD
432A RF-Microwave Powermeter for use with 470 series sensors 430
478A Co-ax sensor for 432 meter 10 MHz-10 GHz 160
X486A Power sensor for 432 meter W.G. 16 160
432A/478A combined price 560
432A/X486A combined price 560
8482H Co-ax sensor for 435/436 100 KHz-4.2 GHz 220

MARCONI
6502 R.F. Powermeter DC-1 GHz 10W max 475
6503 R.F. Powermeter DC-1 GHz 100W max 800
6460/6421 Microwave Powermeter & sensor 0.01-12.4 GHz 500

POWER SUPPLIES etc

ADVANCE
MG5-20 Switching PSU module 5V-20A fixed 90

BRANDENBURG
800 EHT Power supply 3-30 KV-1mA 450

FARNELL
B30/5 0-30V-5A variable 110
B30/20 0-30V-20A variable 225
FFSL 5V – 20A PSU module 80
H60/25 0-60V-25A variable metered 420
B30/10 0-30V-10A variable 190
TOPS/2 Twin 5V @ 5A + 15-0-15V @ 1A 85
TSV70 0-35V-10A or 0-70V-5A variable metered 320

HEWLETT PACKARD
6268B 0-40 V variable 30 A Metered V + I 575

MARCONI
2154 0-30V variable 2A metered 75

PHILIPS
PE1646 0-75V variable 6A Metered V + I 495

PULSE GENERATORS

ADVANCE
PG 52A Modular pulse generator system — wide range of configurations — cost dependent on modules — typical 650
PG5002D 0.1 Hz-1 MHz 50V 100Ω Double pulse R.T. 15ns 290

HEWLETT PACKARD
8011A 0.1 Hz-20 MHz 16V 50Ω RT 10ns inc Burst mode 475
8016A Digital word generator to 50 MHz 9 x 32 bit 3400

LYONS
PG73N 20 MHz 10V 50Ω R.T. 5ns 390

RECORDERS & ACCESSORIES

BRYANS SOUTHERN
BS314 Chart 10" 4 Pen 16 speed 1900

DCM
8100W Wow & Flutter Analyser 800

EM
LVDT Linear Displacement & Transducer 50

FYLDE
154 Bridge supply and Amplifier 110

HEWLETT PACKARD
680M Chart 5" 1 pen 8 speed 750
7015A XY 1 pen A4 size 700

HONEYWELL
5600B Instrumentation tape recorder 14 ch FM/DR 9000

MICRO-MOVEMENTS
M10-120/A Compact UV 10 ch 7 speed recorder (inc. galvos) 1900

PHILIPS
PM8251 Chart 10" 1 pen 12 speed 375

SE LABS
994 6 ch galvo preamp + DC bridge supply 450
6008 UV chart 8" 25 ch 16 speed 950
6150/51 UV recorder 12 ch-inc 6 ch amps 1275

SEIMENS
M936 Chart 5" 1 pen 0-20 mA F.S.D. but can readily be adapted by internal links to a wide range of volt and current measurements 150

SOLARTRON
3240 Modular Data Logger system P.O.A.
Note: UV recorders are priced less galvos

SIGNAL ANALYSIS EQUIPMENT

AIRMEC
210 AM/FM Mod Meter 2.25 MHz-300 MHz 235
248A Wave Analyser 5-300 MHz 200
853 Wave Analyser 30 KHz-30 MHz 200

MARCONI
TF791D FM Mod meter 170
TF2330 Wave Analyser 20 Hz-50 KHz 475
TF2330A Wave Analyser 20 Hz-76 KHz 900

RADFORD
DM52 Distortion meter 20 Hz-20 KHz 200

SOUND TECHNOLOGY
1700A Distortion Meter 10 Hz-100 KHz inc. oscillator 800

WAYNE KERR
A321 Wave Analyser 20 Hz-20 KHz 180
Note: see also "Spectrum Analysers"

SIGNAL/FUNCTION/ + SWEEP GENERATORS

FARNELL
SSG520 10 MHz-520 MHz Generator — Auto Phaselock. AM/FM and SINAD feature. Reverse power protection 2000

GENERAL RADIO
1362 Generator 220-920 MHz 375

GOULD
J3B Generator 10 Hz-10 MHz O/P level meter & Attn. 350
J4 Generator as J3 but no output level meter 220
SG21 Generator — Square Wave only 0.3-100 MHz 80

HEWLETT PACKARD
204C Oscillator 5 Hz-1.2 MHz 230
204D Oscillator 5 Hz-1.2 MHz inc. 80dB attenuator 280
608E Generator 10-480 MHz AM/Pulse 400
8614A Generator 800-2400 MHz AM/FM/Pulse 2800
8660C/86632A/86603A Synthesised Signal Generator 1-2600 MHz AM/FM digital readout, push button controls, BCD programmable 14000
618B Generator 3.8-7.5 GHz 975
612 Generator 450-1230 MHz 750
614 Generator 0.8-2.1 GHz 825

IEC
F51A Function 1 mHz-10 MHz Sin/Sq/Tri/Pulse/Ramp 375

LEVELL
TG150DM Generator 1.5 Hz-150 KHz battery operated 60

MARCONI
TF144H/4S Generator 10 KHz-72 MHz AM 550
TF955/2 Generator 0.2-220 MHz AM/FM 670
TF1066B/1 Generator 10-470 MHz AM/FM 690
TF2000 Generator 20 Hz-20 KHz-111 dB attenuator 750
TF2002/3MI Generator 10 KHz-72 MHz AM only 550
TF2011/S Generator 96-140 MHz FM only 550
TF2012 Generator 400-520 MHz FM 550
TF2015 Generator 10-520 MHz AM/FM 1150
TF2015/1 Generator as 2015 with narrow FM deviation 1350
TF2015/2171 Generator system with phase lock synchroniser 1900
TF2015-1/2171 Generator system with phase lock synchroniser 1950
TF2020 Synthesised AM/FM Generator 50 KHz-520 MHz. Built-in modulation oscillator. State of the art performance. Can use on GP-IB with optional adapter 6900
TF2171 Synchroniser for 2015 1050

PHILIPS
PM5108L Function 0.1 Hz-1 MHz Sin/Sq/Tri O/P meter — 50 and 600Ω 425
PM5127 Function 0.1 Hz-1 MHz Sin/Sq/Tri/Rmp 450
PM5129 Function 1 mHz-1 MHz Sin/Sq/Tri/Ramp/Pulse + Sweep + Burst 645

RADIOMETER
MS27G Generator 0.3-240 MHz AM/FM 585

TEXSCAN
9900 Sweeper 10-300 MHz 6/in CRT disp 525
VS60 Sweeper 5-1000 MHz 890

WAVETEK
143 Function 0.0001 Hz-20 MHz Sin/Sq/Tri/Pulse 695

SPECTRUM ANALYSERS

HEWLETT PACKARD
141T/8552B/8555A 10 MHz-18 GHz system 10250

MARCONI
TF2370 30 Hz-110 MHz Digi-store display built-in counter and tracking gen 7500

TEKTRONIX
7L5/L3 20 Hz-5 MHz Plug-in for 7000 series M/Frame 10 Hz resolution. Sensitivity —148 dBV. Impedance 50Ω, 600Ω and 1MΩ. C.R.T. readout. Digi-store display 6750
7L13 1 KHz-1800 MHz Plug-in for 7000 series M/Frame 7700
7L18 1.5-18 GHz Plug-in for 7000 series. High resolution. Digital storage display. Built-in pre-selector 8500
7603/7L5/L3 System with display 20 Hz-5 MHz 7750
7603/7L13 System with display 0.1-1800 MHz 8900
7613/7L13 System with storage/var. persist. display 9900
7603/7L18 System with display 1.5-18 GHz (60 GHz with external mixers) 9500

VOLT/MULTI-METER (ANALOGUE)

BOONTON
92C AC/RF 10 KHz-1.2 GHZ ½mV-3V 250

HEWLETT PACKARD
400E 10 Hz-10 MHz 1mV-300V DC O/P 285
400H 10 Hz-4 MHz 1mV-300V 75
411A 0.5-500 MHz 10mV-10V DC O/P 175
427 AC/DC/V/Ω 195
3400 TRMS 10 Hz-10 MHz 1mV-300V DC-O/P 390

LEVELL
TM11 Analogue Multimeter AC/DC/V/1/Ω 115

M.L. ENGINEERING
NAMV — DC sensitive μ Volt/nAmp meter centre zero 45

MARCONI
TF2600 10 Hz-10 MHz 1mV-300V AC + DC O/P 230
TF2604 20 Hz-1.5 GHz 300mV-300V 425

PHILIPS
PM2404 Analogue Multimeter AC/DC/V/I/Ω 100

RACAL-DANA (E.I.P.)
9301 RMS 10 KHz-1.5 GHz 100μV-300V 550

VIBRON/E.I.L.
33B-2 1mV-1V Electrometer 200

VOLT/MULTI-METER (DIGITAL)

BOONTON
92AD 1999FSD 10 KHz-1.2 GHz 10μV res 525

FARNELL
DM131D 1999 F.S.D. AC/DC/V/I/Ω & Temperature. Mains/battery — Temp probe included 135

FLUKE
8010A 2000 FSD TRMS AC/DC/VIΩ 140
8010A01 As 8010A + re-charging batteries 159
8050A 20000 FSD AC/DC/VIΩ dB TRMS 215
8050A-01 As 8050A + re-chg batteries 245
8200A 16000 F.S.D. DC only fast reading system Voltmeter 850
8300A 120000 F.S.D. DC only fast reading system Voltmeter 1100
8800A 200000 FSD AC/DC/VΩ 430

GOULD
DMM7 1999 FSD AC/DC/V/I/Ω 80

HEWLETT PACKARD
3490A 100000FSD AC/DC/V/Ω 560

SOLARTRON
A200 19999FSD DC only 1μV-1 KV 65
A203 19999FSD AC/DC/V/Ω 160
A205 19999FSD TRMS AC/DC/V/Ω 175

LOW COST CORNER
Items in this box have 30 day guarantee only.

AIRMEC
210 AM/FM Modulation meter from 2.25-300 MHz 150

HEWLETT PACKARD
1600A Logic Analyser 16 channels 20 MHz Clock rate 990

HEWLETT PACKARD
608E 10-480 MHz AM/Pulse Signal Generator 220

M.L. ENGINEERING NAMV
D.C. Sensitive nAmp/μVolt meter — centre zero 30

TEKTRONIX
575 Transistor Curve Tracer 200

TAYLOR
62A AM/FM Signal Generator 4-120 MHz 85

Full details and specification of equipment listed available. Because of long copy dates this list is not comprehensive — ring for inventory update or tell us your SPECIFIC NEEDS. Hours Monday to Friday, 9.30 a.m.-5 p.m. (lunch, 1-2 p.m.). **Prices exclude delivery and VAT.**
We take Access or Visa.

WW — 012 FOR FURTHER DETAILS

All items have a 12 month guarantee unless otherwise stated.

Carston Electronics Ltd
01-267 5311
Shirley House, 27 Camden Road, London NW1 9NR. Telex: 23920.

Carston Electronics Ltd
01-267 5311
Shirley House, 27 Camden Rd, London NW1 9NR. Telex: 23920

Carstonbuy

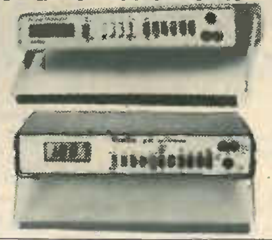
Contact us for a cash quote on your under utilised test equipment

Carstonbuy Carstonsell Carstonbuy Carstonsell Carstonbuy Carstonsell Carstonbuy Carstonsell Carstonbuy Carstonsell

TEST INSTRUMENTS

THANDAR

Quality British-made Portable Instruments



MULTIMETERS:

DM450..........£107
DC 10µHV-1200V — AC 100µV to 750V
DC 0.1nA-10A — AC InA-10A
0.01Ω-20MΩ — 4½ digit LED

TM351 .... £99
DC 100µV-1000V — AC 100µV-750V
DC 100nA-10A — AC 100nA-10A
0.1Ω-20MΩ — 3½ digit LCD

FUNCTION GENERATOR:
TG102.................................. £145
Freg. Range: 0.2Hz-2MHz

PORTABLE OSCILLOSCOPE:
SC110.................................. £139

Carriage for all Thandar Orders £1

SABTRONICS

★ Available in KITS ★

Making Performance Affordable

HANDHELD DMMs

	Assm	Kit
2033	£36.75	
2035A	£62	£49

2033: AC/DC 100µV-1000V; AC/DC 10µA-2A; Ohms 1Ω-20MΩ
2035A: AC/DC 100µV-1000V; AC/DC 0.1µA-2A; Ohm 0.1Ω-20MΩ

FREQUENCY METERS: 8 digit LED

	Assm	Kit
8110A 20Hz-100 MHz	£67	£56
8610A 20Hz-600 MHz	£82	£68

FREQUENCY METERS: 9 digit LED

	Assm	Kit
8610B 10Hz-600MHz (0.1Hz Resolution)	£99	£84
8000B 10Hz-1000MHz (0.1Hz Resolution)	£155	–

Carriage for all SABTRONICS orders £1

SAFGAN BRITISH-MADE SCOPES

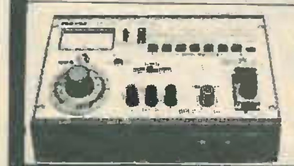
★ DUAL TRACE
★ 5mV/Div Sensitivity
★ XY Facility
★ Z Modulation
★ Calibration Output
★ Portable/Lightweight

DT 410 10MHz.................. £179
DT 415 15MHz.................. £185
DT 420 20MHz.................. £198
XI-REF-X10 probe.............. £11.50
p&p £2

LEADER

When Quality Counts

LSG-16...................£55
A compact solid state RF Signal Generator, most suited for checking the IF circuits and tuners in AM, FM and TV sets.
Frequency range up to 100MHz (300MHz on Harmonics).
Carriage £1



LCR-740 .... £149
A highly efficient impedance bridge for measuring resistance, capacitance and inductance. The D factor of a capacitor and the Q sector of a coil can also be measured.
Carriage £1

Many more instruments available from all these ranges

ADD 15% VAT ON ALL PRICES
All prices correct at 2-2-82 E&OE
Cash with Order or Credit Card

Buy it with Access

CALLERS WELCOME
OPEN MONDAY TO FRIDAY 9am-5.30pm

DAROM SUPPLIES

4 SANDY LANE
STOCKTON HEATH
WARRINGTON
CHESHIRE, WA4 2AY
(0925) 64764

Catalogue available just send A4 size 22p s.a.e.

WW – 024 FOR FURTHER DETAILS

VALVES

Minimum Order £1 — VALVES VAT IS INCLUDED

A1065 1.40
A2293 8.80
A2900 13.75
AR8 0.75
ARP3 0.70
ATP4 0.60
B12H 3.90
CY31 1.40
DAF96 0.70
DET22 26.95
DF96 0.70
DH76 0.75
DL92 0.60
DY86/87 0.65
DY802 0.70
E55L 14.90
E88CC 1.60
E88CC/01 3.10
E92CC 2.80
E180CC 4.20
E180F 7.70
E182CC 8.25
EA76 2.25
EABC80 0.80
EB91 0.60
EBC33 1.15
EBC90 0.90
EBF80 0.60
EBF83 0.60
EBF89 0.80
EC52 0.65
EC91 4.40
EC92 0.85
ECC81 0.65
ECC82 0.60
ECC83 0.65
ECC84 0.60
ECC85 0.60
ECC86 1.70
ECC88 0.80
ECC189 0.95
ECC804 0.90
ECF80 0.85
ECF82 0.65
ECF801 1.05
ECH34 2.25
ECH35 1.70
2.10*
ECH42 1.20
ECH81 0.70
ECH84 0.80
ECL80 0.70
ECL82 0.75
ECL83 1.40
ECL85 0.60
ECL86 0.90
EF37A 2.15
EF39 1.25
EF80 0.65
EF83 1.75
EF85 0.60
EF86 0.75
EF89 1.05
EF91 1.50
EF92 2.90
EF95 0.65
EF96 0.60
EF183 0.80
EF184 0.80
EF812 0.75
EFL200 1.85
EH90 0.85
EL32 1.10
EL34 1.80
2.90*
EL81 2.45
EL82 0.70
EL84 0.80
EL86 0.95
EL90 1.00
EL91 4.20
EL95 0.80
EL504 1.70
EL803 5.90
EL509 3.95
EL802 1.70

EL821 8.20
EL822 9.95
EM80 0.85
EM87 1.30
EY51 0.95
EY81 0.65
EY86/87 0.60
EY88 0.65
EZ80 0.70
EZ81 0.70
GM4 5.90
GY501 1.30
GZ32 1.05
GZ33 4.20
GZ34 2.75
GZ37 3.95
KT66 6.30
9.20*
KT88 8.95
13.80*
MH4 2.50
ML6 2.50
MX10/01 21.50
N78 9.90
OA2 0.70
OB2 0.80
PABC80 0.60
PC85 0.75
PC86 0.95
PC88 0.95
PC97 1.50
PC900 1.15
PCC84 0.50
PCC89 0.85
PCC189 1.05
PCF80 0.80
PCF82 0.70
PCF84 0.75
PCF86 1.50
PCF87 0.50
PCF200 1.60
PCF201 1.65
PCF800 0.50
PCF801 1.75
PCF802 0.85
PCF805 2.45
PCF806 1.20
PCF808 2.75
PCH200 1.35
PCL81 0.75
PCL82 0.95
PCL84 0.90
PCL86 1.05
PCL805/85 1.25
PD500/510 4.30
PFL200 1.10
2.80*
PL36 1.25
PL81 0.85
PL82 0.70
PL83 0.60
PL84 0.95
PL504 1.45
PL508 2.40
PL509 5.60
PL519 6.10
PL802 3.95
PY33 0.70
PY80 0.70
PY81/800 0.85
PY82 0.65
PY83 0.80
PY88 0.85
PY500A 2.10
PY809 6.45
PY801 0.80
QQV03/10 7.50
QQV03-20A 21.50
QQV03-25A 36.50
QQV06/40A 16.10
QV03-12 4.20
SC1/400 4.50
SC1/600 4 50

SP61 1.80
TT21 23.00
TT22 18.50
U25 1.15
U26 1.15
U27 1.15
U191 0.85
U281 0.70
U301 0.65
U600 11.50
U801 0.90
UBC41 1.20
UABC80 0.75
UAF42 1.20
UBF80 0.70
UBF89 0.70
UBL21 1.75
UCC84 0.85
UCC85 0.70
UCF80 1.30
UCH42 1.65
UCH81 0.75
UCL82 0.95
UF41 1.35
UF80 0.95
UF85 0.95
UL84 0.95
UM80 0.90
UM84 0.70
UY82 0.70
UY85 0.85
VR105/30 1.25
VR150/30 1.35
X66 0.95
X61M 1.70
XR1-6400A 82.90
Z759 19.00
Z749 0.75
Z800U 3.45
Z801U 3.75
Z803U 16.00
Z900T 2.45
1A3 0.85
1L4 0.50
1R5 0.60
1S4 0.45
1S5 0.45
1T4 0.45
1U4 0.80
1X2B 1.40
2D21 1.10
1.85*
2K25 16.95
24.50*
2X2 1.15
3A4 0.70
3AT2 2.40
3D6 0.50
3D22 23.00
3E29 19.00
3S4 0.60
4B32 18.25
5B/254M 18.90
5B/255M 14.50
5B/258M 12.50
5C22 29.90
5R4GY 1.80
5U4G 0.75
5V4G 0.75
5Y3GT 0.95
5Z3 1.50
5Z4G 0.75
5Z4GT 1.05
6/30L2 0.90
6AB7 0.70
6AC7 1.15
6AG5 0.60
6AH6 1.15
6AK5 0.65
6AK8 0.60
6AL5 0.60
6AL5W 0.85
6AM5 4.20
6AM6 1.50
6AN8A 2.50

6AQ4 3.40
6AQ5 1.00
6AQ5W 1.80
6AS6 1.15
6AT6 0.90
6AU6 0.60
6AV6 0.85
6AX4GT 1.30
6AX5GT 1.30
6BA6 0.55
6BE6 0.60
6BG6G 1.60
6BJ6 1.30
6BQ7A 0.85
6BR7 4.80
6BW6 8.20
6BW7 0.90
6C4 0.50
6C6 0.55
6CH6 8.20
6CL6 2.75
6CX8 3.80
6CY5 1.15
6D6 0.70
6F6 1.60
6F6GB 1.10
6F7 2.80
6F8G 0.85
6F12 1.50
6F14 1.15
6F15 1.30
6F17 3.20
6F23 0.75
6F24 1.75
6F33 10.50
6FH8 4.20
6GA8 1.95
6GH8A 0.95
6H6 1.60
6J4 1.35
6J4WA 2.00
6J5 2.30
6J5GT 0.90
6J6 0.65
6J6W 0.90
6JE6C 2.95
6JS6C 2.95
6K7 0.80
6KD6 3.35
6L6M 2.80
6L6G 2.50
6L6GC 2.10
6L6GT 1.25
6L7G 0.65
6L18 0.70
6LQ6 2.95
6LD20 0.70
6KG6A 2.70
6Q7G 1.30
6SA7 1.00
6SG7 1.15
6SJ7 1.05
6SK7 0.95
6SL7GT 0.85
6SN7GT 0.80
6SR7 1.10
6SQ7 0.95
6V6G 1.50
6V6GT 0.95
6X4 0.95
6X4WA 2.10
6X5GT 0.65
6Y6G 0.90
6Z4 0.70
7B7 1.75
8BN8 2.95
9D2 0.70
9D6 2.90
10C2 0.85
10F18 0.70
10P13 1.50
11E2 19.50
12A6 0.70
12AT6 0.70
12AT7 0.65
12AU7 0.60

12AV6 0.95
12AX7 0.65
12BA6 0.90
12BE6 1.25
12BH7 1.95
12BY7A 2.30
12C8 0.65
12E1 18.95
12J5GT 0.55
12K7GT 0.70
12K8GT 0.80
12Q7GT 0.60
12SC7 0.65
12SH7 0.65
12SJ7 0.70
12SQ7 1.45
12SQ7GT 0.85
12Y4 0.70
13D3 0.70
13D5 0.90
13D6 0.80
14S7 1.15
19AQ5 0.85
19G3 11.50
19G6 8.50
19H5 39.55
20D1 0.80
20F2 0.85
20E1 1.30
20P1 0.65
20P3 0.75
20P4 1.25
20P5 1.35
25L6GT 0.95
25Z4G 0.75
30C15 0.50
30C17 0.50
30C18 2.45
30F5 1.15
30FL2 1.40
30FL12 1.25
30FL14 2.15
30L15 1.10
30L17 1.10
30P12 1.15
30PL13 1.25
30PL14 2.45
35L6GT 1.40
35W4 0.80
35Z4GT 0.80
50C5 1.15
50CD6G 1.35
75B1 1.25
75C1 1.70
76 0.95
78 0.95
80 1.70
85A2 1.40
2.55*
807 1.25
1.90*
813 19.32
68.50*
829B 14.00
832A 8.90
866A 3.80
866E 6.25
931A 13.80
954 0.80
955 1.20
956 0.60
957 1.05
1625 1.80
1629 1.85
2051 2.90
5763 4.20
5842 7.50
5881 3.40
5933 6.90
6057 2.20
6060 1.95
6064 2.30
6065 3.20
6067 2.30
6080 5.30
6146 4.95

6146B 5.20
6360 2.85
6550 6.60
6870 14.00
8552 8.20
7199 2.85
38P1 11.00
5FP7 18.00
4EP1 32.00
88J 14.00
88L 14.00
CV1526 18.00
DG7-32 34.80
DG7-36 36.00
DPM9-11 38.40
D13-33GM 41.80
* spec Q

PLUMBICON
P800 3LF
P800 IR
P800 IB
XQ1020R
XQ1020B

SPECIAL V
4CX 1000A
4CX 5000A
BM 25L
BW 153
DM 25LB
YL 1420
YL 1430
YL 1440
GXU6
CV1597
CV2116
BR 189
BR 179
CV6131
GMU 2
TY4-500
BK485/5552A
MIL 5948/1754

IC
SN5402N 0.28
SN5410F 0.32
SN5470F 0.48
SN54196J 1.20
SN7407N 0.28
SN7408N 0.18
SN7445P 0.85
SN74453P 1.10
SN7453N 0.18
SN74L73N 0.38
SN7474N 0.30
SN7485N 0.95
SN74L85N 1.10
SN7491AN 0.32
SN74123N 0.42
DM74123N 0.38
SN15836N 0.26
cX4 0.95
SN76013N 1.80
SN76003N 1.60
SN76033N 1.35
MC6800P 5.80
MC68B00P 6.40
MC14511BA 2.20
B1702AL 3.30
MM6300-IJ 3.80
MCM6810AP 3.40
6340-1J 3.60
MIC945-5D 0.28
MIC936-5D 0.22

VALVES AND TRANSISTORS

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

"D10" CABLE FIELD TELEPHONES

Geiger Muller Tubes GM4, MX12/01 and others.

TEST SET FT2 FOR TESTING Transceivers A40, A41, A42 and CPRC26.
HARNESS "A" & "B" CONTROL UNITS "A" "R" "J1" "J2" Microphones No 5, 6, 7 connectors, frames, carrier sets, etc.
DRUM CABLE continuous connection YC 00433.

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

PRICES MAY VARY

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

Signal Generators MARCONI TF 144H/4S; TF144H/6S 10 kHz-72MHz
Prices on application

COLOMOR
(ELECTRONICS LTD.)
170 Goldhawk Rd., London W.12

Tel. 01-743 0899 or 01-749 3934
Open Monday to Friday
9 a.m.-5.30 p.m.

SOUND INVESTMENT

QUALITY REEL TO REEL & CASSETTE TAPE HEADS

FITTING A NEW TAPE HEAD CAN TRANSFORM THE PERFORMANCE OF YOUR TAPE RECORDER. OUR FULL CATALOGUE (PRICE 50p) ALSO INCLUDES TAPE TRANSPORTS, DISC DRIVES, PRE-AMPLIFIERS AND ACCESSORIES

POPULAR UNIVERSAL CASSETTE HEADS TO EIAJ STANDARDS

C21RPS18 MONO R/P £4.62
B24-02 STEREO R/P £7.66
B24-07 STEREO R/P FOR DOLBY SYSTEMS £9.05
C21ES18 MONO/STEREO ERASE HEAD £2.13

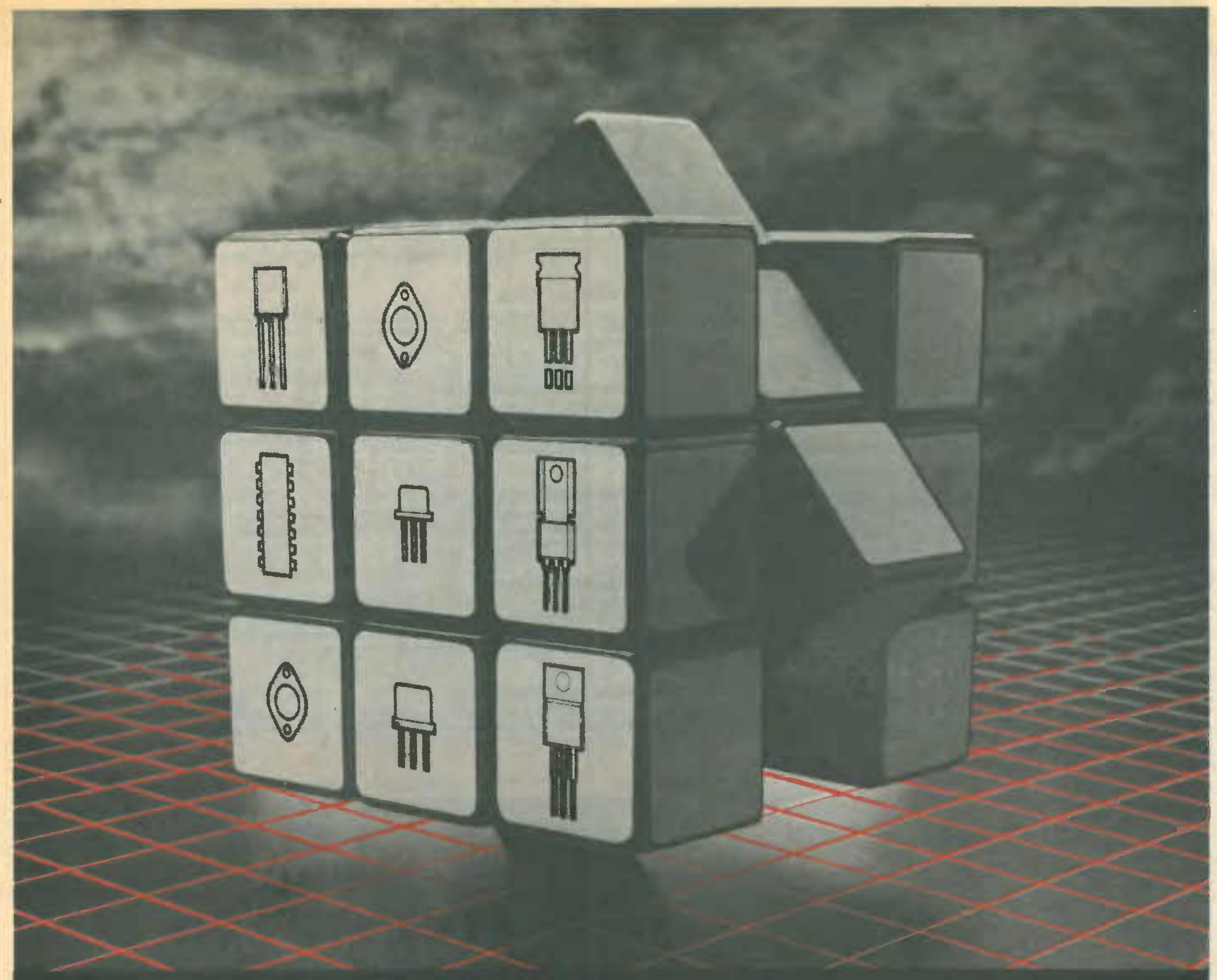
Hole Centres 17mm Apart, 12mm From Head Face
C42RPH20 STEREO R/P SENDUST FOR CHROME/METAL TAPES .. £10.67
C42RPH04 STEREO R/P GLASS FERRITE THE ULTIMATE LONG LIFE, HIGH PERFORMANCE HEAD £13.34

POST AND PACKING 40p EX STOCK DELIVERIES, ALL PRICES INCLUDE V.A.T.

The Monolith Electronics Co. Ltd., 5/7 Church Street, Crewkerne, Somerset TA18 7HR
Tel: 0460 74321.
Telex: 46306 MONLTH G.

MONOLITH electronic products

WW – 043 FOR FURTHER DETAILS



Winning MOSPOWER combinations. We invented the game.

Siliconix invented the MOSPOWER FET game. So, not surprisingly we have a tradition of firsts. First with a medium power MOSPOWER FET in TO-202 packages; first with low cost plastic devices in TO-237 packages; first with n and p-channel quads in 14-pin DIPs.

First for versatility as well. The range includes silicon-gate, metal gate, and high voltage DMOS capability in our double-diffused MOS technology offered in nine different package configurations. So you can have the winning combination for your application - whether it's aerospace, telecomms, data processing or process control.

And our devices feature ultra fast switching, freedom from thermal runaway and secondary breakdown, very high power gain, resistance to noise and false triggering and easy interfacing with low power MOS ICs.

For more information and a copy of our data book, ring Phil Regan/Phil Dewsbury on Swansea (0792) 74681, and discover how our combinations slot into place.

125W	TO-3	350-450V	25W	TO-3	35-90V	6.25W	TO-39	35-90V
1.3W	DIP Quad	20-90V	15W	TO-202	40-80V	0.3W	TO-52	60V
0.4W	TO-92	60V	1W	TO-237	30-240V	20W	TO-220	30-80V

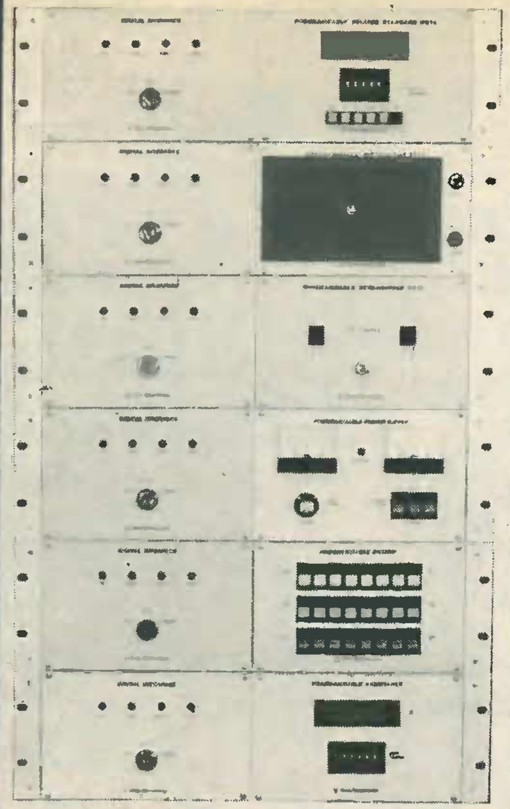
Sales Office: Siliconix Ltd, Brook House, Northbrook Street, Newbury, Berks RG13 1AH. Tel: (0635) 47609. Telex: 849357. **Manufacturing Facility:** Siliconix Ltd, Morriston, Swansea SA6 6NE. Tel: (0792) 74681. Telex: 48197. **Distributors:** Barlec Ltd. (0403) 51881. Dage Eurosem Ltd. (0996) 32881. Macro-Marketing Ltd. (06286) 4422. Semiconductor Specialists Ltd. (08954) 45522. **Representatives:** Scotland & Ireland: Linburg Electronics Ltd. (0383) 32931. South West England: Hartech Ltd. (0243) 573164. **European Headquarters:** Swansea (U.K.) **Corporate Headquarters:** Santa Clara, California. **Far East Headquarters:** Hong Kong. **Nippon-Siliconix,** Tokyo, Japan.

To Siliconix Ltd, Morriston, Swansea SA6 6NE.
Please send me a copy of the "MOSPOWER FET Design Catalogue".
Name
Position
Company
Address
Tel:

Siliconix
The Discovery Company

WW – 010 FOR FURTHER DETAILS

www.americanradiohistory.com



IEEE 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 20mA-200mA. Temperature coeff is less than 20ppm/°C and long term stability better than [illegible]ppm 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 into 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 emfs have been minimised to less than 1μV 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.

TIME ELECTRONICS LTD, Botany Industrial Est., Tonbridge, Kent, England TN9 1RS. Tel: (0732) 355993. Telex: 95481

WW – 069 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 (9461)

WW – 095 FOR FURTHER DETAILS

ELECTRON GUNS TV TUBE COMPONENTS

If you are Rebuilding or Manufacturing TV Tubes – We are the leading suppliers of Electron Guns and TV Tube Components to the TV Tube Industry. We specialise in all aspects of Electron Mount Technology.
Our product range includes more than 250 gun types for Colour, In Line, Mono and Display Tubes along with Mount Parts, Bases, Getters, Sealoffs, and all other associated items for TV Tube Production.
A Full Technical Back-up and Advisory Service is available to all customers Worldwide.
Please request our current catalogues and Data Information.

GRIFTRONIC EMISSION LTD
2 SWAN STREET
ALCESTER
WARWICKSHIRE
B49 5DP
ENGLAND

Telephone: (0789) 76452/764100. Telex: 312354 Grifem G

WW – 041 FOR FURTHER DETAILS

OFFICIALLY APPROVED COMMODORE DEALER

L & J COMPUTERS

192 HONEYPOT LANE, QUEENSBURY, STANMORE, MIDDX HA7 1EE. 01-204 7525

THE "PET" SPECIALISTS

4016 16K Computer	£460
4032 32K Computer	£575
2031 171K Single Drive Floppy Disk	£350
4040 343K Dual Floppy Disk	£575
4022 Tractor Feed Printer	£350
8032 32K Computer	£750
8096 96K Computer	£995
8050 950K Dual Drive Floppy Disk	£750
8023 Tractor Feed Printer	£750
8422 22 Megabyte Winchester Disk	£3250
9000 SuperPet 134K Multilanguage Computer	£1295

TOOL KITS (BASIC 2 & 4). SUPERCHIPS AND ALL SORTS OF OTHER CHIPS

WE HAVE A DAZZLING ARRAY OF CONNECTIONS WITH THE OUTSIDE WORLD!
D TO A CONVERTERS (8, 12 & 16 BIT
A TO D CONVERTERS RESOLUTIONS
X/Y PLOTTERS (A3 SIZE UPWARDS)
DIGITAL INPUTS/OUTPUTS
RS 232: IEEE : CENTRONIC INTERFACES

AS WELL AS BUSINESS SOFTWARE, WE ALSO CAN SUPPLY ENGINEERING REQUIREMENTS, LIKE:
DATA ANALYSIS/STATISTICAL PACKAGES
TAPEPREP FOR ONC MACHINE ROOLS
SECTION CALCULATIONS FOR DRAWING OFFICES
ANALYSIS FOR CONTROL SYSTEMS

COME AND SEE THE NEW VIC 20 £165
FULLY WORKING AND OPERATIONAL
ASK US ABOUT ALL THE ADD-ON-GOODIES THAT GO WITH THE VIC

MASSES OF BOOKS ON THE PET & VIC + INTERFACING & CONTROL

SEND US A LARGE STAMPED ADDRESSED ENVELOPE (12x9) AND WE WILL BE DELIGHTED TO SEND YOU ALL OUR CURRENT INFORMATION!

* PRICES DO NOT INCLUDE VAT

PERSONAL SHOPPERS WELCOME
Phone & Mail Orders accepted

ALL GOODS SENT SAME DAY WHEREVER POSSIBLE
LARGE S.A.E. FOR LISTS ETC.

WILMSLOW AUDIO
The firm for Speakers

Just 50p will bring you the latest Wilmslow Audio 80 page catalogue packed with pictures and specifications of HiFi and PA Speaker Drive Units, Speaker Kits, Cabinet Kits....

1000 items for the constructor.

CROSSOVER NETWORKS AND COMPONENTS. GRILLES, GRILL FABRICS AND FOAM. PA, GROUP DISCO CABINETS – PLUS MICROPHONES – AMPLIFIERS – MIXERS – COMBOS – EFFECTS – SPEAKER STANDS AND BRACKETS – IN-CAR SPEAKERS AND BOOSTERS ETC. ETC.

★ Lowest prices — Largest stocks ★
★ Expert staff — Sound advice ★
★ Choose your DIY HiFi Speakers in the comfort ★ of our listening lounge.
(Customer operated demonstration facilities)
★ Ample parking ★
★ Access · Visa · American Express accepted ★

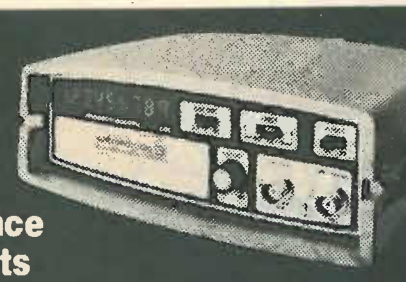
WILMSLOW AUDIO The firm for Speakers
0625 529599

35/39 Church Street, Wilmslow, Cheshire SK9 1AS

Lightning service on telephoned credit card orders!

WW – 089 FOR FURTHER DETAILS

An entire range of low-cost high-performance instruments



sabtronics
'Making Performance Affordable'

*2010A	3½-Digit L.E.D. Bench DMM	5020A	1Hz-200KHz Function Generator
*2015A	3½-Digit L.C.D. Bench DMM	*8110A	100MHz 8-Digit Frequency Meter
2020	3½-Digit L.E.D. Bench DMM with Microcomputer Interface	*8610A	600MHz 8-Digit Frequency Meter
2033	3½-Digit L.C.D. Hand DMM	*8610B	600MHz 9-Digit Frequency Meter
*2035A	3½-Digit L.C.D. Hand DMM	8000B	1GHz 9-Digit Frequency Meter
*2037A	3½-Digit L.C.D. Hand DMM with Temp.	8700	10MHz Universal Frequency Counter/Timer
LP-10	10MHz Logic Probe	PSC-65	600MHz Prescaler
		9005	5MHz Single Trace Oscilloscope

* Also available in kit form.

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.

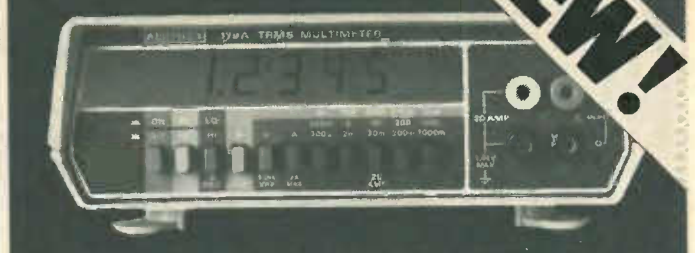
Full colour illustrated brochure and price list from:
BLACK STAR LTD.,
9a Crown Street, St. Ives,
Cambs. PE17 4EB
Tel: (0480) 62440. Telex 32339

Black Star

WW – 045 FOR FURTHER DETAILS

The Keithley 179A

NEW!



A MEASURE OF ACHIEVEMENT.

Specification... Versatility... Accuracy... Price. In almost every major area the new 179A – a 4½ digit bench/portable DMM – from Keithley Instruments sets some pretty impressive standards:
● 20 amp capability ● Full function: 27 ranges including true RMS AC Measurement ● Year's guarantee on spec ● 0.04% DC accuracy ● IEEE option ● Large display and 10μ V dc resolution.

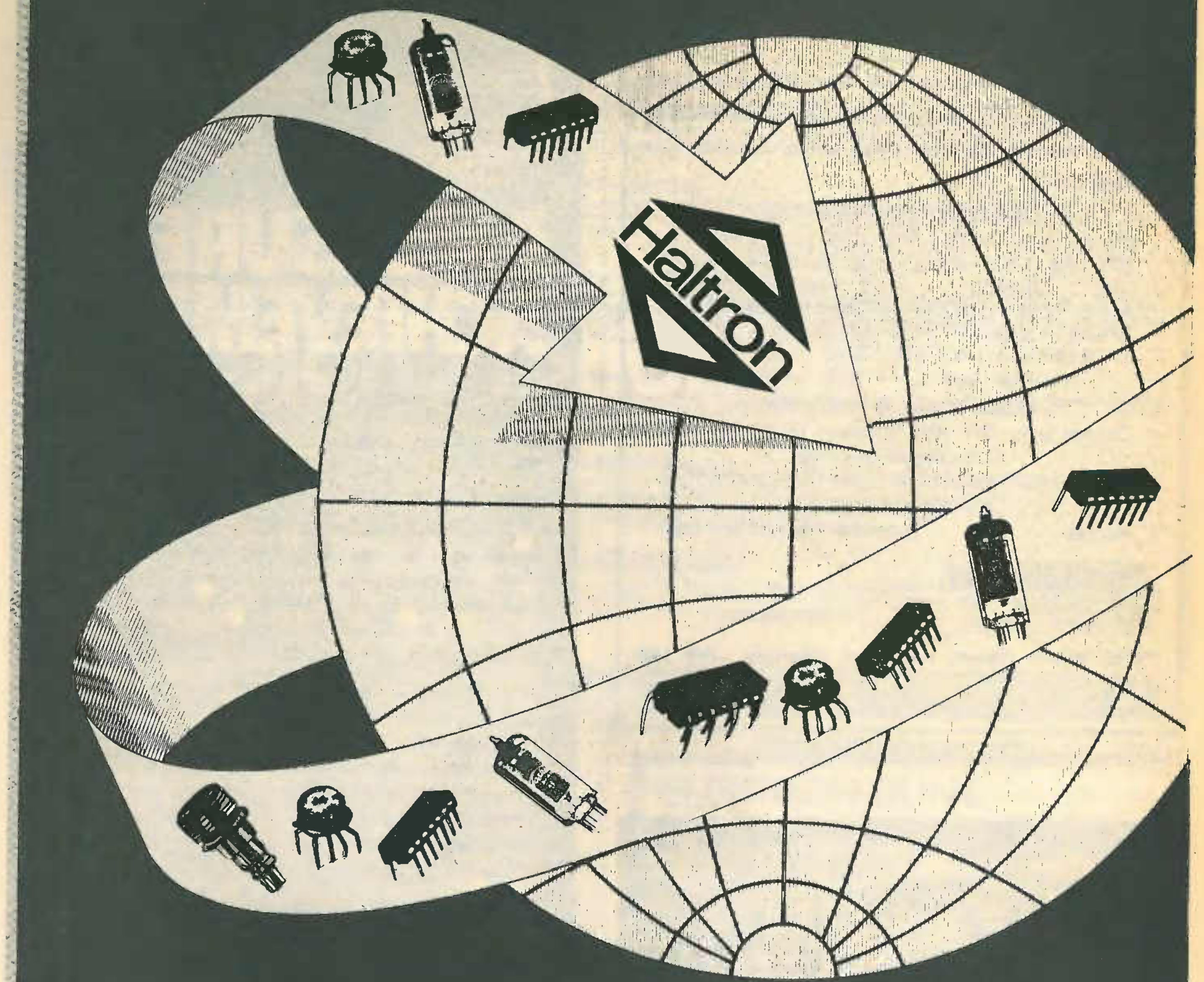
For those requiring 10 times more sensitivity and an analogue output there's the 177, a unit with similar specification to the 179A. Both models are part of a vast range of test equipment from one of the world's leading manufacturers.
For more information fill in the coupon at the bottom of the page.

Alternatively, phone our Instant Information Service on 0734 864784 now.

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

I'd like to know more...
Name ____________
Position ____________
Company ____________
Address ____________
____
Telephone ____________
(WW/6)

WW – 005 FOR FURTHER DETAILS



The Professionals

VALVES, SEMICONDUCTORS & COMPONENTS for:-

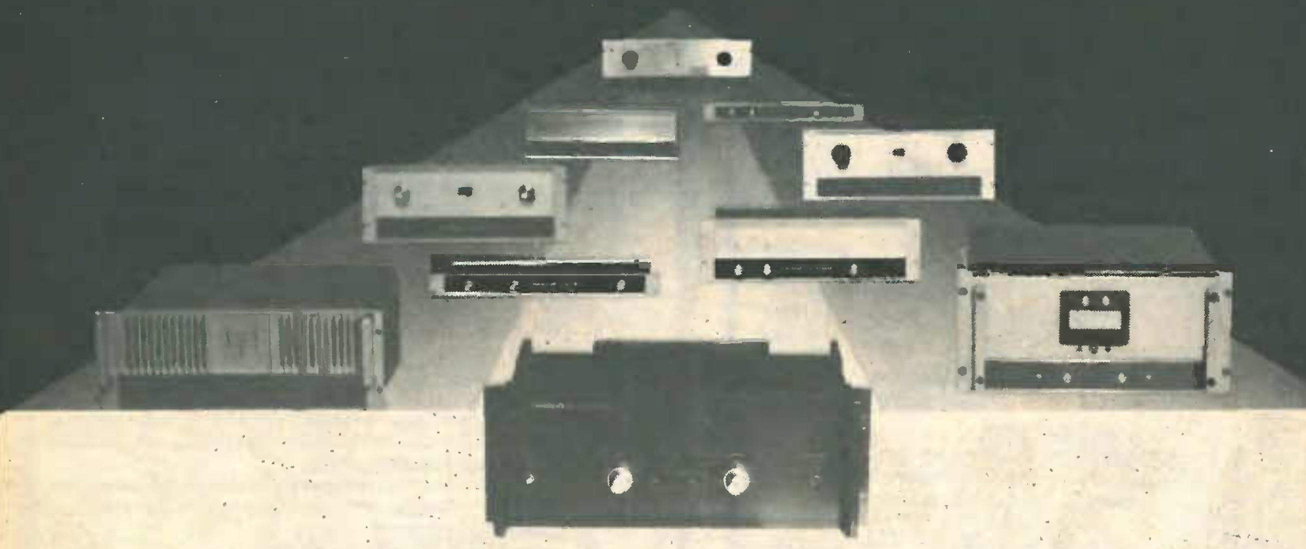
Communications, Displays, Radar, Computer, Audio etc.

Hall Electric Limited
Electron House
Cray Avenue, St. Mary Cray
Orpington, Kent BR5 3QJ
Telephone: Orpington 27099
Telex: 896141

MIN DEF APPROVAL 0529/0531

WW – 063 FOR FURTHER DETAILS

The Professional Choice



amcron

Since the introduction of the DC300 in 1967, AMCRON amplifiers have been used worldwide — wherever there has been a need for a rugged and reliable amplifier. Their reputation amongst professional users, throughout industry, has made the name of AMCRON synonymous with power amplification. For power you can depend on - choose AMCRON, the professional choice.

For further details contact the UK Industrial distributor:

GAS

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

WW – 030 FOR FURTHER DETAILS

www.americanradiohistory.com

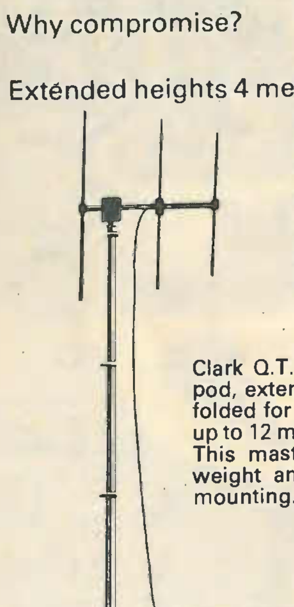
FAST ERECTING
CLARK MASTS

25 years in this specialist field

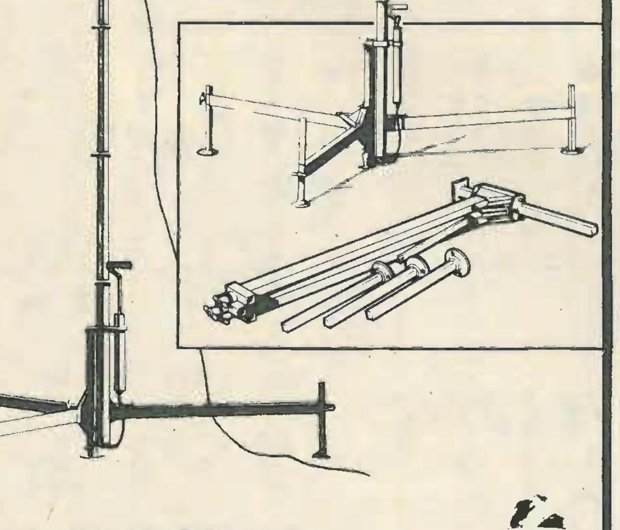
Here is the expertise you can depend on ~

When you choose a mast from the comprehensive Clark range you are assured of a high standard of Engineering and operational reliability.

Why compromise?



Extended heights 4 metres-30 metres, capable of lifting headload 1 kg-200 kgs.
Sectional or telescopic air operated for field or vehicle mounting.
Write or phone us for details today.



Clark Q.T.4M/HP mast shown on tripod, extended to 4 metres and tripod folded for transit. Available in heights up to 12 metres.
This mast is ideal for raising light-weight antennas for field or vehicle mounting.

CLARK MASTS LTD.
Binstead,
Isle of Wight,
PO33 3PA, England.
Telephone: Ryde (0983) 63691, Telex: 86686.

WW – 066 FOR FURTHER DETAILS

TECHNOMATIC TECHNOMATIC TECHNOMATIC

★ SPECIAL OFFER ★

	1.24	25-99
2114L – 200ns	95p	90p
2114L – 450ns	90p	85p
2716 (+5V)	210p	200p
2732	425p	400p
2532	400p	375p
6116P-3	525p	500p

ATOM

Basic Built 8K + 2K £135
Expanded 12K + 12K + VIA £185
(P&P £2.50/unit)
3A 5V Regulated Power Supply £22 (£1.80 P&P) ATOM PSU £7 + £1.20 P&P
F.P. ROM £20 1K RAM £2 (2x2114L) Toolbox ROM £25
New Colour Encoder Card £39 + £1 P&P
ATOM Sound Board Kit £34.95 + £1 P&P
ATOM Vision Kit £46 + £1 P&P
ATOM DISK PACK complete with Controller Card, PSU to run disc pack + 12K + 12K ATOM, Connector cable and socket, instruction book and manual £299 + £6 carriage
FULL RANGE OF ATOM ACCESSORIES & SOFTWARE IN STOCK·
BBC Microcomputer Memories, Expansion Sockets and Connectors now available
Send for our detailed lists

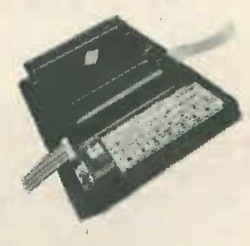
PRINTERS EPSON MX 80 F/T

● 9x9 matrix with true descenders ● 80 CPS Bi-directional with logic seeking ● 80 columns with condensed, emphasised enlarged characters ● Full Graphics capability (F/T 2) ● MX 80 F/T 1 £340 ● MX80 F/T 2 £360
Carriage £10/printer
BBC recommend MX 80 F/T 2 for their computer

MICRO TRAINER

- Based on the successful RCA 1802 CMOS microprocessor, this development kit offers the most comprehensive facilities at the lowest cost; the ideal teaching aid, or a powerful software development tool for 1802 control systems.
- Low resolution video display permits display of 1802 register set or blocks of stored data.
- 4K virtual machine monitor provides single step simulator for program tracing and debugging, with single line dis-assembler.
- 1½K of RAM for user programs.
- Many other features plus professional PTH board for simplified construction.

SOFTY II



An ideal software development tool. A program can be developed, debugged and verified and then can either be committed to an EPROM or the program can be used in any host computer by plugging the SOFTY into its EPROM socket. See the review in Sept. '81 PE for the various facilities provided on SOFTY. SOFTY complete with PSU, ROMULATOR & TV leads
£169

MENTA

New Z80 Development System. Plugs into TV and cassette recorder. 40-key direct ASSEMBLER/EDITOR, 24 bits of I/O. Ideal for study, microcontrol and robotics. Power supply and TV lead incl.
£115

Floppy Disc Drive Mechanism
Teac FD50A 5¼", £150 + £2.50 P&P.
Olivetti FD501AF 5¼", £150 + £2.50 P&P.

Xeltron Diskettes:
S.S.D.D. £23 for 10 Discs + Library Case.
D.S.D.D. £27 for 10 Discs + Library Case.

UV ERASERS

UV1B £42	UV140 £61.50	UV141 £78
Up to 6 EPROMS	Up to 14 EPROMS	As UV140 but with timer

All above ERASERS fitted with the safety interlocks to avoid accidental exposure to UV rays.

TECHNOMATIC TECHNOMATIC TECHNOMATIC

TTLs	
7400	11p
7401	11p
7402	12p
7403	12p
7404	12p
7405	18p
7406	25p
7407	25p
7408	14p
7409	15p
7410	15p
7411	20p
7412	20p
7413	22p
7414	35p
7416	25p
7417	25p
7420	17p
7421	30p
7422	20p
7423	22p
7425	28p
7426	30p
7427	25p
7428	30p
7430	15p
7432	25p
7433	27p
7437	27p
7438	30p
7440	17p
7441	70p
7442A	38p
7443	90p
7445	60p
7446A	93p
7447A	45p
7448	60p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	30p
7474	30p
7475	30p
7476	30p
7480	50p
7481	100p
7482	70p
7483A	45p
7484	100p
7485	90p
7486	20p
7489	210p
7490A	25p
7491	60p
7492A	30p
7493A	30p
7494	50p
7495A	50p
7496	45p
7497	120p
74100	85p
74107	25p
74109	40p
74116	90p
74118	75p
74119	90p
74120	70p
74121	25p
74122	45p
74123	48p
74125	40p
74126	40p
74128	40p
74132	45p
74136	30p
74141	65p
74142	200p
74145	70p
74147	100p
74148	75p
74150	80p
74151A	45p
74153	45p
74154	59p
74155	50p
74156	50p
74157	50p
74159	100p
74160	60p
74161	60p
74162	60p
74163	60p
74164	60p
74165	55p
74166	70p
74170	140p
74172	300p
74173	65p
74174	60p
74175	80p
74176	50p
74177	70p
74178	100p
74180	50p
74181	160p
74182	90p
74184A	90p
74185	120p
74186	500p
74188	325p
74190	50p
74191	50p
74192	50p
74193	50p
74194	50p
74195	60p
74196	60p
74197	70p
74198	100p
74199	100p
74221	60p
74251	70p
74273	75p
74276	140p
74278	150p
74279	80p
74283	75p
74284	200p
74285	200p
74290	100p
74293	100p
74298	100p
74365	55p

74366	58p
74367	55p
74368	55p
74390	100p
74393	100p
74490	120p
74LS SERIES	
74LS00	12p
74LS01	14p
74LS02	14p
74LS03	14p
74LS04	15p
74LS05	15p
74LS08	16p
74LS09	15p
74LS10	15p
74LS11	15p
74LS13	25p
74LS14	38p
74LS15	15p
74LS20	15p
74LS21	15p
74LS22	15p
74LS27	16p
74LS30	15p
74LS32	16p
74LS38	16p
74LS42	36p
74LS47	40p
74LS48	75p
74LS51	15p
74LS55	30p
74LS73	25p
74LS74	15p
74LS75	24p
74LS76	20p
74LS83	45p
74LS85	50p
74LS86	20p
74LS90	28p
74LS92	40p
74LS93	30p
74LS95	45p
74LS96	100p
74LS107	45p
74LS109	45p
74LS112	34p
74LS113	30p
74LS114	30p
74LS122	45p
74LS123	50p
74LS124	120p
74LS125	100p
74LS126	50p
74LS132	45p
74LS133	30p
74LS136	30p
74LS138	34p
74LS139	36p
74LS145	75p
74LS147	160p
74LS148	90p
74LS151	40p
74LS153	40p
74LS154	90p
74LS155	40p
74LS156	40p
74LS157	35p
74LS158	36p
74LS160	40p
74LS161	40p
74LS162	40p
74LS163	40p
74LS164	48p
74LS165	100p
74LS166	90p
74LS170	120p
74LS173	70p
74LS174	45p
74LS175	50p
74LS181	140p
74LS190	50p
74LS191	50p
74LS192	50p
74LS193	50p
74LS194	40p
74LS195	48p
74LS196	60p
74LS197	65p
74LS221	60p
74LS240	70p
74LS241	70p
74LS242	70p
74LS243	80p
74LS244	60p
74LS245	90p
74LS251	40p
74LS253	40p
74LS257	45p
74LS258	45p
74LS259	80p
74LS260	100p
74LS266	25p
74LS273	75p
74LS279	45p
74LS283	45p
74LS298	160p
74LS323	250p
74LS324	150p
74LS348	150p
74LS352	100p
74LS353	100p
74LS363	160p
74LS364	160p
74LS365	32p
74LS367	32p
74LS368	36p
74LS373	70p
74LS374	70p
74LS375	50p
74LS377	90p
74LS378	70p
74LS390	55p
74LS393	55p
74LS399	200p
74LS540	135p
74LS541	135p
74LS640	200p
74LS641	200p
74LS644	250p
74LS645	200p
74LS668	200p
74LS670	170p
74LS682	450p
74LS684	450p
4000 SERIES	
4000	12p
4001	14p

4002	15p
4006	65p
4007	16p
4008	60p
4009	35p
4010	40p
4011	14p
4012	18p
4013	35p
4014	80p
4015	80p
4016	30p
4017	45p
4018	60p
4019	32p
4020	80p
4021	65p
4022	70p
4023	20p
4024	40p
4025	20p
4026	130p
4027	32p
4028	60p
4029	75p
4030	40p
4031	170p
4034	160p
4035	90p
4036	295p
4039	295p
4040	55p
4041	70p
4042	55p
4043	80p
4044	60p
4046	70p
4047	75p
4048	55p
4049	27p
4050	27p
4051	60p
4052	80p
4053	60p
4054	130p
4055	120p
4056	120p
4059	500p
4060	90p
4063	100p
4066	35p
4067	400p
4068	18p
4069	18p
4070	18p
4071	18p
4072	18p
4073	20p
4075	20p
4076	60p
4081	16p
4082	20p
4086	72p
4089	150p
4093	40p
4094	150p
4095	95p
4096	95p
4097	340p
4098	90p
4099	120p
40085	90p
40097	120p
40098	120p
40102	180p
40103	180p
40106	45p
40109	100p
40163	100p
40173	120p
40174	90p
40175	100p
40193	120p
40257	180p
4502	70p
4503	50p
4507	40p
4508	200p
4510	65p
4511	50p
4512	65p
4514	150p
4515	150p
4516	45p
4518	45p
4520	70p
4521	150p
4526	75p
4527	90p
4528	75p
4532	90p
4534	500p
4536	300p
4538	130p
4539	110p
4543	100p
4553	280p
4555	50p
4556	60p
4560	180p
4566	300p
4568	300p
4569	180p
4572	30p
4583	90p
4584	45p
4585	100p
14495	400p
74S SERIES	
74S00	80p
74S04	60p
74S08	75p
74S32	90p
74S74	90p
74S86	300p
74S124	300p
74S132	180p
74S133	75p
74S138	225p
74S139	225p
74S157	250p
74S163	300p
74S174	250p
74S175	320p
74S194	350p
74S241	450p

LINEAR ICs			
AN103	200p	MB3730	£4
AY1-0212	600p	MC1310P	150p
AY1-1313	668p	MC1445	
AY1-1320	320p	MC1458	30p
AY1-5050	140p	MC1495L	350p
AY3-1350		MC1496	70p
AY3-8910	550p	MC3340P	120p
AY3-8912	650p	MC3401	90p
AY5-4007D	520p	MC3403	75p
CA3028A	120p	MK50398	750p
CA3019	80p	ML920	800p
CA3046	70p	MM57160	620p
CA3048	225p	MN6221A	600p
CA3059	300p	NE531	150p
CA3060	350p	NE555	20p
CA3080E	72p	NE556	50p
CA3086	48p	NE564	420p
CA3089	200p	NE565	130p
CA3090AQ	375p	NE566	155p
CA3130E	90p	NE567	140p
CA3140	50p	NE570	375p
CA3160E	100p	NE571	375p
CA3161E	190p	NE5534A	130p
CA3162	450p	PLL02A	500p
CA3189E	300p	RC4136	60p
CA3240	120p	RC4151	200p
CA3280G	200p	S566B	280p
DAC1408-8	200p	SAD1024A	850p
HA1366	300p	SFF96364	800p
HA1388	270p	SL490	350p
ICL7106	850p	SN76477	450p
ICL7216B	130p	SN76488	450p
ICL7217	130p	SP8515	750p
ICL7611	130p	TA7120	160p
ICL8038	300p	TA7204	200p
ICM7555	80p	TA7205	90p
LC7120	350p	TA7222	180p
LC7130	350p	TA7310	180p
LF347	160p	TAA271	275p
LF351	48p	TBA651	200p
LF353	100p	TBA800	90p
LF356P	95p	TBA810	100p
LF357	120p	TBA820	90p
LM10C	425p	TBA950	200p
LM301A	27p	TCA220	350p
LM310	120p	TCA940	200p
LM318	200p	TDA1004A	300p
LM319	225p	TDA1008	320p
LM324	30p	TDA1010	225p
LM334Z	£1	TDA1022	520p
LM335Z	140p	TDA1024	120p
LM339	50p	TDA1034B	250p
LM348	75p	TDA1170	300p
LM358P	60p	TDA2002V	325p
LM377	175p	TDA2006	350p
LM380	75p	TDA2020	320p
LM381AN	180p	TL064	
LM382	120p	TL071/81	45p
LM386	75p	TL072/82	75p
LM387	120p	TL074	130p
LM389	95p	TL084	110p
LM393	100p	TL094	200p
LM394CH	£3	TL170	50p
LM709	50p	TL430C	70p
LM710	50p	UAA170	170p
LM711	70p	UA2240	300p
LM733	70p	ULN2003	100p
LM741	18p	UPC575	400p
LM747	70p	UPC592H	200p
LM748	35p	UPC1156H	300p
LM2917	200p	XR2206	300p
LM3302	90p	ZN414	90p
LM3900	50p	ZN419C	225p
LM3909	95p	ZN423E	150p
LM3911	130p	ZN424E	135p
LM3914	210p	ZN425E	350p
LM3915	225p	ZN427E	625p
LM3916	225p	ZN1034E	200p
LM13600	110p	ZN1040E	700p
M51513L	300p	ZN234	850p
M51516L	500p		
MB3712	200p		

VOLTAGE REGULATORS
FIXED PLASTIC

1A	+ve		-ve	
5V 1A	7805	45p	7905	50p
6V	7806	50p	7906	60p
8V	7808	50p	7908	60p
12V 1A	7812	50p	7912	50p
15V 1A	7815	55p	7915	50p
18V 1A	7818	55p	7918	60p
24V 1A	7824	55p	7924	60p
5V 100mA	78L05	30p	79L05	65p
6V 100mA	78L06	30p	79L12	70p
8V 100mA	78L08	30p	79L15	70p
12V 100mA	78L12	30p	12V	
15V 100mA	78L15	30p	15V	

OTHER REGULATORS

LM309H 1A5V	100p	78HGKC	600p
LM309K 1A 5V	135p	78HO5KC	550p
LM317K	325p	78MGT2C	140p
LM317T 1A Adj	200p	78GUIC	200p
LM337T	225p	79GUIC	225p
LM323K 3A 5V	500p	79HGKC	700p
LM723 150mA Adj	37p	ICL7660	200p
TL494	400p	TL497	300p
78S40	225p	LM305AH	250p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	180p	ORP61	120p
ORP12	120p	TIL78	55p
TIL32	55p		

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL113	90p
ILQ74	240p	TIL116	90p

LEDS

0.125"		0.2"	
TIL209 R	11p	TIL220 R	13p
TIL211 Gr	16p	TIL222 Gr	15p
TIL212 Ye	18p	TIL228 Ye	22p
TIL216 R	18p		

DISPLAYS

3015F	200p	MAN3640	175p
DL704	140p	MAN4640	200p
OL707	140p	NSB5881	570p
OL7750	200p	TIL311	600p
OL7760	200p	TIL312/3	110p
FND357	120p	TIL321	130p
FND500	90p	TIL322	130p
FND507	90p	TIL330	140p

COMPUTER COMPONENTS

CPUs	
1802CE	£7
2650A	£12
6502	£4
6502A	£5
6800	£3
6802	350p
68B02	£8
68B09	£14
6809	850p
6809E	£15
8035	350p
8039	£4
8080A	280p
8085A	450p
1NS8060	£11
TMS9980	£20
Z8	£24
Z80	320p
Z80A	360p
Z80B	£15
8088	£18
SUPPORT DEVICES	
3242	800p
3245	450p
6520	280p
6522	450p
6532	600p
6551	650p
6821	120p
68B21	220p
6851	650p
6821	120p
6850	140p
68B50	220p
6852	250p
6854	£7
6875	600p
8154	950p
8155	450p
8156	£5
8205	225p
8212	160p
8214	350p
8216	100p
8224	200p
8226	250p
8228	250p
8243	320p
8250	850p
8251	320p
8253	450p
8255	300p
8256	£36
8257	500p
8259	500p
8279	550p
8284	350p
8288	£11
Z80P10	280p
Z80AP10	£3
Z80CTC	280p
Z80ACTC	£3
Z80ADART	800p
Z80ADMA	£12
Z80S10-0	£9
Z80S10-1	£9
Z80S10-2	£9
CRT CONTROLLER	
CRT5027	£16
CRT5037	£16
CRT6545	£12
EF9365	£60

MC6845	£10
MC6847	£10
SFF96364	£8
TMS9918	£60
TMS9927	£18
MEMORIES	
21014A	400p
2102-3L	120p
2107B	500p
2111A	300p
2112-A	300p
2114-2L	100p
2147	450p
4027-3	300p
4044-45	450p
4116-15	90p
4116-20	75p
4118-3	500p
4118-4	450p
4164-2	£6
4816AP-3	320p
5101	300p
6116P-3	550p
6116LP-3	750p
6514-45	£3
6810	200p
7489	210p
74S189	325p
74S201	350p
74S289	325p
ROM/PROMs	
74S188	325p
74S287	380p
74S288	226p
74S387	325p
74S471	650p
74S473	850p
74S474	650p
74S570	650p
74S571	650p
74S573	950p
EPROMs	
1702A	500p
2708	300p
2716	225p
2564	£25
2516	225p
2532	425p
2732	425p
2716-350NS	500p
2732-350NS	750p
UARTSs	
AY-3-1015P	300p
AY-5-1013P	300p
COM8017	300p
IM6402	450p
TR1602	300p
CHARACTER GENERATORS	
RO3-2513	
U.C.	750p
L.C.	700p
SN74S262AN	

INTERFACE ICs	
AD558CJ	775p
AD561J	£14
AM25S10	350p
AM25LS2521	£2
AM26LS31	160p
AM26LS32	190p
DAC80	£20
DM8131	375p
DP8304	460p
DS8830	140p
DS8831	140p
DS8832	250p
DS8833	225p
DS8836	150p
DS8838	225p
LF13201	450p
MC1488	55p
MC1489	55p
MC3418	950p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14411	700p
MC14412	900p
MC4044	325p
MM58174	£12
ULN2003A	100p
ULN2004A	100p
75107	160p
75110	160p
75112	160p
75114	160p
75115	160p
75121	140p
75122	140p
75150P	140p
75154	140p
75182	230p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75453/4	72p
75491/2	70p
8T26/28	120p
8T95/96	120p
8T97/98	120p
81LS95/96	90p
81LS97/98	90p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	650p
ZN428E-8	500p
TELETEXT ICs	
SAA5020	£6
SAA5030	£9
SAA5041	£16
SAA5050	£9

CRYSTALS	
32.768KHz	100p
100KHz	250p
200KHz	280p
Freq in MHz	
1.0	290p
1.008	275p
1.5	450p
1.8432	210p
2.00	225p
2.45760	250p
2.5	250p
3.276	150p
3.5795	100p
3.686	300p
4.00	150p
4.194	200p
4.43	110p
4.608	250p
4.915	250p
5.0	175p
6.0	150p
6.144	250p
7.0	150p
7.168	175p
8.00	175p
8.86	175p
10.00	175p
10.5	250p
10.7	150p
12	250p
13	350p
14.318	175p
14.756	250p
15	200p
16.00	250p
18.00	200p
18.432	150p
19.968	150p
20	200p
26.690	150p
27.145	200p
38.6667	175p
48.0	175p
55.5	400p
116	300p
145.80	250p
KEYBOARD ENCODER	
AY-5-2376	700p
74C922	500p
MODULATORS	
6MHz UHF	375p
8MHz UHF	450p
BAUD RATE GENERATOR	
COM8116	£8
MC 14411	£7
4702A	750p
DISC CONTROL	
FD1771	£20
FD1791	£30

CONNECTOR SYSTEMS JUMPER LEADS

24" Cable with Headers

	14pin	16pin	24pin	40pin
Single end	145p	165p	240p	380p
Double end	210p	230p	345p	540p

Cable with Sockets

	20pin	26pin	34pin	40pin
Single end (24")	160p	210p	270p	300p
Double end (18")	290p	385p	490p	540p

ID CONNECTORS
(Speed Bloc type)

No of ways	10	20	26	34	40
Header					
Plug	90p	165p	200p	240p	270p
Recp'cle	90p	165p	200p	240p	270p
Edge conn	200p	240p	300p	380p	550p

EUROCONNECTORS

	Plug	Skt.
DIN 41612 2x32 Way	300p	350p
Angled 2 + 32 Way	350p	400p
DIN 41617 31 Way	200p	200p

(for 2x32 Way please specify A + B or A + C type)

DIN41612 3x3 2-way	350p	420p
DIN41617 21 way	180p	180p

DIL HEADER PLUGS

	14pin	16pin	24pin	40pin
Solder type	50p	80p	100p	275p
IDC type	130p	140p	200p	285p

MIN D CONNECTORS

No. of ways	9	15	25	37
MALE				
Solder	90p	135p	200p	280p
Angled	160p	230p	265p	425p
FEMALE				
Solder	125p	190p	245p	375p
Angled	175p	240p	310p	500p
Hoods	100p	100p	100p	150p

Centronix type 37-way conn. £6.50
25-way D conn. jumper M: £5 F; £5.50
25-way IDC Female connector £4

DIL SWITCHES		ZIF SKTS	
4-way	90p	24 pin	£6
8-way	120p	28 pin	£7
6-way	£105p	40 pin	£10
10-way	150p		

EDGE CONNECTORS

	0.1"	0.156"
2 x 18 Way	–	150p
2 x 22 Way	310p	170p
2 x 23 Way	335p	–
2 x 25 Way	350p	200p
1 x 43 Way	260p	–
2 x 43 Way	450p	–
1 x 17 Way	700p	–

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

TRANSISTORS									
AD161/2	45p	BFX30	27p	TIP32A	40p	2N3055	48p	2SC2078	200p
BC107/8	13p	BFX84/5	40p	TIP32C	45p	2N3442	140p	3N128	120p
BC109C	14p	BFX86/7	27p	TIP33A	70p	2N3553	240p	3N140	120p
BC117	20p	BFX88	27p	TIP33C	80p	ZN3584	250p	3N141	110p
BC147/8	9p	BFX89	150p	TIP34A	90p	2N3643/4	48p	3N201	110p
BC149	10p	BFY50	24p	TIP34C	120p	2N3702/3	12p	3N204	120p
BC157/8	10p	BFY51/2	24p	TIP35A	120p	2N3704/5	12p	40290	260p
BC159	11p	BFY90	80p	TIP35C	140p	2N3706/7	14p	40361/2	75p
BC169C	12p	BRY39	45p	TIP36A	140p	2N3708/9	12p	40408	90p
BC172	12p	BSX19/20	24p	TIP36C	180p	2N3773	300p	40409	100p
BC177/8	17p	BU104	225p	TIP41A	50p	2N3819	25p	40410	100p
BC179	18p	BU105	190p	TIP41C	55p	2N3820	40p	40411	300p
BC182/3	10p	BU108	250p	TIP42A	40p	2N3823	50p	40594	120p
BC184	11p	BU109	225p	TIP42C	65p	2N3866	90p	40595	120p
BC187	30p	BU126	150p	TIP54	160p	2N3902	700p	40673	75p
BC212/3	11p	BU180A	120p	TIP120	75p	2N3903/4	16p	40871/2	100p
BC214	12p	BU205	200p	TIP122	90p	2N3905/6	20p	**DIODES**	
BC237	15p	BU208	200p	TIP142	130p	2N4037	65p	BY127	12p
BC327	16p	BU406	145p	TIP147	130p	2N4123/4	27p	BYX36300	20p
BC337	16p	BUX80	600p	TIP2955	78p	2N4125/6	27p	OA47	8p
BC338	16p	E310	50p	TIP4055	70p	2N4401/3	27p	OA90/91	9p
BC461	36p	MJ802	400p	VN10KM	100p	2N4427	90p	OA95	9p
BC477/8	30p	MJ2501	225p	VN66	80p	2N4871	60p	OA200	9p
BC516/7	40p	MJ2955	90p	ZTX108	12p	2N5087	27p	OA202	10p
BC547B	14p	MJ3001	225p	ZTX300	13p	2N5089	27p	1N914	4p
BC548C	12p	MJE340	60p	ZTX500	15p	2N5172	27p	1N916	7p
BC549C	16p	MJE2955	100p	ZTX502	18p	2N5191	90p	1N4148	4p
BC557B	14p	MJE3055	70p	ZTX504	18p	2N5194	90p	1N4001/2	5p
BC559C	16p	MPF102	40p	2N697	25p	2N5245	40p	1N4003/4	6p
BCY70	18p	MPF103/4	30p	2N698	45p	2N5296	65p	1N4005	6p
BCY71/2	22p	MPF105	30p	2N706A	30p	2N5401	50p	1N4006/7	7p
BD131/2	50p	MPSA06	30p	2N708	30p	2N5457/8	32p	1N5404/5	14p
BD135/6	40p	MPSA12	50p	2N918	45p	2N5459	32p	1N5404/7	19p
BD139	40p	MPSA13	50p	2N930	18p	2N5460	60p	IS920	9p
BD140	60p	MPSA20	50p	2N1131/2	36p	2N5485	44p	**BRIDGE RECTIFIERS**	
BD189	60p	MPSA42	50p	2N1613	25p	2N5875	250p	1A 50V	19p
BD232	60p	MPSA43	50p	2N1711	25p	2N6027	48p	1A 100V	20p
BD241	60p	MPSA56	32p	2N2102	70p	2N6052	300p	1A 400V	25p
BD242	60p	MPSA70	50p	2N2160	350p	2N6059	325p	1A 600V	30p
BF244B	35p	MPSA93	40p	2N2219A	25p	2N6107	65p	2A 50V	30p
BF256B	50p	MPSU06	63p	2N2222A	25p	2N6247	190p	2A 100V	35p
BF257/8	32p	MPSU07	60p	2N2369A	25p	2N6254	130p	2A 400V	45p
BF259	36p	MPSU45	90p	2N2484	25p	2N6290	65p	3A 200V	60p
BF337	30p	MPSU65	78p	2N2646	45p	2SC1172	150p	3A 600V	72p
BFR39	25p	TIP29A	35p	2N2904/5	25p	2SC1306	150p	4A 100V	95p
BFR40/1	25p	TIP29C	40p	2N2906A	25p	2SC1307	150p	4A 400V	100p
BFR79	25p	TIP30A	35p	2N2907A	25p	2SC1957	90p	6A 50V	80p
BFR80/1	25p	TIP30C	40p	2N2926	9p	2SC1969	200p	6A 100V	100p
BFX29	40p	TIP31A	40p	2N3053	30p	2SC2028	120p	6A 400V	120p
		TIP31C	45p	2N3054	65p	2SC2029	250p	10A 400V	200p
								25A 400V	400p

ZENERS	
2.7V-33V	
400mW	9p
1W	15p
TRIACS PLASTIC	
3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p
THYRISTORS	
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	180p
16A 400V	180p
BT106	110p
C106D	45p
MCR101	36p
TIC44	27p
2N3525	130p
2N4444	140p
2N5060	34p
2N5064	40p

PCB MOUNTING RELAYS
6 or 12V DC Coil SPDT 2A 24V DC 160p
6 or 12V DC Coil DPDT 5A 24V DC 240V AC 200p
6 or 12V DC Coil SPDT 10A 24V DC 240V AC 225p

LOUD-SPEAKERS		
Size		
2½"	64R	80p
2½"	8R	80p
2"	8R	90p
1½"	8R	100p

TECHNOMATIC LTD.

MAIL ORDERS TO: 17 BURNLEY ROAD, LONDON NW10 1ED
SHOPS AT: 17 BURNLEY ROAD, LONDON NW10
Tel: 01-452 1500, 01-450 6597. Telex: 922800
305 EDGWARE ROAD, LONDON W2 Tel: 01-723 0233

PLEASE ADD 40p P&P & 15% VAT (Export no VAT)
Government, Colleges, etc. ORDERS WELCOME
VISA & ACCESS CARDS ACCEPTED
ASK FOR A DETAILED PRICE LIST

www.americanradiohistory.com

The simple answer to all your power supply problems.

Uninterruptible Power Supplies — UPS
250va upwards to 25kva, 50 or 60Hz.
☐ STANDBY POWER. Invaluable for winding down a computer programme on mains failure and wherever continuous power is essential. Better than 95% pure sine wave.
☐ STABILISATION. ±5% Vital to combat mains fluctuations and ensure the operation of equipment at peak efficiency.
☐ TRANSIENT ATTENUATION. Provides suppression of mains borne interference (spikes).
An unbeatable power package from £495 ex works.
Maintenance free lead acid batteries, available to suit all needs.
For more information, cut the coupon or contact Galatrek direct. Mr. R. Koffler, Galatrek International, Scotland Street, Llanrwst, nr Llandudno, Gwynedd LL26 0AL, North Wales, Great Britain, Tel No: 0492-640311/641298 Night Service: 0492-30592 Telex: 617114 A/B Galahu.

GALATREK INTERNATIONAL

Please send full details of your range of voltage stabilisers, filters, cutouts UPS and generators.

Name ______________________

Address ______________________

____

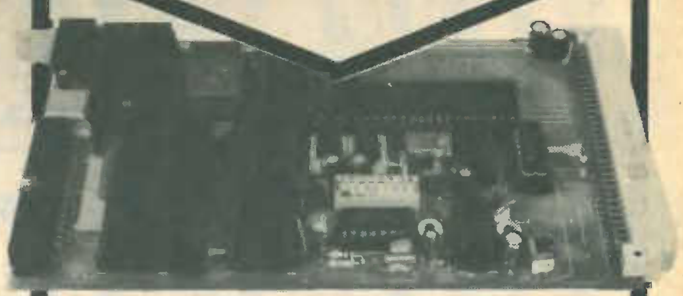
Country ______________________

Telephone No ______________________

(WW/2)

WW – 011 FOR FURTHER DETAILS

NEW... Essex Tiny Basic System



- ✱ RS232 Interface 48 I/O Lines
- ✱ Powerful Tiny Basic Processor
- ✱ Autostart Operation with Watchdog Timer
- ✱ Up to 16K Byte EPROM EPROM Programmer
- ✱ Accommodates Instant ROM ® Modules

The Essex Tiny Basic Computer is an ideal choice for data acquisition and process control systems. Its crystal controlled timer and interrupts provide accurate timing and fast response to critical events, while the watchdog timer ensures reliable operation. Programs can be entered and tested from an RS232 terminal, and then be copied into EPROM. Alternatively, Instant ROM modules may be used both during development and for program storage.

'INSTANT ROM' is the trademark of Greenwich Instruments

PRICE EXCLUDING VAT: £185 — CARRIAGE WITHIN THE UK £2 — PLEASE SEND FOR FULL INFORMATION

Essex Electronics Centre
University of Essex, Colchester, CO4 3SQ.
Telephone: Colchester (0206) 865089

WW – 046 FOR FURTHER DETAILS

New From Barmeco

Introducing a new 3 element H.F. Tribanda with proven performance and reliability.

THE WORLD RANGER TRIBANDER

Designed, engineered and manufactured in the U.K. Use of high-quality materials ensures high electrical stability under all weather conditions with exceptional mechanical rigidity and strength. All traps are high grade P.T.F.E. formers with insulated windings.

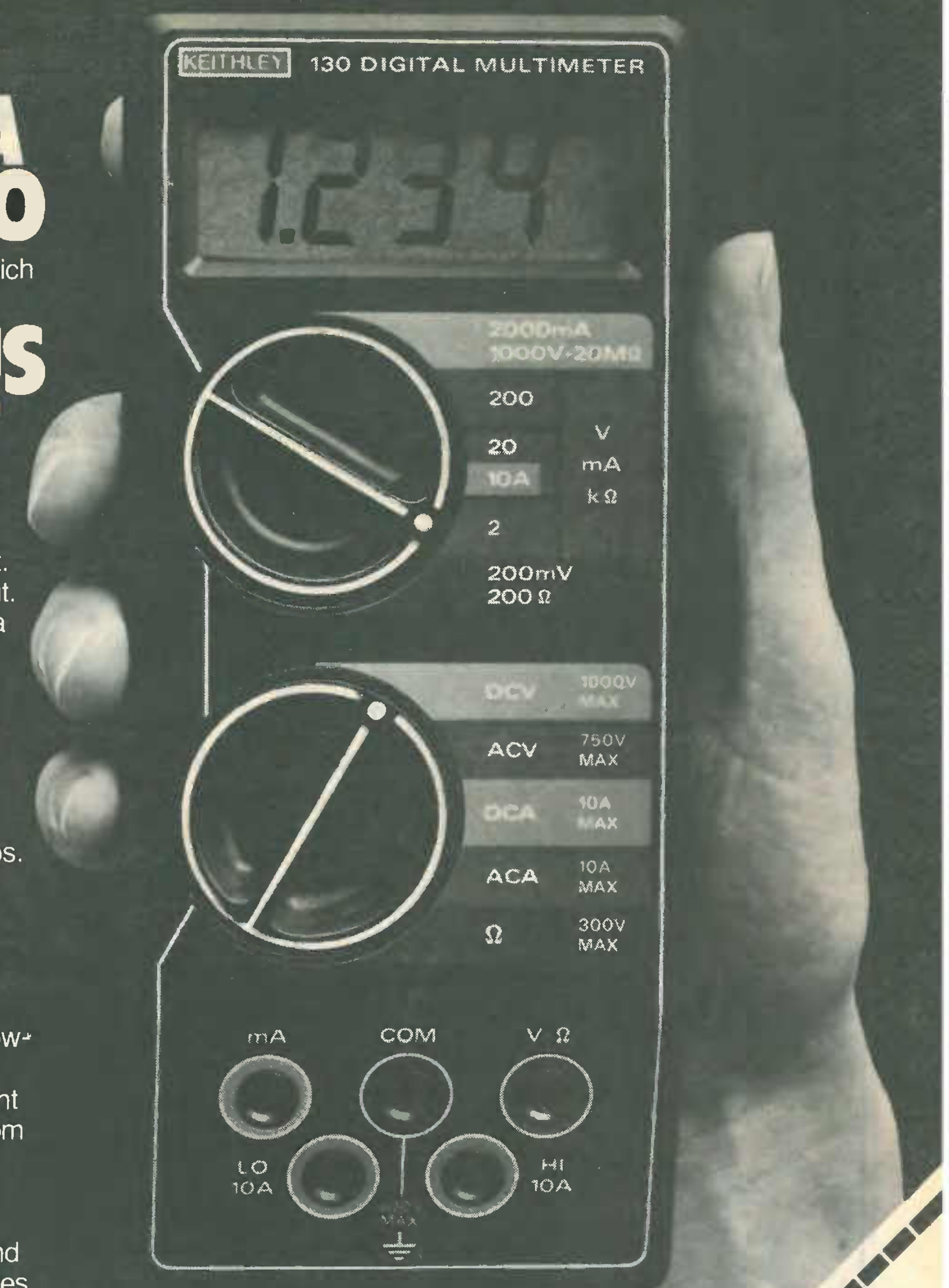
Specification:

Frequency	10,15 & 20 metres
Impedance	52 ohms
R.F. Power (max.)	1 kW (AM) 2 kW (PEP)
VSWR (at resonance)	Less than 2.0:1
Forward gain	up to 8.0 db
Front-to-Back Ratio	25 db
Mast Diameter	31.75mm to 41.30mm
Wind Survival	80 mph
Turning Radius	14'-10''
Longest element	26'
Boom length	12'
Net Weight	21lbs

£120 complete with Balun including carriage and VAT
Balun available at £15 each

Orders to:
BARNET METAL CAR AND CO. LIMITED
Tewin Road, Welwyn Garden City, Hertfordshire
Telephone: Welwyn Garden City 24327
Telex: 28125. Cable: BARMECO

GET YOUR HANDS ON A KEITHLEY 130



The pocket Digital Multimeter by which others are judged.

£89 PLUS VAT

And generous discounts start at 10 units; 5%.

Everything about the 130 is right. Easy to operate, large clear read-out. Compact, robust and reliable. With a specification few can equal in machines costing twice the price:

- Only one calibration adjustment.
- One year guarantee on spec.
- 25 ranges and five functions: ohms, DC and AC volts and amps.
- 10 amp range.
- 100 V, 1 A, 0.1 Ω sensitivity.
- 20,000 hour M.T.B.F.

All this is backed by the immense know-how of a specialist company with an enviable reputation for test equipment spanning almost all requirements from 3½ to 5½ digits.

How do you get one?

Simple. Just send off the coupon enclosing cheque or postal order. And see for yourself how the 130 measures up.

The Keithley 130 – the D.M.M. that won't stretch your pocket!

KEITHLEY
Keithley Instruments Ltd
1 B[illegible] Road Reading Berkshire RG2 0NL
Tele[illegible] 861287

WW – 033 FOR FURTHER DETAILS

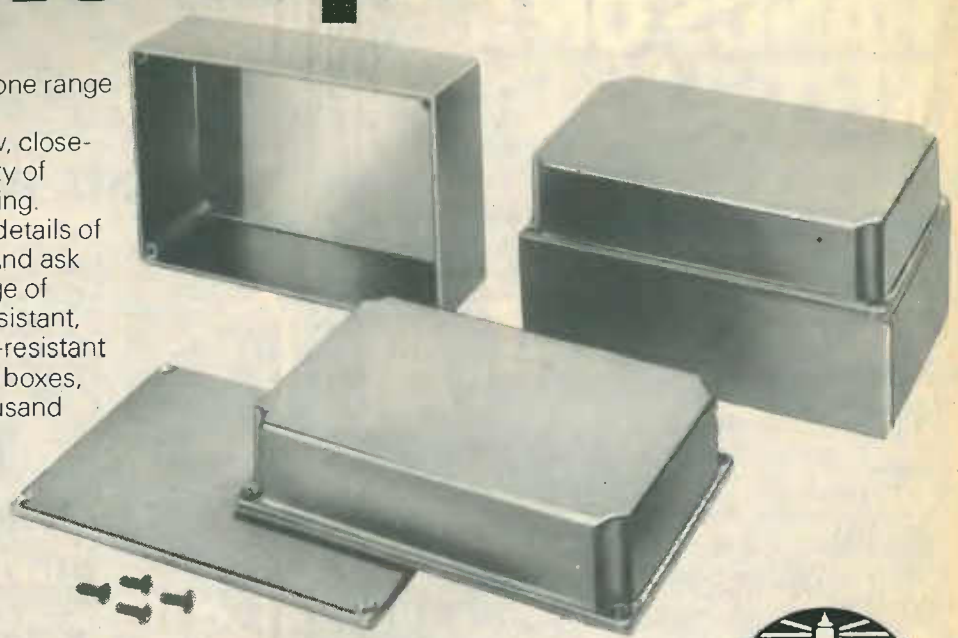
To Keithley Instruments Ltd, 1 Boulton Road, Reading, Berkshire.
Please send me ______ Keithley 130(s) at £102.35 including V.A.T. each.
(Packaging and Postage included).
I enclose a cheque/postal order for ______
Name ______
Address ______

Allow 21 days for delivery. This offer includes postage and packaging in the United Kingdom only.

WW 6/82

www.americanradiohistory.com

Double Top



This new addition to the Eddystone range of diecast boxes is supplied with interchangeable deep or shallow, close-fitting flanged lids giving flexibility of application with minimum stocking.

Please write or telephone for details of the new, versatile 10758P box. And ask about the whole Eddystone range of strong, lightweight, corrosion-resistant, diecast aluminium boxes, water-resistant boxes and moulded ABS plastic boxes, in a range of sizes to meet a thousand applications.

Eddystone Radio Limited
Member of Marconi Communication Systems Limited

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

Eddystone

WW – 070 FOR FURTHER DETAILS

SAFGAN DT-400 Series BRITISH MAKE DUAL TRACE 'SCOPES

DT-410, 10 MHz	DT-415 15MHz	DT-420 20MHz

★ CH1, CH2 5mv/div – 20v/div.
★ Time Base: 1 sec/div – 100ns/div.
★ XY Facility: Matched XY inputs.
★ Trigger: Level control, ± Slope selection.
★ Auto, Normal, TV Triggering.
★ External Trigger
★ Z-Modulation.
★ CAL output 1v 1kHz.
★ Graticule blue ruled 8x10 div. (4in. CRT).
★ Size: H215mm, W165mm, D280mm.
★ Weight: 4kg.

PROBE (XI-REF-X10) £11.50

SAFGAN ELECTRONICS LTD.
OMEGA ROAD, WOKING, SURREY TEL. WOKING (04862) 69560
Carriage: England & Wales £7.50 + V.A.T.; Scotland £10.50 + V.A.T.
London Stockist: Audio Electronics - Tel: 01-724 3564
North-West Stockist: Darom Supplies, Warrington, Ches. - Tel: Warrington 64764
Avon Stockist: L.F. Hanney, Bath - Tel: Bath 24811
Cardiff Stockist: Steve's Electronics Supply Co., Cardiff - Tel: (0222) 41905
Chesterfield Stockist: Kays Electronics, Chesterfield - Tel: (0246) 31696
Newcastle Stockist: Aitken Bros. & Co., Newcastle - Tel: 0632 26729
Birmingham Stockist: P.A.T.H. Electronic Services - Tel: 021-327 2339
Derby Stockist: RTS, Derby - Tel: (0332) 41235

Buy it with Access — BARCLAYCARD VISA

WW – 093 FOR FURTHER DETAILS

PRODUCTION TESTING
DEVELOPMENT
SERVICING

POWER UNITS
Now available with 3 OUTPUTS

Type 250VRU/30/25

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

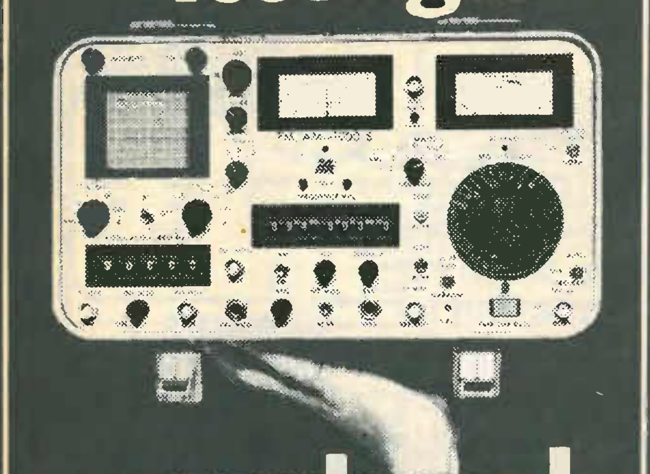
ALL Continuously Variable

Valradio

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

WW – 086 FOR FURTHER DETAILS

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



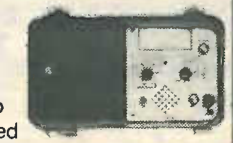
anywhere!

FM/AM 1000s with Spectrum Analyser — we call it the SUPER – S

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

A PRACTICAL TOP UP! MM-100 MULTI-METER

Simply replaces the protective lid of the FM/AM 1000s. 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, Ohms 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

Hunting — Fieldtech Heathrow

Fieldtech Heathrow Ltd.
Huntavia House
420 Bath Road
West Drayton
Middlesex UB7 0LL
Tel: 01-897 6446
Telex: 23734
FLDTEC G

IFR precision simulators

WW – 075 FOR FURTHER DETAILS

MICROCOMPUTER COMPONENTS
LOWEST PRICES – FASTEST DELIVERY

Device	Price
MEMORIES	
2114L-200ns	0.84
2114L-300ns	0.84
(GTE-special for ACORN)	1.55
2708 450ns	3.00
2716 450ns	1.75
(Single + 5V)	
2532 450ns	4.20
2732 450ns	4.00
4116 150ns	0.64
4116 200ns	0.70
4118 150ns	6.00
4118 200ns	3.90
5516 200ns	9.75
6116LP 150ns	10.83
6116LP 200ns	10.00
6116P 150ns	5.25
6116P 200ns	4.95
CRT CONTROLLERS	
EF6845P	9.50
EF9364P	5.94
EF9365P	62.90
BUFFERS	
81LS95	0.90
81LS96	0.90
81LS97	0.90
81LS98	0.90
8T26A	1.20
8T28A	1.20
8T95	1.35
8T97A	1.35
8T98	1.45
DATA CONVERTERS	
ZN425E-8	3.45
ZN426E-8	3.00
ZN427E-8	5.99
ZN428E-8	4.75
ZN429E-8	2.10
ZN432CJ-10	28.09
ZN433CJ-10	2.59
ZN440	56.83
ZN432E-10	13.00
ZN447	9.14
ZN448	6.85
ZN449	3.20
FLOPPY DISC CONTROLLERS	
FD1771	17.12
FD1791	32.61
FD1793	32.61
FD1795	35.33
WD1391	45.50
WD1393	45.50
WD1395	45.50
WD1397	45.50
WD2143-01	5.45
WD1691	10.87
MISCELLANEOUS SUPPORT CHIPS	
AY-3-1015	2.99
AY-3-1270	7.95
AY-3-8910	5.99
AY-5-1013	2.99
AY-5-3600	7.95
AY-5-2376	5.99
DP8304	4.50
MC1488	0.55
MC1489	0.55
MC3446	2.95
MC3448A	4.25
MC3480	7.95
MC3487	2.95
MC14411	6.94
MC14412	7.99
RO-3-2513L	6.99
RO-3-2513U	5.99
ULN2803A(L203)	0.84
DVM CHIPS	
ZN450e	7.61
ZN450E DVM KIT	25.00
LINEARS	
LM301AN	0.25
LM308N	0.89
LM311N	0.69
LM319N	2.14
LM324N	0.30
LM348N	0.59
LM555CN	0.18
LM556CN	0.45
LM725CN	3.20
LM741CN	0.14
LM747CN	0.64
LM748CN	0.34
REGULATORS	
7805	0.39
7812	0.39
7815	0.39
78L05	0.29
78L12	0.29
78L15	0.29
7905	0.55
7912	0.55

Device	Price
7915	0.55
79L05	0.59
79L12	0.59
79L15	0.59
LM309K	0.99
LM317K	3.20
LM323K	4.95
LM338K	4.75
Z80 FAMILY	
Z80 CPU	3.49
Z80A CPU	3.99
Z80 CTC	2.99
Z80A CTC	3.10
Z80 DART	5.45
Z80A DART	5.70
Z80 DMA	9.95
Z80A DMA	11.95
Z80 PIO	2.85
Z80A PIO	3.15
Z80 SIO-0	10.99
Z80A SIO-0	11.99
Z80 SIO-1	10.99
Z80A SIO-1	11.99
Z80 SIO-2	10.99
Z80A SIO-2	11.99
MK 3886	11.00
MK 3886-4	14.47
6800 FAMILY	
6800	2.99
6802	3.99
6803C	11.60
6809	9.99
6810	1.12
6821	1.25
6840	4.20
6850	1.50
6862	6.91
6871AIT	18.70
6880	1.07
6887	0.80
68488	9.11
6875	4.18
6843	13.99
68B00	4.70
68B02	19.11
68B21	2.29
68B10	2.00
68B40	4.70
68B50	2.15
68000C4	110.00
6500 FAMILY	
6502	3.45
6520	2.99
6522	4.75
6532	6.65
8080 FAMILY	
8085A	5.20
8212	1.70
8216	0.80
8224	1.80
8228	3.95
8251	3.19
8253	7.95
8255	3.90
CMOS 4000 'B' SERIES	
4000	0.11
4001	0.11
4002	0.13
4006	0.60
4007	0.15
4008	0.55
4009	0.26

Device	Price
4010	0.35
4011	0.12
4012	0.15
4013	0.29
4014	0.58
4015	0.58
4016	0.25
4017	0.45
4018	0.58
4019	0.29
4020	0.58
4021	0.60
4022	0.62
4023	0.17
4024	0.35
4025	0.16
4026	0.99
4027	0.30
4028	0.55
4031	1.65
4033	1.60
4034	1.55
4035	0.72
4040	0.54
4041	0.69
4042	0.54
4043	0.59
4044	0.84
4045	1.65
4046	0.68
4047	0.68
4048	0.54
4049	0.26
4050	0.26
4051	0.59
4052	0.68
4053	0.59
4054	1.20
4055	1.20
4060	0.79
4063	0.95
4066	0.34
4068	0.17
4069	0.17
4070	0.17
4071	0.17
4072	0.17
4073	0.19
4075	0.17
4076	0.62
4077	0.22
4078	0.24
4081	0.14
4082	0.19
4085	0.63
4086	0.69
4093	0.39
4502	0.69
4507	0.39
4508	1.90
4510	0.60
4511	0.49
4512	0.60
4514	1.49
4515	1.49
4516	0.69
4518	0.40
4519	0.28
4520	0.69
4521	1.49
4522	1.20
4526	0.70
4527	0.69
4528	0.70
4532	0.85
4541	0.99
4543	0.99
4553	2.90

Device	Price
4555	0.39
4556	0.44
4585	0.62
74LS SERIES	
74LS00	0.10
74LS01	0.11
74LS02	0.12
74LS03	0.12
74LS04	0.12
74LS05	0.13
74LS08	0.12
74LS09	0.12
74LS10	0.12
74LS11	0.12
74LS12	0.12
74LS13	0.22
74LS14	0.37
74LS15	0.12
74LS20	0.12
74LS21	0.12
74LS22	0.12
74LS26	0.15
74LS27	0.12
74LS28	0.15
74LS30	0.12
74LS32	0.12
74LS33	0.16
74LS37	0.15
74LS38	0.15
74LS40	0.12
74LS42	0.33
74LS47	0.39
74LS48	0.59
74LS49	0.59
74LS51	0.14
74LS54	0.15
74LS55	0.15
74LS73	0.19
74LS74	0.16
74LS75	0.24
74LS76	0.20
74LS78	0.19
74LS83	0.44
74LS85	0.60
74LS86	0.15
74LS90	0.28
74LS91	0.74
74LS92	0.33
74LS93	0.33
74LS95	0.42
74LS109	0.21
74LS112	0.21
74LS113	0.23
74LS114	0.30
74LS122	0.39
74LS123	0.39
74LS124	1.20
74LS125	0.24
74LS126	0.25
74LS132	0.44
74LS136	0.28
74LS138	0.33
74LS139	0.35
74LS145	0.74
74LS148	0.90
74LS151	0.39
74LS153	0.28
74LS155	0.38
74LS156	0.36
74LS157	0.29
74LS158	0.31
74LS160	0.39
74LS161	0.37
74LS162	0.39
74LS163	0.38
74LS164	0.45
74LS165	0.75

Device	Price
74LS166	0.84
74LS173	0.69
74LS174	0.45
74LS175	0.45
74LS181	1.28
74LS190	0.49
74LS191	0.49
74LS192	0.49
74LS193	0.45
74LS194	0.39
74LS195	0.39
74LS196	0.57
74LS197	0.59
74LS221	0.54
74LS240	0.69
74LS241	0.69
74LS242	0.78
74LS243	0.79
74LS244	0.60
74LS245	0.88
74LS247	0.80
74LS248	0.80
74LS249	0.83
74LS251	0.40
74LS253	0.39
74LS257	0.43
74LS258	0.39
74LS259	0.78
74LS261	1.95
74LS266	0.22
74LS273	0.70
74LS279	0.39
74LS283	0.44
74LS290	0.54
74LS293	0.45
74LS365	0.34
74LS366	0.36
74LS367	0.34
74LS368	0.35
74LS373	0.70
74LS374	0.70
74LS375	0.47
74LS377	0.70
74LS378	0.60
74LS379	0.84
74LS386	0.28
74LS390	0.54
74LS393	0.59
OIL SOCKETS LOW PROFILE - TIN	
8 pin	0.07
14 pin	0.09
16 pin	0.09
18 pin	0.13
20 pin	0.14
22 pin	0.17
24 pin	0.19
28 pin	0.25
40 pin	0.29
LOW PROFILE GOLD	
8 pin	0.22
14 pin	0.29
16 pin	0.31
18 pin	0.33
20 pin	0.35
22 pin	0.40
24 pin	0.42
28 pin	0.54
40 pin	0.81
ZERO - INSERTION FORCE OIL	
24 pin	6.30
28 pin	7.40
40 pin	8.80
CRYSTALS	
1 MHz	2.90
1.008 MHz	2.90
1.8432 MHz	2.20
3.6864 MHz	2.95
4 MHz	1.65
6 MHz	1.90
8 MHz	1.95
14 MHz	3.45
UHF MODULATORS	
6 MHz	3.70
8 MHz	4.40

NEW
NEC 12" MONITOR
Custom made computer display inc built in speaker and amp. Green phosphor display 149.00
(£10 carriage & VAT)

EPROM Erasers
UV141–14 eprom capacity-built in tuner 78.00
(+£5 carriage & VAT)

BBC MICRO UPGRADE KITS

Part No	Description	Price Each
BBC 1	16k Memory Upgrade Kit	32.00
BBC 2	Printer/User I/O Kit	9.50
BBC 3	Floppy Disc Controller Kit	42.50
BBC 4	Analogue Input Kit	9.50
BBC 5	Serial Interface and RGB Connector Kit	11.45
BBC 6	Expansion Bus and 'Tube' Kit	6.95
	Special price for all kits purchased together	99.95

(Converts Model A to Mode B)

OFFICIAL ORDERS WELCOME — VISA — 24 HOUR TELEPHONE SERVICE FOR CREDIT CARD USERS — QUANTITY DISCOUNTS AVAILABLE

★ Free Reply Paid Envelope with every order ★
★ All CWO's receive a voucher value £1 against future purchase ★
★ All prices exclude VAT & P & P (0.75) (Free on CWO's over £10) ★
★ All orders despatched on day of receipt with full refund on out of stock items if requested ★

MIDWICH COMPUTER CO. LTD.
DEPT WW, HEWITT HOUSE, NORTHGATE STREET, BURY ST. EDMUNDS, SUFFOLK IP33 1HQ
TELEPHONE: (0284) 701321 TELEX: 817670

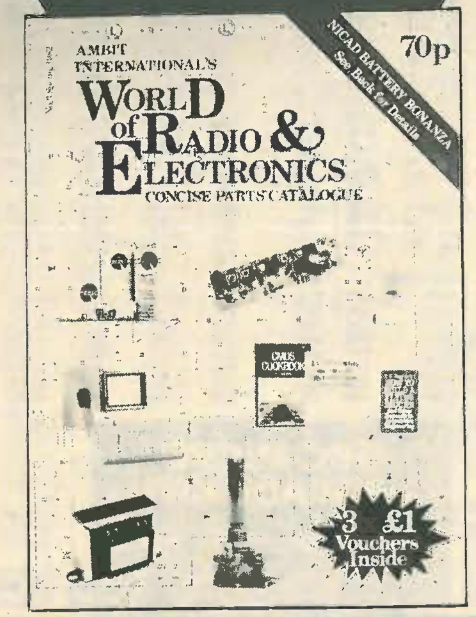
WW – 013 FOR FURTHER DETAILS

www.americanradiohistory.com

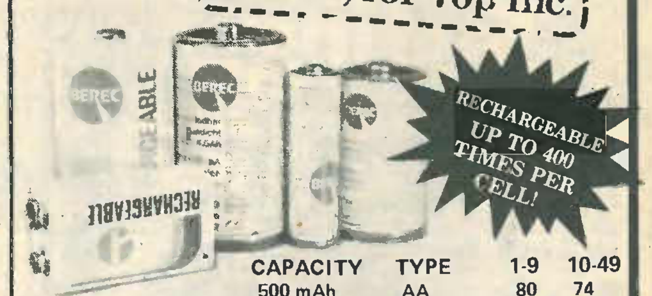
NICADS: UK's LOWEST PRICES

AMBIT'S NEW CONCISE COMPONENT CATALOGUE IS OUT NOW – Available at your newsagent or direct, for 70p inc.

Price on the page



Ambit's new style catalogue continues to lead the market with low prices, new items, info, 3 x £1 discount vouchers. Here's a few examples of some super low prices:



CAPACITY	TYPE	1-9	10-49
500 mAh	AA	80	74
2200 mAh	C	2.35	1.99
1200 mAh	D	2.14	2.06
4000 mAh	D	3.05	2.85
110 mAh	PP3	3.70	3.50

78XX 1A	37p
BC237/8/9	8p
3SK51	54p
10MHz XTALS	£2
8 Pole 10.7MHz XTAL filters	£14.50
2GHz coax relay 150W	£10.95

+ all the usual stuff at rock bottom prices + Toko coils, crystal and ceramic filters, micrometals toroids, Fairite ferrites, Alps switches, OKI LSI, Piezo sounders, RF, IF Modules + Kits etc.

Prices shown EXCLUDE VAT. Access/Barclaycard may be used with written or telephone orders, official MA details on application. E & EO.

POSTAGE and PACKING 50p per order

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

AMBIT international 200 North Service Road, Brentwood, Essex

WW – 009 FOR FURTHER DETAILS

WRONG TIME?

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 and leap year, can expand to Years, Months, Weekdays and Milliseconds, also parallel BCD output for computer or alarm and audio to record and show time on playback, receives Rugby 60kHz atomic time signals, built-in antenna, 1000Km range, GET the RIGHT TIME, £62.80.
V.L.F.? EXPLORE 10-150KHz, Receiver £16.50.
60KHZ RUGBY RECEIVER, as in MSF Clock, serial data output for computer, etc, decoding details, £17.90.

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

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

RADIATION DETECTORS

BE PREPARED

VIEW THRU LENS ▸

Ideal for the experimenter
- THIS DOSIMETER WILL AUTOMATICALLY DETECT GAMMA AND X-RAYS
- UNIT IS SIZE OF FOUNTAIN PEN & CLIPS ONTO TOP POCKET
- PRECISION INSTRUMENT
- MANUFACTURERS CURRENT PRICE OF A SIMILAR MODEL OVER £25 EACH
- 0-5 R

British design & manufacture
Tested and fully guaranteed. Ex-stock delivery.
As supplied to Fire Services/Civil Defence

FREE RECHARGE SERVICE AFTER PURCHASE

£6.95
Add. VAT. Post & Packing

COMPLETE WITH DATA

HENRY'S Official Orders welcome 01-723 1008/9

CALLERS: 404 EDGWARE ROAD, LONDON W2 1ED
Mail Orders/Export Enquiries to: 11-12 Paddington Green, London W2

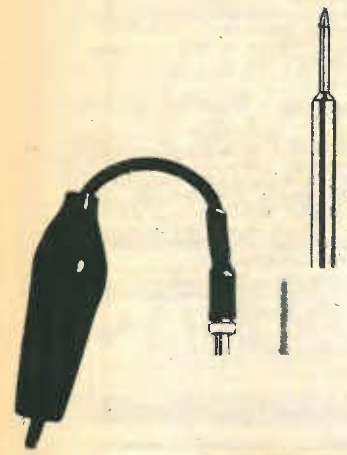
THE MOST ECONOMICALLY – PRICED PROFESSIONAL EPROM PROGRAMMERS AROUND

SUITABLE FOR EPROMS:
2708, 2516, 2716, 2532, 2732, 2732A
plus option for 2564, 2764

DATAPROM STARTING AT £395 + VAT
Albetros (Products) Limited Frances Road Basingstoke Hampshire RG21 3DA
Telephone (0256) 57551

WW – 015 FOR FURTHER DETAILS

The only full-featured ECL Logic Probe...available now!

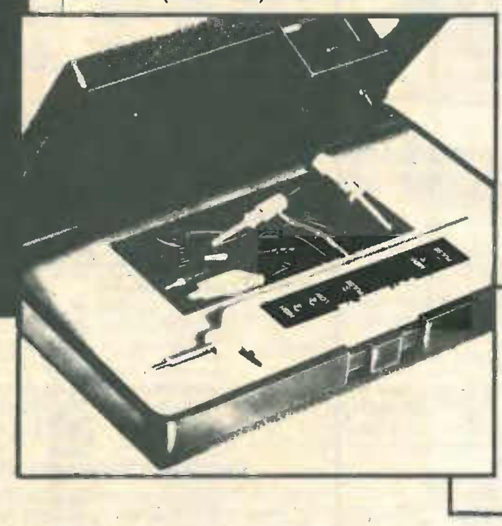


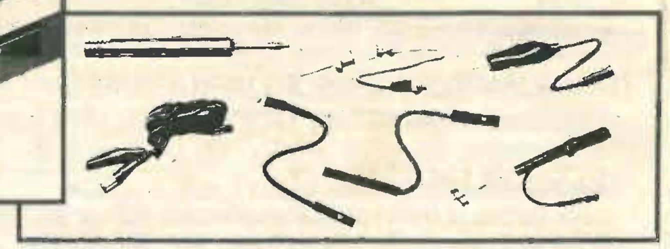
ECL users take heart! Global Specialties' new LP-4 is a full-featured ECL Logic Probe specifically designed to meet the demanding tolerances and speed of emitter coupled logic.

The LP-4 comes complete and ready to use . . . in a compact, rugged carrying case with a full complement of accessories. No need to design and build special adapters or fittings . . . they're all included . . . just power up the LP-4 from the circuit under test (V_{EE}) and you're ready to start looking for transients . . . intermittent pulses . . . stuck nodes and invalid logic levels . . . at frequencies up to 150 MHz and pulse widths down to 3 nanoseconds. Naturally, pulse stretching (.3 sec/event) and memory are built in and switch selectable.

If you're working with emitter coupled logic . . . you need the LP-4. At only £97.00 you can't afford to be without one. Order yours today by phoning 0799 21682 (24 hour service). Price including P&P and 15% VAT £113.85

Specifications: **THRESHOLD VOLTAGES, POSITIVE LOGIC V_{EE} -5.2 ± .01 VDC @ 25°C ± 3°C** Logic One (1): -1.10 ± 0.5 VDC Logic Zero (0): -1.50 ± .05 VDC **V_{EE} -5.2 ± 5%, T_A 10°-40°C** Logic One (1): -1.10 ± 0.1 VDC Logic Zero (0): -1.50 ± 0.1 VDC **INPUT IMPEDANCE** Greater than 10k Ohms **INPUT PULSE WIDTH (MINIMUM)** 3 nano-seconds **INPUT PULSE REPETITION RATE** 100 MHz minimum; (150 MHz typical at 50% duty cycle) **INPUT OVERLOAD PROTECTION** ± 100 VDC, continuous; ± 220 VDC, transients; 120 VAC for 30 seconds (to 1 KHz) **POWER REQUIREMENTS** -5.2 VDC ± 5% at 100 mA, Supply Voltage Protection: -12 to + 200 VDC **OP TEMP** 10-40°C **INCLUDES** Instruction manual, LDA-8 36" power ground leads with alligator clips, LDA-1 1.5" long probe tip, LDA-5 3" long ground alligator clip, LDA-3 3" long easy hook input adapter, LDA-10 BNC input adapter, LDA-11 3" long wire wrap pin-input adapter, LDA-12 3" long wire wrap pin-ground adapter **DIMENSIONS** 5.8 × 1.0 × 0.7 inches L × W × D (147 × 25 × 18 mm) 3 oz (85 gm) **STOCK NO** 07-0010





GLOBAL SPECIALTIES CORPORATION

GSC

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

G.S.C. (UK) Limited, Dept. 7Y, Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

Model LP-4	LOGIC PROBE	Unit price inc P&P 15% VAT £113.85	Qty	

Name
Address

I enclose cheque/P.O. for £ ______ or debit my Barclaycard/Access/American Express card no. ______ exp. date ______

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

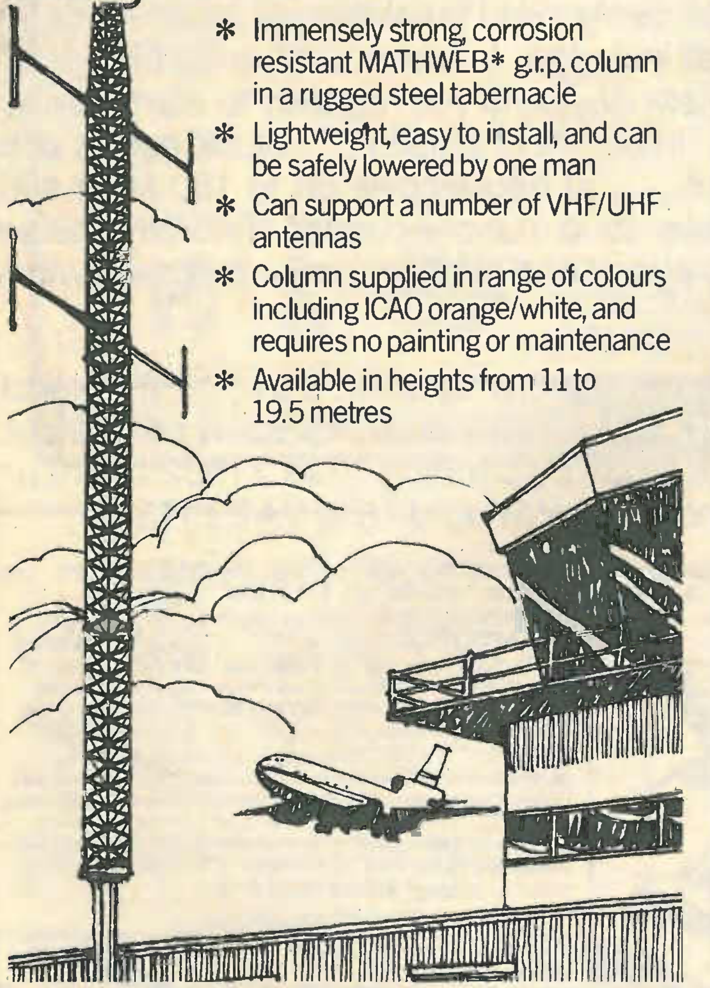
For FREE catalogue tick box

WW – 026 FOR FURTHER DETAILS

www.americanradiohistory.com

Marconi Type R1020 Hinged antenna column.

Easy to raise Easy to lower



- ✻ Immensely strong, corrosion resistant MATHWEB* g.r.p. column in a rugged steel tabernacle
- ✻ Lightweight, easy to install, and can be safely lowered by one man
- ✻ Can support a number of VHF/UHF antennas
- ✻ Column supplied in range of colours including ICAO orange/white, and requires no painting or maintenance
- ✻ Available in heights from 11 to 19.5 metres

OTHER MARCONI SUPPORT STRUCTURES

Include the MATHWEB* Lattice Antenna Mast Type R1010, and the Triangular Section Tubular Steel Self Supporting Tower Type R1060.

For details of these and other Marconi Antennas products please contact Chris Pettitt, Marketing Manager, Antenna Systems Division.

*MATHWEB is a registered trademark of the BP Group

Marconi Antennas

Marconi Communications Systems Limited
Lane Works, Waterhouse Lane, Chelmsford CM1 2QX, England
Tel: 0245 67111 Telex: 99108

A GEC-Marconi Electronics Company

WW – 025 FOR FURTHER DETAILS

IRVINE BUSINESS SYSTEMS LTD **IBS**

NEW PRODUCTS

I.B.S. now manufacture Industrial quality S100 products in Scotland.
I.B.S. 1903 and 1906. S100 19" Sub Rack System.
These racks were designed originally to the exacting specification of the Electricity Generating Board for use on nuclear power stations.
1903 is a 3U high card cage and 8-amp power supply and will take 6 S100 cards.
1906 is a 6U high card cage and 16-amp power supply and will take 12 S100 cards.

- ★ IEC mains connector, filter, fuse and tap change switch on rear panel.
- ★ Key operated ON/OFF/RESET for maximum security.
- ★ Heavy duty painted front panel.
- ★ Carrying handles.
- ★ Supplied assembled complete with Power supply, IEEE (696) motherboard, card guides, and cooling fans.

I.B.S. 1903	£299.00
I.B.S. 1906	£399.00
6-slot Card cage, card guides, mother board and fan	£119.00
12-slot Card cage, card guides, mother board and fans	£249.00

I.B.S. 64K CMOS Static RAM/PROM Board for S100.

This is a superior quality Ram/Prom board for the industrial user, the board will accept either H6116-3 (2K x 8) Ram chips or 2716 EProms in any combination.

- ★ S100 IEEE (696) Compatible.
- ★ 24 Bit Addressing.
- ★ Can be used with any CPU.
- ★ Prom/Ram selectable on 2K boundary.
- ★ Prom/Ram can be disabled to suit popular memory mapped devices.
- ★ Low power.
- ★ Will run at 6Mhz with standard Rams.
- ★ Wait state generation for Proms.
- ★ Phantomable.

PRICES:

	16K	32K	48K	56K	64K
BARE BOARD Assembled/ tested £65.00	£179.00	£239.00	£299.00	£329.00	£359.00

Educational and industrial discounts available.

SOFTWARE SALE (whilst stocks last).

Microsoft Basic 80	WAS £175	NOW £149.00
Microsoft Basic Compiler	WAS £180	NOW £159.00
Introductory offer		
MicroPro CALC STAR	WAS £175	NOW £149.00

- ★ Visit our stand at the Thames Valley Business Show, on 23/24/25th March '82
- ★ Stand H50/51
- ★ The Fulcrum Centre ★ Slough

The above prices exclude VAT at 15%

IRVINE BUSINESS SYSTEMS LTD.
P.O. BOX 5
10 NORTH VENNEL
BOURTREEHILL
IRVINE
AYRSHIRE KA11 1NE

TEL. 0294 218888
Telex 777582
Mark: attn. IBS

BARCLAYCARD VISA

WW – 072 FOR FURTHER DETAILS

RF POWER TRANSISTORS–EX-STOCK

TYPE	£	TYPE	£	TYPE	£	TYPE	£
2N3137	1.88	2N4933	7.80	BLX13C	15.05	BLY53A	7.33
2N3375	5.27	2N5070	10.09	BLX14	25.70	BLY53AP	7.33
2N3553	1.09	2N5071	12.10	BLX65	1.67	BLY55	9.40
2N3632	6.03	2N5090	8.44	BLX66	4.91	BLY83	7.45
2N3733	6.13	2N5102	9.44	BLX67	5.41	BLY84	7.25
2N3866	0.92	2N5590	7.85	BLX68	7.29	BLY85	6.02
2N3924	1.66	2N5591	10.21	BLX69X	21.15	BLY87A	6.43
2N4040	9.29	2N5641	4.68	BLX91A	8.84	BLY87C	6.43
2N4041	10.97	2N5642	8.11	BLX92A	13.06	BLY88A	8.66
2N4127	9.18	2N5643	12.44	BLX93A	19.19	BLY89C	9.10
2N4128	11.03	2N5913	2.34	BLX94A	35.79	BLY89A	12.65
2N4129	12.08	2N6080	5.94	BLX95	44.59	BLY69C	11.90
2N4427	1.15	2N6081	9.87	BLX98	84.95	BLY91A	6.95
2N4429	9.89	2N6082	10.17	BLY33	1.87	BLY91C	6.90
2N4430	11.30	2N6083	11.08	BLY34	1.07	BLY92A	9.25
2N4431	12.50	2N6084	12.27	BLY35	7.50	BLY92C	9.06
2N4932	5.50			BLY36	6.60	BLY93A	13.40
						BLY93C	11.40

COMMUNICATION TUBES–EX-STOCK

TYPE	£	TYPE	£
4-65A	35.10	6155/QY3-125	47.30
4-125A	42.90	6155/QY3-125(AEL)	22.40
4-250A	50.70	6156/QY4-250	45.30
4-400A	58.20	6883B	4.30
4-1000A	331.00	7527/QY4-400	42.00
4CX250B	38.00	7854/YL1060	53.80
4CX350A	55.00	8042	16.50
4CX1500A	498.00	A2426	19.25
4CX1500B	319.00	QQV03-10	5.60
4X150A	36.00	QQV03-10(AEL)	2.54
4X500A	175.00	QQV03-20A	39.00
5B254M	23.40	QQV03(AEL)	17.20
5B255M	23.40	QQV06-40A	43.60
6F33(AEL)	15.62	QQV06-40(AEL)	11.70
12E1	16.94	QQV07-50	68.00
13E1	141.00	QV08-100	125.00
5763	3.25	QY5-3000A	234.00
6080	5.40	TBL2-300	286.00
6146A	3.80	TT21	19.76
6146B	4.07	TT22	19.76

SEND NOW FOR PRICE LISTS SHOWING QUANTITY DISCOUNTS

AEL
EXPORT SPECIALIST

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

WW – 072 FOR FURTHER DETAILS

AUDIO ELECTRONICS

ALL PRICES INCLUDE VAT

RETAIL·MAIL ORDER·EXPORT INDUSTRIAL·EDUCATIONAL

LONDON'S TEST EQUIPMENT CENTRES

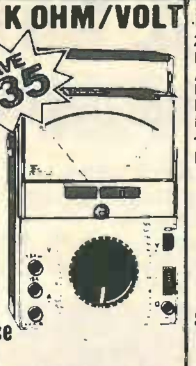
CALL IN AND SEE FOR YOURSELF OPEN SIX DAYS A WEEK *ALL MODELS ON DISPLAY*

CROTECH 3035 10 MHZ Scope Plus Component Tester

SAVE £21 PLUS

5" – 130mm Flat Face Tube DC – 10 MHZ
5mV/DIV 220/240V AC Trig. to 20 MHZ

As advertised by us at £189.75 inc. VAT
NOW **£168.50** Inc.VAT
(UK c/p £3.50) Exclusive to Audio Electronics



PROFESSIONAL 100 K OHM/VOLT MULTIMETER

SAVE £35

30 ranges 15A AC/DC
1.5 KV. 200 meg ohms.
Features mirror scale, polarity reverse, electronic overload protection, taut band suspension.
As advertised by us at £67.50 + case i.e. £84.00
NOW **£49** Inc. VAT
(UK c/p £1.50) with leather case
Exclusive to Audio Electronics

LCD LOW COST MULTIMETERS

2033A Sabtronics version of above	£39.95
DD601 3½ digit LCD 26 range push button 2A AC/DC 20 meg ohm Basic 0.5%	£37.95
HC703 0.1% version of above	£54.00
DM6011A/188m 3½ digit LCD 15 range push button plus Hfe Tester 10A DC (No AC A)	£43.50
189m 3½ digit LCD 30 range Rotary switch plus Hfe Tester 10A AC/DC	£69.95

Callers will always find a range of low cost test equipment, accessories, tools, irons and boards in stock, also special offers for certain equipment which will vary from time to time
Price correct at time of preparation E&OE
All prices include VAT

CHOOSE FROM UK's LARGEST RANGE

STOP PRESS Few only 8110 23 range 10A AC/DC, range hold, continuity buzzer plus much more Rotary switch £59.95

SABTRONICS EQUIPMENT NEW LOW PRICES!!

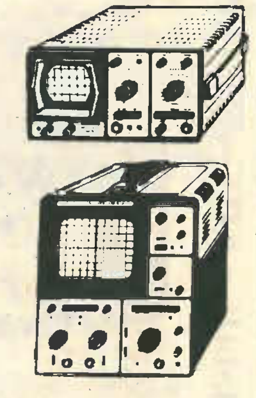
New reliable range of DMM's and frequency computers with those extra facilities and competitive prices. All battery operated (supplied). Except 5020A mains. Optional mains eliminators available.

8 DIGIT COUNTERS 0.1 HZ to 10 HZ Res. 10mV sensitivity to 100 MHZ (UK c/p £1.00)
8110A 20 HZ-100 MHZ in 2 ranges £77.00
8610A 20 HZ-600 MHZ in 3 ranges £94.00

9 DIGIT COUNTERS 30mV sensitivity to 1GHZ. Resolution 0.1 HZ-10 HZ
8610B 10 HZ-600 MHZ in 3 ranges £113.85
8000B 10 HZ-1GHZ in 3 ranges £178.00
2015A LCD version of above £95.00
(c.p 2035/37A 65p: All others £1.00)

FUNCTION GENERATOR (UK c/p £1.00) with mains adaptor
5020A 1 HZ-200 KHZ Sine/Square/Triangle/TTC Freq. sweep. Low distortion £90.00

DIGITAL MULTIMETERS Two LCD hand held – one with temperature range. Also LCD and LED Bench models. 0.1% basic accuracy.
2035A 3½ digit LCD hand 2A AC/DC Meg ohm ETC £71.00
2037A As 2035A with −50°C to +150°C Temp. range 0.1°C resolution £77.00
2033A 3½ digit LCD 2A AC/DC etc., basic 0.5% £39.95
2010A 3½ Digit LED. Auto decimal & minus. 10A AC/DC. 20Meg ohm etc. £81.50
THP 20 Touch and Hold optional probe for DMM's £14.95



HAMEG OSCILLOSCOPES

Range of top quality scopes for Amateur and Professional (UK c/p '307' £3.00, other £4.00)

307 Single trace 10 MHZ. 5mV: 0.5 micro sec. Plus built in component tester 6 x 7cm display	£158.70
(Optional carry case £18.40)	
203 Dual 20 MHZ: Trig to 30 MHZ 5mV: 0.5 micro secs. 8 x 10cm display (replace model 312)	£253.00
412-5 Dual 20 MHZ delayed sweep: trig to 40 MHZ: 5mV 0.1 micro sec 8 x 10cm display.	£402.50
705 Dual 70 MHZ. Delayed sweep: Single sweep: Delay line: Trig to 70 MHZ: 2mV: 0.1 micro sec. 8 x 10cm display	£667.00
Options 203/412/705 Viewing hood	£6.90
Component tester 203, 412, 705	£29.95
Carry case (state model)	£21.85

Optional Probes (All models) X1 £7.95: X10 £9.45 X1-X10 £10.50: X100 £16.95
HZ65 Add on component tester – Any Scope £29.95

RF AND AUDIO SIGNAL GENERATORS Mains operated

(UK c/p £1.00) Audio 20 HZ-200 KHZ 4 band. Sine/Square o/p

TE22D Distortion max 1%	£69.95
LAG26 Distortion 0.5-1% leader	£73.70
LAG120A 5 range 10 HZ-1 MHZ. Size/sq. 0.05-0.8% DIS	£146.00
LAG125 Low distortion version of LAG120A 0.02%	£273.00
AG202A Distortion 0.5-1% Trio	78.20
AG203 10HZ-1 MHZ 5 band max distortion 0.1% Trio	£126.50
RF All feature Int/Ext. MOD. Variable output	
TE20D 100 KHZ-100 MHZ 6 band (300 MHZ harmonics)	£59.95
LSG16 100 KHZ-100 MHZ 6 band (300 MHZ harmonics) Leader	£63.25
SG402 100 KHZ-30 MHZ 6 band professional trio	£68.00

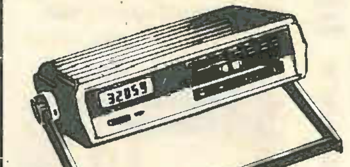
VARIABLE AND FIXED POWER SUPPLIES

(UK c/p £1.00 any model).

SPECIAL PURCHASE
1205 13.8v 5 to 7 amp £12.95

*PP241 0/12-12-24V 0/1 amp £35.00
*PP243 0/12-12/24V 0/3 amp £59.95
*RP154 5-15V 0/3 amp £49.95
*meter display

THURLBY DIGITAL MODEL MULTIMETERS 1503a



4¾ Digit. 0.05% 7 Function LCD 30 ranges: 1200V DC, 750V AC, 10A AC/DC, 32 Meg ohm. Also includes frequency measurement to 4 MHZ and 4 KHZ output.
Made to exacting standards in the UK.
1503Ha High resolution version £189.75
Price is with batteries, test leads and mains adaptor £171.00
(optional carry case £20.45) UK c/p £1.00
1905a £342.70

AMATEUR/CB TESTING–Full lists send SAE

KDM6 1.5 to 250 MHZ 6 range DIP meter £47.95
HM20 20K/VOLT multirange multimeter. Plus SWR/Power meter 150 MHZ £19.95
RC1000 0/10/100/1000 watts. SWR etc. 150 MHZ max. £32.95
UH74 SWR 0/10w Power. 0/50/144/430 MHZ tester. £13.95
FC100M 12V 100 MHZ Freq. Counter £69.95
Just a selection of a huge range in stock – send for latest lists including professional ranges.

SPECIAL CB ACCESSORY PURCHASES (Post 55p)
CB20 SWR/Power twin meter to 30 MHZ. 1Kw £8.95
SWR 50A as above but to 150MHz £11.95
175 SWR/Field strength/aerial matcher single meter £11.95
171 Twin meter SWR/Field strength 0/10/100w Power 144 MHz £10.95
1205G 13.8v 5 to 7 amp regulated power supply (post £1.00) £12.95

PROFESSIONAL MULTIMETERS

(UK c/p £1.50)
All featuring AC/DC Volts/Current & Ohms ranges.

M1500 43 range 20K/Volt: AC/DC 10A	£67.50
M1200 30 range 100K/Volt: AC/DC 15A 200 Meg ohm.	£49.00
K1400 26 range large scale 20K/Volt: 10A AC/DC: 20 Meg ohm: 5kV AC/DC	£95.00
K200 39 range 10 Meg ohm input. 25 HZ-1 MHZ	£105.00

OPTIONS Cases: M 1500 & 1200 £16.50: K1400 £19.00
Temperature Probe for K1400 £16.00

DIRECT READ HV PROBE (UK c/p 65p)

'0/40KV: 20K Volt £18.40

SAFGAN PORTABLE OSCILLOSCOPES

Range of low cost Dual Trace Scopes mains operated. Made in UK to exacting standards. Available as 10 MHZ, 15 MHZ or 20 MHZ. All feature 5mV sensitivity, 0.5 micro sec. 6.4 x 8cm display (UK c/p £2.50)

DT410	Dual 10 MHZ	£205.85
DT415	Dual 15 MHZ	£217.35
DT420	Dual 20 MHZ	£228.85

OPTIONAL 'SCOPE PROBES — SEE HAMEG ABOVE

MADE IN UK

LOGIC PROBES/MONITORS/PULSERS circuit powered (UK c/p 60p)

LP1 DTL/TTL/CMOS. 10 MHZ: Pulse: Memory	£35.50
LP2 DTL/TTL/CMOS. 1.5 MHZ: Pulse:	£19.95
LP3 DTL/TTL/CMOS. 50 MHZ: Pulse: Memory	£55.95
LM1 Logic monitor for 8 to 16 pin IC's	£33.00
OP1 Digital pulser. Single or 100pps.	£58.50
LDP076 50 MHZ: 10Meg ohm: Logic Probe, with case	£56.90

AUDIO ELECTRONICS CUBEGATE LIMITED

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

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

VISA
Order by Post with CHEQUES/ACCESS/VISA or Telephone your order
Allow up to 10 days for delivery

FREE CATALOGUE
Send large SAE (20p UK)
Schools, Companies, etc. free on request.

ALL PRICES INCLUDE VAT

WW 037 – FOR FURTHER INFORMATION

www.americanradiohistory.com

hi! performance hi! competitive hi!

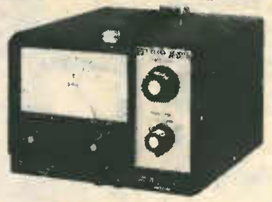
hi! reliability hi! service hi! performance hi! competitive

hi! reliability hi! service hi! performance hi! competitive hi! performance hi! competitive

LOW COST
EXCELLENCE No1
with a 2 Year Guarantee

OSCILLOSCOPES
CO 1303D and 1303G

- DC to 5 MHz
- 10 mV/div. with Var. Atten.
- 4 int. sweep speeds 10 Hz to 100 KHz
- Int. and Ext. Sync.
- Prices from just over **£100.**
- Direct Deflection Terminals on "D" can monitor RF to 450 MHz.
- "G" monitor range 1.8 to 54 MHz, 1 to 500 W direct plus Two Tone Generator,
- Ideal for SSB, AM, CW etc.



RC OSCILLATOR
AG 202A

- 20 Hz to 200 KHz
- Sine and Square wave
- 10 V rms from 600 ohms
- >60 dB of O/P attenuation
- <0.5% Distortion
- Large Scale and smooth precise tuning
- Ext. Sync.
- AG 203 10 Hz to 1 MHz <0.1% Distortion
- SG 402 AM SIGNAL GENERATOR
- 100 KHz to 30 MHz in 6 Bands
- Large clear freq. dial
- 100 mV of variable O/P with Int. and Ext. AM
- Prices from approx. **£60.**

VARIABLE POWER SUPPLIES
PR 601A and PR 602A

- Output 0-25V/3A
- 3 Preset Voltages
- Large Accurate Meter
- Low Ripple and Noise
- Auto. constant I protection
- Visual indication of I overload
- VOLT OHM METER VT 108
- DCV, ACV and Ohms with 30 sec. memory
- 0 to 1500 V DC – 0.1 to 1500 V AC – 0.1 ohms to 1000 M ohms
- 15 Hz to 5 MHz Bandwidth – Battery or AC Adapter (opt.)
- Prices from approx. **£86.**

Also AVAILABLE a range of more than 20 Oscilloscopes from 1 to 100 MHz Real Time, Digital Storage, Battery Portable, X–Y and Programmable – DMMs – Frequency meters – Electronic Voltmeters – Power and DIP meters – Variable Power Supplies – Noise meters – Signal Sources, AF, RF, Function, Sweep, TV Pattern and Stereo – Wow and Flutter etc. etc. Ask for FREE Data and Prices.

House of Instruments
Clifton Chambers, 62 High Street
Saffron Walden, Essex CB10 1EE
Tel: (0799) 24922 Telex: 818750

Extended CREDIT available

TRIO®

hi!

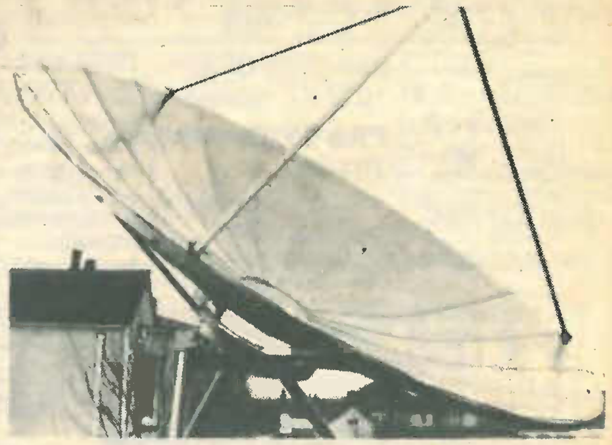
House of Instruments Ltd.

hi! competitive hi!

WW – 035 FOR FURTHER DETAILS

HBED

PARABOLIC DISHES



6ft dia. for use in satellite reception and microwave transmissions. Please send S.A.E. for full details and data sheet.

Harrison Bros.
Electronic Distributors

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

WW – 087 FOR FURTHER DETAILS

INDUSTRIAL MUSCLE
AT A REALISTIC PRICE

- * POWER BANDWIDTH DC to 100KHZ ± 1db
- * OUTPUT POWER IN EXCESS OF 500 WATTS PER CHANNEL INTO 2 OHMS OR IN EXCESS OF 1KW SINGLE CHANNEL IN BRIDGE MODE INTO 6 OHMS
- * HARMONIC DISTORTION LESS THAN 0·01% DC TO 100KHZ AT 1KW INTO 6 OHMS
- * INTERFACE BOARDS CAN BE CUSTOM DESIGNED AND BUILT TO CATER FOR A WIDE RANGE OF SPECIALISED USES
- * OUTPUT MATCHING TRANSFORMERS AVAILABLE TO MATCH VIRTUALLY ANY LOAD
- * UNCONDITIONALLY STABLE INTO ANY LOAD
- * BASIC PRICE INCLUDING BRIDGE MODE SWITCHING AND HANDLES £455

S & R AMPLIFICATION
6 Tanners Hill, London S.E.8
Telephone: 01-692 2009

WW – 084 FOR FURTHER DETAILS

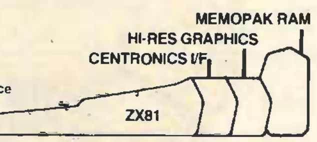
Memotech's New Memory System for the ZX81
It grows as you progress

Memopak 16K Memory Extension - £39.95 incl.VAT

It is a fact that the ZX81 has revolutionised home computing, and coupled with the new Memopak 16K it gives you a massive 16K of Directly Addressable RAM, which is neither switched nor paged. With the addition of the Memopak 16K your ZX81's enlarged memory capacity will enable it to execute longer and more sophisticated programs, and to hold an extended database.
The 16K and 64K Memopaks come in attractive, custom-designed and engineered cases which fit snugly on to the back of the ZX81, giving firm, wobble-free connections.
See below for ordering information

Coming Soon...

A complete range of ZX81 plug-in peripherals
Memotech Hi-Res Graphics
Centronics Interface and Software Drivers
Memotech Digitising Tablet RS232 Interface



All these products are designed to fit 'piggy-back' fashion on to each other, and use the Sinclair power supply.
WATCH THIS SPACE for further details. We regret we are as yet unable to accept orders or enquiries concerning these products – but we'll let you know as soon as they become available.

Memopak 64K Memory Extension -£79.00 incl.VAT

The 64K Memopak is a pack which extends the memory of the ZX81 by a further 56K, and together with the ZX81 gives a full 64K, which is neither switched nor paged, and is directly addressable. The unit is user transparent and accepts basic commands such as 10 DIM A(9000).

BREAKDOWN OF MEMORY AREAS

0–8K . . . Sinclair ROM
8–16K . . . This section of memory switches in or out in 4K blocks to leave space for memory mapping, holds its contents during cassette loads, allows communication between programmes, and can be used to run assembly language routines.
16–32K . . . This area can be used for basic programmes and assembly language routines.
32–64K . . . 32K of RAM memory for basic variables and large arrays.
With the Memopak 64K extension the ZX81 is transformed into a powerful computer, suitable for business, leisure and educational use, at a fraction of the cost of comparable systems.

Unique 3 month trade-in offer!

When your programming needs have outgrown the capacity provided by 16K RAM, and you find it necessary to further extend your ZX81's capacity, we will take back your 16K Memopak and allow a discount of £15.00 against your purchase of our 64K model.*
*We reserve the right to reject, for discounting purposes, units which have been either opened or damaged in any way.

© R. Branton & G A C Boyd 1982

How to order your Memopak.

By Post: Fill in the coupon below and enclose your cheque/P.O./Access or Barclaycard number.
By Phone: Access/Barclaycard holders please ring Oxford (0865) 722102 (24-hour answering service).

Please make cheques payable to Memotech Limited
Please debit my Access/Barclaycard* account number

*Please delete whichever does not apply

SIGNATURE ____ DATE ____

NAME ____ ADDRESS ____

Please send me:

	Quantity	Price	Total
16K RAM, Assembled		£39.95	
64K RAM, Assembled		£79.00	
		Postage	£2.00
		Total Enclosed	

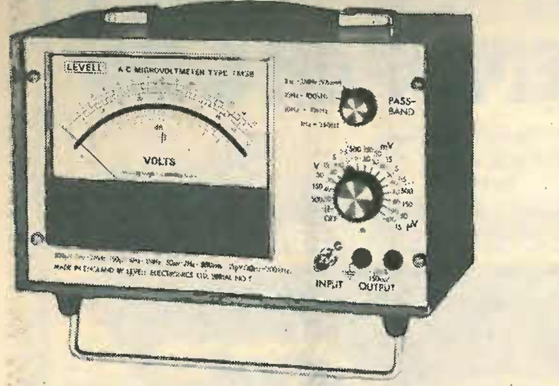
WWI

We want to be sure you are satisfied with your Memopak – so we offer a 14-day money back Guarantee on all our products.
Memotech Limited, 3 Collins Street, Oxford OX4 1XL, England Telephone: Oxford (0865) 722102/3/4/5

WW – 028 FOR FURTHER DETAILS

www.americanradiohistory.com

LOW COST VOLTMETERS



LEVELL A.C. MICROVOLTMETERS AND BROADBAND VOLTMETERS are part of our comprehensive range of test and measuring instruments.
These voltmeters give accurate readings over a wide range of frequencies. They are housed in robust steel cases and are powered by long life batteries. Mains power units and leather carrying cases are available as optional extras.

A.C. MICROVOLTMETERS

VOLTAGE & dB RANGES	15µV, 50µV, 150µV ... 500V fsd Acc. ±1% ±1% fsd ±1µV at 1kHz, −100, −90 ... +50dB. Scale −20dB/+6dB ref. 1mW/600Ω.	type TM3A **£130**
RESPONSE	±3dB from 1Hz to 3MHz, ±0.3dB from 4Hz to 1MHz above 500µV. TM3B filter switch; LF cut 10Hz. HF cut 100KHz, 10KHz or 350Hz.	type TM3B **£145**
INPUT IMPEDANCE	Above 50mV: 10MΩ <20pF. On 50µV to 50mV: >5MΩ <50pF.	

BROADBAND VOLTMETERS

H.F. VOLTAGE & dB RANGES	1mV, 3mV, 10mV ... 3V fsd. Acc. ±4% ±1% fsd at 30MHz, −50, −40 ... +20dB. Scale −10dB/+3dB ref. 1mW/50Ω	type TM6A **£199**
H.F. RESPONSE	±3dB from 300kHz to 400MHz. ±0.7dB from 1 MHz to 50MHz.	type TM6B
L.F. RANGES	As TM3	**£215**

+P&P and VAT

LEVELL
PORTABLE INSTRUMENTS

LEVELL ELECTRONICS LTD.
Moxon Street, Barnet, Herts. Tel. 01-449 5028/440 8686

WW – 077 FOR FURTHER DETAILS

RADIOCODE 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.

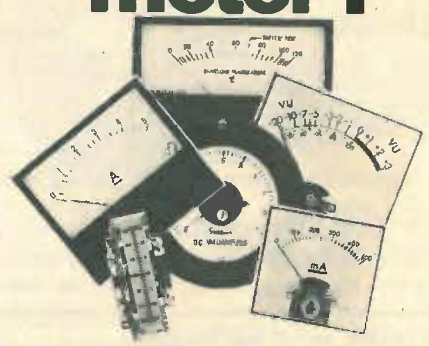
Applications
- Automatic master clock and slave controller.
- Synchronisation of separate equipment and events.
- Programmable energy management system.
- Computer clock/calendar with battery backup.
- Data logging and time recording.
- Process and equipment control.
- Broadcasting, Astronomy, Navigation.
- 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 – 078 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 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,
Trenant Estate, Wadebridge, Cornwall, PL27 6HD.
Telephone: (020881) 2031 Telex: 45451

WW – 073 FOR FURTHER DETAILS

To obtain further details of any of the coded items mentioned in the Editorial or Advertisement pages of this issue, please complete one or more of the attached cards entering the reference number(s). Your enquiries will be passed on to the manufacturers concerned and you can expect to hear from them direct in due course. Cards posted from abroad require a stamp. These Service Cards are valid for six months from the date of publication.

Please Use Capital Letters

If you are way down on the circulation list, you may not be getting the information you require from the journal as soon as you should. Why not have your *own* copy?

To start a one year's subscription you may apply direct to us by using the card at the bottom of this page. You may also apply to the agent nearest to you, their address is shown below.

OVERSEAS SUBSCRIPTION AGENTS

Australia: Gordon & Gotch (Australasia) Ltd, 380 Lonsdale Street, Melbourne 3000, Victoria

Belgium: Agence et Messageries de la Presse, 1 Rue de la Petite-ILE Brussels 7

Canada: Davis Circulation Agency, 153 St. Clair Avenue West, Toronto 195, Ontario

Cyprus: General Press Agency Ltd, 131 Prodromou Street, P.O. Box 4528, Nicosia

Denmark: Dansk Bladdistribution, Hovedvagtsgade 8, Dk. 1103 København.

Finland: Rautakirja OY, Koivuvaarankuja 2, 01640 Vantaa 64, Finland.

France: Dawson-France S.A., B.P.40, F-91121, Palaiseau

Germany: W. E. Saarbach GmbH, 5 Koln 1, Follerstrasse 2

Greece: Hellenic Distribution Agency, P.O. Box 315, 245 Syngrou Avenue, Nea Smyrni, Greece.

Holland: Van Ditmar N.V., Oostelijke Handelskade 11, Amsterdam 1004

India: International Book House, Indian Mercantile Mansion Ext, Madame Cama Road, Bombay 1

Iran: A.D.A., 151 Khiaban Soraya, Tehran

Israel: Steimatzky's Agency Ltd, Citrus House, P.O. Box 628, Tel Aviv

Italy: Intercontinental s.a.s. Via Veracini 9, 20124 Milano

Japan: Western Publications Distribution Agency, 170 Nishi-Okubo 4-chome, Shinjuku-Ku, Tokyo 160

Lebanon: Levant Distributors Co., P.O. Box 1181, Makdesi Street, Halim Hanna Bldg, Beirut

Malaysia: Times Distributors Sdn. Bhd., Times House, 390 Kim Seng Road, Singapore 9, Malaysia.

Malta: W. H. Smith Continental Ltd, 18a Scots Street, Valleta

New Zealand: Gordon & Gotch (New Zealand) Ltd, 102 Adelaide Road, Wellington 2

Nigeria: Daily Times of Nigeria Ltd, 3 Kakawa Street, P.O. Box 139, Lagos

Norway: A/S Narvesens Kioskompani, Bertrand Narvesens vei 2, Oslo 6

Portugal: Livaria Bertrand s.a.r.l Apartado 37, Amadora

South Africa: Central News Agency Ltd, P.O. Box 1033, Johannesburg

Spain: Comercial Atheneum s.a. Consejo de Ciento, 130-136 Barcelona 15

Sweden: Wennegren Williams A B. Fack S-104, 25 Stockholm 30

Switzerland: Naville & Cie SA, Rue Levrier 5-7, CH-1211 Geneve 1 Schmidt Agence AG, Savogelstrasse 34, 4002 Basle

U.S.A.: John Barios, IPC Business Press, 205 East 42nd Street, New York, N.Y. 10017

CUT HERE

Postage will be paid by Licensee

Do not affix Postage Stamps if posted in Gt Britain, Channel Islands, N Ireland or the Isle of Man

BUSINESS REPLY SERVICE
Licence No 12045

2

WIRELESS WORLD
Reader Enquiry Service
429 Brighton Road
South Croydon
Surrey CR2 9PS

CUT HERE

Enquiry Service for Professional Readers

WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....
WW	WW	WW ....

WIRELESS WORLD Wireless World, June 1982 WW 266

Please arrange for me to receive further details of the products listed the appropriate reference numbers of which have been entered in the space provided.

Name ....

Name of Company ....

Address ....

....

Telephone Number ....

PUBLISHERS USE ONLY			A/E			

Position in Company ....

Nature of Company/Business ....

No. of employees at this establishment ....

I wish to subscribe to Wireless World ☐

VALID FOR SIX MONTHS ONLY

CUT HERE

Wireless World: Subscription Order Form

To become a subscriber to Wireless World please complete the reverse side of this form and return it with your remittance to:

Subscription Manager,
IPC Business Press,
Oakfield House, Perrymount Road,
Haywards Heath, Sussex RH16 3DH,
England

www.americanradiohistory.com

Enquiry Service for Professional Readers ONLY.

WIRELESS WORLD Wireless World, June 1982 WW 266

WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .
WW	WW	WW . . . .

Please arrange for me to receive further details of the products listed, the appropriate reference numbers of which have been entered in the space provided.

Name . . . .

Position in Company . . . .

Name of Company . . . .

Address . . . .

. . . .

Telephone Number . . . .

Nature of Company/Business . . . .

No. of employees at this establishment . . . .

VALID FOR SIX MONTHS ONLY

CUT HERE

Postage will be paid by Licensee

Do not affix Postage Stamps if posted in Gt Britain, Channel Islands, N Ireland or the Isle of Man

BUSINESS REPLY SERVICE
Licence No 12045

2

WIRELESS WORLD
Reader Enquiry Service
429 Brighton Road
South Croydon
Surrey CR2 9PS

CUT HERE

Wireless World *Subscription Order Form* Wireless World, June 1982 WW 266

UK subscription rates
1 year: £12.00

Overseas ***1 year:*** £15.00

USA & Canada subscription rates
1 year: $39.00

Please enter my subscription to Wireless World for 1 year

I enclose remittance value.................................**made payable to**
IPC BUSINESS PRESS Ltd.

Name.................................

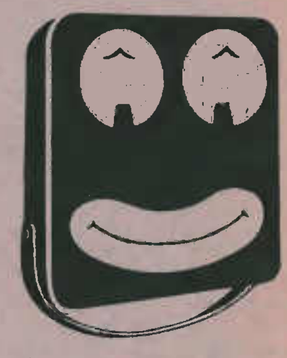
Address.................................

....

....

CUT HERE

BEFORE



AFTER!

PUT A SMILE BACK ON YOUR OLD AVOMETER!

Send it now for estimate, repair or recalibration

Quick turn round on estimates/repairs

Large stocks of new AVOMETERS

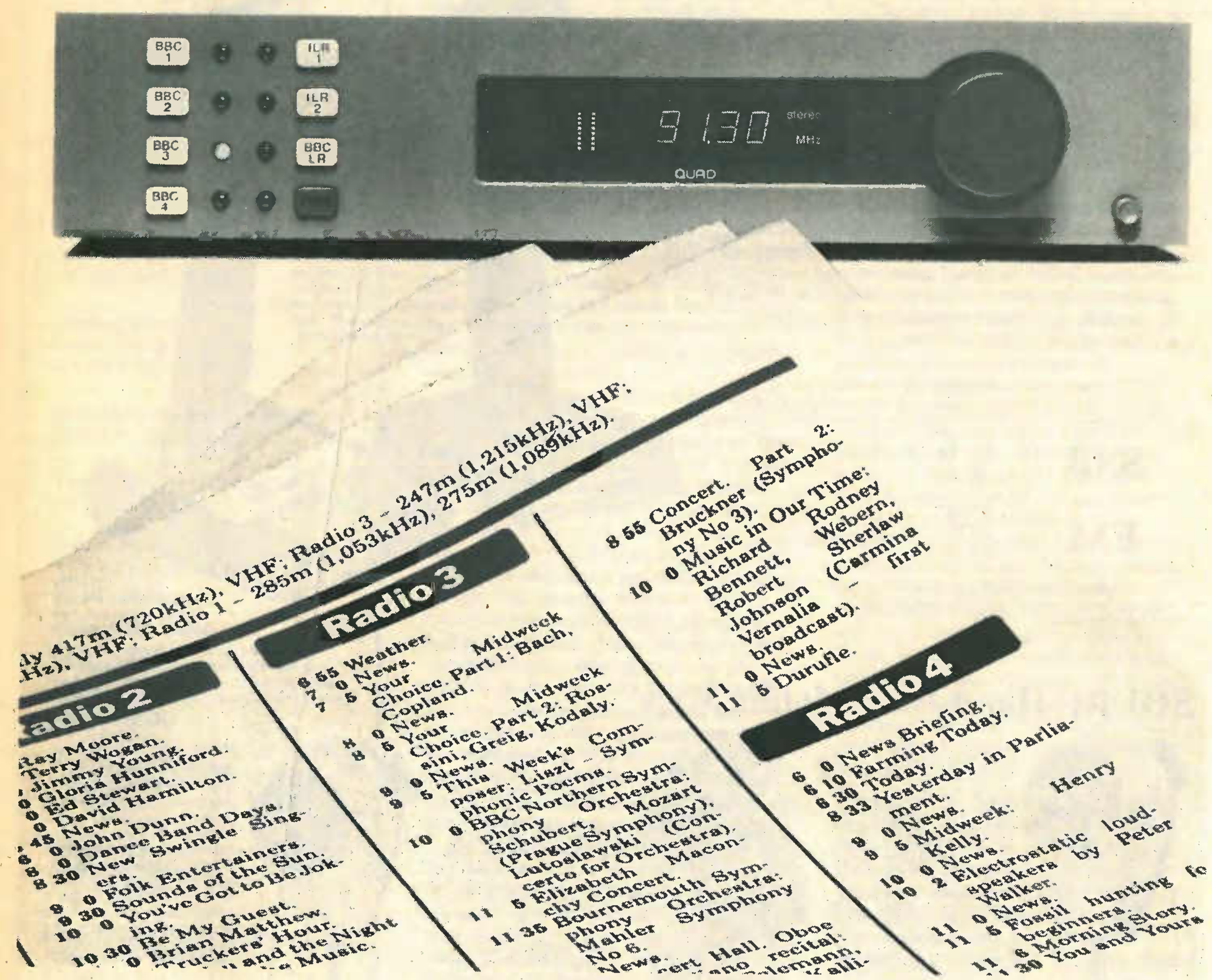
Avo Sales and Service

Farnell International

Farnell International Instruments Ltd., Sandbeck Way, Wetherby
West Yorkshire LS22 4DH
Tel 0937 61961 Telex 55478 Farint G

WW—004 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.

QUAD
for the closest approach to the original sound

WW – 008 FOR FURTHER DETAILS

fact: Shure brings intelligibility & reliability to professional communications microphones

Experienced operators recognize that the audio quality of the transmitter is limited by the quality of the input from the microphone. On the air, there's no mistaking the crisp, intelligible messages from Shure microphones.

Shure microphones have been the overwhelming choice of professional communications users all over the world for over 30 years. Many milestone improvements developed for demanding professionals are found on Shure microphones:

ARMO-DUR® Case: Lightweight, immune to oil, grease, fumes, salt spray, sun, rust, and corrosion. Prevents RF burn!

"Million Cycle" leaf switch: Just one of the crucial wear points Shure-tested to ensure reliability and extraordinary durability.

TRIPLE-FLEX® Cable: Provides three or four times longer flex life than previously available cords on hand-held microphones.

CONTROLLED MAGNETIC® or Dynamic Transducer: The exclusive Shure-designed super-rugged transducers that give excellent voice intelligibility and super reliability.

To improve your on-air intelligibility we suggest the following Shure Microphones:

	Mobile Application	Fixed Station Application
SSB	414A* 407A* 577A**	444D 526T Series II
FM	414B* 507B* 577B**	450 526T Series II

*General recommendation: Consult equipment instruction manual for correct microphone inpedance.
**Noise-cancelling.

SHURE Fixed-Station Mics

Controlled Magnetic® Fixed Station Microphone (Models 444D, 450)
Our most popular fixed-station microphones. Unmatched performance characteristics. Adjustable stand raises microphone for most comfortable talking postion.

New Transistorized Fixed-Station Microphone (Model 526T Series II)
A new design for maximum versatility in fixed-station operation. Modulation level (volume) control for high undistorted output with high- or low-impedance inputs.

SHURE Hand-Held Mobile Mics

Omnidirectional Mics (Models 407A, 407B, 507B)
Small, easy-to-handle design, with rugged Dynamic or CONTROLLED MAGNETIC® transducers for excellent voice intelligibility. Hum-shielded and insulated against shock. Model 507B Dynamic version features extended low and high frequency response, especially suitable for mobile FM transmitters. Modular construction simplifies field service.

Compact Mini Mics (Models 414A, 414B)
Ideal for miniaturized or portable communications systems, or where dashboard space is limited. The 414 Series CONTROLLED MAGNETIC® microphones are about half the size and weight of conventional microphones—yet they are rugged units, recommended for critical outdoor or indoor applications.

Noise-Cancelling Mics (Models 577A, 577B)
These Shure Dynamic microphones shut out background noise, permit clear transmission even where the noise level is so great that the operator cannot hear himself talking! The ARMO-DUR® case is lightweight, feels natural to the touch. The 577A is high impedance; the 577B is low impedance.

Communications Microphones by...

® SHURE ®

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

WW – 032 FOR FURTHER DETAILS

wireless world

Editor:
PHILIP DARRINGTON

Technical Editor:
GEOFF SHORTER, B.Sc.
01-661 8639

Communications Editor:
MARTIN ECCLES
01-661 8638

News Editor:
DAVID SCOBIE
01-661 8632

Drawing Office Manager:
ROGER GOODMAN

Technical Illustrator:
BETTY PALMER

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

DAVID DISLEY
01-661 8641

BARBARA MILLER
01-661 8640

Northern Sales:
HARRY AIKEN
061-872 8861

Midland Sales:
BASIL McGOWAN
021-356 4838

Group Classified Manager:
BRIAN DURRANT
01-661 3106

IAN FAUX
01-661 3033

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

Graven images, new style

When Lech Walesa, the Polish union leader, was asked by the military regime to appear on television and speak for them, he replied, according to a report, "You will have to cut my body into a thousand pieces first". This violently negative response speaks louder of the power of televison than all the strivings of young hopefuls in the entertainment business desperate to claw their way in front of the cameras. It also speaks loudly of the exclusive control of a whole broadcasting system by one authority. But state control only exemplifies, in a brutal way, the fact that television is a highly selective, and therefore exclusive, medium in the hands of anyone who uses it.

Consider first how reality is excluded by the physical details of the television set operating in the home. The images on the screen are produced by means of transmitted light from glowing phosphor sources, whereas we normally see most things in the world by reflected light. Sound is gratuitously present, though the real world often has to be interpreted in silence. The pictures are viewed in the banal surroundings of household objects and events: furious drama may work itself out on the screen immediately next to a plate of sandwiches and a sleeping cat. On this screen the people and objects are miniatures, and the convergence feedback of our binocular vision tells us that the images are not the same as the originals seen at a distance. Overall the effect is that of a brightly-lit toy theatre.

Within these physical limitations the deliberately selective processes of the broadcaster are operating. There is an old adage that newspapers can't tell you what to think but they can tell you what to think *about.* Selection and exclusion begin on television with the overall policy of the broadcaster and are implemented first in programme planning and then in the structure of individual programmes. In political discussions, for example, the agenda is set in advance: any controversy is held within previously determined limits which can be enforced by editing the recording.

It is in the "language" and conventions of the visual presentation, though, that selection and exclusion are seen most immediately. First the sequence of shots is selected. Then each shot is structured by a variety of artifices: by choice of duration, framing, lighting, the angle and distance from which it is taken and so on. The precise meaning or mood which the viewer is expected to attach to the resulting images is fixed by the use of sound. Speech and music are very specific.

One result of this concentration of selective processes is a distancing or alienation of the viewer from normal experience. Jonathan Miller, the television producer and man of many other parts, describes it well in his book on Marshall McLuhan. The images which television presents, he says, are "curiously dissociated from all other senses. The viewer sits watching them all in the drab comfort of his own home, cut off from the pain, heat and smell of what is actually going on. Even the sound is artificial . . . . All these effects serve to distance the viewer from the scenes which he is watching, and eventually he falls into the unconscious belief that the events which happen on tv are going on in some unbelievably remote theatre of human activity. The alienating effect is magnified by the fact that the tv screen reduces all images to the same visual quality. Atrocity and entertainment alternate with one another on the same rectangle of bulging glass. Comedy and politics merge into one continuous ribbon of transmission."

Perhaps what Miller describes is the result of the most powerful selective process of all – in the mind of the viewer. If we seem to go into an hypnotic trance when watching television it is because we have involuntarily agreed to suspend judgement on the reality of what is appearing on the screen. We have colluded with the modern graver of images in allowing ourselves to be transported by his art, shutting out our normal, hard-headed, sceptical selves. In this irrational state of suspended belief the contrived images and sounds become more 'real' to us than the real world. Temporarily we can be persuaded of anything. This mental state, and how to produce it, is well understood by television playwrights, propagandists and makers of commercials. The unperceived surrender of the mind is where the real power of the medium lies.

www.americanradiohistory.com

CRISIS CONTROL

Typical 'spread-panel' control-room display, in which the type of presentation makes it extremely difficult to investigate faults.

There have been occasions in large control complexes when the amount of information presented to controllers has been so vast and, possibly, suspect, that operators have found it impossible to take in. The author presents his views on methods of training for such moments, and on methods of measurement and presentation to reduce the number of malfunctions and the level of stress on operators.

by R. E. Young,
B.Sc. (Eng.), M.R.Ae.S., F.I.E.E.

The Senior Shift Engineer was more bewildered than horrified when he answered the "panic" call to the control room and saw his staff rushing backwards and forwards along the almost infinite assembly of panels, obviously not knowing in the least what was going on, and deafened by the ceaseless and ever-growing noise of the alarms. Full horror was to come almost immediately when he realised that hordes of men were surging into the room from all over the huge plant, summoned in a last desperate attempt to find out which, if any, of the meters and indicators were "telling the truth".

Fictitious? – yes. Exaggerated? – perhaps. Irrelevant? – no, for here is an extract from an account of such a catastrophic 'Incident': " . . . the operators were misled . . . because of a false indicator . . . and by signs of an apparent excess of water . . . All the events were accompanied by an unhelpful cacophony of about 100 alarms sounding off, distracting the operators as they faced panel upon panel of red, green and amber lights and dials indicating entirely unexpected combinations of conditions, and as they tried to grasp the significance of the mystifying changes that were happening . . .".

This description of a 'developed' crisis situation is taken from the masterly summary by Sir Alan Cotterell[1] of what tends to be thought of as the sole example of the large-scale industrial disaster – the Three Mile Island accident. In actual fact, this near-catastrophic type of accident, with its far-reaching consequences, has been experienced in many industrialized countries in the world, but it was not until "Three Mile Island" had occurred that public awareness of the dangers involved became much more apparent. At the same time steps to introduce improved safety precautions were being taken at both national and international levels: for example, the EEC produced a Directive in 1980 aimed at avoiding major industrial disasters, and the Atomic Energy Agency called an international conference in the same year to harmonize nuclear reactor safety standards worldwide.

Both technical and political interests now realize the need to provide additional, entirely new, safeguards in the operational design of large industrial complexes. The implied requirement for major changes in the 'total' approach to high-risk installations in particular becomes clear, and has been brought out in what amounts to public debate, largely critical in nature.

This critical element has been especially marked in relation to "Three Mile Island", where various forms of human error were blamed for the accident; and with strong attacks being made, in effect, not only on the operators themselves but on their selection and training. It is only when one builds up the background to this Incident in the light of 'crisis control' and allied considerations[2] that an entirely different picture emerges, which can be largely summarized by the statement that *within the circumstances in which they were operating*, the control engineers at Three Mile Island could not have achieved more than they did.

Before going into the way in which measurement and other information was presented to them – quite inadequately – and into the whole question of the 'goodness' (integrity) of this information, it is necessary to look at the state in which these engineers found themselves. It was, in a sense utterly fluid and had features which completely defied explanation. In the words of the Cottrell acount: " . . . (they were) faced suddenly with a totally strange combination of events . . ." preceded by " . . . (being) misled . . . *because of a false indicator* . . . and by signs of an *apparent* excess of water . . ."

This is the classic example of the final – full emergency – stage of an incident carrying high potential risk, where the control staff come to the chilling realisation that they are being given wrong information *somewhere* and that they have no possible means of finding out where. Furthermore, as far as their control of the plant is concerned, they are completely out of contact with it; and, added to this, all their sources of control information have to be treated as totally suspect.

Thus it has to be recognized that in such circumstances the stress to which the engineers are subjected can only be described as extreme in the full sense of the word. When it is remembered that the conditions producing the emergency are entirely unforeseen, it becomes clear that it is virtually impossible to predict how any individual will behave in circumstances where "there is nothing to get hold of".

Nevertheless, there are two related areas where experience can be quoted which bears very positively on this general question of behaviour under stress.

The first of these areas is in the field of 'control room' type operations carried out under wartime aerial bombing attacks. Secondly, it is not usually realized that in World War II, 'ultimate crisis control' was carried out under these hostile conditions. This was with extensive integrated broadcasting networks under central master control and with large radar command systems, which became, in effect, the equivalent of modern high-risk installations.

As will be treated in more detail in Part 2 of this article, observation has led to a number of conclusions on unexpected operational stress and methods of preparing people for it.

The most significant of these conclusions was that under such stress, one or other of two conditions – A or B – was reached; assuming, of course, that a panic state was not developed, where 'panic' is differentiated from conditions A and B by being "unreasoning" and "sudden" in nature.

Briefly, condition A is one in which – despite the severe stress – the person thinks and takes action exactly (as far as the outside world is concerned) as before the incident occurred. As will be indicated in Part 2, it is suggested that methods of training and preparation for this condition should be largely 'subliminal' in nature, i.e. without the training mechanism being really obvious.

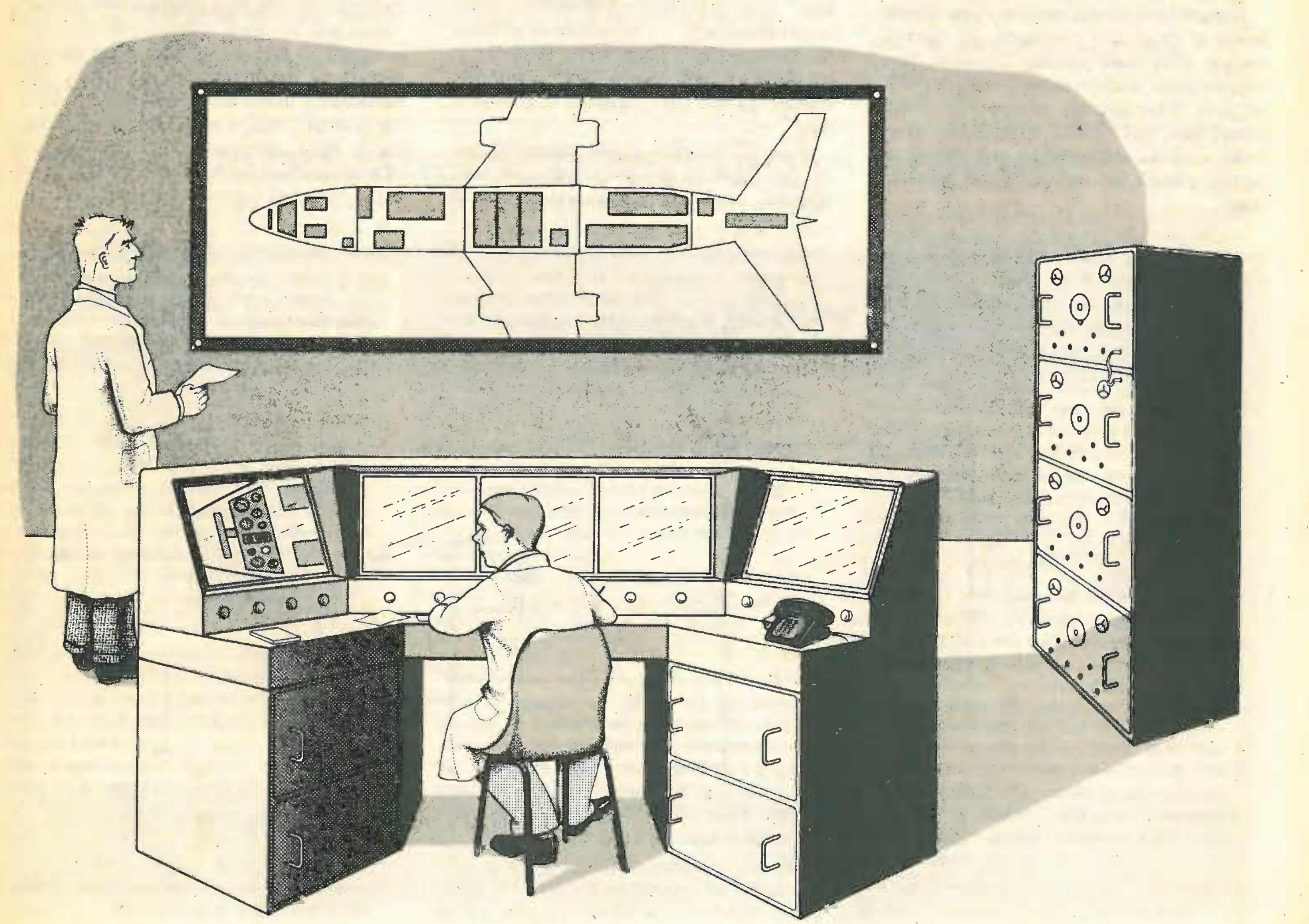
One of the main differences between conditions A and B is the virtual disappearance in B of the ability to take action, i.e. all initiative appears to be lost. In most cases "leadership by example" can restore it, and those in this condition are "near the surface" from this point of view. In practical terms, they appear not to be in a state of shock, as it is generally understood.

However, it is in the almost invariable change in facial expression to the blank look of mental handicap, familiar to those working in that field, which is most characteristic in Condition B. The 'mentally handicapped look' and other relevant aspects of that complaint will be discussed later in the context of a reserch programme which has been in progress for a number of years. This programme, conducted essentially on a voluntary basis, has nevertheless attracted an increasing amount of interest, particularly during the last two years; and has enabled major correlation to be established between observations made in one field and 'practice' in the other. Examples of such correlation include 'thinking fatigue' which is relevant to the design of data presentation and other equipment for crisis control, and which appears as a major problem with the mentally handicapped.

Thinking fatigue may be defined as fatigue produced by 'multi-channel' mental activity, i.e. where several ideas (lines of thought) have to be carried simultaneously and coordinated. Instances are afforded by an author writing a book with a complex, interacting, plot, or by a pilot landing an aircraft under adverse conditions with all the controls having to be operated simultaneously and in relation to a number of rapidly changing events. Another instance was offered by the editor of *Wireless World* last year (1981) as "An engineer preparing for or taking part in a highly technical and diversified international conference".

It may be noted that the direction of 'spin-off flow' in this area has been largely from mental handicap to operational design in that the effects of 'thinking fatigue' can actually be seen with the former, whereas it tends to be regarded as almost hypothetical in the ordinary world. In contrast, in the other example to be quoted at this point, viz. data marshalling (to be described in the next section), the flow has been mainly from the technical side towards mental handicap. This flow tends to become two-way as time goes on; it develops to benefit both sides, and then – in many cases – extends as an interchange of information to other areas, such as geriatric care.

Fig. 1. 'Data-marshalling' type of control-room, proposed for aircraft testing. Overall situation on wall diagram is broken down on operator's screens.



www.americanradiohistory.com

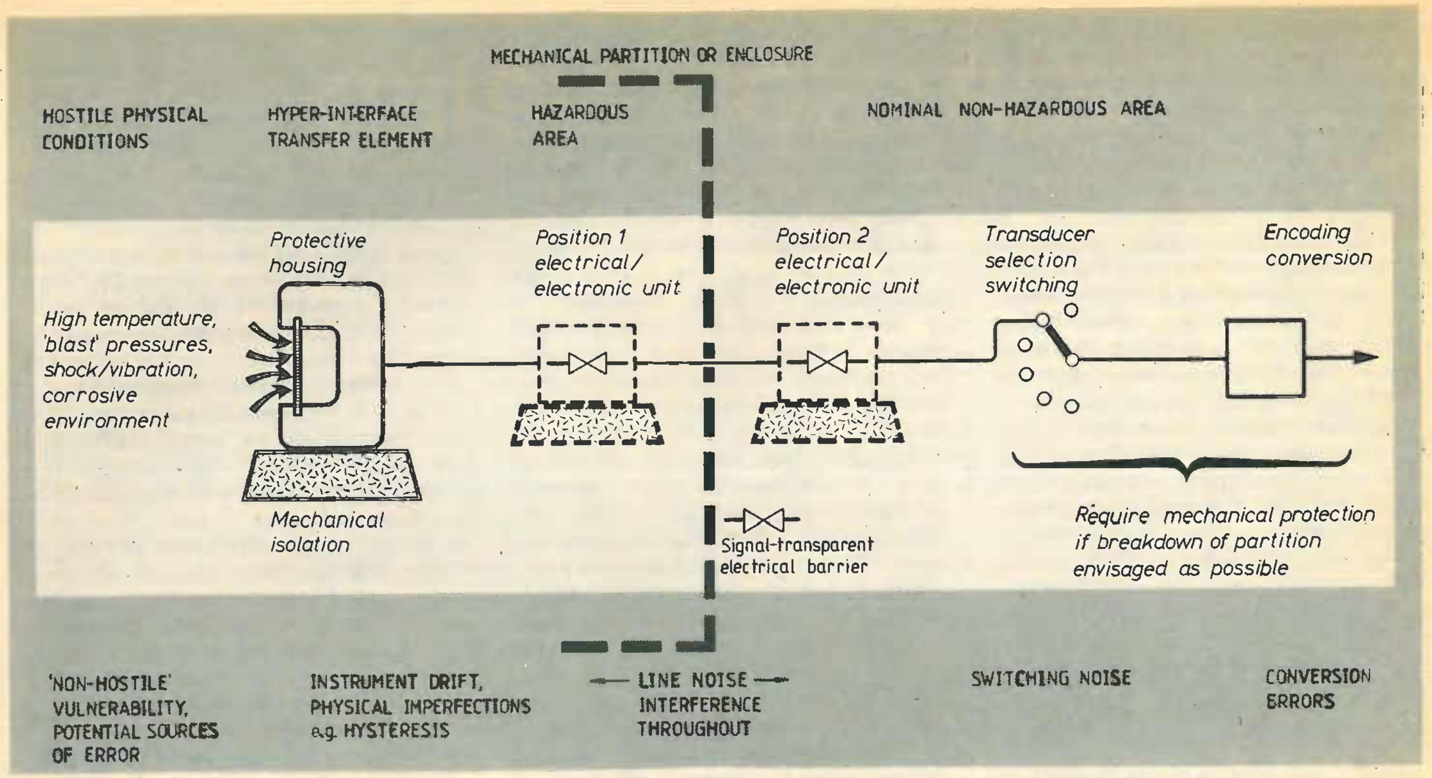


Fig. 2. Transducer instrumentation chain in a totally hostile environment.

Data marshalling

This concept, first introduced by the writer in 1960[3] mainly in connexion with the testing of complex aerospace vehicles and aircraft generally, may be described as the separation, streaming and systematic presentation of "masses of data".

Figure 1 shows the control room installation as originally envisaged for aircraft testing. The main display consisted of a wall diagram of the complete aircraft, with sections of the aircraft, selected on a functional basis and broken down to the next order of detail displayed on corresponding panels placed on the operator's console itself.

The design of the system was aimed at ensuring that "faults at once strike the attention of the operator, and their location and magnitude are clearly apparent to him". Also as a statement of an ideal which is still aimed at "... the action to be taken (in the event of a fault) arises naturally in his mind without the need for the analysis, correlation and interpretation of a mass of data".

Even at that time it was suggested that all the displays, and particularly the wall diagram, might be by large-screen (cinema size) television. It is not generally known that large-screen television was in operation in certain London cinemas before World War II, and in a more advanced form, using high-voltage projection tubes, was demonstrated to the Press in 1948.

In non-aerospace, such as process-plant, applications, the wall diagram becomes an 'alarm and situation' mimic-type diagram, designed to give an overall instantaneous picture of the system at any time, and particularly under alarm conditions. Thus, for example, with a large offshore oilfield, the A. and S. diagram would show a group of well-heads with their main pipeline runs and a pictorial representation of (say) the block of plant at the central platform. Working within a conventional computer-based (central processor) type of control system with visual display unit presentation, alarms shown at critical points on the A. and S. diagram give a combined 'alerting' and 'location' signal to the control engineer should a fault develop.

The resultant system is in sharp contrast with the 'spread-panel' type as shown in the heading illustration, and as described for Three Mile Island. Thus, even if the control engineers had been able to trust all their information during that incident, the presentation of this information was such as to make their task of investigating the fault quite impossible. With this in mind, it would seem pertinent to add that they would appear to have remained in operational Condition A throughout, something which should not be overlooked.

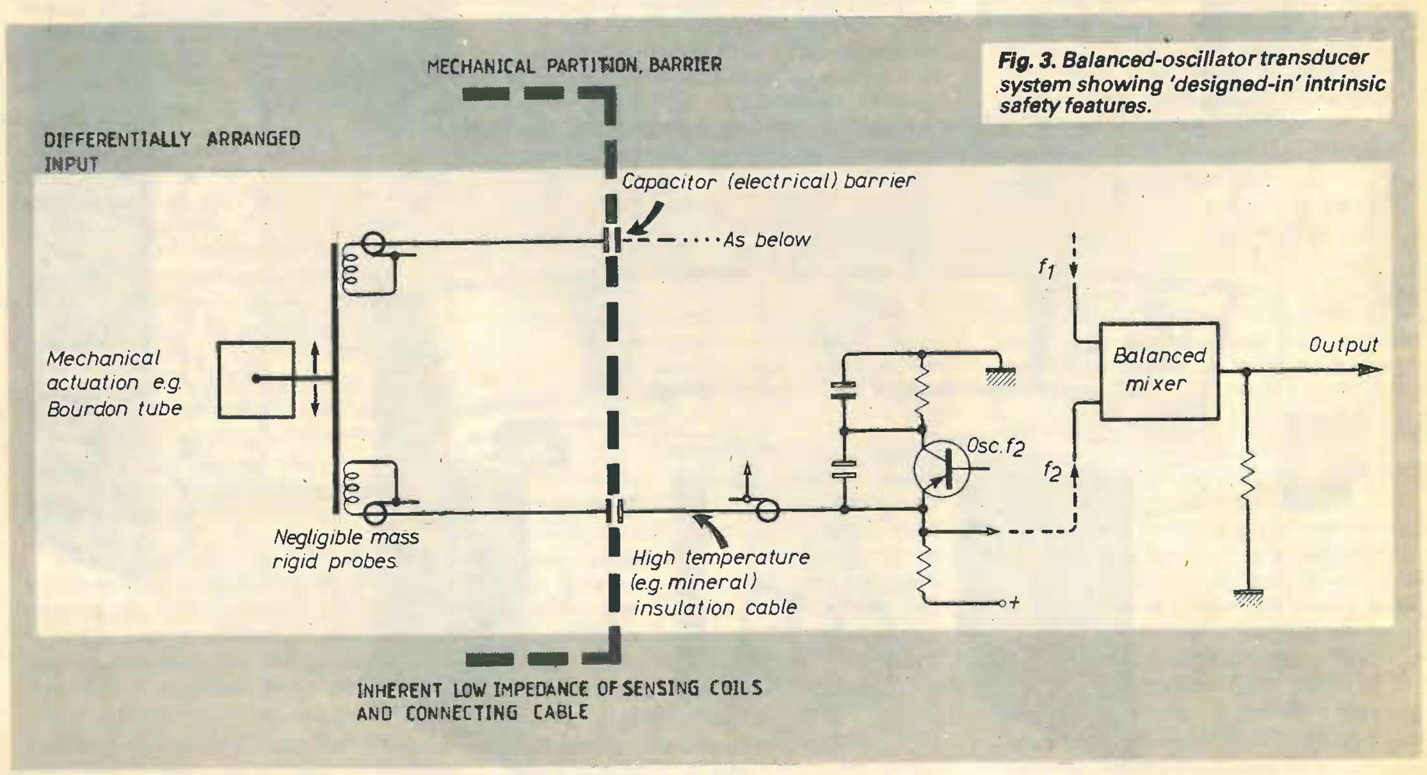


Fig. 3. Balanced-oscillator transducer system showing 'designed-in' intrinsic safety features.

'Telling the truth'

As has been stressed already, the most disturbing influence that a control engineer can experience during a dangerous break-down is the realization that instruments are not 'telling the truth'. It is manifestly impossible to ensure that information will never be false (equivalent to infinite reliability), as, for example, when a position transducer is mounted on the 'drive' side of a break in an actuator shaft. Nevertheless, design for full 'crisis management' demands that every effort must be made to give the maximum integrity to every element in the control system. The process of selecting these elements and determining their ultimate form must be carried out jointly between user and control-system designer[2] if the maximum protection is to be given to the whole installation.

The provision of crisis-level protection is obviously a big subject; as on illustration of the principles involved, consider of transducers as key elements in the overall (combined) main plant and control-system complex. They occupy the most exposed position in the instrumentation chain since they are vulnerable both to severe mechanical and electrical disturbance. Apart from various forms of mechanical protection determined by environmental engineering techniques, reducing vulnerability is fundamentally a matter of the design and construction of the transducer itself and (in the mechanical context) of its physical environment. Instrumentation transducer design is far more involved than is generally thought: this is particularly true at the 'hyper-interface' where the parameter/electrical signal transfer takes place; and it is at this interface that the actual measuring process may be said to take place.

Consequently, it is vital that, under all conditions, the transducers should maintain the integrity of this transfer (i.e. that the transducer itself should 'tell the truth'). The system diagram of Fig. 2 shows how protection against totally hostile physical conditions can be 'designed-in' to the instrumentation chain system; and brings out the extra vulnerability of the transducer in meeting the 'real' hostile conditions such as blast pressures at the hyper-interface. The balanced-oscillator (dual-chain) transducer system of Fig. 3 has been designed from the beginning to exhibit minimum error under abnormal and 'catastrophic' conditions.

This family of transducers have a 'parameter-dependent' frequency output derived as a difference (beat) frequency between two matched oscillators, themselves tuned by high (electrical) resistance moving probes. These probes move differentially within their sensing coils at the input to the dual-chain system, which is terminated with a balanced mixer. The basic symmetry of the mechanical-electrical combination and its inherent balance provide a high degree of compensation for ambient changes.

The greatest attraction of this configuration, however, arises with extreme environments, where the series-resonance operation of the Clapp oscillators which are used, makes it possible to instal the sensing coil and probe remotely from the less 'hard' electronic unit. This is by virtue of the low-impedance (coaxial cable) connexion, which can be used between the two with the series-resonant oscillators. From the diagram it will be seen how this isolation as part of the intrinsic safety precautions built-in to the system, is an advantage. Thus, with the 'barrier' protection shown, the coil can be situated in the hazardous area and can be made effectively neutral, with little risk of energy at this point to initiating a spark.

References

1. Cottrell, A.H.: How Safe is Nuclear Energy?. Heinmann Educational Books, London 1981.
2. Young, R.E.: Control in Hazardous Environments. Peter Peregrinus, Stevenage 1982.
3. Young, R.E.: Data marshalling. Private communication.

To be concluded □

Action on private mobile radio – urgent!

Unless the Government takes action quickly to introduce repeaters, trunking and cellular systems, along with other measures to improve the effectiveness of private mobile radio, commercial enterprises, emergency services and public bodies will become much less efficient than their foreign counterparts and the UK radio industry will suffer.

This is the burden of a report, prepared by PACTEL (PA Computers and Telecommunications) on behalf of the Electronic Engineering Association, which is entitled 'Mobile radio – the case for urgent action'*. It is the latest in a series of attempts to persuade the Government, who control the use of the spectrum, to allow mobile radio users access to a share of the 30MHz-1GHz spectrum more in keeping with potential usage than the nominal 8% they now have (PACTEL say this is really 6.5% because of interference, terrain limitations and official restrictions).

Among the consequences of the failure to secure a more equitable share are high costs, delays, pollution and a poor service to customers of the haulage industry, and a lower level of safety and security.

The depressed use of m.r. in the U.K. (around 0.5% against 2.7% in the US) is, says PACTEL, no help at all to the UK radio industry, in contrast to the state of affairs in Japan and the USA, where a healthy home demand acts as a spur to development and production and results in efficient systems and lower costs.

According to the report, five actions must be taken now. Another 30-35 MHz of spectrum must be released for m.r. use – little enough, since this would bring the total to a mere 10% of the usable 30MHz-1GHz band. Secondly, the Government should take a close look at the amount of spectrum inhabited by the military and by broadcasters. PACTEL says "there is little doubt" that the MoD keeps some of its allocations on ice, unused in peacetime, simply because they might be needed some day, in spite of claims by m.r. lobbyists that, if they were released, they could be taken back in emergency in a matter of hours or even minutes. In the case of broadcasting, the report is critical of the efficiency with which the spectrum is used and says that it could be improved upon without any deterioration in service.

Thirdly, three types of system should, says PACTEL, be promoted to give wide-ranging, low-cost, flexible and spectrum-efficient services: community repeaters, trunked systems and cellular systems.

In a repeater, a common base station, located on high ground, gives a wide coverage, many rented mobiles sharing one channel: a 'channel busy' indicator helps to avoid a user hearing messages not meant for him. The current position is that not enough channels are available for this type of system.

Trunked systems provide a number of channels to each user and are therefore frequency-efficient: the operator uses a multi-channel radio which is tuned automatically to a free channel. For this purpose, blocks of channels are needed – too few are currently available for widespread adoption of this kind of system. More channels are needed.

The third type, the cellular system, relies on dividing the area into cells, each of which is treated as a trunked system. By geographically separating cells which use the same block of frequencies, interference is avoided and the usage of the channel is increased by up to 1200%. Blocks of channels are needed for trunking. Once again, not enough are available (56 instead of a required 300).

The fourth recommendation is that the Government actively promote the use of private mobile radio instead of restricting it.

Finally, says the report, the delay of between three and six months in the issue of licences should be reduced. Otherwise, illegal installations will multiply and make spectrum management virtually impossible.

As John Carlson, chairman of the EEA's Mobile Radio Committee, points out, "if even the manufacturers of private mobile radio equipment put forward the difficulties to their customers, the situation must be bad". And Ray Northcott of PACTEL sums up the current p.m.r. scene by saying "Other countries have taken a conscious decision to encourage p.m.r. – the UK hasn't". □

**Available at £3.00 from The Director, The Electronic Engineering Association, Leicester House, 8 Leicester Street, London WC2H 7BL.*

www.americanradiohistory.com

80-100 WATT MOSFET AUDIO AMPLIFIER

A three-part article on the design and construction of a modern, high-power amplifier begins with a description of the problems of amplifier design in relation to the characteristics of 'vertical' power mosfets. A matching, modular preamplifier design will follow.

by John L. Linsley Hood

The problem with designing audio amplifiers is that there are a number of design requirements which are impossible to satisfy completely: such things as freedom from harmonic and intermodulation distortion; independence, in terms of distortion or transient response, on the nature of the load reactance; freedom from spurious (amplifier-generated) signals over the whole range of signal inputs and likely load characteristics; rapid settling time and freedom from 'hang-up' on step-input or overload, particularly under reactive load conditions; and complete absence of input-signal or load-induced instability.

Not only are these requirements impossible to achieve absolutely, but the work needed to improve one of these may simultaneously bring about a worsening in other respects, so part of the task of the designer is to choose, within the appropriate limits of cost and complexity, between conflicting possibilities and requirements. No two designers (or their commercial or advertising managers) are likely to come to the same balance of compromises in these respects, and this leads to subtle differences in the tonal characteristics of the designs.

A characteristic of commercial trends in the last twenty years, which I view with regret, is an overwhelming concentration on the attainment of very low harmonic-distortion figures over the whole of the audible spectrum, to the extent that many modern commercial designs attain steady-state t.h.d. figures fifty or more times better than possible, under any conditions, from the signal sources which feed the amplifiers. A similar amount of effort is expended commercially in achieving very high signal-to-noise ratios – which would be valuable if it were matched in the handling of programme material by the programme producers.

The reason for this commercial interest is a simple one. the major emphasis in most equipment reviews is placed on t.h.d. and s/n ratio, coupled with, in the case of power amplifiers, power output in watts/pound (sterling) or, occasionally, watts/pound (avoirdupois). This trend would be wholly praiseworthy if it could be achieved without impairment in other desirable characteristics of the equipment: unfortunately, it cannot. If one wants some quality very good, one must accept some others relatively bad! If only one knew which ones were important to the listener, this choice would be easy, but one doesn't. Quite a lot of work has been done in the field of psycho-acoustics to try to characterize the effects on the listener of specific electrical defects, but this work is far from complete and impaired, from the point of view of the designer, by the omission of most of the minor performance defects practical amplifier designs are heir to.

Nevertheless, a predictable result of the accumulation of experimental findings on acoustic effects, coupled with a greater awareness on the part of designers of the existence of residual performance shortcomings, is that there is a keen interest in new developments in components and circuit techniques, as a possible route to improved performance.

Of these new component developments, one of the most interesting, in the field of active devices, has been the growing availability of rugged, reliable and reasonably priced power mosfets (metal-oxide-silicon field-effect transistors). These devices have a very much better h.f. response – almost embarrassingly so – than the normal audio power transistor, and allow a considerable extra freedom in solving h.f. loop-stability problems, where some compromise must always be reached in a feedback amplifier design between the conflicting requirements of gain (or phase) margins and the need to retain a high loop gain at the upper end of the audio spectrum to achieve a high degree of steady-state linearity. In addition, these devices are almost completely free of the charge-storage effects found in junction transistors, which tend to impair complex-signals transfer.

Unfortunately, power mosfets have electrical characteristics and circuit requirements which are very different from those of the junction power transistor, so that they cannot be used as a direct replacement for junction transistors in existing designs. One must reappraise the circuitry.

Power mosfet

Insulated-gate field-effect transistors, of the type shown in outline in Fig. 1(a), and which operate by means of a mobile layer of charge induced in an otherwise non-conducting region of a semiconductor, have been known and used in small-signal applications for many years – particularly in v.h.f. circuitry, where their very fast response times are of great value. However, the conducting path in these devices is, by the nature of their method of construction, parallel to the surface of the semiconductor element. It is difficult, although some semiconductor manufacturers have achieved this in an endeavour to avoid restricting patents, to make this conducting path sufficiently short to achieve a low enough resistance for larger signal use.

The technical breakthrough in this type of device came about when it was appreciated that a 'V' or 'U' groove etched through the junctions in a fairly conventional transistor gave the possibility of an insulated-gate, induced-charge f.e.t., in which the current flow would be 'vertical. (as in the conventional junction transistor) rather than 'lateral. (in relation to the surface of the chip) as in the normal insulated-gate component. This gave a method of manufacture of 'mosfets', as

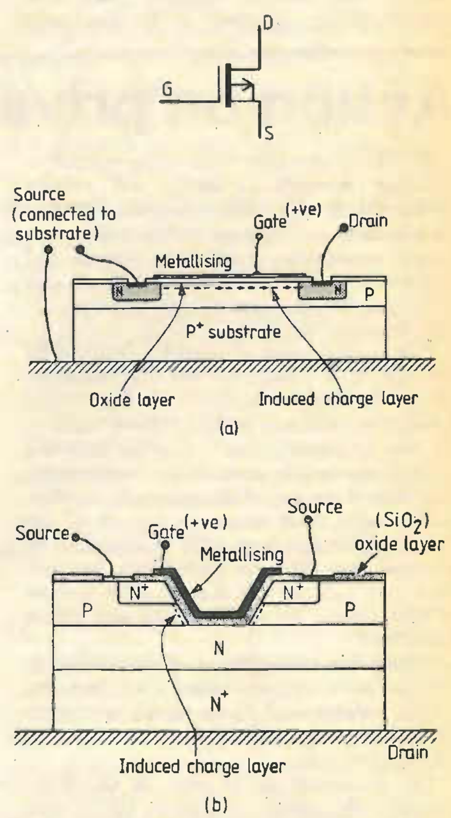


Fig. 1. *Small-signal, n-channel, insulated-gate f.e.t. of 'lateral' construction is shown at (a), while at (b) is the vertical power mosfet, in which the conducting path is a great deal shorter.*

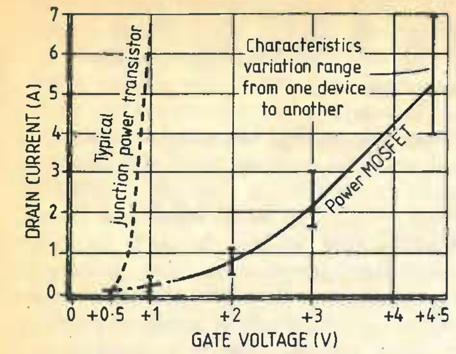


Fig. 2. *D.c. operating conditions of typical power mosfet compared with those of a junction power transistor.*

these devices are now almost universally known, which was open to any manufacturer of epitaxial planar junction transistors with the necessary skills in mask manufacture to fabricate the large number of parallel-connected igfet gates on a single chip, which are needed to lower the conducting resistance and increase the effective mutual conductance (g_m). A typical construction for such a vertical – or power – mosfet is shown in Fig. 1(b), though the proliferation of such designs within the past few years makes the concept of a 'typical' construction progressively less tenable. However, they do all have in common the parallel connexion of a large number of elements, which makes the mask design more complex, and the potential manufacturing reject rate and cost relatively high in comparison with the larger power junction transistors.

The electrical performance, under d.c. conditions, of a power mosfet, is shown in Fig. 2, with a superimposed curve from a junction power transistor added to the graph to draw attention to the differences in performance. Two features are immediately obvious from this graph – that a significantly higher forward voltage applied to the gate of the mosfet is necessary to obtain an adequate, and adequately linear, operating current, and that the mutal conductance of the power mosfet (about 2A/V in its linear region) is very much lower than that of the bipolar junction transistor (which can be in excess of 15A/V, or many hundreds of amps/volt in the case of Darlington-connected pairs).

In conventional audio-amplifier design, as it has become established over the past 20 years, the 'architecture' normally employed in the circuit is a low-power voltage amplifier, usually operated in class A, with as high an a.c. gain as is practicable without the use of an inconvenient number of gain stages, followed by an impedance-converter stage – usually a push-pull pair of compound emitter followers, forward biassed into AB operation, with an operating point chosen so that the mutual conductance of the pair of emitter followers is close to that which will be given by one half, alone, when operating in its linear region. Negative feedback is then applied from output to input to improve the overall linearity and other operating characteristics of the amplifier.

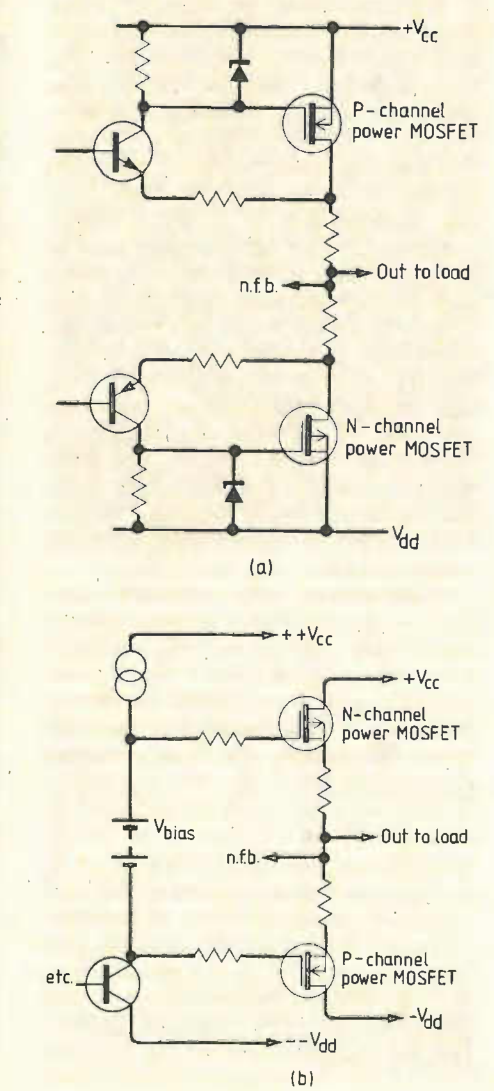
This configuration gives satisfactory bandwidth and linearity, and allows high power outputs with low quiescent thermal dissipation. The main drawback in this system is that there are invariably some low-level residues of crossover distortion, which increase in magnitude at higher frequencies, as the open-loop gain of the class A amplifier decreases – mainly as a result of the added h.f. loop-stabilizing components. This problem is worsened by the loss in loop gain through the output emitter-following stage, in which the gain is always less than unity.

To a first approximation, the output impedance of an emitter follower is $1/g_m$, which would give a gain in the output stage of $Z_L/(1/g_m+Z_L)$ at low frequencies. However, there is a further loss of gain at higher frequencies due to the limitations in turn-on and turn-off times of the transistors, so it is customary to use two or more transistors in a compound configuration in each half of the emitter follower, partly to sustain a low output impedance, and partly to allow the 100% negative feedback within the emitter-follower group to force improvements in the internal h.f. characteristics.

Inevitably, therefore, a complementary pair of output source followers using power mosfets, having a maximum g_m of some 2A/V, will perform less well in terms of linearity with a comparable class A amplifier stage than a pair of compound emitter followers with an effective (overall) g_m of, at least, some 100A/V.

Two solutions are available to this problem, of which the first is simply to incorporate the power mosfets in a compound source-follower circuit, with one or two small-signal bipolar transistors to increase the internal loop gain and reduce the dynamic output resistance and non-linearity of this stage. This provides a very simple answer to the difficulties introduced by the low g_m of the power mosfet, while allowing full advantage to be taken of the advantages of these devices (freedom from 'secondary breakdown', simpler output stage overload protection, and much better h.f. characteristics leading to lower overall t.h.d. and better transient response). I have shown a practical audio amplifier circuit using mosfets in the output stage configuration of Fig. 3(a), in another place[1].

For relatively low-power use, up to say 50 watts, this type of output stage is entirely satisfactory, and gives a good performance without calling for unconventional circuit design. However, there is a practical limitation in higher power use in that the forward voltage drop in each compound half cannot be less than the forward gate voltage (ref. Fig. 2) added



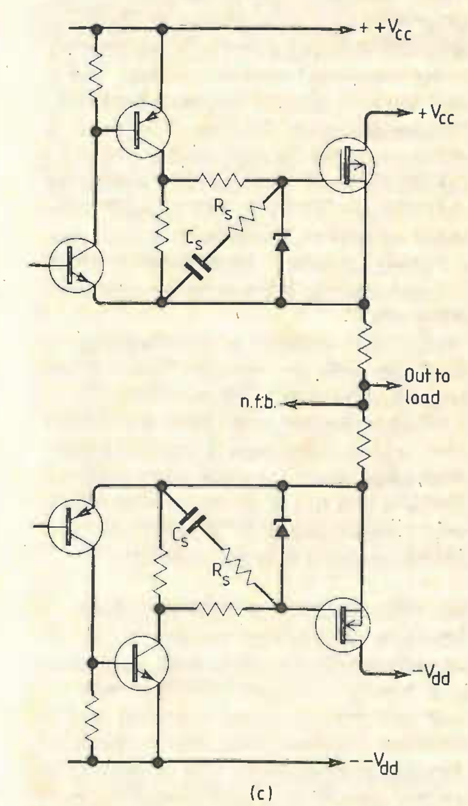


Fig. 3. *To increase the internal loop gain, the mosfet can be used with a small-signal transistor in compound source-follower, which enables low mutual-conductance mosfets to be used, while retaining their advantages, as in (a). At higher powers, larger supply voltages must be used, but circuit at (b) shows that only low-current drivers need be so supplied. Circuit at (c) is extension of approach shown in (b).*

www.americanradiohistory.com

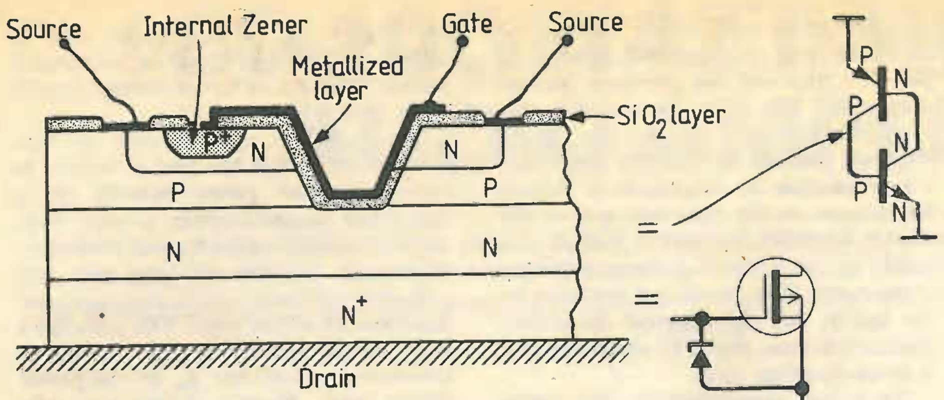


Fig. 6. *Internal protective Zener diode can cause inadvertent thyristor action, in which gate loses control.*

to the saturation voltage (V_{ce}) of the driver transistor, even though the necessary drain-source voltage of the mosfet for this output current may be less than this. This leads to the need for higher supply-line voltages, with a consequent increase in the cost of mains transformer and smoothing capacitors.

In the very simple complementary-mosfet output stage of Fig. 3(b), the driver stages can be supplied from a higher voltage line without so much of a cost penalty, since the supply currents required by the driver stages are comparatively small.

This advantage can be retained by the use of the circuit arrangement of Fig. 3(c), while still allowing a very high effective g_m of the compound emitter follower, and a high level of internal negative feedback. The problem with this circuit is that it is no longer unconditionally stable within its internal feedback loop, and h.f. stabilizing components such as C_s and R_s need to be added to achieve the desired overall gain and phase margins – an elaboration which is unnecessary in the simpler arrangement of Fig. 3(a).

The other solution to the difficulty of the lower effective transfer ratio of the simple mosfet source follower of Fig. 2(b) is to increase the gain of the class A amplifier stage, and this approach is explored below. Meanwhile, there are some other potential pitfalls in the use of power mosfets which need consideration if a workable and reliable design is to be put together.

Specific problems with mosfets

Although the power mosfet is, in its normal method of construction, equivalent to a bipolar junction transistor with its base and emitter joined together, and is therefore immune from the problem of 'secondary breakdown' (the funnelling of emitter current through diminishing areas of the base-emitter junction and consequent localized overheating and damage) it does suffer from other problems which are unique to itself. Of these, the first and most immediate is that the gate insulation layer, an oxide film formed on the surface of the silica, is less than 0.0001in (2.5 microns) thick, and will break down if the voltage between the gate and the source exceeds some 10-20 volts – depending on the device manufacture. Since the time delay involved in this breakdown, which will destroy the device, is likely to be very short, the circuit must be designed to protect the gate against even very brief voltage excursions beyond this limit.

This difficulty can be lessened, in the construction of the device, by incorporating a Zener diode between source and gate, as shown in Fig. 4. However, this technique in its turn leads to the problem that the device must then be protected against a reverse bias – of the order of 0.6 volts – which would cause this internal Zener to conduct, since this can sometimes lead to the triggering of a thyristor-type action within the mosfet, in which the gate is irrelevant. This may not destroy the device, but may damage associated circuit elements. The simplest form of protection is the use of an external germanium diode, connected in parallel with the gate/source Zener, and arranged to conduct before the internal diode. This is not a preferred solution, however, since the reverse insulaton resistance of the Ge diode is much poorer than the unmodified input resistance of the mosfet, and is non-linear with voltage. The circuit of Fig. 3(a) is immune from this problem.

The second difficulty in the use of power mosfets arises from the very high operating frequencies possible with these components. This leads to an effective circuit element of the form shown in Fig.

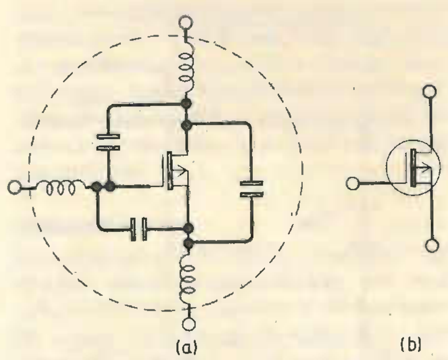


Fig. 5. *At high frequencies, stray capacitances and inductances, shown at (a), turn mosfet into an oscillator, with damaging effect.*

5(a), when the user expects the device to behave as in Fig. 5(b)! This causes immediate high-frequency oscillation, with frequently destructive effects, when such mosfets are incorporated into apparently sensible circuit configurations, and since the resultant burst of oscillation probably occurs in the 200-1000MHz range – and is brief anyway – it is unlikely that it will be seen on any monitoring instrument. The unhappy experimenter is then left contemplating a defunct device, thinking that its sensitivity to static electrification is so great as to render it unusable.

Happily, the internal gate-source capacitance is sufficiently high, typically in the range 600-1500pF, that stray static charge is unlikely to induce an electrical breakdown of the gate insulation. This internal capacitance, which must not be overlooked in circuit design considerations, also provides a convenient means for taming the h.f. behaviour of the transistor, sicne an external 'gate-stopper' resistor can then cause a predictable roll-off in h.f. response, to bring the unity gain transition frequency down to a more manageable level. An external resistor in the range 470R-4k7 is normally adequate.

Given these precautions, my experience is that power mosfets are at least as durable as normal bipolar power transistors, and allow a substantial improvement in circuit performance for a relatively small extra cost.

References

1. Linsley Hood., J. L., *Hi-Fi News and Record Review*, Vol. 25, No. 12 (Dec. 1980) pp. 83-85.

To be continued

LITERATURE RECEIVED

Power semiconductors and d.c. power supplies are detailed in the 1982 edition of the Lambda catalogue. It includes some application notes and dimensional drawings which makes it useful as a handbook. Lambda Electronics Co, Abbey Barn Road, High Wycombe, Bucks.
WW 400

Sôme literature that you would like to receive may be out of print. A service to help you find that elusive book is provided by **The Out of Print Book Service**, 17 Fairwater Grove East, Cardiff, CF5 2JS. They do not charge a fee but ask that all requests for the service should be accompanied with a postage stamp at the current first class letter rate and full details of the book required.
WW 401

Ceramic chip capacitors for high frequency applications are described in a bulletin from Hy-Comp Ltd, 7 Shield Road, Ashford Industrial Estate, Middlesex TW15 1AV. The bulletin lists their stability, specifications and terminations.
WW 402

DIGITAL FILTER DESIGN

Will digital filters take over from their analogue counterparts? Accuracy, versatility and falling cost suggest they will. This second article on microprocessor implementation details a procedure for recursive filter design of Butterworth and Tchebychev response, with examples and Basic programs for pole, zero calculation.

by B. M. G. Cheetham and P. M. Hughes

It has long been recognized that because of the high sensitivity of the roots of high-order polynomials to coefficient values, recursive digital filters are best implemented as cascade or parallel arrangements of second-order filter sections. Cascading several second-order filter sections as illustrated in Fig. 1(a) is equivalent to re-expressing $H(z)$ as the product of second-order transfer functions, i.e.

$$H(z)=H_1(z)\,.\,H_2(z)\,.\,.\,.\,H_m(z)$$

where each $H_j(z)$ is of the form

$$H_j(z)=\frac{1+a_1z^{-1}+a_2z^{-2}}{1+b_1z^{-1}+b_2z^{-2}} \qquad (1)$$

This is often referred to as a biquadratic transfer function and the circuit by which it is implemented a biquadratic section. The signal flow diagram of a commonly used biquadratic section is shown in Fig. 1.

The filter design problem is now that of deciding how many biquadratic sections are required, and calculating the coefficients for each of them. There are a variety of solutions to this problem, and the procedures are divided into two broad groups: direct methods in which the poles and zeros of the digital filter are computed directly in the z-plane, and indirect methods which involve the design of an analogue prototype filter which is transformed to give a suitable digital equivalent. Details of the commonly used indirect design methods can be found in the standard texts[1]. The direct method detailed here for the design of Butterworth and Tchebychev-type digital filters is probably the simplest approach; it is non-iterative and does not require the use of a large computer. Further details and program listings for the more complex direct design methods are to be found in the standard texts.

Recursive filters

The effect of a digital filter may be represented in z-transform notation as

$$Y(z) = H(z).X(z)$$

where $X(z)$ is the z-transform of the filter input sequence, $Y(z)$ is the z-transform of the output sequence, and $H(z)$ is the filter transfer function, as shown in a previous article (May issue). For a general filter, $H(z)$ may be expressed as

$$H(z)=\frac{\sum_{i=0}^{M} a_i z^{-i}}{1-\sum_{j=1}^{N} b_j z^{-j}}$$

where coefficients $a_0, a_1, \ldots a_M$ and $b_1, b_2, \ldots b_N$ are fixed constants. This article considers the design of a class of recursive filters i.e. filters for which $N > 0$ in the above expression. Recursive filters, generally speaking, are the most economic in both hardware and processing time requirements.

Butterworth and Tchebychev filters

Most filtering applications require an amplitude response that allows selected frequency bands to pass through the filter unaltered and eliminates as nearly as possible frequency components outside these bands. In many applications, particularly where a degree of phase distortion is acceptable in the passbands, Butterworth and Tchebychev-type filters are often used, whose responses approximate the magnitude-frequency response of an ideal filter. The difference between the two classes lies in the nature of the approximation. In the case of Butterworth-type filters, the magnitude of the frequency response is maximally flat over the passband, falling by 3 dB at the cut-off frequencies and decreasing monotonically in the stopbands. The rate of fall-off of gain in the stopbands is fixed and determined solely by the order of the filter. Tchebychev-type filters display an equi-ripple passband response with specificable ripple amplitude δ. The filter gain falls monotonically in the stopband at a rate depending on the passband ripple amplitude: the larger the ripple amplitude, the sharper is the transition from passband to stopband. Tchebychev-type filters generally show an increased rate of fall-off of gain over the equivalent Butterworth-type filter of the same order. Unlike analogue filters, a number of alternative methods exist for the design of Butterworth and Tchebychev digital filters. For a given set of design parameters, there will be a number of digital filter transfer functions which may be classed as Butterworth or Tchebychev type. The method presented here, referred to as the squared magnitude approach, is described in detail by Rader and Gold[2], and used by Ackroyd[3]. The poles and zeros of the digital filter are deducted directly from the squared magnitude of the required response with no constraints placed on the phase response, which may therefore be non-linear. Once the pole and zero positions have been determined, it is a simple matter to calculate the a_i and b_j coefficients for each of the cascaded second-order sections. As the design procedure simply consists of the evaluation of a number of given formulae, it is particularly suitable for a programmable calculator or microcomputer. The first design procedure given is that for a lowpass digital filter, which also forms the basis of the design methods for highpass, bandpass and bandstop filters.

Lowpass Butterworth filters

An analogue lowpass filter is an nth-order Butterworth type if its response $G(j\Omega)$ satisfies

$$|G(j\Omega)|^2=\frac{1}{1+\left(\dfrac{\Omega}{\Omega_c}\right)^{2n}}$$

where Ω signifies angular frequency. This formula gives a passband which is maximally flat, with a gain of 0dB at d.c. falling to −3dB at the cut-off frequency

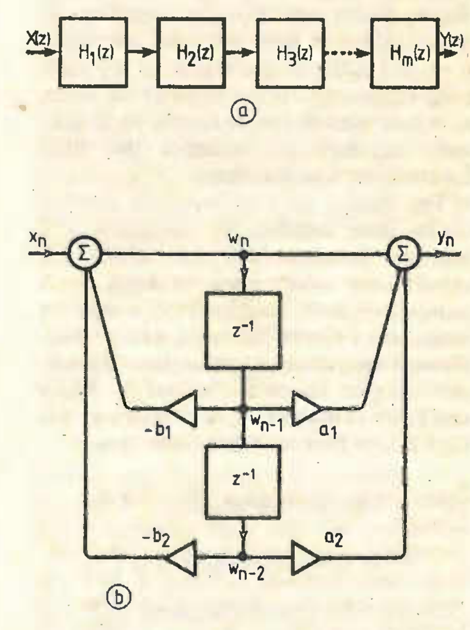


Fig. 1. *Recursive digital filter is realised as a cascade of second-order sections with transfer functions $H_1(z)$, $H_2(z)$, etc. $X(z)$ and $Y(z)$ are the z-transformed input and output sequences respectively (a). Biquadratic section (b) has input sequence $\{x_n\}$ and output $\{y_n\}$ with $w_n=x_n-b_1w_{n-1}-b_2w_{n-2}$*
so $(1+b_1z^{-1}+b_1z^{-2})W(z)=X(z)$.
Also $y_n=w_n+a_1w_{n-1}a_2w_{n-2}$
so $Y(z)=(1+a_1z^{-1}+a_2z^{-2})W(z)$
$=\left(\dfrac{1+a_1z^{-1}+a_2z^{-2}}{1+b_1z^{-1}+b_2z^{-2}}\right)X(z)$, as required.

www.americanradiohistory.com

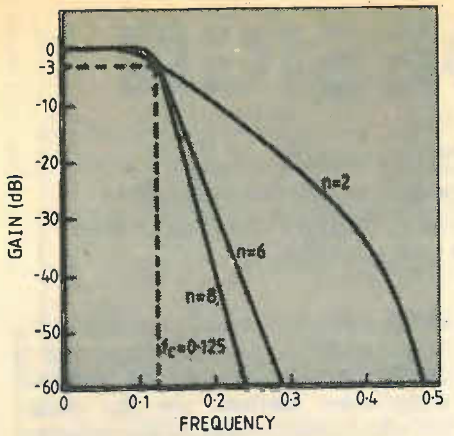


Fig. 2. Amplitude response of three Butterworth-type lowpass digital filters with cut-off equal to 0.125 effect of increasing the filter order.

Ω_c. A corresponding forumla for digital filters which produces a frequency response with similar properties to that of an analogue Butterworth filter is

$$|H(e^{j\omega})|^2=\frac{1}{1+\left(\frac{\tan\omega/2}{\tan\omega_c/2}\right)^{2n}} \qquad (2)$$

where ω_c is equal to the radian cut-off frequency. In place of radian frequency ω it is often convenient to refer to relative frequency f, obtained by dividing ω by 2π. Hence f is the relative frequency of a sinusoid of frequency $F=f\times(1/T)$. Because F must be less than $1/2T$ to satisfy the sampling theorem, values of f need only be considered in the range 0 to 0.5. Fig. 2 shows the magnitude responses of three digital filters specified by equation 2. These filters all have a cut-off frequency $f_c=\omega_c/2\pi$ equal to one-eighth of the sampling frequency. As the order of the filter, n, is increased the more closely its magnitude response approximates the ideal lowpass filter characteristic.

The design of a Butterworth lowpass digital filter requires the invention of a suitable function $H(z)$ for which the substitution $z=e^{j\omega}$ gives equation 2. A number of such functions of z may be found, their derivation being a fairly complicated mathematical procedure. A suitable transfer function derived by Rader and Gold[2] is found to have poles located at U_m+jV_m in the complex z-plane, where

$$U_m=(1-\tan^2\pi f_c)/D_m$$

$$V_m=(2\tan\pi f_c\sin\theta_m)/D_m$$

$$\text{with } D_m=1-2\tan\pi f_c\cos\theta_m+\tan^2\pi f_c$$

$$\text{and } \theta_m=\frac{(2m+n+1)\pi}{2n} \qquad (3)$$

where $m=0$ 1, . . . $(n-1)$ for a filter of even-order n; odd-order Butterworth filters may also be specified. Each of the n transfer function zeros is located at $z=-1$.

Once the poles and zeros of a recursive digital filter have been calculated the next stop in the design process is to determine the coefficients a_1, a_2, b_1 and b_2 of equation 1 for each cascaded second-order section. For even-order filters, the transfer function poles can always be grouped as complex conjugate pairs.

Hence the overall filter transfer function $H(z)$ expressed as a product of $n/2$ second-order (biquadratic) transfer functions is

$$H(z)=A_0\prod_{m=0}^{n/2-1}\times\frac{(1+z^{-1})(1+z^{-1})}{[1+z^{-1}(U_m+jV_m)][1+z^{-1}(U_m-jV_m)]}.$$

Expanding the above equation yields the required form

$$H(z)=A_0\prod_{m=0}^{n/2-1}\times\frac{1+2z^{-1}+z^{-2}}{1-2U_mz^{-1}+(U_m{}^2+V_m{}^2)z^{-2}} \qquad (4)$$

$$\frac{1}{A_0}=H(z)|_{z=1}=H(e^{j\omega})|_{\omega=0}. \qquad (5)$$

Tchebychev filters

The squared magnitude of the frequency response of a Tchebychev low-pass digital filter with cut-off ω_c is

$$|H(e^{j\omega})|^2=\frac{1}{1+\epsilon^2V_n{}^2\left(\frac{\tan\frac{\omega}{2}}{\tan\frac{\omega_c}{2}}\right)} \qquad (6)$$

where $V_n(x)$ denotes the nth-order Tchebychev polynomial function of x and ϵ is a parameter used to set the pass band ripple amplitude. Fig. 3 shows the frequency response of a typical fourth-order Tchebychev filter. The magnitude of the pass band ripple δ is related to the parameter ϵ by

$$\epsilon=\left(\frac{1}{(1-\delta)^2}-1\right)^{1/2} \qquad (7)$$

Increasing δ has the effect of sharpening the cut-off region of the filter and increases the stop band attenuation, but only at the expense of increasing the pass band ripple.

The transfer function poles of an nth-order digital filter whose frequency response satisfies equation 6 are located at U_m+jV_m in the complex z-plane where

$$U_m=\{2(1-a\tan\pi f_c\cos\theta_m)/D_m\}-1$$

$$V_m=(2b\tan\pi f_c\sin\theta_m)/D_m$$

$$\text{with } D_m=(1-a\tan\pi f_c\cos\theta_m)^2+b^2\tan^2\pi f_c\sin^2\theta_m$$

$$\text{for } m=0,\ 1,\ 2,\ \dots\ n-1 \qquad (8)$$

$$\text{and } 2a=(\sqrt{\epsilon^{-2}+1}+\epsilon^{-1})^{1/n}-(\sqrt{\epsilon^{-2}+1}+\epsilon^{-1})^{-1/n}$$

$$2b=(\sqrt{\epsilon^{-2}+1}+\epsilon^{-1})^{1/n}+(\sqrt{\epsilon^{-2}+1}+\epsilon^{-1})^{-1/n}$$

θ_m is calculated as for Butterworth filters from equation 3 and each of the n transfer function zeros is again located at $z=-1$. Once the poles and zeros of the transfer function have been calculated, substituting for U_m and V_m in equation 4 gives the $n/2$ biquadratic transfer functions used in the realization of the filter.

Example 1

Design a low pass Butterworth digital filter with the specification

sampling frequency	12 kHz
cut-off frequency	3.2 kHz
attenuation at 4.0 kHz	>20dB i.e. 10
passband gain	0dB

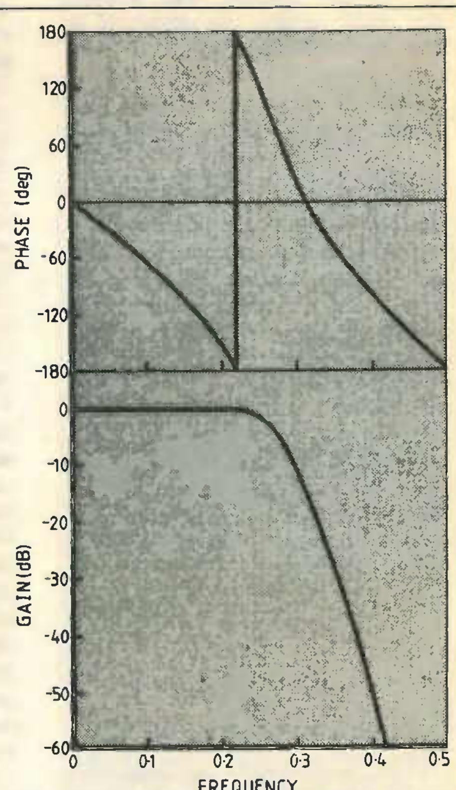
From this the relative cut-off frequency is $f_c=3.2/12=0.2667$. For the attenuation at 4 kHz to be greater than 10, it follows from equation 2 that

$$\frac{1}{10}>\left(1+\left(\frac{\tan4\pi/12}{\tan3\cdot2\pi/12}\right)^{2n}\right)^{-1/2}$$

The lowest even-order filter which will satisfy these requirements had $n=6$. The six poles for this filter are

m	U_m	V_m
2, 3	−0.0533	0.1313
1, 4	−0.0613	0.4129
0, 5	−0.0831	0.7640

Substituting these values into equation 4 gives three biquadratic transfer functions in the form of equation 1 with coefficients a_1, a_2, b_1 and b_2 as shown below. Scaling factor A_0, calculated by means of equation 5, should be set to 0.0401 to give unity passband gain. The magnitude and phase responses of the filter are shown alongside.



Amplitude and phase response of sixth-order Butterworth-type lowpass filter designed in Example.

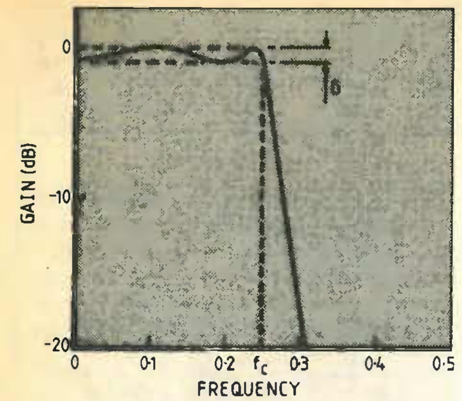


Fig. 3. Amplitude response of a typical fourth-order Tchebychev low pass filter with cut-off equal to 0.25 and specified ripple, δ.

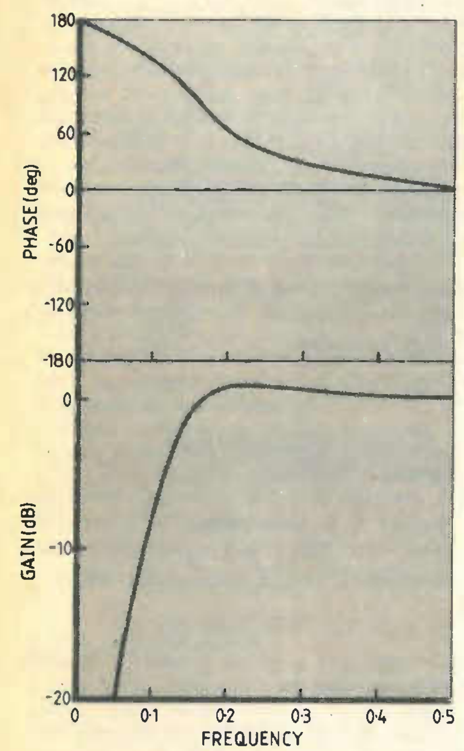


Fig. 4. Amplitude and phase response of second-order Tchebychev-type highpass digital filter designed using lowpass to highpass transformation.

Example 2

Design a second-order Tchebychev low-pass digital filter with $f_c=1/3$ and a pass-band ripple of 0.1 (0.915 dB).

By equation 7, $\epsilon=0.4843$ and a and b and thus calculated to be 0.844 and 1.2834 respectively. Substituting these values into equations 8 with θ_m obtained from equation 3 for $m=0$ and 1 shows that the poles of the filter lie at

$$z=-0.38075\pm j\,0.49030.$$

Calculating now the biquadratic transfer function for the single section required gives

$$H(z)=A_0\frac{1-2z^{-1}+z^{-2}}{1+0.7615z^{-1}+0.3854z^{-2}}$$

Substituting $z=1$ into the above shows that A_0 must be set to 0.5367 for unity gain at d.c.

Example 3

Design a fourth-order bandpass Butterworth type filter with a sampling frequency of 16 kHz and cut-off frequencies of 2 and 4 kHz.

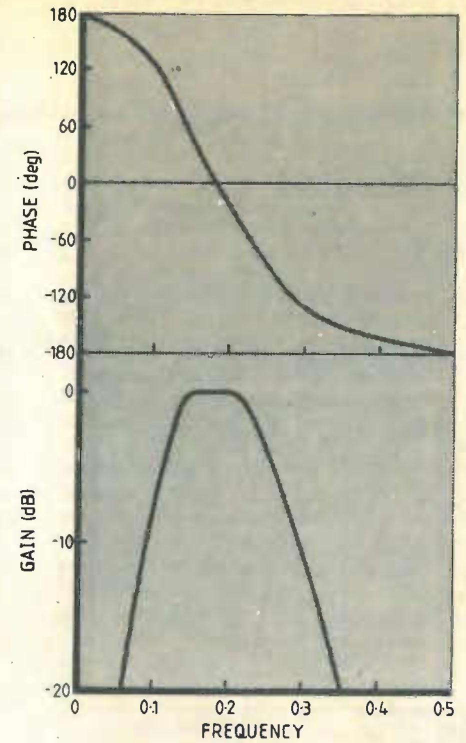
As the bandpass transformation doubles the order of the prototype filter, a second-order Butterworth lowpass prototype is required with a relative cut-off frequency $f_c=(4-2)/16=0.125$. The two poles of the prototype filter, calculated from the expressions for U_m and V_m (eqns 3), lie at $z=0.4714\pm j0.3333$. The two zeros are at $z=-1$. Substituting for $f_h=4/16$ and $fl=2/16$ in equation 9 gives $\alpha=0.4142$. By equation 10 the poles of the bandpass filter are calculated to be

$$z=0.5262\pm j0.5885$$
$$z=0.0833\pm j0.7266.$$

The zeros of the prototype filter transform to two zeros at $z=-1$ and two at $z=+1$. Pairing the zeros at $z=-1$ with the poles at $z=0.0883\pm j0.7266$, gives $H(z)$

$$=\left(\frac{1-2z^{-1}+z^{-2}}{1-1.0524z^{-1}+0.6232z^{-2}}\right)\left(\frac{1+2z^{-1}+z^{-2}}{1-0.1665z^{-1}+0.5348z^{-2}}\right)$$

The passband gain is set to 0 dB by scaling $H(z)$ by a factor of 0.0976. *Graph* shows the magnitude and phase responses of the designed filter.



Amplitude and phase response of fourth-order Butterworth-type bandpass filter designed in Example

Highpass, bandpass and bandstop filter design

The design of Butterworth and Tchebychev filters may be carried out by transformations applied to lowpass prototype filters obtained by the methods described earlier 4. The simplest of the transformations is that of low to highpass. A lowpass filter with relative cut-off frequency f_c, is transformed to a high-pass filter with relative cut-off frequency 0.5 $-f_c$, by replacing z^{-1} with $-z^{-1}$ in the filter transfer function $H(z)$.

Applying this transformation to the lowpass Tchebychev filter in the previous example, we obtain a high-pass Tchebychev filter with a relative cut-off frequency of 1/6. The resulting transfer function $H(z)$ is

$$0.5367\left(\frac{1-2z^{-1}+z^{-2}}{1+0.7615z^{-1}+0.3854z^{-2}}\right)$$

The magnitude and phase responses of this filter are shown in Fig. 4.

Low to band pass transformation

A low pass prototype filter with relative cut-off frequency f_c is transformed to a bandpass filter with lower and upper cut off frequencies of f_l and f_l+f_c $(=f_h)$ respectively, by the replacement of z by

$$\frac{z(z-\alpha)}{(\alpha z-1)}$$

in the prototype transfer function, where

$$\alpha=\frac{\cos\pi(f_h+f_l)}{\cos\pi(f_h-f_l)}. \qquad (9)$$

This has the effect of doubling the order of the prototype filter, and consequently each second-order section in the lowpass filter is transformed to a fourth-order transfer function in the bandpass filter. It is necessary therefore to reduce each of these fourth-order transfer functions to the product of two-second order sections. The transformation may be conveniently applied by considering the poles of the prototype each of which produces two poles in the resulting bandpass filter. For each pole of the prototype filter situated at $z=p$, say, the transformed filter will have poles at values of z which satisfy

$$p=\frac{z(z-\alpha)}{(\alpha z-1)}$$

$$\text{i.e. at } z=\tfrac{1}{2}\alpha(1+p)\pm\left\{\frac{1}{4}\alpha^2(1+p)^2-p\right\}^{1/2} \qquad (10)$$

As p in this equation will normally be a complex number, computation of the poles of the bandpass filter involves the calculation of a complex square root, see appendix. The $2n$ poles of the band-pass filter may then be determined by substituting each of the n prototype poles into equation 10. The band-pass poles may then be grouped into complex conjugate pairs to produce the denominators for each of the n biquadratic transfer functions which comprise the overall filter transfer function, $H(z)$. The zeros of the bandpass filter are calculated from the zeros of the prototype using the same formulae as were used for the poles. By substituting $p=-1$ into equation 10 the n zeros of the lowpass prototype located at $z=-1$, transform to $2n$ zeros in the bandpass filter, n located at

www.americanradiohistory.com

```
10 ! CALCULATE BWORTH LP. POLES
15 DISP "FILTR ORDER" @ INPUT N
20 DISP "REL. CUT-OFF FREQ.?"
25 INPUT F1@ I2=3*N/2-1 @ I1=N
30 DISP "POLES OF FILTER"
35 DISP "     REAL          IMAG"
40 FOR I=I1 TO I2 @ T=2*I+1
45 T=T/(2*N)*PI @ C1=PI*F1
50 A=TAN(C1) @ A2=A*A @ B=2*A
55 D=1-B*COS(T)+A2 @ U=(1-A2)/D
60 V=B*SIN(T)/D
65 DISP USING 70 ; U,V
70 IMAGE 2X,SD.4D,5X,SD.4D
75 V=V*-1 @ DISP USING 70 ; U,V
80 NEXT I
85 END
```

Programs to calculate poles of lowpass filters – Butterworth above, Tchebychev below – and for lowpass transformation to bandpass and bandstop, right.

```
10 ! CALCULATE TCHEB LP. POLES
15 DISP "FILTR ORDER" @ INPUT N
20 DISP "REL. CUT-OFF FREQ.?"
25 INPUT F1@ DISP "RIPPLE ?"
30 INPUT R@ W=1-R @ E=W^2
35 W=1/E-1 @ E=SQR(W)
40 M=1/(E*E)+1 @ M=SQR(M)+1/E
45 M1=LGT(M)/N @ M1=10^M1
50 M2=1/M1 @ A=.5*(M1-M2)
55 B=.5*(M1+M2) @ Y=N @ Z=3*N/2
60 Z=Z-1 @ DISP " FILTER POLES"
65 DISP "     REAL          IMAG"
70 FOR I=Y TO Z @ T=2*I+1
75 T=T/(2*N)*PI @ C1=PI*F1
80 W=TAN(C1) @ W2=W*W
85 U=1-A*W*COS(T)
90 D=U*U+B*B*W2*SIN(T)^2
95 U=2*U/D-1 @ V=2*B*W*SIN(T)/D
100 DISP USING 105 ; U,V
105 IMAGE 2X,SD.4D,5X,SD.4D
110 V=V*-1
115 DISP USING 105 ; U,V
120 NEXT I
125 END
```

```
10 ! BANDPASS TRANSFORMATION
15 DISP "PROT. ORDER" @ INPUT N
20 DISP "LWR CUTOFF" @ INPUT F1
25 DISP "UPR CUTOFF" @ INPUT F2
30 F=(F2+F1)*PI @ F4=(F2-F1)*PI
35 A=COS(F)/COS(F4)
40 FOR 1=1 TO N/2
45 DISP "REAL(POLE)" @ INPUT U
50 DISP "IMAG(POLE)" @ INPUT V1
55 V2=V1*-1 @ P1=1+U
60 R7=A*P1/2 @ I1=A*V1/2
65 I2=A*V2/2 @ A2=A*A
70 V=V1 @ GOSUB 175
75 U8=R7+B0 @ U9=R7-B0
80 V8=I1+B1 @ V9=I1-B1 @ V=V2
85 GOSUB 175
90 U7=R7+B0 @ U6=R7-B0
95 V7=I2+B1 @ V6=I2-B1
100 DISP "TRANSFORMED POLES"
105 DISP "     REAL          IMAG"
110 DISP USING 115 ; U8,V8
115 IMAGE 2X,SD.4D ,5X,SD.4D
120 DISP USING 115 ; U7,V7
125 DISP USING 115 ; U6,V6
130 DISP USING 115 ; U9,V9
135 DISP @ DISP "QDRTIC COEFFS"
140 B1=-2*U8 @ B2=U8*U8+V8*V8
145 DISP USING 150 ; B1,B2
150 IMAGE X,"B1,B2",2(4X,SD.4D)
155 B1=-2*U9 @ B2=U9*U9+V9*V9
160 DISP USING 150 ; B1,B2
165 DISP @ NEXT I
170 END
175 ! CALCULATE (1+P)^2
180 R2=P1*P1-V*V @ J2=2*P1*V
185 ! CALCULATE A^2*(1+P)^2/4
190 R0=A2*R2/4 @ J0=A2*J2/4
195 ! SUBTRACT P
200 R1=R0-U @ J1=J0-V
205 ! CONVERT TO EULER FORM
210 R=R1*R1+J1*J1 @ R=SQR(R)
215 T=ATN2(J1,R1)
220 ! TAKE SQUARE ROOT
225 R=SQR(R) @ T=T/2
230 ! BACK TO CARTESIAN
235 B0=R*COS(T) @ B1=R*SIN(T)
240 RETURN
```

```
10 ! BANDSTOP TRANSFORMATION
15 DISP "PROT. ORDER" @ INPUT N
20 DISP "LWR CUTOFF" @ INPUT F1
25 DISP "UPR CUTOFF" @ INPUT F2
30 F=(F2+F1)*PI @ F4=(F2-F1)*PI
35 A=COS(F)/COS(F4)
40 FOR I=1 TO N/2
45 DISP "REAL(POLE)" @ INPUT U
50 DISP "IMAG(POLE)" @ INPUT V1
55 V2=V1*-1 @ P1=1-U
60 R7=A*P1/2 @ I1=A*V1/2
65 I2=A*V2/2 @ A2=A*A
70 V=V1 @ GOSUB 175
75 U8=R7+B0 @ U9=R7-B0
80 V8=I1+B1 @ V9=I1-B1
85 V=V2 @ GOSUB 175
90 U7=R7+B0 @ U6=R7-B0
95 V7=I2+B1 @ V6=I2-B1
100 DISP "TRANSFORMED POLES"
105 DISP "     REAL          IMAG"
110 DISP USING 115 ; U8,V8
115 IMAGE 2X,SD.4D ,5X,SD.4D
120 DISP USING 115 ; U7,V7
125 DISP USING 115 ; U6,V6
130 DISP USING 115 ; U9,V9
135 DISP @ DISP "QDRTIC COEFFS"
140 B1=-2*U8 @ B2=U8*U8+V8*V8
145 DISP USING 150 ; B1,B2
150 IMAGE X,"B1,B2",2(4X,SD.4D)
155 B1=-2*U9 @ B2=U9*U9+V9*V9
160 DISP USING 150 ; B1,B2
165 DISP @ NEXT I
170 END
175 ! CALCULATE (1-P)^2
180 R2=P1*P1-V*V @ J2=2*P1*V
185 ! CALCULATE A^2*(1-P)^2/4
190 R0=A2*R2/4 @ J0=A2*J2/4
195 ! ADD P
200 R1=R0+U @ J1=J0-V
205 ! CONVERT TO EULER FORM
210 R=R1*R1+J1*J1 @ R=SQR(R)
215 T=ATN2(J1,R1)
220 ! TAKE SQUARE ROOT
225 R=SQR(R) @ T=T/2
230 ! BACK TO CARTESIAN
235 B0=R*COS(T) @ B1=R*SIN(T)
240 RETURN
```

$z=1$, the other n at $z=-1$. When the order of the prototype filter is even, as is normally arranged, the zeros of the bandpass filter may be grouped in pairs such that of the n second-order sections which comprise the filter, half will have transfer function numerators equal to

$$1+2z^{-1}+1 \text{ (two zeros at } z=-1)$$

whilst the remaining half have numerators of

$$1-2z^{-1}+1 \text{ (two zeros at } z=+1)$$

The n biquadratic transfer functions may now be completed by pairing each of the calculated numerators with a suitable denominator. As a general rule, the denominators of the second-order sections should be parried with the numerators in such a way that the poles of each section are those nearest to the zeros it implements. The filter transfer function $H(z)$ is simply the product of the n calculated biquadratic transfer functions. The passband gain may be set to one by the introduction of a scaling factor A_0 equal to the reciprocal of $H(e^{jw})$ evaluated at the central frequency of the passband.

Lowpass to bandstop transformation

A lowpass filter with relative cut-off frequency f_c is transformed to a bandstop filter with lower and upper cut-off frequencies of f_l and f_h respectively, where

$$f_c=0.5+f_l-f_h$$

by replacing z in the prototype transfer function with

$$\frac{z(z-\alpha)}{1-\alpha z}$$

where α is defined as for the bandpass transformation. Apply the transformation to poles and zeros it is readily shown that a pole or zero of the prototype located at $z=p$ transforms to two poles or zeros of the bandstop filter located at

$$z=\tfrac{1}{2}(1-p)\alpha\pm\left\{\frac{1}{4}(1-p)^2\alpha^2+p\right\}^{\frac{1}{2}} \quad (11)$$

The procedure for calculating the second-order sections of a bandstop filter is similar to that for a bandpass filter. In this case, however, the zeros are no longer located at $z=\pm1$ but form complex conjugate pairs which must be expanded in the normal way to give the numerators of the second-order sections. The numerators of all the second-order sections will be identical.

Continued on page 79

Example 4

Design a fourth-order bandstop Tchebychev filter with a sampling frequency of 20 kHz, lower and upper cut-off frequencies of 1 and 1.2 kHz respectively and a passband ripple of 0.1.

A second-order Tchebychev lowpass prototype is required with a relative cut-off frequency of 0.49 and a passband ripple amplitude of 0.1. The two poles of this filter are found to lie at $z=-0.9681\pm j0.0482$, with the two zeros at $z=-1$. Using the transformation of equation 11 the poles and zeros of the band-stop filter are

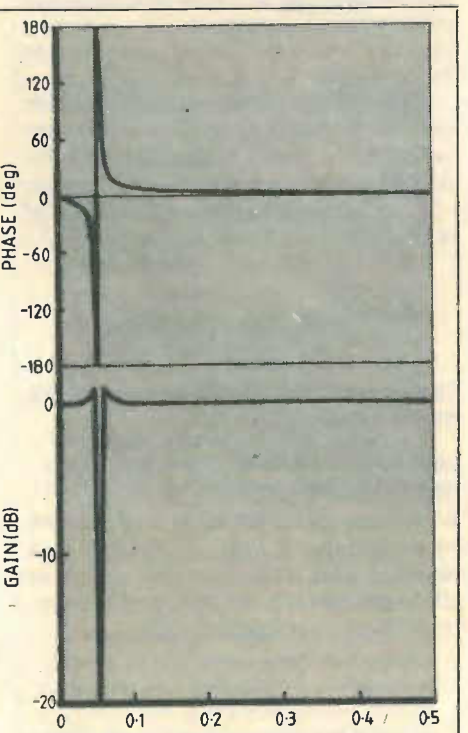
poles	zeros
$0.9356\pm j0.3099$	$0.9414\pm j0.3374$
$0.9171\pm j0.3553$	$0.8414\pm j0.3374$

The filter transfer function $H(z)$ is thus calculated to be

$$\left(\frac{1-1.8827z^{-1}+z^{-2}}{1-1.8712z^{-1}+0.9714z^{-2}}\right)$$

$$\left(\frac{1-1.8827z^{-1}+z^{-2}}{1-1.8341z^{-1}+0.9672z^{-2}}\right)$$

which must be scaled by 0.969 to set the d.c. gain to unity. The magnitude and phase responses of this filter are shown alongside.



Amplitude and phase response of Tchebychev-type bandstop or notch filter designed using lowpass to bandstop transformation in Example 4.

LETTERS

WIRELESS?

I have just bought a copy of your magazine, for the first time in some years, and after reading it with some amusement I have the following comments to make.

Firstly, I suggest you rename the magazine *Computer World (Wireless Computer?, Computer Wireless??)* – I bought the magazine because I want to buy a communications receiver – I work with computers and I find it amusing that your magazine is now full of computer projects rather than the radio projects it used to be.

Secondly, with respect to Mr B. Reay's letter (April 1982) – I have heard of the RSGB's opposition to c.b., but not experienced it directly – I am a c.b. user, but find the RSGB has nothing to worry about. Most c.b. users would not join the RSGB (they can barely operate a 'rig' much less pass the RAE). Those who are interested in radio (myself included), find c.b. very frustrating (2 watts e.r.p. and 200 users per channel – at least in London) and this exposure to radio usually causes strong motivation to take (and pass) the RAE, thus escaping from the school-children and 'wallys" (although I hear 2 metres is not much better); and thus the serious user ends up as an amateur anyway. I have heard that the RSGB has been swamped with enquiries since c.b. legalization!

On "Microchips and Megadeaths" – if all of us who work irrelevant fields would refuse to work on weapons systems (as I have done), there would be no such systems.

Finally, what has happened to the glossy paper *WW* used to be printed on? and where can I buy a second-hand communications receiver?.

Hugh J. Davies
East Barnet
Herts

DISC DRIVES

I refer to Mr Watkinson's article on disc drives in your March issue in which he states that a 16-bit computer can only address 32K memory locations. It is well known that 16 bits can address 64K locations (2^{16} = 65,536), a feature common to most microprocessors. Could Mr Watkinson please explain his apparently erroneous mathematics?

P. C. Major
Winchester
Hants.

The author replies:

I am grateful to Mr Major for giving me the opportunity to explain a problem which has been encountered by many familiar with microprocessors when faced with more powerful hardware. I am sure, however, that Mr Major would agree that such treatment would be out of place in a series which is primarily devoted to disk drives.

The definition of a 16 bit machine which I find most satisfactory is that it possesses a data path of 16 bits in the c.p.u. Neglecting more complex machines which employ block fetching in conjunction with a cache memory, a 16 bit machine will have 16 bit wide memory locations. This allows an entire parameter to be fetched with one memory cycle. In such machines, the smallest entity of interest is still the 8 bit byte, of which there are two in each location. As one address bit is necessary to specify whether the high byte or the low byte is of interest, only 15 bits are left to specify the location. 2^{15} locations equals 32K as stated.

The address range of a processor is determined by circuitry quite distinct from the data paths in both microprocessors and minicomputers. For example, the 8085 has an 8 bit data path, but has the ability to generate 16 bit addresses by the time consuming expedient of a two-byte program counter which has to be loaded a byte at a time. This is simply the result of designing for a different price performance target. Thus on the one hand we might have a minicomputer which obtains two bytes at a time from 32K locations, and on the other hand a microprocessor which obtains one byte at a time from 64K locations. The number of available bytes is the same in each case, but all other things being equal, the minicomputer will be about twice as fast.

For further reading on the subject I would recommend the Intel 8085 Manual and the PDP 11/04 Processor Handbook.

BLUMLEIN BIOGRAPHY

The September 1973 issue of *Wireless World* carried a letter from Rex Baldock which contained the following paragraph:

"The full story of Alan Blumlein's contribution to technical history will appear in the forthcoming biography by Mr F. P. Thomson, written in conjunction with Simon Blumlein, and anyone with information likely to be of value should write to Mr Thomson at 39 Church Road, Watford WD1 3PY Herts, England."

On the 1st June 1977, a GLC plaque to Blumlein was unveiled and Mr F. P. Thomson gave a speech in which he said he had been "persuaded to write a biography" on Blumlein. I, for one, reported the prospect of a Blumlein biograophy in print (e.g. *Hi Fi News*, August, 1977) and in February 1982 wrote to Mr Thomson querying progress on his biography. In reply I have received letters which tell me that I am "impertinent" and my own articles on Blumlein are "inaccurate", but offer no information on a publication date of the mooted biography.

I would be interested to hear from anyone who answered the call for biographical information nearly ten years ago, and is now concerned. My address is Garden Flat, 5 Denning Road, London NW3 1ST.

Barry Fox
Hampstead
London NW3

MICROCHIPS AND MEGADEATHS

Steve Coleman (April letters), has taken too literally my plea for refusal to fight. This was intended to apply to opposition in its widest sense, both militarily and industrially, now and in the future.

Electronic engineers in the UK, the USA and USSR are in ideal positions to frustrate the arms race. Also well placed are their supporting teams, without whose help they cannot operate. This applies to those who type, drive lorries and serve in canteens. When the Americans say "tell that to the Russians", I have little doubt that the Russians say "tell that to the Americans". The decisions of Nuremberg tell us that obedience to orders from higher authority is no defence against charges of immoral acts.

The records of both super-powers are appalling, and give us no justification for an alliance with either power. Balance the massacre of Katyn against that of Mi Lai. Balance Afghanistan against Vietnam. Balance the rapes of the Baltic states and Central Europe against the many American invasions of South America, the destabilization of its emerging democracies and the military support of regimes as foul as that of Hitler. It was the US which dropped two atomic bombs on Japan when the latter was on the verge of surrender. The US has come close to using atomic weapons several times since then.

How can we depend upon British political parties? The government of Anthony Eden handed Russian prisoners over to Stalin and almost certain death, and later ordered the invasion of Suez. The government of Clement Attlee agreed to the use of atomic bombs on Japan. The Wilson government supported the US over Vietnam. The answer is that individuals must act according to their own consciences, or like lemmings we will follow each other into oblivion.

By the laws of chance, if weaponry be retained at its present level, sooner or later, by virtue of a technical fault or the action of a person of deranged mind, disaster must follow.

Yes, Steve Coleman, let us extend our scientific interest in technology into a scientific analysis of society.

R. Whitehead
Sutton
Surrey

POOR DEAL FOR AMATEUR RADIO

I was very interested in the letter from B. Reay in your April issue. My copy was available before the 1st of the month, otherwise I might have thought that this was a special "All Fools" feature.

May I first of all make it quite clear that, as many of your readers will know from my call-sign, although I am employed by the RSGB I am not privy to any matters of policy and I do not even work at the Society's premises. These comments are therefore made purely from the standpoint of an ordinary member of forty years standing and a reasonably active transmitting amateur since 1948.

Everyone will regret that your correspondent receives no replies to his letters, and it is up to him to take this matter up with the appropriate representatives and committee members. On the other hand however, nobody is obliged to reply to unsolicited communications which contain nothing but unconstructive criticisms and/or impossible demands, particularly from individuals claming to speak for many others.

Dealing with Mr Reay's points in roughly the same order as in his letter, first of all I do not agree that the RSGB have been anti-c.b. I have no feelings either way in this matter, but it seems to me that the Society dealt with the matter very fairly, even issuing a list so that the uninitiated could be told the essential differences between the two Services.

With regard to the 70 MHz band, this is of course not an international allocation but is made available on a "grace and favour" basis subject to the requirements of the priority users

www.americanradiohistory.com

of the band. Incidentally, Mr Reay, either by accident or design, makes no mention of the new u.h.f. allocations made available, together with the three new h.f. bands, at the 1979 WARC as a result of much hard work done by national societies, including the RSGB. So far one h.f. band has been allocated to UK amateurs, with the remainder to follow. It is also worth remembering that, despite the weight of ARRL, amateurs in the USA do not yet have any of these facilities.

With regard to the abuse of the London repeaters, this is often referred to in "*Radio Communication*", and to close the repeaters down would be about as logical as terminating the telephone system because some people "fiddle" coin-boxes or make obscene calls. As for persuading the Home Office to catch the offenders, this suggestion fails to appreciate the finance and manpower position in which the authorities find themselves at present, not to mention the limitations of the Wireless Telegraphy Act in its present form.

Concerning the RAE, I agree that this to many people seems to be more a lottery than an examination, this being all part of the general lowering of standards. However, Mr Reay has presumably joined in the joke and obtained his callsign. If the "B" licence (introduced at the insistence of RSGB, by the way) does not give him sufficient scope, he only has to pass the Morse test to obtain extended facilities and, by his operating, help to stem the undeniable decline in amateur radio.

With regard to amateur radio being a technical hobby, not many people build or repair their equipment these days, and why on earth should they, unless they are so inclined? None of my licences, not even the old "Experimental" one, has made any reference as to who makes my equipment; why is it, therefore, that from time to time those who are presumably still living in the times when it was not possible to buy ready-made gear, raise this old red herring. The acid test always used to be the quality of one's signals and the manner in which the station was operated. No-one expects Keegan to tan a piece of leather for his boots or Boycott to turn his bat on the lathe!

Finally, therefore, I would submit that as a result of having a strong and vigilant society the British amateur, far from being given a raw deal, can look to the future with confidence. An example of this is the prompt action taken after the recent Home Office gaffe over the licence schedule.

If Mr Reay, and any who think like him, would only stop and reflect, they may yet see the wood through the trees.

E. G. Allen, G3DRN
London SW20

As an RSGB member, the letter from B. Reay in the April edition was very interesting to me, and I agree with many of the points raised. It is sad that the growing numbers of concerned and disenchanted members have to air their views in a companion journal, as the Society claiming to represent all radio amateurs is totally out of touch with, and does not appear to want to listen to, its membership.

The current licensing fiasco show the Society is not in touch with the Home Office either, admitting in March *Radio Communication* "The first the Society knew about the publication of the Gazette notice was when a Member telephoned . . .". At £229, I don't subscribe to the Gazette, but surely with an income of around £700,000 the Society should. It seems the member who kindly telephoned was lucky to get an answer – it's difficult to hear the 'phone with your head in the sand!

When tuning across the bands you often hear someone complaining about the RSGB – not another band plan – yet more repeaters to be introduced – the list is endless, so I won't compile yet another one here. I'll simply say to the "Old Boys" at the RSGB, listen to the disenchanted membership, and get a much-needed decent deal for the radio amateurs you claim to represent.

Peter Thurlow, G8SUH
Dagenham
Essex

DATA STORAGE

In reply to the letter by B. Savage on the subject of "An economical Z-80 development system" (*Wireless World*, April 1982), I must say, I find his comments somewhat irrelevant. Although I agree with him on the availability and advantages of fast, reliable serial data transfer facilities, for bulk storage on cassette or for long distance communication, the article describes a technique which allows the two otherwise separate microcomputers to become integral components in a much more powerful, versatile and self-contained development system. Using this philosophy the interconnecting wires which Mr Savage refers to present absolutely no hardship.

Parallel data transfer generally requires no error checking, communication medium bandwidth presents no problem, transfer speed is optimized, more flexibility is possible in the software 'management' package and as an added bonus, the tape interface remains available on both systems for bulk storage.

On the subject of efficiency, it may be noted that two-way handshaking is involved. This was a deliberate policy to ensure universal compatibility with 'host computers' of widely varying operating speeds and with their own special data transfer facilities. Transfer speed may be improved by utilising the interrupt facilities of both computers but for absolute maximum efficiency, DMA must be used.

G. Winstanley
Bio-medical Eng. Unit
N. Staffordshire Polytechnic

AMATEURS AND C.B.

I see from recent reports that the number of applicants for amateur radio licences is continuing at a high level. I listen to the anarchy that prevails on the h.f. bands at present I wonder why anyone bothers to go to all the expense and effort of passing the requisite examinations. Quite often there seems to be more DX activity going on around 11 metres by illegal c.b. operators than in the 10 metre Amateur band. One can often hear these operators describing their 250 watt rigs over the air and exchanging names and addresses for QSL cards, indicating that they consider the chances of being prosecuted to be negligible.

It is when you start talking to the engineers of British Telecom who operate the detection service for illegal transmissions on behalf of the Home Office that the magnitude of the problem becomes apparent. Until a few years ago complaints came in from the public about interference on radio or television at such a rate that in a typical telephone area about 100 were waiting to be investigated at any time. During the past couple of years so many complaints have been received that the backlog in many areas has risen into the thousands, completely overwhelming the small detection teams that the Home Office is prepared to pay for. In fact, one engineer told me sadly that if you confined your illegal transmissions to the bands between 1.6 and 30 MHz and minimized the interference you caused to tv or the broadcast bands your chances of being caught were practically nil.

By all accounts, the Home Office has little interest in the problem and hopes that it will just go away. An example of its attitude to radio matters can be seen in the recent modification to Amateur licensing conditions announced in the London Gazette. Here we had a government ministry modifying the law of the land by a decree which was so incompetently drafted and carelessly checked that even to the most casual reader several mistakes were immediately apparent. Obviously, these matters are of so little concern to the Home Office that they can be dealt with by the office junior.

I suppose the policing of the radio waves must be a very dull job. But unless the Home Office gets a grip on the problem in the next few months it might just as well give up, abandon the licensing of radio transmitters altogether and open the whole radio spectrum to all comers. Personally, I am not sure that it hasn't started along that path already.

In the event of your using this letter, I would be grateful if you would not publish my address as many of us have found to our costs that criticism of any aspect of c.b. activity usually leads to harassment.

C. G. Howard
Oxfordshire

ALIEN INTELLIGENCE

In your March, 1982 editorial you speak of the lack of response to the Japanese challenge. If your thinking is prevalent in Britain then I can explain why. After all, if Britain were to make a large effort to develop 5th generation computers as the Japanese have announced they will, then it would be "evidently out to destroy all of Western industry". and so, being a decent nation, it doesn't!

Please, no more racist remarks in *Wireless World!*

Erich Unteregelsbacher
Kingston
Ontario
Canada

SELF-HELP TELEVISION

V. Lewis reported in your February issue that a licence had not yet been issued for the Redbrook active-deflector system (Self-Help Television, p.71). In fact, the licence was issued on September 14, 1981.

M. S. D. Granatt,
Home Office.

HIGH-LOSS POWER SUPPLY?

The low-loss power supply shown on page 42 of your February issue is potentially lethal! It is essential that the voltage rating of R_1 is not exceeded, as a failure could put mains voltage on the +12V terminal, having blown up the 470μF capacitor. This usually means that R_1 should be at least two resistors in series. Experience shows that carbon-composition resistors fail to any value – high or low. Carbon, metal-film and metal-oxide resistors almost always fail to a higher value, so should be used in this circuit.

Any mains-supplied circuit should have an appropriate fuse in the live line. A zener clamp (say 22V0) across the 0-12V output would be an additional safety factor. It should be hefty enough to carry sufficient current to blow the fuse in the case of other components failing (1.7 times rated current of the fuse).

Direct connexion of low-voltage equipment to the mains is always potentially dangerous and is best avoided.

R. Jenkins
Cheltenham,
Gloucestershire

COST-EFFECTIVE IGNITION

It is unfortunate that you have published another constructional article – Cooper's article on an electronic ignition system, March, 1982, p4 – which falls into the common trap of using device characteristics that are not specified by the manufacturer.

The devices in question are the 1N4000 series. These are low-frequency rectifiers, and the JEDEC specification to which their numerous manufacturers conform contains no information about their use at high frequencies. While the devices used by Mr Cooper were evidently adequate, devices from another batch or from another manufacturer could be completely unusable at 15kHz. There is no shortage of devices designed and characterized for use at tv line frequency; for example, the 1N4933 would replace the 1N4001. If a 600V rating is considered sufficient for the s.c.r., D_2 and D_3 could be the BY299, an 800V, 2A fast device.

R. E. Pickvance
ITT Semiconductors
Foots Cray
Kent.

The author replies:

Mr Pickvance is quite wrong to say the article "falls into a trap", because I went to some lengths in the article to show why I used the 1N4000 series diodes and also included a graph to show their limitation, with the advice to use high-frequency diodes beyond 15kHz. Perhaps he hasn't read this part of the article?

Most of the reputable manufacturers (Motorola for instance) actually provide information on the frequency characteristics of the 1N4000 series although it isn't, strictly speaking part of the JEDEC specification. One firm devotes a whole page of its data sheet to this aspect (see enclosed photostat), so they clearly acknowledge that this diode is used at higher frequencies.

The main reason why I chose this diode is because it is readily available to the constructor. Although high-frequency diodes appear in manufacturers' catalogues, they are not available from suppliers such as Electrovalue, Maplin, Marshall's, or Semiconductor Supplies. Nowhere in these firms' catalogues are the 1N4933 or BY299 diodes to be found. To reinforce this point, I rang ITT's own main stockists, VSI (tel 0279-29666) and Nobel (tel 01-309-0500) and asked them to quote for the 1N4933 and BY299. Neither firm had any stocks of the 1N4933 or intended to stock it, and would not even quote a price. Neither firm had any stocks of the BY299, but Nobel did at least quote a delivery (6 to 8 weeks!) and a price of 17p. This latter firm, when they found out the application of the diode, went so far as to recommend the 1N4000 series as a substitute!

However, all the suppliers mentioned sell the 1N4000 series, and at a moderate cost, too – about 50p will buy all five diodes used in this circuit; and this brings me to my third point.

If the circuit were designed around specialized components instead of general-purpose components, the price would go through the roof, and the whole essence of this particular electronic ignition was that it could be paid for out of the savings on one year's motoring. If I uprated the diodes it would make even better sense to substitute the TIP3055 switching transistor, improve the transformer windings, select a military-grade capacitor for C_1 and specify a high-grade thyristor. This I would like to do, but there would be very little economic sense in it; it would no longer be cost-effective.

Finally, I suggest that Mr Pickvance reads *Wireless World* Letters to the Editor for Oct 1975 p.465, and June 1975 p.265 – and indeed anyone intent on criticism, before they put pen to company notepaper, would do well to read these letters.

HEATING-FUEL SAVER

Mr Ryder's central heating fuel saver is pretty obviously going to be cost effective but it does seem to be amenable a further cost-effective modification. This is to add a further thermistor to measure the indoor temperature and hence the temperature difference between inside and out which will better reflect the time needed to reach the desired temperature.

As it stands there is a distinct and obvious weakness in using the device with the popular time clocks providing a gap during the day, long for those at work and shorter for those staying at home. The lowest outdoor temperatures are almost always reached at night and the house has far longer to cool down, whilst during the day it is possible to have quite large solar gains to further diminish indoor temperature reduction. Therefore it obviously makes sense to respond to both temperatures.

What may be less obvious is that a linear type response is not really needed In cold weather the heating system loses more heat to the outside and thus take longer to warm inside, (in the extreme it cannot even reach the desired indoor temperature). If, as seems reasonable, non linearity can be a virtue it does seem feasible to replace R_s, the fixed resistor, with a combination of a thermistor and resistance. the actual choice of values may be made empirically if one has a fairly good idea of the characteristics of one's own heating system performance.

An allied device would be a "time extender" when switching off. The "off" time would be chosen to suit a warm day and the actual close-down would be later according to the temperature outside. One can usually tolerate a few degrees drop but this is a matter very much of personal feelings, and keenness to save fuel. With cast iron boilers and systems having a large water content there is also hot water left after the boiler stops which can be used if the pump is allowed to run longer. Thus two "time extenders" can be of value – one to let the boiler run longer in cold weather and the other a simple fixed "extender" to give about half an hour extra for the pump.

Having suggested that two thermistors are needed to measure the temperature difference it might be worth experimenting, when the time clock has no OFF period during the day, with a thermistor mounted indoors but near to a window so that it is exposed both to the outside and room temepratures. Quite obviously such a thermistor must not be exposed to the sun but the author's choice of a north facing window is unduly restrictive.

As probably 99% of domestic heating systems are just thrown together rather than designed to suit the actual house and the needs of its occupants, it is fairly safe to say that great precision in timing the heating will be uncalled for. The occupants will already suffer from wrongly sized or placed radiators and many other problems, so errors in timing of ± 15 minutes are unlikely to be noticed in terms of comfort.

L. Streatfield
Poole
Dorset

The author replies:

I am obliged to Mr Streatfield for his constructive remarks. If the thermometer facility is not required, then certainly an indoor thermistor could partly replace resistor R_s; or it might be used to modulate the 555 period, via pin 5. With a divide-by-two circuit (such as that of p. 66 *W.W.* Nov. 79) the a.m. and p.m. signals from the time-clock could be distinguished, and the operation modified to suit, for example by switching the 555 timing resistor. The difficulties lie not so much in meeting a particular set of requirements, as in defining the requirements, in the first place.

CARTRIDGE ALIGNMENT

When dealing with tone-arm geometry the tendency is to picture things as they are seen on the turntable and to always include the arc described by the stylus. If instead the stylus/cartridge assembly is imagined to be fixed and the turntable spindle itself moving about the arm pivot, the relative positions of stylus, spindle and pivot are as before but the facts are more clearly illustrated. More importantly, new facts reveal themselves.

Starting from a point representing the stylus, a perpendicular line – a datum line – from which tracking errors may be determined is drawn. Along this line the two zero tracking radii are marked. Through these points an arc with radius equal to the spindle-to-pivot distance is described from a point which, of course, represents the pivot. Any important platter radius may now be marked on the arc directly from the stylus point.

The diagram here is drawn considerably out of scale to avoid crowding. For the same reason lines have been omitted: in an endeavour to

www.americanradiohistory.com

LETTERS

avoid confusion, points are symbolized by some letters not customarily employed.

Position of spindle when stylus is on:

outermost groove,	A
innermost,	B
intermediate radius of high error,	C
any radius (A B etc) included,	R
inner zero tracking radius	p
outer zero tracking radius	q

D, spindle to pivot dist. (arc radius)
L, stylus to pivot
O, offset angle
$L\text{-}D$=overhang=$\sqrt{D^2+pq}-D$
x, angle at R.

$$\sin=\frac{R^2+L^2-D^2}{2LR}=\frac{R^2+pq}{2LR}.$$

When this is applied to p,

$$\sin=\frac{p^2+pq}{2Lp}=\frac{p+q}{2L}=\sin O$$

Similarly with q. ($(p+q)/2L=\sin O$ is clear from the diagram). When applied to C,

$$\sin=\frac{C^2+pq}{2LC}.$$

Now $\sqrt{pq}=C$ therefore $pq=C^2$ and

$$\frac{C^2+pq}{2LC}=\frac{2C^2}{2LC}=\frac{C}{L}=\sin x \text{ at } C.$$

To clarify this, it can be seen from the diagram that $C^2=L^2-D^2$. Now if we join point q to the pivot point, a triangle is completed one side of which is common to another triangle whose hypotenuse is L, because of this

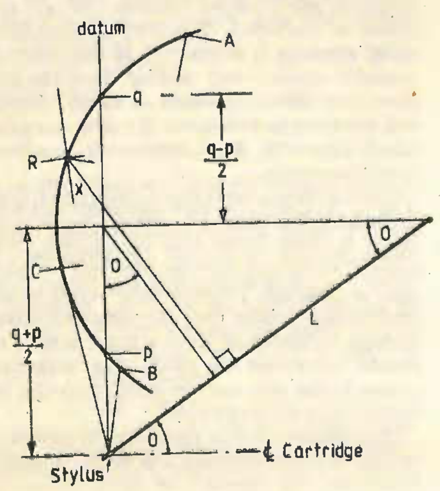
$$D^2-\left(\frac{q-p}{2}\right)^2=L^2-\left(\frac{p+q}{2}\right)^2,$$

therefore

$$L^2-D^2=\left(\frac{p+q}{2}\right)^2-\left(\frac{q-p}{2}\right)^2=pq.$$

(Quickly proved by substituting figures for p and q.)

It is useful to note that while the magnitude of the tracking errors (difference between x and O) depends on the values of D and L, their proportions depend on the zero tracking radii. When p and q are 66 and 121, for instance, the errors at A and B are 1.7 and 0.7 of that found at C. When p and q are 49 and 110, at A the error is double that found at C, while at B it is two thirds. If a diagram is drawn to scale showing only the arc, datum line and points A, B and C joined by straight lines to the stylus point, tracking errors might be measured directly with a protractor. R. J. Gilson's factors would place B on the other side of the datum line.



It follows from the foregoing that $p+q=\sin O2L$. This facilitates the process of calculating the zero tracking radii in a case such as that dealt with in Gilson's final paragraphs page 64, *Wireless World* Oct. 1981. After finding O with his formula 4(b), find $p+q$ from this equation. Then p and q can be found from $pq/p=(p+q)-p$. There seems to be quite a bit of latitude for rounding off the results while ensuring negligible changes in the values of L, the intermediate radius and all angles.
P. E. Cryer,
Thornlie,
Western Australia.

THE NEW ELECTRONICS

I have every sympathy with Hugh Jacques article in your January issue – and I certainly do not find low standards in Germany an excuse for our own low standards, as C. Wehner's letter in the April issue seems to imply (in part at least).

I am now a secondary school teacher of physics and have been appalled at the philosophies built into education; standards here are definitely falling – but a whole re-shuffle of aims and objectives and a change in examination syllabuses and in the exams themselves all combine to camouflage the drop in standard. I have often wondered when this fall in standard was going to affect university standards and higher up. Mr Jacques article confirms my fears.

What with a philosophy that views the child in terms of its needs instead of in terms of its responsibility and society's expectations from it – there has developed the sort of approach which has the following characteristics:
1) educationally – the child considered in terms of its needs must be given automatic promotions to prevent any sense of inferiority, frustration or maladjustment;
2) socially – the same child must be guaranteed cradle-to-grave security lest a trauma be produced;
3) the cure for failure to learn is to devaluate learning and the cure for social failure is to devaluate success.

I trust this will give food for thought for concerned parents and then, perhaps, lead them to action.
S. Georgeoura
Ardgay
Ross-shire

WOODPECKER

Mr Martinez' letter, (April), gives an interesting and quite possibly correct explanation of the Russian "Woodpecker" transmissions. There are one or two points arising from his letter.

The suggestion that the code auto-correlation, *i.e. the "compressed" radar signals, would have virtually no sidelobes may be a little optimistic. One might expect, in a practical system, that the peak signal sidelobes would not be more than about 25 dB at best below the main lobe. One would also have to examine the ambiguity functions of these signals to determine their properties in the range-Doppler domain where their sidelobe performance might be rather different if the radar were used to detect high-velocity incoming targets.

Another point arises from the statement that the compressed signal would have "31 times the amplitude . . ." etc. The equalizer, (i.e. the matched filter), would theoretically conserve signal energy and its peak output would have 31 times the peak *power* of the uncompressed signal, not 31 times its amplitude.

Finally the statement about the radar having 31 times the "sensitivity" of a 100μs radar of the same power, should be interpreted with caution. Two radars of differing pulse durations but of the same *mean* power, and having properly matched filters in the receivers, would have the same "sensitivity". Their difference in the present context would, as Mr Martinez states, lie in their resolution capability. Pulse compression, as such, does not introduce some mysterious improvement in system sensitivity; with matched filter receivers, whatever the transmitted pulse duration, the "sensitivity" remains a function of the ratio of the received signal *energy* to noise power spectral density.
* (strictly the *cross*-correlation function of the transmitted signal with that received, taking account also of any "weighting" which might be used to improve signal sidelobe levels, albeit at some expense to resolution.)
M. G. T. Hewlett
Midhurst
West Sussex

THE FUNCTION OF FUNCTIONS

I was interested to read Thomas Roddam's remarks (*Wireless World*, December, 1981. p. 37) concerning the notion that used to be fairly prevalent, that denies the existence of sidebands in amplitude modulation. After all, with "pure" amplitude modulation the number of cycles per second of the wave remains constant whether it be modulated or not, doesn't it? Be it said that the idea is not entirely dead even yet; there are still people to be found who hanker after it. And it may be said that they are in tolerably good company, too, as anybody may see for themselves by consulting the files of **Nature** for 1930 (pp.92-3, 198-9, 271-3, 306-7, 726-7) in which Sir Ambrose Fleming, no less, categorically denies the existence of sidebands, declaring on the contrary that they are but a mathematical fiction, and stubbornly refusing to accept correction from his colleagues.

The curious thing about it all is that the sideband-deniers have never had any difficulty in accepting that a baseband signal occupies finite spectrum space, not realising, of course, that a baseband signal is but two (superimposed) sidebands, "centred" on zero frequency. A simple thought-experiment: displace the carrier frequency progressively upscale from zero and observe the two sidebands separating out.

And consider, furthermore, that proper reconstruction of a baseband signal to (say) audible form requires re-insertion of the zero-frequency carrier, e.g. in the polarizing firld of a loudspeaker or telephone receiver.
D. C. Sutherland
Wanganui
New Zealand

MICRO-CONTROLLED RADIO-CODE CLOCK

Several standard-frequency transmissions throughout the world provide time and date information controlled by caesium atomic clocks, with potential for automatic time and date information at reasonable cost. This design offers a compromise between economy and complexity suitable for both non-critical professional applications and domestic use.

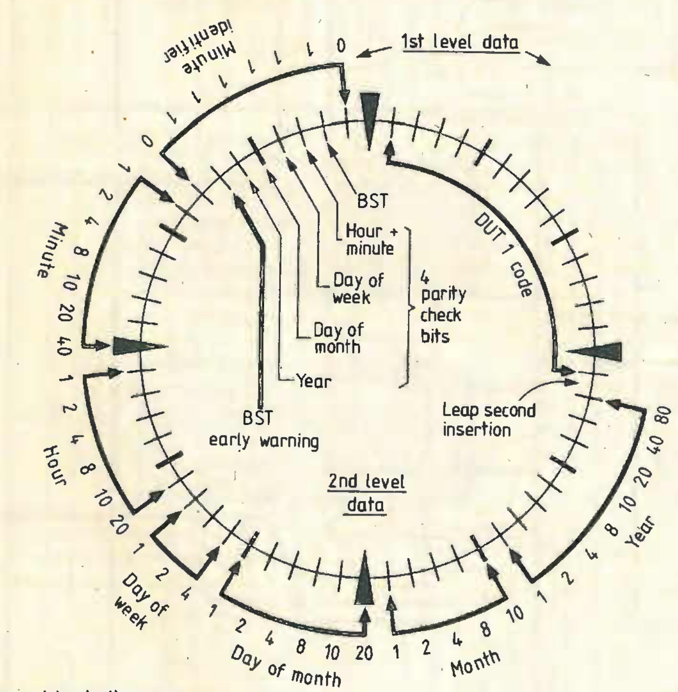
by N. E. Sand

The 60kHz standard-frequency transmission from Rugby MSF now includes fast and slow time codes, both of which provide full time and date information once every second. The signal is transmitted 24 hours every day except for a maintenance period on the first Tuesday of each month. The transmitter power is 50kW e.r.p. which, with the long wavelength, provides propagation over a range of several hundred miles. With careful circuit design, useable reception can be achieved throughout Britain, but because there is a skywave and groundwave component, certain areas can experience cancellation or addition where mixing takes place. This problem is complicated because the areas of mixing change from daytime to nighttime as the ionosphere changes.

Successful reception has been achieved with specialized equipment at over 3,000 km from the transmitter, but with simpler designs 750 km is a more realistic range.

This design uses the slow code, which for most applications provides better results and requires less critical timing. The slow code format shown in Fig. 1 extends from second 17 to second 59 each minute. A logic zero is represented by a carrier break of 100ms and a 1 is represented by a break of 200ms. Other information, such as parity bits, is represented by a carrier break of 100ms displaced by 200ms from the start of the second. To synchronize with the serial code it is necessary to recognize the start of each minute, so an identifier sequence from second 52 to 59 is provided.

Fig. 1. Slow-code format from Rugby MSF.

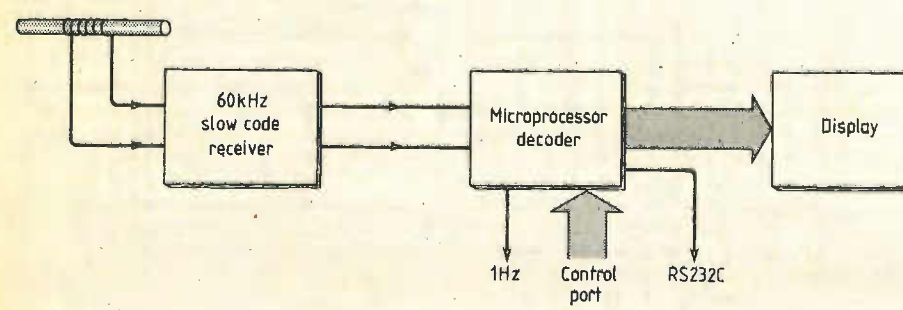


The most important part of the design, as shown in Fig. 2, is the receiver which must be capable of producing a consistent output in the presence of noise. Unfortunately there are several common sources of interference at 60kHz, for example the harmonics from the line output transformer of colour television receivers are powerful sources of interference for v.l.f. transmissions, as well as fluorescent tube fittings and even hand-held calculators. Carefully designed t.r.f. and phase-locked loop receivers can work satisfactorily at moderate gains, but commonly suffer from self pick up which limits their sensitivity. In the case of the p.l.l., radiation from the v.c.o. will generally weaken the signals. For best results a low-current superheterodyne receiver should be used, but it is costly and difficult to adjust for optimum noise performance at v.l.f.

An alternative receiver which is much simpler and with careful design can produce acceptable results is shown in Fig. 3. The input stage uses a cascode circuit which enables the antenna coil to be directly connected without a transformer winding and gives good stability at high gain by minimizing Miller feedback. A multiplier* is used for low-level detection of the 60kHz carrier, a technique which avoids high levels of 60kHz and therefore enhances receiver stability. The multiplier generates a double frequency component and a differential voltage proportional to the carrier level at the two load resistors. The double frequency output is ignored by the following amplifier stage which produces the demodulation carrier. To minimize power requrement, operating current in each arm of the multiplier is set to 50μA. To avoid drift at the multiplier output the potentiometer should be a ten-turn cermet type and the two load resistors metal film.

To optimize receiver performance for all signal levels at the antenna a normal gain-control loop to the cascode stage would provide satisfactory results. However, a better method is to gate the a.g.c. loop because the 60kHz carrier is 100% modulated and will cause errors in a conventional loop. In this design an undelayed signal from the output of IC_2 switches the

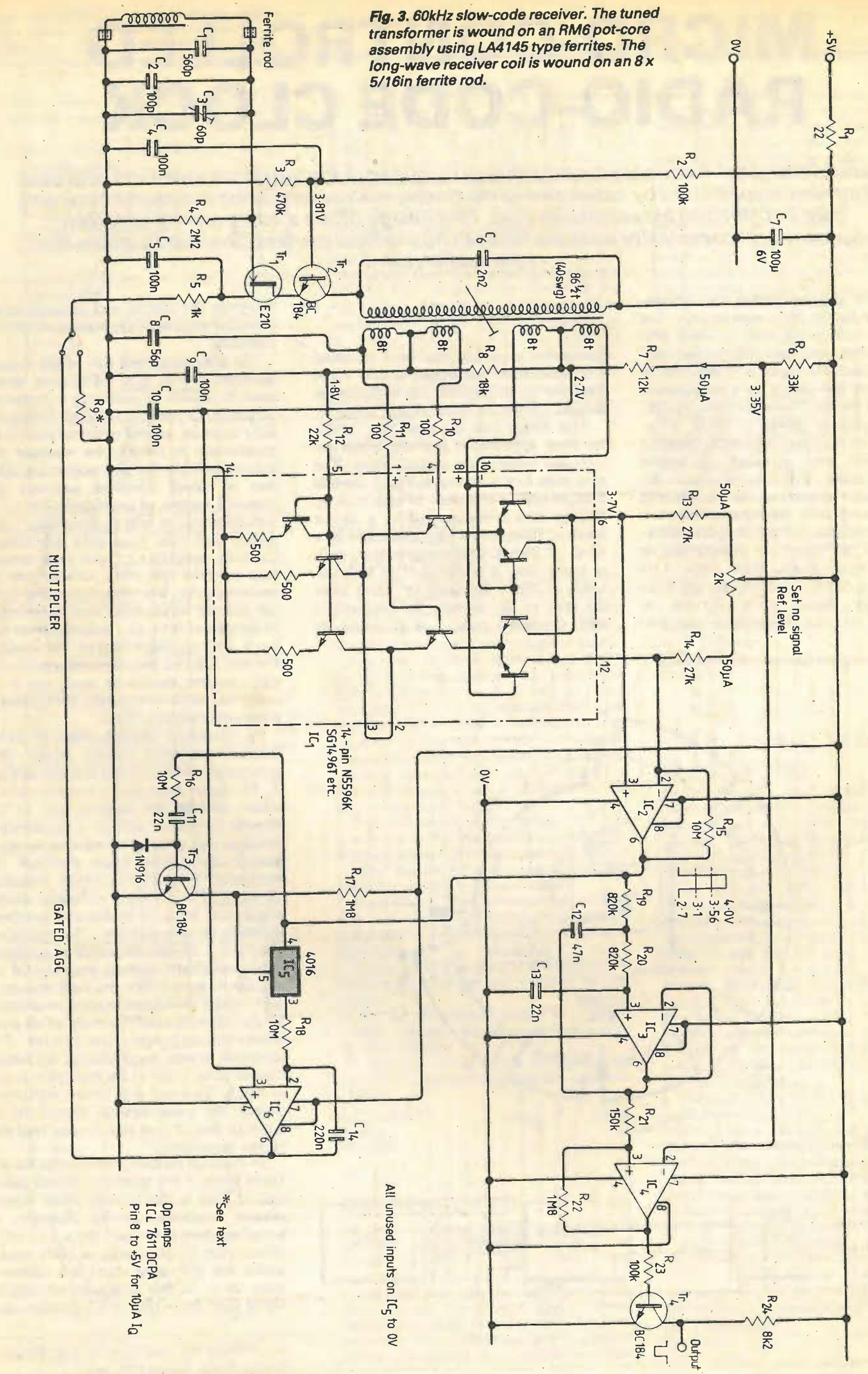
Fig. 2. Hardware block diagram.

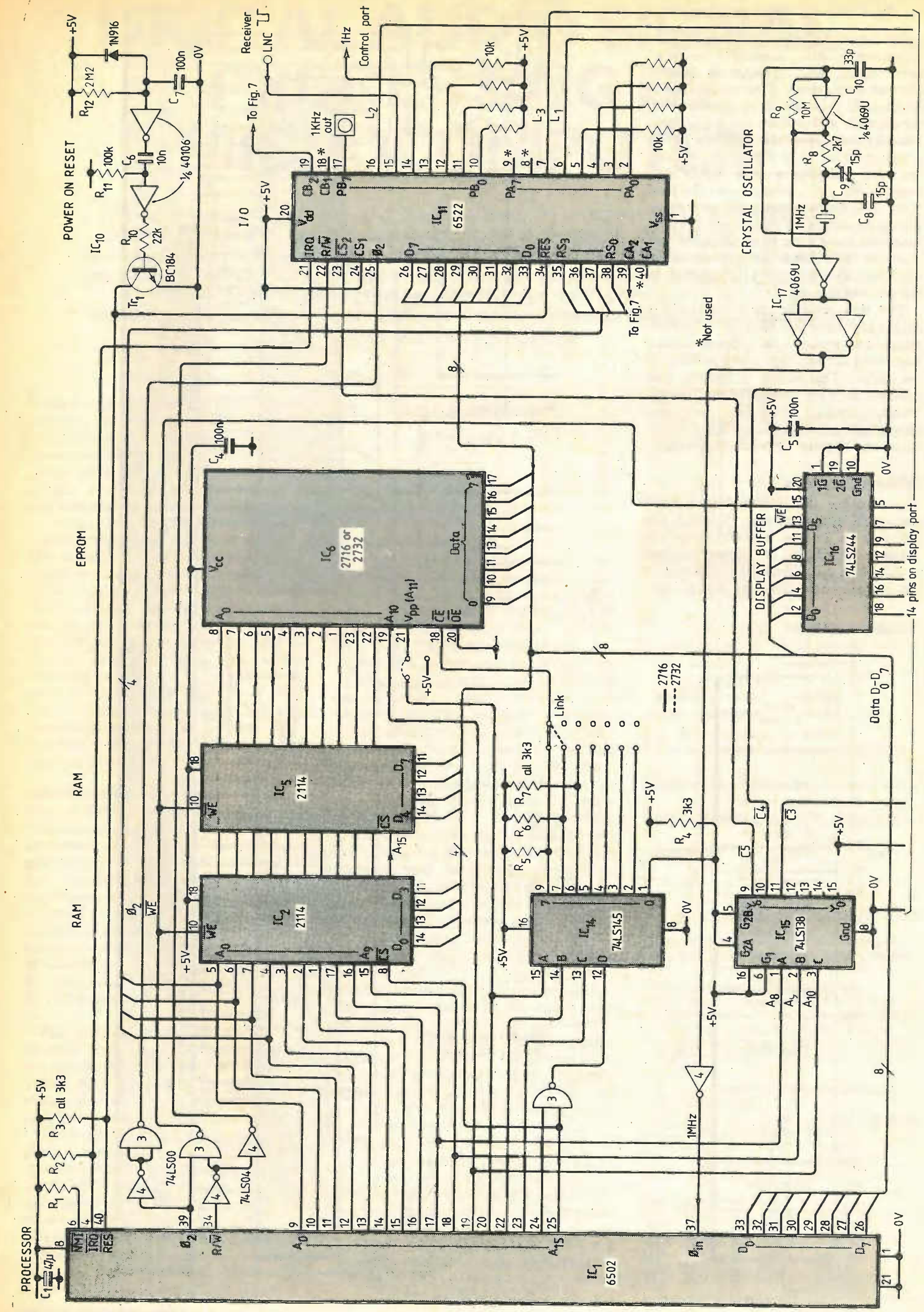


* Self-setting time code clock, by N. C. Helsby, *Wireless World*, August 1976, pp?

www.americanradiohistory.com

Fig. 3. 60kHz slow-code receiver. The tuned transformer is wound on an RM6 pot-core assembly using LA4145 type ferrites. The long-wave receiver coil is wound on an 8 x 5/16in ferrite rod.





◀ *Fig. 4. Microprocessor decoder*

gating control for the a.g.c. amplifier IC_6. Transistor Tr_3 is a.c. coupled to the undelayed signal and provides a simple time-out arrangement if no modulation is detected. If this occurs Tr_3 remains off permanently and enables the a.g.c. loop. During normal operation, when the carrier is pulsed off for up to 500ms, Tr_3 remains on, the transmission gate opens and switches the a.g.c. integrator to the hold state. This action prevents the gain rising during the normal off periods which would otherwise cause noise to be amplified and excessive overshoot in the received carrier level, which in turn causes timing errors in the demodulated signal.

The d.c. amplifier is followed by a simple active low-pass filter and a Schmitt-trigger level sensing stage which provides a logic level output, high corresponding to no carrier. This output is inverted and buffered for t.t.l. compatibility. Complementary m.o.s. apmplifiers are used throughout to reduce the current requirements and dispense with dual supply rails.

Micro decoder

The complete decoding system is based on a 6502 microprocessor. Although this device is not the most powerful in terms of number crunching, its memory-mapped architecture and addressing modes make it an ideal choice for industrial control appli-

Continued on page 59

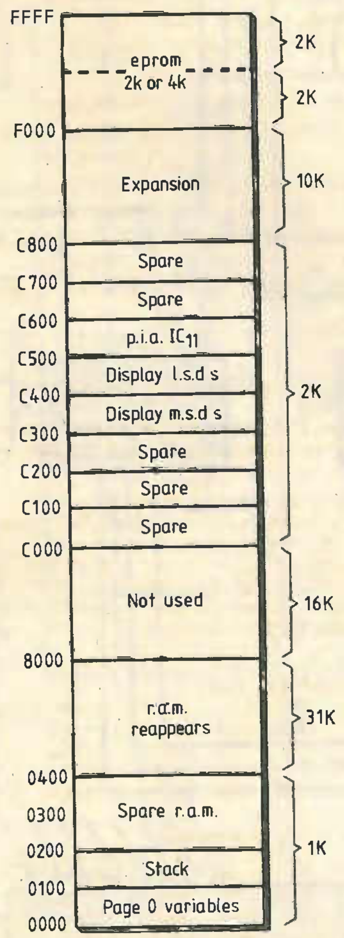


***Fig. 5.** Memory map.*

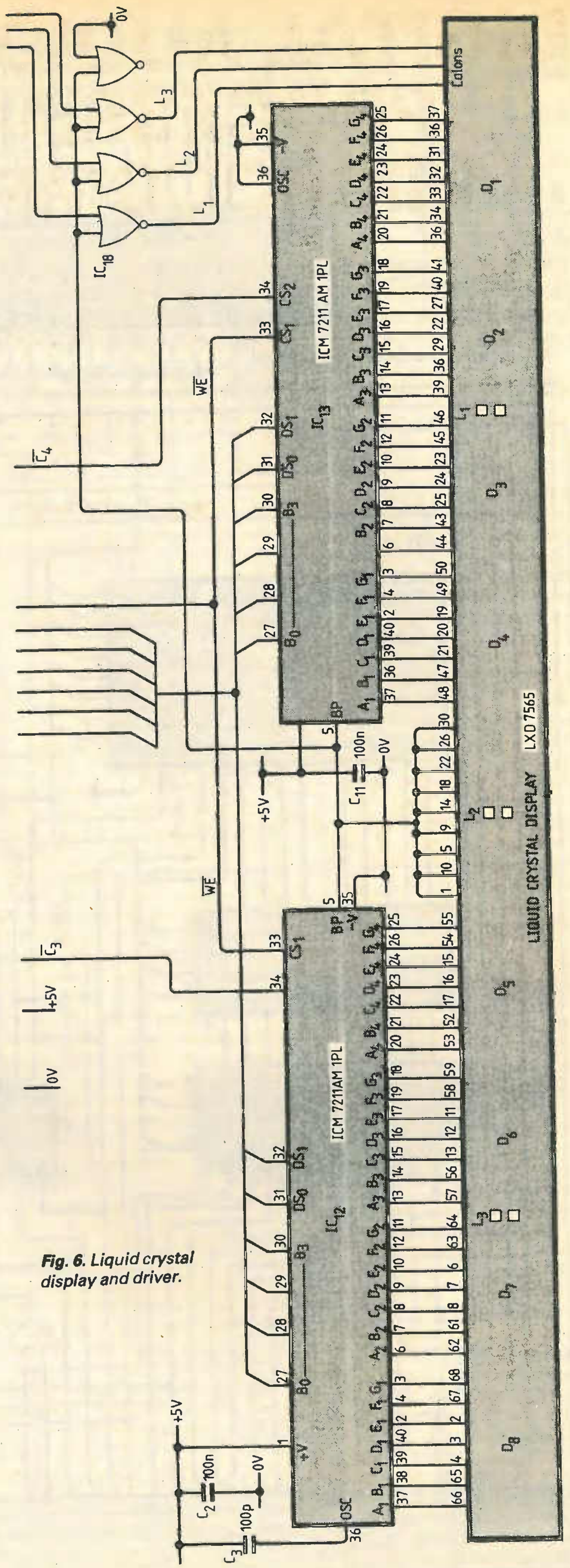


***Fig. 6.** Liquid crystal display and driver.*

DIGITAL AUDIO SIGNAL PROCESSING BY MICROCOMPUTER

The author suggests that audio-frequency signal processing is the most recent area in broadcasting to benefit from digital technology. He lists the currently accepted digital sampling characteristics which limit the reduction of programme modulation noise, idle-channel noise, distortion and wow and flutter. The article includes a brief review of the development of microcomputers, compares analogue and digital companding and describes how companding is affected by use of a microprocessor.

by J. B. Watson*

B.Eng., M.I.E.E.

From the point of view of the broadcasting industry, there can be no doubt that digital technology carries with it numerous benefits to both listener and viewer, more than compensating for the additional complexity and expense of the signal origination and transmission plant involved.

Those who possess or have heard demonstrated audio discs cut from a digitally recorded master tape can confirm the significant improvements in clarity and fidelity now obtainable. This is in spite of the fact that the digital processing component here represents only a small part of the total recording/reproduction system. Further developments in laser optical recording may, in the future, finally resolve the contentious question of what truly constitutes 'high fidelity' audio by providing, for all practical purposes, absolute fidelity between recording studio and listening auditorium.

Digital audio characteristics

Reasons for the subjective superiority of digital audio over the traditional analogue equipment are its much reduced programme-modulation noise, idle-channel noise, distortion and wow and flutter. The magnitudes of these improvements are determined by the digital sampling characteristics, minimum standards for which are generally accepted to be, for broadcasting:

- Sampling rate: 32 000 samples/second.
- digital resolution: 14-bits/sample
- Pre/de-emphasis: CCITT characteristic.

Pre-emphasis and de-emphasis are not essential with digital audio, but give worthwhile improvements in high-frequency noise performance for signals possessing limited energy at the upper end of the audio spectrum.

These standards provide for an audio-channel bandwidth to 15 kHz (provided that great care is taken in the manufacture of the anti-aliasing filter), and a signal/noise ratio of better than 85 dB. The needs of the recording studios, where the final output is derived from a large number of independent sources, are more stringent; hence the use of 16-bit sampling at rates between 48 000 and 64 000 per second in order to minimize signal degradation through the mixing processes.

ADC considerations

The following specification figures underline the reasons for the relative delay between the general acceptance of digital video and digital audio technology. For example, the 'aperture time' required of an 8-bit, 5 MHz video sampling circuit, is only 20% shorter than that for a 16-bit 15 kHz audio sampler; but the precision of the audio circuit needs to be better by a factor of 256. Thus, although proprietary video analogue-to-digital converters (a.d.cs) have been obtainable for the past three or four years, audio a.d.cs with adequate performance have only recently become available. Table 1 shows the specification of such a device. Although sufficiently accurate and sufficiently fast for broadcast-quality audio, this a.d.c. (in common with many other proprietary units) has the disadvantage of "offset-binary' digitally-coded outputs (see Table 2). This means that the most critical zone in its transfer characteristic occurs at the mid-point, where the digital output changes from 011 . . .111 to 100 . . .000. Since this is normally the quiescent operating region, careful circuit layout and screening are essential to minimize digital-analogue crosstalk. A more suitable coding technique for digital audio is the sign-plus-magnitude arrangement, shown in Table 2, which has the effect of moving the most critical region away from the quiescent operating point.

Digital-to-analogue converters (d.a.c.s) are usually less costly than the corresponding a.d.cs, but can introduce non-linearity into the audio channel if their output circuits are 'slew-rate limited.' This problem disappears if the d.a.c. output is re-sampled by a sample-and-hold device designed specifically for audio applications.

*Independent Broadcasting Authority

Table 1. Specification for a proprietary a.d.c. device suitable for broadcast-quality digital audio.

Analogue-to-digital converter Type MP8016, Analogic:

input voltage range:	−10V to +10V bipolar
input impedance:	5.0 kΩ
digital resolution:	16 bits
relative accuracy:	±0.0015% of full scale
absolute accuracy:	±0.003% of full scale
quantizing error:	±½ least sig. bit
monotonicity:	guaranteed
recommended calibration interval:	6 months
Warm-up time to specified accuracy:	10 minutes
conversion time:	0.6 to 2.0 µs per bit (adjustable)
digital output code:	offset binary or two's complement
power supplies:	±15V, 65 mA and +5 V, 300 mA
dimensions:	102×77×13 mm

Table 2. Comparison of offset-binary and sign-plus-magnitude a.d.c. output codes

The offset binary code is easier to implement in hardware, and is the one most commonly used in proprietary a.d.cs. The sign-plus-magnitude code may be more suitable for an audio a.d.c, but suffers the disadvantage of two equally-valid codes for zero input.

Offset-binary code:				
1111	1111	1111	1111=	+9·9997 volts input
1000	0000	0000	0001=	+0·0003 ,, ,,
1000	0000	0000	0000=	0·0000 ,, ,,
0111	1111	1111	1111=	−0·0003 ,, ,,
0000	0000	0000	0000=	+10·0000 ,, ,,
sign + magnitude code:				
0111	1111	1111	1111=	+9·9997 volts input
0000	0000	0000	0001=	+0·0003 ,, ,,
0000	0000	0000	0000=	0·0000 ,, ,,
0000	0000	0000	0000=	0·0000 ,, ,,
1000	0000	0000	0001=	−0·0003 ,, ,,
1111	1111	1111	1111=	−9·9997 ,, ,,

www.americanradiohistory.com

Table 3. Comparison of three generations of microprocessor from a single manufacturer

The 8088 is a development of the 16-bit 8086, but communicates via an 8-bit data bus.

	'First generation' (p-mos technology)			'Second generation' (n-mos technology)		'Third generation' (h-mos technology)		Future
microprocessor type	4004	8008	4040	8080	8085	8086	8088	iAPX 432
date introduced	1971	1972	1974	1974	1976	1978	1979	1981
accumulator capacity	4-bits	8-bits	4-bits	8-bits	8-bits	16-bits	16-bits	32-bits
no of instructions	46	48	60	111	113	300+	300+	very many
min. instruction cycle time	10·8 μs	20 μs	10·8 μs	2 μs	1·3 μs	0·4 μs	0·4 μs	0·1 μs
memory addressing capability	4 K×8	16 K×8	8 K×8	64 K×8	64 K×8	1 M×8	1 M×8	4000 M×8
no of general purpose registers	16×4-bit	7×8-bit	24×4-bit	7×8-bit	7×8-bit	12×16-bit	12×16-bit	?
power supplies	+5V, −10V	+5V, −9V	+5V, −10V	±5V, +12V	+5V	+5V	+5V	+5V
sub-routine nesting levels	3	7	7	unlimited	unlimited	unlimited	unlimited	unlimited
no of interrupt types	0	1	1	8	12	256	256	none
interrupt latency (approx.)	–	40 μs	30 μs	6 μs	4 μs	12 μs	12 μs	–
address, data bus width	12 addr. 4 data 4 r.a.m. sel	14 addr. 8 data	12 addr. 4 data 4 r.a.m. sel 2 r.o.m. sel	16 addr. 8 data	16 addr. 8 data	20 addr. 16 data	20 addr. 8 data	32 addr. 32 data

Signal processing by microcomputer

Before considering in detail the type of audio signal processing appropriate to microcomputers, it may be instructive to consider the history of the development of these devices since their introduction about eight or nine years ago. Table 3 summarizes the characteristics of three 'generations' of microprocessor originating from a single manufacturer, the demarcations corresponding loosely with the fabrication of the silicon chip by p-channel, n-channel and h-mos technology. Details of a prospective 32-bit device are also included.

Of particular relevance to audio processing are the accumulator capacity (16-bits being desirable), instruction cycle time and interrupt response time (latency). First generation devices (4004, 4040, 8008) were relatively slow in operation, offering instruction times of several microseconds, and possessing extremely limited – or, in the case of the 4004, non-existent – interrupt handling capability. Real-time processing of broadcast quality digital audio signals was not feasible with these processors, although the 8008 did find application in the military communications field as a speech processor.

Second generation processors, such as the still-current 8085, exhibit speed improvements of an order of magnitude over their predecessors. With an instruction cycle time of 1.3 microseconds, between 12 and 24 simple processing steps can be undertaken in the interval separating adjacent audio samples (this varies from 30 to 15 microseconds, for sampling rates of between 32 000 and 64 000 per second). Interrupt latency is of a low order, allowing rapid re-programming of peripheral devices after the treatment of blocks of data. Self-contained hardware multiply and divide features, however, are not typical of second generation microprocessors. Complex digital filtering operations requiring weighting factors related by integral powers of two. On the other hand, digital audio companding can be implemented with this type of processor, since the essential feature of a companding algorithm is a multiple-bit shifting operation.

Extremely powerful processing possibilities are now available, following the introduction of the 8086 and other similar devices such as the Z8000 and M68000. These computers operate directly on 16-bit sampled data values, have fast and comprehensive instruction repertoires including hardware multiply and divide, and can directly address memory arrays in excess of a million bytes. The very complex nature of these machines, however, necessitates some compromise in performance in the real-time environment, the most serious being an interrupt latency approaching 15 to 30 μs sampling interval of high-quality audio.

This arises from the extended memory addressing and interrupt type handling capabilities. The 8086 computer, for example, responds to an interrupt by storing the current program counter and memory segment register (16-bits each), calculating the location of the appropriate interrupt vector, and reloading new program count and segment values from the vector location. Flexibility of operation is thus achieved at the expense of speed, the complete process occupying approximately 12 μs. This trend is likely to continue with the emergence of new device types (e.g., iAP 286) capable of directly addressing thousands of megabytes of memory. Future microprocessors designed for 'mainframe' applications might dispense entirely with interrupt facilities, since these prejudice the 'number crunching' performance.

The solution to this problem, in the critical real-time signal processing area, is in the use of dedicated input/output processors. These are intended specifically for rapid peripheral device servicing duties, and communicate with the main processor system via block transfers on direct-memory-access channels. Operating speed improvements anticipated with the h-mos process are also likely to simplify the task of the digital audio engineer.

Digital companding

An example of the type of digital audio processing now possible with microcomputers occurs in signal compression and expansion (companding). Analogue companding is used extensively in the magnetic tape recording of music, where it provides an improved signal/noise ratio, particularly at high frequencies. The widespread acceptance of the Philips audio cassette as a satisfactory medium for domestic sound recording is, in fact, largely due to the adoption of Dolby or similar companding techniques.

Analogue systems of this type separate the incoming audio signals into several frequency bands, each channel during recording being compressed by amounts depending upon the peak levels present in each appropriate spectral band. The accuracy of the reciprocal expansion process during playback is seldom perfect, since great reliance is placed on carefully matching the filters, time constants and level-dependent amplifiers, in the record-replay chains.

The processes involved with digital companding are, on the other hand, accurately reversible. The degree of compression applied by the encoder is transmitted, together with the audio sample values, along a separate time-multiplexed channel to the decoder. No gain errors or time constant mismatching errors occur, but a degree of programme-modulation noise is introduced, the magnitude of which is governed by the type of digital companding used. It might seem paradoxical that digital companding apparently worsens the audio signal/noise ratio, whereas analogue companding improves it. This arises from the different areas of application in which the two techniques find justification, digital companding being used in bandwidth reduction rather than noise reduction. Alternatively, the companding process can be regarded as a 'trade-off' between idle-channel (background) noise and modulation noise in a channel of defined capacity or bandwidth. This 'trade-off' takes place

Table 4. 14: 10 A-law companding

14-bit audio samples are compressed before transmission to a 6-bit representation (X's in the Table), the less significant bits being truncated (shown as T's in the table). A 3-bit scale factor indicating the audio level within a range of 2: 1 is appended. Finally, the 'sign' bit (13) is added, making 10 bits altogether. A refinement of the procedure is to 'round-up' the levels by one half least significant bit to improve accuracy.

A-Law range no.	Scale factor			Bit no. 13 (m.s.b.)	12	11	10	9	8	7	6	5	4	3	2	1	0 (l.s.b.)
7	1	1	1	0	1	X	X	X	X	X	X	T	T	T	T	T	T
6	1	1	0	0	0	1	X	X	X	X	X	X	T	T	T	T	T
5	1	0	1	0	0	0	1	X	X	X	X	X	X	T	T	T	T
4	1	0	0	0	0	0	0	1	X	X	X	X	X	X	T	T	T
3	0	1	1	0	0	0	0	0	1	X	X	X	X	X	X	T	T
2	0	1	0	0	0	0	0	0	0	1	X	X	X	X	X	X	T
1	0	0	1	0	0	0	0	0	0	0	1	X	X	X	X	X	X
	0	0	0	0	0	0	0	0	0	0	0	X	X	X	X	X	X

in both analogue and digital companding, as sensitive ears can easily recognise, and there is, therefore, no paradox.

Many different types of digital companding have been proposed, these being within two main categories of 'instantaneous' and 'near-instantaneous' (or 'quasi-instantaneous') form. Table 4 depicts the operation of a simple 'A-Law' instantaneous compander, used for reducing to 10-bits per sample a 14-bits per sample audio signal. The companding algorithm is simply expressed as follows: The position of the most significant '1' digit in the 14-bit data word is a measure of the signal magnitude within a 2:1 range. A 3-bit digital code representing the number of leading (more significant) '0' bits in each word is transmitted with the word, the leading zeros and the most significant '1' being suppressed. The remainder of the digital word is transmitted with a precision of seven bits, with the less significant bits truncated.

The resulting signal comprises ten bits per sample, three bits of which define the approximate value, within a 2: 1 range, and seven the more precise magnitude within that range. One of the seven bits indicates the signal polarity. Digital sample values with more than five leading zeros experience no compression and are therefore expanded without loss of resolution. For signals of larger magnitude, the compression takes the form of a truncation of the less significant bits, giving rise to coarser quantizing steps and associated programme modulation noise. Listeners accustomed to the very high sound quality reproduced by digital systems have observed that, with experience, their threshold of tolerance to modulation noise tends to decline. Acceptable standards of performance based on subjective tests may, therefore, become more stringent as the use of digital audio equipment increases.

'Near-instantaneous' companding makes more efficient use of the available channel capacity, and thus achieves a lower level of modulation noise. By deriving scale factors related to the peak amplitudes of groups of audio samples, rather than to individual sample values, more capacity is available for accurately resolving the signal levels. In two systems recently proposed [2,3], groups of samples representing a duration of approximately 1 ms are examined before defining the degree of companding appropriate to the group as a whole. Subjective comparison tests of various digital companders tend to the conclusion that the 'near-instantaneous' principle provides a standard of performance equivalent to that of an 'instantaneous' system employing at least one more bit per sample. Many of the differences between the various contending schemes proposed for international programme exchange arise from attempts by their proponents to make maximum use of the different hierarchical levels available on Posts, Telegraphs and Telephones (PTT) networks. Until detailed plans for digital sound channels are published by the PTT authorities, however, an optimum transmission system is unlikely to be realised. Tariff structures are likely to play a more important role than technical reasons in deciding which form of the companding, if any, should be universally adopted.

Companding by microprocessors

Since both 'instantaneous' and 'near-instantaneous' companders employ the same basic principle in deriving their respective scale factors, i.e., the determination of the position of the most significant bit in a digital code, it is possible to devise hardware configurations capable of operating in either mode.

Figure 1 illustrates a digital audio compression system used in the laboratories of the IBA to evaluate the performance of a variety of companding algorithms.

The system is designed as a peripheral interface to an 8-bit 8085 microcomputer, the 14-bit audio samples requiring two operations per processing step because of the 8-bit accumulator limitation. A priority encoder device (see Table 5) with complemented data inputs locates the position of the more significant '1' bits in the sampled data, and generates a 3-bit code related to the compression scale factor. Because the chosen a.d.c. produces an 'offset binary' output, positive values require to be complemented before reaching the priority encoder. This is effected by applying the most significant bit to a set of exclusive 'Or' gates. Samples from a 'sign-plus-magnitude' converter would not require correction in this manner.

The audio samples are 'left-justified' to remove leading zeros by means of a multiplying technique. By decoding the scale factor in the 3: 8-line decoder shown in Fig. 1, a digital number of the form 2^n is produced. This number is applied to the B inputs of a pair of 8 × 8 parallel multiplier chips, causing a left shift (by n places) of the data samples entering the multiplier A inputs. Finally, the two partial products resulting from the 8 × 8 multiplying operation are combined, and the appropriate number of less significant bits truncated. Strictly, the multiply combiner should take the form of a digital adder circuit, but a simple Or gating arrangement suffices since one of the operands is of the type 2^n. The circuit described can perform either on a sample-by-sample basis, thus providing an instantaneously companded A-law output, or it can generate scale factors derived by the computer from peak measurements of groups of samples, resulting in near-instantaneous companding.

Figure 2 shows the microprocessor configuration, based on the 8085 computer and standard memory and input/output devices. The interval between audio samples is 31.25μs (32 kHz sampling), permitting a reasonable amount of signal processing on a per-sample basis, bearing in mind the 1.3 μs instruction cycle time of the 8085. For example, the peak value of a group of audio samples can be calculated by complementing negative values, Or-ing each word with previous samples, and scanning the resultant value at the end of a cycle to determine the scale factor for the group. Insufficient processing power is available from the 8085 system to perform A-law companding by software, hence the derivation of 'instantaneous' scale factors

Table 5. Transfer function, 74148 Priority encoder device

The device generates a 3-bit output code indicating the position of the most-significant 0 bit in an 8-bit word. It can be used as the basis of a digital compander if its input signals are complemented.

Inputs 7	6	5	4	3	2	1	0	Outputs A2	A1	A0
0	X	X	X	X	X	X	X	0	0	0
1	0	X	X	X	X	X	X	0	0	1
1	1	0	X	X	X	X	X	0	1	0
1	1	1	0	X	X	X	X	0	1	1
1	1	1	1	0	X	X	X	1	0	0
1	1	1	1	1	0	X	X	1	0	1
1	1	1	1	1	1	0	X	1	1	0
1	1	1	1	1	1	1	0	1	1	1

www.americanradiohistory.com

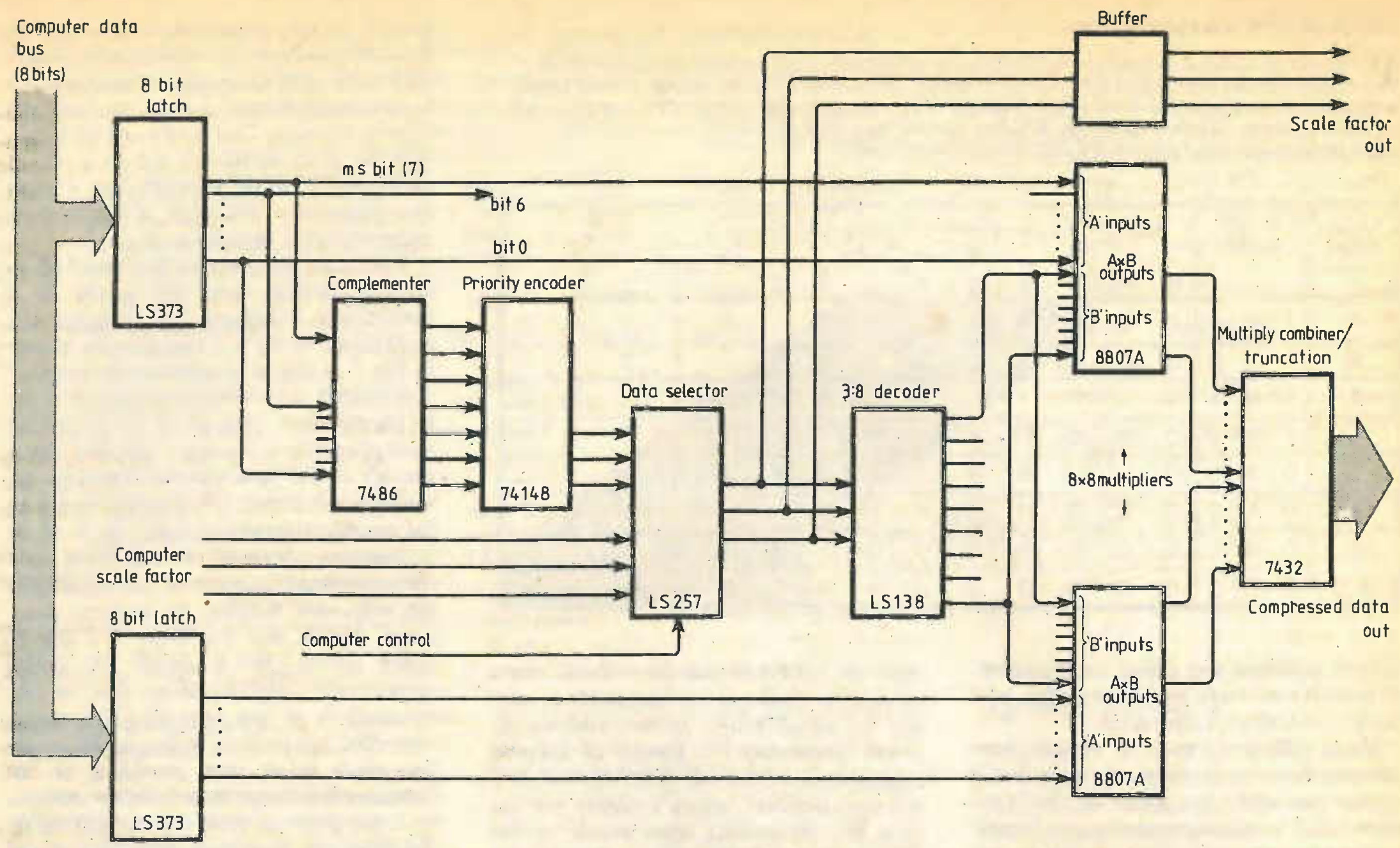
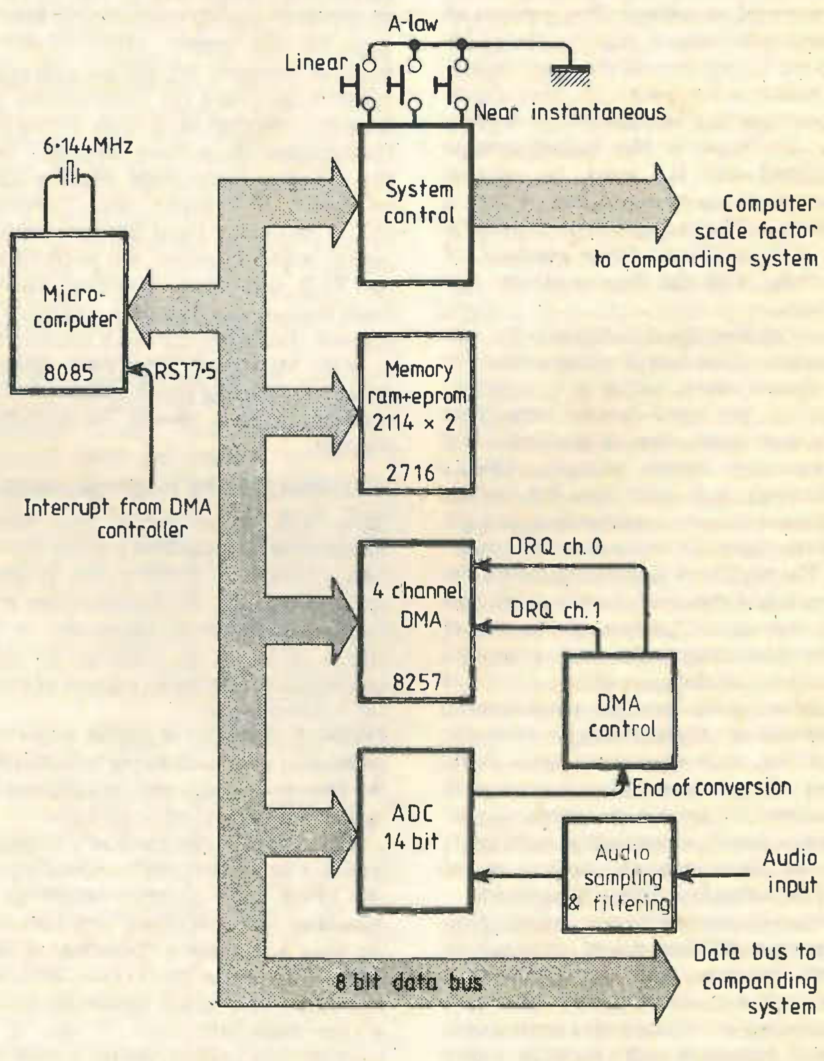


Fig. 1. Digital audio compression system. Compression is effected by shifting the digital samples left (towards the most significant bit) by an amount equal to the number of leading zeros in the data value. The 74148 priority encoder locates the position of the most significant '1' bit and produces a 3-bit code which is then decoded by the LS138 and applied to two 8 × 8 multiplier chips. These multipliers, together with the multiplier combiner, shift the input data word by the required amount.

Fig. 2. Microprocessor system for digital audio companding. Digital companding experiments can be undertaken with a relatively simple microprocessor system. The hardware configuration shown employs 1K x 8 r.a.m. and 2K x 8 e.p.r.o.m. 14-bit audio samples are processed as 8-bit word pairs.

by the 74148 priority encoder in Fig. 1. However, the usual benefits of software control, including versatility, cheapness and reliability, apply to the remainder of the data processing hardware. An interesting feature of this arrangement is that less hardware is required for 'near-instantaneous' campanding than for the A-law algorithm; i.e., a reversal of the usual situation.

The system software operates on three distinct blocks of data, audio sample words originating from the a.d.c., stored blocks awaiting analysis, and output data for the expander logic arrangement (not shown, but similar in concept to the compression circuit of Fig. 1). Both input and output data streams communicate directly with memory via direct-memory-access (d.m.a.) channels. D.m.a. management is performed by the 8257 chip, which receives 'data requests' from the currently active peripheral and responds with 'data acknowledge' when the computer has disabled its bus signals. Data transfer then takes place, and the memory pointer for the channel in use is incremented. A time penalty of about one microsecond is incurred while the computer data and control busses 'freeze' during the transfer, in comparison with the several microseconds necessary for conventional input/output procedures. However, because of the automatic address incrementing performed by the d.m.a. controller, new address pointers have to be entered before the selected location exceeds the available memory space. It is convenient to manipulate the audio samples in blocks, and to re-initialise the d.m.a. controller at the end of each block. The execution time of the software routine controlling this function must, of necessity, be shorter than the audio sampling interval, otherwise samples could be lost. This segment of code is therefore designed around register manipulation instructions which are much faster than memory accessing operations. Software for the complete system, capable of rapidly switching between 14-bit linear (uncompanded), 14: 10 A-law and 14: 10 near-instantaneous companding algorithms, occupies less than 1000 words.



Subjective tests of the system described have confirmed that the effect of 14: 10 digital companding, whatever the algorithm, is inaudible with normal programme material, but discernible when pure tones are transmitted. Results from other workers in the field[4] show that 14: 10 near-instantaneous companding provides a standard of performance virtually identical with uncompanded sound. This is likely to be of great importance for satellite transmission, where significant savings in capital plant can be achieved if more channels can be accommodated within a given bandwidth.

Future techniques

Voice synthesis by microcomputer is a rapidly developing technique, especially for electronic toys and games. Most such devices currently available appear to possess American or Japanese accents, so revealing their places of origin. Economy of storage and audio bandwidth is afforded by masculine voices, but this is likely to become a minor consideration as the cost of memory chips continues to decline. Solid-state recording of high-quality musical performances is a more difficult matter, unlikely to be solved by the silicon chip for many years hence. For example, any recording of Beethoven's ninth symphony would require a digital storage array of approximately 2000 megabits. Current prices of memory chips would need to fall by a factor of 100 000 to render viable any such scheme. Meanwhile, more traditional devices such as magnetic tape, hard disc storage and the newer 'Winchester disc' continue to improve in performance, possibly rivalling the storage density achieved by laser-optical techniques.

In the digital processing area, one of the more interesting new devices to emerge is the Intel 2920 processor. This comprises an analogue-to-digital converter, a signal-processing computer and a digital-to-analogue converter, all contained on a single silicon slice. Current technology limitations restrict its operating frequency to about 14 kHz. However, speed improvements to at least five times that figure, whereby it would admirably suit the needs of the digital audio engineer, can now be expected. □

References

1. Sanchey, A A, 'A new ultra-linear 16-bit digital-to-analogue conversion system for professional audio'. 66th AES Convention, Los Angeles, 6-9th May 1980.
2. Jones, A H, 'Digital Coding of Audio Signals for Point-to-Point Transmission'. Publication 166, IBC London 1978.
3. de Lamare E, 'Le Codage numerique des signaux sonores de haute qualite. . .' *Revue de Radiodiffusion-télévision.* No 44 Sept-Oct 1976, pp 12-33.
4 Gilchrist, N H C, 'Digital Sound Signals: Tests to compare the performance of five companding systems for high quality signals'. BBC Research Department Report, RD 1978/26.

Based on an article first published in *IBA Technical Review*, No 15. □

Continued from page 54

cations. And because the 6502 has been chosen by many of the microcomputer manufacturers, continued production seems assured for the forseeable future.

The hardware shown in Fig. 4 has been kept as standard as possible to reduce the overall cost, and the memory map for this arrangement is shown in Fig. 5. Circuits IC_2 and IC_5 provide 1K of r.a.m. for essential variables, the stack in pages 0 and 1, plus spare areas in pages 2 and 3. The r.a.m. is not fully decoded and appears throughout the bottom half of the 64K address space. An e.p.r.o.m. containing the firmware is assigned to the top 2 or 4K of memory with address decoding provided by IC_{14} for an expanded system. Wire-ORing of the address decoder outputs provides addressing options. Circuit 15 is enabled at C000 (hex.) to provide sub-divided outputs for display drivers and a versatile interface adapter.

The system clock is provided by a 1MHz crystal oscillator using unbuffered c.m.o.s. gates. This also provides the timing for a back-up system and is trimmed for best results in this mode. Power-on reset is provided by two Schmitt inverters which allow the power supply to stabilize before the program is initiated.

A potentially troublesome source of interference for v.l.f receivers is the conventional multiplexed display, and for this reason a low-current liquid crystal type is recommended. A suitable display and driver circuit which will plug directly into

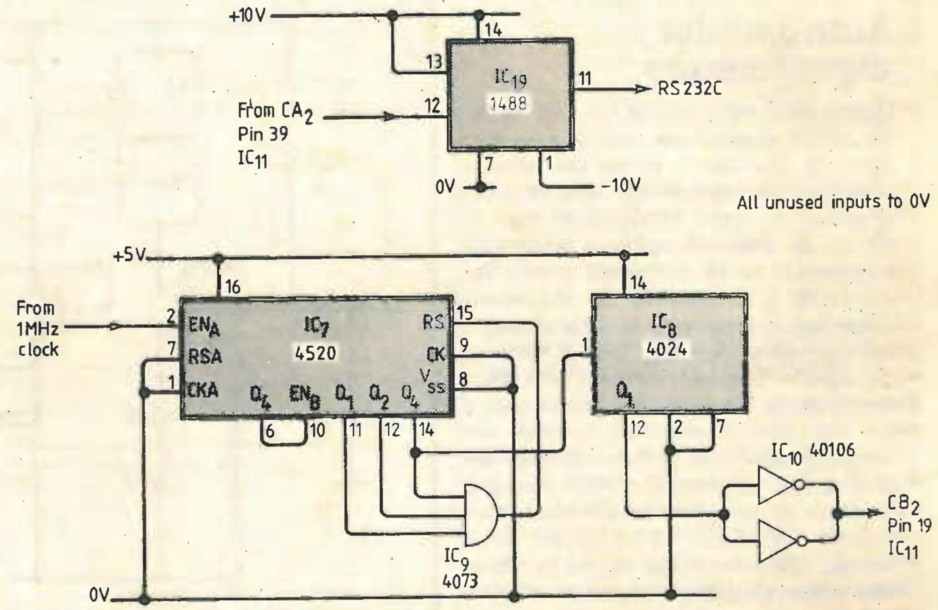


Fig. 7. RS232C generator and level translator.

the display port is shown in Fig. 6. The eight-digit panel allows six 0.5in digits to be displayed with spaces to improve legibility. The control port of IC_{11} allows different displays to be selected. It is important to use only the AM version of the 7211 display drivers as these include display blanking and a microprocessor interface. Because the display port has been designed to drive remote displays via a short length of ribbon cable, IC_{16} is necessary to buffer the 6502 data bus.

As well as displaying time and date information, the evaluation system can be used with other equipment via an RS232C interface which transmits ASCII information. The necessary hardware additions are shown in Fig. 7. IC_7 divides the 1MHz clock to provide a 2,400 baud generator, and IC_{19} converts the serial data from the v.i.a. to an RS232 level.

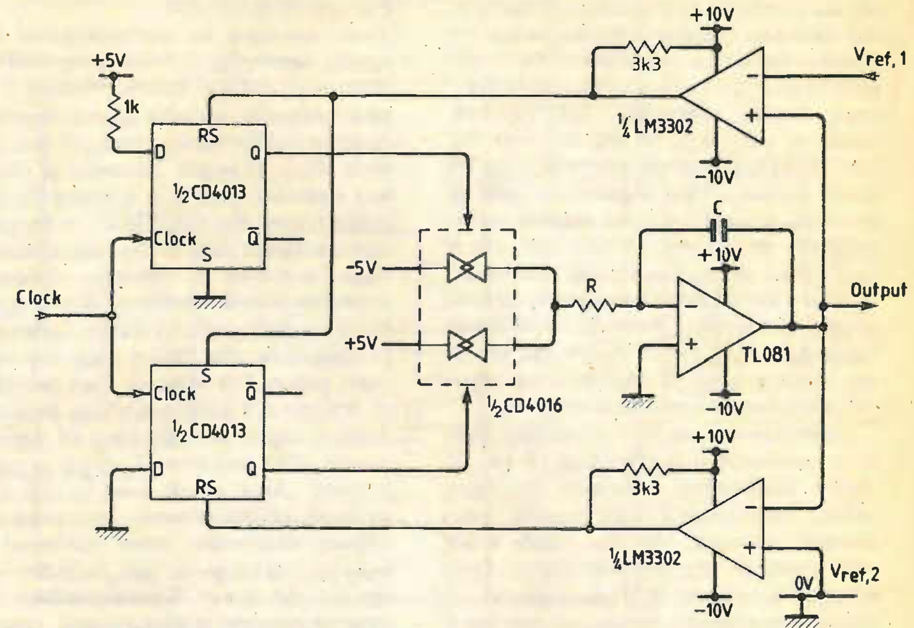
Part two of this article describes firmware, construction and testing. A complete kit of components for this design will be available from Circuit Services, 6 Elmbridge Drive, Ruislip, Middx (telephone Ruislip 76962).

www.americanradiohistory.com

CIRCUIT IDEAS

Clock-triggered triangular pulse generator

A double pulse is applied to the inverting input of a TL081 operational amplifier connected as an integrator and a triangular pulse is obtained at the output. The required double pulse is formed by two direct voltages −5V, +5V, applied to the integrator input *via* a pair of analogue switches. Two D-type flip-flops control these switches. The two flip-flops are triggered by the rising edge of the clock pulse applied to their clock inputs. When the clock-pulse triggers the two flip-flops, the First flip-flop's Q-output becomes equal to 1 and the Q-output of the second equal to 0. Consequently, one switch is enabled and the other disabled. Thus an input voltage equal to −5V is applied to the integrator. When no input voltage is applied to the integrator, $V_{out}=0$. Then, $V_{in}=-5V$ and V_{out} increases; when it equals the reference voltage $V_{ref,1}$ the output of the comparator goes high, and the first flip-flop's Q-output is reset to 0, while the second's Q-output is set to 1. Thus the switches change state, so that $V_{in}=+5V$ and V_{out} decreases. When $V_{out}=V_{ref2}=0V$, the output of the second comparator goes high resetting the Q-output of flip-flop 2 to 0. So both switches are disabled, and no input voltage is applied to the integrator. Consequently $V_{out}=0$ until the next rising edge of the clock pulse triggers the flip-flops. The duration of the triangular pulse is $T=2t_i$ where $t_i=1/RC$ is the time constant of the integrator.

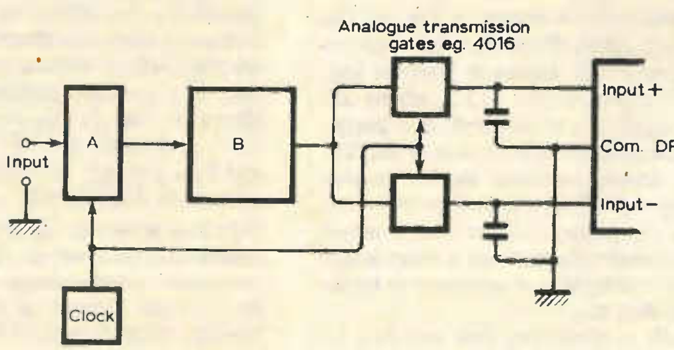


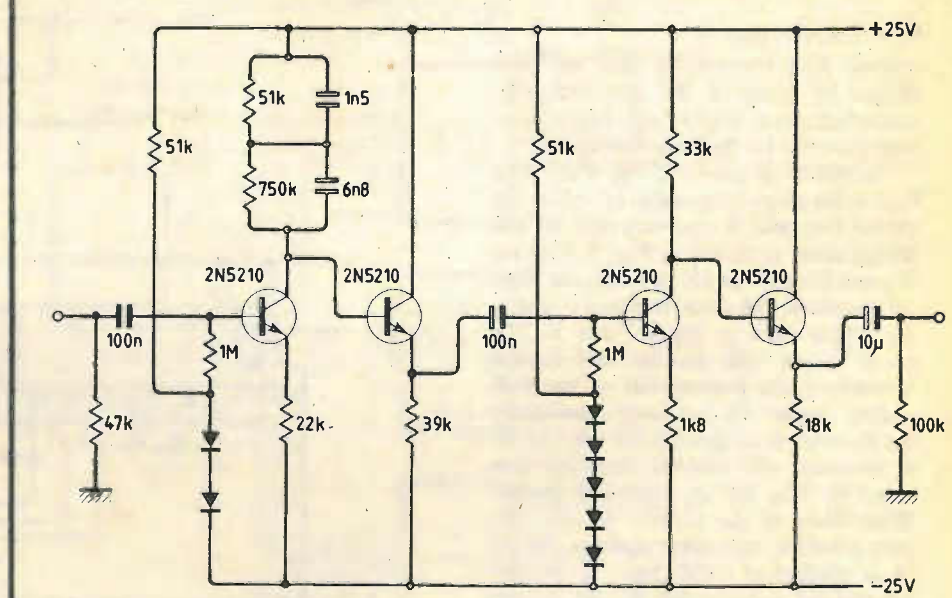
G. Tombras
Athens

Auto-zero for digital meters

Digital panel meters using i.cs such as the ICL7106/7 already have internal auto-zero circuitry, but this is of no use when a particular instrumentation case requires amplifiers or signal conditioners prior to the d.p.m. Offset in op-amps drifts with temperature so an automatic system for correcting it is desirable. In the circuit given, box A represents circuits to switch the instrumentation amplifiers B between the input to be measured and a zero reference level. At the same time, the output of the amplifiers is switched between the sampling capacitors so that one holds the amplified input plus offset, and the other holds the offset only. The differencing action of the d.p.m. cancels the offset voltage. Clock frequency should be higher than the sampling frequency of the d.p.m.

K. Wood
Ipswich
Suffolk



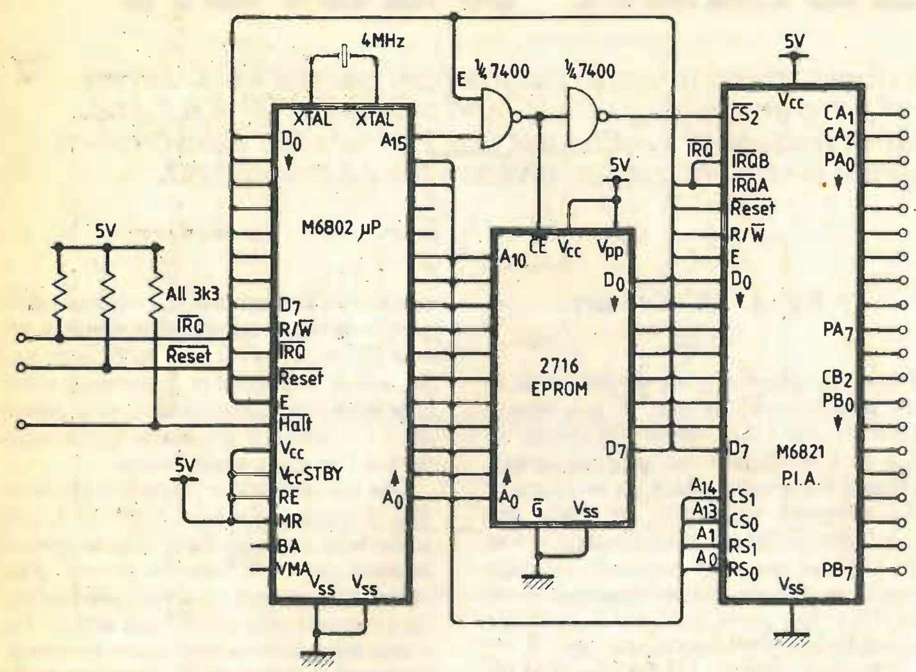


Preamp with no t.i.m.

Circuit shows a stable small-signal preamplifier with passive magnetic pick-up equalization but without overall negative feedback.

At 1kHz, the circuit has an overall gain of 50 and its input and output impedances are 47k and 1.7kΩ, respectively. Peak-to-peak maximum input and output voltages are 0.5 and 25V respectively.

Shausin Yang
National Chiao Tung University
Taiwan



Minimum component-count microprocessor

This microprocessor circuit brings the number of components required for certain control applications to a minimum and lends itself particularly to machine-control design. Address bus decoding is divided up into two 32K-byte pages and the e.p.r.o.m. is situated at 8000 or at 2K-byte images up to F800. The M6802's eight interrupt vector bytes should begin at 87F8 or its respective images. Two sets of eight i/o lines, A and B, are provided by the M6821 peripheral interface adapter; A addresses are decoded as 7000 and 7001 and B addresses as 7002 and 7003. Locations 0000 to 007F are used for the M6802's 128-byte r.a.m.

Other e.p.r.o.m.s, such as the 2758 or 2532, may be used in place of the 2716 with only minor alterations. The two spare NAND gates can be used to provide a bit-rate generator if necessary.

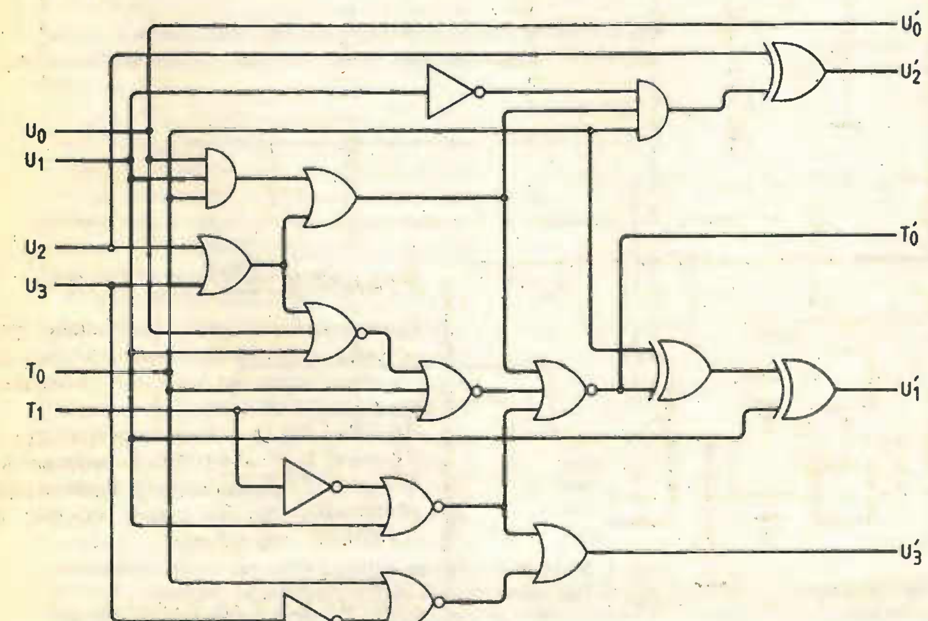
Y. C. Cheah
Wellington
New Zealand

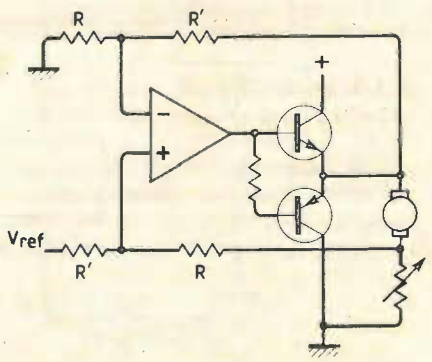
24-to-12-hour clock decoder

A digital clock may have a 24-hour display, which many people would find less preferable to the more normal 12-hour display. For example, the time-coded radio signals from Rugby work on the 24 hour clock.

The circuit shown is an economical decoder of b.c.d. 24-hour information (0 0 T_1T_0; $U_3U_2U_1U_0$) to b.c.d. 12-hour (0 0 0 T_0; $U_3'U_2'U_1'U_0'$). If c.m.o.s. i.cs are used, types 4001 (quad 2-input NOR), 4025 (triple 3-input NOR), 4030 (quad exclusive OR), 4069 (hex inverter), 4071 (quad 2-input OR) and 4073 (triple 3-input AND) are required.

W. Gough
Whitchurch
Cardiff





Accurate motor speed control with braking

Mr Malvar's 'Accurate motor speed control' (*WW* Circuit Ideas, August 1980) described a circuit in which the effect of motor armature resistance was cancelled by using the armature current to provide positive feedback to the drive amplifier. The amplifier used a booster transistor which entailed the motor stopping under open circuit conditions.

Accurate motor speed control is often required with a fast stop/start, and this can be achieved by the addition of a transistor complementary to the booster transistor.

The circuit shows this addition, with a somewhat modified bridge circuit. When $R_1=R\alpha$ the armature back e.m.f. is equal to V_{REF}, which can be gated or switched to provide a fast stop/start (R_1 being the variable resistor). A single supply may be used.

K. G. Barr
University of the West Indies
Barbados

www.americanradiohistory.com

DIGITAL FREQUENCY SYNTHESIZER DESIGN

Digital frequency synthesis is now commonplace in commercial transceivers. James Bryant discusses the design of programmable counters and prescalers for v.h.f. and u.h.f. synthesizers using a family of frequency synthesizer i.cs. He includes a description of a basic computer program which will design dividers for v.h.f. and u.h.f.

by J. M. Bryant
B.Sc.

A basic frequency synthesizer, shown in Fig. 1, consists of a voltage-controlled oscillator, programmable divider, phase detector, low-pass filter and a stable reference frequency source. The v.c.o. and l.p.f. are the most critical parts of the design, and the v.c.o. must be isolated from the output and the input to the divider. Operation of the synthesizer is straightforward: the v.c.o. output is fed to the programmable divider and then compared with the reference signal in the phase comparator, whose output controls the v.c.o. The system is therefore a phase-locked loop acting to maintain the divider output in phase with the reference input. The v.c.o. frequency is stabilized at n times the reference frequency, i.e. $F_{out}=nf_{ref}$ where n is the division ratio of the programmable divider. If n is altered by unity, the v.c.o. output will change by f_{ref}, so a synthesizer can generate several channel frequencies which are multiples of the reference frequency. In v.h.f. and u.h.f. synthesizers channel spacings of 5 to 50 kHz are normally required, although synthesizers with channel spacings down to 1Hz or less can be built but these would normally use multi-loop techniques.

Although the v.c.o., phase comparator and l.p.f. can be built using discrete components, for a complex circuit such as the programmable divider the use of i.cs is essential. Unfortunately, current integrated-circuit programmable dividers use c.m.o.s., n.m.o.s. or t.t.l. technology and are unable to operate at frequencies above 25MHz (a little higher in the case of Schottky t.t.l.) which is not nearly high enough for v.h.f. or u.h.f. synthesizers.

One solution to this problem is shown in Fig. 2 where a fixed v.h.f. or u.h.f. prescaler with a division ratio of m is inserted between the v.c.o. and the divider. This reduces the output to a frequency which the programmable divider can accept, but it also introduces several other problems. However because fixed dividers using e.c.l. technology are available with input frequencies up to 1.8 GHz, this system is often used in commercial equipment. Two minor problems with this approach are the high power consumption of e.c.l., and interfacing. A major and intractable problem is the effect on f_{ref} because the introduction of fixed prescaling changes the synthesizer law to $f_{out}=m\times n\times f_{ref}$. If the same channel spacing is needed, the reference frequency must be reduced by a factor of m, which will generally lie between 10 and 256. This complicates the design of the l.p.f., increases by a factor of m the time required for the synthesizer to lock and, unless extreme care is taken in the v.c.o. design, worsens the noise and reference sideband levels in the synthesizer output.

In applications where this degradation is unacceptable, the use of a mixer synthesizer as shown in Fig. 3 is often considered. The v.c.o. is mixed with a signal frequency f_m and the difference frequency $(f_{out}-f_m)$ is applied to the programmable divider via a l.p.f. This system has a number of advantages, f_m can be switched to give i.f. and repeater shifts, power consumption is usually low, and it is easily understood. However, the overall system stability depends on two oscillators (f_{ref} and f_m), low noise levels in the second oscillator and the mixer are vital for good system performance (noise in the reference oscillator is less important because f_{ref} is usually divided from the reference oscillator) and the system is more complex. Nevertheless, many synthesized transceivers use this technique.

A better system, known as a multi-modulus prescaling, is shown in Fig. 4. The simplest form uses a two-modulus prescaler (sometimes called a swallow counter) and when the system starts counting, the two programmable counters are reset to zero. The prescaler divides the v.c.o. output by $m+1$ and its output pulses increment both programmable counters. When the count reaches a, the prescaler modulus is changed to m and the a counter stops (at this point $a\times(m+1)$ cycles of the input frequency have been counted). The n counter continues to count the prescaler output until it reaches n and passes a pulse to the phase comparator. Both counters are then reset, the prescaler reverts to $(m+1)$ ratio and the cycle restarts. In the second half of the cycle, the system counts $(n-a)\times m$ cycles of the input frequency. Therefore, a full cycle of the counter delivers one output pulse for each $a\times(m+1)+m\times(n-a)$ input cycles, so the division ratio is $nm+a$:1.

The complete system forms a v.h.f. or u.h.f. programmable counter, but the programmable counter only operates at a few MHz which enables c.m.o.s., n.m.o.s. or t.t.l. devices to be used. Also, although two programmable counters are required, they are simpler than the type in Fig. 2 and the overall complexity is only slightly greater. There are, of course, drawbacks. The division ratios of a two modulus prescaler will normally be between 10/11:1 and 100/101:1, but ratios of over 20/21:1 are required at v.h.f. if the programmable counter input frequency is to be low enough for c.m.o.s. or n.m.o.s. devices.

For an $m/m+1$:1 prescaler the a counter

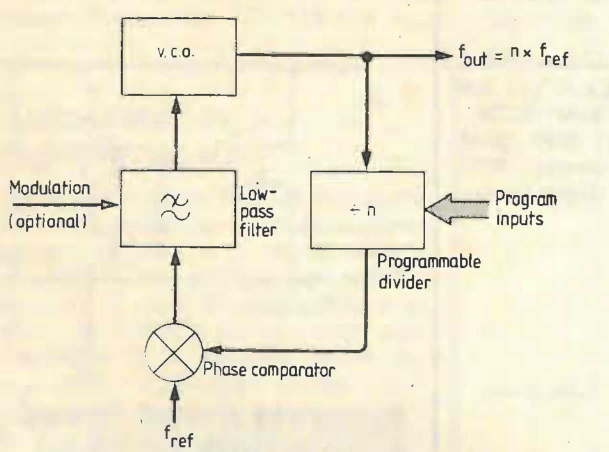


Fig. 1. *V.c.o. frequency is stabilized at n times the reference frequency in the basic synthesizer. Several frequencies can be generated by altering n.*

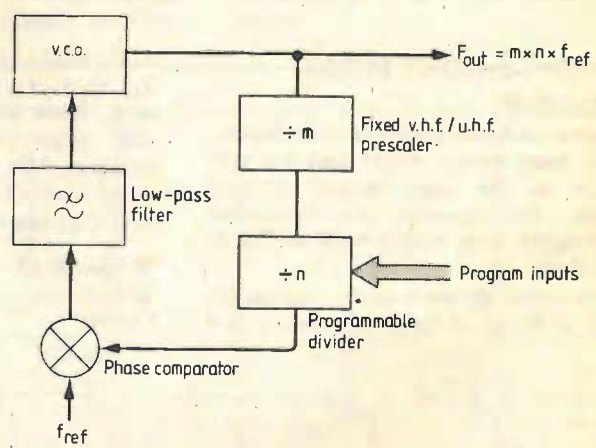


Fig. 2. *Including fixed prescaler in divider loop allows v.c.o. to operate at frequencies higher than c.m.o.s. or t-t logic allows.*

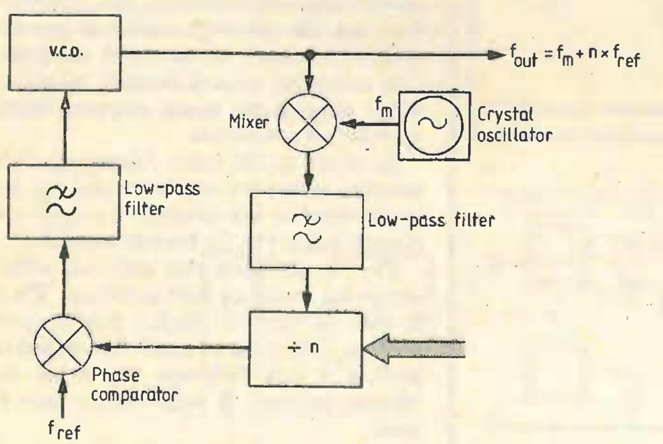


Fig. 3. *To avoid some of the problems with the fixed prescaler technique the v.c.o. is mixed with a frequency f_m and the difference applied to the divider.*

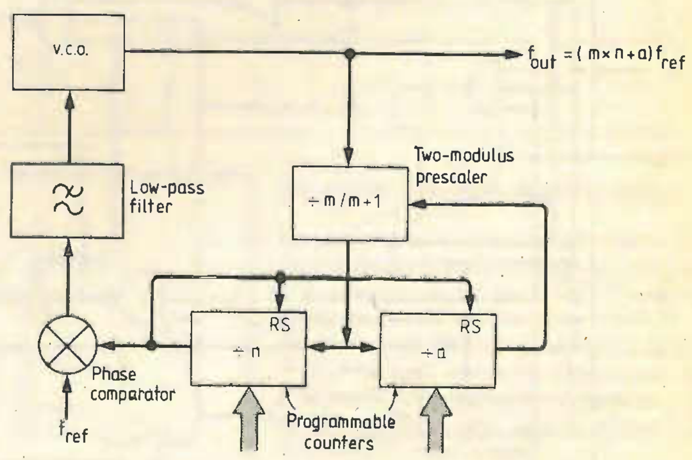


Fig. 4. *Multi-modulus prescaling avoids the noise problem of Fig. 3. Full counter cycle delivers one pulse for each $a(m+1)+m(n-a)$ input cycles. Scheme works to u.h.f. though the two simple counters need only work to a few MHz.*

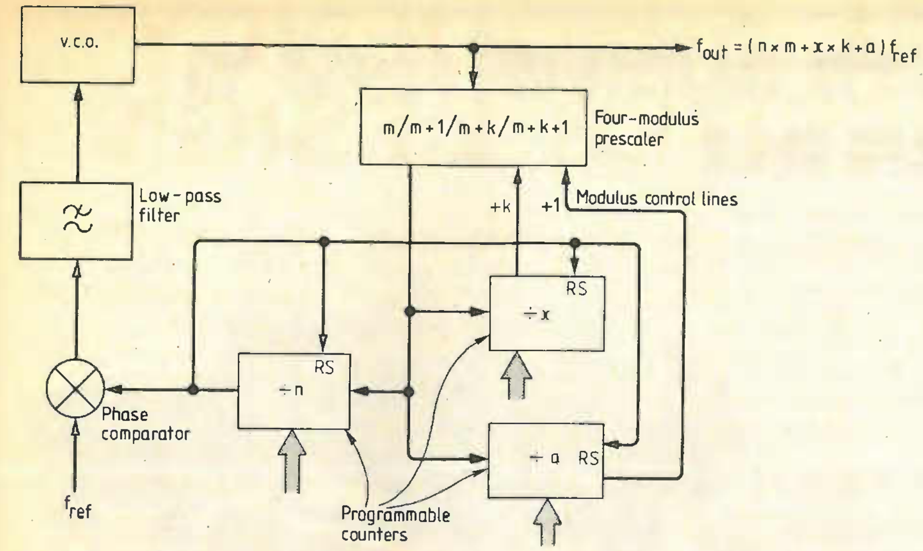


Fig. 5. *Four-modulus prescaling overcomes the limitation on lowest frequency of Fig. 4.*

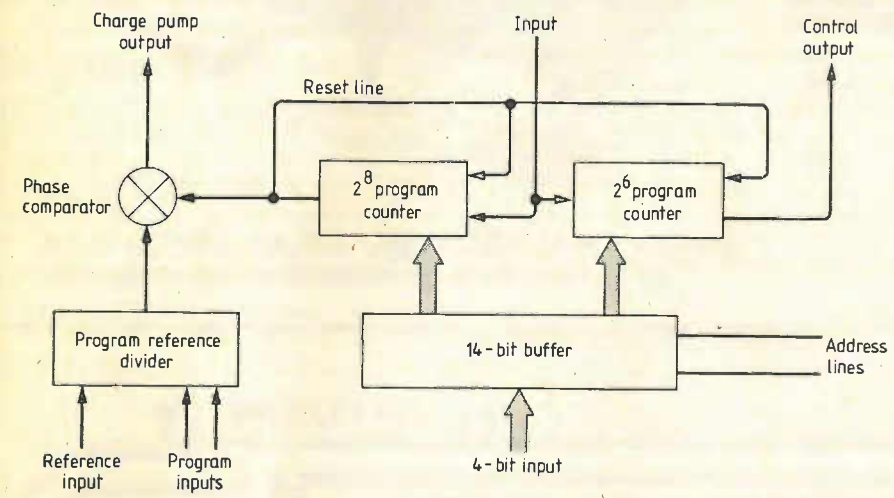


Fig. 6. *Synthesizer type NJ8811 is made from n-m.o.s. to reduce power consumption but it also reduces chip size and the number of diffusions required.*

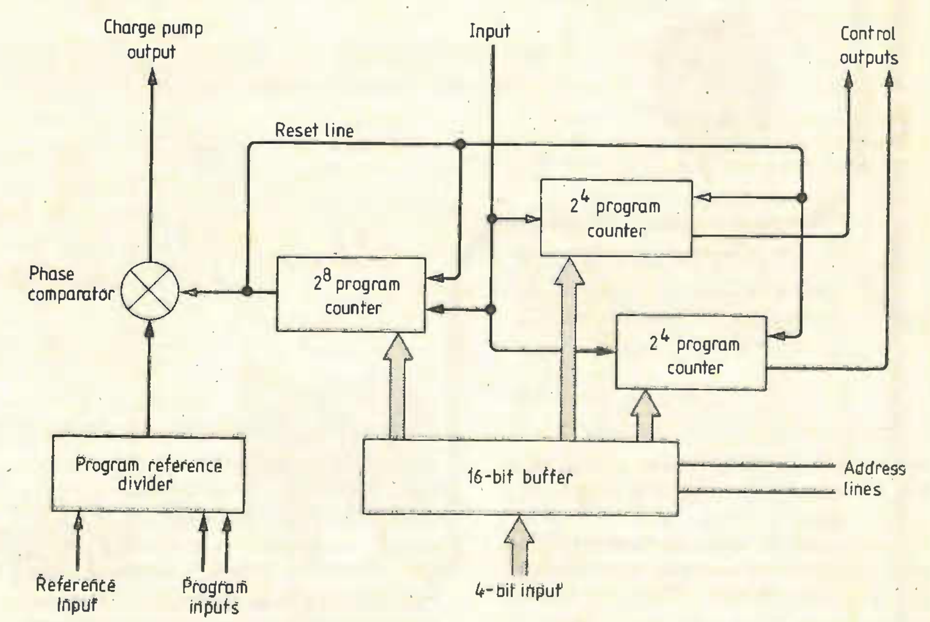


Fig. 7. *Although NJ8811 and NJ8812, above, will generally be programmed by a r.o.m. and channel switch they are compatible with microprocessor-based systems as well.*

www.americanradiohistory.com

Basic synthesizer design program

```
1 P$="REFERENCE":S$="SYNTHESIS":F$="FREQUENCY":G$=" FREQUENCIES":X$="PROGRAM
2 D$="DIVISION RATIO":E$=" DIVIDER":U$="TRANSCEIVER":P$="PRESENT":O$="PRESCALER
"
3 W$="HARMONIC":V$=" CHANNEL SPACING":C$="ENTER ":Z$="INPUT ERROR - TRY AGAIN"
4 PRINT"[][][][][]PLESSEY SEMICONDUCTORS LTD.[][]":PRINTTAB(15)P$"[][]":T=2:GOSUB
68:GOSUB138
5 T=3:GOSUB68:PRINT"[]";:GOSUB138:M$="MAXIMUM ":PRINT"[]PLESSEY SEMICONDUCTORS M
AKE A RANGE OF
6 N$="MINIMUM ":O$="[]PIN 1 IS CONNECTED TO":PRINT"INTEGRATED CIRCUITS FOR USE I
N "F$;
7 PRINTS$"ERS.  THIS "X$" IS AN AID TOTHE DESIGN OF VHF & UHF "S$"ERS FOR";
8 PRINT"MOBILE,AERONAUTICAL,SATELLITE,MARINE AMDHAM "U$"S WITH"V$"S
9 H$=" PART ":PRINT"OF BETWEEN 1 & 100 KHZ.[]":PRINT"    THE FIRST"H$"OF THE "X$

10 PRINT" TAKES":PRINT"THE HIGHEST AND LOWEST"G$" TO BE"S$"ED, THE I.F. OFFSET
(WHICH MAY
11 PRINT"BE 0 IF THE "S$"ER IS NOT FOR A" PRINTU$"), AND THE"V$"." PRINT"IT CHE
CKS WHE";
12 PRINT"THER THE "S$"ER MAY BEMADE WITH PLESSEY INTEGRATED CIRCUITS" PRINT"AND
WHICH ",
13 I$=" IS TOO HIGH ":PRINT"ONES SHOULD BE USED.[]":PRINT"TO CONTINUE"; GOSUB137
14 PRINT"[]PLEASE INPUT THE FOLLOWING"G$" IN MEGAHERTZ:" W=4.8E6:U=W:O=0
15 PRINTH$:INPUTF:IFF>1800.001THEN102
16 PRINTN$;:INPUTL:IFL>FTHENPRINT"[]ERROR! MIN>MAX":T=2:GOSUB68:GOTO14
17 O=0:PRINT"INTERMEDIATE "F$" ("C$"ZERO IF   NOT A "U$") [][][]";:INPUTI:A=1E6
18 F=A*F:L=A*L:I=A*ABS(I):H=F-J=L-IFI>0THENPRINT"HIGH OR LOW SIDE INJECTION?",:
GOSUB66
19 IFA$="H"THENO=1:PRINT" HIGH" IFF+I>1.801E9THENF=(F+I)/1E6:GOTO102
20 IFA$="L"THENO=-1:PRINT " LOW" L=L-I
21 IFO=0ANDI<>0THENPRINT" NONE
22 T=.3:GOSUB68:PRINTC$"THE"V$" IN KILOHERTZ" INPUTP:P=P*1E3:IFI/P<>INT(I/P)THE
N124
23 IFO=1THENF=F+I
24 PRINT"STANDARD "R$" INPUT IS 4.8 MHZ.    DO YOU WANT A DIFFERENT ONE?";
25 GOSUB66:IFA$<>"Y"THENPRINT" NO" T=.7:GOSUB68:GOTO27
26 PRINT" YES" PRINTC$R$" INPUT IN MHZ":INPUTW:W=W*1E6:U=W
27 IFF>1E9THENA$="SP8619 PLUS SP8906" R=4:GOTO128
28 IFF>5.12E8THENA$="SP8901" R=2:GOTO128
29 IFF>2E8ORF/P>16960THEN127
30 PRINT"[]THE SYNTHESISER MIGHT USE"AN NJ8811 OR   AN NJ8812.  IF YOU WISH TO US
E":
31 PRINT" THE" PRINT"NJ8811 "C$"1", OTHERWISE"; GOSUB137:IFA$="1"ORA$="I"THEN127
32 IFL/P<1600THEN106
33 A$="SP8793" T$="2" R=1:V=P:X=1:GOSUB131
34 RESTORE F7=0:A=N/V:FORB=0TO3:READC:FORD=0TO3:DATA128,160,192,240
35 IFA=INT(C*2^D+.5)THENB1=B:D1=D:F7=1:GOSUB71
36 NEXTD,B:RESTORE:IFF7=0THENA=.9*W/V:GOTO107
37 PRINT"[]"R$" "D$" IS"A PRINTR$" "F$" IS"V/1E3"KHZ." GOSUB139:PRINT"[]TO SET "R
$" "D$
38 PRINT"CONNECT PIN 8 TO PIN"B1 B1=3-D1 GOSUB139:PRINT"AND PIN 9 TO PIN"B1
39 IF(X=2ANDF/P>69376ANDL/P>=36608)OR(X=1ANDF/P>11840ANDL/P>=6270)THEN132
40 IF(X=2ANDF/P<69376)OR(X=1ANDF/P<11840)THENG=0:PRINTO$" VCC" Y=1600-2240*(X=2
):GOTO47
41 PRINT"[]"F$" RANGE IS SO LARGE THAT PIN 1
42 PRINT"(OFFSET PIN) MUST BE SWITCHED TO ALLOW  THE MAIN"E$" TO COVER THE RANG
E
43 PRINTL/1E6"TO"F/1E6"MHZ.  IN ANY CASE
44 PRINT"SUCH A WIDE RANGE OF"G$" (RATIO IS"F/L"" 1)".
45 PRINT"NECESSITATES SWITCHING THE" PRINT"V.C.O. RANGE. CALCULATE IN SECTIONS.
46 T=3:GOSUB68:GOTO14
47 GOSUB72:IFO=UTHENU=W:O=0:GOTO27
48 PRINT:PRINT"TO ACCESS"H$"2"; GOSUB137
49 PRINT"[]   [][]"H$"2 OF THIS "X$" CALCULATES
50 PRINT"THE DATA INPUTS NECESSARY TO "X$
51 PRINT"DISCRETE"G$"." PRINT
52 S=0:IFI>0THENPRINT"     ARE CHANNELS SIMPLEX OR DUPLEX?" GOTO121
53 T=3:GOSUB68:A=1E6
54 IFS<2THENPRINT"[]"C$"F$" (MHZ)". INPUTF:F=K*A:IFH<KORK<JTHENPRINTZ$:T=2:GOSUB6
8:GOTO54
55 IFS<2THENM=M+O*I:GOTO59
56 PRINT"[]"C$"T"[] "F$" (MHZ)". PX "F$" (MHZ)", INPUTM:M=M+A:N=N+A
57 IFH<LORH<MOR[]JORN<JTHENPRINTZ$:T=2:GOSUB68:GOTO56
58 N=N+O*I
59 PRINT"[]"D$. IFS>OTHENPRINT" TX".
60 D=O:PRINT" -". B=M/P:PRINTB N=N/1E6:GOSUB88:IFZ=1THEN62
61 IFZ>OTHENPRINT"[]"D$" RX" -" B=N/P PRINTB N=N/1E6:GOSUB88
62 IFZ=1THENZ=O:PRINT"RETURN TO"H$"1 FOR NEW VALUES." T=3:GOSUB68:GOTO14
63 IFZ=1THEN131
64 PRINT"[]DO YOU WANT ANOTHER CHANNEL" ". GOSUB66:IFA$<>"N"THENPRINT"YES" T=1
:GOSUB68:GOTO54
65 PRINT"NO" END
66 GETA$:IFA$=""THEN66
67 RETURN
68 T=TI+60*T IFT>5183990THENRETURN
69 GETA$ IFT>TITHEN69
70 RETURN
71 PRINT"[]"R$" INPUT -".U/1E6."MHZ." RETURN
72 A=1E6 IFH-J>=UTHENGOSUB78 RETURN
73 IFINT(H/U)-INT(J/U)=0ANDJ/U<>INT(J/U)THEN RETURN
74 PRINT"[]THERE IS A "W$" OF THE "R$"    OSCILLATOR AT":INT(H/U)*U/A.
75 PRINT"MHZ." PRINT"DO YOU WANT A DIFFERENT "R$" INPUT ". GOSUB66 IFA$<>"Y"THE
NRETURN
76 R=U/V FORA=0TO3 RESTORE FORB=0TO3 READC IFR<C*2^ATHEN114
77 NEXTB,A
78 PRINT"[]IT IS INEVITABLE THAT ONE OR MORE
79 PRINTW$"S OF THE "R$" OSCILLATOR   WILL LIE BETWEEN"J/A"AND"H/A  .
80 PRINT"MHZ. TO LIST THEM PRESS 'Y' " PRINT"N.B.THIS ERASES "P$" SCREEN CONTENT
S
81 PRINT"OTHERWISE", GOSUB137 IFA$<>"Y"THENRETURN
82 PRINT"[]", GOSUB87:PRINT B=INT(J/U)+1 B=INT(J/U)+1 GOSUB86 IFB*U>HTHENRETURN
83 PRINT"[]"; GOSUB87:PRINT,,
84 GOSUB86:IFB*U>HTHENRETURN
85 GOTO84
86 PRINTB,"[][][][]"B*U/1E6, B=B+1 RETURN
87 PRINTW$,"F - MHZ", RETURN
88 IFB-1E-4>INT(B)THENPRINTF$" NOT A MULTIPLE OFTHE"V$ Z=1 RETURN
89 PRINTF$" -"N"MHZ[]" PRINTO$; IFG=1THENPRINT" GROUND
90 IFG=0THENPRINT" VCC
91 B=B-Y PRINTX$" NUMBER IS:-"B IFX=1THENB=B+192*INT(B/64)
92 C=16:B(1)=INT(B/(2^12)) B=B-2^12*B(1) B(2)=INT(B/(2^8)) B=B-2^8*B(2)
93 B(3)=INT(B/C) B=B-B(3)*C B(4)=INT(B+.1)
94 FORB=1TO4 IFB(B)<10THENB$(B)=RIGHT$(STR$(B(B)),1)
95 IFB(B)>9THENB$(B)=CHR$(B(B)+55)
96 NEXT PRINT"WHICH IS  "; FORB=1TO4 PRINTB$(B), NEXT PRINT"( IN HEXADECIMAL":P
RINT"AND   ";
97 FORB=1TO4 T=B(B):T$="0":IFT>=8THENT$="1" T=T-8
98 A$="0":IFT>=4THENA$="1":T=T-4
99 T$=T$+A$ A$="0":IFT>=2THENA$="1" T=T-2
100 T$=T$+A$:A$="0":IFT=1THENA$="1"
101 T$=T$+A$:PRINTT$;" "::NEXT:PRINT"( IN BINARY" RETURN
102 PRINT"[]"F/1E3"GHZ"I$"A "F$" FOR" PRINT"THIS TYPE OF "S$"ER AT "P$" (BUT";
103 PRINT"TRY US AGAIN NEXT YEAR!)[][]" T=3:GOSUB68:GOTO14
104 PRINTM$D$I$:PRINT"EITHER REDUCE "M$F$" OR":PRINT"INCREASE"V$".
105 W=4.8E6 U=W:PRINT"[]TO TRY NEW VALUES"; GOSUB137:GOTO14
106 PRINT"[]"N$D$" IS TOO LOW":PRINT"EITHER INCREASE "N$F$" OR":PRINT"DECREASE"V
$"." GOTO105
107 FORB=0TO3 RESTORE:FORC=0TO3 READE:D=INT(E*2^B+.5):IFD>ATHENB1=C:D1=B:B=4:C=
B NEXTC,B GOTO109
108 NEXTC,B
109 A=D U=D*V IFU>12E8THEN112
110 IFU<2.5E6THEN113
111 GOSUB71 GOTO37
112 PRINT"[]"R$" "F$I$:GOTO37
113 GOSUB71 PRINT"(LOWER THAN OPTIMUM - SUGGEST USE OF":PRINT"EXTRA"E$")":GOTO3
7
114 D=0 IFA=3THENA=2
115 IFB=3THEN RESTORE B=0 A=A+1
116 READC B=B+1 D=D+1 R=C*2^A:O=V*R IFINT(H/O)-INT(J/O)=0ANDJ/O>INT(J/O)THEN119
117 IFD=4THENPRINT"THERE IS NO PRACTICAL VALUE OF "R$;:GOTO120
118 GOTO115
119 PRINT"NEW STANDARD "R$" INPUT IS"O/1E6"MHZ.":W=O U=O T=1.5 GOSUB68 RETURN
120 PRINTF$" WHICH IS FREE OF IN-BAND":PRINTW$".":RETURN
121 GOSUB66 IFA$="S"THENPRINT" SIMPLEX" S=1:GOTO53
122 IFA$="D"THENPRINT" DUPLEX":S=2:GOTO53
123 GOTO121
124 PRINT"[]THE I.F.IS NOT A MULTIPLE OF THE"V$; PRINT". CHOOSE EITHER A NEW I.F
 OR A
125 PRINT"NEW"V$".":PRINT"N.B.CHECK THAT CHOICE OF 1/2 OR 1/4 OF
126 PRINTP$V$" IS NOT ALL THAT IS NEEDED." T=5 GOSUB68 GOTO14
127 A$="SP8906" R=1
128 X=2 T$="1" GOSUB131:IFF/P>102143THEN104
129 IFL/P<3840THEN106
130 GOTO34
131 PRINT"[]"O$" - "A$ PRINTX$"MABLE"E$" - NJ881"T$ PRINTP$" IS"1/R"TIMES"V$ V=P
*R RETURN
132 G=1:PRINTO$" GROUND" Y=6270-30338*(X=2) GOTO47
134 PRINT"[]N.B. USE OF NJ8812 MODIFIES THE BINARY  AND HEXADECIMAL NUMBERS BECA
USE",
135 PRINT" OF THE  INSERTION OF TWO EXTRA UNUSED BITS INTO THE SECOND LEAST ";
136 PRINT"SIGNIFICANT WORD." GOTO64
137 PRINT" PUSH ANY KEY." GOSUB66 RETURN
138 PRINTTAB(8)"**"F$"  "S$"**" PRINTTAB(10)"--------------------" RETURN
139 B1=6-(B1=1)-11*(B1=2)-7*(B1=3) RETURN
```

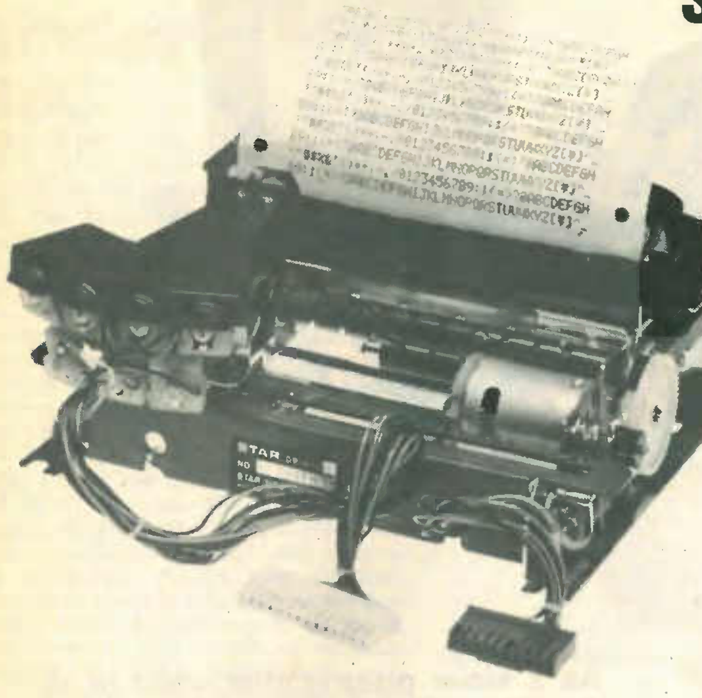
must be programmable over a range of m and the n counter must always divide by a larger number than the a counter. Therefore, to be fully programmable, the total system division ratio must be equal to, or greater than m^2. This sets a lower frequency limit for such synthesizers, for example, with 25kHz channel spacing and a 40/41 prescaler the minimum division ratio is 40^2 so the minimum frequency is 40 MHz.

Generally, the programmable counter sets a limit which is higher than the theoretical minimum. If wider tuning is required, four-modulus prescaling can be used. A typical system is shown in Fig. 5 with four moduli, $m/m+1/m+k/m+k+1$, which are set by $+1$ and $+k$ control lines. There are three programmable counters and the conditions which limit the ratios are, a must count over a range of k, x must count over a range of $(m+k+1)/k$, and n must count at least the minimum value of a or k. For a 55/56/63/64 prescaler, the division ratio limit is 512, which allows 25kHz channel synthesis above 12.8 MHz. Again, in a practical system, the programmable counter will generally set a higher minimum. The overall division ratio of this system is $m\times n+k\times x+a$ where n, x and a are the counts in their respective counters.

Continued on page 83

DP-824-24 PRINTER KIT SPECIAL OFFER

SAVE £33.89 (UK ONLY)



To compliment the excellent article in this issue of Wireless World, Roxburgh Printers Ltd are making an offer of:

1pc DP-824F-24 Printer Mechanism
1pc DPC-4A Controller Chip
1pc 82910180 Paper Tear Bar
1pc 8002 Paper Roll Holder
1pc 114080-RO-000-SP-P Paper Roll

Normal price with carriage and VAT would be £119.38
Offer price inclusive of carriage and VAT is **£85.49**

Cheques should be made payable to Roxburgh Printers Ltd.

If you would like further data on this or the complete range of Printers and Interfaces, please contact us.

ROXBURGH PRINTERS LIMITED
22 Winchelsea Road, Rye, East Sussex.
Telephone: Rye 079 73) 3777. Telex: 957066

WW053 – FOR FURTHER DETAILS

D.S.N. MARKETING Ltd.

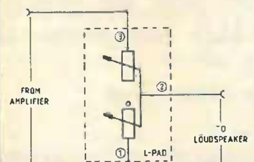
Bullet LOUDSPEAKER COMPONENTS

D.S.N. Marketing is a newly established subsidiary company, part of a group of companies centred around one of the U.K. market leaders in electro-acoustic equipment, established for over 50 years. We make use of the extensive research facilities on our premises, which include a large anechoic chamber and B & K measuring equipment, to ensure the highest quality of our products.

AT-SERIES L-PAD CONTROLS
A range of constant impedance loudspeaker level controls. By employing a twin-track wire wound power potentiometer in an L-circuit configuration a constant impedance of 8 ohms within ± 25% is achieved over the whole attenuation range. The 'H' models are standard potentiometers with a 10mm long M-9 threaded shaft. The 'S' models come complete with a recessed indication panel and control knob.

Model	Power Rating −2 dB	−6 dB	−12 dB	Attenuation Range	Rotation Torque	R.R.P. incl. V.A.T.
AT-40H	15 W	10 W	6 W	0 : −40 dB	70 : 450 g/cm	£1.10
AT-40S	15 W	10 W	6 W	0 : −40 dB	70 : 450 g/cm	£2.45
AT-50H	30 W	25 W	15 W	0 : −28 dB	200 : 500 g/cm	£2.55
AT-50S	30 W	25 W	15 W	0 : −28 dB	200 : 500 g/cm	£3.40
AT-60H	50 W	35 W	25 W	0 : −40 dB	200 : 600 g/cm	£4.15

Different models and impedances available to special order (O.E.M. only)



These level controls can easily be incorporated in any low impedance loudspeaker circuit and are most useful for compensation of acoustic absorption and efficiency differences in 2- or 3-way loudspeaker systems. They are also widely used for level setting in multi-loudspeaker chains, such as for monitor, paging or background music applications.

SEE OUR STAND AT A.P.R.S. 82 INTERNATIONAL EXHIBITION OF PROFESSIONAL RECORDING EQUIPMENT, 23-24-25 JUNE, 1982, KENSINGTON EXHIBITION CENTRE, LONDON

To order: send this coupon together with cheque/postal order, payable to D.S.N. Marketing Ltd, or give Access/Visa card number. Access/Visa car holders also can phone their orders through for extra fast service. All prices include VAT @ 15%, subject to availability.
Please supply the following:

quantity	product	unit price	total price
	AT-40H L-Pad Control	£1.10	
	AT-40S L-Pad Control	£2.45	
	AT-50H L-Pad Control	£2.55	
	AT-50S L-Pad Control	£3.40	
	AT-60H L-Pad Control	£4.15	
Tick for further details		UK P&P £2.00	
		TOTAL	

NAME....................
Address....................
....
....
Signature....................
WW 682
Access/Visa No....................

D.S.N. MARKETING LTD, Westmorland Road, London NW9 9RJ
Telephone: 01-204 7246. Telex: 895 4243.
Trade, Wholesale, O.E.M. & Export enquiries welcome.

VISA

WW – 027 FOR FURTHER DETAILS

www.americanradiohistory.com

EP4000 EPROM EMULATOR PROGRAMMER

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. Tel: Plymouth (0752) 332961 Telex: 42513

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

WW – 023 FOR FURTHER DETAILS

Sinclair versus BBC

Clive Sinclair with his new colour graphics computer the ZX Spectrum

When the BBC announced that they had selected Acorn to produce their microcomputer, Clive Sinclair was furious. He said that he could offer "any facilities that the Corporation might require at a lower price than any competitor". The Sinclair ZX Spectrum is his attempt to prove it and he recently launched it as "not the BBC Computer". In his promotional literature he lists features included on the Spectrum and compares them with rival colour-display computers in an attempt to prove that the Sinclair can out-perform the others, especially the BBC model 'A', at less than half the price.

As he has invited the comparison, it is worth taking a closer look at both the BBC model A and the ZX Spectrum. The first obvious difference is the keyboard. The BBC has a conventional typewriter layout with 73 keys including ten user-definable function keys. The Spectrum has 40 keys and some have six functions which involves extra shift-keys to get the required function. This is offset by the single keystroke entry of all the Basic keywords available. Unlike the miniature membrane of the ZX81, the Spectrum has moving keys at typewriter pitch, but instead of concave full-sized keys they are in the flat, calculator style.

The Spectrum offers eight-colour graphics with 190 x 256 pixels and 32 x 24 text: other modes are user definable. The BBC 'A' has a choice of modes with four-colour graphics, 160 x 256 pixels and 20 x 32 characters. Higher definition is possible on the BBC 'A' at the expense of using fewer colours.

The Sinclair has overcome one of the major bugbears of the ZX81, that of loading and saving programs and data onto a cassette recorder. The Spectrum has a cassette interface that records a tone onto the tape: when loading, the computer automatically adjusts to the tone so that the correct input level is set. This overcomes the automatic recording level fluctuations on some recorders. The BBC 'A' uses a test tape to tell the operator when the recording level is correct after it has been adjusted manually. Spectrum can load a program faster at 1500 baud compared with 1200 baud.

Using a BEEP command, the Spectrum can generate sound which may be controlled in pitch and duration, but the model A has three-voice music synthesis with full envelope control.

The ZX printer plugs directly into the Spectrum and offers the same high resolution and graphics capabilities, without the colours, as the screen, and can reproduce anything displayed. Model A has no printer interface – it is only available on the enhanced model B. An input/output port is available for the Spectrum and not for model A.

The BBC computer uses a version of Basic with a very large number of keywords. The ZX Basic is an extended version of the ZX81 but has fewer keywords than the BBC. Some of the more useful keywords available to the BBC computer are AUTO for automatic program line numbering and RENUMBER. OLD restores a program that has been released from memory by NEW. There are about 30 other keywords which are not available on the Spectrum. However, there are some on the Spectrum which do not occur in model A, especially VERIFY which can compare a program which has been saved with the original; and MERGE which can combine a program being loaded with another in the memory. The BBC seems to have more powerful file-handling facilities. In practice, both computers will be able to perform similar functions but the Sinclair may need some additional steps in the more complex programs.

The memory (r.a.m.) capacity of both machines is the same at 16K and, while the BBC may be expanded to 32K, the Sinclair can have 48K. The Sinclair claims to have more efficient memory 'packing' so that more r.a.m. is left available when using high resolution graphics.

BBC model A may be enhanced to model B and then has a very wide choice of extra facilities; analogue inputs, serial and parallel ports. An 8-bit Centronics printer port, viewdata and teletext buffered extension bus, Red, Green, Blue, and sync. outputs and a disc memory filing system. So far the Spectrum will operate the ZX printer. An RS232 serial interface board is to become available soon, as are the Microdrives – miniature microfloppy disc drives which will hold up to 100Kbytes of data. Eight of them may be linked together. Each Microdrive will cost about £50. The prototype Microdrive demonstrated by Sinclair recently was only about 70mm wide, so the discs are very small.

When we come to compare the prices, the Sinclair has the distinct advantage. The basic model costs £125 and the 48K memory model, £175. BBC model A cost just under £300 and model B, £400. The Sinclair ZX81 attracted a wide variety of peripherals from other manufacturers: at a recent computer fair there were demonstrations of high resolution graphics, interface for all kinds of equipment including full-size parallel printers, music synthesizers and even colour graphics. If the ZX Spectrum attracts similar support from these manufacturers, or others, it seems there could be few limitations to its abilities while remaining within the price ceiling set by its rival.

Meanwhile, Sinclair Research will continue to produce and sell the ZX81. 400,000 have been sold in a year and Mr Sinclair believes that it is still the best introduction to computing for those unwilling to undertake a higher financial commitment. The price of the add-on 16K r.a.m. has been reduced to £30 but the ZX printer increased to £60. Despite the high profits of Sinclair Research over the last year, Sinclair is looking for more capital to finance some of their other activities including Clive Sinclair's pet project, an electric car. For this he is investigating the possibility of selling some shares in the company.

Sinclair might not lead the low-cost colour computer market for long. It is rumoured that Acorn, the makers of the BBC computer, are to produce their own colour device, the Electron, for about the same price as the Spectrum.

Flat-screen 'scope

It is often forgotten that liquid crystals are a British invention and that their development at the Royal Signals and Radar Establishment earns the UK royalties from all over the world. The earlier 'twisted nematic' l.c.d used in digital watches and calculators need polarized light to make them visible, but the newer 'dye-phase-change' l.c.d use the optical properties of dyes, dissolved in the liquid crystal, which make them brighter and not subject to the restricted viewing angle of the earlier type. The development of these displays has enabled them to be made much larger. This, however has led to problems of addressing and driving the display elements. Time division multiplexing may be used but the limit has been achieved in a message display with four lines of text.

Oscilloscope displays are fractionally easier to produce as the information displayed is simpler in form than that presented on message displays. It is usually necessary to distinguish only one element in each column for a waveform to be displayed. The method invented by Dr Ian Shanks of the RSRE uses row and column drive waveforms which are divided into discrete time

www.americanradiohistory.com

periods. In each period the drive waveform is either on or off associated with the logic states '1' or '0' respectively. The drive waveform is therefore binary and the sequence of logic states may be repeated every 30ms. The waveforms can be supplied by standard c.m.o.s. logic circuits, unlike message displays which need special decoder/drivers. Unfortunately direct voltages cannot be used to drive liquid crystals. They would cause chemical decomposition. This problem is overcome in the 'scope display by generating pseudorandom binary sequences in the drive waveforms. A different waveform may be applied to each row of the display. Any of these or a different set of waveforms are also applied to the columns. Only when the same waveform is applied to both row and column in the matrix will there be no voltage difference and so that element will be 'off'. As there will be a voltage difference on all the other elements in the column, they will be 'on' and therefore distinguishable. The vertical height of the 'off' element is determined by the choice of waveform for that column and this is in turn determined by the value of the sample taken from the input signal waveform. As the 'off' element depends on zero voltage difference, the device is not sensitive to voltage changes caused by temperature and full performance is maintained under a variety of conditions.

A display using this system was incorporated into a prototype oscilloscope at the RSRE, Malvern, with a 100 × 100 element matrix. In 1977, the NRDC invited Scopex to see the work at Malvern and this has eventually led to the development and production of the first commercially available flat screen oscilloscope. The Scopex Voyager has a 128 × 256 element display with a graticule of 60 × 100mm. The bandwidth is d.c. to 150kHz sampled eight times for each cycle. Analogue signals are converted to digital using a successive approximation method. The 7 bit digital words so produced are written into a r.a.m. in a location which corresponds to its position in relation to the timebase or X-axis of the instrument. The contents of the r.a.m. at a particular address are used to define the pseudo-random binary sequence waveform for the column corresponding to that address and thus the vertical level of the display element. Waveforms can be up-dated or held in the r.a.m. This gives a stable image to the display which does not flicker or fade. A 'save memory' function allows a waveform to be stored after the instrument is switched off. Waveforms from different sources may be compared using the dual-trace function. There is also a pre-trigger function. The use of an external timebase or X input converts the oscilloscope to an XY plotter.

At the analogue input end of the 'scope, Scopex have retained their 'easy to use' philosophy, using as few external controls as possible. To this end, the vertical amplifier, trigger and timebase controls are similar to those on Scopex analogue oscilloscopes. There are two Y inputs to provide a dual-trace and in order to cope with the 7-bit resolution and the 1.25MHz conversion rate, a switching speed of 60ns is achieved using a Schottky diode ring gate. The 'scope is powered by rechargeable internal batteries through a switch-mode supply. All this is housed in a plastics case and weighs only 2.5kg. Along with probes and a battery charger it is presented in a leather briefcase for £2,500.

The Scopex Voyager oscilloscope is the first commercially available to include a flat l.c.d., making it smaller and with lower power requirements than conventional instruments.

The Datakey contains an e.a.r.o.m. It fits on a keyring, is virtually indestructable and the contents of the memory are not affected by electromagnetic fields.

Memory key

Plastic credit cards can be damaged or stolen, the magnetic strip information can be copied and is limited in the amount of information that can be stored. An alternative has been produced by a manufacturer of plastic cards, Data Card International, which is a plastic key incorporating an electrically alterable read only memory (e.a.r.o.m.). The memory has a capacity for 300 characters and the key is used in conjunction with a keyhole or 'Keyceptacle', (sic), with the appropriate electrical contacts and a 'Keytroller' – a micro-controlled interface unit which allows the contents of the key to be communicated to a host computer. The Keytroller also 'manages' the data so that the most efficient use is made of the memory.

The system is inherently secure as the details are entered at random. Sections of the data may be protected by access codes and the memory is sufficient to contain a variety of details or personal data known only to the keyholder. If anyone were able to copy the key, it would be no good without the knowledge of the appropriate codes.

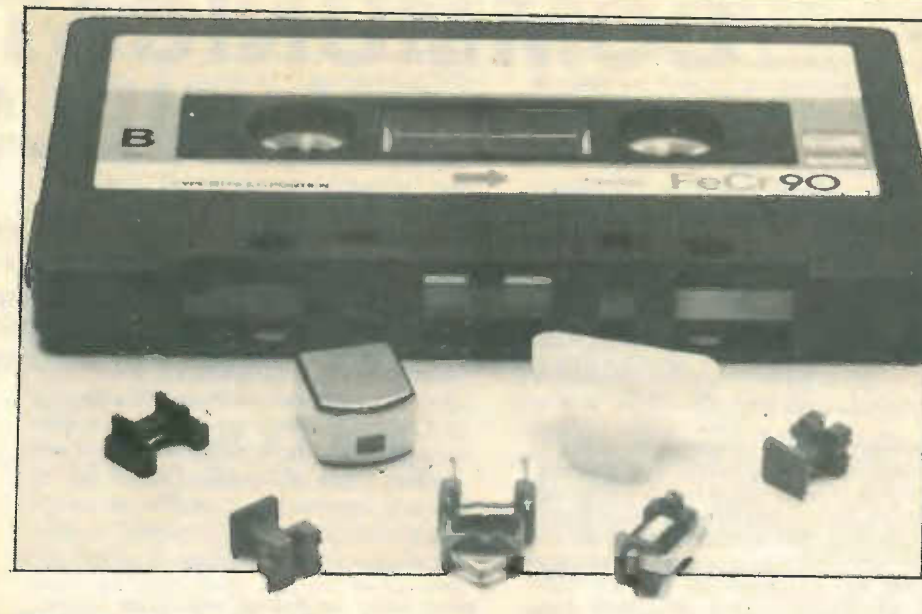
The Datakey, as it is called, can be used for access to areas or machines that are secure against unauthorised users in much the same way as a plastic card. It has many additional uses as it can contain a programme for almost any computer or controller. Thus it may be used for work and time logging, for monitoring patients or medical staff, for vehicle records etc.

A particular advantage of the system is the ability to alter the contents of the memory. It can hold details of an account, and money or other token units may be added to or subtracted from a total held in the memory. This enables it to be used as a credit card to be used with a variety of vending or dispensing machines. An example is the dispensing of petrol at a pump controlled by the key.

A further example of the use of the key is the storage of instructions for a machine tool. A change of key instantly changes the instruction set without the need for re-programming or loading punched tape. Keys may be used in combination with one key specifying a product type while another may hold details which may vary within the type.

A Datakey development system, including a number of the keys and a keyboard/display programming unit, is available to OEM customers.

Sir Kenneth Corfield (right) receives the Royal Charter of the Engineering Council from John Wakeham, Under-Secretary of State for Industry. The Council was set up as a result of the Finniston Report to act 'as an engine for change in shifting national attitudes and priorities'. The new Council will take over most if not all of the executive functions of the Council of Engineering Institutions, especially the supervision of the training and qualifications of engineers. The CEI has agreed that 'when the time is right' it will seek agreement of its members to transfer the Engineers Registration Board. The right time depends on the Engineering Council and is likely to be in about two years. If the new Council assumes all the functions of the CEI, then the CEI will 'undoubtedly wind itself up', according to Bryan Hildrew, the retiring Chairman of the CEI in his foreword to the CEI Annual Report.



These miniscule plastics bobbins are used in cassette tape recording heads. The sort of thing that one associates with far Eastern manufacturers, these are made in Alcester, Warwickshire and exported to the Far East by Dyncast International, who have won a contract for eight million of them.

Intelsat VI – a new series

Five new Intelsat telecommunications satellites will offer three times the capacity of the current series V, and will be in operation by 1987.

The satellites are to be built by the Hughes Aircraft Company who will be joined by an international team of subcontractors. British Aerospace has a major role with about £50 million worth of orders over a seven-year period. After the initial five there is an option for eleven additional spacecraft.

Each satellite will be nearly 12m tall and 4m in diameter with a weight of 1,800kg. The solar panels will generate 2,200W to power up to 33,000 two-way telephone channels and four tv channels.

The spacecraft has been designed for launching by both the ESA Ariane and the NASA space shuttle. As the shuttle does not reach the required altitude for geosynchronous orbit, there needs to be an additional booster stage and a system for launching the satellite from the shuttle. BAe will design and build the cradle for carrying the spacecraft in the shuttle bay. This will include electronics units and the power and signal interface which connects the shuttle and spacecraft. They will also design and build the C and K band dish reflectors, other structures and wiring harnesses.

British Telecom has the second largest share in the International Telecommunications Satellite Organisations of which there are 106 members. The new satellites will help BT meet the demand for international telephone calls which grows at a rate of more than 20% each year.

In brief

80% useful energy conversion is claimed for NASA's latest fuel cells. Forty-five fuel-cell plants each housed in cabinets 2.7×1.5×2m and capable of generating 40kW, are to be installed experimentally in various sites around the U.S.A. The fuel cell power generators produce electricity from hydrocarbons by first converting to a hydrogen-rich fuel and then feeding it to one electrode in a cell of phosphoric acid electrolyte, while the other electrode is fed with oxygen. The cells produce heat as well as electricity and if the heat is used for heating homes or commercial buildings, the combined output of electricity and heat represents an energy conversion factor of about 80%. This compares with about 30% energy conversion from conventional electricity generators.

Home Radio (Components) have moved to 169 London Road, Mitcham, Surrey; their address for postal enquiries remains at PO Box 92, 215 London Road, Mitcham. They may be contacted by telephone at 01-648 3077.

Thomson-CSF claim the **world's fastest integrated circuit** operating at room temperature, an 11-stage ring oscillator with a gate delay of only 22 picoseconds. Structured from gallium aluminium arsenide/gallium arsenide junctions, the molecular-beam expitaxial process used is capable of controlling the crystal growth of the various layers down to the thickness of a single atomic layer.

On 5th April, a 'magazine' called Electronic Insight appeared on Prestel. This publication is intended to provide news, comment, product information and advertizing concerning electronics and telesoftware for microcomputer users. The potential exists to update news by the minute – 24 hours a day – and readers can pass from product news to product feature to comparison chart to stockists and retailers quickly. The magazine's editorial and commentary "maintains a fully independent view", says the publishers.

www.americanradiohistory.com

LEAKY FEEDER COMMUNICATION IN TUNNELS

Since the earliest days of radio – and certainly before the advent of broadcasting – attempts have been made to apply it in mines and tunnels using conventional apparatus of the day and relying on natural propagation of the waves. All these efforts were doomed to failure, and the reasons are now well understood: radio waves cannot propagate usefully in such conditions by any natural means.

by D. J. R. Martin,
B.Sc., Ph.D., F.Inst.P., F.I.E.R.E.

Radio waves cannot propagate naturally to any useful extent in mines and tunnels. Since about 1920, many attempts to use radio in such conditions have been made, without success.

There are two important exceptions to this generalization. At very low frequencies, certainly below any used for broadcasting, there is a limited capability of waves to penetrate rock or other strata. This property has recently been thoroughly investigated in the USA and exploited in the development of equipment intended for possible communication with trapped miners from the surface above. Through-the-earth ranges of up to 300 m have been demonstrated, but speech modulation is not practicable at the very low frequencies necessary and so the system uses baseband audio-frequency induction (for the 'down-link') and a coded c.w. carrier (for the 'up-link'). The possibilities have been studied but discounted for British mines, where average depths are greater and mining techniques less suitable, though equipment operating at slightly higher frequencies and using speech modulation has been successfully used by cave explorers. Useful ranges with speech modulation have also been achieved in South African mines, where geological conditions seem more favourable for propagation, and special equipment developed[1].

At the other end of the practical radio spectrum, waves in the u.h.f. range and above can often propagate usefully through a tunnel in what amounts to a waveguide mode, as first demonstrated by such investigators at Foot[2]. This form of communication is now being considered seriously by British Rail, whose operational train communications are normally in the standard mobile radio u.h.f. band following agreed European practice, and is also being investigated for the National Coal board by the University of Surrey. Negotiation of obstacles is the obvious difficulty, and in mining applications some practical means would need to be devised for re-directing the waves round a corner.

In 1955 Wyke and Gill[3] reviewed the situation as they then saw it with regard to mine communications and their paper gives many interesting references to the futile earlier experiments. One such investigator, in sheer negation of the traditional scientific attitude, made the infamous remark 'as successful means of wireless communication have not been discovered, details of the apparatus used and experiments carried out have not been included in this paper'.

Wyke and Gill themselves drew attention to the possibilities of inductive-type communication in coal mines, using frequencies in the range 15 to 150 kHz and relying on 'guidance' by any conductors present, such as power cables and telephone lines. Suitable equipment was, in fact, developed over the next decade or so and became a standard attachment to underground locomotives and cable-hauled man-riding trains. Generally, it was found worth while to install special well-positioned conductors or 'guide wires' for the purpose. By this means, reliable communication over distances of a kilometre or so could be obtained, especially if the conductor wire were galvanically connected to the base station instead of relying on inductive coupling there.

While fulfilling an important need in mine vehicular communications, the inductive equipment never achieved any success as a two-way personal system. The reasons for this were the fairly high transmitter powers required (about 5 W) and the resulting heavy batteries, the cumbersome loop or frame aerials involved, and the need for fairly close coupling to the conductor wire. In all applications, trouble was experienced with 'blind spots' or standing waves on the line, due to a lack of appreciation of the need for correct impedance termination or periodic phasing, and this often was the limiting factor on range. Such inductive systems have now been completely superseded in UK coalmines by the later developments to be described, though they are still used widely in some overseas countries, notably the USA and West Germany.

The key to the revolution in underground communications came in 1956 with the publication by Monk and Winbigler[4] of a paper describing how v.h.f. radio communication had been successfully maintained with a moving train in a long railway tunnel. Following a logical idea, they first installed a standard coaxial cable (RG-8/U) through a section of the tunnel, connected to a normal base station at one end and having dipole aerials bridged across it at frequent intervals. This worked extremely well, and so the spacing between the aerials was then progressively increased until they had all been removed; good communication was still maintained throughout the length of the section, although it had not been possible before the installation of the cable. It became clear then, that the communication was through the stray fields of the cable, and there was born what is now known as the 'leaky feeder' or 'leaky cable' principle.

With the realization that the cable itself was providing the necessary fields, the obvious next step was to substitute one known to have a higher leakage, and so a change was made from the coaxial to an unscreened two-wire line, a rather heavier version of the 'ribbon feeder' or 'twin-lead' then in common use for television downleads. This was also a more economical type of cable to use in terms of longitudinal attenuation for weight of copper.

Following this pioneering work of Monk and Winbigler, the leaky feeder principle was applied for communication in several American underground railway systems, notably the New York Subway, substantially unchanged in detail. But it was ignored by mining interests worldwide, and also in the UK generally, until the present author[6] commenced an investigation into its possibilities for mining use in 1966 at the same time that similar interest was being shown in Belgium[5]. Since then, the subject has been well served with expert theoretical and practical investigation in several countries, leading to a deeper understanding of the basic processes involved and improved designs of feeder cable, as will be described in this part of the article. At the same time, it has been appropriate to develop new and dedicated systems techniques to complement the new basic principle, and these will be described in Part 2.

The author

Since graduating as a physicist at King's College London in 1945, D. J. R. Martin has run the gamut of the spectrum from d.c. to microwaves. At BSIRA (now the Sira Institute) he devised new techniques in low-level d.c. amplification and a.c. voltage stabilization. On joining the National Coal Board in 1958 he developed remote-control systems for roof supports in the automatic-coalface projects of the time, and introduced loudspeaking telephones to the coalface.

At the same time he became fascinated by the propagation problem which had for so long defeated all attempts at radio communication underground, and eventually obtained approval to embark on a full-time investigation.

He studied the scientific basis and developed the technology extensively for mining use; for this work he received his doctorate in 1973 – and was married in the same year.

He has continued to specialize in the subject, working closely with colleagues in Europe and North America. In 1981 he took early retirement from the NCB to work privately in the field. At present he is helping to supervise a study of microwave propagation in mine tunnels, being undertaken by the University of Surrey on behalf of the NCB for possible application in underground rescue operations.

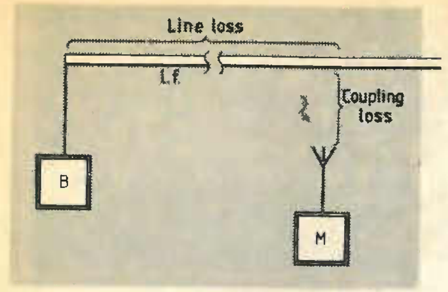


Fig. 1. Diagram of the basic leaky-feeder principle, depicting how the base station B communications both ways with the mobile station M through the leakage fields of the feeder LF. The total path loss is made up of two components, the line loss and the coupling loss.

Leaky-feeder principle

The basic leaky-feeder principle is illustrated in Fig. 1: B is a conventional two-way radio base station; LF is the leaky feeder, installed throughout the tunnel or environment where communication is required and connected to the base station in lieu of a normal aerial; M is a conventional two-way mobile or personal radio set, communicating with the base station through the leakage fields of the feeder.

The total path loss between the base station and the mobile is made up of two components: (a) the transmission loss within the feeder itself, between the base station and the region of the feeder in the vicinity of the mobile; and (b) the 'coupling loss', which is measured between the same region of the feeder and the aerial terminal of the mobile set.

Note that no assumptions are made here about the direction of transmission; the overall path is truly reciprocal, and so the principle is valid equally for mobile-to-base as for base-to-mobile communication. However, the processes involved are perhaps easier to visualize as operating in the base-to-mobile direction, and so consideration of coupling loss especially is usually from that point of view. Much of the theoretical work on the subject is similarly oriented; experimental observations, on the other hand, are often more conveniently based on the reciprocal path, with a mobile source inducing signals into the feeder. Reciprocity, of course, applies to the signal transmission only, and excludes the effects of any external interference or internal noise sources in the path; this factor is important when system aspects are considered, and will be covered in Part 2.

It may also be noted in passing that a leaky feeder may be used to allow direct communication between mobiles, without the intermediary of a base station. In this case the feeder operates in a purely passive or 'parasitic' mode, and two coupling losses are involved in the path. This form of operation was the basis of the pioneering Belgian work[5].

Consider now the separate loss components shown in Fig. 1. The feeder is basically a transmission line, in spite of its leakage, and so the signal within it will decay exponentially along its length – that is, the loss in dB will be directly proportional to distance. Generally, this attenuation will still be largely determined by the normal copper and dielectric losses, the leakage contributing little, and so a heavier and thus more expensive cable will give correspondingly better performance in this respect. It also follows that the attenuation rate is a stable characteristic which can be closely predicted or specified in the design of the cable.

The coupling loss, on the other hand, is a vague and variable quantity, being a function not simply of cable leakage (however that may be assessed) but also of the cable mounting, the environment, the characteristics and polarization of the mobile aerial and its distance from the cable. In a tunnel or any enclosed space pronounced multipath effects will inevitably occur, causing the 'instantaneous' value of the coupling loss to vary by 20 dB or more over short distances. Figures for coupling loss attributed by manufacturers to their cables, usually in unrealistic conditions, should be taken only as a very rough guide; an experienced system designer will prefer to work with more measurable fundamental characteristics of the cable together with a knowledge of its construction and a consideration of the environment and application concerned; in this particular respect the subject is best regarded as an art rather than a science.

The longitudinal attenuation of the feeder, again, is a well-established increasing function of frequency, which on this account should be set as low as possible. The leakage fields are generally considered to be substantially independent of frequency; however, other factors such as the size and efficiency of mobile aerials, the availability of suitable equipment or the need for compatibility with surface systems have discouraged the use of frequencies below 30 MHz. One therefore finds most applications of the leaky feeder principle operating in the standard v.h.f. mobile radio bands, with a minority in the h.f. and u.h.f. ranges.

Bifilar lines

For a decade or so following the original Monk and Winbigler publication, unscreened bifilar or 'balanced' types of line were used exclusively as leaky feeders, and were shown capable of giving very satisfactory performance. It became clear, in fact, that the high field strengths being

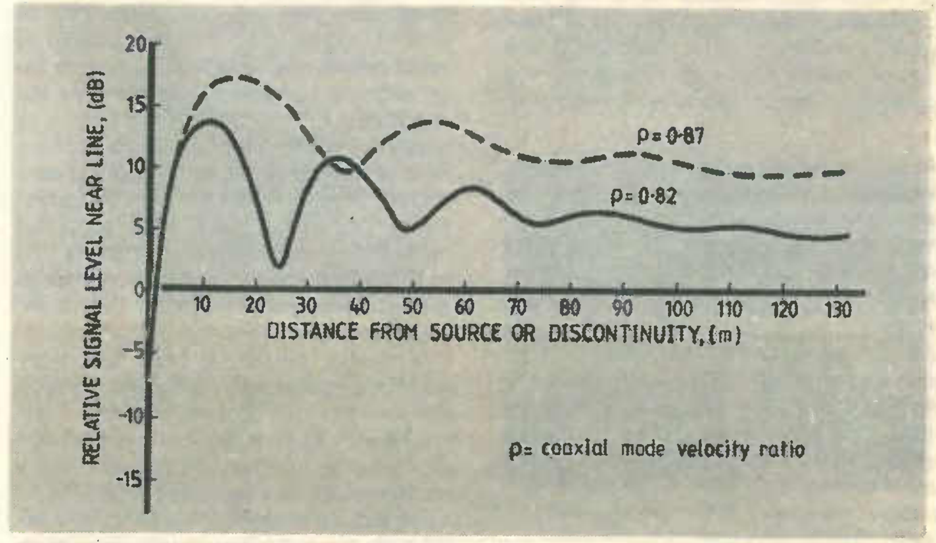


Fig. 2. Typical long standing wave as predicted to occur on a leaky feeder near the base station or any discontinuity as a result of waves travelling with differing velocities and attenuation rates (based on a computer analysis by A. M. Schmidt, Technische Hogeschol, Delft, Netherlands).

www.americanradiohistory.com

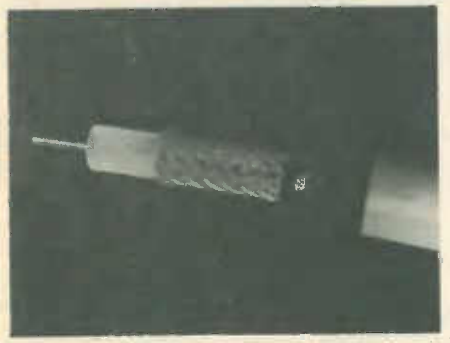
encountered in practice were far higher than would be expected theoretically from balanced cables[10], and this led to the conclusion that an imperfection or imbalance was the key factor in the success of the schemes. Such imbalance would result from inevitable assymmetries and irregularites in the mounting arrangements and in proximity effects, and led to the postulation of a continuous or continual interchange of energy between the low-field balanced mode and the high-field unbalanced or 'monofilar' mode; the balanced or 'bifilar' mode provided the longitudinal transmission, while the monofilar mode provided the coupling to the mobile set. It was shown experimentally that improving the balance by twisting the feeder, as might be expected, improved the longitudinal transmission at the expense of the leakage field, while 'careless' installation of an untwisted line close to metal structures or other cables would enhance the field locally to the detriment of the longitudinal transmission.

Deryck[7] has extensively studied the use of bifilar lines as leaky feeders, and has devised discrete 'mode converters' for introducing a controlled interchange of energy at specific points in a feeder[11].

Bifilar lines were intially considered for the first UK coal-mine system, commissioned at Longannet in 1970; the requirement there was for a radio system to serve a single 9 km tunnel linking four mines underground. But conditions there are extremely wet, and precautionary test showed that in such an environment the longitudinal attenuation of the simple 'ribbon feeder' proposed for use rose drastically and became extremely unstable. In the following years, evidence also came to light that bifilar feeders installed in the early railway stems were suffering from the effects of build-up of grime on their surfaces, and some were having to be cleaned regularly.

Coaxial feeders

For the Longannet system, further tests were made using a standard low-loss coaxial television downlead in which the outer conductor braid was applied in a 'loose weave' for cheapness and which could thus be presumed to have a high leakage. It was confirmed that this cable had broadly suitable characteristics for a leaky feeder: the longitudinal and coupling losses were both less favourable than those of the ribbon type in clean and dry conditions, but they were completely stable against surface moisture and grime, and the cable could even be installed close to a wall or alongside other cables without detriment to the attenuation. This experience established the open-braided coaxial type of feeder as the standard for use in UK mines, though the actual cables used are specially designed heavier versions than television downlead in the interests of robustness and a lower attenuation. This move back towards coaxial feeders has also been followed generally in railway and other transportation systems.



Typical leaky cable of the open-braided type. The dielectric is of semi-airspaced thread-and-tube construction, for maximum velocity ratio (about 0.87). The inner sheath is of polythene, the outer of pvc.

With the general adoption of coaxial types of leaky feeder, the need arose for a better understanding of their mode of operation, rather than the vague notion of leakage of energy through the interstices of the braid. At that time, screening efficiency of coaxial cables was assessed in terms of a 'surface transfer impedance', a measurable characteristic of the braid alone[8]. From this starting point, the present author developed a theory of continuous 'mode conversion', analogous to that of Deryck for bifilar lines, with the surface transfer impedance replacing the casual assymmetries of the bifilar line[9]. This led directly to some useful practical improvements and also predicted effects which have since been confirmed in experience, though the subject has now been dealt with more rigorously and elegantly by such writers as Wait[12] and Delogne[13].

The first important conclusion from the theoretical work – and in truth a prior hunch which had prompted it – was that the internal phase velocity of the cable in its normal coaxial mode was a key factor in determining the leakage fields, along with the more obvious surface transfer impedance of the braid. In fact, changing the dielectric from solid polythene to a semi-airspaced construction was shown to improve the external coupling in typical conditions by 20 dB – a change that would otherwise correspond to a reduction in braid cover, for example, from 93% to 39%. Unfortunately, the relationship is not a simple one, involving also such intangibles as the attenuation rate and the characteristic impedance of the line in its monofilar mode, parameters which must depend heavily on the environmental conditions. It is therefore not possible to formulate a 'figure of merit' for a particular cable for direct comparison purposes; the individual parameters and a knowledge of the environment have to be considered together.

A further prediction from the theory was the existence of standing-wave effects on the line, quite separate from any multipath effects in the environment and any reflections which may occur from a mis-termination of the line. Potentially the most serious of these disturbances occurs towards the beginning of the line where the base station is connected, and arises from the inadvertent launching of a faster wave, travelling at near free-space velocity, in monofilar mode on the outside of the feeder. Of near-identical initial amplitude to that of the 'true' leakage field, and in initial phase opposition, it results in a modal-interference standing wave being set up on the line – and thus in the near field – with a wavelength several times the free-space wavelength. Fortunately, it decays at the rate of the monofilar mode attenuation, which is generally quite high; further, its effects near the base station are mitigated by the lower system loss there, reducing the seriousness of any 'dropouts' which might result. In theory, it would be possible to suppress the launching of the interfering wave, or to launch another in phase opposition; however, the wave can be regenerated subsequently by any discontinuity, such as in mounting arrangements, which might occur further down the line. The effects have not proved serious or even noticeable in the operational systems now being installed by London Transport.

A typical long standing wave effect at the beginning of a line is illustrated in Fig. 2, which also shows the advantage in coupling obtainable through using a cable with a semi-airspaced dielectric (ρ=0.87) rather than foam (ρ=0.82). Both curves are for a frequency of 72 MHz, and assume coaxial-mode and monofilar-mode attenuation rates of 36 dB/km and 0.3 dB/m respectively. The monofilar-mode velocity ratio is taken as 0.95.

The theory has also served to discount early fears expressed that any attempt to introduce in-line amplification into a leaky feeder would risk instability through feedback between the outgoing and incoming sections of feeder unless non-leaky 'tails' were introduced. In fact, it can be confidently shown that with a typical feeder, such as the standard NCB open-braided type, repeater gains of well over 100 dB would be necessary to incur such risk.

Field characteristics

Confusion has occasionally arisen over the use of the terms 'monofilar mode' and 'mode conversion' in the operation of coaxial leaky feeders. In his early coupled-lines treatment the present author looked upon the monofilar mode as being the whole of the field external to the cable, and upon mode conversion as a continuous process which maintained it. In this simple view, the standing wave at the source as seen as a natural process of establishment and 'synchronization' of the mode. Later workers[12, 13] have taken the analysis further and resolved the external field into two major components. One of these is identified as the true leakage or 'spilling out' of the inner coaxial mode, travelling at coaxial-mode velocity and reaching its full amplitude immediately at the source. The other is the 'inadvertent' wave, launched at the source and at every discontinuity, and now accounting by interference for the long standing waves; this wave alone may be truly designated the 'monofilar mode', travelling strictly at monofilar velocity and also decaying at the higher monofilar rate. 'Mode conversion' becomes a discrete process, occurring only at the launching points of the monofilar mode.

Resolving the wave on the line into two major components in this way simplifies a prediction of the nature of the resulting fields away from the line. It has been pointed out that the true monofilar mode will have a larger effective radius from the line than the continuous leakage mode, by virtue of its higher phase velocity. The relevant relationship approximates to

$$r_e = \frac{\rho\lambda}{2\pi(1-\rho)}$$

where r_e is the effective radius, λ the free-space wavelength and ρ the velocity ratio (in comparison with free space).

Thus, the leakage field of a typical solid-dielectric cable (ρ = 0.67) at 85 MHz would have a radius of 1.14 m. Use of a foam dielectric cable (e.g. 'Radiax', ρ = 0.82) would increase the radius to 2.6 m. Changing to a semi-airspaced type (e.g. NCB standard, ρ = 0.87) would increase it to 3.8 m. Against these figures, the velocity ratio of the monofilar mode is very close to unity and its effective radius will be several times greater again.

In fact, experiments in the Mersey (No. 1) tunnel have shown the field at 170 MHz to be reliably maintained across the full width of the 12 m carriageway from a feeder of semi-airspaced construction installed along one side. This suggests that in such practical situations of larger tunnels (or higher frequencies) the monofilar mode resulting from 'inadvertent' mode conversions must contribute substantially and usefully to the observed fields, though in smaller tunnels the effects are probably detrimental.

Whichever mode is considered, the physical picture of the external field is of a TEM wave with the outer conductor of the cable forming the inner conductor of a larger coaxial structure having the tunnel wall as its outer conductor. At low propagation velocities or higher frequencies, or in larger tunnels, the electric field lines will tend to curve and eventually will break away from the tunnel walls and return to the cable, in the manner of a Goubau wave supported entirely on the cable.

In this picture, the communication is entirely through induction fields, and so the use of the term 'radiating cables' in respect of leaky feeders in general is incorrect. It is true that any discontinuity which causes mode conversion may in the same process provoke 'inadvertent' radiation; this may be useful or even necessary in larger tunnels or at higher frequencies by extending the field in the same manner as the monofilar mode, but otherwise the effects are more likely to be detrimental by setting up long standing waves.

The simple picture becomes complicated by severe distortions in the fields, caused by irregularities and obstacles in the tunnel and by the induction-field equivalent of radiation 'multipath' effects. Polarization away from the feeder in such conditions is generally found to be random, while signal amplitudes can vary locally by the 20 dB or so that is typical for conventional mobile radio schemes in heavily built-up areas. But, as will be seen later in discussions on systems techniques, there need be no difficulty in accommodating such variations.

Practical feeders and their installation

Bifilar feeders have the advantage of being comparatively cheap and lightweight, but their use should be considered only in clean and dry conditions where they can also be installed at least 20 cm clear of walls, structures and other conductors; even then, their variability makes them unsuitable for use in long repeatered systems. The one-time favourite type, RG-86/U, has in fact not been manufactured for several years.

A bifilar type could, however, meet a need for an extemporized system in a dry and clean underground environment such as the worked-out stone quarries that have been used as store depots in Wiltshire, or for a temporary system for use during maintenance of a dry tunnel. A good choice in such a situation would be 300Ω

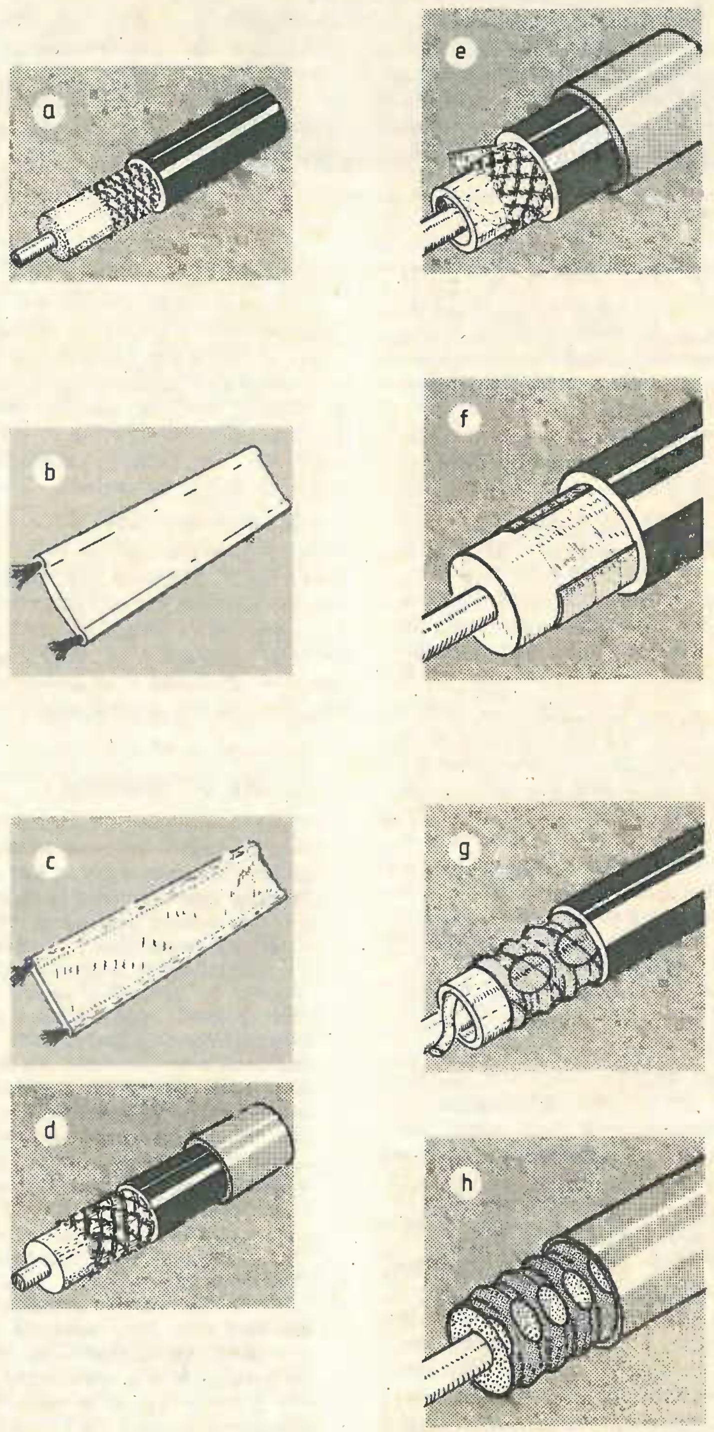
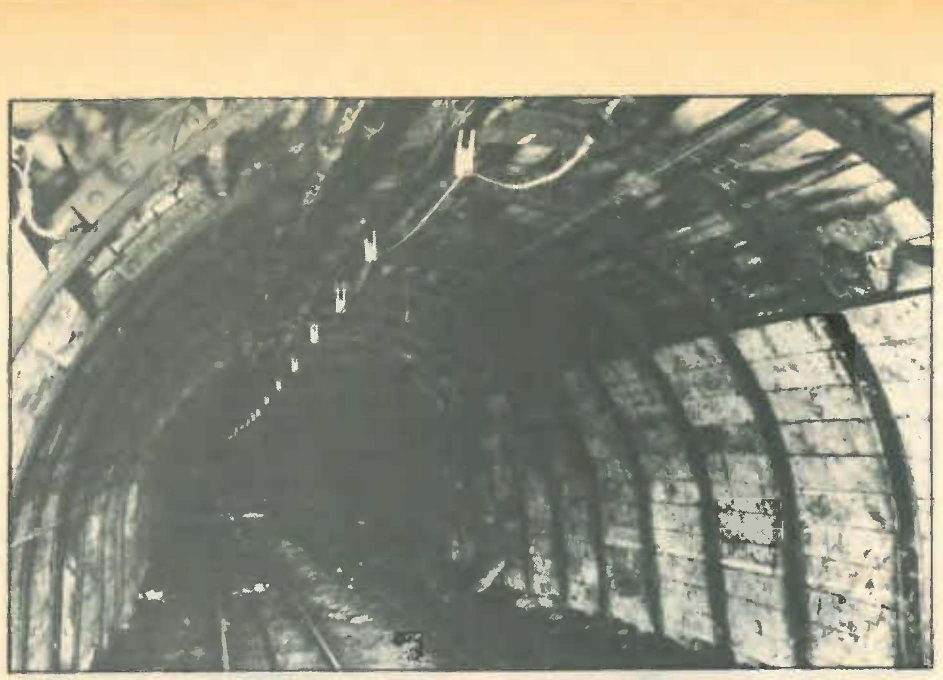


Fig. 3. Types of feeder used in underground communications. At (a) is a foam-dielectric, open-braid coaxial type, and at (b) and (c) two kinds of bifilar feeder for use in clean conditions. A solid-dielectric cable with an open braid is seen at (d). The open-braid coax. at (e) has a 'thread and tube' semi-airspaced construction and (f) shows an early design with a continuous slot in the outer. Two kinds of cable with discrete holes are (g) with punched apertures and thread-and-tube and (h) Radiax, which has milled holes in the screen and foam dielectric.

www.americanradiohistory.com



Leaky feeder installed in a coal mine. A line-powered repeater of early design is visible at the top of the picture.

'ribbon feeder', such as BICC type T3101 or T3129. However, it may well be found that this has to be made to order; in any case, for reasonably long unbroken lengths it is usually necessary to place a special order with the manufacturer.

In the type of use envisaged, a bifilar line can be suitably installed by suspending it in loops of nylon cord below existing cables or from any convenient brackets or fixings. Suspension from a tunnel roof, rather than attachment to a wall, will normally ensure the necessary clearances more easily but otherwise will not substantially affect the performance. Such an installation can be used simply in parasitic mode to enhance the communication between two or more personal radio sets over ranges up to a kilometre; or the range might be increased by connecting one end of the feeder directly to one of the sets – ideally through a balun but not essentially so. It is not necessary to terminate free ends of the feeder in any way.

In any more permanent or vulnerable application, the use of a coaxial type of feeder is advisable. Of the various constructions that are now available, many experienced users still prefer the original 'open-braided' type for its mechanical flexibility, comparative cheapness and insensitiveness of its internal attenuation to mounting arrangements. Such cables are available with a semi-airspaced dielectric construction (such as 'thread and tube') which ensures the high internal velocity ratio (about 0.87) that is so advantageous in respect of both general coupling level and the effective radius of the field.

A braid coverage factor of 67% is typical, giving a surface transfer impedance of perhaps 700 mΩ/m at 30 MHz, the usual reference frequency for that measurement. Generally, a braid with a fairly long 'lay' (smaller braid angle) gives the best compromise in attenuation and coupling for a given weight of copper. But decreasing the braid angle below about 30° may unduly weaken the cable against bending, and the situation is also influenced by systems aspects such as the span loss between repeaters.

Braided leaky cables are usually supplied with a polythene sheath, either alone or with a pvc outer sheath for flame retardance and mechanical protection. The polythene itself is usually considered necessary for waterproofing, though the need for that with a thread-and-tube dielectric might be queried.

Like all coaxial leaky feeders, braided cables will usually give a better coupling performance if spaced away from continuous conducting surfaces and other cables. On the other hand, an occasional or periodic proximity of metal (as might occur in the fixing arrangements) will often enhance the general coupling by setting up 'inadvertent' mode conversions or even radiation. Mounting arrangements have no influence on internal attenuation except at the higher frequencies (e.g. in the u.h.f. range) or with excessively open braids. Surface contamination affects neither coupling nor attenuation.

Another early type of leaky coaxial cable had a solid outer conductor with a continuous longitudinal slot, giving an aperture of typically 25% of the circumference, and having a solid or foam dielectric. Such a cable has sometimes been considered intermediate in its mode of operation between a bifilar and a coaxial type. Indeed, it has proved to be very dependent on mounting position, in the manner of a bifilar line, yet with no compensating advantage of cheapness.

A type popular in the USA and Canada has discrete holes milled in an otherwise solid corrugated outer conductor ('Radiax'). In mode of operation it is closely similar to the open-braided type. However, there is some evidence, with theoretical support, that 'hole size' is the key factor in determining the susceptibility of the longitudinal attenuation of a cable ot the mounting arrangements and surface contamination. For a given surface transfer impedance – and thus coupling efficiency – immunity to such external effects will be better with a larger number of small holes than the converse, and in this respect the braided type must be supreme (it should be noted that total optical cover is not a reliable indicator of coupling efficiency, and is not in question here).

The milled-hole type has a foam dielectric, which is slightly less favourable than the thread-and-tube construction in respect of the all-important phase velocity.

A somewhat similar type manufactured in the UK employs a 'punched tape' construction, with an outer conductor made of copper foil in which discrete holes have been previously punched. The holes here are even larger than those of the milled-hole type, and so such cables should be used with discretion where close-mounting is inevitable. The dielectric construction is the favoured thread-and-tube.

Leaky coaxial cables are available in both 50Ω and 75Ω characteristic impedances, and it may well be asked which is the better choice. So far as the leakage is concerned, the considerations are more complex than might appear, but whatever difference may exist in practice is not likely to be significant. When it comes to longitudinal transmission efficiency, standard textbook treatment applies as for conventional coaxial cables, and shows that 75Ω is close to the theoretical optimum.

For a fuller treatment of the various types of practical leaky feeder, and an assessment of their relative performance, reference is recommended to the paper by Cree and Giles[14].

INIEX systems

It has been shown earlier that in order to account for the strong fields that are consistently maintained at distances of many wavelengths from a leaky feeder it is necessary to postulate the occurrence of 'inadvertent' mode conversions at irregularities in the feeder or tunnel. The resulting monofilar modes generally have a larger effective radius than the 'true' leakage field, though they are attenuated comparatively rapidly along the line and so require continual regeneration.

Delogne[15] has developed a system in which inadvertent mode conversions are replaced by deliberate conversions, effected through special 'mode converters' which may be inserted into the cable run at carefully determined points. Furthermore, the cable itself is a conventional non-leaky type; the true leakage field is thus abandoned and eliminated, and communication is entirely through the closely regulated monfilar mode. The system has been sponsored and promoted by INIEX, the Belgian 'Institut National des Industries Extractives'.

The main advantage of this 'INIEX-Delogne' system is that the interchange of energy between coaxial and monofilar modes is entirely under the control of the system designer and thus can be optimized for best use of the energy available by careful design and spacing of the mode converters. At their simplest, these devices could comprise a single large hole in the outer conductor; in practice, both conductors are usually interrupted and the gaps bridged by reactive elements. The spacing is typically 100 m, but the system may be 'graded' by varying the spacing according to the residual energy in the line and so maintaining a consistent performance regardless of distance form the base station. The devices are normally installed in pairs, spaced a quarter-wavelength apart, to give a forward directivity to the launch of the monfilar mode.

Since only one mode is present, there is no risk of potentially troublesome long standing waves. The system can be used over a wide range of frequencies, typically down to 2 MHz, by designing the mode converters to suit rather than by changing the design of a leaky cable. Against this, it could well be disadvantageous to have to interrupt the cable run at such short intervals. More important, perhaps, is the need for the cable to be kept well clear of walls or metal structures for the whole of the run, for if the monofilar mode becomes dissipated inadvertently by such a proximity effect it cannot be regenerated until the next converter, and an extended 'blind spot' could result.

At frequencies above the tunnel cut-off frequency – say, in the u.h.f. band for a road or twin-track rail tunnel – the INIEX-Delogne system operates differently. Here, the monofilar mode is likely to be attenuated too rapidly to be useful. Instead, the radiation which the mode-cônverter also provokes now launches a wave in the tunnel itself. In this case, the cable mounting arrangement between mode converters is immaterial since the cable is not called upon to support a monofilar mode. At even higher frequencies, of course, the tunnel propagation improves beyond that of the coaxial mode of the cable itself, and so the system then becomes superfluous except, perhaps, in the negotiation of corners and obstacles.

In a later development [16] the discrete mode-conversion devices are replaced by lengths of leaky feeder inserted into the otherwise non-leaky cable run. This 'leaky sections' technique operates broadly on the same principles as before, but offers the advantage that the alternating leaky and non-leaky sections could be arranged in the manufacture of a continuous cable, so eliminating the need for frequent interruptions and connections of the cable in installation.

The length of a leaky section in such a system is fairly critical, and the optimum can be shown to be equal to

$$\frac{\rho\lambda}{2(1-\rho)}$$

where λ is the free-space wavelength and ρ is the velocity ratio of the leaky cable section. Not surprisingly, this is one-half the length of the long standing wave which the original coupled-line theory shows would be set up at the beginning of a continuous leaky feeder of the same type.

It also follows simply that the monofilar mode set up by such a leaky section will have an initial amplitude 6 dB greater than the true leakage field of the corresponding continuous feeder. Furthermore, of course, it will have the advantage of the increased effective radius over the leakage field. Against this, the amplitude will decay at the rapid monofilar rate, and so the 6 dB advantage will usually be lost before the next leaky section.

Again, the leaky section will operate more as a radiator than as a mode converter at frequencies above tunnel cut-off.

A prime objective in the development of these INIEX systems has been to achieve the maximum possible longitudinal range from a system without recourse to in-line repeaters or other active techniques. Once active devices become necessary, as they normally do in any case beyond a few kilometres, the use of these systems becomes less attractive. However, there is no fundamental reason why they should not be used, in the same way as 'conventional' leaky feeders, with the active systems techniques to be described in Part 2.

To be concluded

'Leaky' or 'radiating'?

The terminology to be used in referring to these 'assisted-propagation' techniques and systems has been a bone of contention for several years. The committee organizing the 1974 Guildford conference (see refs. 10 to 14) decided upon 'leaky feeder' in preference to 'radiating cable' on the main grounds that the basic process involved was probably not one of radiation but induction, an assumption now generally confirmed by theorists. The distinction is not simply one of distance from the cable, as would be the case for a normal aerial: a leaky feeder in perfectly uniform conditions cannot radiate at all except at its extremities, whereas the induction or leakage fields can and do extend along its length.

But the situation is complicated by the fact that true radiation can be provoked inadvertently, or even intentionally, at any point in the line by the introduction of irregularities or discontinuities into the line or its environment, and these will exist naturally to some extent in any practical system. In a tunnel the additional effect may be useful, but is more likely to be detrimental. Certainly, in a surface system (where the techniques can also be used) any radiation will run counter to the main purpose in such circumstances, that of spectrum conservation. The term is clearly best avoided.

On the other hand, the epithet 'leaky' has outraged some manufacturers who seem more concerned about the image of their product than with scientific accuracy, and 'leaky feeder' has come in for ribald comment. There have even been some qualms expressed in academic circles about the strict meaning of 'leaky' as applied in transmission-line theory. As for 'feeder' or 'cable', the only reason for preferring the former is that conceivably an open-wire line could be used (and in fact was considered at one time for NCB use) and this could hardly be described as a 'cable'.

The present writer stands by 'leaky feeder' in alluding to the techniques and systems; the term is certainly preferred by most serious investigators of the subject, and in particular is now general in the USA and mainland Europe. 'Leaky cable' remains a useful variant in reference to the product itself.

It is also worth noting that the International working group advising the XVth Plenary Assembly of the CCIR in such matters recently came down in favour of 'leaky cable', and this recommendation is likely to prevail.

References

1. B. A. Austin: Single-sideband transceiver design. Underground application uses simple ceramic wideband filter, *Wireless World*, Vol. 84, pp. 75-6, Feb. 1978
2. J. B. L. Foot: Transmission through tunnels, *Wireless World*, Vol. 56, pp. 456-8, Dec. 1950
3. P. N. Wyke and R. Gill: Applications of radio type mining equipment at collieries, *Proceedings of the Institution of Mining Electrical and Mechanical Engineers*, Vol. 36, Nov. 1955, pp. 128-37
4. N. Monk and H. S. Winbigler: Communication with moving trains in tunnels, *IRE Trans. Vehic. Comm.*, Vol. PGVC-7, Dec. 1956, pp. 21-8
5. R. Liégeois: Télécommunications souterraines et télécommande par radio dans la mine, *Bulletin Technique INIEX 'Mines et Carrières'*, No. 117, Oct. 1968, 51 p. (Belgium; in French)
6. D. J. R. Martin: Radiocommunication in mines and tunnels, *Electronics Letters*, Vol. 6, No. 18, pp. 563-4, 3rd Sept. 1970
7. L. Deryck: Etude des modes de propagation d'ondes électromagnétiques susceptibles d'exister sur une ligne bifilaire en milieu souterrain, *Annales des Mines de Belgique*, 1970, No. 7/8, pp. 939-49, July/Aug. 1970
8. G. W. A. Dummer and W. T. Blackband: Wires and RF cables, (Pitman, London, 1961)
9. D. J. R. Martin: Transferred surface currents in braided coaxial cables, *Electronics Letters*, Vol. 8, No. 18, pp. 465-6, 7th Sept. 1972
10. D. J. R. Martin: A general study of the leaky-feeder principle, *Radio and Electronic Engineer*, Vol. 45, No. 5, pp. 205-14, May 1975
11. L. Deryck: Control of mode conversions on bifilar lines in tunnels, *ibid.*, pp. 241-7
12. J. R. Wait: Theory of transmission of electromagnetic waves along multiconductor lines in the proximity of walls of mine tunnels, *ibid.*, pp. 229-32
13. P. P. Delogne and M. Safak: Electromagnetic theory of the leaky coaxial cable, *ibid.*, pp. 233-40
14. D. J. Cree and L. J. Giles: Practical performance of radiating cables, *ibid.*, pp. 215-23
15. P. P. Delogne: Système INIEX/Delogne de télécommunications et télécommande par radio, *Annales des Mines de Belgique*, 1972, No. 11, pp. 1069-81, Nov. 1972
16. P. P. Delogne and L. Deryck: Underground use of a coaxial cable with leaky sections, *IEEE Trans. Ant. Prop.*, Vol. AP-28, No. 6, pp. 875-83, Nov. 1980

Further reading

Other authors who have contributed significantly to a basic understanding of leaky feeders include J. C. Beal, Q. V. Davis, P. Degauque, B. Demoulin, A. S. C. Fernandes, J. Fontaine, R. Gabillard, D. A. Hill, R. Johannessen, R. J. Slaughter and A. M. Schmidt.

www.americanradiohistory.com

MICROPROCESSOR-CONTROLLED LIGHTING SYSTEM

This final article describes the overall operation and performance of the prototype lighting system. Details are given of the operating system, equalization table, and the hardware required to set-up the control desk's processing and recording modes.

by John D. H. White and Nigel M. Allinson*

Before discussing the operating software used in the lighting system, its relevance is best understood by considering the layout of a typical control desk, as shown in Fig. 1, and how such a desk is operated. The desired lighting pattern is set on the channel faders (presets), and this pattern is stored in the processor-system memory by pressing the 'record' button associated with a particular master fader, or 'master preset'. This pattern will be recalled and sent to the dimmer modules whenever its associated master preset is not at zero. Assuming for the moment that only one master preset is at a non-zero setting at any one time, any other master preset may now be used and another lighting pattern set in the same manner. Hence, a complete lighting pattern may be stored for each master preset.

There are two ways in which these stored patterns may be controlled using the master presets.

– Scaling – the equivalent of analogue control-desk processing – in which each preset level is multiplied by the master preset level and the resulting signals sent to the dimmer channels. Relative levels of the channels are maintained at all times.

– And stepping, where the master preset level is compared with the stored preset levels and the lesser of the two levels used for output. This type of processing is used to build up a lighting pattern, i.e., all dimmer outputs rise according to the level of the master preset and then stop at their predetermined levels. In an analogue control desk, this type of processing would require very complex circuits.

By using more than one master preset at a time, lighting patterns can be gradually changed from one stored pattern to another. As the operating program endlessly polls all the faders and record buttons, any lighting pattern produced by a combination of master and channel presets may be recorded by simply pressing the appropriate master-preset record button.

Operating Software

The operating program and the 'look-up', or equalization table, are contained in just over 1/2Kbyte of p.r.o.m. The requirements for r.a.m. depend on the overall size of the control desk. Around 256 bytes are required for the operating program and $N(M+1)$ bytes for lighting pattern storage, where N is the number of channel presets and M the number of master presets. Except for the largest of systems, 2Kbytes of r.a.m. will suffice. Organization of the data structures is shown in Fig. 2. The present memory stores the lighting-pattern preset levels associated with each master preset. The output-buffer memory is used to store the required lighting pattern temporarily, before the levels are converted to output signals for the dimmer modules, using the equalization table.

The equalization table performs two important functions. Firstly, the scaling process entails the multiplication of numerous channel and master preset levels. Without an external multiplier unit, most microprocessors carry out multiplication relatively slowly (some recent microprocessors, such as the 6809 and 9995 have such a multiplier internally). The multiplication problem could have been solved by using a logarithmic a-to-d converter, but in this case, logarithmic-law faders were used together with a look-up table containing base 2 antilogarithms for the 256 possible levels – hence, multiplications become simple additions.

Secondly, the table provides compensation for the non-linear relationship between the fader position and the subjective brightness of the lamps, mentioned in the first article. This code transformation is fairly difficult to formulate, and will be of more general interest than the code transformation used in the prototype system which combines both this subjective brightness compensation and the antilogarithm conversion, so this coding is given in Table 1.

The operating program is not listed because it is specific to the processor used and consists of only eight short sub-routines and three core-routines for lighting pattern recording and processing. However, using the flow-chart of Fig. 3, it should be possible to program most microcomputer systems to provide the facilities described. The program tests data present on the data bus to decide whether scaling/stepping processing, or recording mode is required. The hardware needed for this is described in the next section. Note that, to reduce processing time to a minimum, there are a number of conditional branches dependant on channel or master levels being zero.

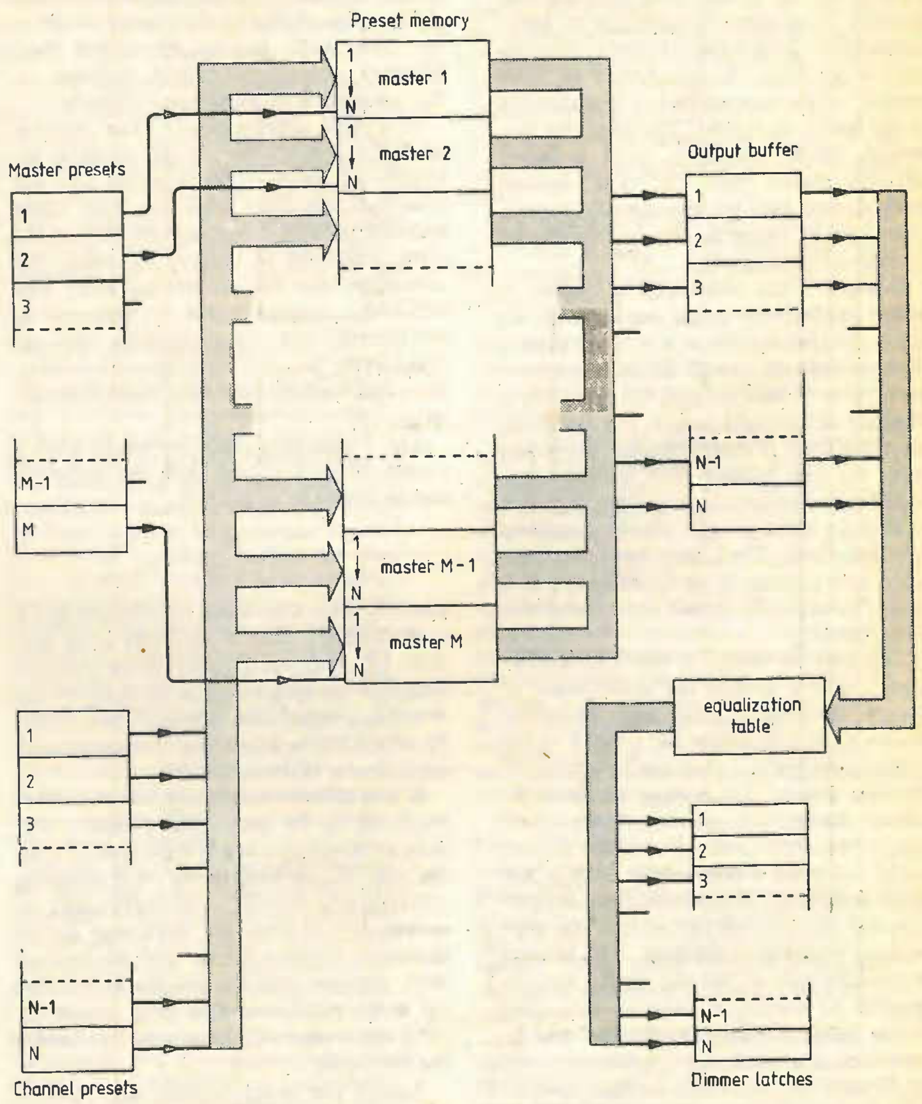
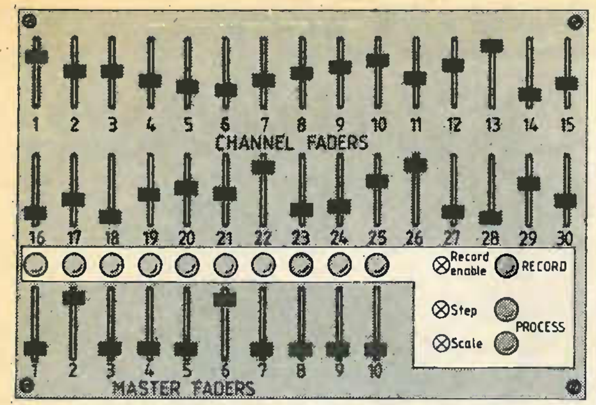


Fig. 2. Data structures used in the control-desk software. M is the number of master presets, and N is the number of channel presets.

* University of Keele



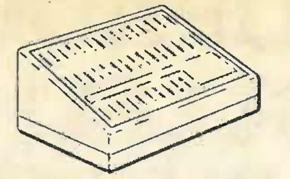


Fig. 1. Layout of a 30-channel/10-master control desk.

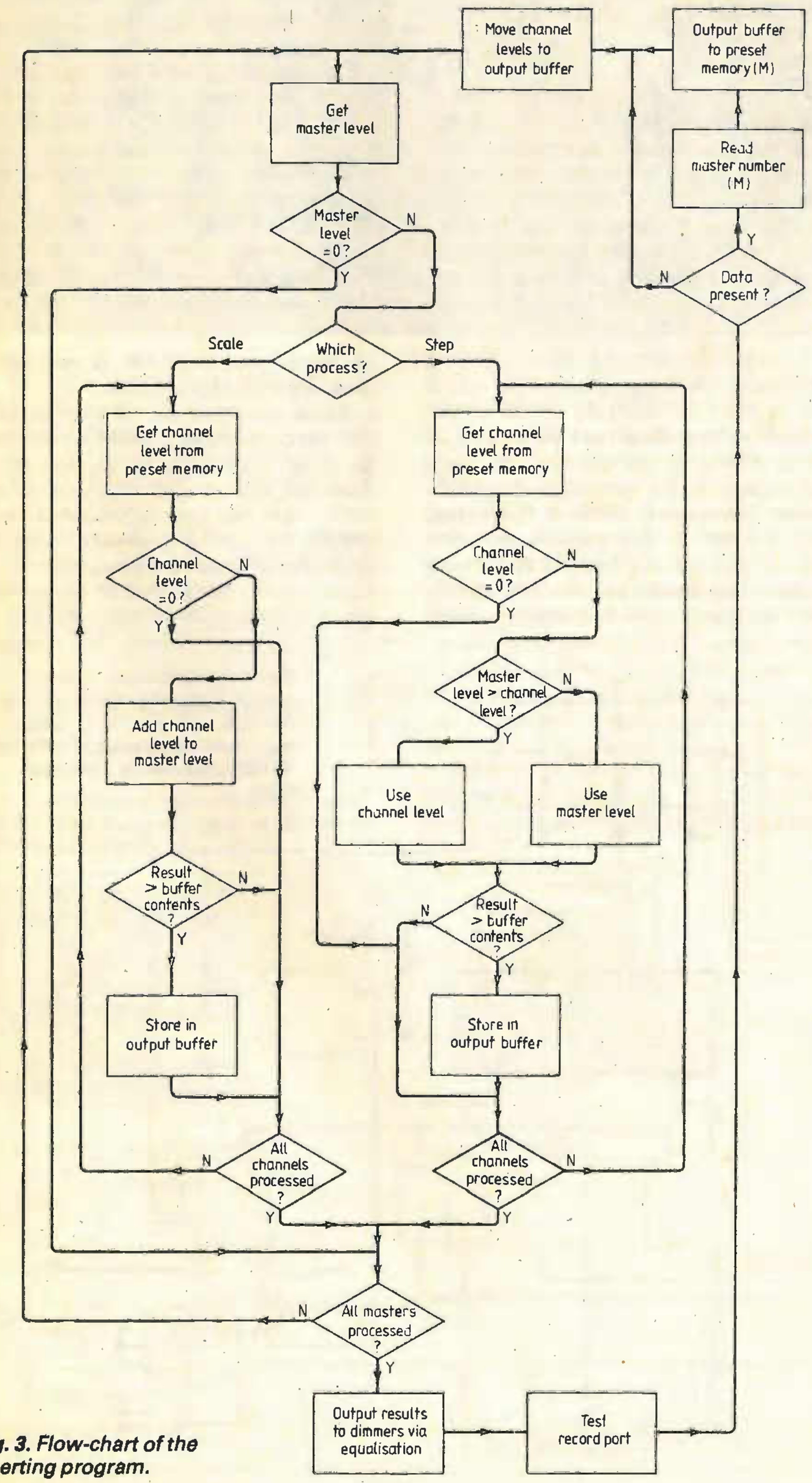


Fig. 3. Flow-chart of the operting program.

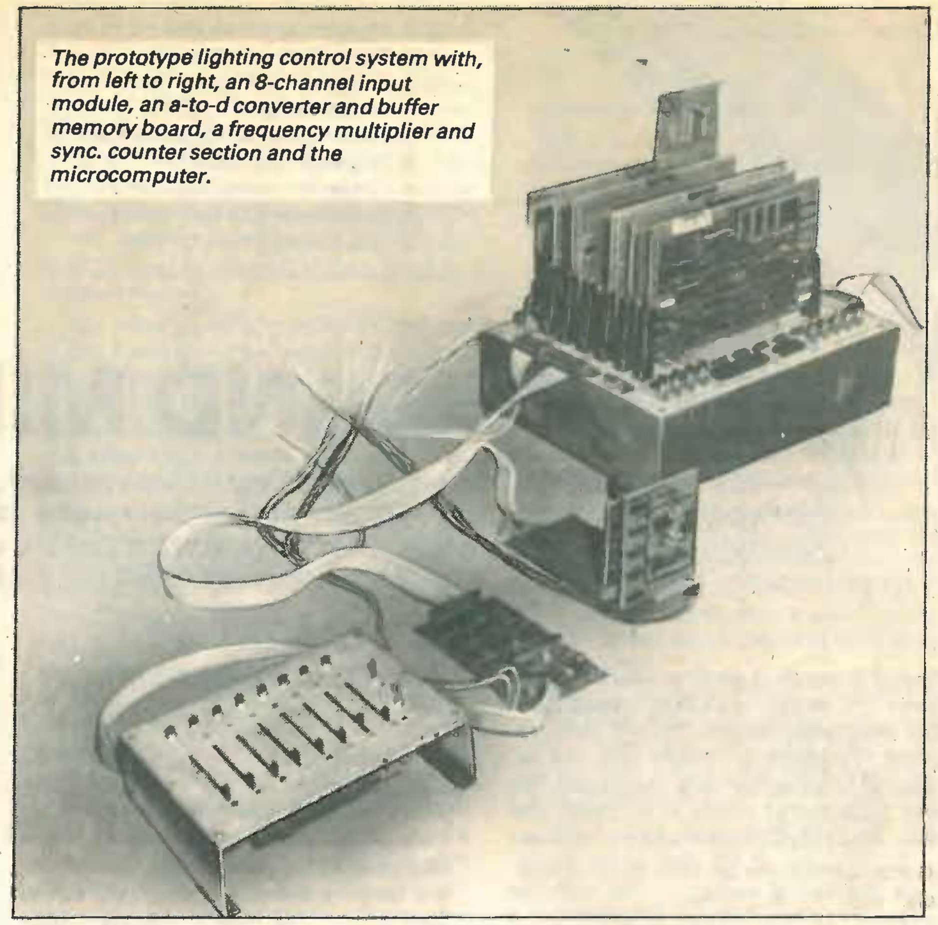
Process/record select circuits

The operating program must test whether stepping/scaling processing, or pattern recording is required. This could be achieved by connecting the control desk's record and process keys, through some form of keyboard encoding, to a programmable i/o device (such as the 8155/6). However, since mapped-memory techniques are used for all other data input and output, a single i/o port can be connected directly to the data bus which is enabled when the IO/M status line goes high. Figure. 4 shows the process/record-select circuit. When the 'record enable' key is pressed, the octal encoder (74148) is enabled and its output will stay high until a master-preset record key is pressed. The three RS flip-flops connected to the octal encoder are reset, and hence the 4-bit binary counter (74163) is enabled. The counter outputs are connected, through a 4-to-16-line demultiplexer (74154), to sixteen cross-lines in the master-preset 'record' key-matrix. When a key is pressed, at least one of the encoder's outputs goes low and disables the counter. The three-state buffer is enabled when either $\overline{E}$, $W/\overline{R}$ or $M/\overline{IO}$ is low, and the input data is transferred to the processor data bus. Also, the four inputs to the NAND gate (1/2 7420) are high, and on the next rising edge of the system-enable, $\overline{E}$, a '0' is clocked out of the D-type flip-flop and the four RS flip-flops are reset. The next $\overline{E}$ pulse will enable the system again. The 0 input of the octal encoder is not used, as a low level on this input will cause all three outputs to be high (i.e., equivalent to no key being pressed).

www.americanradiohistory.com

Table 1: Code conversion for subjective brightness correction: I is input, in hexadecimal form, O is output, also in hexadecimal form and L is relative luminous intensity.

I	O	L				I	O	L				I	O	L				I	O	L			
			1F	3D	224				5F	60	160				9F	7C	97				DF	A1	32
			20	3E	223				60	60	160				A0	7D	95				E0	A1	32
00	00	255	21	3F	222	40	51	191	61	61	158	80	6E	129	A1	7D	95	C0	8D	63	E1	A2	30
01	12	254	22	3F	222	41	51	191	62	61	158	81	6F	126	A2	7E	93	C1	8D	63	E2	A3	29
02	17	253	23	40	220	42	52	189	63	62	156	82	6F	126	A3	7E	93	C2	8E	61	E3	A4	28
03	1B	252	24	41	219	43	52	189	64	62	156	83	70	124	A4	7F	91	C3	8E	61	E4	A5	27
04	1E	251	25	41	219	44	53	187	65	63	154	84	70	124	A5	7F	91	C4	8F	59	E5	A6	26
05	20	250	26	42	217	45	54	186	66	63	154	85	71	122	A6	80	89	C5	8F	59	E6	A7	25
06	22	249	27	43	216	46	54	186	67	63	154	86	71	122	A7	80	89	C6	90	57	E7	A8	24
07	24	248	28	43	216	47	55	184	68	64	151	87	71	122	A8	80	89	C7	91	56	E8	A9	23
08	26	247	29	44	214	48	55	184	69	64	151	88	72	119	A9	81	86	C8	91	56	E9	AA	22
09	27	246	2A	45	213	49	55	184	6A	65	149	89	72	119	AA	81	86	C9	92	54	EA	AB	21
0A	29	245	2B	45	213	4A	56	181	6B	65	149	8A	73	117	AB	82	84	CA	92	54	EB	AC	20
0B	2A	244	2C	46	211	4B	56	181	6C	66	147	8B	73	117	AC	82	84	CB	93	52	EC	AD	19
0C	2B	243	2D	46	211	4C	57	179	6D	66	147	8C	74	115	AD	83	82	CC	94	51	ED	AE	18
0D	2D	242	2E	47	209	4D	57	179	6E	67	145	8D	74	115	AE	83	82	CD	94	51	EE	AF	17
0E	2E	241	2F	48	208	4E	58	177	6F	67	145	8E	76	113	AF	84	80	CE	95	49	EF	B0	16
0F	2F	240	30	48	208	4F	58	177	70	67	145	8F	75	113	B0	84	80	CF	95	49	F0	B1	15
10	30	239	31	49	206	60	59	176	71	68	142	90	75	113	B1	85	78	D0	96	47	F1	B3	14
11	31	238	32	49	206	51	59	175	72	68	142	91	76	110	B2	85	78	D1	97	46	F2	B4	13
12	32	237	33	4A	204	52	5A	173	73	69	140	92	76	110	B3	86	76	D2	97	46	F3	B6	12
13	33	236	34	4B	203	53	5A	173	74	69	140	93	77	108	B4	86	76	D3	98	44	F4	B7	11
14	34	235	35	4B	203	54	5B	171	75	6A	138	94	77	108	B5	67	74	D4	99	43	F5	B9	10
15	35	234	36	4C	201	55	5B	171	76	6A	138	95	78	106	B6	87	74	D5	99	43	F6	BB	9
16	36	233	37	4C	201	56	5C	169	77	6A	138	96	78	106	B7	88	72	D6	9A	41	F7	BD	8
17	37	232	38	4D	199	57	5C	169	78	6B	135	97	79	104	B8	88	72	D7	9B	40	F8	BF	7
18	38	231	39	4D	199	58	5D	167	79	6B	135	98	79	104	B9	89	70	D8	9B	40	F9	C1	6
19	38	231	3A	4E	197	59	5D	167	7A	6C	133	99	7A	102	BA	89	70	D9	9C	38	FA	C4	5
1A	39	229	3B	4E	197	5A	5E	165	7B	6C	133	9A	7A	102	BB	8A	68	DA	9D	37	FB	C7	4
1B	3A	228	3C	4F	195	5B	5E	165	7C	6D	131	9B	7A	102	BC	8B	67	DB	9E	36	FC	CA	3
1C	3B	227	3D	4F	195	5C	5E	165	7D	6D	131	9C	7B	99	BD	8B	67	DC	9E	36	FD	CF	2
1D	3C	226	3E	50	193	5D	5F	162	7E	6E	129	9D	7B	99	BE	8C	65	DD	9F	34	FE	D6	1
1E	3C	226	3F	50	193	5E	5F	162	7F	6E	129	9E	7C	97	BF	8C	65	DE	A0	33	FF	FF	0



The prototype lighting control system with, from left to right, an 8-channel input module, an a-to-d converter and buffer memory board, a frequency multiplier and sync. counter section and the microcomputer.

Hence up to seven modules may be used, each with 16 master presets.

Processing-mode keys are simply latched by an RS flip-flop and connected to D_7 of the data bus. Unlike the record-key data, they do not form a destructive read circuit.

Conclusion

For the 8085A microprocessor used and with a system clock of 3MHz, Fig. 5 shows the experimentally determined relationship between processing speed (that is, the time taken for all the output channels to be updated) and the number of master presets in use at any one time. Assuming that the minimum acceptable update frequency is 20Hz, a 60-channel desk will operate fast enough, provided that less than about 20 master presets are in use. This limitation will not usually effect operation as the maximum number of master presets in use at one time is normally from four to eight.

There are a number of ways in which this prototype system could be extended. In most stage applications, the control desk and dimmers are remote from each other, and the system described would require an expensive 40-way connecting cable. Some form of high-speed serial interface, with high noise immunity, would be of greater practical use. Because the major cost of most installations is in the dimmer modules, the replacement of an analogue control desk with a digital one would most effectively be achieved by providing a low-cost interface between the digital output data and the existing 0-10V-direct voltage-controlled dimmers. More permanent lighting pattern storage could be easily achieved by providing either battery back-up for some of the r.a.m., or a tape interface. In exacting situations where the colour, or hue, of lights has to be maintained as their luminosity changes, the software could be extended, and lighting sets with three primary coloured gels used.

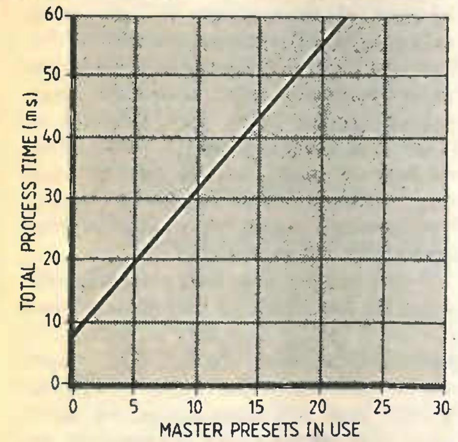


Fig. 5. Experimentally determined process time, i.e., time for updating all dimmers, for a 60-channel control desk.

Estimates of the cost of a digital control desk compared with a conventional analogue desk suggest that the former solution is the cheaper alternative for systems with more than 40 channels and 20 master presets. The fixed cost element of the microprocessor system is offset by the absence of a diode-matrix board and the large reduction in the number of faders.

The authors are grateful for the use of the microprocessor development facilities provided in the final-year Electronics laboratory at the University of Keele, and the technical help provided by B. W. Cornes and E. J. T. Greasley. □

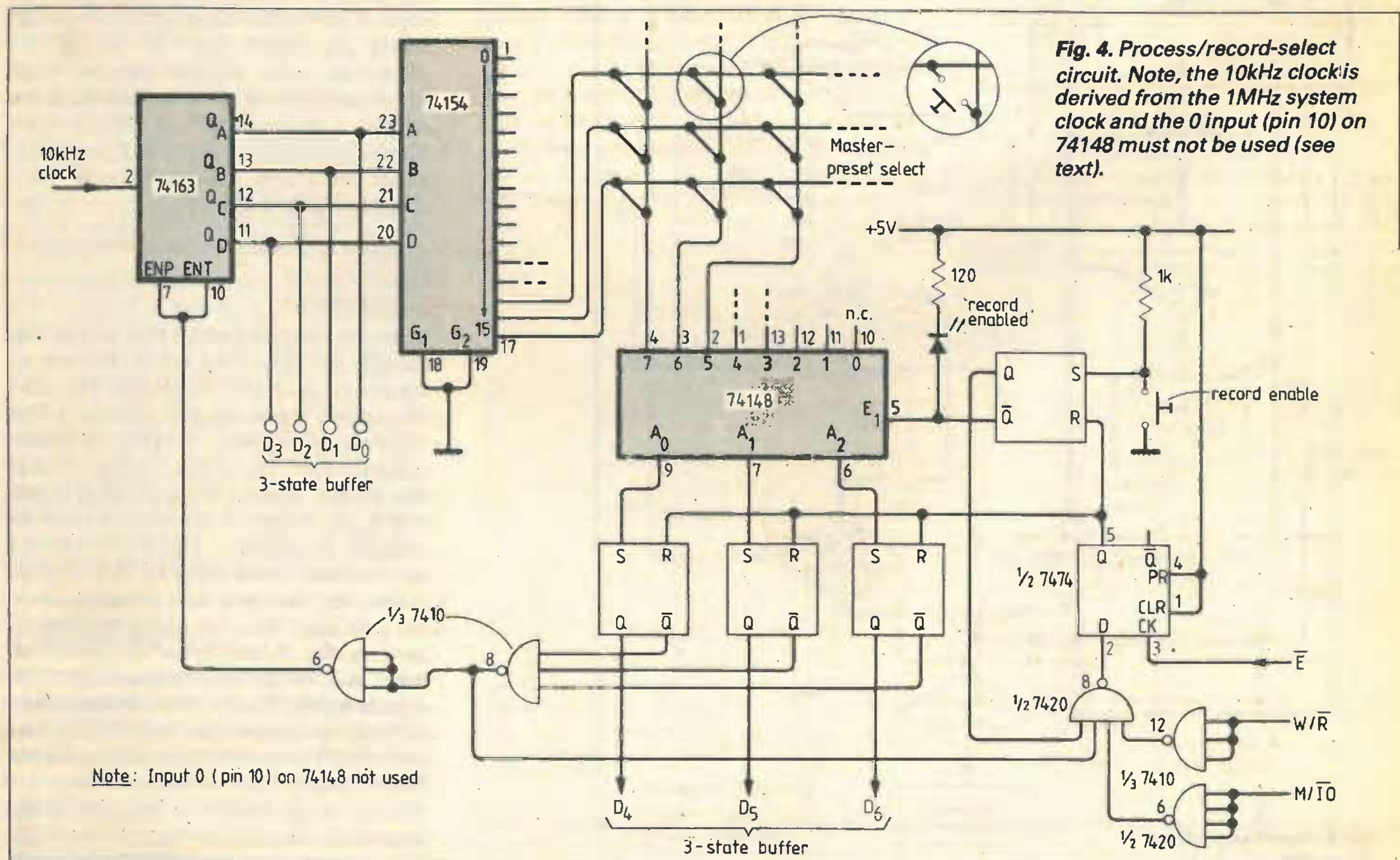
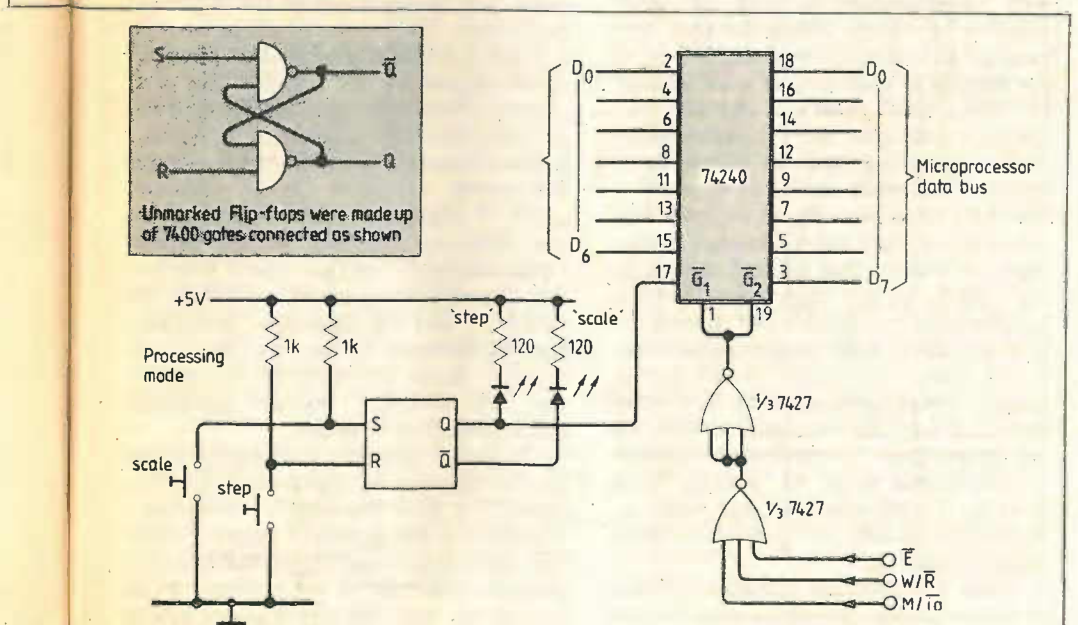


Fig. 4. Process/record-select circuit. Note, the 10kHz clock is derived from the 1MHz system clock and the 0 input (pin 10) on 74148 must not be used (see text).



From page 46

Computation

The calculations illustrated may be carried out with the aid of a pocket calculator. Access to a computer is clearly advantageous and Fortran programs have been previously published [3] for the procedures required. For convenience, four simple Basic programs are presented on page 46 for the pole and zero calculations constituting the most difficult part of the computation. These programs may be readily incorporated into a complete digital filter design package for a desk-top computer. The programs have been developed and listed on a Hewlett Packard HP 85 microcomputer which allows several statements per line, separated by @. The command DISP may have to be replaced by PRINT in may Basic implementations.

Bibliographical references have had to be held over and will be included in a third part of this series.

www.americanradiohistory.com

A Heretic's Guide to Modern Physics

THEORIES AND MIRACLES

Enormous gaps exist in our understanding of Nature, and many of our fundamental theories are not very credible. In a controversial review of current doctrine in nine instalments, Dr Murray investigates the electromagnetic theory, photons, duality, quantization, matter-waves, indeterminacy and haziness, and reviews the state of physics today.

by W. A. Scott Murray,
B.Sc., Ph.D.

Many thousands of professioanl radio engineers can design television transmitters, and almost anyone can build a radio receiver, but there is nobody who can explain in a plausible and watertight way how radio energy comes to be transferred from the Crystal Palace transmitting tower to the H-aerial on the roof of my house. This transfer of energy – the radiation process – is miraculous, if we define a "miracle" as a physical occurrence for which we can offer no physical explanation. (I'll just say that again: a miracle is *a physical occurrence for which we can offer no physical explanation*). It is just over 100 years since James Clerk Maxwell gave us a good working description of what happens – the equivalent of saying that if you lie in hot sunshine you will get sunburned – but he did not *explain* the radiation phenomenon; and nobody has explained it since.

Here, then, is a fine example of modern technology in action. We know how to build a radio transmitter and we can calculate very accurately what will happen when we switch it on. Something will travel from transmitter to receiver at the speed of light, and we shall be able to detect its arrival and make whatever use of it we please for our convenience and entertainment. But except that it may consist of physical energy, or at least that it may carry physical energy with it, *we have no idea* what it is that does the travelling.

Confronted with this true statement of our human ignorance, ninety-nine people out of every hundred will probably say they do not care. The radio is for listening to, not wondering about; wondering about such things is a job for scientists. But now we come to the crunch, for I have to make a similar report to you about the attitudes of the scientists themselves. Nine out of every ten physicists today would also say they didn't care – they are far too busy to be bothered with such abstract, impractical matters. On the other hand, the one physicist in ten who does care about such things is likely to be seriously worried.

If one were to identify and question this minority, their concensus view would almost certainly be that vast gaps exist in our knowledge of physical phenomena that take place not only in complex laboratories and remote galaxies, but also "right on our doorstep" – of which domestic radio radiation and sunlight are commonplace examples. From a purist point of view it is a pity that our progress in understanding such things should have come to a grinding halt in about 1920. (The fundamental basis for atomic energy was laid by Einstein in 1907, and that for the laser in 1917.) Of the new concepts which have arisen in physics since that time very few, if any, have dealt credibly with fundamental matters. I include in this category the major speculative adventure of the 1930s, which failed amid general confusion and is one of the main topics to be examined here.

There would seem to be little doubt that progress in fundamental physics, as opposed to technology, has not kept pace with contemporary progress in other branches of science during the past fifty years or so. It should have done, in view of the number of physicists at work all over the world, but it hasn't. Every now and then, it is true, some new hypothesis seems locally promising and is hailed as a triumph; but when one seeks to apply it elsewhere it does not fit, and it leads one sooner or later to a logical impasse. Nowadays, for reasons that we will explore in due course, we no longer reject a failed hypothesis as we should, but instead we tend to retain it on the pragmatic basis that it may prove more useful to have wrong concepts than no concepts at all. From that point it is very easy to forget that they *are* wrong concepts – scientifically disproved – and instead to go on building upon them as if they were true and valid: an elementary mistake, surely, but one which we go on making.

There are countless examples of this trouble in modern physics, so that it is the rule rather than the exception. The cumulative effect of such errors has been confusion on a majestic scale. We are left with a tangle of separate, uncoordinated, and very often mutually-exclusive concepts. "Sometimes light behaves as waves, sometimes as particles", it is said, yet the concepts of electromagnetic light-waves and particles (photons) are mutually exclusive. Our picture of the physical world has become less clear, rather than more clear, with the passing years. This, I submit, is evidence of a lack of progress. In the 1980s we have to admit that we have not yet found answers to some simple but important questions which were asked as long ago as 1920, and even earlier.

Now when you have been searching diligently for something for fifty or sixty years and failed to find it, it may be sensible to pause and consider whether there might not be some reason for the failure. In our present case two possibilities are more likely than others: either the thing we are looking for doesn't exist, so that we are mistaken in looking for it, or we are looking for it with the wrong kind of spectacles. Let us examine these two possibilities in turn.

There is a doctrine of modern physics, whose origins we will identify later and criticise, which says that scientific theories are limited in their application to providing descriptions of physical events, and are intrinsically incapable (in an absolute sense) of explaining them. According to this doctrine, questions of the nature "what happens?" may give rise to descriptive answers – in numerical detail, of course – and are legitimate questions, whereas questions of the type "how?" or "why?" cannot be answered by science and are therefore *improper* questions which should not be asked.

To take an example, experiments show convincingly that all negative electrons are identical in their behaviour – "indistinguishable" in the approved jargon – and that short of its complete annihilation the physical properties of an electron never vary in any way; one never comes across bigger or smaller electrons, or parts of an electron. Now: to the question "Why is the structure of an electron so phenomenally stable?", current doctrine returns the answer that the mass of the electron is so small that its structure must be quantum-indeterminate, which means that the question of its mechanical stability does not arise. That question is a non-question, an irrelevance that does not *require* an answer.

For convenience of reference I propose to call this the Doctrine of Haziness: "Microphysical entities are hazy, and one should not ask old-fashioned questions about them". Personally I am very suspicious indeed of this doctrine. It seems to be just a little too flexible in its application to be intellectually honest. For instance, in another example,

Question: Why are the wavelengths of the spectrum lines from a gas in a discharge tube so precisely defined?
Answer: Because the permitted energies that electrons can assume within the atoms are precisely quantized.
Question: Oh – I thought it was the electron's angular momentum that was quantized?
Answer: That is also true. Both energy *and* angular momentum are precisely quantized.
Question: If that is so, then the position of an atomic electron must be precisely determined. How far is it from the nucleus?
Answer: We cannot tell you that, because of the Uncertainty Principle of Professor Heisenberg. We can only tell you where you are most *likely* to find it.
Question: So its energy and momentum are in fact *not* precisely determined?
Answer: That is so; they may take on any values within Heisenberg's limits.
Question: Then why are the spectral wavelengths, which you now say are dependent on indeterminate energy and momentum, themselves precisely defined?
Answer: Your questions pre-suppose that the atom has a mechanical structure. Our modern theory is a *mathematical* theory, not a mechanical theory. Hence the questions you ask are meaningless.
Question: But I thought you said the mathematical theory dealt with energy and angular momentum. Are these not ordinary mechanical quantities?
Answer: You are wasting my time. It is a matter of statistics. Look up the theory in any textbook.

You will have noticed the testiness of tone which arises characteristically at that point in the discussion. We shall look into that little "matter of statistics" and form conclusions about it which are not entirely conventional. As I said earlier, the doctrine of haziness seems a shade too convenient to be true. It enables its adherents to wriggle out of logical impasses by sheltering in mysticism, a particular mysticism which as we shall see is linked directly to an unexpected and, as I shall assert, erroneous and quite unjustified denial of the Law of Causation. These are deep waters which can bear being looked into. The doctrine of haziness also offers comfort to the lazy physicist (or shall we say, the too-busy physicist?). Current theories suggest that Nature may be stranger than our forbears thought, for human understanding. If so, we should not be surprised that we have made so little progress recently. (I need hardly emphasize that if this defeatist attitude should become held generally – and it seems to be gaining ground – it must spell the end of the philoshpical road for physical science.)

The other possible explanation for our failure to achieve that steadily-improving understanding of the working of the physical world which human instinct (*and* previous experience in physics, *and* current experience in other disciplines) suggests we ought to be achieving, is that there is something there to see but that we have been looking for it with the wrong spectacles. We cannot see radio waves or electrons with the naked eye, of course, but we infer their existence from the readings of our instruments. Our "electron spectacles" are not the instruments we use, but *the scientific theories* with and against which we interpret our observations. A current theory is an expression of a contemporary attitude of mind.

We can be, and historically often have been badly misled by our theories. To take a classically familiar example, in times past the motion of the planets across the night sky could be *described* to any desired degree of accuracy on the basis of the Earth being the dynamic centre of the universe. It could be *explained* – that is, accounted for rationally with a minimum of underlying assumption – much more readily by means of a Sun-centred theory. From experience we have come to believe that the more closely a scientific theory reflects the mechanism of the physical world, the simpler will its concepts appear and the wider will be its field of application. In this example, planetary astronomy had been bogged down for a thousand years under the geocentric theory, and progress had virtually stopped. Further advance depended on the rejection or overthrow of the geocentric theory and its replacement by the alternative which is still in use today. And what an advance that proved to be! One of its earliest consequences was Newton's law of universal gravitation.

We may perhaps read that experience across into the area of fundamental physics where our recent progress seems to have been surprisingly, and disappointingly, slow. Slow progress does not prove that anything is wrong with our current theories and doctrines, but it raises that possibility. It is possible that some of our fundamental thinking may have been on the wrong lines (and by wrong lines I mean lines which do not accord with those of physical Nature). If so, then much of the elaborate, self-generating and *untested* structure of mathematico-physical theory that has been built up during the past fifty years may turn out in the end to have been irrelevant, if not actually misleading. I am suggesting that the time is now ripe for a critical review of modern physical theory, much of which has not been of a type to inspire confidence.

There was for many years a powerful body of opinion which in the teeth of all the evidence for the heliocentric theory maintained that the Earth, as the abode of Man, *must be* the centre of the physical universe. To such opinion no factual proof was convincing: one can neither prove nor disprove an Article of Faith. Thus the ancient polarisation between churchman and scientist tended to continue. Yet it is a feature of modern physics, unexpected but explainable, that in its philosophy it is more akin to a religion than to a classical science. Mysticism has returned in a big way. It seems that in the fundamentals area we are dealing with matters of faith and doctrine, dogma and heresy, so that formal experimental proofs are no more to be expected in fundamental physics nowadays than in a theology. There may even be resentment against anyone who presumes to question the One True Faith; but this time the conservative Establishment is likely to be found within the ranks of science itself.

The significance of that remark will become clear when I declare my main thesis, which is that physical science made a sequence of errors during the 1930s from which it has never recovered. I am in good company in this, since that view was to a greater or lesser extent shared from the early days of Quantum Theory by Einstein, Planck, von Laue, and Schrödinger, all of whom were central in the original arguments. Theirs was a "realistic" view, which in the climate of the times did not prevail against the novel, mystical doctrines of Bohr, Heisenberg, Dirac, and others. The last-mentioned became established and remain formally accepted today. But attitudes may now be changing after fifty years: at any rate I hope so. I propose to identify some of the errors in the 1930's doctrines, show that they were indeed errors, and show how they came about. To my physicist colleagues I say, If your faith is not strong enough to withstand such criticism you should read no further, for I have no wish to cause you offence. To the layman I say, Here for you entertainment is a real-life, up-to-date version of Hans Andersen's famous story of the King's New Clothes.

To sum this up: every scientific theory is somebody's particular pet. Rather than attack the established theories of physics – which would force their doting owners to rush to their defence, and lead to quite unnecessary altercations – I propose to examine a selection of miracles. A miracle, you will remember, is a physical occurrence for which we can offer no physical explanation. There are plenty of miracles to choose from, so we can afford to be selective. We shall find that our miracles have a certain hallmark about them, from which we can deduce not understanding, perhaps, but clues towards understanding. The nature of current theories will become clearer, so that we shall discover when it is safe – philosophically safe – to use these theories, and when dangerous. When fully developed this technique should enable us

Continued on page 87

www.americanradiohistory.com

ERROR CORRECTING SOFTWARE

Software solution avoids complexity of convolutional coding; program computes error signal which would have been the output of a convolution decoder.

by N. Darwood

In digital equipment a single parity bit is often added to a word to increase reliability by detecting an erroneous read. For words which are recorded in blocks as on paper-tape, floppy discs, cassette or magnetic tape we can time-share the single parity bit over a number of words. Fig. 1 shows the idea. Here the parity bit is formed from the data bits of the current word and one data bit per channel staggered to produce a staircase parity-checking area as shown.

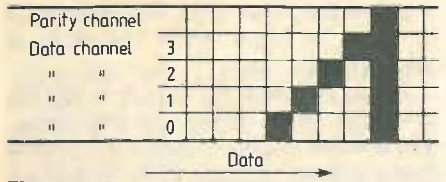


Fig. 1

Using a technique described in *Wireless World*, "Improved parity checker" Jan 1981, p. 81/2, multiple errors can be detected, although only a single parity bit is employed. Fig. 2 illustrates how eight errors would be detected.

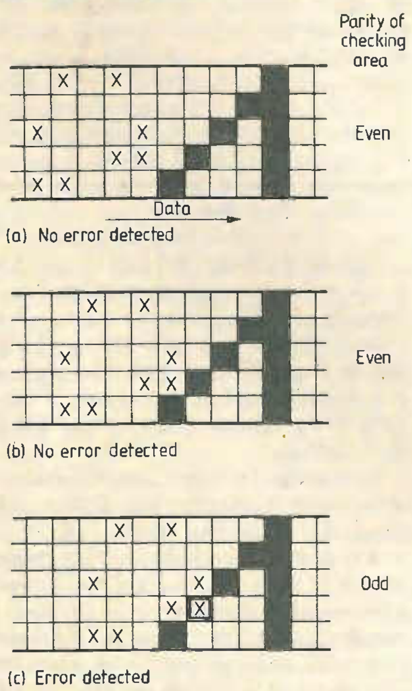


Fig. 2

If the parity bit at the transmitter was coded for say even parity then on reception any single error in the checking area will result in an odd parity for this area of bits. This fact signals an error has occurred. Single error correction with regard to the error signatures produced will be as shown in Fig. 3.

However Fig. 4 shows a double error which although detected gives an error signature which corresponds to the single error signature of channel 0 in Fig. 3.

Parity channel		0	0	0	0	0	0	1	0	0
Data channel	3	0	0	0	0	0	1	1	0	0
" "	2	0	0	0	0	1	0	1	0	0
" "	1	0	0	0	1	0	0	1	0	0
" "	0	0	0	1	0	0	0	1	0	0

Fig. 3

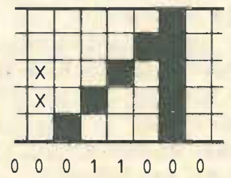
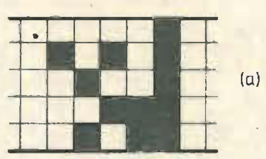


Fig. 4

If error correction is required then this problem can be overcome still employing only one redundant bit, i.e. the parity bit, by applying more complexity to the time sharing of the data bits. An example of a more complex template is given in Fig. 5(a) together with the single error signatures. This template was formed almost at random – any multiple errors are detected and it appears single errors give unique signatures. Armed with this fact we can detect multiple errors and correct single errors.



0	0	0	0	0	1	0
0	1	0	1	0	1	0
0	0	1	0	0	1	0
0	0	0	1	1	1	0
0	0	1	0	1	1	0

(b)

Fig. 5

The error detecting software described is useful to

- assess the merits of a particular template
- as a program in its own right used in place of hardware
- to test (2) or for the following reason.

The procedure described here is a form of convolution code. This can be seen by converting the parallel characters to a serial bit stream using a serial shift register. This is given in Fig. 6 for the template of Fig. 1.

Now the convolution approach is far more complicated than the technique described here, but the theory of convolution coding does show that the defining polynomial of Fig. 1 is

$$X^1+X^7+X^{13}+X^{19}+X^{25}+X^{26}+X^{27}+X^{28}+X^{29}+X^{30}.$$

Hence the software approach described can be useful in investigating convoluting codes where here the template, i.e. the polynomial, can easily be changed.

The prompts given by the program and the inputs required in response are shown in Fig. 7 while Fig. 8 shows the notation used for the template data.

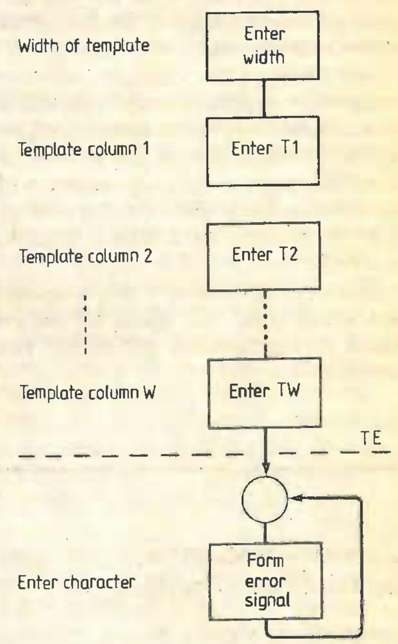


Fig. 7. *Prompts given by the program and inputs required in response.*

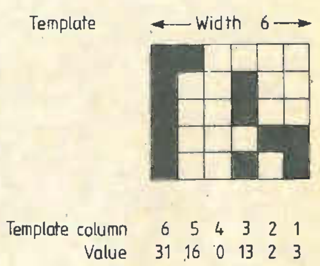


Fig. 8

A column is indicated by the decimal equivalent of the binary code where a 1 indicates that the bit is part of the template, that is, an input to the parity-generating hardware.

Having completed entering the template data a continuous series of decimal values are entered as shown in Fig. 9. This series is in response to the prompt *N* where *N* is the *N*th error pattern in the series. An error pattern is simply a character with or without errors, Fig. 9.

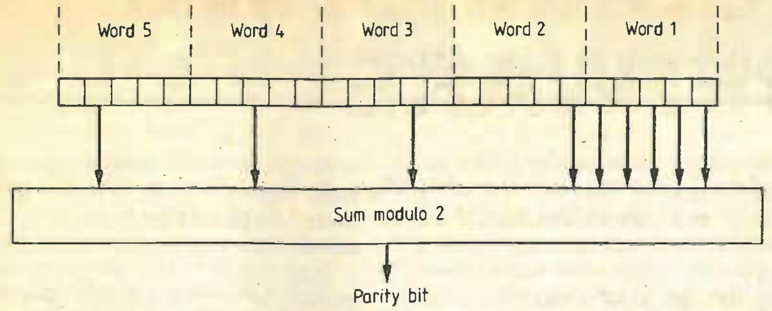


Fig. 6. *Software approach described is much simpler than convolutional approach to Fig. 1 template in which parallel characters are converted to a serial bit stream by shift register.*

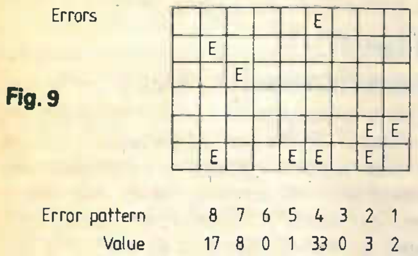


Fig. 9

For each error pattern input the program computes the error signal which would have been the hardware output of the convolution decoder, that is it computes the parity of the error pattern within the template area. The output is a one if an error is detected and a zero if no error is detected.

The program assumes that even-parity was transmitted and thereafter an error signal results from an odd parity in the template.

Error detecting program

```
10 DIM T(15), P(15)
20 FOR I=1 TO 15
30 LET T(I)=0
33 LET P(I)=0
35 NEXT I

38 PRINT "TEMPLATE WIDTH IS";
40 INPUT W

50 PRINT "INPUT TEMPLATE CO-
   LUMN VALUES 1TO" W
60 FOR I=1 TO W
70 PRINT I
80 INPUT
90 NEXT I

92 PRINT "ENTER CHARACTERS"
100 LET N=1

104 PRINT N
107 INPUT P(W+1)
108 LET N=N+1
110 IF P(W+1) <0 THEN 990

120 FOR I=1 TO W
130 LET P(I)=P(I+1)
140 NEXT I
150 LET E=0
160 FOR I=1 TO W
170 LET A=T(I) (AND) P(I)
175 LET E=A (EOR) E
180 NEXT I

187 LET A=0
190 FOR I=1 TO 15
192 LET A=E (EOR) A
194 LET E=E(SHFT,-1)
200 NEXT I

210 PRINT A (AND)#1
220 GOTO 104
990 END
```

A block diagram of the program would show that for each error pattern input value, Fig. 9, the previous W values, Fig. 8, are right-shifted one place and the last one drops off the end to retain W values. The corresponding columns in the sense of Figs 8 & 9 are first ANDed with the template. This results in one word. The bit pattern of this one word is parity checked, i.e. the bits counted modulo 2, down to one bit by the exclusive-OR instructions. This bit indicates an even number of bits in the checking area if zero, and an odd number of bits in the checking area (the template) if one, which indicates an error. To change the template the program is re-run. To stop the program a negative integer is entered as data. □

Digital frequency synthesiser design

Continued from page 64

Integrated circuit two-modulus and four-modulus v.h.f. and u.h.f. counters have been available for some time, as have general purpose c.m.o.s. and t.t.l. programmable counters. However, dedicated l.s.i. circuits which can interface directly with two and four-modulus prescalers have only recently been introduced. The diagram in Fig. 4 shows a two-modulus prescaler with i/o ports and a control line which is used to alter the division ratio. The input may be balanced or unbalanced, but the output and control normally operate at c.m.o.s. or t.t.l. levels. A similar four-modulus prescaler which uses two control lines instead of one is shown in Fig. 5.

At frequencies over 1GHz, separate prescalers or mixing techniques must be used. The SP8619 divide by 4 prescaler will operate up to 1.8 GHz and can drive an SP8906 four-modulus divider. Therefore, synthesizers using this combination will have a channel spacing of four times the reference frequency. The highest output frequency available from an SP8906 or SP8901 is 512/239 MHz, i.e. 2.142 MHz. An n.m.o.s. synthesizer circuit, the NJ8811, which has been designed for use with the 8906 and 8901 is shown in Fig. 6. This device contains the programmable dividers, reference divider, phase comparator and a data buffer which enables it to be used with a 4-bit data bus for programming by a r.o.m. and channel switch or a microprocessor system.

Using the NJ8811 and SP8906, in the type of design shown in Fig. 5, provides a synthesizer which operates from 40 to 512 MHz. The programmable reference divider allows the choice of sixteen channel spacings, via two program control lines, from a single standard 4.8 MHz reference input. If the NJ8811 is used with a SP8901, channel spacings and frequency ranges are doubled. The NJ8812 shown in Fig. 7 is almost identical to the 8811, but is designed for use with the SP8793 prescaler in low-power synthesizers at frequencies up to 200 MHz. This combination has an average power consumption of around 55mW and is therefore suitable for portable equipment.

Page 64 is a Basic program for designing v.h.f. and u.h.f. synthesizers using the i.cs described earlier. The first part of the program requests frequency limits, channel spacing, injection mode and other details of the required synthesizer. The circuits to be used and interconnections are then determined together with the reference frequency and reference division ratio for minimum reference harmonics in the working band. The second half of the program requests details of the individual channels required and provides r.o.m. programming information for them. The program was written for a PET 2001 computer, although it will run with other Basic computers with minor dialect modifications. The compact form of program and lack of REM statements is due to memory limitations of the computer involved, but in its present form it works well and is a useful aid for designing frequency synthesizers in the v.h.f. and u.h.f. range. □

www.americanradiohistory.com

COMMUNICATIONS

Radio-frequency or data processing?

Modern radio communications, it is often stressed, represent the marriage of data processing with traditional radio-frequency technology. But sometimes the problem is to determine which is the dominant partner. The r.f. engineers often feel that they are in danger of being smothered by the embrace of the systems-approach of the computer people. In an analogue world, careful alignment and circuit optimization tend to be admired more than the "go/no-go" attitude of the digital designers. Digital technology has advanced spectacularly, tending to obscure the steady improvements in crystal filters, mixers of great dynamic range and the opening up of a whole new world by low-noise microwave amplifiers.

Glancing through the technical-papers programme for Communications 1982 (still at the time of writing in the future though already over when these notes appear) one notes – a little regretfully – that relatively few of the 80 or so papers cover the more traditional r.f. subjects of receivers, transmitters, aerials and r.f. propagation. The themes are mostly allied to what was once called "telecommunications" with networks, switching, multiplexing, electronic (telephone) exchanges and fibre-optics technology prominent among them.

Nevertheless, work continues in the r.f. field. New techniques for land-mobile (admittedly including digitized speech), radio pagers with monolithic v.h.f. receivers (STL work on direct-conversion f.m. techniques combined with Plessey work on the chips); more progress on the s.s.b. polar-loop transmitters developed at the University of Bath and showing one effective way in which v.m.o.s.-type devices can provide good linearity at v.h.f.); a University of Leeds paper on envelope-detectable s.s.b. (also with the land-mobile service in view); the intensive work on developing gallium-arsenide integrated circuits for microwave receivers (in this case by Plessey, Research though intensive work is also going on elsewhere).

The Communications 82 programme may not promise many entirely new developments, but does reflect continued progress over a broad spectrum. The computer/communications marriage is clearly well past the honeymoon period and seems to have settled down to quiet domesticity. But r.f. must be careful not to be dominated by the intrusive digits.

F.e.t. or bipolar r.f. power?

Recent years have seen the appearance of practical r.f. mosfet power devices with the basic V-groove or alternatively "hex" or "T" vertical channel structures where the rather difficult V-groove is replaced by a gate within a straight service. This has given the designer of m.f., h.f. and v.h.f. transmitters new scope, and much has been made of the freedom of such devices from secondary breakdown and thermal runaway, although there is still a vital need to avoid even momentary over-voltages that could cause gate punchthrough. The older bipolar devices can often (but not always) provide greater linearity at v.h.f. (this can be overcome by such techniques as the polar-loop arrangement and for some stringent applications including amplitude-compandored s.s.b. the powerfet may prove superior). It is easier to bias a bipolar device for Class B operation. Input impedance of the mosfet is more constant with varying drive levels, and intermodulation distortion can be lower. A larger die is required for comparable power with the mosfet. Each form of device has advantages and disadvantages and there is seldom a clear-cut, no-choice situation. Motorola however has recently shown an interesting form of Class D (switching) amplifier based on power mosfets that can provide 1 kW output at up to 10 MHz with an efficiency of 85 per cent and a power gain of 30 dB.

Thought-provoking antennas

Most of the books published by the amateur radio organizations are stronger on surveying accepted theory than on taking a searching and thought-provoking look at ideas that have been accepted by amateurs (and professionals) over a number of years. Once an idea has been widely accepted it tends to survive without further critical examination. But a new book (which deserves to be read by all concerned with h.f. communications and h.f. broadcast reception) is a notable exception to this rule.

"HF antennas for all locations" is by L. A. Moxon, G6XN – a name familiar to readers of *Wireless World* – who has a highly professional communications background and combines theory with practice to a rare degree, with specialist knowledge of aerial theory and h.f. radio propagation (one of the first persons in the U.K. to recognise the important implications of Albrecht's work on chordal hop). But he also possesses to an unusual degree an uncompromising ability to spot and explain why "sure-fire" designs so frequently fail to live up to the designer's expectations while at the same time often prepared himself to introduce novel ideas.

The current scene – professional as well as amateur – includes, he considers, "serious errors by some of the experts" leading to "consequent waste of much time, money and effort in the pursuit of better results by methods which either have no chance of success or lead to undesirable compromises of one sort or another; in addition it has ensured that virtually all such designs have been in some degree, or in some respect, sub-optimum". Experimental findings, he stresses, should always be subject to the test "does it make sense?". His advice is, however, positive as well as negative, with recommendations firmly based on theory *and* practice. Equally remarkable is to find in a 1982 publication 260 well-illustrated pages in hard covers selling at £5.

The III-V semiconductors

The development of 12 GHz receivers for domestic reception of satellite broadcasting is clearly going to emphasise the importance of current work on III-V semiconductor technology, now being ever more intensively pursued to overcome the limitations of silicon technology, particularly at microwave frequencies. Relatively unfamiliar terms such as "mesfet" (metal semiconductor field effect transistor) and "digfet" (diamond gate structure field effect transistor) are emerging from the laboratories with GaAs mesfets already available for u.h.f. television receivers (3SK97 etc).

The "Annual Review 1981" of Plessey's Allen Clark Research Centre at Caswell shows clearly the many applications foreseen in the communications field for both discrete and integrated circuit devices based on semi-conductors using materials made from combinations of Group III elements of the periodic table (boron, aluminium, gallium and arsenide) and Group V elements (nitrogen, phosphorus, arsenic and antimony). Indium phosphide InP, for example, is increasingly yielding millimetric active devices including advanced field-effect transistors. Gallium arsenide is being used for power f.e.t.s and for microwave integrated circuits. Apart from Plessey, Texas Instruments, Hewlett-Packard and Hughes have all reported progress in this field.

AMATEUR RADIO

dBW carrier power

Although many of the technical anomalies and actual errors of the now notorious February 12 licence schedule have been corrected – and the whole question of imposing "equivalent isotropic radiated power" limitations above 1 GHz has been deferred pending further consideration, the revised schedule still retains the controversial "dBW carrier power supplied to the antenna" definition. It replaces the traditional "d.c. input power", i.e. total direct current power input to (i) the anode circuit of the valve (s) or (ii) any other device energizing the antenna, as used for some 60 years as the basis of the licence for modes other than s.s.b.

Admittedly, 20 dBW output power is roughly equivalent to 150 W d.c. input. So it may seem only a quibble to worry about this change of definition. Presumably it has been made as part of a general move on the part of the licensing authority to standardize all licences issued under the Wireless Telegraphy Acts. But there are surely valid objections to the change and it seems a pity that the R.S.G.B. seems to have conceded the point.

In the first place the syllabus for the Radio Amateur's Examination has never included any requirement for candidates to understand or use decibel notation; but even more to the point is that relatively few amateurs have test equipment capable of measuring acurately the carrier power supplied to the aerial (and is this the power supplied to the feeder or to the actual radiating element – often two very different things?). Nor is there any real reason why amateurs should be forced into acquiring such a measurement capability. A d.c. input limitation encourages high-efficiency amplifiers and sets a clear, and easily measured, limit to the power.

The delays and problems in respect of the new "schedule" were reflected in the time it took to issue new licences to those who passed the R.A.E. last year. The situation in the U.K. compares unfavourably to those in many other countries. In Sweden, for example, where the multiple choice technique is also used, it is possible to take the examination on any working day throughout the year and to be told whether you have passed or failed at the time. The Swedish Morse examinations (no test for Technician licence for v.h.f.; 8 w.p.m. for 10-watt Class C novice c.w. licence; 12 w.p.m. for 75-watt Class B licence; 16 w.p.m. for 500 W Class A licence) are machine generated and the candidates sending is recorded. Sweden is even prepared to issue "guest" licences to foreign amateurs on merit without insisting on an official reciprocal licence agreement. One result is that there are some 8500 licences in a population of about 7.5-million, and Swedish amateurs are a pleasure to contact, reflecting the sensible regulations.

Cable tv problems

In North America leakage of amateur signals into and out of wideband cable television systems is becoming a major problem to radio amateurs. It has even been termed "a new strain of the radio-frequency-interference virus" in a strongly worded *QST* editorial by Richard Palm, K1CE. He points out that while, on paper, cable systems are non-broadcast facilities close to the outside environment this is often far from being the case in practice. But it does mean that the frequencies used for distributing television signals along relatively-leaky co-axial cables are chosen by the industry itself on economic grounds alone. The result is that the distribution frequencies are more and more often within the v.h.f. bands allocated internationally and by the F.C.C. to amateur radio. Instead of being true "closed-circuit" the systems leak signals out into highly-used bands, including 144MHz, in violation of F.C.C standards and so ruin weak-signal reception by amateurs, but are also themselves frequently susceptible to strong local transmissions from amateur stations operating fully in accordance with their licences. When viewers complain to the cable companies, A.R.R.L. suggest, "many companies promulgate the myth that the amateur is at fault." Poorly shielded components and installation, poor maintenance of the cable systems, the choice of frequencies with amateur bands, are all adding to the problem, while the current cut-backs in the American government-funding of F.C.C. mean that the regulatory organization is now in the throes of a financial crisis and "willing but unable to enforce its rules" on the cable companies.

An h.f. convention

V.h.f. conventions in the UK have a long and extremely successful record stretching back over many years, attracting attendences of over 1000 enthusiasts. But attempts to organise equivalent conventions for h.f. enthusiasts have a more chequered history with some having to be cancelled for lack of support. However this has not deterred the R.S.G.B.'s h.f. committee from organising an ambitious one-day event at the Belfry Hotel and Conference Centre, Milton Common, some 9 miles along the M40 (Exit 7) from Oxford, on Saturday, June 19. The programme includes a trade exhibition, lectures, forum, films, a special display and demonstration of low-power (QRP) operation with the co-operation of the G-QRP-Club using the call-sign GB2HF. A talk on h.f. aerials, including those for 10, 18 and 24MHz, is to be given by Louis Varney, G5RV while the writer of these notes is trying to work out what to say about h.f communications receivers.

Hazard of PCBs

The recent disclosure that there was a large spillage of polychlorinated biphenyls (PCBs) in 1981 due to bomb damage in Northern Ireland to a large power transformer shows once again that there is still a lot of this highly-dangerous substance around. For many years PCBs were widely used as a coolant in oil-filled transformers and capacitors, including some used with fluorescent lamps. Manufacture did not stop in the U.K. until 1977, following the discovery of its dangerous effects.

Any oil-filled component that shows signs of leakage should be treated with care. A useful test recently suggested by Brian Castle, G4DYF is to take a piece of copper wire. Put it in a gas flame and burn off the dirt until the flame is clear. Allow the wire to cool, then dip it in the suspect oil and return it to the flame. If it now burns yellow, it is ordinary oil. If it burns bright green, PCBs are *probably* present. Note that this is not a positive test but it does provide a useful guide as to whether the oil is harmless.

Here and there

A new 28MHz beacon is expected in operation shortly on Gough Island in the South Atlantic. With callsign ZD9GI it will operate on 28.2125MHz.

A balloon carrying a 146/432MHz translator plus beacon transmitters and expected to reach heights of 15 to 20km is due to be flown several times this year in South Africa. After reaching its maximum height the balloon is expected to burst and the equipment come down on parachute at distances up to about 250km from the launching point. As it comes down a 144MHz transmitter will be activated to allow the package to be tracked by d/f and recovered.

Membership of the British Amateur Television Club is expected to reach 1400 this year. The club notes that the BBC microcomputer is well suited to the display of slow-scan television pictures on domestic tv sets. The club has recently published a special issue of *CQ-TV* (no 117) largely devoted to amateur television equipment for the 24cm band. It also proposes a plan for this amateur band including a main tv repeater channel (output 1242.25MHz vision, input 1274.25 MHz vision) an alternative repeater channel (output 1250.25MHz, input 1282.25MHz) and a simplex amateur television channel (1258.25 MHz). In each case the sound channel would be 6MHz higher.

Forthcoming mobile rallies: June 20 Denby Dale at Shelley High School, Skelmanthorpe, near Huddersfield. June 27 Longleat mobile rally organized as the Bristol RSGB group's 25th event; Rolls Royce Sports & Social Club, Barnoldswick (6 miles south of Skipton). July 11 Worcester rally at High School, Ombersley Road, Droitwich. July 18 Pembroke's "Bucket and Spade Party", The Regency Hall, Saundersfoot; Sussex rally at Brighton Racecourse; and Cornish rally at Technical College, Camborne.

PAT HAWKER, G3VA

www.americanradiohistory.com

NRZ RECORDING FOR SMALL COMPUTERS

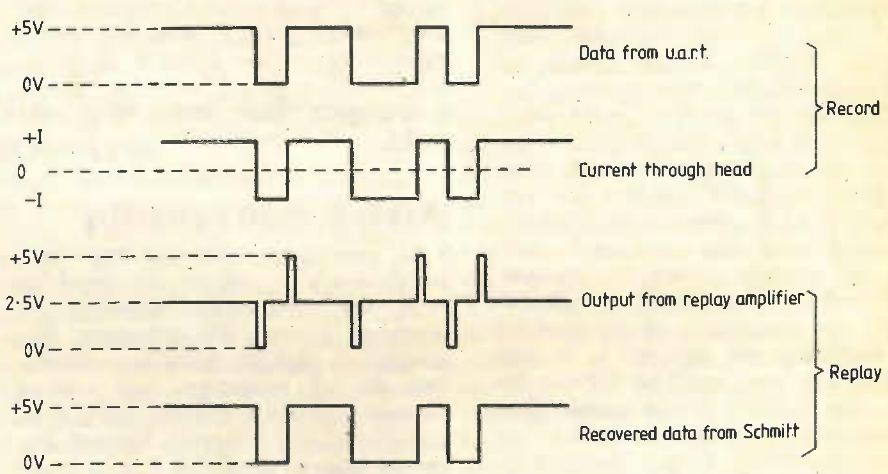
The majority of small computer recording systems use the Kansas City cassette recording format, with a data rate limited to a few hundred baud. L. Hayward proposes a non-return to zero recording system for the Nascom 1 and 2 – the circuit should be adaptable to others – and compares performance with that of the Kansas City interface.

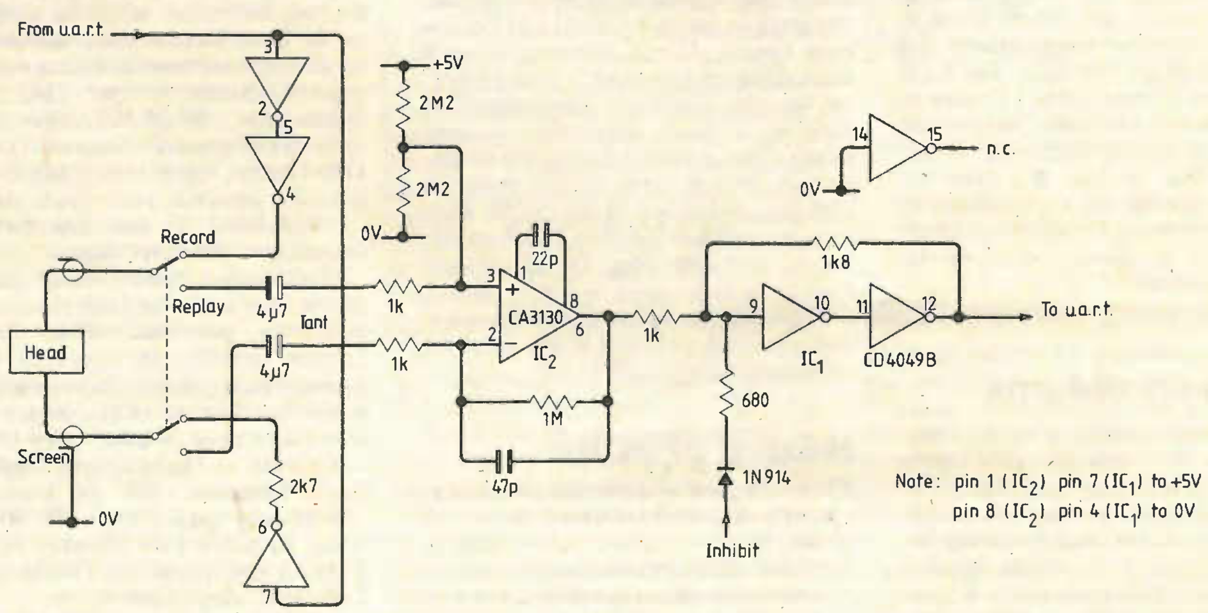
By L. Hayward

Most small computer systems, in particular those machines offered to the amateur user, have adopted the audio cassette as a convenient method of data storage. Cassette players are readily available at a low price, the only reasonable alternatives being open-reel recording or expensive disc drives. The Kansas City recording standard, developed to use the audio cassette, works well and has become popular due to its tolerance of tape-speed variation, typically 30%. This allows users to exchange recordings between machines of almost any type. But this speed tolerance is the only significant advantage of the system – its disadvantages are susceptibility to tape dropout and slow data speed. Some systems optimistically offer a data rate of 1200 baud, but using cheap cassette decks the best that can normally be attained is 300 baud. The encoding and decoding circuitry involved is fairly complex, using as many as seven or eight large-scale integrated circuits, and enables the user to adapt either the existing audio cassette recorder, or use a "bare-bones" deck, with mechanism and record-playback head only.

Using one of the worst cassette decks I have encountered reliable recording was achieved to a rate of 1200 baud, with fair operation to 2400 baud 1⅞ in/s. The only disadvantage of this is its in tolerance of speed variation: 5% instead of the 30% offered by Kansas City, assuming that the usual uart (universal asychronous receiver-transmitter) is used in the computer. This speed restriction will normally only be a disadvantage if tape transfers from one recorder to another are to be made. Any recorder having a cyclic speed variation of greater than 0.5% would be totally useless for musical reproduction, and most cassette recorder mechanisms can achieve better speed regulation.

The n.r.z. system is well known, and has been used in computing systems for years. No h.f. head bias is used, and the tape is magnetically saturated in a negative or positive sense, depending on whether a zero or a one is written. There is no condition of zero flux, hence the name: non-return to zero. As the tape is saturated no erase head is required, and the system is less sensitive to tape drop-out or variation between various types of tape. Ideally, the system should use heads and tape designed specifically for this type of operation; practical results have shown however, that ordinary heads and tape are quite suitable. The use of certified digital cassettes such as the Scotch type 834A is recommended for the most reliable operation. The circuit shown was specifically designed for use with Nascom 1 and 2 computers, but should be suitable for most other computer systems with little change.



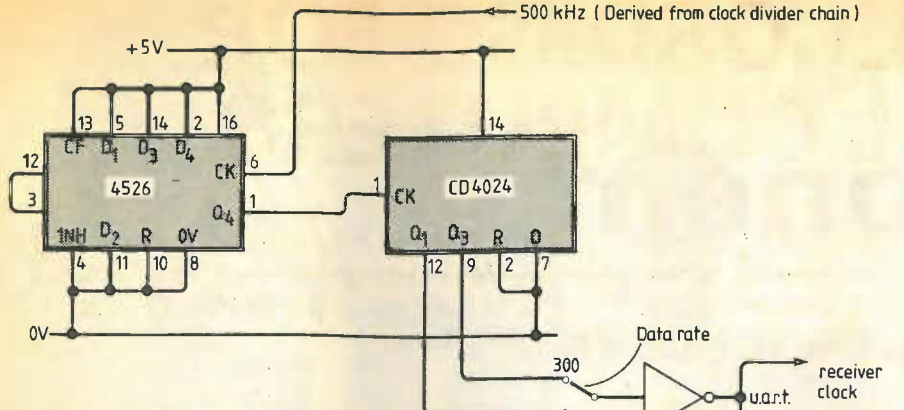


Principles of operation

Record mode. The data output from the u.a.r.t. is applied to a 4049 buffer. Sections of this buffer are connected so that the current through the head and current-limiting resistor is reversed in direction as the input changes from logic high or low. The choice of resistor shown is suitable for a typical cassette recorder audio head. It may be reduced if more current is required, up to a maximum of 10 mA for other heads.

Replay mode. A 3130 op-amp is used as a differential amplifier. This mode of operation permits considerable hum to be picked up in the head connecting wires without interference. The gain of 1000 was found to be sufficient to cause the output to clip when replaying data. The input coupling capacitors were made much larger than necessary, considering the frequencies involved, to permit the head to short-out the amplifier input at low frequencies and prevent hum pick-up by capacitive stray coupling. The high frequency response of the amplifier is rolled off to avoid possible pick-up from the nearby clock generator and dividers in the computer.

As the voltage output from the head is proportional to the rate of change of flux the amplifier output will consist of narrow pulses coincident with the timing and direction of the data. In between these pulses, the amplifier output falls to 2.5V. A Schmitt trigger circuit using part of the 4049 is used to hold the state of the previous positive or negative excursion, and thus output restored data to the u.a.r.t. Hysteresis is used to make the output insensitive to spurious small outputs from IC2. The u.a.r.t. requires that the receiver input terminal remains high until the data transmission begins. An inhibit input is provided, which when high prevents IC2 from changing the Schmitt trigger output. This point is conveniently connected to the drive l.e.d. transistor collector in the Nascom, thus making the computer ignore all data until the 'c Load' or 'R' command is executed. The suggested divider circuit is useful if the standard data rates of 300 and 1200 baud are required from the Nascom 1. Power supply required is a single +5V supply; current drain is so small that an existing computer supply should easily accommodate it.



In this proposed data-rate divider for Nascom, clock rate is 16 times data rate.

I suggest that circuits such as this be included in small computer systems as an alternative or addition to Kansas City. It shouldn't be too difficult for manufacturers of ready-built systems to offer a completed cassette system as part of the package. If such devices are made available with accurate speed control, thus giving interchangeability, it is likely that the more logical n.r.z. will be adopted universally.

It should be fairly easy to produce a machine with a speed correct to within 5% for reasonable cost. A normal diesel engine with a crude mechanical governor can meet 5% regulation of speed, so why not a simple cassette drive? □

Heretics guide to modern physics

Continued from page 81

to judge the *physical credibility* of any new hypothesis, providing us with a critical faculty which in recent times has been woefully lacking.

The first miracle we shall examine will be the one I mentioned at the opening, namely the mechanism of the transmission of light energy through empty space. Our first philosophical milestone will be consequential and closely related to it: an understanding of the true function of "waves" in modern physics. We shall have to go back some 200 years in scientific history to find a suitable starting point. Our route will take us from Newton to Heisenberg: via electromagnetic theory and the acute distress it suffered when denied an aether; via practicable photons, quantization, non-existent matter-waves, and a *restricted* Principle of Indeterminacy; and ultimately to an affirmation that the Law of Causation is obeyed in physics not only statistically but in all circumstances. In each of these areas I will present ideas for your consideration which although far removed from conventional scientific doctrine are yet strictly in accord with the findings of experiment. These ideas will add up eventually to a self-consistent whole, but not yet, I regret, to a fully-developed Theory.

All that I have to say is very simple, and indeed I hope to show how simple Nature really is when the dust of man-made confusion has been swept away. William of Occam said that fundamental assumptions should not be multiplied unnecessarily, and I am a follower of William of Occam. □

Summary

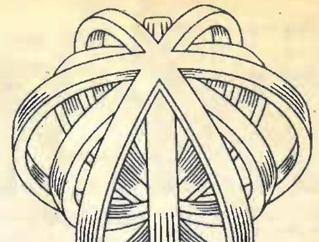
The phenomenon of the radiation of light and radio energy is a "miracle" – a well-established physical occurence for which science can offer no physical eplanation. Modern technology uses these radiations and others every day without understanding them. Progress toward understanding such things effectively came to a halt in about 1920, after which fundamental concepts in physics began to become confused and mutually contradictory. This lack of progress may have been due to one of two possible factors: either Nature is too mysterious for us to understand, so that it is not worth the bother of trying, or our fundamental thinking may have taken a wrong turning 50 years ago. There are historical precedents both for such errors and for conservative pressures against correcting them. Nevertheless, enough material now exists to warrant a major rethink, based on a return to the earlier philosophy of realism in physical science which reflects the underlying simplicity of Nature.

C.b. frequency synthesis

In Fig. 4 of the article on 40 channel c.b. frequency synthesis, which appeared in the November 1981 issue of *Wireless World*, there should be a 1nF capacitor in the line between the bottom end of L_1 and the MV2110 variable-capacitance diode. Without this capacitor the a.f.c. is inoperative.

www.americanradiohistory.com

Paris components show



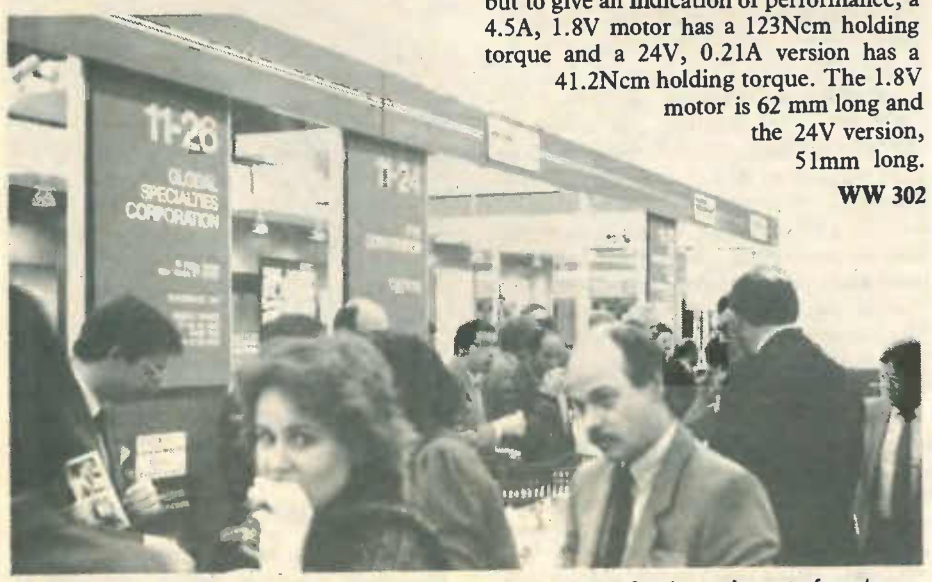
from Martin Eccles in Paris

France's foremost electronics exhibition – Salon International des Composants Electroniques – this year attracted over 1700 exhibitors representing 31 different countries. Held for the last time at Paris's Parc des Expositions, the 25th annual Paris Components Show, despite slight increases in the number of visitors from outside France and the total number of exhibitors, saw a fall in attendance. According to the French Trade Exhibitions office in London, there were just over 85700 visitors, as opposed to last year, when 95124 permanent passes were issued. But considering current economic restraints, the figures are still quite impressive.

In 1983, the show is to be held in November, instead of early April as has been the tradition, at the North Paris Exhibition Grounds, and after that become biennial to alternate with the Munich exhibitions. A more specialized exhibition will be held at the North Paris site each even year.

Surprisingly, perhaps, the current 'world's fastest' **16K c.m.o.s. static r.a.m.** has been developed in France and is, initially at least, to be manufactured there. Access time of the HM65161 2K by 8-bit memory is 55ns (maximum) and its power consumption is 500μW in standby mode or 30mW while enabled. This device is the outcome of joint efforts by Harris and the exhibitors, Matra Harris, who were also showing the HD6409, a c.m.o.s. Manchester II encoder/decoder for full duplex operation up to 1Mbit/s, the MA1200 30 MHz gate array with 1200 gates each with a propagation-delay time of between 2 and 4ns, and the HM8048 microcontroller together with its c.m.o.s. counterpart.

WW 301



By far the majority of contemporary exhibition stands consist for the main part of nooks, often formed by zig-zagged partitions, the most effective of which are erected diagonally across the podium. Often, traders without visitors will step away from their stand waiting for an unsuspecting fly to be attracted into one of these embryonic niches and, when fairly certain of their potential prey's species, move in from behind and weave their web. This show is no exception, but as it is so large, one can still find many of the more modest exhibitors with stands where one can browse without being pounced upon.

Oriental Motors are contemplating distributing their products in the UK, possibly by the end of the year. When asked why their motors might be bought in the UK in preference to similar products from other manufacturers, the representative replied predictably that they would be competitively priced. The company's **stepping motors,** part of a large range of induction, reversible, synchronous, geared and fan motors, have a step angle of 1.8° and are designed for a −10 to +50°C operating-temperature range. Direct-voltage ratings of the 19 motors range from 1.8 to 24V and current-per-phase ratings range from 0.2 to 4.5A. Maximum and minimum voltage/current ratings don't always coincide, but to give an indication of performance, a 4.5A, 1.8V motor has a 123Ncm holding torque and a 24V, 0.21A version has a 41.2Ncm holding torque. The 1.8V motor is 62 mm long and the 24V version, 51mm long.

WW 302

A **computer-aided design system** shown by EIE, a Swiss company specializing in the manufacture and distribution of printed-circuit board design equipment since 1974, has its limitations. Firstly, boards greater than 232dm^2 and containing more than 360 i.cs cannot be designed on it. Further, only 15 colours from a choice of 4096 may be used, restricting the system's use to designing boards with no more than 15 layers. But as 25ft^2 boards and printed circuits with more than 15 layers are hard to find, further comment is justified. The computer can resolve layout tolerances down to 0.0025mm and, when combined with the company's drum photo-plotter, be used to produce art work accurate to within ±0.01mm. Dimensions may be displayed on the screen in two ways, either from the board's pole to the cursor or between two points on the 'drawing', and commonly used component forms may be selected from a permanent memory. To the operator, System 81 looks like a large desk with a keyboard, swivelling v.d.u. and joystick. A 32-bit, bit-slice processor coordinates the graphics, supplemented by 1.5M byte of semiconductor memory, an LSI11 for handling i/o and arranging data files and two 8in disc drives. Options other than the drum photo-plotter already mentioned include 20M byte hard-disc drives, a printer and GPIB pen plotter interface – so one can imagine the further limitations.

WW 303

Still on the same subject, but at the other end of the price scale, Colvern had a microcomputer with colour graphics adapted for computer-aided design on their stand. The company isn't moving into this area though – they only manufacture the 3-axis controller used. Bitstik-Apple graphics, as the system is called, is a product of Robocom and can be supplied as a basic conversion kit for existing Apples, with or without colour facilities, or alternatively as a complete system with various options for hard-copy, etc. The kit, priced at around £187, comprises the previously mentioned controller (which is actually a joystick, but not to be confused with a games paddle) design-aid software on disc and a manual. As this is a **general-purpose design aid** intended for compiling anything from artistic to architectural drawings, component 'library' software for printed-circuit board design is to be available as an option. One feature of this

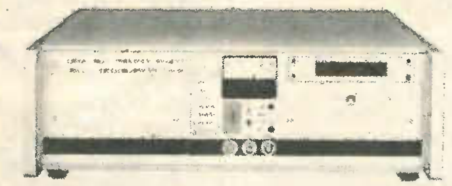
system is that a single picture element may be zoomed in on to fill the whole screen, i.e., a single master page may be broken down into 16000 pages. This means that information, such as an op-amp's parameters, may be stored in a small area which is invisible on the overall view.

WW 304

Numerous photographs of disc-drive heads initially attracted us to this company's stand. On glancing at the brochures there, we found that Paris's Samson Data, and their Belgian counterpart, Samson Computer Supplies, represent Information Magnetics Corporation, an American company offering a hard-disc head refurbishing service. They also supply numerous **professional computer and computer-related appliances,** such as disc packs, read/write heads, magnetic tapes, alignment discs and anti-glare filters for v.d.us. Occasionally at such exhibitions we meet people who hear the name *Wireless World* for the first time and respond cautiously, and probably in their eyes tactfully, with "I don't think we have anything that will be of interest to your readers." To explain the evolution and current scope of the magazine is time consuming so we usually take one or two issues along to keep initiation discussions brief. A genial M. Samson hadn't heard of us and on seeing our only two issues decided to keep them, despite our insisting that we wanted them back. We thought at first that he had simply become accustomed to people handing out free magazines but after a brief rapport realized that he was serious. Finally, M. Samson won, after fruitlessly offering a cheque or cash and the promise of a subscription in exchange for the two magazines, by tendering a slightly imperfect disc-drive carriage fitted with 13 heads – an offer we couldn't refuse.

WW 305

Caesium frequency standards are not uncommon nowadays. Besides their more obvious uses in national time services, metrological applications and power stations, they are also used for a number of scientific and industrial purposes and in data-transmission systems, satellite ground stations and observatories. In outline, the International Telegraph and Telephone Consultative Committee (CCITT) recommends that international digital links should be synchronized with a frequency error of less than 1×10^{-11}: the only practical way of achieving this accuracy is by using a caesium frequency standard. Oscilloquartz was showing part of its range of caesium standards and systems alongside its more conventional quartz crystals, oscillator units and frequency references. The 3000 is an uncased caesium oscillator with frequency and long-term stability errors of $\pm 7 \times 10^{-12}$ and $\pm 3 \times 10^{-12}$ respectively, intended as a module for use by



equipment manufacturers. It gives a 1V r.m.s. sine-wave output at 5MHz. Model 3120 incorporates the 300 oscillator and gives sine-waves of 1, 5 and 10MHz with the same accuracy. This cased instrument is fitted with a 6-digit clock, control and monitoring facilities, output buffers, batteries and p.s.u. It measures 131 by 428 by 546mm and is suitable for rack mounting. The company can also provide complete systems for all the applications mentioned above and a number of accessories are available for the standards mentioned.

WW 306

Of course, the more familiar faces were also at the exhibition. Philips were exhibiting quite a number of recent and new products, among them a dual-clock analyser/35MHz oscilloscope. The PM3543, 10MHz **logic-state analyser** has disassembly facilities for 16-bit microprocessors, including the Z8001/2 and 8086, and for 8-bit devices from a number of manufacturers. Because of the dual clock, multiplexed-bus data and address lines may be separated so up to 16 data bits and 21 address bits may be displayed, together with status information, using only 24 inputs. The analyser section has a 255-word memory, and threshold levels may be set for t.t.l. or varied between −3 and +12V. Once logic has been analysed, the instru-

ment can be used as a 35MHz oscilloscope to aid fault location. An IEEE-bus interface is available as an option. Among other new products shown by Philips were two 75MHz lightweight service oscilloscopes, one with a single timebase and the other dual, and an audio-distortion meter for measurements to DIN standards.

WW 307

Two types of **liquid-crystal display** with **129mm-high characters,** one with seven segments and the other with a 6-by-7 dot matrix, have been produced by Fairchild's optoelectronics division. Measuring 165 by 110mm, these displays require typically 5V r.m.s. at 5μA with all segments on and take either 45 and 130ms or 80 and 150ms to turn on and off respectively, depending on the type-number suffix. Seven-segment types are disignated LTR1341 and dot-matrix types LTR1401.

WW 308

In addition to a number of new semiconductors, RCA were illustrating the advantages of their **colour-enhanced development system** for 1802 c.m.o.s. microprocessor products. "Colour", say the company, "not only enhances the display, but also simplifies and speeds up screen editing." Fairly obvious, we thought, but that doesn't detract from the usefulness of the system. Floating-point Basic is held in part of a 30K r.o.m., as is assembling, editing and monitoring software. A further 5K r.a.m. is included, leaving 29K free memory area for expansion, and permanent storage is possible using one of two cassettes. Any CDP18S600 series Microboard may be used with the system. The semiconductors mentioned earlier are firstly; two 4MHz microprocessors, similar in architecture to the 1802 but with 113 instructions as opposed to the 02's 91, one with 64 bytes of r.a.m., the 1805, and one without, the 1806. Secondly, an 8-bit flash a-to-d converter for sampling speeds up to 15MHz with 150mW power consumption, and a range of N-channel power m.o.s.f.e.ts, dubbed 'low cost', with current ratings from 1 to 18A and voltage ratings from 80 to 450V were mentioned. The converter i.c. is the CA3308, and the power f.e.ts are RCA91XX and 92XX devices.

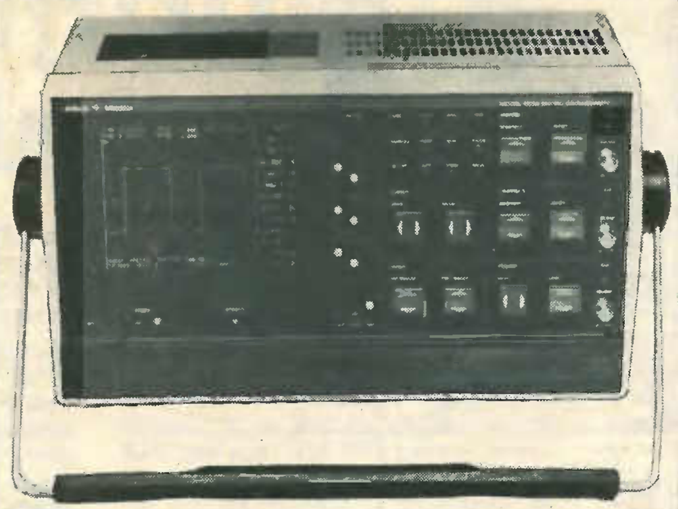
WW 309

www.americanradiohistory.com

NEW PRODUCTS

DIGITAL STORAGE OSCILLOSCOPE

Two 100MHz a-to-d converters, one for each 35MHz bandwidth channel, are used in Gould's 4500 storage oscilloscope. Shown for the first time in the UK at the All Electronics Show, this instrument can be used to store and display 'single-shot' or repetitive waveforms and is suitable for bench use, when it will be operated by means of its front panel controls, or as part of a test system under GPIB control. It can resolve 5.1 bits at 35MHz, introduces a maximum absolute voltage error of ±6.6% f.s. over the recorded range and, after 40ns, responds to transients with a relative error of ±0.4% Setting up of the front panel is aided by software-generated menus displayed on the screen; once a setting has been made, it may be stored for later use or comparison. With these menus, the operator can select control functions for signal averaging, cursor positioning, trigger source and filtering options and plotter digital interface operation. Mathematical comparisons of reference and acquired waveforms are possible. For waveform comparisons, the 4500 has a 4Kbyte reference memory and for acquired waveforms, a 1Kbyte per channel (or 2Kbyte in single-channel mode) memory. A floppy disc will be available for storing up to 30 waveforms for later use either with the oscilloscope or with an external computer/controller. The 4500's price is around £11,500, and it can be obtained from Gould Instruments Ltd, Roebuck Rd, Hainault, Ilford, Essex IG6 3UE.
WW310

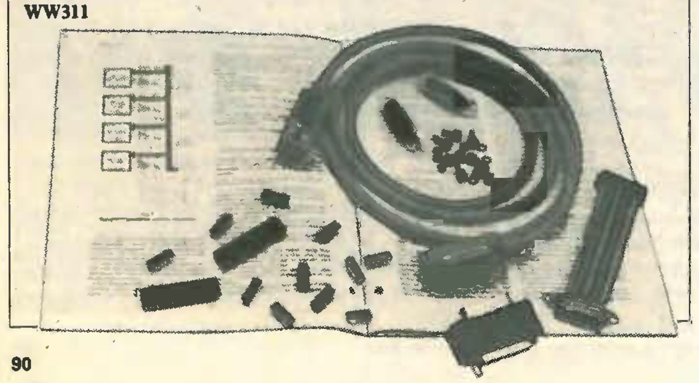


WW310

GPIB COMPONENTS SERVICE

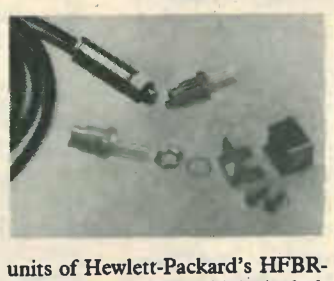
Accessories and components specifically for general-purpose interface buses are available from one source. With prior knowledge of the problems involved in designing GPIB's, Wasec have formed a service offering a range of bus transceivers, control i.cs, connectors, studs, cables, adapters, specifications and other data pertaining to these buses for enthusiasts, manufacturers and designers alike. A leaflet describing the service is available on request. Wasec, 45 Hurstcourt Rd, Sutton, Surrey, SM1 3JF.
WW311

WW311



SMALL FIBRE-OPTIC LINK

This 0 to 5Mbaud fibre-optic link with very small emitter and detector elements can be used to transmit data over distances of up to 1200m. Transmitter and receiver units of Hewlett-Packard's HFBR-0200 measure 7.8mm high, including shielding and connectors, and function at temperatures within the range −20 to +85°C. The receiver i.c. has an optically transparent, yet electrically conductive, shield to improve its immunity to electromagnetic interference and electrostatic discharge; the receiver also has a logic-compatible output. Suspended sapphire-ball lenses optically connect emitter and detector i.cs with the cable, without mechanical contact. These lenses also make connector alignment problems less critical. A kit, including transmitter, receiver, mounting hardware and 10 metres of cable costs £104.60 if less than ten are bought. Hewlett-Packard Ltd, King Street Lane, Winnersh, Wokingham, Berks RG11 5AR.
WW312



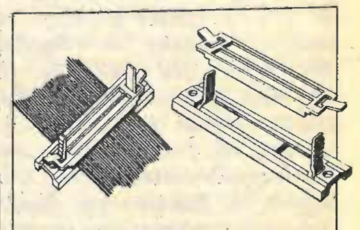
MICROCOMPUTER FOR EDUCATION AND CONTROL

Some 12Kbytes of Basic tailored for control applications is a feature that Midwich Computer Co. hope will bring their MC system into educational establishments and laboratories. If a separate board, called an experimental unit, is connected to the Z80-based computer, combinations of an analogue-input board, analogue-output board and digital-input/output board may be used with the system to perform many complex control applications simply. The computer has 16Kbytes of r.a.m., a 300 or 1200 baud RS232 interface and a 300 or 1200 baud cassette-recorder interface with motor switch. Binary, octal, decimal and hexadecimal numbers can be handled by the interpreter, which also has facilities for simplifying communications between Basic and machine-code routines, and real-time interrupt handling and nested scheduling facilities. A machine-code monitor is included. Prices are, £375 for the Microcontroller computer, £145 for the experimental unit, £55 and £35 respectively for analogue input and output boards and £55 for a digital i/o board. Discounts on the computer are available for educational establishments. Midwich Computer Company Limited, Hewitt House, Northgate Street, Bury St Edmunds, Suffolk IP33 1HQ.
WW313

WW313

FLAT-CABLE CLAMP

A two-part plastic assembly for clamping flat cables is available from Winslow. The Ribbon Wrap can hold up to eight, 0.89mm-thick flat cables and is obtainable in three widths, for 26, 40 or 64-core ribbons. Rivets, bolts, screws or self adhesive pads may be used to secure the base-plate section. Two ratchet-type lugs on the base plate hold the clamping section in place. Winslow International, 71 Tunnel Road, Tunbridge Wells, Kent TN1 2BX.
WW314



WW314

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.

ELECTROVALUE

FREE VOUCHERS TO SAVE YOU UP TO £2·10

Send for Catalogue 82 before August 31 (60 pages, A4 – 70p post paid) and we give you **THREE 70p REFUND VOUCHERS FREE** valid for spending singly at any time on any one C.W.O. order minimum list value £10 to quickly save you a total of £2.10. Send 70p now for your EV Catalogue 82 + 3 free vouchers by return . . . and all in addition to the other benefits (discounts, guarantees to spec., brand new stock, etc) you enjoy by buying from Electrovalue.

+ USUAL DISCOUNTS + FREE POSTAGE

DISCOUNTS
5% on orders over £23 (inc. V.A.T.)
10% on orders over £57.50 (inc. V.A.T.)
on most catalogue items but not on payments by credit cards.
POSTAGE
Not charged on U.K. orders over £5.75 (inc. V.A.T.). If under, add 40p handling charge.

★ SEMICONDUCTORS/ICs/OPTRONICS
★ COMPUTERS/SOFTWARE, etc
★ CAPACITORS/RESISTORS
★ CONNECTORS/SWITCHES/KNOBS
★ POTS/FERRITES/METERS
★ BOOKS/SOLDER TOOLS

and more and more and more

ELECTROVALUE LTD. 28A St. Jude's Road, Englefield Green, Egham, Surrey TW20 0HB. Telephone Egham 33603 (London 87 33603: STD 0784 33603) Telex 264475 Northern Branch (Shop service only) 680 Burnage Lane, Manchester M19 1NA. Telephone 061-432 4945.

Time's running out... for Ni-Cads!

NEW NEC SUPERCAPS

Available from stock NOW!

1.0 FARAD SUPERCAP + 5101 C.MOS R.A.M.	1.0 FARAD SUPERCAP + 1703 Programmable Tuner Chip	1.0 FARAD SUPERCAP + 7507 C.MOS Microcomputer
1 MONTH	1 WEEK	1 DAY

Only part of the Anglia range of NEC components

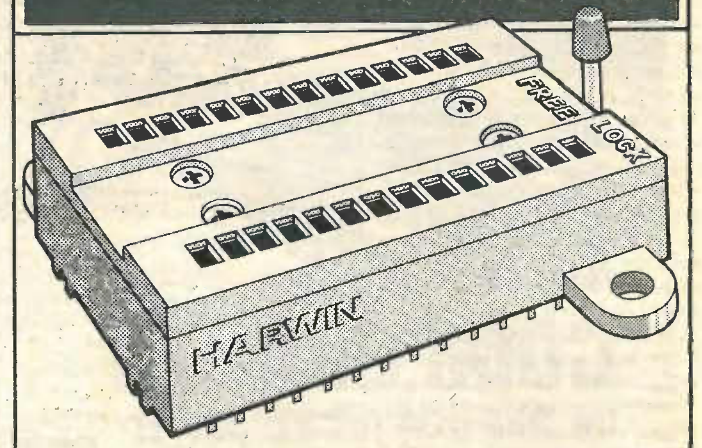
Anglia COMPONENTS

Burdett Road, Wisbech, Cambs, PE13 2PS
Telephone 0945 63281
Telex 32630 ANGLIA G

THE PARTS YOU NEED – *fast!*

WW – 080 FOR FURTHER DETAILS

Z.I.F. SOCKETS



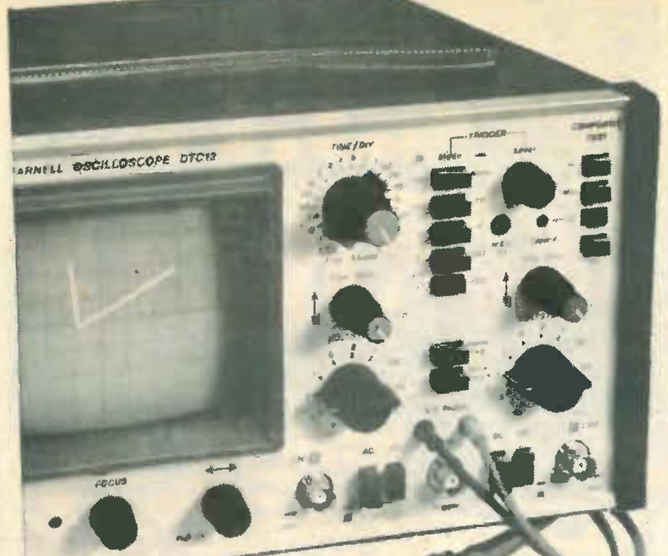
- 24, 28 and 40 Way Zero-Insertion Force Sockets
- Beryllium-copper "side wipe" contacts actuated by end lever
- High temperature (+150°C), solvent resistant mouldings
- Can be used for programming, test, or burn-in
- Made in the U.K. by:

HARWIN

Harwin Engineers SA,
Fitzherbert Road, Farlington,
Portsmouth, PO6 1RT, Hants.
Tel: (0705) 370451 Telex 86125

WW – 007 FOR FURTHER DETAILS

www.americanradiohistory.com



TEST COMPONENTS
ON THIS NEW OSCILLOSCOPE!

- Test solid state devices in, or out of, circuit
- Fast location of shorted, open and leaky components
- Test diodes, transistors, LEDs, electrolytics, FETs, MOS and CMOS etc.

PLUS . . .

- Full function, dual trace, 12MHz oscilloscope
- Fine sweep and gain controls
- Differential measurement mode – essential for effective servicing of disc drives and tape recorders

A really versatile 'scope for the test, service or development engineer.

Details from:

Farnell

FARNELL INSTRUMENTS LIMITED
WETHERBY LS22 4DH · TEL. (0937) 61961
or TEL. (05827) 66123 (Southern Office)

WW – 050 FOR FURTHER DETAILS

RF Communications Spares

Transistors • Antenna • Batteries • Tubes

Lowest Cost – Highest Quality Spares for
Motorola: Repco: G.E.: Johnson: Hallicafters
Also Military Radio Types
PRC 25 : PRC77 : VRC12 : VRC240

Look at these examples:

RF Power Transistors

2N3553	0.98	2N5070	8.98	MRF450	9.80
2N3733	5.80	2N5590	6.98	MRF453	14.45
2N4127	8.80	2N6080	5.30	MRF646	20.91
2N4128	10.77	2N6084	10.27	MHW710-1	53.10

Communications Tubes

4-250A	49.88	6146A	3.60	6155	44.48
4CX250B	36.10	6146B	3.95	6156	42.89

All prices f.o.b. London packed for export.
PLEASE APPLY FOR QUANTITY DISCOUNTS
Call, Telex or write for more details or with your quotation request.

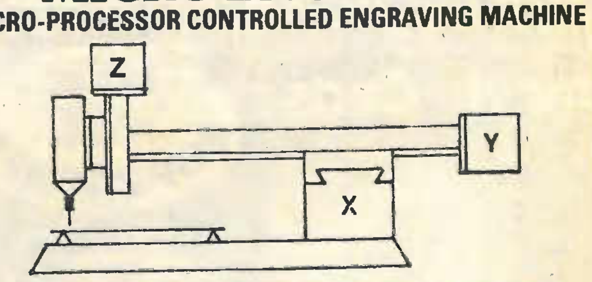
SURSU

We export throughout the world

SURSU LTD.
159a Boyne Valley Road,
Maidenhead,
Berks SL6 4DT,
England.
Tel: 0628 - 74615
Telex: 848556 Sursu G.

WW – 059 FOR FURTHER DETAILS

MICRO ENGRAVER
MICRO-PROCESSOR CONTROLLED ENGRAVING MACHINE



STEPPING MOTOR XYZ MACHINE. Complete with micro-processor controller and software programmed to engrave alphabet and numbers. Also features easy operator programmable XYZ sequences to engrave, drill or cut out special shapes and logos. XY axis travel 180 x 150 mm., Z 10 mm. Mixed character sizes on a label from 1-99 mm. high. Qwerty keyboard, 20 character L.E.D. display. Machine supplied complete and ready to manufacture labels. We can also supply labels. **PRICE £2,350.**

F.H. PRECISION ENGINEERS
24 Belvoir Ave., Trentham, Stoke-on-Trent ST4 8SY – 0782 643278

POWER SUPPLIES

HIGH QUALITY COMBINATION SWITCH MODE AND STATIC POWER SUPPLIES

Model No.		Price
AV81	5v 8A	£28
AV82D	12v 5A. + 5v 1A. Disc Drive supply Teac FD 50 Series	£29
AV83	+ 5v 8A. +12v 800mA. −12v 50mA. −5v 10mA. +25v 30mA.	£33
AV84	+5v 8A. ±12v 50mA. +25v 30mA	£33
AV86	Transformer, Rectifier, Mounting Plate and Fuse	£18
AV87	Power fail detect board 15mS	£7.50

Please add £1.20 p.&p. to order. All units are supplied on a satisfaction or money back basis and carry a full guarantee.

Send cheque/P.O. to:

AVALON ELECTRONICS
72 Ship Lane, Farnborough, Hants
Tel. 0252 511098
Trade and other enquiries welcome

WW – 094 FOR FURTHER DETAILS

U.K. RETURN OF POST MAIL ORDER SERVICE, ALSO WORLDWIDE EXPORT SERVICE

BSR DE LUXE AUTOCHANGER £20

Plays 12", 10" or 7" records, Auto or Manual. A high quality unit backed by BSR reliability. Stereo Ceramic Cartridge. AC 200/250V. Size 13½×11¼in. 3 speeds. Above motor board 3¾in. Below motor board 2½in.
Post £2 Cut Board **£1** extra

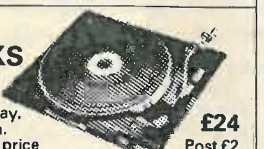
HEAVY METAL PLINTHS Post £2

Cut out for most BSR or Garrard decks. Silver grey finish, black trim. Size 16x13¾in. **£4**

DECCA TEAK VENEERED PLINTH. Post £1.50 Superior finish with space and panel for small amplifier. Board is cut for B.S.R. 18¾in.×14¼in×4in. Black/chrome facia trim. Also with boards cut out for Garrard £3. **Plastic cover £6** **£5**

TINTED PLASTIC COVERS			Post £2
17⅞×13⅛×3¼in.	£6	18¼×12½×3in.	£6
17¼×9⅜×3½in.	£3	14⅜×12½×2⅞in.	£5
13¾×12×2¼in.	£5	16⅝×13×4in.	£6
15¼×13½×4in.	£6	14½×13⅛×2¾in.	£5
17×12⅞×3½in.	£6	17¼×13¾×4⅛in.	£6
Callers Only (not suitable for post)			
21½×14¼×2½in.	£6	21×13⅞×4⅛in.	£6
23¾×14×3⅞in.	£6	30¾×13⅜×3¼in.	£6

BSR SINGLE PLAYER DECKS



BSR P232 BELT DRIVE QUALITY DECK
Manual or automatic play. Precision ultra slim arm. Cueing device. Bargain price With stereo ceramic cartridge **£24** Post £2

BSR P204 SINGLE PLAYERS SPECIAL OFFERS
Two speed 33/45 r.p.m. hi-fi decks with stereo cartridges, cueing device and snake arm.
Ceramic – 240V AC **£15** or 9V DC **£19**
Magnetic – 240V AC **£20** or 12V DC **£24**

GARRARD 6-200 SINGLE PLAYER DECK £22 Post £2
Brushed Aluminium Arm with stereo ceramic cartridge and Diamond Stylus, 3-speeds. Manual and Auto Stop/Start. Large Metal Turntable. Cueing Device. Ready cut mounting board £1 extra.
GARRARD 730SP. 240V. **£27.50.** Magnetic Cartridge Snake arm, 3-speed single player, p.p. £2

BATTERY ELIMINATOR MAINS to 9 VOLT D.C.
Stabilised output, 9 volt 400 m.a. U.K. made in plastic case with screw terminals. Safety overload cut out. Size 5 x 3¼ x 2½in. Transformer Rectifier Unit. Suitable Radios, Cassettes, models, £4.50. Post 65p.

DE LUXE SWITCHED MODEL STABILISED. £7.50. Post £1. 3-6-7½-9 volt 400ma DC max. Universal output plug and lead. Pilot light, mains switch, polarity switch.

DRILL SPEED CONTROLLER/LIGHT DIMMER KIT. Easy to build kit. Controls up to 480 watts AC mains, £3. Post 65p.
DE LUXE MODEL READY-BUILT 800 watts. Front plate fits standard box, £5. Post 65p.

EMI 13½x8in. LOUDSPEAKERS

Model 450, 10 watss R.M.S. with moving coil tweeter and two-way crossover; 3 ohm or 8 ohm.
£9.50 post £1.50. "Final Clearance".
SUITABLE BOOKSHELF CABINET
£6.50. Size 18×11×6in. Post £1.50.

RELAYS. 6V DC **95p.** 12V DC **£1.25.** 18V **£1.25.**
BLANK ALUMINIUM CHASSIS. 6×4–**£1.45;** 8×6–**£1.80;** 10×7–**£2.30;** 12×8–**£2.60;** 14×9–**£3;** 16×6–**£2.90;** 16×10–**£3.20.** All 2½in. deep. 18 swg.
ANGLE ALI. 6×¾×¾in. 18 swg. **30p.**
ALUMINIUM PANELS, 18swg. 6×4–**45p;** 8×6–**75p;** 14×3–**75p;** 10×7–**95p;** 12×8–**£1.10;** 12×5–**75p;** 16×6–**£1.10;** 14×9–**£1.25;** 12×12–**£1.50;** 16×10–**£1.75.**
PLASTIC AND ALI BOXES IN STOCK. MANY SIZES
ALUMINIUM BOXES. 4×4×1½ **£1.** 4×2½×2 **£1.** 3×2×1 **£1.** 6×4×2 **£1.60.** 7×5×3 **£2.40.** 8×6×3 **£2.50.** 10×7×3 **£3.** 12×5×3 **£2.75.** 12×8×3 **£3.60.** All with lids.
BRIDGE RECTIFIER 200V PIV 2a **£1.** 4a **£1.50.** 8a **£2.50.**
TOGGLE SWITCHES SP **30p.** DPST **40p.** DPDT **50p.**
RESISTORS. 10Ω to 10M. ¼W, ½W, 1W, **2p:** 2W **10p.**
HIGH STABILITY. ½w 2% 10 ohms to 1 meg. **10p.**
Ditto 5%. Preferred values, 10 ohms to 10 meg. **3p.**
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt **20p.**
PICK-UP CARTRIDGES SONOTONE 9TA **£2.50.** 9TAHC **£3.80.**
BSR Stereo Ceramic SC7 Medium Output **£2.** SC12 **£3.**
PHILIPS PLUG-IN HEAD. Stereo Ceramic. AU1020 (G306 - GP310 - GP233 -AG3306 - AG3310) **£2.**
LOCKTITE SEALING KIT DECCA 118. Complete **£1.**
ANTEX SOLDERING IRON 240V 15W 3mm bit **£5.25.**
JACK PLUGS Mono Plastic **25p;** Metal **30p.**
JACK PLUGS Stereo Plastic **30p;** Metal **35p.**
JACK SOCKETS Mono Open **20p;** Closed **25p.**
JACK SOCKETS Stereo Open **25p;** Closed **30p.**
FREE SOCKETS – Cable end **30p.** Metal **45p.**
2.5mm and 3.5mm **JACK SOCKETS 20p. Plugs 20p.**
DIN TYPE CONNECTORS
Sockets 3-pin, 5-pin **10p.** Free Sockets 3-pin, 5-pin **25p.** Plugs 3-pin **20p;** 5-pin **25p;** Speaker plugs **20p;** Sockets **15p.**
PHONO PLUGS and SOCKETS ea. 15p.
Free Socket for cable end **20p.** Screened Phono Plugs **25p.**
300 ohm TWIN RIBBON FEEDER 10p yd.
U.H.F. COAXIAL CABLE SUPER LOW LOSS. 25p yd.
COAX PLUGS 30p. COAX SOCKETS 20p.
NEON PANEL INDICATORS 250V 30p.
SOLID DIELECTRIC 100pf, 500pf £1.50.

POTENTIOMETERS Carbon Track

5kΩ to 2MΩ. LOG or LIN. L/S **50p.** DP **90p.** Stereo L/S **£1.10.** DP **£1.30.** Edge Pot 5K. SP **45p.**

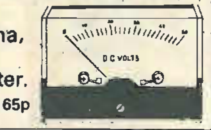
MINI-MULTI TESTER NEW

De luxe pocket size precision moving coil instrument. Impedance + Capacity – 4000 o.p.v. Battery included.
11 instant ranges measure:
DC volts 5.25, 250, 500.
AC volts 10, 50, 500, 1000.
DC amps 0-250μa, 0-250mA.
Continuity and resistance 0 to 600K ohms.

£6.50 Post 65p

De Luxe Range Doubler Model, 50,000 o.p.v. £18.50. 7×5×2in. Post £1

NEW PANEL METERS £4.50



50μa 100μa, 500μa,
1ma, 5ma, 50ma, 100ma,
500ma, 1 amp, 2 amp
25 volt, 50 volt, VU Meter.
2¼x2x1¼in. Post 65p

RCS SOUND TO LIGHT CONTROL KIT

Kit of parts to build a 3 channel sound to light unit. 1,000 watts per channel. Suitable for home or disco. Easy to build. Full instructions supplied. **£15** Post 95p
Cabinet £4.50 extra. Operates from 200MV to 100W.
200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights, Edison Screw. 6 for £4, or 12 for **£7.50.** Post 65p. Suitable panel mounting holders **85p.**

RCS "MINOR" 10 watt AMPLIFIER KIT £14

This kit is suitable for record players, guitars, tape playback, electronic instruments or small PA systems. Two versions available: Mono, **£14;** Stereo, **£20.** Specification 10W per channel; size 9½×3×2in. SAE details. Full instructions supplied. 240V AC mains. Post £1.

RCS STEREO PRE-AMP KIT. All parts to build this pre-amp. Inputs for high, medium or low imp per channel, with volume control and PC Board Can be ganged to make multi-way stereo mixers **£2.95** Post 65p

MAINS TRANSFORMERS

		Post
250-0-250V 70mA, 6.5V, 2A	£4.50	£2
250-0-250V 80mA, 6.3V 3.5A, 6.3V 1A	£5.00	£2
350-0-350V 250mA, 6.3V 6A CT	£12.00	£2
300-0-300V 120mA, 2×6.3V 2A C.T.; 5V 2A	£12.00	£2
220V 45mA, 6.3V 2A	£2.50	£1

AUTO 115V to 240V 150W **£9.** 250W **£10.** 400W **£11.** 500W **£12.** £2.

GENERAL PURPOSE LOW VOLTAGE

Tapped outputs available	Price	Post
2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V	£6.00	£2
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£6.00	£2
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£10.50	£2
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£12.50	£2
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£16.00	£2

5-8-10-16V. ½ amp.	£2.50	80p	15-0-15V. 2 amps	£3.75	£1
6V. ½ amp.	£2.00	£1	20V 1 amp	£3.00	£1
6-0-6V. 1½ amp.	£3.50	£1	20-0-20V 1 amp	£3.50	£1
9V. 250ma.	£1.50	80p	20-40-60V 1 amp	£4.00	£2
9V. 3 amp	£3.50	£1	25-0-25V 2 amps	£4.50	£1
9-0-9V. 50ma	£1.50	80p	28V 1 amp Twice	£5.00	£2
10-0-10V. 2 amps	£3.00	£1	30V 1½ amp	£3.50	£1
10-30-40V. 2 amps	£3.50	£1	30V 5 amp and 17-0-17 2a	£4.50	£2
12V. 100ma	£1.50	80p			
12V. 750 ma	£2.00	80p	35V 2 amps	£4.00	£1
12V 3 amps	£3.50	£1	TOROIDAL 30-0-30V 4a and 20-0-20V ½a £10 £2		
12-0-12V. 2 amps	£3.50	£1			

CHARGER TRANS	Post	RECTIFIERS	Post
6-12 volt 3a	£4.00+£2	6-12 volt 2a	£1.10+80p
6-12 volt 4a	£6.50+£2	6-12 volt 4a	£2.00+80p

OPUS COMPACT SPEAKERS £22 pair Post £2

TEAK VENEERED CABINET
11×8½×7in, 15 watts
50 to 14,000 cps. 4 ohm or 8 ohm

OPUS TWO 15×10½×7¾in 25 watt 2-way system **£39 pair.** Post £3.

LOW VOLTAGE ELECTROLYTICS **10p**
1 mf, 2 mf, 4 mf, 8 mf, 10 mf, 16 mf, 25 mf, 30 mf, 50 mf, 100 mf, 250 mf. All 15 volts. 22 mf/6v/10v; 25 mf/6v/10v; 47 mf/10v; 50 mf/6v; 68 mf/6v/10v/16v/25v; 100 mf/10v; 150 mf/6v/10v; 200 mf/10v/16v; 220 mf/4v/10v/16v; 330 mf/4v/10v; 500 mf/6v; 680 mf/6v/10v/16v; 1000 mf/2.5v/4v/10v; 1500 mf/6v/10v/16v; 2200 mf/6v/10v; 3300 mf/6v; 4700 mf/4v.
500mF 12V **15p;** 25V **20p;** 50V **30p.** 1200mF 76V **86p.**
1000mF 12V **20p;** 25V **35p;** 50V **50p;** 100V **70p.**
2000mF 6V **25p;** 25V **42p;** 40V **60p;** 1200mF 76V **80p.**
2200mF 63V **90p.** 2500mF 50V **70p;** 3000mF 50V **65p;**
4700mF 64V **£2.** 4700mF 63V **£1.20.** 2700mF/76V **£1.**

HIGH VOLTAGE ELECTROLYTICS

2/500V	45p	8+8/450V	75p	32+32+16/350V	90p
8/450V	45p	8+8/500V	£1	100+100/275V	65p
16/350V	45p	8+16/450V	75p	150+200/275V	70p
32/500V	75p	32+32/350V	50p	220/450V	95p
32/350V	50p	32+32/500V	£1.80	32+32+32/325V	75p
50/450V	95p	50+50/300V	50p	50+50+50/350V	95p

CAPACITORS WIRE END High Voltage
.001, .002, .003, .005, .01, .02, .03, .05 mfd 400V **5p.**
.1MF 200V **5p.** 400V **10p.** 600V **15p.** 1000V **25p.**
.22MF 350V **12p.** 600V **20p.** 1000V **30p.** 1750V **50p.**
.47MF 1500V **10p.** 400V **20p.** 630V **30p.** 1000V **60p.**
VALVE OUTPUT Transformers (small) **90p.**
TRIMMERS 30pF, 50pF, **10p.** 100pF, 150pF, 500pF **30p.**
MICROSWITCH SINGLE POLE CHANGEOVER 40p.
SUB-MIN MICROSWITCH, 50p, Single pole changeover.
TWIN GANG, 120pF **50p.** 500 plus 200pF **£1.**
GEARED TWIN GANGS 25pF **95p.**
GEARED 365+365+25+25pF **£1.**
TRANSISTOR TWIN GANG. Japanese Replacement **£1**

HEATING ELEMENTS, WAFER THIN
Size 11×9×⅛in. Operating voltage 240V, 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters, Propagation, etc. Must be clamped between two sheets of metal or ceramic, etc.
ONLY **60p** EACH (FOUR FOR **£2**) ALL POST PAID.

NEW baker Star sound

high power full range quality loudspeakers produced to give exceptional reproduction. Ideal for Hi-Fi, music P.A. or discotheques. These loudspeakers are recommended where high power handling is required with quality results. The high flux ceramic magnet ensures clear response.

MODEL	INCHES	OHMS	WATTS	TYPE	PRICE	POST
MAJOR	12	4-8-16	30	HI-FI	£14	£2
DELUXE MK II	12	8	15	HI-FI	£14	£2
SUPERB	12	8-16	30	HI-FI	£24	£2
AUDITORIUM	12	8-16	45	HI-FI	£22	£2
AUDITORIUM	15	8-16	60	HI-FI	£34	£2
GROUP 45	12	4-8-16	45	PA	£14	£2
GROUP 75	12	4-8-16	75	PA	£18	£2
GROUP 100	12	8-16	100	Guitar	£24	£2
DISCO 100	12	8-16	100	Disco	£24	£2
GROUP 100	15	8-16	100	Guitar	£32	£2
DISCO 100	15	8-16	100	Disco	£32	£2

BAKER 150 WATT MIXER/POWER AMPLIFIER £89 Post £2

SLAVE VERSION £75

For Organs, Discotheque, Vocal, Public Address. Three loudspeaker outlets for 4, 8 or 16 ohms. Four high gain inputs, each 20 mv, 50K ohm. Individual volume controls "Four channel" mixing. 150 watts into 8 ohms R.M.S. Music Power. Distortion less than 1%. Slave output 500 M.V. 25K.ohm. Frequency Response 25 Hz – 20kHz ± 3dB. Integral Hi-Fi preamp separate Bass & Treble. Compact – 16" x 8" x 5½". Lightweight – 14lb: Master volume control. Made in England. 12 months' guarantee. 200/250v A.C. mains or 120V to order. All transistor and solid state devices. 100 Volt Line £15 extra.
New Stereo Slave Model 150 + 150 watt £125. Post £4.
BAKER'S NEW PA150 MICROPHONE PA AMPLIFIER £129. PP £3
4 channel 8 inputs, dual impedance, 50K-600 ohm 4 channel mixing, volume, treble, bass. Presence controls, Master volume control, echo/send/return socket. Slave input/output sockets.

BAKER £69 Post £2 50 WATT AMPLIFIER

Ideal for PA systems, Discos and Groups. Two inputs, Mixer, Volume, Controls, Master Bass, Treble Gain.

RCS offers MOBILE PA AMPLIFIERS. Outputs 4-8-16 ohms
20-watt RMS 12v DC, AC 240v, 3 inputs. 50K **£46** PP £2.
40-watt RMS 12v DC, AC 240v, 4 inputs. 50K 100v Line **£75** PP £2
Mic 1; Mic 2; Phono; aux. outputs 4 or 8 or 16 and 100v line
60-watt RMS, Mobile 24 volt DC & 240-volt AC mains. inputs 50K. 3 mics + 1 music. Outputs 4-8-16 ohm + 100 volts line **£95** PP £2

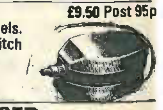
FAMOUS LOUDSPEAKERS "SPECIAL PRICES"

MAKE	MODEL	SIZE	WATTS	OHMS	PRICE	POST
SEAS	TWEETER	4in	50	8	£9.50	£1
GOODMANS	TWEETER	3½in	25	8	£4.00	£1
AUDAX	TWEETER	4in	30	8	£6.50	£1
SEAS	MID-RANGE	4in	50	8	£7.50	£1
SEAS	MID-RANGE	5in	80	8	£12.00	£1
SEAS	MID-RANGE	4½in.	100	8	£12.50	£1
GOODMANS	HIFAX	7½×4¼	100	4/8/16	£22	£2
GOODMANS	WOOFER	8in	25	4/8	£6.50	£1
GOODMANS	HB	8in	60	8	£12.50	£1
RIGONDA	GENERAL	10in	15	8	£5	£2
AUDAX	WOOFER	10in	50	8	£16.00	£2
GOODMANS	HPG	12in	120	8/15	£29.50	£2
GOODMANS	GR12	12in	90	8/15	£27.50	£2
GOODMANS	HPD	12in	120	8/15	£29.50	£2

SPEAKER COVERING MATERIALS. Samples Large S.A.E.
B.A.F. LOUDSPEAKER CABINET WADDING 18in wide 35p ft.
CASSETTE MONO REPLAY. Complete working **£12.50**
CASSETTE MECHANISM. 12V Stereo Heads **£5**
CROSSOVERS. TWO-WAY 3000 c/s 3 or 8 or 15 ohm **£1.90.** 3-way 950 cps/3000 cps. 20 watt rating. **£2.20.** 3 way 60 watt **£6.**
LOUDSPEAKER BARGAINS
3 ohm, 4in, 5in, 7×4in, £1.50; 6½in, 8×5in, £3; 8in, £3.50. 10in, £5.
8 ohm, 2¾in, 3in, 5in, £1.50; 6½in, £3; 8in, £4.50; 12in, £6.
15 ohm, 3¼in, 5×3in, 6×4in, £2.50.
25 ohm, 3in, 5×3in, 7×4in, £2.50. 120 ohm, 3¼in dia. £1.

MOTOROLA PIEZO ELECTRIC HORN TWEETER, 3¾in. square **£5**
100 watts. No crossover required. 4-8-16 ohm, 7⅜x3⅞in. **£10.50**

THE "INSTANT" BULK TAPE ERASER **£9.50** Post 95p



Suitable for cassettes and all sizes of tape reels. AC mains 200/250V. Hand held size with switch and lead (120 volt to order).
Will also demagnetise small tools.
Head Demagnetiser only £5.

R.C.S. LOW VOLTAGE STABILISED POWER PACK KITS **£3.95.** Post 65p
All parts and instructions with Zener diode printed circuit, mains transformer 240V a.c. Output 6 or 7½ or 9 or 12V d.c. up to 100mA or less. Please state voltage required.

RADIO COMPONENT SPECIALISTS
337 WHITEHORSE ROAD, CROYDON
Open 9-6. Closed all day Wed. Open Sat. 9-5.

Radio Books and Components Lists 31p stamps. (Minimum post/packing charge 65p.) Access or Barclaycard Visa. Tel: 01-684 1665 for SAME DAY DESPATCH. Cash prices include VAT.

www.americanradiohistory.com

NEW QUALITY OSCILLOSCOPES, THE RANGE FOR EUROPE!

HM307.4 £138
Y: Bandwidth DC-10MHz (-3dB) — Sensitivity 5mV-20V/cm (±5%)
X: Timebase 0.2s-0.5µs/cm (±5%) — Triggering 2Hz-30MHz (3mm) — Built in component tester — Calibrator — Screen 6 x 7 — 1kV.

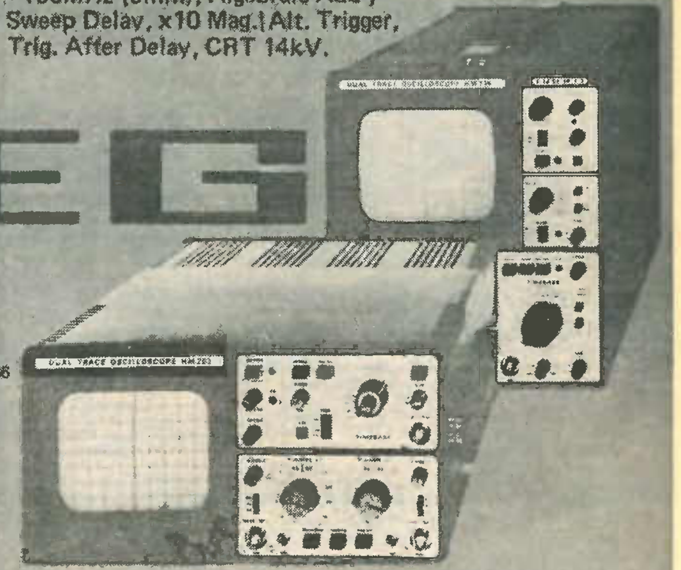
HM203 £220
Y: Bandwidth DC-20MHz (-3dB) — Sensitivity 5mV-20V/cm (±3%) — Dual trace
X: Timebase 0.2s-40ns/cm incl.x5 Magn. — Trigger 3Hz-30MHz (4mm) — X-Y operation — Calibrator — Screen 8 x 10cm — 2kV.

HM412 £350
Bandwidth DC-20MHz (-3dB) Sensitivity 2mV/cm 20V/cm(±3%) Timebase 40ns/cm Triggering DC 40MHz (5mm) Algebraic Add., Sweep Delay, x5 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 - 100MHz (5mm), Algebraic Add., Sweep Delay, x10 Mag.(Alt. Trigger, Trig. After Delay, CRT 14kV.

For free data sheets of the full range contact:

HAMEG



England
HAMEG, LTD.
74-78 Collingdon Street
Luton, LU1 1RX
Tel: (0582) 413174/Telex: 825484

France:
HAMEG S.A.R.L.
5-9, Avenue de la République
94800 Villejuif,
Tél: 678.09.98/Télex: 270705

West Germany:
HAMEG GmbH
6 Frankfurt am Main 71,
Kelsterbacher Str. 15-19
Tel: 0611/676017/Telex: 0413866

Spain
HAMEG IBERICA S.A.
Villaroel 172-174
Barcelona 36
Tel: 230.15.97

United States:
HAMEG, INC.
88-90 Harbor Rd.
Port Washington, N.Y. 11050
Phone: 516-883-3837/516-883-6428
TWX: 510 223 0885

Prices U.K. List Ex. VAT

WW — 067 FOR FURTHER DETAILS

NEW

Programming the **PET/CBM**

'This book is excellent.'
- *Jim Strasma*

'Unquestionably the most accurate and comprehensive reference I have seen to date.'
- *Jim Butterfield*

Bestseller — comprehensive teaching and reference book on all software aspects of Commodores 2000, 3000, 4000 and 8000 microcomputers and peripherals.

Many programs, charts and diagrams. 17 chapters, appendices, and index. iv + 504 pages. 19 x 26 x 2½cm. Paperback. ISBN 0 9507650 0 7. Price in UK and Europe £14.90 each (incl. post and heavy-duty packing). LEVEL LTD., PO Box 438, Hampstead, London NW3 1BH. Tel: 01-794 9848.

Cut out or copy coupon, or write to:
LEVEL LTD., PO Box 43B, Hampstead, London NW3 1BH.

Send ...... copy/ies of *Programming the PET/CBM* at £14.90 (post free)

I enclose cheque/P.O. for £..........or official order.
NAME ....
ADDRESS ....
....

Fast Service — same day despatch (WW682)

WW — 091 FOR FURTHER DETAILS

MICROPROCESSOR APPLICATIONS HANDBOOK

by D. F. Stout **£31.00**

Electronic Components and Systems *by W. H. Dennis*	£13.50
The Electronic Office *by D. Jarrett*	£13.50
H/B of Semiconductor and Bubble Memories *by W. A. Triebel*	£19.70
Practical Techniques of Electronic Circuit Design *by R. L. Bonebreak*	£25.00
Digital Integrated Electronics *by H. Taub*	£9.95
Electronic Devices and Circuit Theory *by R. L. Boylestad*	£10.95
The Soul of a New Machine *by T. Kidder*	£8.50

★ PRICES INCLUDE POSTAGE & PACKING ★

THE MODERN BOOK CO
Specialist in Scientific and Technical Books
15/21 Praed Street, London, W2 1NP
PHONE: 01-402 9176 : Closed SATURDAY 1 p.m.
Please allow 14 days for reply or delivery

WW — 034 FOR FURTHER DETAILS

LOW PROFILE KEYBOARDS

16 switch (4x4). Phos./Bronze gold-plated contacts.
Keytop legends 0-9 plus 6 plain.
G.F.P.C. Board with edge connections.
Overall switch height from board 12.5mm. Switch pad area 65mm. sq. approx.
PRICE £7 plus postage and VAT.
Cheques for £9.20 payable to:

AVONSWITCH PRODUCTS LTD.
River Street, Pewsey, Wiltshire SN9 5DH
Delivery within 14 days

WW — 060 FOR FURTHER DETAILS

THE CINTEC SINUSOIDAL FREQUENCY AND VOLTAGE STABILIZER

APPLICATIONS
* SOUND RECORDING
* VIDEO RECORDING
* MEDICAL
* MARINE
* COMPUTERS
* NAVIGATIONAL SYSTEMS

Applications for the use of CINTEC FREQUENCY & VOLTAGE STABILIZER are more numerous than can be listed. Therefore, if you have a supply problem, contact CINTEC LIMITED whose engineers will be only too pleased to assist.

* 500VA OR 250VA
* SOLID STATE
* HIGH STABILITY
* ROBUST
* VERSATILITY
* RELIABILITY
* SINUSOIDAL

Reliable Frequency & Voltage Stabilization

The efficient operation of sophisticated electrical and electronic equipment is, in many cases, dependent upon an electrical supply which is stable in both frequency and voltage.

In many countries and even in the United Kingdom during periods of heavy demand, the variation in the frequency and voltage is sufficient to introduce errors and the malfunction of such items as Recording equipment etc. Likewise, in certain areas, the only source of supply is from a Generator, the output of which can vary considerably when different loads are imposed. This has precluded the use of a wide range of equipment in many countries. Voltage Stabilizers are readily available, but these do not stabilize the frequency of the supply which, in many instances, is essential.

The CINTEC FREQUENCY & VOLTAGE STABILIZER provides the answer to both these problems

When the supply frequency is fluctuating wildly, between 45Hz and 65Hz and the voltage by more than 10% the output from the Stabilizer will not vary more than .01% from 50Hz or 1% in voltage, even when different loads are imposed.

Used by Government establishments, oil rigs, hospitals, police, video and electronic industry, shipbuilders etc, for a wide range of applications including video systems, medical, frequency conversion, navigational aids and sound recording systems.

The CINTEC FREQUENCY & VOLTAGE STABILIZER is also available for supplies of 100-125 volts, 45-65Hz with an alternative output of 50Hz or 60Hz at 115 volts or 230 volts and as a dual frequency model with a switchable output of 50Hz or 60Hz.

The Stabilizer may also be used as a frequency converter. For example, the supply to it can be any frequency between 45-65Hz and the output can be switched to either 50Hz or 60Hz.

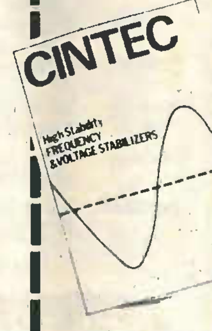
SPECIFICATION

INPUT	105-125 volts or 210-250 volts at 45-65Hz.
OUTPUT	115 volts at 230 volts
RATING	500VA or 250VA
STABILITY Voltage	± 1% No load to full load —
Frequency	± 0.01% No load to full load
FREQUENCY	50Hz or 60Hz. Single or dual versions
WAVEFORM	SINUSOIDAL
DISTORTION	Less than 2%
AMB TEMP	−20°C to +40°C
COOLING	Fan cooled
DUTY	Continuous
DIMENSIONS	432 (W) x 196 (H) x 508mm (D) (17" x 7¼" x 20")
WEIGHT	45 or 30Kg unpacked
CONSTRUCTION	Cabinet or rack mounting
TERMINATION	Cannon Connections at rear of case

NATO CODIFIED

24V DC Inverter
In addition to the A.C. operated models, a 24v D.C. INVERTER Stabilizer is available which operates from a heavy duty 24 volt battery and has output ratings similar to the A.C. models. This type of Stabilizer is particularly suitable for mobile operation.

Cintec Ltd., Wandle Way, Mitcham, Surrey CR4 4NB, England. Tel: 01-640 2241. Telex: 946177



Details Specification and Brochure—Available Post Coupon or Telephone/Telex

Name ____________________
Position ____________________
Company ____________________
Address ____________________

WW6/82

CINTEC LTD

Wandle Way, Mitcham, Surrey CR4 4NB, England. Telephone: 01-640 2241 Telex: 946177

WW — 056 FOR FURTHER DETAILS

www.americanradiohistory.com

PORTABLE MAINS FILTER

This portable mains interference filter has been developed to provide good attenuation against both incoming and outgoing interference.
The filter unit is rated conservatively at 13 amps and incorporates an earth line choke and ZNR for full protection against mains transients as well as R.F.I. The capacitors to earth meet the BS 613 limits for portable equipment. A discharge resistor is provided to prevent shocks when handling the 13 amp plug.
The filter is suitable for a wide variety of uses including the protection of VDU, desk top computers, EPROM programmers and microprocessor development systems, as well as the usual range of digital and analogue instruments.

Roxburgh Suppressors also manufacture a standard range of mains filters for general purpose applications and offer RFI laboratory facilities for custom built suppression.

£42.49 inclusive of VAT and carriage.

ROXBURGH SUPPRESSORS LTD.

EAGLE ROAD, RYE, EAST SUSSEX   TELEPHONE RYE(079 73) 3725

WW – 076 FOR FURTHER DETAILS

D.I.L. MINIATURE ON-OFF SWITCHES
Gold-plated contacts. Sealed base. Ideal for programming. 6-position at less than half manufacturer's price
ONLY 75p
Will fit into 14-pin dil socket. Ten at 65p ea.; per 100 55p ea.

HONEYWELL PROXIMITY DETECTOR integral amplifier, 8v. D.C., £3.50 ea
PHOTO CONDUCTIVE CELL, £1.25. High-power Cds cell, 600MW, for control circuits. Resistance 800 ohm to 4K. Max. volts 240. Size 1½ × ½in.
RIBBON MICROPHONE with pre-amp. on chassis, £1.75.

MULLARD MODULES
LP1171 IF. Strip; LP1179 AM/FM Front end — Pair £5.75
Complete with Data
LP1186 varicap £5.00; LP1157 Med. & Long Tuner £2.50

ULTRA SONIC TRANSDUCERS 40KC/S. Complete on 18in. Screened cable, £1.75 each; pairs £2.95.
ULTRA SONIC TRANSMITTER. Complete unit (uncased requires 1.5V). £3.25.
FOSTER DYNAMIC MICROPHONES. 200 ohm impedance. Moving coil. Complete on chassis. £1.75 pair.

CRYSTALS COLOUR TV
4.433619 mc/s £1.25
Miniature type sealed

U.H.F. MODULATORS
Latest type, adjustable, ideal for computers. with data circuit
Size 3×2½×1 inch
Only £3.50
In screened case

LM380 Amplifier 85p
LM318N Hi-Slew Op. Amp. £1.50
LM323K, 5v. 3-amp, reg. £3.50
LM310N Volt, Follower Amp £1.20
LM311H High Perf. Volt, Comparator £1.00
LM384N, 5-watt Amp £1.20
LM393N Dual Com. 60p
7905 Reg. –5v 75p

MINIATURE HIGH-QUALITY FANS
"Whisper Model" by Roton. Low-power consumption (less than 10 watts). Silent running. 115v. (two in series for 230v.). 50/60Hz. Size 4½ × 4½ × 1½in. ONLY £6.50 EACH incl. V.A.T.
BRAND NEW
50% less than manufacturer's price

STEREO CASSETTE
Mechanisms 6 or 12 volt. Complete with Heads + Erase and Solenoid. Brand new .... £5.50 ea.

TV CONVERGENCE POTS (LIN)
50 ohm, 100 „, 200 „, 5K „ — ALL 50p ea.

MINIATURE EDGE INDICATOR METER
With illuminated dial scale 0-10. F.S.D. 100 microamp. Size 1½ × 1½ × ½ deep. Only £1.65.

MONSANTO
Half-inch ±1 Display
High Intensity
£1 each
set of 4 £3.50
Common anode
14 Pin Dil Package

STEREO CASSETTE TAPE HEADS. Quality replacement for most recorders with mounting plate. Record/Replay £2.80
MARRIOTT TAPE HEADS Quarter track.
Type
XRPS18 Record/Replay (each) £2.00
XRPS36 Record/Replay (each) £3.00
XES11 Erase (each) £1.00

HEWLETT-PACKARD DISPLAYS
5082-7650
HIGH EFFICIENCY AND VERY BRIGHT
Only £1.00 each
Set of 6 for £5
Half-inch red common anode will replace DL70/14-pin Dil.

EX-MOTOROLA 5 + 5-WATT CAR STEREO AMPLIFIERS
Complete and tested units. Medium and Long Wave. Supplied as two built units (5 × 2 × 2in.) with circuit and data. Only £5 pair. Includes pre-amp.

BRIDGE RECTIFIER
800 PIV 35 amps
1½×1½×½in. £3.50

NATIONAL
P.8080A Chips £2.95
8216 .... £1.75
IN4148 DIODES
Full spec. but no polarity band. Per 1,000 .... £10
MINIATURE MP.C. POTENTIOMETERS. Model M2. High-quality, 5% tolerance, 2-watt, with 1in. spindles. All values, 47 ohms-47k only 60p each per 10; 50p each per 100; 40p each.

RECHARGEABLE BATTERIES
VARTA 3.6 volts DEAC, M/AH 225 .... £1.50
DRYFIT 6-volt, 4.5 amp. £7.50

XTAL FILTER 10.7 mc/s. 12.5DB separation, 1½×1¼×1 inch £7.00
100KC/S + 1 meg. 3-pin £2.00

"CHERRY" ADD-ON KEYPAD

A compact 12-button keypad suitable for use with Keyboard extend its functions plus four extra keys
Supplied brand new
A 3 × 4 non-encoded single mode keyboard

QUANTITY DISCOUNTS on *ALL* items (unless stated), 15% per 10, 20% per 50, 25% per 100. All items *BRAND NEW* (unless otherwise stated).
DELIVERY from stock – Add post 35p per order.

EXPORT enquiries invited
TELEX 262284 Transonics Mono 1400

HENRY'S 01-723 1008/9

Callers to: 404 EDGWARE ROAD, LONDON W2 1ED
ALL MAIL ORDERS/EXPORT ENQUIRIES 11/12 PADDINGTON GREEN, LONDON, W2

TYPE 9056	1500 MHz. FREQUENCY DIVIDER BY 10. Divides input frequencies in the range 100-1500 MHz. by 10. May be used ahead of frequency meters and counters to increase the frequency of measurement. Enables UHF oscillators to be phase-locked to a lower frequency high stability reference. POST AND PACKING	£59.50 £1.50
TYPE 8032	PHASE LOCKED SIGNAL SOURCE 1-1000 MHz. POST AND PACKING	£54.50 £1.50
TYPE 9030	WIDEBAND RF PREAMPLIFIER. 10 KHz.-100 MHz. Without tuning. N.F. 3.0 dB. Gain 40 dB. Increases sensitivity of instruments by 100 times. POST AND PACKING	£29.50 £1.50
TYPE 9025/FM	BAND 2. 88-108 MHz. N.F. 1.0 dB. Gain 40 dB. adjustable –40dB. Masthead/Lab. use. 15V. + DC at 30ma. POST AND PACKING	£29.50 £1.50
TYPE 9025	RF PREAMPLIFIER. Aligned to your specified frequency in the range 1-250 MHz. N.F. 1.0 dB. Gain 40 dB. adjustable –40 dB. Masthead/Lab. use. POST AND PACKING	£29.50 £1.50
TYPE 9001	GASFET STRIPLINE UHF TELEVISION PREAMPLIFIER. N.F. 0.6dB. Gain 20 dB. Ch. group 'A' 21-34, 'B' 39-51, or 'CD' 49-68. Masthead/local use. POST AND PACKING	£49.50 £1.50
TYPE 9000	GASFET STRIPLINE UHF PREAMPLIFIER. N.F. 0.5 dB. Gain 25 dB. Masthead/local use. Satellite 400 MHz. Radio Astronomy 408 MHz. Amateur 432 MHz. POST AND PACKING	£49.50 £2.50
TYPE 9045	VMOS WIDEBAND LINEAR POWER AMPLIFIER. 30 KHz.-20 MHz. without tuning. 4 watts RF output. POST AND PACKING	£49.50 £3.00
TYPE 9050	VMOS WIDEBAND LINEAR POWER AMPLIFIER. 20 MHz-200 MHz. Without tuning. 4 watts RF output. POST AND PACKING	£49.50 £3.00
TYPE 9053	LINEAR POWER AMPLIFIER. Television bands 4 and 5. 8 watts RF output. POST AND PACKING	£85.00 £4.00
TYPE 9051	VMOS LINEAR POWER AMPLIFIER. 10 watts RF output. 1-250 MHz. POST AND PACKING	£65.00 £4.00
TYPE 9054	VMOS LINEAR POWER AMPLIFIER. 20 watts RF output. 1-230 MHz. POST AND PACKING	£85.00 £4.00
TYPE 9061	VMOS WIDEBAND LINEAR POWER AMPLIFIER. 20 MHz.-200 MHz. Without tuning. 20 watts RF output. POST AND PACKING	£120.00 £4.00
TYPE 9062	VMOS WIDEBAND LINEAR POWER AMPLIFIER. 30 KHz.-20 MHz. Without tuning. 20 watts RF output. POST AND PACKING	£120.00 £4.00
TYPE 9063	VMOS LINEAR POWER AMPLIFIER. 1-250 MHz. 100 watts RF output. POST AND PACKING	£195.00 £5.00

PLEASE ADD V.A.T. 15% ON TOTAL

RESEARCH COMMUNICATIONS LIMITED
43/A COURT STREET, FAVERSHAM, KENT ME13 7AL
Telephone: 010 33 45 96 36 39

WW – 014 FOR FURTHER DETAILS

Item No.		
1	TEKTRONIX PORTABLE OSCILLOSCOPE type 422. Dual Trace	£350
2	TEKTRONIX STORAGE MONITOR type 613	£495
3	TEKTRONIX Dual Trace OSCILLOSCOPE type 581A with CA Plug-in	£160
4	TEKTRONIX CURVE TRACER type 575	£150
5	TEKTRONIX AMPLIFIER type 1121	£40
6	TEKTRONIX SAMPLING PLUG-IN type 1S1	£175
7	TEKTRONIX PLUG-IN type O Single Trace High Gain DC Differential	£20
8	TEKTRONIX PLUG-IN type E Single Trace Low Level AC Differential	£20
9	TEKTRONIX PLUG-IN type G Single Trace Wide Band DC Differential	£25
10	TEKTRONIX PLUG-IN type L Single Trace 30MHZ High Gain	£25
11	TEKTRONIX PLUG-IN type M 4 Trace DC-20MHZ	£125
12	TEKTRONIX PLUG-IN type O Operational Amplifier	£95
13	TEKTRONIX PLUG-IN type Q Transducer & Strain Gauge	£75
14	TEKTRONIX PLUG-IN type R Transistor Rise Time	£75
15	TEKTRONIX PLUG-IN type W Differential Comparator	£125
16	TEKTRONIX PLUG-IN type Z Differential Comparator	£75
17	HEWLETT PACKARD LCR BRIDGE type 4261A	£795
18	HEWLETT PACKARD QLC METER type 4342A	£1,150
19	HEWLETT PACKARD DC CURRENT SOURCE type 6181B 0-100V; 0-250MA	£125
20	HEWLETT PACKARD WIDE RANGE OSCILLATOR type 200CD	£35
21	HEWLETT PACKARD AUDIO OSCILLATOR type 200J	£35
22	HEWLETT PACKARD PULSE GENERATOR Model 212A	£25
23	HEWLETT PACKARD DC MICRO VOLT AMMETER type 425A	£40
24	HEWLETT PACKARD OSCILLOSCOPE 182A with 1808A and 1825A. 75MHZ Dual Trace Delayed Sweep	£950
25	HEWLETT PACKARD DIGITAL VOLTMETER type 3430A	£65
26	HEWLETT PACKARD VACUUM TUBE VOLTMETER type 410B with Probes	£30
27	MARCONI IN SITU UNIVERSAL BRIDGE type TF2701. Battery Operated	£95
28	MARCONI WIDE RANGE OSCILLATOR type TF1370. 10HZ-10MHZ	£65
29	MARCONI (SANDERS) MICROWAVE POWER METER type 6598	£150
30	MARCONI UHF SIGNAL GENERATOR type TF1060	£95
31	MARCONI FM SIGNAL GENERATOR type TF1077/1 19.7-102.5MHZ	£30
32	MARCONI UNIVERSAL BRIDGE type TF1313. 0.25%	£185
33	MARCONI VARIABLE ATTENUATOR type TF1073A/2S (CT421)	£30
34	MARCONI UNIVERSAL BRIDGE type TF2700	£195
35	MARCONI AM/FM SIGNAL GENERATOR TF995A/3/S (CT402) 1.5-220MHZ	£200
36	MARCONI AC MILLIVOLTMETER type TF2600 10HZ-5MHZ; 1mV-300V	£95
37	B & K ACCELEROMETER PREAMPLIFIER type 262	£30
38	B & K DEVIATION BRIDGE type 1503	£50
39	B & K DEVIATION BRIDGE type 1504	£65
40	B & K MICROPHONE AMPLIFIER type 2602	£55
41	B & K MICROPHONE AMPLIFIER type 2605	£30
42	B & K BEAT FREQUENCY OSCILLATOR type 1013	£95
43	B & K BEAT FREQUENCY OSILLATOR type 1018	£50
44	B & K AUDIO FREQUENCY SPECTROMETER type 2112	£225
45	B & K FREQUENCY RESPONSE TRACER type 4707	£200
46	B & K LEVEL RECORDER type 2305. 50dB Potentiometer. Brand new with accessories	£650
47	TEXAS SILENT 700 PRINTER Model KSR733 — 300 baud	£275
48	CALCOMP DRUM PLOTTER Model 564	£395
49	MOSELEY WAVEFORM TRANSLATOR type 101	£50
50	HOUSTON INSTRUMENTS LOG VOLTMETER-CONVERTOR Model HLVC150	£75
51	POLARAD FIELD STRENGTH METER type FIM-B2 with RF Tuning Unit FIM-X2 7360-10,000MHZ	£95
52	POLARAD MICROWAVE RECEIVER MODEL R with RF Tuning Units covering 400-2950MHZ and 7400-22,000MHZ	£150
53	POLARAD MICROWAVE SIGNAL GENERATOR Model MSG-1 950-2400MHZ	£150
54	POLARAD MICROWAVE SIGNAL GENERATOR Model MSG-2 2150-4600MHZ	£150
55	GENERAL RADIO MICROWAVE OSCILLATOR type 1360B 1.7-4.1GHZ	£275
56	GENERAL RADIO FREQUENCY/DISCRIMINATOR METER type 1142A 0-1.5MHZ	£95
57	GENERAL RADIO OSCILLATOR 1209C; 1209CL; 1215C with Power Unit type 1263B 50-980MHZ	£95
58	GENERAL RADIO DECADE CAPACITOR 1413 with ANALOG LIMIT COMPARATOR 1782 and IMPEDANCE COMPARATOR 1654	£150
59	STODDART RADIO INTERFERENCE & FIELD INTENSITY METER type N-M 52A	£195
60	KEITHLEY REGULATED HIGH VOLTAGE SUPPLY type 241	£145
61	BRANDENBURGH HIGH VOLTAGE GENERATOR type MR50	£75
62	BRANDENBURGH HIGH VOLTAGE P.U. Model 705. Metered 0-15KV. +/-	£100
63	BELIX POWER UNIT type CMT3001. +/- 0-1000 Volts in 3 ranges	£40
64	PLESSEY TELEGRAPH SIGNAL GENERATOR TSG10 with TOMS type 70. Speed 50-75-100 (2 units)	£60
65	As Above but SPEED 45.5 -50 -75	£80
66	RACAL H.F. SELECTIVE ANALYSER type 9056	£235
67	RACAL UHF FREQUENCY METER type 9839. 10-560MHZ	£225
68	RACAL 600MHZ DECADE DIVIDER type 9010	£40
69	RACAL AUTO FREQUENCY CONVERTOR type 803R 500MHZ	£20
70	RHODE & SCHWARZ NOISE GENERATOR SKTU BN4151/2/50 3-1000MHZ	£75
71	R & S UHF TEST RECEIVER BN1523 280-940MHZ	£50
72	R & S FREQUENCY METER VHF-UHF 30-300MHZ type W10 BN442	£40
73	R & S ATTENUATOR type DPR BN18042/50	£25
74	R & S RESONANCE FREQUENCY METER 30-500MHZ WAM BN4312/2	£50
75	R & S SELEKTOMAT USVW BN15221/2	£50
76	R & S UHF MILLIVOLTMETER URV BN1091	£65
77	R & S CAPACITANCE METER BN5201	£50
78	ISOLATING TRANSFORMER 240V Input 240V Output 1300 Watts	£15
79	AUTO TRANSFORMER +/- KVA Pri Volts 90/240 Sec Volts 115	£15
80	DC SERVO MOTOR 110V 2.5A Cont. Double Shaft. 4 wire 4 brush. New	£15
81	CLAUDE LYONS AUTOMATIC VOLTAGE STABILISER. Input 204-252 Volts Output 240V +/- 0.3% 13A 3.12KVA	£75
82	PHILIPS VIDEO COLOUR TEST GENERATOR type PM5522	£175
83	As above but NO CASE	£145
84	PHILIPS FM STEREO GENERATOR type PM6456. Separate L & R Signals Carrier Freq 100MHZ +/- 1% RF O/P 3mV pk-pk	£125
85	PHILIPS COMPARATOR 278KHZ	£30
86	PHILIPS AUTOMATIC ELECTRONIC VOLT OHM METER type PM2405	£20
87	KAY ELECTRIC VARI-SWEEP Model 400 15-470MHZ	£150
88	HEWLETT PACKARD DC POWER SUPPLY type 6448B. 0-600 Volts 0-1.5 Amps	£295
89	ADVANCE UHF SIGNAL GENERATOR SG69 370-1040MHZ	£125
90	ADVANCE PULSE GENERATOR type PG5002D	£20
91	ADVANCE LF OSCILLATOR TYPE SG65A	£50
92	ADVANCE GENERATOR type 62A 150KHZ-220MHZ	£35
93	ADVANCE BEAT COUNTER type 4B41	£20
94	ADVANCE AUDIO SIGNAL GENERATOR type J1A	£30
95	ADVANCE SIGNAL GENERATOR type E2 100KHZ-100MHZ	£45
96	PYE SCALAMP 40KV RMS Max ELECTROSTATIC VOLTMETER	£55
97	PYE SCALAMP 20KV RMS Max ELECTROSTATIC VOLTMETER	£35
98	RANK ABENA E.H.T. METER 0-30KV	£35
99	SINE & SQUARE WAVE AUDIO GENERATOR type TE-22 20HZ-200KHZ	£35
100	BLACK & WHITE 20" MONITOR by IKEGAMI type PM201TS. Solid State	£65

PLEASE CHECK AVAILABILITY BEFORE ORDERING
COMPONENT LIST AVAILABLE S.A.E. OR PHONE

MARCONI AM/FM SIGNAL GENERATOR
type TF1066B/6S
10-470 MHZ in 5 bands
£275 each

WAYNE KERR COMPONENT BRIDGE
type B521 (CT 375)
Resistance 1mOhm – 1000 MegOhm
Capacitance 50 KμF – 500 pF
Inductance 1μH – 500 kH
with copy of manual
ONLY £40 each

AVO VALVE TESTER type CT160
(22 valve bases) with copy of manual
£20 each
Copy of Valve Data **£5**
(only available with unit)

AVO TRANSISTOR ANALYSER
type CT446 with copy of manual
£20 each
Copy of Transistor Data **£5**
(only available with unit)

AVO SIGNAL GENERATOR
No. 2 AM/FM
AM 0.45-225 MHZ; FM 20-100 MHZ
with copy of manual
£75 each

MARCONI COUNTER/FREQUENCY METER
TF1417/2 with Convertor type
TF 2400/TM7164 – 500 MHZ
£35

SINE & SQUARE WAVE AUDIO GENERATOR
type TE-22, 20HZ-200KHZ. Portable as new
ONLY £35 each. P&P £4

MULTIMETER
Russian Type 4324
AC/DC volts; AC/DC current; ohms, etc.
Brand new, boxed.
£12.50 each. P&P £2.50

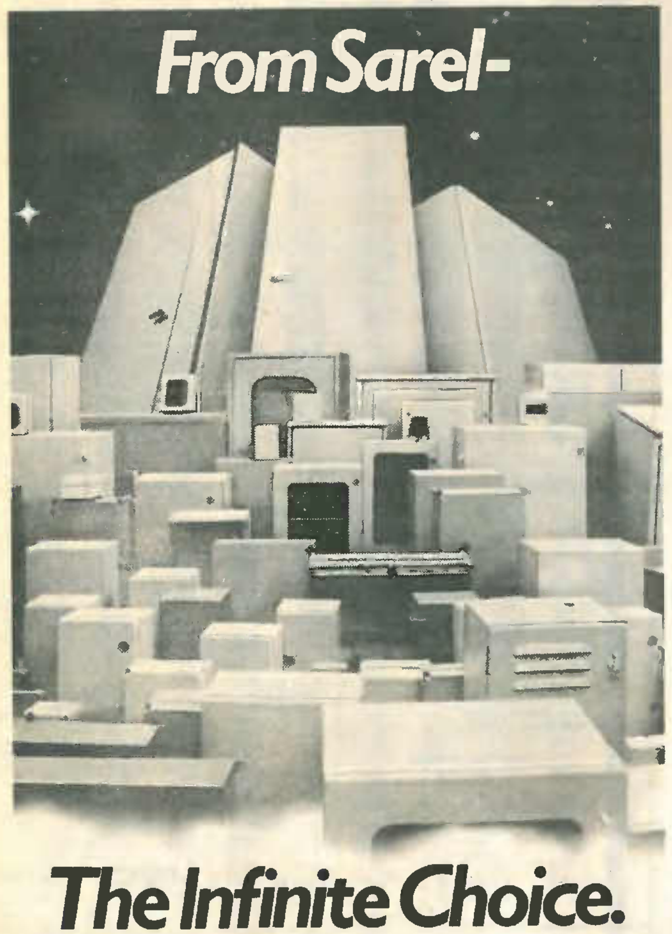
IKEGAMI MONITOR
20" Black & White
Solid state. Video in, int. ext. Sync.
£65 each

TELETYPE PRINTERS
KSR 33 – ASCII Keyboard **£50**
ASR 33 – as above with 8-bit Punch and Reader **£75**
PDP 8 in 6ft RACK CABINET **£100**

BARCLAYCARD (VISA) and ACCESS taken. Official orders welcome
CALLERS VERY WELCOME STRICTLY BETWEEN 9am-1pm and 2-5pm Monday to Saturday inc.
All units £6 carriage. Plus V.A.T. on total

CHILTMEAD LTD

NORWOOD ROAD, READING   **TELEPHONE NO. READING 669656**
(2nd turning left past Reading Technical College in King's Road then first right – look on right for door with "Spoked Wheel")



Enclosures, desks, cabinets, boxes and accessories — whatever your needs, the choice is enormous — available ex-stock from Luton and through our 52 national distributors.
In all shapes — from the big 'H' Range of adaptable enclosures to front and top opening control desks.
In all sizes — from the smallest electronic assembly box to the giant monobloc 18000 Series (2100 × 1200 × 400mm).
In all finishes — watertight steel, corrosion resistant plastic and tough glass fibre reinforced polyester.
Whatever your choice, our highly trained sales staff can offer a total service.
Assuring fast reliable delivery, at the right price — to the right place — and right on time.
It'll pay you to choose Sarel, we have some great special net price quotations on large orders — phone now on Luton 20122 or clip the coupon for our comprehensive, fact-packed catalogue and price list.

Sarel — the infinite choice for enclosures.

Think big – think Sarel
Sarel Electric Limited
Cosgrove Way, Luton, Beds. Tel: Luton 20122

I am very interested to learn more about your full enclosure range.
Name ....
Position ....
Company ....
Address ....

WW – 006 FOR FURTHER DETAILS

www.americanradiohistory.com

TEST COMPONENTS
ON THIS NEW OSCILLOSCOPE

...from Farnell

USE READER CARD FOR DETAILS

WW – 047 FOR FURTHER DETAILS

CHILTERN ELECTRONICS
B.C.M., Box 8085, London WC1N 3XX. Tel. 0494 714483

MAIL ORDER BARGAINS
All prices include VAT and Postage – Same-day despatch

CYCLON POWER PACKS. Chloride CYCLON power batteries deliver the same power as a car battery, at a fraction of the size/weight, but are completely sealed and can be used in any position. Charge at any rate on an ordinary car charger. Extremely rugged and virtually everlasting, these batteries are usually used on expensive aircraft systems. Two in series make ideal heavy duty supply for mobile 12-volt systems. Rated 6v 25 AH. Brand new, straight from USA, and not out of date – and at a quarter of list price .... **£28.75 inc. VAT/Postage**

GOULD SWITCH-MODE POWER SUPPLIES, 5v 20 amps. (BRAND NEW). These little pocket size modules weigh less than 4lbs. but deliver full 20 amps at 5v. Add a pot to make variable 0-6v, or connect in series for higher voltages. 0.1% Regulation and full over V/I protection. List price £250+. .... **Our price £40.25**

PROTOTYPE PC CARDS. Over 200 Common ICs (most 7400 series) in wire wrap sockets on useful wire-wrap cards. ICs/Sockets easily removed – no unsoldering .... **Only £11.50**

VIDEO MONITORS 9-INCH. Standard Composite Video in. 240v PSU. Excellent definition – ideal for micro. Complete with service manual and ready to plug in **£34.50**

ASCII KEYBOARDS. Top quality 84-key ASCII with all U/L Case and Control codes in case **£34.50**

POWER SUPPLIES 5v 3 amp. Standard Mains Input – out 5v 3a fully regulated and protected **£11.50**

EPROMS–TMS 2518. Brand new – these usually cost around £3 to £5 each. .... **Our price £13.80 for 10**

MODEM PROTECTION BOXES RS232. Completely isolate your valuable system from over voltage – consists of 2 RS232 Cannon Connectors, one on long lead, and neat aluminium box with 16 Zener diodes and fuses. If you are using external lines, connect this between your system and it could save you thousands of pounds **£11.50**

WE STOCK COMPLETE RANGE OF DEC SYSTEMS FROM PDP8E TO PDP11/70 AND VAX
FOR MORE DETAILS
TELEPHONE NIGEL DUNN ON 0494 714483, ANY TIME
For regular copies of our catalogue please send postcard with address

WW – 051 FOR FURTHER DETAILS

PM COMPONENTS LTD
VALVE & COMPONENTS SPECIALISTS

INTEGRATED CIRCUITS

SEMICONDUCTORS

BC148B	0.09	BD136	0.30	BF259	0.28	R2008B	1.70	2SC2091	0.85
BC149	0.09	BD137	0.28	BF271	0.26	R2010B	1.70	2SC2314	0.80
BC157	0.10	BD138	0.30	BF273	0.13	R2322	0.58	3N211	1.50

DIODES

AA119	0.08	BY126	0.10	BYX36-150R	0.20	IN4001	0.04	IN5405	0.13
BA102	0.17	BY127	0.11	BYX38-600R	0.60	IN4002	0.04	IN5406	0.13
BA115	0.13	BY133	0.15	BYX55-600	0.30	IN4003	0.04	IN5407	0.16
BA145	0.16	BY164	0.45	BYX71-600	0.60	IN4004	0.05	IN5408	0.16
BA148	0.17	BY176	1.20	OA47	0.09	IN4005	0.05	ITT44	0.04
BA154	0.06	BY179	0.63	OA90	0.05	IN4006	0.05	ITT827	0.48
BA155	0.13	BY206	0.14	OA91	0.06	IN4007	0.06	ITT921	0.09
BA156	0.15	BY208-800	0.33	OA95	0.06	IN4148	0.02	ITT923	0.15
BAX13	0.04	BY210-800	0.33	OA202	0.10	IN4448	0.10	ITT2002	0.11
BAX16	0.06	BY223	0.90	IN60	0.06	IN5401	0.12		
BB105B	0.30	BY298-400	0.22	IN914	0.04	IN5402	0.14		
		BY299-800	0.22			IN5403	0.12		
		BYX10	0.20			IN5404	0.12		

SPECIAL TUBE
M17.151 GV/R
198.00

WIREWOUND RESISTORS

PREFERRED VALUES

4 Watt	4R7-1K8	0.15
	2K2-6K8	0.18
	10K	0.24
7 Watt	R47-4K7	0.18
	5K6-12K	0.19
	15K-22K	0.20
11 Watt	1R-10K	0.20
	15K-22K	0.24
17 Watt	1R-10K	0.26
	15K-22K	0.28

BASES ETC.

B7G	0.15
B7G Skirted	0.30
B8G	0.70
B9A	0.20
B9A Skirted	0.30
B10B	0.16
B13B	0.50
8 Pin DIL	0.10
14 Pin DIL	0.12
14 Pin DIL/Q	0.30
16 Pin DIL	0.15
OCTAL	0.35
CANS	0.27

ZENER DIODES

BZX61 0.15
6V2 7V5 8V2 9V1 10V 11V 12V 13V 15V 16V 18V 20V 22V 24V 27V 30V 33V 36V 39V 47V 51V 56V 68V 75V

BZY88 0.07
2V7 3V 3V3 3V6 3V9 4V3 4V7 5V1 5V6 6V2 6V8 7V5 8V2 9V1 10V 11V 12V 13V 15V 18V 20V 24V 27V 30V

THERMISTORS

VA1040	0.23
VA1056S	0.23
VA1104	0.70
VA8650	0.45

BATTERIES

7V Power Mike batteries
TR175 £1.40 ea
other prices on request

PHONE
0474 813225
3 LINES

P. M. COMPONENTS LTD
SELECTRON HOUSE, WROTHAM ROAD
MEOPHAM GREEN, MEOPHAM, KENT DAI3OQY

TELEX
965966
WEST ST G

A SELECTION FROM OUR STOCK OF BRANDED VALVES

A1714	14.50
A1998	11.50
A2087	11.50
A2134	14.50
A2293	7.20
A2426	22.50
A2521	19.00
A2599	37.50
A2900	15.00
A3042	24.00
AC/HL/DD	3.00
AC/THI	2.50
AC/PEN	3.50
AC/SP3	4.50
ACP	3.00
ACVP1	3.50
ACVP2	3.50
AH201	4.00
AH221	39.00
AH238	31.50
AP4	1.50
APV4	1.50
AR8	0.70
ARP12	0.70
ARP34	2.00
ARP35	1.50
ARP37	1.00
AU13	1.50
AZ31	2.00
B2A	6.00
B36	1.85
B65	0.69
B349	0.75
B719	0.80
B729	1.20
BL63	1.20
BS450	87.00
BS810	63.00
BT5B	43.50
BT17A	95.00
BT19	32.50
BT79	12.50
CIK	14.00
C3JA	16.00
C143	18.50
C180	18.50
C1108	55.00
C1111	15.50
C1112	52.16
C1134	15.50
C1148A	60.00
C1534	32.00
CBL31	2.00
CCA	2.60
CL30	1.05
CMG25	9.00
CMG29	10.85
CMV25	10.00
CV Nos prices on request	
D3a	35.00
D63	0.60
DA107	6.00
DAC32	1.20
DAF91	0.45
DAF96	0.65
DC70	1.75
DC90	1.20
DCX4-1000	35.00
DET10	6.00
DET22	28.00
DET24	45.00
DF33	2.50
E236L	9.00
E280F	19.50
E283CC	8.25
E810F	12.50
E2134	12.00
EA50	1.00
EA52	29.00
EA76	2.00
EAA91	0.60
EAA901S	1.50
EABC80	0.56
EAC91	0.90
EAF42	1.40
EAF801	1.40
EB34	1.50
EB41	2.30
EB91	0.52
EBC21	1.50
EBC33	2.50
EBC41	0.85
EBC81	0.85
EBC89	0.85
EBC90	0.75
EBC91	0.75
EBF33	2.50
EBF80	0.50
EBF85	0.95
EBF89	0.70
EBF93	0.95
EBL1	1.50
EBL21	2.00
EBL71	4.00
EC52	1.25
EC80	4.25
EC81	4.50
EC86	1.00
EC88	1.00
EC90	0.60
EC91	7.00
EC93	0.80
EC95	7.00
EC8010	6.00
ECC32	3.00
ECC33	4.00
ECC34	4.00
ECC35	4.00
ECC40	2.30
ECC80	1.50
ECC81	0.55
ECC82	0.55
ECC83	0.60
ECC82 Philips	1.10
ECC83 Philips	1.10
ECC84	0.80
ECC85	0.60
ECC86	1.66
ECC88	0.65
ECC88 Mullard	1.85
ECC91	0.65
ECC180	0.72
ECC189	0.78
ECC230	4.50
ECC801S	2.50
ECC803S	2.50
ECC804	0.40
ECC808	3.15
ECC2000	12.00
ECF80	0.65
ECF82	0.60
ECF86	1.50
ECF802	1.20
EL84	0.66
EL85	3.85
EL86	0.80
EL90	0.82
EL91	6.00
EL95	0.70
EL183E	3.50
EL183P	3.50
EL360	8.35
EL503	19.00
EL504	1.40
EL508	1.90
EL509	3.75
EL519	4.50
EL802	1.40
EL821	10.00
EL822	10.00
EM1	4.00
EM4	9.00
EM34	11.00
EM80	0.70
EM81	0.70
EM84	0.70
EM85	0.85
EM87	1.10
EMM803	2.50
EN10	8.00
EN32	9.00
EN91	0.96
EN92	4.00
ESU101	11.50
ESU103	12.00
ES1500	115.00
ET1	11.00
EY3	2.50
EY51	0.80
EY84	8.00
EY84W	10.00
EY86/87	0.50
EY88	0.60
EY91	1.00
EY500A	1.50
EY802	0.70
EZ35	0.80
EZ40	2.00
EZ41	1.25
EZ80	0.75
EZ81	0.56
EZ90	0.96
F6059	3.20
F6060	2.50
F6158	2.75
F6870	6.00
FW4/500	2.00
G1/371K	30.00
G55/1K	8.00
G120/1B	8.00
G150/2D	4.00
G180/2M	9.00
G400/1K	14.00
G550	11.50
GC10B	11.50
GC10D	11.50
GC10/4B	11.50
GC10/4E	11.50
GD85M/S	2.00
GD87M	1.75
GD90M	2.10
GD86W	6.00
GDT120M	5.00
GN4	4.00
GN10	15.00
GN24	1.50
GR10G	4.00
KTW63	1.50
KTZ41	2.00
KTZ63	1.25
KY50	0.68
KY80	0.90
L63	1.00
L102/2K	8.00
L120/2K	12.00
LF183	0.90
LS731	28.00
LZ319	0.65
LZ329	0.65
LZ339	0.40
M502A	135.00
M537A	160.00
M5143	165.00
M8079	6.00
M8083	3.25
M8091	7.50
M8096	3.00
M8100	2.85
M8136	7.00
M8137	5.50
M8162	5.50
M8163	3.85
M8190	3.85
M8195	3.00
M8196	3.25
M8204	2.00
M8223	1.50
M8224	1.50
M8225	1.20
ME1400	4.00
ME1501	14.00
MH4	3.50
MH41	3.50
MHLD6	1.50
ML4	4.50
MS4B	5.00
MU2	11.75
MU12	1.50
MU14	1.50
N78	16.50
N118	1.00
N119	0.78
N154	0.60
N308	0.52
N329	0.60
N369	1.50
N379	0.65
N709	0.68
N727	0.82
NGT1	1.00
NR14	9.00
NR48	1.00
NR64	1.50
NR68	1.20
NR73	3.50
NR81	1.00
NR82	0.85
NU3	1.50
NU7	11.75
NU17	1.50
NU18	1.50
NU20	0.86
OA2	0.60
OA2WA	1.50
OA3	3.95
OB2	0.65
OB2WA	1.25
OC3	1.05
OD3	1.70
OE3	5.40
OG3	2.00
OM3	0.60
OM4	1.00
OM5B	3.60
OM6	1.75
PL83	0.52
PL84	0.65
PL88	1.00
PL95	1.00
PL302	1.00
PL345	12.50
PL500	1.12
PL504	1.20
PL508	1.75
PL509	3.50
PL519	3.50
PL801	1.50
PL802	2.95
PL820	3.00
PL806	2.75
PL6574	9.00
PT4	6.00
PT15	4.50
PY31	0.60
PY32	0.60
PY33	0.60
PY81	0.70
PY82	0.55
PY83	0.70
PY88	0.74
PY500A	1.70
PY800	0.70
PY801	0.70
PZ30	0.60
Q13-110BA	47.50
QB3-300	30.50
QE03-10	3.50
QE08-200	130.00
QP25	1.00
QQE02-5	12.75
QQE03-12	4.50
QQE03-20	27.00
QQE06-40	19.50
QQV02-6	12.75
QQV03-10	4.50
QQV03-20A	17.00
QQV03-20B	32.00
QQV06-40A	18.00
QQZ06-40A	45.25
QS75/20	2.50
QS75/40	3.00
QS83/3	2.00
QS95/10	4.85
QS108/45	4.00
QS150/15	5.00
QS150/30	1.15
QS150/40	1.15
QS150/45	7.00
QS1200	3.95
QS1202	3.95
QS1203	4.15
QS1205	3.95
QS1206	1.05
QS1207	0.90
QS1208	0.90
QS1209	2.00
QS1210	1.50
QS1211	1.50
QS1212	3.20
QS1213	5.00
QS1215	2.10
QU37	15.00
QV03-12	3.50
QV04-7	5.00
QV05-25	1.75
TB2-300	45.00
TD1-100	19.00
TD03-10F	28.00
TD3-12	4.00
TP25	1.50
TT11	1.50
TT21	14.75
TT22	14.75
TY2-125A	45.00
TY3-250	45.00
TY4-350	90.00
TY4-400	60.00
TY4-500A	85.00
TY7-6000A	315.00
TY8-600W	315.00
TYS2/250	750.00
U10	1.50
U12	1.50
U14	1.50
U15	1.50
U17	1.50
U18-20	2.00
U19	11.95
U22	1.00
U24	2.00
U25	0.68
U26	0.90
U27	1.50
U37	12.00
U41	0.70
U50	2.00
U52	1.00
U54	4.50
U82	3.00
U191	0.70
U193	0.65
U281	1.00
U282	1.00
U291	0.60
U301	0.60
U309	0.60
U801	0.80
UABC80	0.65
UAF42	1.00
UBF80	0.80
UBC81	1.00
UBF89	0.60
UBL21	1.20
UC92	0.80
UCC84	0.70
UCC85	0.60
UCH21	1.20
UCH41	1.20
UCH42	1.20
UCH81	0.65
UCL82	0.76
UCL83	1.75
UF41	1.15
UF42	1.15
UF80	0.80
UF86	1.10
UF89	1.10
UL41	1.85
UL84	0.78
UU5	2.50
UU7	8.00
UU8	8.00
UY1N	0.90
UY41	1.95
UY85	0.70
UY224	2.50
V339	3.50
V884	2.50
YL1071	98.50
YL1370	5.50
Z63	1.00
Z66	1.00
Z77	1.20
Z300T	5.00
Z303C	9.00
Z502C	12.00
Z504S	13.50
Z700U	1.00
Z749	0.48
Z759	16.00
Z800U	4.00
Z801U	4.00
Z803U	13.50
Z7014	9.00
ZA101	5.00
ZA1000	9.00
ZA1002	1.48
ZC1040	8.00
ZM1001	5.00
ZM1005	6.00
ZM1020	4.00
ZM1021	8.00
ZM1023	6.00
ZM1041	13.00
ZM1080	12.50
ZM1084	10.00
ZM1202	78.00
ZM1263	4.00
ZM1612	3.00
ZX1000	5.00
ZX1061	5.00
1AC6	1.20
1AH5	0.65
1AJ4	0.65
1B22	10.00
1B3GT	1.00
1B5	2.50
1C1	1.20
1C2	1.20
1C5GT	1.00
1D5	1.00
1FD1	0.90
1G3GT	1.00
1L6	1.50
1LA6	1.00
1M1	1.10
1N5GT	2.50
1S2	0.55
1T4	0.55
1U5	1.00
1X2A	1.15
1XBB	1.15
2AS15A	11.00
2B46	4.95
2C21	1.00
2C34	1.00
2C39A	19.00
2C42	4.00
2C51	0.75
2B7	1.50
2D21	0.95
2D21W	2.00
2E26	11.00
2K25	17.50
3A/147J	7.50
3A/167M	10.00
3A2	3.00
3A3A	3.00
3A4	1.10
3AT2	1.75
3AW2	3.35
3B28	12.00
3C4	1.00
3C45	12.50
3D21A	24.00
3W4GT	2.50
6/30L2	0.70
6A/203K	9.00
6A6	1.50
6A8G	1.50
6AB7	0.60
6AB8	0.66
6AC7	1.00
6AF4A	1.20
6AG7	1.20
6AH6	1.00
6AJ7	2.00
6AK5	0.60
6AK6	2.00
6AL5	0.52
6AM4	2.50
6AM5	6.00
6AM6	1.30
6AM8A	2.00
6AN5	2.00
6AN8A	2.50
6AQ5	0.82
6AR5	2.00
6AR8	2.00
6AS5	1.50
6AS6	2.50
6AS7G	6.00
6AT6	0.80
6AV5GTA	1.50
6AU6	0.55
6AV6	0.72
6AW8A	2.50
6AZ8	1.80
6B8G	0.75
6B10	2.50
6BA6	0.50
6BA6W	3.00
6BA7	3.75
6BA8A	3.50
6BC8	1.00
6BD6	1.10
6BE6	0.72
6BF5	1.10
6BH6	1.60
6BH8	1.00
6BJ6	1.05
6BK4	2.75
6BK7A	1.50
6BM8	0.58
6BN4	1.25
6BN6	1.30
6BN7	3.50
6BN8	2.00
6BQ5	0.80
6BQ6GA	2.00
6BQ7A	0.72
6BL8	0.65
6BR5	0.70
6BR7	3.75
6BR8	1.20
6BR8A	1.20
6BS7	3.30
6BS8	1.88
6BU6	2.00
6BU8	1.15
6BW4	1.30
6BW6	4.50
6BW7	0.75
6BW8	4.00
6BX7GT	2.00
6BZ6	2.00
6BZ7	2.50
6BZ8	0.95
6C4	0.60
6C6	0.50
6C8G	1.25
6C11	2.50
6C15	2.50
6C18	2.50
6F17	3.00
6F18	1.50
6F19	0.48
6F21	2.50
6F22	0.70
6F23	0.48
6F24	1.25
6F25	1.25
6F26	0.48
6F28	1.25
6F33	19.00
6FG5	1.50
6FH5	1.50
6FN5	1.50
6FL2	1.50
6GH8A	0.80
6GK5	1.00
6GK6	2.00
6H2N	0.70
6H3N	0.70
6H6	1.35
6H6GT	1.20
6HG8	1.50
6HZ6	1.00
6J5GT	0.75
6J6	0.55
6J7	1.05
6J7GT	1.25
6JB6A	3.95
6JE6	2.10
6JE6C	3.50
6JS6A	4.00
6JS6C	3.50
6K4N	1.00
6K7	1.50
6K7G	0.70
6K8GT	1.75
6KD6	4.50
6L1	2.50
6L6GC	1.90
6L6GT	1.20
6L7	0.55
6L15	1.50
6L17	1.50
6L18	0.60
6L19	1.00
6LD3	0.85
6LD20	0.60
6P15	0.60
6P25	4.00
6P28	2.00
6Q7	1.20
6S2	0.50
6S2A	0.50
6S7	1.10
6SC7	1.20
6SG7	1.20
6SJ7	1.20
6SK7	0.80
6SK7GT	1.20
6SL7GT	0.72
6SN7GT	0.69
6SS7	1.50
6U4GT	1.75
6U5G	2.50
6U8	0.60
6U8A	1.00
6V4	0.75
6V6GT	0.90
6W4GT	1.00
6X2	0.80
6X2N	1.00
6X4	0.96
6X5GT	0.60
6X8A	2.25
7A3	4.00
7A6	2.00
7A7	2.00
11E2	16.50
11E3	55.00
12A4	2.50
12AC6	0.80
12AD6	0.80
12AE6	0.85
12AG6	1.50
12AH7GT	0.85
12AH8	5.50
12AL5	1.00
12AT6	0.59
12AT7	0.55
12AT7WA	2.50
12AU6	0.80
12AU7	0.55
12AV6	0.80
12AX4GT	1.00
12AX7	0.60
12AX7WA	2.50
12AY7	4.00
12AZ7A	1.50
12B4A	1.60
12BA6	0.75
12BE6	1.05
12BH7	0.95
12BH7A	0.95
12BL6	0.70
12BY7A	3.75
12C8GT	0.70
12CX6	1.20
12E1	16.50
12E14	28.00
12GN7	3.95
12HG7A	3.95
12J5GT	0.48
12J7GT	0.70
12K5	1.00
12K7GT	0.60
12K8	1.10
12Q7GT	0.50
12S7	1.00
12SA7GT	1.00
12SJ7	0.60
12SL7	1.50
12SN7GT	1.85
12SR7	0.70
12U7	1.50
12Y4	0.60
13D3	3.20
13D7	3.20
13E1	97.50
14K7	1.20
14S7	1.00
15A6	1.00
15D2	1.00
15E	1.00
17DW4A	1.75
17JZ8	1.60
18D3	1.60
19AQ5	0.70
19G6	9.00
20A2	4.00
20D1	0.70
20D4	1.75
20F2	0.75
20K	1.00
20L1	0.95
20P1	0.55
20P3	0.60
20P4	1.05
20P5	1.15
29C1	19.50
30	2.85
30C1	0.70
30C15	0.40
30C17	0.40
30C18	2.00
85A1	5.40
85A2	2.00
89	1.20
90AV	10.00
90C1	2.10
90CG	10.85
91AG	10.00
92AG	10.00
92AV	10.00
150B2	3.00
150B3	3.90
150C4	1.50
150CV	150.00
155UG	25.00
185BT	1.50
257A	8.00
329	5.00
408A	4.00
431U	2.00
708A	5.00
715A	6.00
715C	15.50
801A	2.00
803	16.00
807	1.50
808	3.00
811A	9.00
813	18.50
833A	115.00
836	7.00
845	8.00
866A	3.00
868	5.00
885	2.00
954	0.50
955	0.90
958A	0.90
1267	7.00
1299A	0.60
1927	5.00
2050	8.00
4212E	230.00
5557	19.50
5636	3.00
5642	5.00
5651	1.75
5654	1.95
5670	3.50
5675	5.15
5683	14.00
5692	3.50
5696	2.55
5718	3.50
5725	3.50
5726	1.50
5727	2.00
5749	2.00
5750	2.00
5751	1.50
5763	3.50
5814A	2.75
5840	2.50
5842	6.50
5876	8.25
5879	3.90
5899	2.00
5915	2.00
5963	1.50
5965	2.25
5993	8.00
6005	3.50
6057	1.85
6059	3.75
6060	1.50
6064	1.85
6067	1.50
6072	4.20

★ WE HAVE NOW MOVED TO LARGER PREMISES ★

CALLERS WELCOME

★ ENTRANCE ON A227 BY THE "LITTLE BLUE HOUSE" 50 YDS SOUTH OF MEOPHAM GREEN

CAR PARKING AVAILABLE

★ HOURS: MON.–FRI. 9.00–5.30. SATURDAY 9.30–12.00
★ 24 HOUR ANSWERPHONE SERVICE ★
ACCESS AND BARCLAYCARD ORDERS WELCOME
★ MANY OTHER ITEMS AVAILABLE ★

UK ORDERS P&P 50p PLEASE ADD V.A.T. AT 15%

EXPORT ORDERS WELCOME. CARRIAGE/POST AT COST

WW – 049 FOR FURTHER DETAILS

www.americanradiohistory.com

B. BAMBER ELECTRONICS

Airmec Millivolt Meter Type 301A £50
Pye UHF Signal Generator Type SG1U £150
Marconi AM/FM Signal Generator Type TF1066 B/6 .... £300
Marconi 20 mHz Sweep Generator Type TF1099 .... £25
Motors suitable for driving cam switches 120volt AC 1 RPM .... £1 each
Advance Signal Generator Type C2 .... £25
Servomex AC Voltage Stabiliser 240v.a.c. 9 amp £25
Cathode Ray Tubes Type M38-100LG & M28-233GH new & boxed .... £5 each
Very Large Capacitors 8 mfd 7-10 KV D.C. Wkg. £25
Modern Telephones 746 style two tone grey, used but good condition .... £8 each
Scottish Instruments Microfiche Reader Model M20 £25
Antique Cambridge Portable Electrocardiograph £50
Mains Isolating Transformer 500 VA 240volt input, 240volt C.T. output housed in metal box but less lid .... £15 each
Volstat Constant Voltage Transformer 190-260 volt input, 240 volt RMS output 250 watt £45
Gould 25 watt miniature switching power supplies 5 volt 5 amp £25
Marconi AM/FM Signal Generator Type TF995A/5 £250
Belix Power Unit Type TSS 156 0-30 volt 0-15 amp. Var. £40
Avo Valve Characteristic Meter MK IV £55
Marconi Carrier Deviation Meter Type TF791D £185
Airmec Modulation Meter Type 210 .... £75
Schomandl Frequency Meter Type FD1 30-900 mHz £50
EEL Street Lighting Photometer Type 106/2 .... £40
Marconi HF Spectrum Analyser Type OA 1094A/S £100
Meguro Signal Generator Type MG6-230E 16kHz-50mHz £185
Rhode & Schwarte Polyskop SWOB 1 Type BN4244/2/75 .... £250
Sinclair Digital Multimeter Type DM450 .... £95
Telequipment Scope Type S51B £95
Hewlett Packard Spectrum Analyser Type 851B £1200
PYE WESTMINSTER W15 AMD mid-band multichannel sets only. No mikes, speakers, cradles or leads. **£45**

PYE WESTMINSTER W15 AMD mid-band crystalled and converted to 129.9 MHz, 130.1 MHz and 130.4 MHz. Very Good Condition. **£140**
PYE WESTMINSTER W30 AM Low band sets only. No control gear. Sets complete and in good condition. **£45**
PYE VANGUARD AM 25T High band, complete with leads, control box, etc. **£25**
PYE VANGUARD AM 25B Low band, sets only. **£10**
PYE BASE STATION F27. High band. **£100**
PYE RTC Controller units for remotely controlling VHF and UHF fixed station radio telephones over land lines. **£20**
PYE PC1 Radiotelephone controller, good condition, 2 only at **£50 each**
PYE CAMBRIDGE AM10D dash mount sets complete and in good condition but untested. **£40**
PYE CAMBRIDGE AM10B Boot mount sets, high band sets only, no control gear, good condition. **£25**
PYE REPORTER MF6 AM High band sets, complete but less cradles. Few only at **£150**
PYE EUROPA MF5 FM Low band sets, complete but less mike and cradle. **£90**
PYE EUROPA MF5 UHF Mobile sets complete but less mike and cradle. **£90**
PYE R412 UHF Base station receiver. **£120**
PYE F460 UHF Base station complete and in good condition. **£150**
PYE F9U UHF Base station. **£50**
PYE F401 Base station, High band AM. **£400**
PYE BC10A Battery chargers for PF2, with battery adaptor. **£25**
PYE POCKETFONES PF1. Suitable for 70cm, supplied with service manual. **£25**
PYE BC5 (New) Chargers for PF1 Pocketfones. **£25**
PYE PF2 High Band, Pocketfones. **£80**
24 VOLT to 12 volt Converters to Westminster, etc. **£15**

PLEASE NOTE all sets are sold less crystals unless otherwise stated. Carriage on RT equipment – Mobiles £2 each. Base stations £15 each. Red Star available at cost.

IC TEST CLUPS, clip over IC while still soldered to pcb or in socket. Gold plated pins, ideal for experimenters or service engineers 28 pin DIL **£1.75**. 40 pin DIL **£2.00**. Or save by buying one of each for **£3.50**.
10.7 MHz SSB XTAL FILTERS (2.4kHz Bandwidth). Low imp. type. Carrier and unwanted sideband rejection min −40dB (needs 10.69835 and 10.70165 xtals for USB/LSB not supplied). Size aprox 2″ × 1″ × 1″. **£10.00 each.**
LOW PASS FILTERS (Low imp. type). 2.9MHz small metal encapsulation. Size 1½″ × ¾″ × ¾″. **75p each.**
VIDICON SCAN COILS (Transistor type, but no data) complete with vidicon base **£3.50 each.** Brand new.
ISEP SLOTTED HORIZONTAL RAIL available in 9ft lengths. **£4.00 each.**
ERSIN MULTICORE SOLDER 3 core solder wound on a plastic reel, 20 swg. Alloy 60/40 tin lead. Available in 500gm reels. **£5.75 each.**
BNC RIGHT ANGLED PLUGS 75 ohm type GE 37502 C12 **50p each** or 12 for **£5.00**.
SCREWS. Pack of nuts, bolts, washers, tags, self taps etc. Mixed BA and metric. Sold by weight. **£2.00** per Kilo.
FERRANTI MICROSPOT CATHODE RAY TUBES Type 3H/1010. Suitable for Photographic Multi-Channel Recorder Systems. Fitted with a mounting collar and prism cemented to the faceplate, screen aluminised Phosphor P. The tubes are also fitted with mounting units type MU1053 and deflection coil type SC48A. Few only at **£55.00** each.

We are open all day Saturday. Hundreds of bargains for callers. Stockist of Switches, Relays, Caps, Resistors, etc. Please remember to add 15% VAT to all Mail Orders.

GOOD SECONDHAND EQUIPMENT ALWAYS WANTED FOR CASH

ALL PRICES QUOTED EXCLUDE P/P AND VAT UNLESS OTHERWISE STATED

BARCLAYCARD VISA

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

Pay it with Access

WW – 071 FOR FURTHER DETAILS

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.**

1982 edition out now! Price £7·00 post free

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 5AS.
Please send me ...... copy/ies of Electricity Supply Handbook 1982 at £7.00 per copy, incl. p&p
I enclose cheque/P.O. for £ ...... made payable to IPC Business Press Ltd.
Name .... Address ....

Company registered in England No. 677128. Reg office: Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. WWO

THE CASE FOR ILP

It's the chance every constructor wants

It's something you have always wanted....something to build your equipment into that's smart, modern, strong, adaptable to requirement and not expensive. The 'UniCase' is yet another triumph of I.L.P. design policy. It presents totally professional appearance and finish, ensuring easier and better assembly to make it equal to the most expensive cased equipment.
The all-metal 'UniCase' is enhanced by precision aluminium extruded panels engineered for speedy and perfect aligned assembly within a mere five minutes. Designed in the first case to accommodate I.L.P. power amps with P.S.U's, the range will shortly be extended to house any other modular projects.

POWER AMPS

P.S.U's

PRE-AMP MODULES

WHAT WE DO FOR CONSTRUCTORS

Our product range is now so vast we cannot possibly hope to show it all in our advertisments without overcrowding or abridging information to the point of uselessness. So we have devised a solution which we invite you to take advantage of without delay. ALL YOU NEED DO IS FILL IN AND FORWARD THE COUPON BELOW TO RECEIVE OUR NEWEST COMPREHENSIVE I.L.P. CATALOGUE POST FREE BY RETURN. It gives full details of all current I.L.P. products for the constructor together with prices, full technical and assembly details, wiring and circuit diagrams etc. and it's yours, FREE. You don't even have to stamp the envelope if you address it the way we tell you.

ILP ELECTRONICS LTD.

FREEPOST 5
GRAHAM BELL HOUSE, ROPER CLOSE, CANTERBURY CT2 7EP
Telephone Sales (0227) 54778 **Technical Only** (0227) 64723 Telex 965780

FREEPOST
Mark your envelope clearly FREEPOST 5 and post it WITHOUT a stamp to I.L.P. at address above. We pay postage when your letter reaches us.

Did you know

I.L.P. are the world's largest designers and manufacturers of hi-fi audio modules?

I.L.P. pioneered encapsulated power amps and pre-amps for enhanced thermal stability, mechanical protection and durability?

There are TWENTY power amplifiers from 15 to 240 watts RMS including the very latest super-quality Mosfets to choose from?

TWENTY pre-amp modules allow you to incorporate exciting professional applications to your equipment never before available to constructors and experimenters?

I.L.P. are suppliers to the B.B.C., I.B.A., N.A.S.A., British Aerospace, Marconi, Racal, Ferranti, G.E.C., Rolls Royce etc?

Goods are despatched within 7 days of your order reaching us and covered by our 5 year no-quibble guarantee?

SEND COUPON
(NO STAMP NECESSARY)
FOR YOUR FREE I.L.P. CATALOGUE AND OPEN UP TO A NEW WORLD OF QUALITY & VALUE

To: **I.L.P. ELECTRONICS LTD.**
PLEASE SEND ME I.L.P. CATALOGUE, POST PAID BY RETURN

I HAVE/HAVE NOT PREVIOUSLY BUILT WITH I.L.P. MODULES

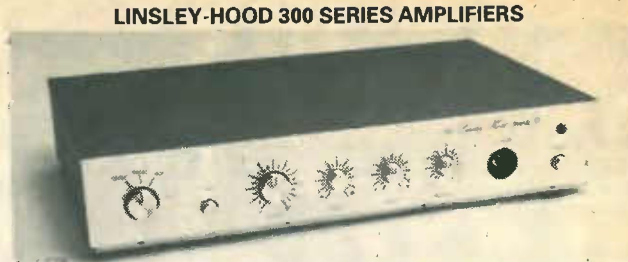
Name: ______________________
Address: ______________________

I.L.P. products are available also from Henry's, Marshall's, Technomatic & Watford.

WW – 029 FOR FURTHER DETAILS

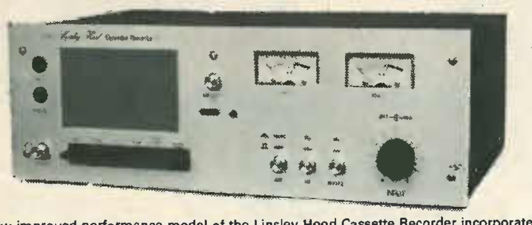
www.americanradiohistory.com

LINSLEY-HOOD 300 SERIES AMPLIFIERS



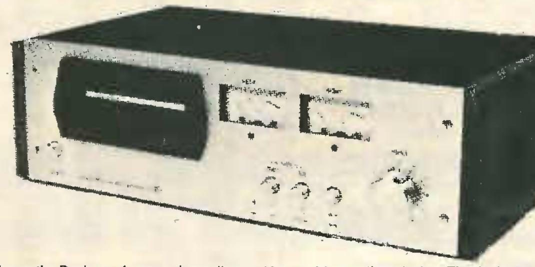
These latest designs from the drawing board of John Linsley-Hood, engineered to the very highest standard, represent the very best that is available on the kit market today. The delicacy and transparency of the tone quality enable these amplifiers to outperform, on a side-by-side comparison, the bulk of amplifiers in the commercial market-place and even exceed the high standard set by his earlier 75-watt design.
Three versions are offered, a 30-watt with Darlington output transistors, and a 35- and 45-watt, both with Mosfet output devices. All are of identical outside appearance which is designed to match and stack with our Linsley-Hood cassette recorder 2.
As with all Hart kits the constructors interests have been looked after in a unique way by reducing the conventional (and boring) wiring almost to the point of extinction.
Any of these kits represents a most cost-effective route to the very highest sound quality with the extra bonus of the enjoyment of building a sophisticated piece of equipment.
30-watt Darlington amplifier, fully integrated with tone controls and magnetic pick-up facility. Total cost of all parts is £81.12. Special offer price for complete kits £72.
35-watt Mosfet amplifier. Total cost of parts £98.41. Special offer for complete kits, £87.40.
45-watt Mosfet amplifier. Total cost of parts £104.95. Special offer price for complete kits £94.80.
Reprints of original Articles from Hi-Fi News 50p. Post free. No VAT.
Reprints of MOSFET article 25p. No V.A.T. Post free.

LINSLEY HOOD CASSETTE RECORDER 2



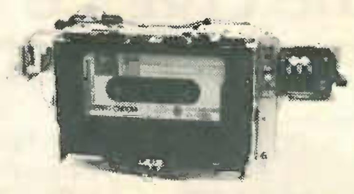
Our new improved performance model of the Linsley Hood Cassette Recorder incorporates our VFL 910 vertical front mechanism and circuit modifications to increase dynamic range. Board layouts have been altered and improved but retain the outstandingly successful mother-and-daughter arrangement used on our Linsley-Hood Cassette Recorder 1.
This latest version has the following extra features: Ultra low wow-and-flutter of .09% – easily meets DIN Hi-Fi spec. Deck controls latch in rewind modes and do not have to be held. Full Auto-stop on all modes. Tape counter with memory rewind. Oil damped cassette door. Latching record button for level setting. Dual concentric input level controls. Phone output. Microphone input facility if required. Record interlock prevents recording on valued cassettes. Frequency generating feedback servo drive motor with built-in speed control for thermal stability. All these desirable and useful features added to the excellent design of the Linsley-Hood circuits and the quality of the components used makes this new kit comparable with built-up units of much higher cost than the modest, £94.90 + V.A.T. we ask for the complete kit.

LINSLEY-HOOD CASSETTE RECORDER 1



We are the Designer Approved suppliers of kits for this excellent design. The Author's reputation tells all you need to know about the circuitry and Hart expertise and experience guarantees the engineering design of the kit. Advanced features include: High-quality separate VU meters with excellent ballistics. Controls, switches and sockets mounted on PCB to eliminate difficult wiring. Proper moulded escutcheon for cassette aperture improves appearance and removes the need for the cassette transport to be set back behind a narrow finger trapping slot. Easy to use, robust Lenco mechanism. Switched bias and equalisation for different tape formulations. All wiring is terminated with plugs and sockets for easy assembly and test. Sophisticated modular PCB system gives a spacious, easily-built and tested layout. All these features added to the high-quality metalwork make this a most satisfying kit to build. Also included at no extra cost is our latest HS 16 Sendus Alloy super head, available separately at £8.20 but included free with the complete kit at £75 plus VAT.
Reprints of the 3 original articles describing this design 45p. No VAT.
Reprint of the subsequent postscript article 30p. No VAT.

FEED YOUR MICRO BYTES WITH OUR SOLENOID CONTROLLED CASSETTE DECK



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

HART TRIPLE-PURPOSE TEST CASSETTE TC1

One inexpensive test cassette enables you to set up VU level, head azimuth and tape speed. Invaluable when fitting new heads. Only £2.70 plus V.A.T. and 50p postage.

CASSETTE HEADS

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

All prices plus VAT

PRACTICAL WIRELESS 'WINTON' TUNER

Brilliant new Ted Rule designed Tuner with everything! Gives you fantastic stereo f/m reception with pilot cancelling decoder i.c., fluorescent display, digital frequency readout and even TV sound. Further details are in our lists; send for your copy.

Part Cost of Post, Packing and Insurance
Order up to £10–50p
Orders £10 to £49–£1
Over £50–£1.50
P&P Export Orders–Postage or shipping at cost plus £2 Documentation and Handling

Please send 9 × 4 S.A.E. or telephone for lists giving fuller details and price breakdowns.
Instant easy ordering, telephone your requirements and credit card number to us on Oswestry (0691) 2894

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

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 ft. sq. (45p)
Double-sided £2.25 ft. sq. (60p)

Pre-coated Fibre-glass Board:
8″x4½″....£1.75 (25p) 16″x9″.........£7 (60p) 24″x18″...£18 (£1.70)
8″x9″.......£3.50 (45p) 24″x12″...£13 (£1.20) Eurocard £1.25 (25p)

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

WHITE HOUSE ELECTRONICS
P.O. Box 19, Praa Sands, Penzance TR20 9TF
Telephone: Germoe (073-676) 2329

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

LANGREX SUPPLIES LTD

Climax House, Fallsbrook Rd., Streatham, London SW16 6ED
RST Tel: 01-677 2424 Telex: 946708 RST

SEMICONDUCTORS

AA119	0.12	ASZ15	1.38	BC172	0.13	BD131	0.51	BF257	0.31	GEX541	5.75	OAZ207	1.73	OC205	3.16	ZTX504	0.24	2N1671	5.75	2N3819	0.35
AAY30	0.20	ASZ16	1.27	BC173	0.13	BD132	0.55	BF258	0.31	GJ3M	1.73	OC16	2.88	OC206	3.16	ZTX531	0.28	2N1893	0.37	2N3820	0.45
AAY32	0.48	ASZ17	1.15	BC177	0.32	BD135	0.46	BF259	0.32	GM0378A	2.02	OC20	2.88	OC207	2.88	ZTX550	0.29	2N2147	4.60	2N3823	0.69
AAZ13	0.17	ASZ20	2.64	BC178	0.16	BD136	0.46	BF336	0.39	KS100A	0.52	OC22	2.88	OCP71	2.30	1N914	0.06	2N2148	4.31	2N3866	1.15
AAZ15	0.17	ASZ21	2.88	BC179	0.32	BD137	0.46	BF337	0.38	MJE340	0.69	OC23	4.60	ORP12	1.15	1N916	0.10	2N2218	0.37	2N3904	0.20
AAZ17	0.17	AU113	2.88	BC182	0.13	BD138	0.55	BF338	0.41	MJE370	0.84	OC24	3.45	R2008B	2.30	1N4001	0.07	2N2219	0.37	2N3905	0.20
AC107	0.63	AUY10	3.45	BC183	0.13	BD139	0.55	BFS21	4.60	MJE371	0.82	OC25	1.15	R2009	2.59	1N4002	0.07	2N2220	0.23	2N3906	0.20
AC125	0.29	AU110	2.88	BC184	0.13	BD140	0.58	BFS28	2.58	MJE520	0.54	OC26	1.73	R2010B	2.30	1N4003	0.07	2N2221	0.23	2N4058	0.23
AC126	0.29	BA145	0.15	BC212	0.13	BD144	2.30	BFS61	0.23	MJE521	0.84	OC28	2.30	T1C44	0.31	1N4004	0.08	2N2222	0.23	2N4059	0.23
AC127	0.29	BA148	0.17	BC213	0.13	BD181	1.38	BFS98	0.23	MJE2955	1.50	OC29	2.30	T1C226D	1.38	1N4005	0.10	2N2223	4.89	2N4060	0.18
AC128	0.35	BA154	0.12	BC214	0.13	BD182	1.36	BFW10	1.12	MJE3055	1.27	OC35	1.73	T1L209	0.18	1N4006	0.13	2N2368	0.29	2N4061	0.18
AC141	0.32	BA155	0.13	BC237	0.13	BD237	0.62	BFW11	1.10	MPF102	0.40	OC36	1.73	T1P29A	0.49	1N4007	0.14	2N2369A	0.29	2N4062	0.18
AC141K	0.40	BA156	0.12	BC238	0.13	BD238	0.62	BFX84	0.35	MPF103	0.40	OC41	1.04	T1P30A	0.52	1N4009	0.08	2N2484	0.29	2N4124	0.18
AC142	0.32	BAW62	0.06	BC301	0.38	BDX10	1.05	BFX85	0.35	MPF104	0.40	OC42	1.04	T1P31A	0.38	1N4148	0.05	2N2646	0.58	2N4126	0.18
AC142K	0.40	BAX13	0.07	BC303	0.39	BDX32	2.30	BFX87	0.35	MPF105	0.40	OC43	1.73	T1P32A	0.41	1N5400	0.15	2N2904	0.37	2N4286	0.17
AC176	0.35	BAX16	0.07	BC307	0.13	BDY20	1.73	BFX88	0.35	MPSA06	0.30	OC44	0.98	T1P33A	0.62	1N5401	0.15	2N2905	0.37	2N4288	0.21
AC187	0.32	BC107	0.18	BC308	0.13	BDY60	3.16	BFY50	0.29	MPSA56	0.32	OC45	0.75	T1P34A	0.77	1S44	0.05	2N2906	0.24	2N4289	0.21
AC188	0.32	BC108	0.18	BC327	0.14	BF115	0.40	BFY51	0.29	MPSU01	0.61	OC71	0.63	T1P41A	0.51	1S920	0.09	2N2907	0.24	2N5457	0.37
ACY17	1.50	BC109	0.18	BC328	0.14	BF152	0.18	BFY52	0.29	MPSU06	0.75	OC72	1.15	T1P42A	0.48	1S921	0.10	2N2924	0.30	2N5458	0.37
ACY18	1.32	BC113	0.17	BC337	0.14	BF153	0.18	BFY64	0.35	MPSU56	0.79	OC73	1.15	T1P2955	0.81	2G301	1.15	2N2925	0.25	2N5459	0.37
ACY19	1.27	BC114	0.17	BC338	0.14	BF154	0.20	BFY90	1.09	NE555	0.52	OC74	0.81	T1P3055	0.64	2G302	1.15	2N2926	0.17	2S017	11.50
ACY20	1.27	BC115	0.21	BCY30	1.44	BF159	0.20	BSX19	0.31	NKT401	4.03	OC75	0.75	T1S43	0.49	2G306	1.15	2N3053	0.30	2S019	13.80
ACY21	1.32	BC116	0.22	BCY31	1.73	BF160	0.20	BSX20	0.31	NKT403	2.88	OC76	1.15	ZS140	0.29	2N404	1.50	2N3054	0.63	2S026	28.75
ACY39	2.88	BC117	0.26	BCY32	1.73	BF167	0.28	BSX21	0.33	NKT404	2.53	OC77	1.15	ZS170	0.24	2N696	0.37	2N3055	0.75	2S103	1.73
AD149	0.86	BC118	0.21	BCY33	1.27	BF173	0.35	BT106	1.38	OA5	1.38	OC81	0.75	ZS178	0.62	2N697	0.37	2N3440	0.81	2S302	2.30
AD161	0.40	BC125	0.21	BCY34	1.15	BF177	0.40	BTY79/400R	2.30	OA7	0.69	OC81Z	1.38	ZS271	0.26	2N698	0.37	2N3441	0.98	2S303	4.03
AD162	0.40	BC126	0.21	BCY39	3.91	BF178	0.40	BU205	1.50	OA10	0.63	OC82	1.04	ZS278	0.65	2N705	1.44	2N3442	1.44	2S322	4.03
AF106	0.40	BC135	0.17	BCY40	3.22	BF179	0.40	BU206	1.73	OA47	0.14	OC83	0.92	ZTX107	0.14	2N706	0.29	2N3614	2.53	2S324	4.03
AF114	0.86	BC136	0.22	BCY42	0.35	BF180	0.32	BU208	2.30	OA70	0.29	OC84	0.92	ZTX108	0.14	2N708	0.29	2N3702	0.13	2S701	2.30
AF115	0.86	BC137	0.22	BCY43	0.35	BF181	0.32	BY100	0.46	OA79	0.14	OC122	3.16	ZTX109	0.14	2N930	0.29	2N3703	0.13	2S745A	1.09
AF116	0.86	BC147	0.14	BCY58	0.22	BF182	0.35	BY126	0.15	OA81	0.20	OC123	2.30	ZTX300	0.15	2N1131	0.35	2N3704	0.13	2S746A	1.09
AF117	0.86	BC148	0.14	BCY70	0.20	BF183	0.32	BY127	0.16	OA85	0.20	OC139	3.45	ZTX301	0.16	2N1132	0.35	2N3705	0.13		
AF139	0.38	BC149	0.15	BCY71	0.21	BF184	0.32	BZX61	0.20	OA90	0.09	OC140	4.60	ZTX302	0.21	2N1302	1.38	2N3706	0.13		
AF186	1.15	BC157	0.15	BCY72	0.20	BF185	0.35	Series		OA91	0.09	OC141	4.93	ZTX303	0.21	2N1303	0.92	2N3707	0.13		
AF239	0.45	BC158	0.15	BCZ11	2.01	BF194	0.16	BZY88	0.12	OA95	0.09	OC170	1.44	ZTX304	0.23	2N1304	1.38	2N3708	0.12		
AFZ11	4.60	BC159	0.15	BD115	0.48	BF195	0.14	Series		OA200	0.17	OC171	1.44	ZTX311	0.15	2N1305	1.15	2N3709	0.13		
AFZ12	4.60	BC167	0.13	BD121	1.96	BF196	0.15	CRS1/40	0.69	OA202	0.17	OC200	1.73	ZTX314	0.29	2N1306	1.73	2N3710	0.12		
ASY26	1.61	BC170	0.13	BD123	3.22	BF197	0.16	CRS3/40	0.86	OA211	1.73	OC201	2.88	ZTX500	0.16	2N1307	1.27	2N3711	0.12		
ASY27	1.04	BC171	0.12	BD124	2.30	BF200	0.46	CRS3/60	1.04	OAZ200	1.73	OC202	3.16	ZTX501	0.16	2N1308	2.01	2N3771	1.61		
						BF224	0.29	GEX66	3.45	OAZ201	1.73	OC203	3.45	ZTX502	0.21	2N1309	1.38	2N3772	1.84		
						BF244	0.32			OAZ206	1.73	OC204	3.45	ZTX503	0.22	2N1613	0.37	2N3773	2.07		

VALVES

A1834	10.35	E130L	19.39	EF86	1.74	GXU1	16.10	PC97	1.38	QY5-3000A	356.66
A2087	13.58	E180CC	11.39	EF89	1.84	GXU2	28.43	PC900	1.38	QZ06-20	34.16
A2134	20.13	E180F	7.83	EF91	2.07	GXU3	30.49	PCC84	1.15	R10	5.75
A2293	8.62	E182CC	13.80	EF92	6.68	GXU4	32.77	PCC85	1.38	R17	1.89
A2426	17.63	E186F	12.58	EF93	1.15	GXU50	17.25	PCC88	1.38	R18	4.89
A2521	24.38	E188CC	9.40	EF94	1.24	GY501	3.16	PCC89	1.56	R19	1.38
A2900	14.43	E280F	25.88	EF95	6.27	GZ32	1.44	PCC189	1.61	R20	1.66
A3343	51.75	E283CC	9.02	EF98	1.44	GZ33	4.60	PCC805	1.51	RG3-250	35.77
AZ31	1.26	E288CC	18.54	EF183	0.92	GZ34	2.88	PCC806	2.07	RG3-250A	37.49
AZ41	1.32	EA52	28.18	EF184	0.96	GZ37	4.60	PCE82	2.07	RG3-1250	63.94
BK448	110.27	EA76	2.30	EF804S	12.65	KT61	4.02	PCF80	1.15	RG4-1250	43.13
BK484	149.09	EABC80	1.38	EF805S	12.65	KT66	11.50	PCF82	1.15	RG4-3000	90.36
BS90	52.27	EAC91	0.92	EH90	1.61	KT88	13.80	PCF86	1.84	RR3-250	53.54
BS810	86.25	EAF42	1.44	EK90	1.24	KTW61	2.02	PCF87	1.84	RR3-1250	94.83
BT5	58.13	EAF801	2.02	EL32	1.73	KTW62	2.02	PCF200	3.74	S11E12	55.20
BT17	106.89	EB41	2.30	EL33	4.02	KTW63	2.02	PCF201	2.45	S130	3.45
BT19	36.17	EB91	1.01	EL34TH	2.53	M8079	12.29	PCF801	1.84	S130P	4.03
BT29	327.69	EBC33	2.02	EL34MUI	3.16	M8080	9.49	PCF802	2.19	STV280-40	11.50
BT69	333.50	EBC41	1.44	EL36	1.84	M8081	11.30	PCF805	1.84	STV280-80	24.15
BT75	102.46	EBC81	1.26	EL41	1.44	M8082	9.87	PCF806	1.84	SU41	2.88
BT95	127.02	EBC90	0.97	EL42	2.02	M8083	8.54	PCF808	1.84	SU42	10.35
CBL31	2.30	EBF80	0.58	EL81	4.03	M8091	11.99	PCL82	1.15	TD03-10	32.78
CL33	2.30	EBF83	1.44	EL83	4.03	M8096	4.31	PCL83	2.30	TD03-10E	32.78
CY31	1.15	EBF89	0.97	EL84	1.15	M8097	4.09	PCL84	1.15	TD03-29F	33.93
C1K	21.30	EBL31	2.88	EL86	2.88	M8098	5.50	PCL85	1.24	TT15	34.50
C3A	11.50	EC90	1.28	EL90	1.10	M8099	5.98	PCL86	1.24	TT21	16.98
C3JA	23.23	EC91	9.33	EL91	8.21	M8100	9.49	PCL805/85	1.24	TT22	16.98
DA41	28.75	EC92	[illegible]	EL95	1.51	M8136	9.98	PD500	4.14	TT100	59.51
DA42	21.51	EC157	349.26	EL156	27.60	M8137	9.73	PE06-40N	31.40	TY2-125	69.01
DA100	97.93	ECC33	4.02	EL360	9.77	M8140	5.17	PFL200	2.07	TW4-400	74.07
DAF91	0.46	ECC35	4.02	EL500/504	2.16	M8141	5.52	PL36	1.38	TY4-500	105.97
DAF96	1.15	ECC40	2.30	EL509	3.63	M8142	7.77	PL81	1.38	TY5-500	187.45
DET22	32.78	ECC81	1.01	EL821	11.96	M8144	4.31	PL81A	1.38	TY6-800	193.20
DET24	52.90	ECC82	0.82	EL822	12.55	M8149	5.86	PL82	1.38	TY6-5000A	356.50
DF91	0.46	ECC83	1.01	EM34	5.75	M8161	9.11	PL83	2.55	TY6-5000B	264.50
DF96	1.15	ECC84	1.36	EM80	1.26	M8162	10.36	PL84	1.24	TY6-5000W	316.25
DK91	1.21	ECC85	1.38	EM81	1.15	M8163	5.17	PL504/5	1.61	TY7-6000A	368.80
DK92	1.44	ECC86	2.30	EM84	1.73	M8190	5.29	PL508	2.07	TY7-6000W	322.00
DK96	1.26	ECC88	2.07	EM85	1.44	M8195	4.25	PL509	3.73	TZ40	28.75
DL92	1.26	ECC89	1.88	EM87	1.73	M8196	7.47	PL519	3.73	U18-20	2.88
DL94	1.38	ECC91	10.27	EN32	13.66	M8204	6.57	PL801	1.27	U19	15.81
DL96	1.26	ECC189	1.90	EN91	2.94	M8212	12.47	PL802	3.40	U25	1.33
DLS10	9.48	ECC807	2.02	EN92	5.23	M8223	3.80	PY33	1.27	U26	1.66
DLS15	12.37	ECC808	2.59	EY51	2.02	M8224	4.66	PY81	0.97	U37	10.35
DLS16	12.37	ECF80	1.24	EY81	1.89	M8225	2.99	PY82	0.92	UABC80	1.44
DLS19	12.37	ECF82	1.38	EY83	2.02	M8248	13.32	PY83	0.81	UAF42	1.44
DM70	1.44	ECF86	1.73	EY84	10.57	MU14	1.73	PY88	1.01	UB41	1.44
DM71	1.44	ECH35	2.30	EY86	0.96	MX119	58.65	PY500A	2.07	UBC41	1.73
DM160	3.96	ECH42	1.32	EY88	2.02	MX123	67.85	PY800	0.97	UBF89	1.38
DY87	0.74	ECH81	1.38	EY500A	2.23	MX145	62.10	PY801	0.97	UCC84	1.26
DY802	0.96	ECH83	1.44	EY802	0.94	MX151	17.25	QQV02-6	16.17	UCC85	1.38
E55L	25.17	ECH84	1.47	EZ35	0.97	MX152	143.75	QQV03-20A	20.13	UCF80	1.32
E80CC	11.27	ECL80	1.15	EZ40	1.44	MX161	166.75	QQV06-40A	47.15	UCH42	1.38
E80CF	12.96	ECL81	1.73	EZ41	1.44	MX163	23.11	QQV07-50	60.66	UCH81	2.67
E80F	14.19	ECL82	1.15	EZ80	0.96	MX164	27.95	QQZ03-20A	59.80	UCL82	1.20
E80L	13.98	ECL83	1.73	EZ81	0.96	MX166	161.00	QQZ06-40A	63.37	UCL83	1.66
E81CC	6.62	ECL84	1.61	EZ90	1.38	MX168	48.30	QU37	14.38	UF41	1.15
E81L	14.06	ECL85	1.28	FW4-500	2.88	N78	20.13	QV03-12	5.62	UF42	1.44
E82CC	7.03	ECL86	1.38	FW4-800	2.88	OA2	2.30	QV04-7	2.88	UF80	1.66
E83CC	7.16	EF37A	4.02	G1.371K	41.40	OA3	5.69	QV08-100	137.08	UF85	1.66
E86C	13.23	EF39	3.16	G551K	12.65	OA4	4.02	QY3-65	57.06	UF89	1.66
E88C	7.12	EF40	3.45	G180.2M	18.42	OB2	1.44	QY3-125	62.40	UL41	2.88
E88CC	3.86	EF41	2.30	G240.2D	12.85	OB3	2.20	QY4-250	77.05		
E90CC	9.94	EF42	2.30	G400.1K	19.28	OC2	3.04	QY4-400	80.44		
E90F	11.39	EF50	1.73	GN4	8.62	OC3	2.20	QY5-500	168.83		
E91H	5.34	EF54	5.75	GN4A	8.62	OD3	2.20				
E92CC	9.40	EF55	2.88	GS16	10.35	OZ4	1.84				
E99F	10.16	EF80	0.92	GT1C	14.38	PC86	1.61				
		EF83	4.03	GU50	14.31	PC88	1.61				
		EF85	0.92	GU51	13.62	PC95	1.49				

UL84	1.38	4B32	29.16	6CW4	8.83	12BE6	2.79	5670	5.18
UM80	1.15	4C35	74.75	6D2	1.01	12BH7	1.29	5675	21.47
UY41	1.44	4CX250B	51.75	6DK6	3.00	12BY7	3.11	5687	6.31
UY85	1.20	4CX350A	80.50	6DQ6B	4.69	12E1	19.67	5696	4.35
VLS631	15.24	4X150A	24.41	6EA8	3.38	12E11TT	19.26	5718	7.87
XG1-2500	58.02	4X150D	28.75	6EB8	2.44	12E14	34.50	5725	5.62
XG2-6400	113.50	5B254M	23.12	6EW6	1.73	13E1	123.05	5726	3.62
XG5-500	28.23	5B255M	23.12	6F6	2.02	19H4	28.75	5727	6.47
XG2-6400	155.42	5C22	74.75	6F23	1.84	19H5	40.25	5749	5.14
XR1-1600A	58.88	5J180E	1380.00	6F28	1.33	24B9	55.20	5751	4.80
XR1-3200	87.15	5R4GY	4.03	6F33	34.50	30C15	1.84	5763	4.66
XR1-3200A	93.15	5U4G	1.75	6H1	14.38	30C17	1.84	5814A	4.28
XR1-6400	108.30	5U4GB	2.90	6H2N	1.21	30C18	1.84	5840	5.06
XR1-6400A	164.23	5V4G	1.75	6H3N	1.21	30F5	1.93	5842	13.90
YD1120	264.50	5Y3GT	0.98	6H6	1.73	30FL1/2	1.28	5876A	19.55
YD1240	366.62	5Z3	1.73	6J4	6.10	30FL12	2.07	5879	5.38
Z759	19.32	5Z4G	1.75	6J6	6.21	30FL14	1.84	5886	12.08
ZM1000	6.03	5Z4GT	1.75	6J7	2.88	30L1	1.15	5963	3.38
ZM1001	6.19	6-30L2	1.79	6K4N	1.44	30L15	2.07	5965	4.00
ZM1020	10.83	6AB4	1.44	6K6GT	1.50	30L17	2.07	6005	5.62
ZM1021	10.17	6AB7	1.73	6K7	1.73	30P4	1.06	6021	5.13
ZM1022	10.60	6AC7	1.61	6K8	2.02	30P19	1.38	6057	4.02
ZM1023	8.81	6AF4A	1.84	6KD6	7.31	30PL1	2.88	6058	12.47
ZM1040	22.26	6AG7	2.30	6L6G	2.88	30PL14	1.93	6059	4.60
ZM1041	19.16	6AH6	5.52	6L6GA	1.73	30PL15	2.07	6061	4.89
ZM1042	20.44	6AK5	4.15	6L6GT	2.24	35W4	0.69	6062	4.31
ZM1051	100.05	6AK6	2.81	6L6GC	2.88	50C5	0.81	6063	4.20
1B3GT	2.58	6AL5	1.01	6L7	2.30	75B1	5.38	6064	8.54
1B24	11.50	6AM4	2.65	6N2P	1.21	75C1	2.70	6067	4.02
1B35A	28.75	6AM5	8.21	6N3P	1.21	85A1	8.63	6072	5.80
1B63	57.50	6AM6	2.07	6N7	1.73	85A2	2.75	6080	7.88
1R5	1.21	6AN5	4.45	6P25	4.14	90AG	14.90	6097AxBxC	166.75
1S5	0.46	6AN8A	3.97	6Q7	2.53	90AV	14.90	6146A	12.24
1T4	0.46	6AQ5	1.10	6R7	2.07	90C1	3.35	6146B	9.34
2AS15	11.50	6AS6	5.73	6SA7	1.67	90CG	16.72	6159B	19.91
2C39A	21.85	6AS7G	9.49	6SC7	1.73	90CV	17.50	6189	10.03
2C43	20.70	6AT6	0.98	6SF7	1.84	92AG	14.90	6201	10.92
2D21	2.94	6AU5GT	4.97	6SH7	1.73	92AV	14.90	6442	17.25
2E26	17.86	6AU6	1.24	6SJ7	1.84	95A1	7.48	6883B	14.64
2J42	109.25	6AV5GA	4.52	6SK7	1.50	150B2	3.47	6973	4.38
2J55	239.97	6AV6	0.98	6SK7GT	3.08	150B3	6.39	7025	2.73
2J70A	442.75	6AX5GT	3.57	6SN7GT	1.84	150C2	2.21	7551	6.45
2J70B	418.34	6B7	1.73	6SQ7	1.50	150C4	2.75	7586	11.66
2K25	40.25	6B8	2.02	6SR7	1.73	211	21.85	7587	20.11
3-400Z	57.50	6BA6	1.15	6SS7	2.07	723AB	40.25	7609	36.57
3-500Z	63.25	6BA7	5.89	6U5G	2.30	803	11.50	7868	5.04
3A5	2.70	6BA8A	4.31	6U8	0.92	805	23.00	7895	13.25
3B24	9.20	6BC4	4.27	6U8A	3.38	807	4.31	8005	86.40
3B28	16.50	6BE6	1.24	6V6GT	1.84	811A	21.08	8068	6.33
3B29	11.50	6BH6	1.75	6X4	1.38	812A	21.08	8122	60.11
3B240M	17.25	6BJ6	1.24	6X5GT	0.97	813	91.15	8136	2.48
3B241M	17.25	6BK4	4.84	7B7	1.96	833A	153.57	8417	6.76
3C23	26.83	6BL6	97.75	7C5	3.40	866A	17.56	18042	8.63
3C45	28.18	6BL7GT	4.44	7C6	2.60	872A	24.69	18045	12.06
3CX100A5	23.00	6BM6	97.75	7H7	2.30	922	5.01	Tested Ex-Equipment	
3E29	29.67	6BN6	1.89	7R7	1.73	931A	18.15	4CX250B	5.75
3S4	1.26	6BQ7A	4.28	7S7	2.59	1624	2.59		
3V4	1.38	6BR7	4.60	7Y4	1.84	1625	1.96		
465A	29.15	6BR8	2.02	7Z4	2.13	2050	8.00		
4-125A	41.99	6BS7	4.60	11E3	60.82	4212E	304.75		
4-250A	41.99	6BW6	4.60	12AT6	1.38	4212H	304.75		
4-400A	52.05	6BW7	1.75	12AT7	1.01	5544	62.10		
		6BX7GT	5.70	12AU6	2.97	5545	67.85		
		6BZ6	2.73	12AU7	0.83	5551A	123.51		
		6C4	1.01	12AV6	2.55	5552A	166.98		
		CB6A	2.86	12AV7	4.00	5553A	259.10		
		6CD6GA	5.83	12AX7	1.01	5642	6.45		
		6CG7	2.62	12AY7	4.69	5654	3.93		
		6CH6	11.96	12B4A	3.62	5651	4.66		
		6CL6	4.12	12BA6	2.52				

BASES

B7G unskirted	0.25
B7G skirted	0.35
B9A unskirted	0.25
B9A skirted	0.35
Int Octal	0.40
Loctal	0.63
Nuvistor base	0.86
8 pin DIL	0.17
14 pin DIL	0.17
16 pin DIL	0.20
Valve screening cans all sizes	0.35

CRTs

2AP1	9.78	5ADP1	40.25	VCR138A	14.38
2BP1	10.35	5BP1	11.50	VCR139A	9.20
3BP1	11.50	5CP1	11.50	VCR517A	11.50
3DP1	5.75	5CP1A	46.00	VCR517B	11.50
3EG1	11.50	5FP15A	17.25	VCR517C	11.50
3FP7	6.90	5UP7	28.75		
3GP1	6.90	DG7-5	72.82		
3JP1	9.20	DG7-31	66.78		
3JP2	9.20	DG7-32	66.78		
3JP7	11.50	DH3-91	67.65		
3KP1	17.25	DH7-11	130.09		
3RP1	40.25	VCR97	13.80		
3WP1	23.00	VCR138	11.50		

Tube Bases Prices on application

INTEGRATED CIRCUITS

7400	0.18	7423	0.38	7460	0.21	7495	0.84	74136	0.59	74175	1.17	TBA480Q	2.12
7401	0.20	7425	0.35	7470	0.44	7496	0.94	74141	1.02	74176	1.33	TBA520Q	2.65
7402	0.20	7427	0.35	7472	0.38	7497	3.62	74142	2.64	74178	1.56	TBA530	2.28
7403	0.20	7428	0.50	7473	0.44	74100	1.77	74143	2.99	74179	1.56	TBA540Q	2.65
7404	0.21	7430	0.20	7474	0.44	74107	0.52	74144	2.99	74180	1.38	TBA550Q	3.70
7405	0.21	7432	0.35	7475	0.62	74109	0.84	74145	1.15	74190	2.19	TBA560CQ	3.70
7406	0.49	7433	0.46	7476	0.48	74110	0.59	74147	2.30	74191	2.19	TBA673	2.52
7407	0.49	7437	0.37	7480	0.64	74111	0.82	74148	2.02	74192	2.19	TBA700	1.75
7408	0.23	7438	0.37	7482	0.86	74116	2.13	74150	2.07	74193	2.19	TBA720Q	2.65
7409	0.23	7440	0.37	7483	1.15	74118	1.15	74151	1.08	74194	1.44	TBA750Q	2.38
7410	0.20	7441	1.04	7484	1.21	74119	1.77	74154	2.07	74195	1.38	TBA800	1.38
7412	0.33	7442	0.83	7486	0.45	74120	0.95	74155	1.04	74196	1.55	TBA920	3.34
7413	0.37	7447AN	1.35	7490	0.69	74121	0.49	74156	1.04	74197	1.55	TBA920Q	3.34
7416	0.37	7450	0.21	7491	0.94	74122	0.71	74157	0.86	74198	3.11	TBA990Q	3.34
7417	0.37	7451	0.21	7492	0.69	74123	1.36	74159	2.53	74199	2.64	TCA270Q	3.34
7420	0.21	7453	0.21	7493	0.69	74125	0.67	74170	2.76	76013N	2.02	TCA760A	1.59
7422	0.23	7454	0.21	7494	0.94	74126	0.67	74172	5.06	TAA570	2.65		
						74128	0.72	74173	1.63	TAA630S	4.02		
						74132	0.83	74174	1.84	TAA700	4.50		

Terms of business: CWO. Postage and packing valves and semiconductors 58p per order. CRTs £1.73. All prices include VAT.
Price ruling at time of despatch.
In some cases prices of Mullard and USA valves will higher than those advertised. Prices correct when going to press.
Account facilities available to approved companies with minimum order charge £10. Carriage and packing £1 on credit orders.
Over 10,000 types of valves, tubes and semiconductors in stock. Quotations for any types not listed. S.A.E.

Telephone 01-677 2424/7
Telex 946708
E. & O.E.

Open to callers Monday-Friday 9 a.m.-5 p.m.

www.americanradiohistory.com

TOROIDALS

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

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 7 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with no price penalty.

★ **294 TYPES TO CHOOSE FROM!**

★ **ORDERS DESPATCHED WITHIN 7 DAYS OF RECEIPT FOR SINGLE OR SMALL QUANTITY ORDERS**

★ **5 YEAR NO QUIBBLE GUARANTEE**

TYPE	SERIES No.	SECONDARY Volts	RMS Current	PRICE
30 VA 70×30mm 0.45Kg Regulation 18%	1x010	6+6	2.50	**£5.12** +p/p £1.04 +VAT £0 92 TOTAL £7 08
	1x011	9+9	1.66	
	1x012	12+12	1.25	
	1x013	15+15	1.00	
	1x014	18+18	0.83	
	1x015	22+22	0.68	
	1x016	25+25	0.60	
	1x017	30+30	0.50	
50 VA 80×35mm 0.9 Kg Regulation 13%	2x010	6+6	4.16	**£5.70** +p/p £1.30 +VAT £1 05 TOTAL £8 05
	2x011	9+9	2.77	
	2x012	12+12	2.08	
	2x013	15+15	1.66	
	2x014	18+18	1.38	
	2x015	22+22	1.13	
	2x016	25+25	1.00	
	2x017	30+30	0.83	
	2x028	110	0.45	
	2x029	220	0.22	
	2x030	240	0.20	
80 VA 90×30mm 1 Kg Regulation 12%	3x010	6+6	6.64	**£6.08** +p/p £1 67 +VAT £1 16 TOTAL £8 91
	3x011	9+9	4.44	
	3x012	12+12	3.33	
	3x013	15+15	2 66	
	3x014	18+18	2.22	
	3x015	22+22	1.81	
	3x016	25+25	1.60	
	3x017	30+30	1.33	
	3x028	110	0.72	
	3x029	220	0.36	
	3x030	240	0 33	
120 VA 90×40mm 1.2 Kg Regulation 11%	4x010	6+6	10.00	**£6.90** +p/p £1 67 +VAT £1 29 TOTAL £9 86
	4x011	9+9	6.66	
	4x012	12+12	5.00	
	4x013	15+15	4.00	
	4x014	18+18	3.33	
	4x015	22+22	2.72	
	4x016	25+25	2.40	
	4x017	30+30	2.00	
	4x018	35+35	1.71	
	4x028	110	1.09	
	4x029	220	0.54	
	4x030	240	0.50	
160 VA 110×40mm 1.8 Kg Regulation 8%	5x011	9+9	8 89	**£7.91** +p/p £1 67 +VAT £1 44 TOTAL £11 02
	5x012	12+12	6.66	
	5x013	15+15	5.33	
	5x014	18+18	4.44	
	5x015	22+22	3.63	
	5x016	25+25	3.20	
	5x017	30+30	2.66	
	5x018	35+35	2.28	
	5x026	40+40	2.00	
	5x028	110	1.45	
	5x029	220	0.72	
	5x030	240	0.66	

TYPE	SERIES No.	SECONDARY Volts	RMS Current	PRICE
225 VA 110×45mm 2.2 Kg Regulation 7%	6x012	12+12	9.38	**£9.20** +p/p £2 00 +VAT £1 68 TOTAL £12 88
	6x013	15+15	7.50	
	6x014	18+18	6.25	
	6x015	22+22	5.11	
	6x016	25+25	4.50	
	6x017	30+30	3.75	
	6x018	35+35	3.21	
	6x026	40+40	2.81	
	6x025	45+45	2.50	
	6x033	50+50	2.25	
	6x028	110	2.04	
	6x029	220	1.02	
	6x030	240	0.93	
300 VA 110×50mm 2.6 Kg Regulation 6%	7x013	15+15	10.00	**£10.17** +p/p £2 00 +VAT £1 83 TOTAL £14 00
	7x014	18+18	8.33	
	7x015	22+22	6.82	
	7x016	25+25	6.00	
	7x017	30+30	5.00	
	7x018	35+35	4.28	
	7x026	40+40	3.75	
	7x025	45+45	3.33	
	7x033	50+50	3.00	
	7x028	110	2.72	
	7x029	220	1.36	
	7x030	240	1.25	
500 VA 140×60mm 4 Kg Regulation 4%	8x016	25+25	10.00	**£13.53** +p/p £2 35 +VAT £2 38 TOTAL £18 26
	8x017	30+30	8.33	
	8x018	35+35	7.14	
	8x026	40+40	6 25	
	8x025	45+45	5.55	
	8x033	50+50	5.00	
	8x042	55+55	4.54	
	8x028	110	4.54	
	8x029	220	2.27	
	8x030	240	2.08	
625 VA 140×75mm 5 Kg Regulation 4%	9x017	30+30	10.41	**£16.13** +p/p £2 50 +VAT £2 79 TOTAL £21 42
	9x018	35+35	8.92	
	9x026	40+40	7.81	
	9x025	45+45	6.94	
	9x033	50+50	6.25	
	9x042	55+55	5.68	
	9x028	110	5.68	
	9x029	220	2.84	
	9x030	240	2.60	

IMPORTANT: Regulation—All voltages quoted are FULL LOAD. Please add regulation figure to secondary voltage to obtain off load voltage.

The benefits of ILP toroidal transformers

ILP toroidal transformers are only half the weight and height of their laminated equivalents, and are available with 110V, 220V or 240V primaries coded as follows:

For 110V primary insert "0" in place of "X" in type number.

For 220V primary (Europe) insert "1" in place of "X" in type number.

For 240V primary (UK) insert "2" in place of "X" in type number.

How to order Freepost:

Use this coupon, or a separate sheet of paper, to order these products, or any products from other ILP Electronics advertisements. No stamp is needed if you address to Freepost. Cheques and postal orders must be crossed and payable to ILP Electronics Ltd. Access and Barclaycard welcome. All UK orders sent within 7 days of receipt of order for single and small quantity orders.

Also available at Electrovalue, Maplin and Technomatic.

Please send ____

Total purchase price ____

I enclose Cheque ☐ Postal Orders ☐ Int. Money Order ☐

Debit my Access/Barclaycard No. ____

Name ____

Address ____

Signature ____

Post to: ILP Electronics Ltd, Freepost.5 Graham Bell House, Roper Close, Canterbury CT2 7EP, Kent, England.

Telephone Sales (0227) 54778: Technical (0227) 64723: Telex 965780.

ILP TRANSFORMERS (a division of ILP Electronics Ltd)

WW – 022 FOR FURTHER DETAILS

Happy Memories

Part type	1 off	25-99	100 up
4116 200ns	.95	.85	.70
4116 250ns	.90	.80	.60
4816 100ns For BBC comp	3.30	2.95	2.70
4164 200ns	6.15	5.25	4.65
2114 200ns Low power	1.25	1.15	.95
2114 450ns Low power	1.20	1.10	.90
4118 250ns	3.45	3.15	2.65
6116 150ns CMOS	4.95	4.45	3.65
2708 450ns	1.95	1.90	1.80
2716 450ns 5 volt	2.25	2.15	1.95
2716 450ns three rail	6.40	6.00	4.95
2732 450ns Intel type	4.25	3.95	3.35
2532 450ns Texas type	4.25	3.95	3.35

Z80A-CPU £4.75 Z80A-P10 £4.25 Z80A-CTC £4.25

Low profile IC sockets: Pins	8	14	16	18	20	22	24	28	40
Pence	9	10	11	14	15	18	19	25	33

Soft-sectored floppy discs per 10 in plastic library case:
5 inch SSSD £17.00 5 inch SSDD £19.25 5 inch DSDD £21.00
8 inch SSSD £19.25 8 inch SSDD £23.65 8 inch DSDD £25.50

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

Please add 30p post & packing to orders under £15 and VAT to total. Access & Barclaycard welcome. 24hr. service on (054 422) 618. Government & Educational orders welcome, £15 minimum. Trade accounts operated
Telephone or write for details:

HAPPY MEMORIES (WW)
Gladestry, Kington
Herefordshire HR5 3NY
Tel. (054 422) 618 or 628

ERASERS FOR THE DEVELOPMENT LAB

UV1B
Powerful, compact unit to clean up to six EPROMS quickly and safely (illustrated)
£46.95 + VAT

UV1T
with accurate electronic timer
£59.13 + VAT

CARRIAGE PAID (U.K.)

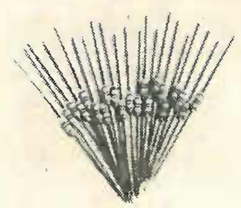
IN USE IN DESIGN LABS & EDUCATIONAL ESTABLISHMENTS AROUND THE WORLD

Also available in London from:
Technomatic Ltd
Henrys Radio
Ambit International

NORTHERN ELECTRONICS
51 Arundel Street, Mossley, Lancashire Tel: Mossley (04575) 4119

WW055 – FOR FURTHER DETAILS

METALFILM RESISTORS
1% Tolerance, ¼ Watt



100R	1k	10k	100k
110R	1k1	11k	110k
120R	1k2	12k	120k
130R	1k3	13k	130k
150R	1k5	15k	150k
160R	1k6	16k	160k
180R	1k8	18k	180k
200R	2k	20k	200k
220R	2k2	22k	220k
240R	2k4	24k	240k
270R	2k7	27k	270k
300R	3k	30k	
330R	3k3	33k	330k
360R	3k6	36k	–
390R	3k9	39k	–
430R	4k3	43k	–
470R	4k7	47k	470k
510R	5k1	51k	–
560R	5k6	56k	560k
620R	6k2	62k	–
680R	6k8	68k	680k
750R	7k5	75k	–
820R	8k2	82k	820k
910R	9k1	91k	1M

ONLY 3p EACH
Minimum order £10
Minimum 5 pcs per value
89 Values (£24)

Special Offer: 5 PCS of EACH (445 RESISTORS) ONLY **£11.50.**
High Quality High Stability. Huge Strength.
VAT inclusive. Add £1.00 p&p all areas.

ORION SCIENTIFIC PRODUCTS LTD.
4 Golden Square, London, W.1

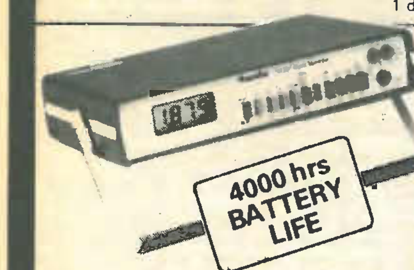
WW – 096 FOR FURTHER DETAILS

thandar's
COMPLETE PORTABLE TEST BENCH

LCD HAND HELD MULTIMETERS

TM354 3½ Digit
● DC Volts : 1mV to 1000V ● AC Volts : 1V to 500V AC rms ● DC current : 1μA to 2A ● Resistance : 1Ω to 2MΩ ● Diode Check ● Basic accuracy : ± (0.75% of reading + 1 digit) ● Battery life : Typically 2000 hours ● £39.95 + VAT

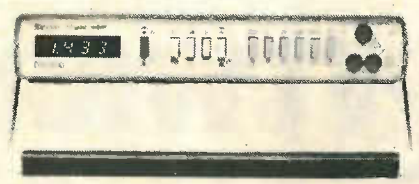
TM 352 3½ Digit
● DC Volts : 100μV to 1000V ● AC Volts : 1V to 1000V ● DC current : 100nA to 10A ● Resistance : 1Ω to 2MΩ ● Diode check ● hFE measurement ● Audible continuity check ● Basic accuracy : ± (0.5% of reading + 1 digit) ● Battery life : 150+ hours ● £49.95 + VAT



LCD BENCH MULTIMETERS

TM351 3½ Digit
● DC and AC Volts : 100μV to 1000V (750V AC rms) ● DC and AC current : 100nA to 10A (20A for 10 secs) ● Resistance : 100mΩ to 20MΩ ● Diode check ● Basic accuracy : ± (0.1% of reading + 1 digit) ● Battery life : up to 4000 hours ● £99 + VAT (inc. batts).

TM353 3½ Digit
● DC and AC Volts : 100μV to 1000V (750V AC rms) ● DC and AC current : 100nA to 2A ● Resistance : 1Ω to 20MΩ ● Diode check ● Basic accuracy : ± (0.25% of reading + 1 digit) ● Battery life : Typically >3000 hours ● £75 + VAT (inc. batts).



LED MULTIMETERS

DM235 3½ Digit
21 ranges; 0.5% basic accuracy; £52.50 + VAT

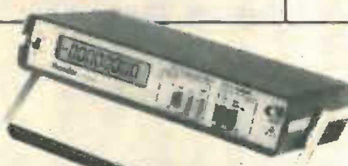
DM350 3½ Digit
34 ranges; 0.1% basic accuracy; £72.50 + VAT

TG105 5MHz Pulse Generator
● Period : 200nsec to 200ms (5MHz to 5Hz) ● Pulse width : 100nsec to 100ms ● 50Ω output range : 0.1V-10V ● TTL output ● Sync. output ● Operating modes: run, external trigger, external gate, manual 1-shot or gate ● Complement and square wave ● £85 + VAT

PULSE & FUNCTION GENERATORS

TG 100 100kHz
TG 102 2MHz
Function Generators
● Functions : Sine, Square, Triangle and DC from variable 600Ω (TG100) or 50Ω (TG102) output ● Output range : 1mV-10V peak-peak ● DC offset range : ±5V ● TTL output ● External sweep : ≥1000 : 1 linear range ● £79 + VAT ● £145 + VAT

FREQUENCY METERS



TF040 8-Digit LCD
● Frequency Range : 10Hz-40MHz (to 400MHz with TP600) ● Sensitivity : 40mV ● Timebase accuracy : better than 0.5 ppm ● Battery life : Typically 80 hours ● £110 + VAT (inc. batts).

TF200 8-Digit LCD
● Frequency Range : 10Hz-200MHz (to 600MHz with TP600) ● Sensitivity : 10mV rms 20Hz-100MHz, 30mV rms 10Hz-20Hz, 100MHz-200MHz ● Timebase accuracy : better than 0.3 ppm ● Battery life : Typically 200 hours ● £145 + VAT (inc. batts).

PFM200A 8-Digit LED Hand Held Meter
● Frequency Range : 20Hz-200MHz (to 600MHz with TP600) ● Sensitivity : Typically 10mV ● Timebase accuracy : better than 2 ppm ● Battery life : Typically 10 hours ● £58.69 + VAT

TP600 600MHz Prescaler
● Frequency Range : 40MHz to 600MHz ● Sensitivity : 10mV ● Output : Typically 500mV peak-peak ● £37.50 + VAT

GOLD MEDAL WINNER

SC110 Single Trace Low Power 2" Oscilloscope
This truly portable oscilloscope, the only British product to win a Gold Medal at the 1980 Brno Trade Fair, boasts the following specification: ● Bandwith DC to 10MHz ● Sensivity : 10mV/div to 50V/div ● Sweep Speeds : 0.1μsecs/div to 0.5 secs/div ● Power Requirements : 4 to 10V DC from 4 'C' cells or AC adaptor ● Size and weight: 255 × 150 × 40mm; 800gms excl. batteries ● £139 + VAT

thandar
ELECTRONIC LIMITED
ELECTRONIC TEST & MEASUREMENT
LONDON ROAD, ST. IVES,
HUNTINGDON, CAMBS. PE17 4HJ
Tel: St. Ives (0480) 64646 Telex 32250

Thandar Electronics Ltd. reserve the right to alter prices and specifications on their equipment without prior notice. ALL THANDAR PRODUCTS CARRY A FULL 1 YEAR WARRANTY

WW – 074 FOR FURTHER DETAILS

www.americanradiohistory.com

Samson's (ELECTRONICS) LTD.

9 & 10 CHAPEL STREET, LONDON, NW1

01-723 7851 01-262 5125

ADJACENT TO EDGWARE ROAD MET. LINE STATION

PLEASE ADD 15% TO ALL ORDERS INC. CARR.
CURRENT RANGE OF NEW L.T. TRANSFORMERS
OPEN TYPE TAG CONNECTIONS
ALL PRIMARIES 220-240V

Type	Sec. Taps	Amps	Price	Carr.
1	24-30-40-48-60v	12	£36.50	£2.00
2	24-30-40-48-60v	10	£31.50	£2.00
3	24-30-40-48-60v	8	£27.50	£1.75
4	24-30-40-48-60v	5	£16.75	£1.75
5	24-30-40-48-60v	3	£11.50	£1.25
6	24-30-40-48-60v	2	£7.50	£1.25
	6-8-10-12-16-18-20-24-36-40-48-60V CAN BE OBTAINED FROM THE ABOVE RANGE			
7	19-25-33-40-50V	10	£27.50	£2.00
8	19-25-33-40-50V	6	£19.50	£1.75
9	19-25-33-40-50V	3	£9.25	£1.25
10	19-25-33-40-50V	2	£7.75	£1.25
	5-7-8-10-13-15-17-20-25-30-40-50V OR 25-0-25V OR 20-0-20V CAN BE OBTAINED FROM THE ABOVE RANGE			
11	12-15-20-25-30V	10	£18.50	£1.75
12	12-15-20-25-30V	5	£10.50	£1.50
13	12-15-20-25-30V	2	£6.25	£1.25
	3-4-5-6-8-9-10-12-15-18-20-24-30V OR 12-0-12V OR 15-0-15V CAN BE OBTAINED FROM THE ABOVE RANGE			
14	12-24v	12v 60A, 24v 30A	£39.50	£3.50
15	12-24v	12v 30A, 24v 15A	£19.50	£2.00
16	12-24v	12v 20A, 24v 10A	£15.25	£2.00
17	12-24v	12v 10A, 24v 5A	£8.75	£1.50
18	12-24v	12v 4A, 24v 2A	£4.25	£1.25

HEAVY DUTY OP TRANSFORMERS
Type OT28EL 100 watts, 3.75Ω, 7.5Ω, 15Ω, 1.75K CT, 4 EL34 2x25 m/a dc max. **£15.50**, P&P £1.25. Type OT29EL 50 watts, 3.75Ω, 15Ω, 3.5K CT, rated 2x125 m/a dc max **£8.95**, P&P £1.

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

SPECIAL OFFER. HINCHLEY MAINS ISOLATION TRANSFORMERS
Prim 240V. Sec 240V 250 watts. Open frame type. Tag connections. Fused input. **£10**, p.p. £2, V.A.T. £1.80. Parmeko pri tapped 115-220-240V. Sec 240V 6 amps. Fully shrouded top panel connections. Sec can be wired to give 120-0-120V. **£25**, carr. £5, V.A.T. £4.50.

HEAVY DUTY ISOLATION TRANSFORMERS
240-240V ex-computer equipment. Large selection available 10-15 amps. Fraction of maker price. Telephone for further details.

SPECIAL OFFER HEAVY DUTY TRANSFORMERS
Pri 240V sec 50V 15 Amps. Twice will give 100V CT or 50V 30A. Open frame type. Terminal block primary. Sec heavy wire leads. Frame size 8½ x 7 x 5 inches. Screen winding between pri and sec. Brand new, fraction of list price, **£32**, carr £5, V.A.T. £5.55.

HEAVY DUTY LT C CORE TRANSFORMERS
Pri 110-220-240V Secs 14V, 3V, 1½V, 1V. Separate windings. All at 40 Amps. 14-15-15½-17-18-18½-19-19½V can be obtained. **£25**, carr £4, V.A.T. £4.35.

INDUSTRIAL AUTOMATIC 24 VOLT 20 AMP BATTERY CHARGERS
AC input 240V 50Hz. DC output 24V 20A. Built in steel case size 15 x 12 x 9½ ins. Complete with battery leads **£65** + V.A.T. Callers only.

HIGH-GRADE TRICKLE CHARGERS
Input 240v AC. Output 12v DC 2 Amps. With mains lead. red and black battery leads with attached clips. Completely fused. Housed in wall mounting, steel case size 6 x 4¾ x 4in. **£4.50.** P&P £1.50 plus VAT. Total £6.90.

HEAVY DUTY LT TRANSFORMERS BY FAMOUS MAKERS
Pri 220-240V sec 70-0-70V 10A C core type top panel connections **£20**, carr £4, V.A.T. £3.60. Pri 115-220-240V sec 22.8V 10.5A and 10V 14A open frame tag panel connections **£10**, P&P £2, V.A.T. £1.80. Pri 220-240V secs 40V 8A. 38V 4A. 20V 4A. 30V 2.6A. 26V 2.6A 28V 2.5A. 51V 200 M/A **£15**, carr £3. Pri 110-220-240V secs 14V 5A. 14V 2½A. 12V 10A. 8V 10A. 24V 1A. Separate windings **£10**, carr £3, V.A.T. £1.95.

ISOLATION TRANSFORMERS
Pri tapped 220-240V sec 240V 500 watts. Open frame type, top panel connections. Ex-equipment, but in perfect condition, **£15**, carr £3, V.A.T. £2.70.

BERCO VARIABLE TRANSFORMERS
Type 42A panel mounting, input 240V, output 0-270V 2A with control knob. Ex-equipment, but in perfect condition, **£10**, P&P £2.50, V.A.T. £1.88.

DC WKG BLOCK CAPACITORS
8 MFD 1000V DC WKG **£3**, P&P £1, V.A.T. 60p. 8 MFD 350V DC WKG **£1.25**, P&P 50p, V.A.T. 26p. 6 MFD 350V DC WKG **£1**, P&P 50p, V.A.T. 22p. 4 MFD 500V DC WKG **£1**, P&P 50p, V.A.T. 22p. 2 MFD 600V WKG **60p**, P&P 20p, V.A.T. 12p. 1 MFD 1000V DC WKG **60p**, P&P 20p, V.A.T. 12p. 1 MFD 600V DC WKG **5 for £1.50**, P&P 50p, V.A.T. 30p. 0.25 MFD 500V DC WKG **5 for £1.25**, P&P 50p, V.A.T. 16p. 0.1 MFD 1500V DC WKG **5 for £1.25**, P&P 50p, V.A.T. 16p. 2 MFD 100V DC WKG **ten for £1.50**, P&P 75p, V.A.T. 33p. Tubular metallised paper caps 20 MFD 350V DC WKG with clip **£3**, P&P 50p, V.A.T. 52p.

IMPORTANT NEWS!!
We would like to announce the opening of our new branch at **21-23 BELL ST., NW1.** It will, of course, stock our fantastic range of products that have made us famous over the past 25 years, **PLUS!!** many new ranges, i.e. computer and electronic components, test equipment, panel meters, multimeters, semiconductors, ICs and a large selection of plugs and sockets.
WHY NOT PAY US A VISIT — IT COULD SAVE YOU **POUNDS!!**

SPECIAL OFFER. HIGH POWER AMPLIFIER TRANSFORMERS
Pri tapped 120-240V sec tapped 34-29-0-29-34V 6 amps and 46V 1A. Open frame type. Tag connection. Size 5 × 4½ × 4 ins. **£9** inc. postage and V.A.T.

POTTED HT CHOKES
4.5H 280 M/A **£3.95**, P&P £1.75, V.A.T. 70p. 10H 180 M/A **£3.95**, P&P £1.75, V.A.T. 70p. 10H 120 M/A **£3**, P&P £1, V.A.T. 60p. 5H 180 M/A **£3**, P&P £1, V.A.T. 60p. 15H 300 M/A **£5**, P&P £2, V.A.T. £1.05. 100H 10 M/A **£1.75**, P&P £1, V.A.T. 40p. 50H 25 M/A **£2**, P&P £1, V.A.T. 45p. 10H 75 M/A **£2**, P&P £1, V.A.T. 45p. Open types top panel connections 5H 350 M/A **£3.50**, P&P £2, V.A.T. 82p. 1H 1 amp **£3.95**, P&P £2, V.A.T. 90p. 25H 60 M/A **£1.75**, P&P £1, V.A.T. 40p. 15H 75 M/A **£2**, P&P £1, V.A.T. 45p. Gardners enclosed type 180H 24 M/A **£4**, P&P £2, V.A.T. 90p. 30H 120 M/A **£4**, P&P £2, V.A.T. 90p.

LT CHOKES
'C' core 8 M/H 15A **£6.75**, P&P £2, V.A.T. £1.32. 4.8 M/H 10A open frame type **£3.95.** P&P £1.50, V.A.T. 81p. Potted types 100 M/H 2A **£4.50**, P&P £1.50, V.A.T. 90p. 130 M/H 1.15A **£2.50**. P&P £1, V.A.T. 52p. 2 M/H 12A x 2, 2 M/H 24A or 4 M/H 12A **£4.50**, P&P £1.50, V.A.T. 90p. Open type 20 M/H 3A open type **£1.95**, P&P 75p, V.A.T. 40p. 'C' core 10 M/H 25A **£10**, Carr £3, V.A.T. £1.95. 'C' core 200 M/H 8A size 9 x 8 x 7 in, **£20**, Carr £5, V.A.T. £3.75.

MONITORS
12 inch monochrome chassis, suitable for use with home computers. Video input. Overall size of chassis 16 x 14 x 14 ins, **£45**, V.A.T. £6.75. Callers only.

SPECIAL OFFER OF ERIE ELECTROLYTIC CAPACITORS
22,000 MFD 63V DC WKG **£4.50** inc. postage and V.A.T. 6800 MFD 100V DC WKG **£2.50** inc. postage and V.A.T. 3600 MFD 150V DC WKG **£2.50** inc. postage and V.A.T. 10,000 MFD 16V DC WKG **five for £2.50** inc. postage and V.A.T. 100 MFD 25V DC WKG **ten for £1** inc. postage and V.A.T. 4.7 MFD 50V DC WKG **ten for 75p**, inc. postage and V.A.T. 22,000 MFD 10V DC WKG **five for £2.50** inc. postage and V.A.T.

AC WKG BLOCK CAPACITORS
15 MFD 250V AC WKG **£2**. 8-4 MFD 250V AC WKG **£1.50**. 5 MFD 440V AC WKG **£2**. 2.5 MFD 360V AC WKG **£1**. 2.7 MFD+0.1 MFD 700V AC WKG **£2**. 1.5 MFD 370V AC WKG **£1**. 0.75 MFD 440V AC WKG **75p**. 0.25 MFD 1500V AC WKG **£1**. 4MFD 250V AC WKG **£1**.

SPECIAL OFFER VARIABLE TRANSFORMERS
Brand new, boxed, input 240V, output 0-265 volts 5 amps. Base or panel mounting with calibrated dial 0-265 volts and control knob. Price **£26** inc. carr. and VAT.

LOW CURRENT LT TRANSFORMERS
Open frame clamped type, split bobbin. All primaries 240V No. 1 sec tapped 12-15-20-24-30V 750 M/A **£4**. No. 2 sec 9-0-9V 1A and 6.3V 200 M/A **£2.50**. No. 3 15-0-15V 600 M/A and 6.3V 200 M/A. No. 4 sec 12-0-12V 750 M/A and 6.3V 200 M/A **£4**. No. 5 sec 13V ½A **£1.50**. No. 6 sec 8V ½A 6.3V 600 M/A, 6.3V 300 M/A, 50V 40 M/A **£2.50**. No. 7 sec 17V ½A (DC) **£1.75.** No. 8 sec 16.5V ½A x 2 **£1.75**. No. 9 sec 18V 2A **£4**. No. 10 sec 24V 2A **£4.50**. No. 11 sec 15V 2A **£3.50**. All prices include postage and V.A.T.

SPECIAL OFFER LT TRANSFORMERS
Computer grade Pri 115-230V sec 27V 10A. 9V 3A. 15V 0.5A. 15V 0.5A. 175V 100 M/A. Separate windings, open frame type, top panel connections, **£3.95**, postage £2.40, V.A.T. 94p.

LATEST PURCHASE. COMPUTER GRADE T TRANSFORMERS. All Primaries 240V. No. 1 secs. 26V 6A **£6.50**, carriage £1.50.
No. 2 sec. tapped 26-31-36V, 11.2A **£12**. P&P £2.
No. 3 sec. 36V 6A **£6.50**. P&P £1.50.
No. 4 sec. 43V 3A **£4.75**. P&P £1.50.
No. 5 sec. 24V 2A **£2.75**. P&P £1.25.
No. 6 sec. 27.5-0-27.5V 1.2A and 7-0-7V 0.75A **£3.50**. P&P £1.25.
No. 7 17V 1A **£2** P&P 75p.
No. 8 13V 3A and 15V 1A **£3.50**. P&P £1.25.
No. 9 18V 2A **£2.50**. P&P £1.
PLEASE ADD V.A.T.

WW – 081 FOR FURTHER DETAILS

FREE ZX81 SOFTWARE!

The June issue of Your Computer contains a FREE software offer of special interest to ZX 81 owners.

This takes the form of a flexi-disc bearing a program for a well-known board game.

An article tells you how to transfer the software from the disc to your ZX 81, thus avoiding the laborious process of keying in program listings.

Also in this issue:
- Review of VIC 20 software
- BBC micro: what the manual didn't tell you
- Writing a word processing package

At all leading newsagents. Price 60p.

Why not place a regular order with your newsagent? Or take out a subscription by completing the coupon.

To **Marketing Department, Room 316, 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.......................................

* WW11

CRICKLEWOOD ELECTRONICS LTD.

40 CRICKLEWOOD BROADWAY, LONDON NW2 3ET. Tel: 01-452 0161

Many of you have been our customers for many years. Our shop has been in **CRICKLEWOOD** for over a decade under a different name, which we will not mention out of respect. **CRICKLEWOOD** is the shop with probably the widest range of components, because of our policy of stocking to the needs of our customers. **CRICKLEWOOD'S** approach is different because we listen and learn from our customers. If you don't see what you want discuss it with us — we may be able to help. All in-stock items despatched to you same day. Quantity discounts given. Govt. Depts., Schools, Exports catered for. Please enquire.

SUPERIOR QUALITY CARBON FILM RESISTORS, HI STAB LOW NOISE

¼W 10Ω-1MΩ 5% E24	2
½W 10Ω-10MΩ 5% E24	3
1W 10Ω-10MΩ 5% E12	6
2W 10Ω-10MΩ 5% E12	15

METAL OXIDE/FILM RESISTORS Very high thermal & electrical stability

400V Polyester Capacitors 1nF, 1.5nF, 2.2nF 18; 3.3nF, 4.7nF, 6.8nF 19; 10nF, 15nF, 22nF 20; 33nF, 47nF, 68nF 22

2219	27	3715	331	4915	295			
2219A	28	3716	360	4916	48			
2220	22	3724	75	4917	47			
2221	22	3725	85	4918	95			
2221A	23	3730	465	4919	128			
2222	25	3732	288	4920	134			
2222A	31	3734	130	4921	109			
2223	260	3735	245	4922	129			
2223A	415	3738	200	4923	134			
2303	110	3740	238	4924	92			
		3741	276	4926	95			

Quality Electrolytics By Matsushita or Siemens AXIALS

TANTALUM BEADS .1/35V 17; .22/35V 17; .33/35V 17; .47/35V 17; .68/35V 17; 1.0/35V 17

1500VDC Caps (300VAC) Axial 1nF, 2.2nF 30; 3.3nF, 4.7nF 32

ORDERING FROM CRICKLEWOOD IS EASY!!!
★ **BY PHONE (QUICKEST WAY):** Quote Barclaycard, Visa, American Express, Access number for immediate service. (No minimum order)
★ **BY POST:** Cheque, PO or send card no. with signature (No minimum order)
★ **CALL IN & COLLECT:** Please add 15% VAT & 70p p&p to all orders — more for heavier goods

CRICKLEWOOD ELECTRONICS
40 BROADWAY, LONDON NW2 3ET. TEL: 01-452 0161

WW – 020 FOR FURTHER DETAILS

www.americanradiohistory.com

TRANSFORMERS

Despatch by return

CONTINUOUS RATINGS

MAINS ISOLATORS (screened)

Pri 0-120; 0-100-120V (120, 220, 240V) Sec or split bobbin to BS.

Ref.	VA (Watts)	£	P&P
07★	20	5.32	1.50
149	60	8.37	1.60
150	100	9.38	1.84
151	200	13.69	2.12
152	250	16.31	2.64
153	350	18.07	2.12
154	500	25.02	2.90
155	750	35.91	OA
156	1000	45.89	OA
157	1500	60.02	OA
158	2000	72.43	OA
159	3000	101.12	OA
161	6000	203.65	OA

★115 or 240v sec only. State volts required. Pri 0-220-240V.

12 or 24-VOLT RANGE

Separate 12V windings Pri 220-240V

Ref.	12v Amps	24v	£	P&P
242	300mA	150mA	2.41	.90
213	1.0	0.5	3.19	1.20
71	2.0	1.0	4.25	1.20
18	4.0	2.0	4.91	1.60
85	5.0	2.5	6.78	1.50
70	6.0	3.0	7.69	1.40
108	8.0	4.0	8.98	1.64
72	10.0	5.0	9.82	1.80
116	12.0	6.0	10.89	1.90
17	16.0	8.0	12.97	2.12
115	20.0	10.0	17.46	2.44
187	30.0	15.0	21.69	2.64
226	60.0	30.0	44.45	OA

50 VOLT RANGE

Sec. Volts available ·5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40 or 20V-0-20V or 25V-0-25V

Ref.	Amps 50v	25v	£	P&P
102	·5	1	4.13	1.40
103	1	2	5.03	1.40
104	2	4	8.69	1.84
105	3	6	10.36	1.90
106	4	8	14.10	2.12
107	6	12	16.37	1.84
118	8	16	24.52	2.70
119	10	20	30.23	OA
109	12	24	36.18	OA

30 VOLT RANGE (Split Sec)

Sec. Volts available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V or 15V-0-15V

Ref.	Amps 30v	15v	£	P&P
112	0.5	1	3.19	1.20
79	1	2	4.32	1.40
3	2	4	6.99	1.60
20	3	6	8.10	1.85
21	4	8	9.67	1.90
51	5	10	11.95	2.00
117	6	12	13.52	2.02
88	8	16	18.10	2.26
89	10	20	20.88	2.24
90	12	24	23.20	OA
91	15	30	26.60	3.00
92	20	40	35.64	4.83

60 VOLT RANGE

Pri 0-220-240V (Split Sec)
Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V, or 24V-0-24V or 30V-0-30V

Ref.	Amps 60v	30v	£	P&P
124	·5	1	4.70	1.50
126	1	2	7.15	1.50
127	2	4	9.20	1.90
125	3	6	13.31	2.02
123	4	8	15.15	2.26
40	5	10	19.16	2.24
120	6	12	21.86	2.64
121	8	16	30.72	OA
122	10	20	35.76	OA
189	12	24	41.22	OA

SCREENED MINIATURES Pri 240V

Ref.	mA	Sec Volts	£	P&P
238	200	3-0-3	3.11	.90
212	1A, 1A	0-6, 0-6	3.45	1.20
13	100	9-0-9	2.59	.80
235	330, 330	0-9, 0-9	2.41	.90
207	500, 500	0-8-9, 0-8-9	3.36	1.20
208	1A, 1A	0-8-9, 0-8-9	4.27	1.40
236	200, 200	0-15, 0-15	2.41	.90
239	50MA	12-0-12	3.11	.90
214	300, 300	0-20, 0-20	3.39	1.20
221	700 (DC)	20-12-0-12-20	4.13	1.20
206	1A, 1A	0-15-20, 0-15-20	5.60	1.60
203	500, 500	0-15-27, 0-15-27	4.83	1.50
204	1A, 1A	0-15-27, 0-15-27	7.30	1.60

400/440V ISOLATORS

400/440 to 200/240V

VA	Ref.	£	P&P
60	243	8.11	1.50
250	246	16.07	OA
350	247	19.88	OA
500	248	24.77	OA
1000	250	50.53	OA
2000	252	74.79	OA
3000	253	104.86	OA
6000	254	207.92	OA

AUTO TRANSFORMERS

Voltages available 105, 115, 190, 200, 210, 220, 230, 240. For step up or step down.

Ref.	VA (Watts)	TAPS	£	P&P
113*	15	0-10-115-210-240V	2.39	1.20
64	80	0-10-115-210-240V	4.84	1.40
4	150	0-10-115-200-220-240V	6.48	1.60
67	500	0-10-115-200-220-240V	13.30	2.24
84	1000	0-10-115-200-220-240V	22.70	2.80
93	1500	0-10-115-200-220-240V	28.17	OA
95	2000	0-10-115-200-220-240V	42.14	OA
73	3000	0-10-115-200-220-240V	71.64	OA
80s	4000	0-10-115-200-220-240V	93.01	OA
57s	5000	0-10-115-200-220-240V	108.30	OA

CASED AUTOS

240V cable input USA 115V outlets

VA	Price	P&P	Ref
20	£7.21	1.25	56W
80	£9.35	1.50	64W
150	£12.10	1.84	4W
200	£12.02	1.44	65W
250	£14.73	1.60	69W
500	£22.14	2.24	67W
1000	£33.74	2.80	84W
2000	£60.47	OA	95W

CONSTANT VOLTAGE TRANSFORMERS

For 'clean' mains to computers, peripherals..

250VA £137.36
500VA £159.43
1kVA £213.12
+ p&p + VAT

SPECIALIST TRANSFORMER WINDING SERVICE

7.5-0-7.5V (15VCT)

Ref.	Amp	Price	P&P
171	500MA	2.53	.90
172	1A	3.59	1.20
173	2A	4.35	1.20
174	3A	4.54	1.20
175	4A	6.93	1.40

TOROIDALS NOW AVAILABLE

30VA 60VA 100VA 160VA 230VA 330VA 530VA

Send stamp for list

PLEASE ADD 15% VAT AFTER P&P
Overseas post extra

OTHER PRODUCTS

AVO TEST METERS

8 Mk. 5 Latest Model £122.10
71 (Electronics & £49.30
73 TV Service) £68.90
MM5 Minor £43.60
DA211 LCD Digital £58.50
DA212 LCD Digital £81.90
DA116 LCD Digital £131.30
Megger 70143 500v £97.20
Megger Battery BM7 £71.60
Avo Cases and Accessories
P&P £1.32 + VAT 15%

MAINS BATTERY ELIMINATORS

No wiring, ready to plug into 13A socket. 6, 9, 12V DC 300mA £5.10 + VAT

ANTEX SOLDERING IRONS 15W. CCN240 or C £4.50
Safety stand .... £1.75 25W X25 .... £4.80
12V 25W car soldering kit.............................. £5.30
P&P 50p + VAT

PANEL METERS £6.70 ea + 76p P/P + VAT
43 × 43mm or 82 × 78mm
V.U. Indicator
50µA, 500µA, 1mA, 30V d.c. etc. £1.95 + 30p P&P + VAT
Educational Meter 10A8 30V £4.50 + VAT

Precision De-Solder Pumps – Spring loaded quick action button release for one hand working. Large £5.86 P&P 35p + VAT. Small £5.17 P&P 30p + VAT. Replacement tips: Small 65p + VAT. Large 86p + VAT.

ANTEX SOLDERING IRONS 15W CCN240 or C £4.50 25W X25 £4.80. 12V 25W car solder kit £5.30. Safety stand £1.75. P&P 55p + VAT

BRIDGE RECTIFIERS

200v	2A	45p
400v	2A	55p
100v	25A+	£2.10
100v	50A	£2.60
200v	4A	65p
400v	4A	85p
400v	6A	£1.40
500v	12A	£2.85

P&P 20p. VAT 15%

METAL OXIDE RESISTORS £1/100

Special Offer TR4 5% Electrosil (100s only). Use in place of c.film. 47Ω - 75Ω - 180Ω - 360Ω - 390Ω - 430Ω - 470Ω - 510Ω - 560Ω - 820Ω - 1K - 1K2 - 1K3 - 1K6 - 1K8 - 2K - 2K4 - 3K - 16K - 20K - 22K - 24K - 27K - 47K - 82K - 100K - 110K - 120K - 130K - 180K - 220K - 270K - 300K. P&P 30p + VAT

Send 20p for catalogue.
Prices correct at 20/3/81

Barrie Electronics Ltd.

3, THE MINORIES, LONDON EC3N 1BJ
TELEPHONE: 01-488 3316/8
NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST.

WW – 036 FOR FURTHER DETAILS

AUDIO BENCH TEST SET CT373 three function unit AF Osc 17c/s 170Kc, V.T.V.M. to 300v & Dist Meas Set to 20Kc 10/30/100% FSD 240v mains new cond with book. £80.
RECORDING TAPE Ampex new Mil Spec ¼" 3600ft on 10½" spools £7.50.
RADIOSONDES British Mk.11 battery operated, Tx on 27Mc/s use tone modulation for Temp, Press & RH. new with chart. £7.50.
AIRCRAFT CABIN SPEAKERS size 17×3½×2½ contain 4 3 ohm 3×3" spk black crackle finish. £7.50 Transis Amp unit plugs in spk. £3.50.
HANDSETS lightweight moving coil with ext cord nom 50 ohm. £3.50.
BENCH P.U. Solatron 240v mains OPs 0 to 500v DC at 100 Ma & 6.3v at 3 amps fitted meter tested. £30.
BLOWER UNITS. H.D. for 240v outlet 2½×3½" new cond. £13.50 also similar outlet 2×2½" new cond. £11.50 also Axial type 115v fan size 5×4" with air filter as new cond. £8.50.
STANDARD CELLS Muirhead 1.01859v size 3½×1½×¾" tested. £5.75.
HIGH RESIST TEST SETS 240v see list. £40.
RECTIFIER UNITS 240v I/P O/P 28v DC at 15 amps with meter tested. £38, M.O.D.
RECORD PLAYER UNITS for 240v mains as Goldring Lenco 4 speed deck with mono amp about 10w push pull, int spk provision for ext 4 or 15 ohm spk, as bass & treble controls, Gram & Mike vol controls in wood case size 17×15×11" good cond with circ. £45.
MARCONI TF1041B VTVM mains operated. 300Mill/V to 1Kv DC 300Mill/V to 300v AC. Ohms 50 to 500Meg FSD, as RF probe to 500Mc/s, good cond, tested with book. £48.
INTERCOMM SET 36. for use by aircraft ground servicing teams provides communications for up to 3 persons by means of headsets & throat mikes, supplied in fitted case size 20×13×13" this also contains amp unit for mains or 24v also contains range of extension cables 25 & 120 Ft, cable clamps, etc new cond with circ. £45.
MAINS ROTARY INVERTORS I/P 24v DC at 10 amps for full O/P, provides 230v, at 50c/s 140 watts Sine Wave O/P complete in carrying case with connectors, good cond. £45 or Inv only £27.
COAX RELAYS small 24v coil 50 ohm with connec ex new equip. £5.
RADIO VALVE KIT as follows all CV types 6BA 6×5, 6BE6×2, EF91×4, EB91×3, EL91 total 15. £10.
AIRCRAFT ADF EQUIP. comprises Rx R1937, Rx Control Box, Loop Ae, Mech Drive unit for Ae, 360' bearing Ind, Ae Amp, Junction box, will provide ADF or Manual bearings on signals in range 150Kc to 1500Kc can also be used as normal Rx reqs 24v DC at 5 amps, some tech info. £85.
BENCH P.U. heavy duty O/P var 0 to 40v and 0 to 40 amps, over volt & current limit, fitted volt & amp meters, 19" panel, new condition, for 240v mains. £125.
MARCONI TF867 Sig Gens 15Kc to 30Mc/s £65. TS419 Sig Gen 900/2100Mc/s 115v. £65.
REDIFON GR286 Marine VHF base station, one only. £115.
AUTO TRANS 200/250v to 115v at 560 watts enclosed. £14.50
COLLINS R278 UHF Rx 225 to 400Mc/s in 100Kc steps any 11 freq can be selected from front panel, uses 38 xtals no ext xtals req, AF O/P 3 watts 600 ohm for 230v mains 19" rack mt about 50Kg tested with book. £115. S.T.C. STR.18.
AIRCRAFT RADIO EQUIP comprises various items to make up a 24 chan remote controlled HF Tx/Rx installation 2.8 to 18Mc/s rated 100 Watts AM/CW mains items R4187, Rx, T4188 Tx, T4180 ATU, T4243 Tx C.U., T4192 Mod & P.U., T4189 C/Bx circs available no cables reqs 24 & 19v DC, uses Hc6/u xtals not supplied, good cond. £115.

Above prices include Carr/Postage & Vat.
Goods ex-equipment unless stated new. SAE with enquiry or 2× 15½p stamps for List 28. Allow 14 days for delivery.

A. H. SUPPLIES

122 Handsworth Rd., Sheffield, S9 4AE
Ph. 444278 (0742)

FIRST IN THE WORLD

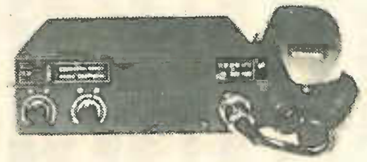
The ICM-12, synthesized, marine hand-portable radio

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. RTD HP 105.
- **PRICE £199.13 + VAT. Free carriage.**

Also IC-M25D 25W, synthesized 25 channel VHF marine transceiver **£207.83 + VAT.**

Trade enquiries very welcome – Ask for Phil Hadler



We can also supply the ICOM IC100E Highband PMR Base and Mobile transceivers. Fully approved, very compact, built-in CTCSS and at very competitive prices. **Dealer outlets required, ask for Dave Stockley.**

Thanet Electronics ICOM

143 Reculver Road, Herne Bay, Kent
Tel: 02273 63859. Telex 965179

WW – 016 FOR FURTHER DETAILS

Who takes care of your EPROMS?

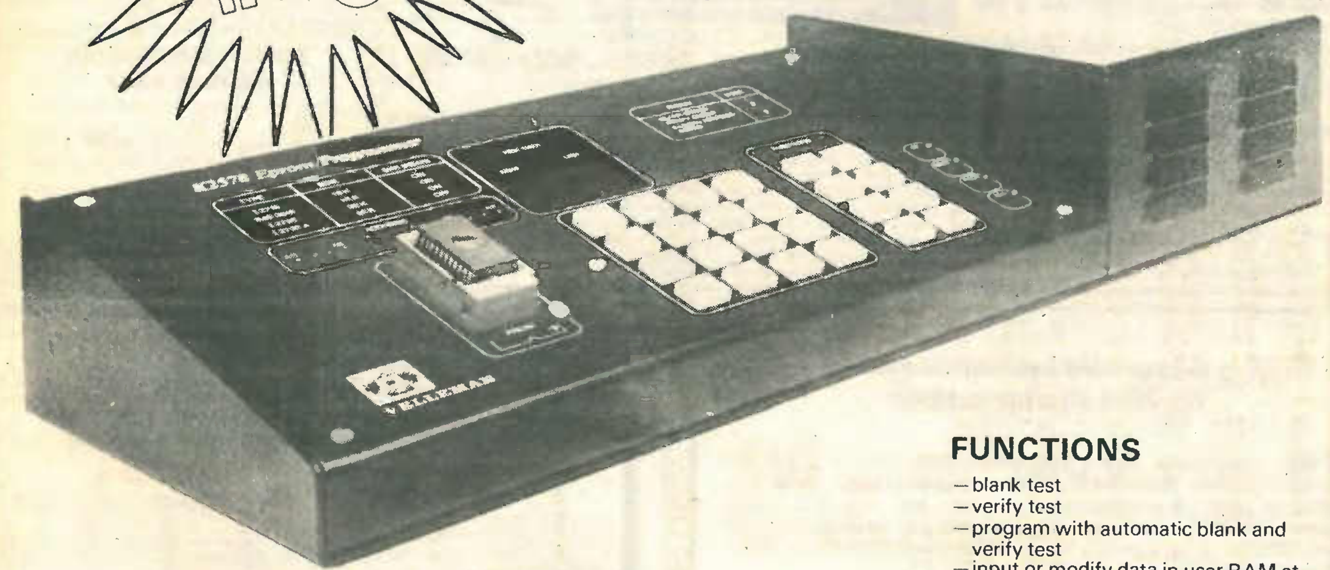
... WE DO!

MICROPROCESSOR CONTROLLED EPROM PROGRAMMER

Qualified by INTEL and new to the UK. home market, Velleman UK. are offering you their **K2578** EPROM programmer This compact unit is complete with the power supply and available assembled or in kit form.

The K2578 will test, verify, copy and programme the following EPROMS with **No need for any other personality module** – 2716 (Intel or equivalent) - 2732 (Intel or equivalent - 2732A (HMOS version of Intel) and TMS2516 (Texas Instruments).

Ideal for industry, repair shops, schools or the home enthusiast, the K2578 works independently and has no specific relation with any development system.



CONTROLS

- 24 key pad includes hexadecimal keyboard and function keys.
- 12 address LED's.
- 4-function LED's (error, prog, ok and size).
- 2 hexadecimal displays.

SPECIAL OFFER

Assembled £270.00
Kit Form £180.00

Prices exclude V.A.T. and carriage.

TECHNICAL INFORMATION

- power supply: 220/110V AC 50/60 Hz
- supply current: typ 70mA/220V 150mA/110V
- 2K byte STATIC RAM STANDARD (expandable to 4K byte)
- microprocessor controlled
- CMOS/TTL LOGIC
- Textool test socket

MECHANICAL SPECIFICATIONS

- length: 420mm
- depth: 190mm
- height: 78mm
- weight 3.75Kg

FUNCTIONS

- blank test
- verify test
- program with automatic blank and verify test
- input or modify data in user RAM at any desired address
- load RAM function to fill the RAM area with data from a preprogrammed PROM to perform a copy
- Parallel load capability from a DMA controlled RAM field
- size selection (16/32K) with single push-button
- OK indication for successful executed functions
- ERROR indication with error codes on display
- blank error
- verify error
- illegal address access error
- increment function which stores the input data via hex. keyboard and jumps to the next address in user RAM
- reset

VELLEMAN UK. LTD

P.O. Box 30, St. Leonards-on-Sea, East Sussex TN37 7NL.
Telephone: Hastings (0424) 753246.

WW – 057 FOR FURTHER DETAILS

www.americanradiohistory.com

RHODE & SCHWARZ

Selective UHF V/Meter. Bands 4 & 5. USVF
Selectomat Voltmeter USWV **£450.**
UHF Sig. Gen. type SDR 0.3-1GHz
UHF Signal Generator SCH **£175.**
XUD Decade Synthesizer & Exciter.
POLYSKOPS SWOB I and II.
Modulator/Demodulator BN17950/2.

MARCONI

TF995B/2 AM/FM Signal Generator.
TF2500 Audio power meter
TF1101 RC oscillators **£65.**
6551 SAUNDERS. 1400-1700MHz. FM.
TF1066B/1. 10-470MHz. AM/FM.
TF1152A/1. Power meter. 25W. 500MHz **£50.**
TF1370A RC Oscillator **£135.**
TF791D Carrier Deviation Meter.

BECKMAN TURNS COUNTER DIALS

Miniature type (22mm diam.). Counting up to 15 turn "Helipots". Brand new with mounting instructions. Only **£2.50** each.

★ VIDEO EQUIPMENT SALE ★
CONTENTS OF COMPLETE MONOCHROME STUDIO

MARCONI Video/Audio mixing desks.
Monochrome Video cameras complete with on-board monitors.
Video monitors types CONRAC II (9" tube) PROWEST 13".
To be sold in first-class working condition.
Offers invited for complete lot.

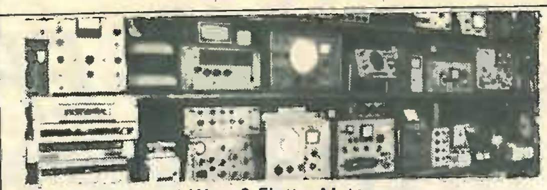
SEALED LEAD ACID BATTERIES

Gould GELYTE type PB660. 6V. 6A.H. Measures 3¾x2¾x2¾ inches. Excellent condition. **£4.50.** (75p post).

20-WAY JACK SOCKET STRIPS. 3 pole type **£2.50 each** (+ 25p p.p.). Type 316 three-pole plugs for above—**20p ea.** (p.p. free).

P. F. RALFE ELECTRONICS

10 CHAPEL STREET, LONDON, NW1
TEL: 01-723 8753



RANK KALEE 1742 Wow & Flutter Meter.
AIRMEC 314A Voltmeter. 300mV (FSD)-300V.
AIRMEC Wave Analysers types 853 & 248A.
DERRITRON 1KW Power Amplifier with control equipment for vibration testing, etc.
TELONIC type 1204 0-500MHz sweep generator **£150**
TELONIC type 121 Display scopes **£90**
TELONIC type 101 Display scopes **£75**
WAYNE KERR AF signal generator S121 model **£85**
RADIOMETER Distortion Meter BKF6 **£125.**

SPECIAL PURCHASE OF TEKTRONIX 454 PORTABLE OSCILLOSCOPES

Tektronix 454 DC-150MHz dual-beam oscilloscopes in stock now. 5mV/cm Y-amplifier (1mV cascaded). 2.4ns risetime. Calibrated sweep delay. We can offer these units in first-class operational condition complete with three months' guarantee, for a once only price of ~~£850~~.

SPECIAL OFFER FOR THIS MONTH REDUCED TO £650.00

★ OSCILLOSCOPES ★
TEKTRONIX 500 SERIES SCOPES AT BARGAIN PRICES:

All in good working order. Available to callers only
TYPE 543B with 'CA' plug-in 25MHz DB.......... SOLD OUT
TYPE 545B with 'CA' plug-in 25MHz DB.......... SOLD OUT
TYPE 585A with '82' unit. 80MHz. Few left ~~£250~~. Reduced to **£200**

PLEASE NOTE. All the pre-owned equipment shown has been carefully tested in our workshop and reconditioned where necessary. it is sold in first-class operational condition and most items carry a three months guarantee. For our mail order customers we have a money-back scheme. Repairs and servicing to all equipment at very reasonable rates. PLEASE ADD 15% VAT TO ALL PRICES.

DC POWER SUPPLIES

★APT 10459/8, 12-14V @ 5 Amps **£25** (£2 p.p.)
★APT 10459/8, 24V @ 5 Amps **£25** (£2 p.p.)
★We can supply the above power supply at any fixed voltage between 5V and 36V at 5A **£25.**
★Mullard Dual supplies. Brand new with handbook. Pos & Neg 12V at 1A and 0.4A respectively. Dimensions 9x4x5ins. **£10** + (£1 p.p.)
★FARNELL Current limited. Dimensions 7x5x4ins. Following types available: 13-17 Volts @ 2A **£15.** 27-32 Volts @ 1A 5V **£15.** 5V @ 3A **£15.** (pp £1.50).

SPECIAL PURCHASE
LAMBDA POWER SUPPLIES

Excellent LXS Series DC power units at less than a tenth of new price. The snag? — they're all 110V AC Input. Prices as follows:
5V at 24A. LXS D5 0V R. **£25.** (List £350).
5V at 14A. LXS CC 5 0V. **£20.** (£258).
24V at 3.1A. LCS C 24. **£15.** (£223).
Carriage each £2.50 extra
Special note: The 5V power supplies may be operated (both primary from 230V) and DC output to give a maximum output voltage of 12.5DC when connected in series. Deduct 10% from price for two off or more, i.e., 12V DC at 24A for **£45** + Tax! Very cheap!

VARIABLE VOLTAGE BENCH SUPPLIES

Variable voltage DC power supplies for workshop use. Constant voltage, variable 0-30V output at 1A. Cased, free standing, volt-metered output. Short circuit proof. Size 4 x 5x 7". Only **£30**—each (pp £1.50).

COMMUNICATIONS TEST EQUIPMENT

MARCONI TF1066B/1. AM/FM Signal Generator. 10-470MHz. 0.2uV-200mV output. FM Deviations up to ±100KHz from 30Hz-15KHz **£550**
MARCONI TF995A/5 AM/FM Signal generator. Narrow deviation model 995 covering 1.5-220mHz **£450**
MARCONI TF1064B/5 FM signal generator covering in three ranges 68-108, 118-185 and 450-470MHz. Modulation FM fixed deviations of 3.5 and 10KHz. AM fixed 30% **£225**
MARCONI TF791D FM Deviation meter..... £185

ROTRON INSTRUMENT COOLING FANS

Supplied in excellent condition, fully tested:
115V, 4.5 × 4.5 × 1.5" **£4.50.** 230V **£5.** 115V, 3 × 3 × 1.5" **£4** + postage ea. 35p.

100V DC ELECTROLYTIC CAPACITORS

Sprague 'Powerlytic' type 36D. 10,000uF. 100V. Brand new at surplus price! Only **£4 ea.** PP 50p.

EV88 — A low-cost evaluation system for the 8088 microprocessor

EV88 is a single board microcomputer that is ideal for evaluating the 8088 8-bit/16-bit microprocessor. EV88 can also be used as a powerful controller, and, with a suitable cross-assembler running on a standard microcomputer, and an EPROM programmer, for low-cost development of 8088-based systems.

EV88 is supplied fully assembled and tested, with comprehensive documentation, and a copy of The 8086 Book, by Rector and Alexy. All you need is a 5V 1A power supply and a terminal or a suitable microcomputer.

★ 8088 microprocessor in minimum mode (software compatible with the 8086 16-bit microprocessor).
★ Comprehensive monitor in 2K EPROM.
★ 2K CMOS RAM.
★ Cassette interface.
★ 24 lines of I/O.
★ Eight levels of interrupt.
★ RS-232 compatible serial interface (300 baud to 9600 baud).
★ Three-channel counter/timer.
★ Buffered data, address and control lines.
★ Double Eurocard.
★ On-board expansion to 16K EPROM/RAM (sockets provided).
★ Breadboarding area.
★ All bus signals available on 64-way DIN 41612 connector.
★ Single 5V supply.
★ Price £300 plus VAT. Includes delivery.

8088/8086 design service available (software and hardware).

LFH Associates Ltd.
40A High Street
Stony Stratford
Milton Keynes
(0908) 566660

WW – 092 FOR FURTHER DETAILS

SUPERSEM

PLYMOUTH 0752 21256

MEMORIES AT UNFORGETTABLE PRICES

	1-24	25-99	100+	1,000+
4116 P-3 200ns	.90	.85	.80	.75
2114 LP 450ns	.90	.87	.85	.80
2708k 450ns	2.70	2.50	2.30	2.25
2716k 450ns	2.45	2.30	2.10	2.00
2732k 450ns	3.85	3.65	3.60	3.25
8981 P-45 Cmos	2.25	2.15	2.05	1.85
8725 S 200ns	7.05	6.55	6.05	5.55
K4164 200ns	5.00	4.75	4.50	4.25
8039 8-bit	3.05	2.90	2.75	2.45
8080AP CPU	2.15	2.05	1.95	1.75
8085A CPU	2.80	2.65	2.50	2.20
8155P + Timer	3.10	2.95	2.80	2.50
8156P + Timer	3.45	3.25	3.05	2.65
8212P i/o Port	1.10	1.05	1.00	.85
8216 Bus Driver	1.05	1.00	.95	.85
8224P Clock Gen	1.30	1.20	1.15	1.05
8226P Bus + B/Drives	.92	.87	.82	.75
8228P System Cont	2.25	2.15	2.05	1.85
8243P i/o Exp	2.00	1.95	1.90	1.80
8251AP Prog. Int./Face	2.60	2.50	2.40	2.30
8253P Prog. Int./Time	3.60	3.40	3.20	2.85
8255AP Perip./Inter	2.25	2.15	2.05	1.85
8257P DMA Cont	3.75	3.65	3.35	3.00
8259 Inter Cont	3.60	3.40	3.20	2.85
8279P Key Disp	4.60	4.50	4.00	3.50
4044 P-3 300ns	1.90	1.80	1.70	1.55

Please add V.A.T. to all orders

FAST DELIVERY : TOP QUALITY

Phone 0752 21256

SUPERSEM

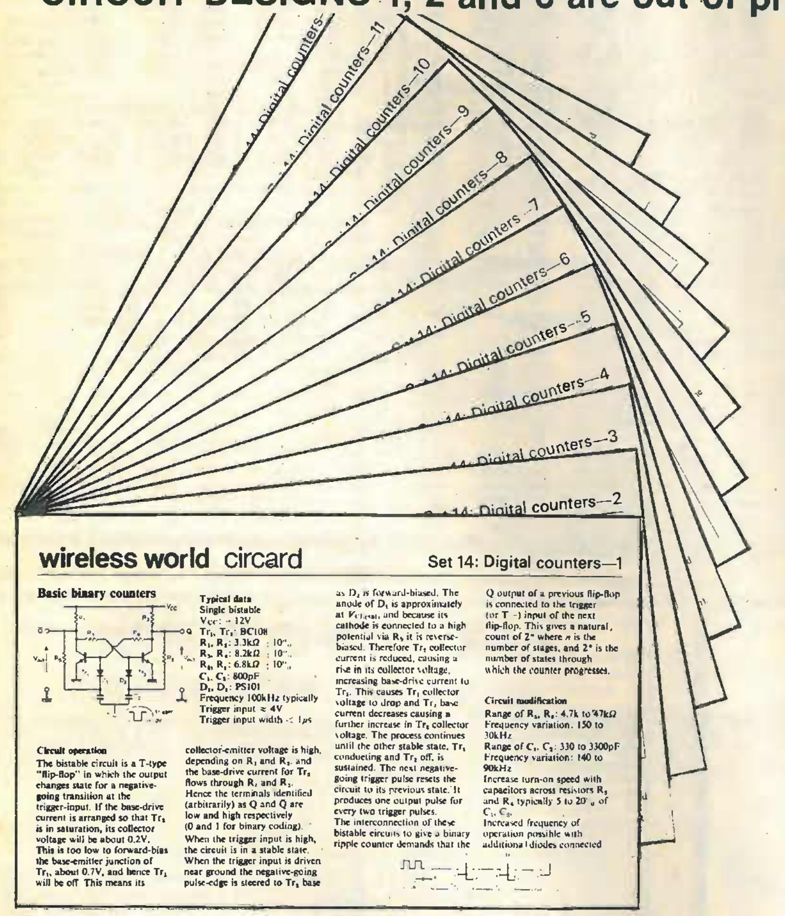
Export enquiries welcome

3rd Floor
Britannic House
Drake Circus
Plymouth PL4 8AQ

WW – 085 FOR FURTHER DETAILS

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)
6 Constant current circuits 7 Power amplifiers 8 Astable circuits 9 Optoelectronics 10 Micro power circuits 11 Basic logic gates 12 Wideband amplifiers 13 Alarm circuits 14 Digital Counters 15 Pulse modulators 16 Current differencing amplifiers – signal processing 17 Current differencing amplifiers – signal generation 18 Current differencing amplifiers – measurement and detection 19 Monostable circuits 20 Transistor pairs 21 Voltage-to-frequency converters 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).....................

..

www.americanradiohistory.com

HEMMINGS ELECTRONICS AND MICROCOMPUTERS

16 BRAND ST
HITCHIN
HERTS
SG5 1JE

Tel: (0462) 33031
Shop open Mon.-Sat. 9 a.m.-5.30 p.m.
Closed all day Wednesday

Buy it with Access

Professional quality electronic components, brand new and fully guaranteed. Mail order by return of post. Cash/Cheque/POs or Banker's Draft with order, payable to Hemmings Electronics Ltd.
Official orders from schools, colleges and universities welcome. Export enquiry welcome. P.&P. add 60p to all orders under £10. Telephone your Access orders, using our 24-hr. Ansaphone service.
VAT – All prices exclusive of VAT – Please add 15% to total cost including P.&P. No VAT on export orders or books.

74LS TTL

LS00	12p
LS01	12p
LS02	14p
LS03	15p
LS04	15p
LS05	15p
LS08	15p
LS09	15p
LS10	15p
LS11	15p
LS12	15p
LS13	29p
LS14	45p
LS15	15p
LS20	15p
LS21	15p
LS22	15p
LS26	20p
LS27	18p
LS28	20p
LS30	16p
LS32	15p
LS33	16p
LS37	16p
LS38	16p
LS40	16p
LS42	38p
LS47	50p
LS48	72p
LS49	65p
LS51	15p
LS54	16p
LS55	25p
LS73A	28p
LS74A	24p
LS75	30p
LS76A	30p
LS77	32p
LS78A	32p
LS83A	48p
LS85	65p
LS86	30p
LS90	38p
LS91	75p
LS92	38p
LS93	38p
LS95B	45p
LS107A	45p
LS109A	30p
LS112A	30p
LS113A	35p
LS114A	35p
LS122	42p
LS123	50p
LS125A	35p
LS126A	35p
LS132	42p
LS133	36p
LS136	30p
LS138	35p
LS139	37p
LS145	85p
LS151	40p
LS153	40p
LS155	40p
LS156	40p
LS157	35p
LS158	35p
LS160A	42p
LS161A	42p
LS162A	42p
LS163A	42p
LS164	48p
LS165	70p
LS166	80p
LS168	120p
LS169	120p
LS170	95p
LS173	70p
LS174	63p
LS175	55p
LS181	125p
LS182	120p
LS183	120p
LS190	60p
LS191	60p
LS192	60p
LS193	60p
LS194A	45p
LS195A	45p
LS196	65p
LS197	65p
LS221	55p
LS240	80p
LS241	80p
LS242	80p
LS243	80p
LS244	80p
LS245	95p
LS251	40p
LS253	40p
LS256	96p
LS257A	42p
LS258A	42p
LS259	80p
LS260	22p
LS266	22p
LS273	80p
LS279	80p
LS283	45p
LS290	45p
LS293	45p
LS295A	96p
LS298	90p
LS352	96p
LS353	96p
LS365A	40p
LS366A	40p
LS367A	40p
LS368A	55p
LS373	75p
LS374	75p
LS375	45p
LS377	75p
LS378	75p
LS379	65p
LS385	260p
LS386	45p
LS390	85p
LS393	58p
LS395	150p
LS398	130p
LS399	120p
LS490	120p
LS540	105p
LS541	140p
LS568	345p
LS569	345p
LS640	190p
LS641	190p
LS642	190p
LS643	190p
LS644	200p
LS645	190p
LS670	135p
LS796	210p
LS797	210p
LS798	210p

CMOS 4000B

4000	14p
4001	14p
4001U	14p
4002	14p
4002U	14p
4006	65p
4007	16p
4008	65p
4011	14p
4011U	14p
4012	16p
4012U	16p
4013	33p
4014	70p
4015	65p
4016	35p
4017	48p
4018	65p
4020	65p
4021	72p
4022	70p
4023	16p
4023U	16p
4024	55p
4025	18p
4025U	18p
4027	37p
4028	48p
4029	60p
4032	120p
4034	165p
4035	90p
4038	120p
4040	58p
4042	62p
4043	70p
4044	70p
4046	65p
4049U	28p
4050	28p
4051	72p
4052	72p
4053	72p
4060	90p
4066	35p
4068	18p
4069U	18p
4070	20p
4071	20p
4072	20p
4073	20p
4075	20p
4076	65p
4077	20p
4078	20p
4081	20p
4082	20p
4093	40p
4094	120p
4099	110p
4160	80p
4161	80p
4162	80p
4163	80p
4174	80p
4175	100p
4194	100p
4433	620p
4443	390p
4447	390p
4493	320p
4494	320p
4495	320p
4499	330p
4501U	25p
4502	89p
4503	60p
4504	100p
4506	68p
4508	240p
4510	75p
4511	75p
4512	75p
4513	160p
4514	180p
4515	180p
4516	90p
4517	290p
4518	56p
4519	36p
4520	80p
4521	195p
4522	110p
4526	110p
4527	110p
4528	90p
4529	120p
4530	90p
4531	95p
4532	120p
4534	480p
4536	290p
4538	105p
4539	105p
4541	110p
4543	120p
4544	175p
4547	130p
4549	380p
4551	105p
4553	295p
4554	165p
4555	70p
4556	75p
4557	260p
4558	125p
4559	410p
4560	180p
4561	100p
4562	395p
4566	165p
4568	280p
4569	170p
4572U	38p
4580	395p
4581	240p
4582	65p
4583	105p
4584	50p
4585	95p
4597	295p
4598	295p
4599	290p
44100	625p
44110	498p
44111	450p
44115	426p

LINEAR

709	35p
741	25p
741S	55p
747	65p
748	35p
LF355	80p
LF356	90p
LF357	100p
LM301A	30p
LM307	50p
LM308A	95p
LM311N	66p
LM324	45p
LM339	55p
LM348	80p
LM358	60p
MC1455	86p
MC1456	135p
MC1458	45p
MC3302	95p
MC3401	65p
MC3403	70p
MC3456	107p
MC34001	58p
NE555	24p
NE556	45p
NE565	155p
NE567	140p
SN76477	175p
TL061	40p
TL062	60p
TL064	98p
TL071	30p
TL072	50p
TL074	100p
TL081	25p
TL082	45p
TL084	95p

TRANSISTORS

BC107	12p
BC107B	15p
BC108	12p
BC108B	15p
BC109	12p
BC109B	15p
BC109C	15p
BC177	25p
BC178	25p
BC179	25p
BC182	10p
BC182A	10p
BC182B	10p
BC183A	10p
BC183C	10p
BC184	10p
BC184C	10p
BC212	10p
BC212A	10p
BC212B	10p
BC213A	10p
BC213C	10p
BC214	10p
BC214C	10p
BC237A	12p
BC237C	12p
BC238	12p
BC238A	12p
BC238B	12p
BC238C	12p
BC239	12p
BC239C	12p
BC307A	15p
BC307C	15p
BC308	15p
BC308A	15p
BC308B	15p
BC308C	15p
BC309	15p
BC309C	15p
BC327	15p
BC328	15p
BC337	15p
BC338	15p
BCY70	20p
BCY71	20p
BCY72	20p
BD135	48p
BD136	48p
BD139	45p
BD140	45p
BD165	45p
BD166	45p
BD169	45p
BD170	45p
BD677	60p
BD678	60p
BD679A	60p
BD680A	65p
BFY50	40p
BFY51	40p
BF244A	30p
MJE241	60p
MJE251	80p
MJE340	50p
MJE350	90p
MJE370	95p
MJE520	65p
MJE2955	90p
MJE3055	65p
MPF102	45p
MPS2369	25p
MPS3640	30p
MPS3646	30p
MPSA06	20p
MPSA13	20p
MPSA14	20p
MPSA18	20p
MPSA27	45p
MPSA42	25p
MPSA56	25p
MPSA63	30p
MPSA64	45p
MPSA77	50p
MPSA92	30p
TIP29	35p
TIP29A	35p
TIP29B	55p
TIP29C	60p
TIP30	50p
TIP30A	50p
TIP30B	50p
TIP30C	50p
TIP31A	45p
TIP31B	48p
TIP31C	55p
TIP32	50p
TIP32A	60p
TIP32B	70p
TIP32C	65p
TIP33	65p
TIP33A	65p
TIP33B	70p
TIP33C	70p
TIP34	75p
TIP34A	75p
TIP34B	99p
TIP34C	90p
TIP35	160p
TIP35A	165p
TIP35B	170p
TIP35C	185p
TIP36	170p
TIP36A	175p
TIP36B	185p
TIP36C	190p
TIP41	55p
TIP41A	55p
TIP41B	60p
TIP41C	60p
TIP42	60p
TIP42A	65p
TIP42B	70p
TIP42C	75p
TIP47	75p
TIP48	75p
TIP49	95p
TIP50	95p
TIP110	30p
TIP111	35p
TIP112	30p
TIP115	40p
TIP116	30p
TIP117	45p
TIP120	35p
TIP121	100p
TIP122	99p
TIP125	20p
TIP126	80p
TIP127	45p
TIP130	45p
TIP140	130p
TIP141	140p
TIP142	180p
TIP145	140p
TIP146	180p
TIP147	170p
TIP2955	60p
TIP3055	75p
2N1613	30p
2N1711	35p
2N1893	35p
2N2218A	45p
2N2219	30p
2N2221/A	30p
2N2222/A	25p
2N2904A	30p
2N2905	30p
2N2905A	30p
2N2906A	25p
2N2907A	25p
2N3053	30p
2N3054	70p
2N3055	50p
2N3439	80p
2N3440	60p
2N3771	160p
2N3772	160p
2N3773	250p
2N3821	120p
2N3822	120p
2N3823	95p
2N3824	95p
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N4391	70p
2N4392	70p
2N4400	20p
2N4401	20p
2N4402	25p
2N4403	25p
2N4410	45p
2N4416	95p
2N4856	280p
2N4857	120p
2N4858	90p
2N4859	90p
2N4919	120p
2N4920	130p
2N4921	105p
2N4922	95p
2N4923	95p
2N5190	75p
2N5191	75p
2N5192	75p
2N5194	75p
2N5195	110p

68B40	620p
6844	1295p
6845	795p
6850	165p
6852	250p
6854	795p
6875	495p
8T26A	140p
8T95	105p
8T96	105p
8T97	105p
8T98	105p
8T28	140p
8080A	360p
8085A	595p
8155	880p
8212	170p
8216	70p
8224	200p
8226	275p
8228	280p
8251	320p
8253	800p
8255	300p
8257	800p
8259	880p
8279	950p
MC1408	295p
MC1488	60p
MC1489	80p
MC3459	265p
75491	80p
75492	80p

COMPUTER ICs

Z80ACPU	440p
Z80APIO	340p
Z80ACTC	340p
Z80DART	475p
6800	350p
68B00	450p
6802	395p
6809	995p
68B09	1495p
6809E	1295p
6810	150p
6821	150p
68B21	250p
6829	1335p
6840	410p

MEMORIES

2114L-200n	90p
2114-450n	90p
2716-450n	210p
2732-450n	440p
4116-200n	85p
4164-200n	680p
6116-150n	600p

A large range of Vero products in stock

Disc ceramic capacitors. 50V E6 range 2.2pF-47n 8p

A large range of Axial Electrolytics in stock

Carbon film resistors 5%, E24 series ¼W & ½W 1Ω-10M 2p

Voltage Regulators

+Ve 100mA	
78L05	30p
78L08	30p
78L12	30p
78L15	30p
500mA	
78M05	55p
78M06	55p
78M08	55p
78M12	55p
78M15	55p
78M18	55p
78M24	55p
1A	
7805	45p
7806	65p
7808	65p
7812	60p
7815	60p
7818	65p
7824	65p

–Ve 100mA	
79L05	35p
79L12	35p
79L15	35p
1A	
7905	60p
7906	70p
7908	70p
7912	60p
7915	60p
7918	70p
7924	70p
OTHERS	
LM309K	130p
LM317K	295p
LM317T	165p
LM317L	60p

LM317M	90p
LM350K	495p
723	35p

A large range of Tantalum Bead capacitors

We have much more in stock. Please phone for details or send s.a.e. for full price list

Precision tools, soldering irons, etc. Phone for details

DIL SOCKETS

	Low Profile	Wire Wrap
8 pin	10p	30p
14 pin	12p	38p
16 pin	13p	48p
18 pin	18p	–
20 pin	24p	60p
24 pin	25p	70p
28 pin	28p	95p
40 pin	30p	120p

RIBBON CABLE ASSEMBLY 24"

Ways	Single Ended	Dble Ended
14 way	150p	220p
16 way	170p	250p
24 way	250p	360p
40 way	395p	550p

RIBBON CABLE
16 way 36p ft
24 way 57p ft

EUROCARD CONNECTORS DIN 41612
2x32 way
Socket 345p
Plug (Solder) 230p
Plug (Wire Wrap) 325p

D CONNECTORS (SOLDER BUCKET)

	Male	Female	Hoods
9 way	95p	120p	60p
15 way	135p	155p	64p
25 way	205p	235p	67p
37 way	270p	335p	75p

IC TEST CLIPS

14 pin	344p
16 pin	363p
20 pin	882p
24 pin	1060p
28 pin	1163p
40 pin	1604p

WW – 18 FOR FURTHER DETAILS

NOW! FROM SESCOM

ORDER YOUR FAVOURITE AUDIO ACCESSORIES BY MAIL

SEND FOR YOUR FREE COPY OF OUR 1982 CATALOG

48 PAGES 8½"x11"

OVER 250 ITEMS

INCLUDING DIRECT BOXES, MIC-SPLITTERS, SIGNAL PROCESSING, AUDIO MODULES, TRANSFORMERS & MANY OTHER ACCESSORIES

WITH TECHNICAL DATA & USE DIAGRAMS

We Ship the Fastest & most convenient way for you! Most Shipments From Stock

SESCOM, INC.
RETAIL SALES DIVISION
1111 Las Vegas Blvd. North
Las Vegas, NV 89101-1197 U.S.A.
(702)384-0993
(800)634-3457
TWX (910)397-6996

WW – 097 FOR FURTHER DETAILS

P.&R. COMPUTER SHOP

IBM GOLFBALL PRINTER 3982, £70

EPSON MX-80 80.GPs 3982 IBM I/O PRINTERS DOT MATRIX PRINTER WITH SPECIAL INTERFACES. VDUs, ASCII KEYBOARDS, ASR, KSR, TELETYPES, PAPERTAPE READERS, PAPERTAPE PUNCHES, SCOPES, TYPEWRITERS, FANS 4" 5" 6". POWER SUPPLIES, STORE CORES, TEST EQUIPMENT AND MISCELLANEOUS COMPUTER EQUIPMENT. OPEN: MONDAY TO FRIDAY 9 a.m.-5 p.m., SATURDAY TILL 1 p.m.

COME AND LOOK AROUND

SALCOTT MILL, GOLDHANGER ROAD
HEYBRIDGE, ESSEX
PHONE MALDON (0621) 57440

WW – 044 FOR FURTHER DETAILS

THE STATE-OF-THE-ARTWORK LIGHTBOX

DESIGNED FOR THE PROFESSIONAL DRAWING OFFICE

Correctly sized for laying-up 2:1 eurocard PCB artwork. Full 450 x 310mm viewing area illuminated by four 8watt fluorescent tubes, 5.5mm white opal Perspex panel. Cross-flow ventilation ensures cool, continuously rated, operation.
Solid mahogany frame, overall height (inc. rubber feet) 85mm. Price includes IEC fused chassis plug, socket and 2 metre flex.
HORIZONTAL VERSION: £72 + VAT (£10.80) + UK POSTAGE (£2.20) = £85.
ADJUSTABLE TILT VERSION (Max. 10deg.) £80 + VAT (£12) + UK post (£3) = £95.

ELECTRONIC ASSISTANCE LTD.
Unit 1, Brynberth Ind. Est., Rhayader, Powys.
Tel. (0597) 810711

WW – 062 FOR FURTHER DETAILS

COMPUTER WAREHOUSE

NOW OPEN MONDAY-SATURDAY 9.30-5.30

BULK BUY SPECIALS

RAM SCOOP
4116 200 NS 8 for £12.95
4164 200 NS £8.50 each
2102-650 NS 8 for £5.50
INC VAT

25 WAY "D" CONNECTORS

		50+	100+
25p	1.70	1.10	0.95
25S	1.90	1.20	1.00

ALL + VAT

WIRE WRAP SKTS.
24 Pin Vero 28p
14 Pin Gold 22p
16 Pin Gold 24p
100 PCS Min Ord.

C10 DATA CASSETTES
10 for £5.75
Inc. VAT

RF CONNECTORS
50Ω BNC PLG 50p
75Ω BNC PLG 50p
PL259 PLG 40p
SO239 SKT 35p
100 PCS MIN ORD.

TELETYPE ASR33 I/O TERMINALS

From £195 + CAR + VAT

Fully fledged industry standard ASR33 data terminal. Many features including: ASCII keyboard and printer for data I/O, auto data detect circuitry, RS232 serial interface, 110 baud, 8 bit paper tape punch and reader for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order. Options: Floor stand £12.50 + VAT
KSR33 With 20ma loop interface £125.00 + VAT.
Sound proof enclosure £25.00 + VAT

"OLIVETTI TE300" PRINTER/TERMINALS

A complete I/O terminal with integral 8 hole paper tape punch and reader, full ASCII keyboard, 120 column printer, and control unit. The printer is capable of 150 baud with a serial TTL or balanced input-output sold in good overall condition but untested. Connect direct to your micro at ONLY £99.00 + £11.50 carr + vat.

MPU EXPERIMENTORS +5v +12v -12v +24v POWER SUPPLY

Once again we are very pleased to offer this superb Power Supply Unit, and hope to satisfy most of our previous customers who were disappointed when we sold out due to demand last time they were advertised!!! These units may just have well been made for your lab., they consist of a semi-enclosed chassis measuring 160mm x 120mm x 350mm containing all silicon electronics to give the following fully regulated and short circuit proof outputs of:
+ 5v @ 2 amps DC + 12v @ 800 ma DC
-12v @ 800 ma DC + 24v @ 350 ma DC
and if that's not enough a fully floating 5v output @ 50 ma DC which may be seriesed to give a host of other voltages. All outputs are brought out to the front panel via miniature jack sockets and are also duplicated at the rear on short flying leads. Units accept standard 240v mains input. They are ex GPO and may have minor scratches on the front panels, they are sold untested but in good internal condition. £16.50 each + £2.50 p+p complete with circuit and component list. Transformer guaranteed. HURRY WHILE STOCKS LAST!!

STOP PRESS

SUPER SCOOP CENTRONICS 739-2 PRINTERS
£299+VAT+£10 carr.
Datasheet on request

DISTEL ©

"Dial our Database!"
Get information on 1000's of stock items and order via your computer. 300 baud on 01-689 6800 18.30 to 0900 6 days a week and all day Sundays. IT'S FREE!

DIABLO S30 DISK DRIVES

Another shipment allows us to offer you even greater savings on this superb 2.5 MB (formatted) hard disk drive. Two types are available both fully refurbished and electronically all tested, the only difference is the convenience of changing the disk packs.
S30 front loader, pack change via front door £550 + vat
S30 fixed, pack change via removal of top cover £295 + vat
+ & – 15v PSU for 2 drives £125 + vat
Carriage & insurance on drives £15.00 + vat fully DEC RK05, NOVA, TEXAS compatable further info on controllers etc on request.

SAVE OVER £1400

THE PRINTER SCOOP OF THE YEAR

THE LOGABAX Z80 MICROPROCESSOR CONTROLLED LX180L MATRIX PRINTER

A massive bulk purchase enables us to offer you this superb professional printer at a fraction of its recent cost of over £2000. Utilising the very latest in microprocessor technology, it features a host of facilities with all electronics on one plug in P.C.B. Just study the specification and you will instantly realise it meets all the requirements of the most exacting professional or hobbyist user.
STANDARD FUNCTIONS ★ Full ASCII character set ★ Standard ink ribbon ★ RS232/V24 serial interface – 7 xtal controlled baud rates up to 9600 ★ 194 characters per line ★ Parallel interface ★ Handshakes on serial and parallel ports ★ 4 Type fonts, italic script, double width, italic large, standard ★ Internal buffer ★ Internal self test ★ 170 CPS ★ Variable paper tractor up to 17.5" wide ★ Solid steel construction ★ All software in 2708 eproms easily reconfigured for custom fonts etc.
All this and more, not refurbished but BRAND NEW At Only £525 +VAT
OPTIONAL EXTRAS lower case option £25.00 16k buffer £30.00 Second tractor for simultaneous dual forms £85.00 Floor stand £45.00 specialist carriage £19.00 All items plus VAT data sheet on request.

SOFTY 1 & 2

EPROM BLOWER
Software development system invaluable tool for designers, hobbyists, etc. Enables open heart surgery on 2716, 2708 etc. Blows, copies, reads EPROMS or emulates EPROM/ROM/RAM in situ whilst displaying contents on domestic TV receiver. Many other features. £115 + carr. + VAT. Optional 2716, 2716 Function Card £40 + VAT. PSU £20 + £1.50 carr. + VAT.
Softy 2 for 2716/2732 £169+VAT
Write of phone for more details.

9" VIDEO MONITORS

Ex-equipment 9" Motorola Video Monitors 75Ω composite input, tested but unguaranted. £39.99 +£7.50 carriage + VAT. Complete with circuit.

SEMICONDUCTOR 'GRAB BAGS'

Mixed Semis amazing value contents include transistors, digital, linear, I.C.'s, triacs, diodes, bridge recs., etc. etc. All devices guaranteed brand new full spec with manufacturer's markings, fully guaranteed. 50+ bag £2.95 100+ bag £5.15
TTL 74 Series
A gigantic purchase of an "across the board" range of 74 TTL series I.C.'s enables us to offer 100+ mixed "mostly TTL" grab bags at a price which two or three chips in the bag would normally cost to buy.
Fully guaranteed at I.C.'s full spec. 100+ £6.90 200+ £12.30 300+ £19.50

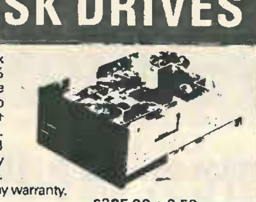
MAINS FILTERS

Professional type mains filters as used by "Main Frame Manufacturers" ideal for curing those unnerving hang ups and data glitches. fit one now and cure your problems!
Suppression Devices SD5 A10 5 amp £6.95
Corcom Inc F1900 30 amp £13.95 + pp £1.00

DC SYSTEM SUPPLY

Professional fully cased fan cooled system supply. Standard 240 Vac input with the following DC outputs 5V @ 11 amps +15-17v @ amps -15-17v @ 8 amps and +24v @ 4 amps. All outputs are fully crowbar protected and the 5 volt output is fully regulated. Sold tested and in a new or little used condition complete with circuit £55.00 + carr £8.50 + vat DIM 15.5" x 9" x 6"

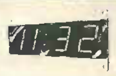
8" FLOPPY DISK DRIVES



Unbelievable value the DRE 7100 & 7200 8" disk drives utilise the finest technology to give you 100% bus compatability with most drives available today, the only difference being our PRICE and the superb manufacturing quality. The 7100 single sided & 7200 double sided drive accept hard or soft sectoring, IBM or ANSI standard giving a massive 0.8 MB (7100) & 1.6 MB (7200) of storage. Absolutely SHUGART, BASF, SIEMENS etc compatable. Supplied BRAND NEW with user manual and 90 day warranty.
7100 single sided £225.00 + 9.50 carr + vat
7200 double sided £295.00 + 9.50 carr + vat
full technical manual £20.00 alone £9.00 with drive. refund of difference on purchase of drive. Data sheet on request.
SPECIAL new, KODE PSU, drives 2 DRE drives £39.99 + carr + vat
8" single sided, single or double density diskettes £1.80 each £15.00 for 10 inc. lib case + vat.

NATIONAL MA1012 LED CLOCK MODULE

★ 12 HOUR
★ ALARM
★ 50/60 HZ

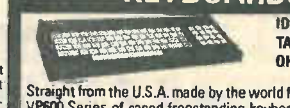


The same module as used in most ALARM/CLOCK radios today, the only difference is our price! All electronics are mounted on a PCB measuring only 3" x 1½" and by addition of a few switches and 5/16 volts AC you have a multi function alarm clock at a fraction of cost. Other features include snooze timer, am pm, alarm set, power fail indicator, flashing seconds cursor, modulated alarm output etc. Supplied brand new with full data only £5.25
Suitable transformer £1.75.

COOLING FAN SPECIAL

Keep your equipment cool and reliable with our range of professional fans.
ETRI 99XU01 Miniature equipment fan 240 vac working DIM 92 x 92 x 25 mm BRAND NEW complete with finger guard. Makers price £16 our price £10.25
BUHLER 69.11.22 micro miniature 8-16 v DC reversible fan. Measures only 62 x 62 x 22 mm. Uses a brushless DC servo motor, almost silent running ideal portable equipment, life in excess of 10,000 hours. BRAND NEW manufacturers price £32.00 our price £13.95
MUFFIN/CENTAUR cooling fans, tested ex equipment 240v £6.50, 115v £5.50 + p&p £1.90
KOOL TRONICS Powerful snail type blower gives massive air movement with centrifugal rotor DIM as a cube 8" x 8" x 6" air aperture 2.5" x 2.5" with flange fixing. BRAND NEW 110v 50 Hz ac working ONLY £9.95 + £1.90 p&p.

RCA FULLY CASED ASCII CODED KEYBOARDS



IDEAL – TANGERINE, OHIO ETC.

Straight from the U.S.A. made by the world famous R.C.A. Co., the VP600 Series of cased freestanding keyboards meet all requirements of the most exacting user, right down to the price! Utilising the latest in switch technology. Guaranteed in excess of 5 million operations. The keyboard has a host of other features including full ASCII 128 character set, user definable keys, upper/lower case, rollover protection, single 5V rail, keyboard impervious to liquids and dust, TTL or CMOS outputs, even an on-board tone generator for keypress feedback, and a 1 year full R.C.A. backed guarantee.
VP601 7 bit fully coded output with delayed strobe, etc. £43.95
VP611 Same as VP601 with numeric pad. £54.95
VP606 Serial, RS232, 20MA and TTL output, with 6 selectable Baud Rates. £64.26
VP616 Same as VP606, with numeric pad, £84.34
Plug and cable for VP601, VP611 £2.25
Plug for VP606, VP616 £2.10
Post, Packing and Insurance. £1.95
ORDER NOW OR SEND FOR DETAILS.

ELECTRONIC COMPONENTS & EQUIPMENT 66% DISCOUNT

Due to our massive bulk purchasing programme which enables us to bring you the best possible bargains, we have thousands of I.C.'s, Transistors, Relays, Cap's., P.C.B.'s, Sub-assemblies, Switches, etc. etc. surplus to our requirements. Because we don't have sufficient stocks of any one item to include in our ads., we are packing all these items into the "BARGAIN PARCEL OF A LIFETIME" Thousands of components at giveaway prices! Guaranteed to be worth at least 3 times what you pay plus we always include something from our ads. for unbeatable value!! Sold by weight
2.5kls £ 4.75 + pp £1.25 5kls £ 6.75 + pp £1.80
10kls £11.75 + pp £2.25 20kls £19.99 + pp £4.75

5v D.C. POWER SUPPLIES

Following the recent "SELL OUT" demand for our 5v 3 amp P.S.U. we have managed to secure a large quantity of ex-computer systems P.S.U.'s with the following spec.; 240 or 110v A.C. input. Outputs of 5v @ 3-4 amps, 7.2v @ 3 amps and 6.5v @ 1 amp. The 5v and 7.2v outputs are fully regulated and adjustable with variable current limiting on the 5v supply. Unit is self contained on a P.C.B. measuring only 12" x 5" x 3". The 7.2v output is ideal for feeding "on board" regulators or a further 3 amp LM323K regulator to give an effective 5v @ 7 amp supply.
Supplied complete with circuit at only £10.95 + £1.75pp.
Believed working but untested, unguaranteed.

DISPLAY ELECTRONICS

Dept. W.W., 64-66 Melfort Rd., Thornton Heath, Croydon, Surrey. Tel: 01-689 7702 or 01-689 6800
MAIL ORDER INFORMATION
Unless otherwise stated all prices inclusive of V.A.T. Cash with order. Minimum order value £2.00 Prices and Postage quoted for UK only. Where post and packing not indicated please add 60p per order. Bona Fida account orders minimum £20.00. Export and trade enquiries welcome. Orders despatched same day where possible. 3% surcharge on Access and Barclaycard orders.

WW – 064 FOR FURTHER DETAILS

www.americanradiohistory.com

Advertisements accepted up 12 noon Monday, May 31, for July issue, subject to space being available.

DISPLAYED APPOINTMENTS VACANT: £13.50 per single col. centimetre (min. 3cm).
LINE advertisements (run on): £2.50 per line, minimum 5 lines. (Prepayable.)
BOX NUMBERS: £1.50 extra. (Replies should be addressed to the Box Number in the advertisement, c/o Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.)
PHONE: IAN FAUX, 01-661 3033 (DIRECT LINE)
Cheques and Postal Orders payable to IPC Business Press Ltd.

RF DESIGNER

WITH INVENTIVE FLAIR AND A TASTE FOR RURAL LIFE

Our clients are a small cheerful and highly motivated company who are sole manufacturers of a socially essential paramedical product.
They are in the throes of moving to a Georgian manor house with eight acres of land, in rural England (with low housing costs).
The need is for an engineer, probably between 25 and 45, with a genuinely radical and inventive approach to design and a sound knowledge gained in the radio frequency (ideally, low power) field.
The successful candidate will work in a small specialist team. The potential and prospects attached to the position are second to none.
Apart from a competitive, negotiable salary, the company offer excellent relocation expenses to this attractive low cost housing area.
To discuss this position or any other specialist Communications vacancies we may have, telephone Paul Hecquet on 044 46 47301/2/3/4 or write with a brief C.V.

The Electronics Recruitment Company
18 Station Road, Burgess Hill, West Sussex RH15 9DE

Communications Division

04446 47301/2/3/4

(1629)

Electronics, Medicine and £12,000 p.a. Tax Free Where's the Connection?

Allied Medical group are the British consultants to the Riyadh Al-Kharj health care programme in Saudi Arabia. The two hospitals which comprise the programme are new, superbly equipped, and mainly UK staffed.
Sophisticated electronic systems and equipment feature prominently in the hospitals. The electronics laboratory and mechanical workshop look after all aspects of maintenance, repair, test and calibration. There is a wide variety of equipment and the facilities are excellent.
You will need an HNC (or equivalent) or should be taking the examinations this year, and experience in maintenance and testing is required though not necessarily in the medical field.

As well as the tax-free salary we have already quoted, these single-status contracts offer one of the best benefits packages in the Middle East.
If you're interested, quote Ref. RKH 426, to: Malcolm Craig, Senior Personnel Officer, Allied Medical Group, 18 Grosvenor Gardens, London SW1W 0DZ. Alternatively, call our 24-hour answering service on 01-730 5339, quoting the reference number.

(1435)

Allied Medical Group

ALLIED MEDICAL GROUP – The Best of British Health Care in the Middle East.

ecm

IF YOU SEEK a
**DESIGN
SOFTWARE
TEST
PROJECT
FIELD SERVICE
SYSTEMS
APPLICATIONS
SALES**
or
COMMISSIONING APPOINTMENT
to work with
**MICROPROCESSOR
MEDICAL
HF/UHF/VHF
SONAR
MICROWAVE
SATCOM
MINI COMPUTER
MAINFRAME
PROCESS CONTROL
SIMULATION
IMAGE PROCESSING
DATACOMMS
VIDEO
WEAPON SYSTEMS
AUDIO
or AUTOMATIC TEST
EQUIPMENT**

and EARN £7000-£20000

then CONTACT
ELECTRONIC COMPUTER
&
MANAGEMENT APPOINTMENTS
148/150 High Street
Barkway, Royston
Herts
076-384 676/7/8
(till 8pm most evenings)

TV STUDIO PROJECT ENGINEERS

Due to the continuing expansion of the Projects Department we are looking for Project Engineers. If you have had experience in television broadcasting either as a project engineer or in the operational side of broadcasting we would like to hear from you.
We design and build outside broadcast vehicles and studios for television broadcasters throughout the world.

SALES SUPPORT ENGINEER

(TV COLOUR CAMERAS)

Our Sales Support engineering activities include customer demonstrations, both here in Andover and away from base, supervising acceptance, test and after-sales activities. If you have worked in television broadcasting or have an engineering knowledge of modern colour television cameras we would like to hear from you.

Both positions involve occasional overseas travel. For further information please contact our Personnel Department either in writing or by telephone on Andover (0264) 61345.

(1651)

LINK ELECTRONICS
Walworth Industrial Estate Andover, Hampshire, England
Telephone: Andover (0264) 61345

EDITOR WANTED

REQUIRED: A RADIO AMATEUR WHO CAN COMMUNICATE

We are looking to expand our current team of editors with someone who can communicate with today's radio enthusiasts. This person will ideally be a licensed amateur and have some journalistic experience.
ASP is a rapidly expanding specialist publishing company and this vacancy offers the opportunity to join us in a senior position. A keen interest is required as is the ability to write clearly and authoritatively.
Salary is negotiable, but will reflect the seniority of the position. Applicants should write, enclosing full c.v., to:

**R. Harris
Managing Editor
ARGUS SPECIALIST PUBLICATIONS LTD.
145 Charing Cross Road
London WC2H 0EE**

Publishers of: Electronics Today, Hobby Electronics, Computing Today, Electronics Digest, Personal Software, ZX Computing, Which Video, Citizen's Band, Video Today.

Argus Specialist Publications Ltd.
145 Charing Cross Road, London WC2H 0EE. Tel. (01) 437-1002. Telex 8811896.

ELECTROSONIC

We are a leading company in audio-visual, lighting control, and communication systems. In order to maintain its technological lead the company now seeks to strengthen its team of engineering professionals through the appointment of a

**SENIOR ELECTRONIC DESIGN ENGINEER
to £9,500 per annum**

To become a member of a small team responsible for innovation and development of new microprocessor based products; the ideal candidate will be qualified to degree level and have at least 2 years' design experience, although a thorough knowledge of digital/microprocessor hardware and software design is necessary, a broad-based background in analogue design would be considered a distinct advantage.

The position carries excellent employment conditions.

Please write or telephone for an application form:
Peter Smith – Design Manager
Electrosonic Limited
815 Woolwich Road
London, SE7 8LT
Telephone: 01-855 1101

1978 (1618)

**THE OPEN UNIVERSITY
FACULTIES OF TECHNOLOGY AND SCIENCE
ELECTRONICS COMMON FACILITY**

ASSISTANT ELECTRONICS DESIGNER

Applications are invited for an Assistant Electronics Designer, to work under the Senior Design Engineer on a wide variety of work in the interfaculty Electronics Common Facility.
The design work will involve both digital and analogue circuitry and will include a growing involvement in microprocessors and their associated software.
The work will appeal to someone with a keen interest in electronics, who is eager to learn new techniques and who should already have some experience in working, at least on a small scale, to his/her own designs or modifications of other designs.
Qualifications: Minimum equivalent to TEC, C&G or ONC backed up by proven experience. Experience will be the most important factor in determining the successful applicant.
The salary for this post will be on the T5 scale £5695-£6650 per annum.
Application forms and further particulars are available from: **Mrs. S. McBrearty (498/1), Faculty of Technology, The Open University, Walton Hall, Milton Keynes MK7 6AA, or telephone Milton Keynes, (0908) 653941 – there is a 24-hour answering service on 653868.**
Closing date for applications:

(1646)

www.americanradiohistory.com

Electronics Design Engineers

Take your career a step in the right direction

Having introduced an extended new product range, many of which are microprocessor based, Marconi Instruments has once again confirmed itself as Europe's leading manufacturer of test equipment and measurement systems. Our products are selling throughout the world to all leading users in the Telecommunications and Aerospace industries and we are naturally developing further innovative designs. That is why we are now looking for more Design Engineers with experience in any of the following areas:

RF, Microwave, Analogue, Digital, Software, ATE, Microprocessor Applications.

Whatever your level of experience we would like to hear from you. We offer excellent salaries plus a wide range of large company benefits including relocation expenses where appropriate.

NAME ______ AGE ______

ADDRESS ______

TEL. NO. WORK ______ HOME ______

YEARS OF EXPERIENCE: 0-1 ☐ 1-3 ☐ 3-6 ☐ OVER 6 ☐

PRESENT SALARY: £5,500 to £8,000 ☐ £8,000 to £10,000 ☐ £10,000 to £12,000 ☐ OVER £12,000 ☐

QUALIFICATIONS: HNC ☐ DEGREE ☐ OTHERS ☐

PRESENT JOB: ______

marconi instruments

So take a positive step in the right direction and join us in developing tomorrow's technology today. Cut the coupon and send it to John Prodger, Recruitment Manager, Marconi Instruments Limited, FREEPOST, St. Albans, Herts AL4 0BR. Tel: St. Albans (0727) 59292.

(1234

SIEMENS

Make better use of your electronics experience

As a medical service engineer

Siemens has always been in the forefront of medical engineering and our products are helping doctors in hospitals all over the world to save lives.

But the equipment on its own is not sufficient.

We also need men and women with sound electronics experience to strengthen our service team based at Sunbury. You will visit hospitals throughout London and the South East installing and servicing vital equipment to ensure optimum performance for our customers.

Currently we require an engineer to work with electro-medical products.

You should be able to bring ONC/HNC level qualifications and at least 3 years' experience, working in the hospital environment and live or be prepared to live within an approximate 30 mile radius of Sunbury.

A car or car allowance will be provided, and a full range of excellent benefits including non-contributory pension scheme, first-class sick pay, generous daily allowances for time spent away from your base and a competitive salary.

Please contact Mrs. S. Betteridge, Personnel Dept, Tel. Sunbury 85691 or write to her for a comprehensive information package at Siemens Limited, Siemens House, Windmill Road, Sunbury on Thames, Middlesex.

£25,000?

SYSTEMS ENGINEER
Command and control system with emphasis on communications and interface equipment. **£10,000+ – Surrey.**

RF DESIGN
Engineer to design power amplifiers up to 100 watts. **MoD Contract Rates. – Hants.**

DESIGN ENGINEER
To work on receiver for advanced radar system. HF (120MHz). MoD. To **£10,000 – Surrey.**

DEVELOPMENT ENGINEER
Microwave and satellite communications systems from base band to 6 GHz. To **£10,000 – Essex.**

DESIGN ENGINEER
For RF and microwave communications equipment. **£10,000+ – Bucks.**

SENIOR DEVELOPMENT ENGINEER
For RF Transponder in radar project, controlling 2 staff. **£10,000+ – Surrey.**

CLIVEDEN CONSULTANTS
87 St. Leonard's Road
Windsor, Berks.
Windsor (07535) 57818/58022
24-hour service (1646)

CLIVEDEN

ELECTRONICS COMPANY

Specialists in RF communications, digital and low frequency analogue equipment, urgently require a design and development Engineer. Remuneration according to experience. £7,250 to £8,000 per annum.

Ring 01-250 0894

Maritime communications. New frontiers.

Inmarsat – providing a revolutionary global satellite communications service – is now live.

Today over 1,000 ships and offshore oil and gas platforms are equipped with Inmarsat shipboard terminals giving them direct access to our communication satellites.

Today all the world's oceans are covered whatever the weather, 24 hours a day, 7 days a week.

Maritime communications has come of age.

With an investment of US \$300m and the participation of 37 countries, Inmarsat has one of the most innovative systems yet devised. But we are not complacent. Not only are we dealing with today's system but we are looking to tomorrow. In particular to the design, development and implementation of the second generation Inmarsat system. This is where you come in.

As an experienced Electronics Engineer, it will be up to you to provide support to the system as well as to develop new capabilities and take us even further into the future.

We now have a need for experienced technical staff to be based at Inmarsat's directorate in London, England.

We need specialists experienced in spacecraft and launch vehicles, satellite payload design, digital communications technology, earth station equipment or the design of sophisticated shipboard electronic equipment.

Depending upon your speciality and experience you will be involved in a full range of satellite communications engineering – particularly development of new and innovative communications services and new generations of satellites.

You will be a graduate with substantial experience in your chosen field. You will be active, creative, and willing and able to develop your own role and initiate your own responsibilities to meet demands.

You will be fluent in English. Other languages would be an asset.

The Inmarsat salary and benefits package is highly attractive. As a member of our international staff, your salary – starting in the range £12,900–£21,000 – *will be net of tax.* Relocation expenses will also be provided.

These appointments are immediate. So for a personal history form apply to the Personnel Manager, Inmarsat, Market Towers, 1 Nine Elms Lane, London, SW8 5NQ, England.

INMARSAT

1428

www.americanradiohistory.com

ENGINEERS

c £8000 p.a. **Coventry**

The present level of world demand for advanced telecommunications technology holds great potential for the future in terms of security, job satisfaction, financial reward and career development.

As part of a team of Contract Engineers you will be specifying for manufacture, a variety of transmission equipments, such as: telegraph and channel equipment, translating and generating equipment, coaxial and optical fibre line systems, baseband, switching, supervisory equipments and several microwave equipment types between 2GHz and 19GHz.

Also, you will design interface wiring diagrams for equipment racks and repeater stations. Prepare station and system schematics. Supervise design interfaces of civil works, including prime power equipment, buildings and microwave towers.

In addition to interesting and varied work you'll be receiving a competitive salary plus big-company benefits which include a generous relocation package where appropriate. You'll find all the big-city amenities in Coventry, including some outstanding sports facilities – and you'll be surprised by the wide range and low cost of housing.

Please complete and return this coupon – enclose details if you wish

To: Mr. Z. K. Flizak, GEC Telecommunications Ltd.,
P.O. Box 53, Coventry CV3 1HJ

Tick area of experience

Repeater station testing ☐
Transmission system commissioning ☐

HM FORCES equipment maintenance
GEN'R & TRANSP equipment ☐
UHF radio ☐
SHF radio ☐

Name & Address...

Experience...

Present Post & Duties.............................. Present salary.............................. (1633)

GEC Telecommunications

SCHOOL OF ELECTRICAL AND ELECTRONIC ENGINEERING

Applications are invited for the post of

SENIOR LABORATORY/ WORKSHOP TECHNICIAN

Applicants should possess a good electrical/electronic technician qualification and experience in electrical-/electronic repair or maintenance.

Salary Grade: T2(15-18) £5064 to £5526 plus up to £108 per annum for possession of appropriate qualifications.

Application forms and further details available from the Personnel Officer, Preston Polytechnic, Corporation Street, Preston PR1 2TQ. Tel: Preston 262037.

Ref. No. NT/81/82/24
Closing date: 28th May 1982

PRESTON POLY TECHNIC

(1615)

APPOINTMENTS IN ELECTRONICS to £15,000

MICROPROCESSORS COMPUTERS - MEDICAL DATA COMMS - RADIO

Design, test, field and support engineers – for immediate action on salary and career advancement, please contact.

Technomark
Engineering and Technical Recruitment
11, Westbourne Grove
London W2. 01-229 9239 (1296)

PHONE YOUR CLASSIFIEDS TO IAN FAUX ON 01-661 3033

SCOTTISH OFFICE
DIRECTORATE OF TELECOMMUNICATIONS

WIRELESS TECHNICIANS

(£5,300-£7,060)

Applications are invited for at least 3 posts of Wireless Technician in the Central Services Department of the Scottish Office. The posts are expected to be based in Edinburgh, East Kilbridge and Montreathmont (near Forfar). Candidates must hold an Ordinary National Certificate in Electronic or Electrical Engineering **or** a City and Guilds of London Institute Certificate in an appropriate subject **or** a qualification of a higher or equivalent standard and have 3 years' appropriate experience. Some assistance may be given with re-location expenses.

A valid UK driving licence and ability to drive private and commercial vehicles are essential.

Application forms and further information are obtainable from Scottish Officer Personnel Division, Room 110, 16 Waterloo Place, Edinburgh EH1 3DN (quote ref PM(PTS) 2/2/82 (031-556 8400 Ext. 4317 or 5028).

Closing date for receipt of completed application forms is 14 May, 1982.

(1623)

CAPITAL APPOINTMENTS LTD.

CAPITAL HOUSE
29-30 WINDMILL STREET
LONDON W1P 1HG
TEL: 01-637 5551

THE UK's No. 1 ELECTRONICS AGENCY

Design, Development and Test to £14,000
Ask for Brian Cornwell

SALES to £15,000 plus car
Ask for Maurice Wayne

FIELD SERVICE to £12,000 plus car
Ask for Paul Wallis

We have vacancies in ALL AREAS of the U.K.

Ask for a Free Jobs List

Telephone: 01-637 5551 (3 lines) (291)

NO CONCESSION TO RECESSION!

In communications, the industry of the 21st Century, the BBC is forging ahead with its programme of expansion. This year we are seeking 150 young, enthusiastic Engineers both in London and throughout the United Kingdom to work in the expanding field of Television.

The ability to handle new technology long before it appears in other industries, a thorough understanding of traditional electronics and the motivation to have found out about Broadcasting technology, together with the right personality are just some of the qualities we are seeking.

Many have already accepted the challenge and joined us, but there are vacancies in the Television Service, London for those men and women with the right qualities. If you are qualified, or soon to be qualified, with a Degree in Electrical and Electronic Engineering, Applied Physics or equivalent and have both normal hearing and colour vision why not fill in the coupon for further details, quoting reference number 82.E.4029/W.W.

Starting salary in the Television Service, London is in the range £7314 to £7892 plus shift working allowance of between £800 and £1000pa.

We are an equal opportunities employer.

To: The Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA. Reference No. 82.E.4029/W.W.

Name:

Address:

Tel. No:

Qualification/Date obtained:

BBC

150 TELEVISION ENGINEERS

www.americanradiohistory.com

OTC AUSTRALIA

TECHNICAL STAFF

Would you like an opportunity to live in Australia and pursue a career in Telecommunications?

The Overseas Telecommunications Commission (Australia) which links Australia with the rest of the world by communications satellites, submarine cables and radio has vacancies for Technicians and Technical Officers.

The successful applicants will be involved in one of the following areas in the operation and maintenance of the Commission's:
- processor controlled switching and transmission equipment in the Sydney Metropolitan area
- international satellite communication facilities at Carnarvon – Western Australia, Ceduna – South Australia and Moree – New South Wales.
- submarine cable and HF radio facilities at Commission stations situated on the Australian Coast and Guam.

REMUNERATION:

Technician	**$A14805-16080 p.a.**
Technical Officer Grade 1	**$A14805-17759 p.a.**
Technical Officer Grade 2	**$A18180-19086 p.a.**
Senior Technical Officer Grade 1	**$A19597-20517 p.a.**

QUALIFICATIONS:
Successful completion of Part 3 – full Technological Certificate of the Telecommunications Technician's Course conducted by the City & Guilds of London Institute.
The Higher National Certificate in electrical or Electronic Engineering and registration as a Technician Engineer with the U.K. Engineer Registration Board.
Or a recognised equivalent of the above.
For Technicians: 4 years of experience including time in training.
For Technical Officer: 6 years of experience including time in training.

General:
OTC offers excellent working conditions. At most locations staff work rostered shifts with a 9-day fortnight and attractive shift penalties are applicable.
Good opportunities exist for advancement to higher positions. Successful applicants must be prepared to serve at any of the Commission's stations within Australia if and when required. The Commission will reimburse removal expenses between stations.
Applications should set out details of position/s applied for, present position, qualifications and experience. Applications should be addressed to:

The Director, Personnel and Administration Branch,
Overseas Telecommunications Commission (Australia),
G.P.O. Box 7000, SYDNEY. N.S.W. 2001.

Applicants will be supplied with an information leaflet giving full details of the positions and conditions of employment.
OTC Representatives will be conducting interviews in the United Kingdom.

1624 C727E

Electronic Engineers –
What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £12000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you. All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL PERSONNEL SERVICES,
12 Mount Ephraim,
Tunbridge Wells,
Kent. TN4 8AS.
Tel: 0892 39388

TJB

Please send me a TJB Appointments Registration form:

Name ....

Address ....

....

(861)

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.

Hydes of Chertsey Ltd., 56/60 Guildford Street, Chertsey, Surrey. KT16 9BE. Chertsey 63243.

(1434)

DIGITAL EXPERIENCE?

FIELD SUPPORT
R & D AND SALES
VACANCIES IN COMPUTERS
NC, COMMS., MEDICAL
VIDEO, ETC.

For free registration ring
0453 883264
01-290 0267

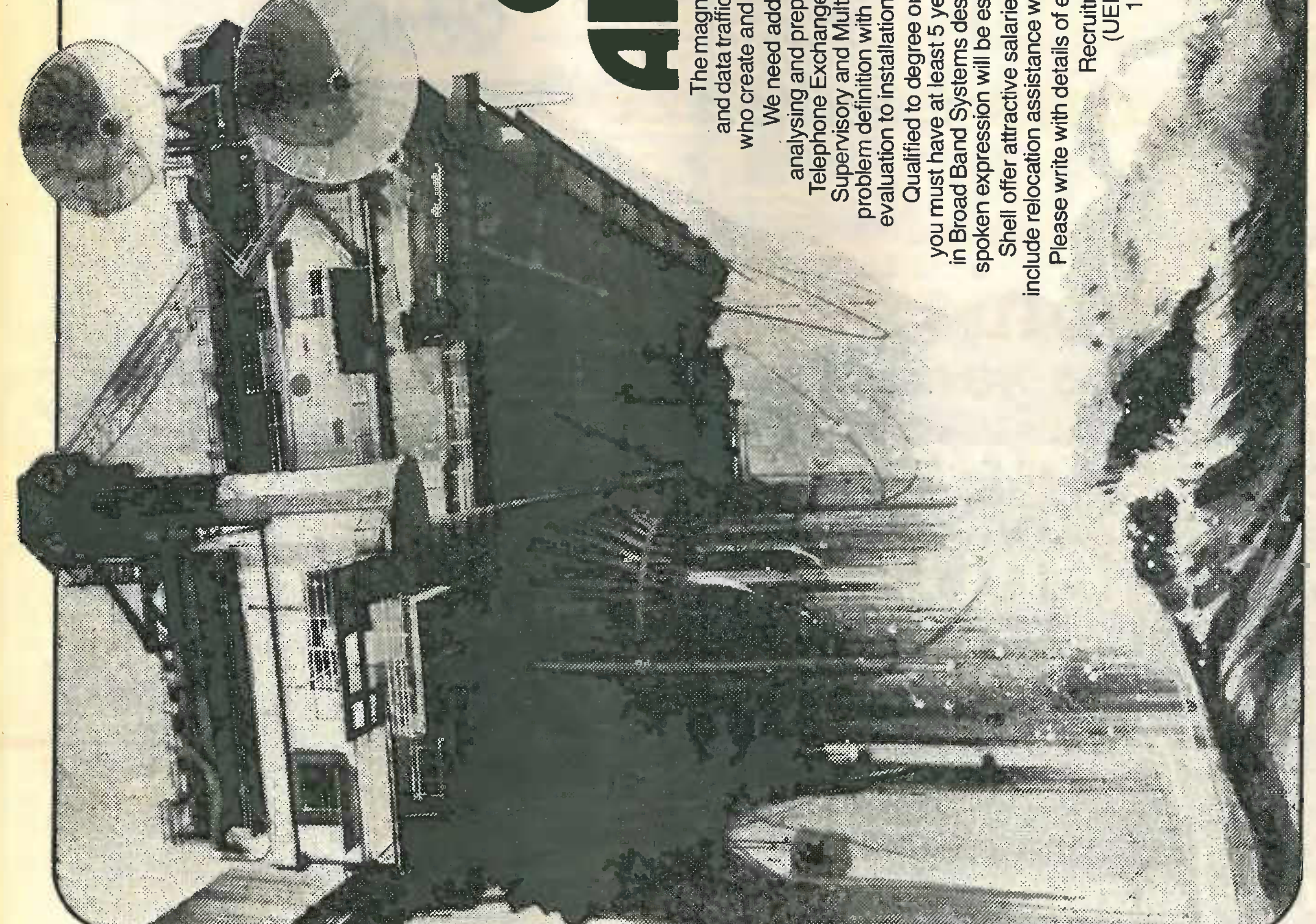
LOGEX

ELECTRONICS RECRUITMENT SERVICE
LOGEX HOUSE, BURLEIGH, STROUD
GLOUCESTERSHIRE GL5 2PW
TEL. 0453 883264, 01-290 0267

(321)

FOR TELECOMMS DESIGNERS...

PROBLEM-SOLVING ON CROWDED AIRWAVES



The magnitude of our offshore operation and the huge general increase in voice and data traffic over the North Sea creates tremendous demands on the engineers who create and develop our advanced communications system.

We need additional problem solvers to join a telecomms team responsible for analysing and preparing detailed designs and specifications for Public Address, Telephone Exchanges, Narrow and Broad Band Radio, Tropospheric Scatter, Supervisory and Multiplex Systems and Data Communications. Involvement will be for problem definition with user departments through contract preparation and tender evaluation to installation of the system.

Qualified to degree or HNC/HND level in a relevant subject, you must have at least 5 years' telecomms experience including 3 in Broad Band Systems design. Self motivation and good written and spoken expression will be essential.

Shell offer attractive salaries and comprehensive benefits which will include relocation assistance where appropriate.

Please write with details of experience and qualifications to:
Recruitment and Development Officer, (UEPA/113), Shell U.K. Exploration & Production, 1 Altens Farm Road, Nigg, Aberdeen AB9 2HY.

Shell

www.americanradiohistory.com

Hardware and Software Development Engineers

Powerful and advanced computer based work stations

Manchester

Salaries negotiable

Working right at the forefront of technology in this field, our Advanced Development Centre offers a number of challenging projects for creative, innovative engineers. Projects which are free from immediate product line constraints, but which are firmly intended to pave the way for future products with a wide range of non military applications.

There are a number of opportunities within the Centre. In particular the Graphic Systems Unit needs adaptable engineers, able to explore novel image and graphic systems and who can carry high speed logic and circuit design through to experimental prototype, construction and demonstration.

The positions call for an exceptional blend of high-level hardware skills with the ability to handle low-level software design, dedicated to single users.

Ideal candidates will currently be working on graphic systems and have 2 or 3 years experience in detailed design, including Analogue Circuitry. They should have new ideas and perhaps an MSc or Ph.D.

Above all, they will be practical and able to exploit fully the extensive facilities available in the Development Centre, with its links to Universities in this field.

Salaries are negotiable, depending on age and experience and working conditions within this recently expanded location are first rate.

Working in Manchester will give you the opportunity of living in close proximity to fine countryside, to the north or south of the city, where housing is reasonably priced. Greater Manchester itself has a superb communications net work of motorways, bringing the rest of the country within easy reach, and offers a superb range of social and cultural amenities.

Career prospects are good throughout this international organisation which is now facing the future with confidence.

For details of these opportunities, contact Chris Burton or John Pratt on 061-223 1301 Ext. 2474, or write with career details to Peter Forbes at ICL, Wenlock Way, West Gorton, Manchester M12 5DR. quoting Ref: WW 2117.

We also have similar opportunities available at our site in Kidsgrove, which is located on the Staffordshire/Cheshire border.

International Computers

ICL

(1636)

Engineers & Scientists

£8,589

At HM Government Communications Centre, we're applying the very latest ideas on electronics and other technologies to the problems of sophisticated communications systems, designed to enable and protect the flow of essential information.

The work is of the highest technical challenge, offering full and worthwhile careers to men and women of high ability, on projects covering the following areas of interest: —

RADIO – from HF to microwave, including advanced modulation systems, propagation studies, applications of Microcircuitry.

ACOUSTICS — SIGNAL ANALYSIS
MAGNETICS — SYSTEMS ENGINEERING

Applicants, under 30 years of age, should have a good honours degree or equivalent qualification in a relevant subject, but candidates about to graduate may also apply.

Appointments are as Higher Scientific Officer (£6,530–£8,589) or Scientific Officer (£5,176–£6,964) according to qualifications and experience. Promotion prospects.

For an application form, please write to the Recruitment Officer (Dept. WW 6), HM Government Communications Centre, Hanslope Park, Milton Keynes, MK19 7BH.

Communications R & D...
...the leading edge

(1589)

Systems Assembly/ Test Engineer

Granger Associates is a leader in the Communications Equipment Industry manufacturing and marketing a wide range of sophisticated UHF Radio, Multiplex and SCADA products. Continuing expansion has created a vacancy for a Systems Assembly/ Test Engineer. The position will require final assembly and system test of Radio/Multiplex terminals and therefore demands a high degree of responsibility.

The successful candidate must be self-motivated and have at least two years' experience in the UHF and F.D.M. field.

Salary will be in the region of £8,000 + per annum with excellent prospects for advancement within the Company.

Please write in the first instance with full particulars (preferably CV) to the following address:

Mrs. L. M. Tabb
Granger Associates Limited
1 Brooklands Road
Weybridge
Surrey KT13 0SD

Granger Associates Ltd.
Solutions for Telecommunications

Electronic Engineering

Dolby Laboratories, the world famous audio noise reduction company, was founded by an engineer. We are a company that believes in engineers and engineering. Small enough for you to make a contribution, we have the minimum bureaucracy, are well established, and have a track record of innovation and quality.

Assistant Production Manager
(Male or female)
A newly created position to support the implementation of computer based production control (IBM 34).

Electronics Engineer
For the extension of ATE (Racal) testing.

Production Engineers & Technicians
Expansion of a well established department to support new products.

Test Engineers
To join our well supported test group and fault find, when all else fails!

Q A Engineer & Technician
Opportunities to join our newly established QA group.

Applicants for the senior positions need to be experienced graduates.
Excellent salary and benefits package.

Contact Steve Matta, by phone or in writing, at:
Dolby Laboratories Inc.,
346 Clapham Road,
London SW9.
01-720 1111

Dolby®

DESIGN & MANUFACTURING ENGINEERS

NORWAY

An outstanding opportunity has arisen for engineers, educated to degree level, to play an active role in the design, development and production of high technology electronic components and related custom designed products.

The product range includes thick and thin film hybrid circuits, monolithic integrated circuits (CMOS, Bipolar Linear and IIL), transducers, opto-electronic components, and hf/vhf communications systems. Vacancies exist in component, circuit and system design areas and for production technologists to be responsible for the introduction and on-going development of sophisticated manufacturing processes.

Working conditions and salary levels are excellent and the generous relocation package would include return airfares to the UK during the first year of employment.

The factory is situated in an attractive coastal location close to Oslo and has facilities for a wide range of outdoor activities, including water sports, skiing, camping, etc. Oslo itself being a major leisure/cultural centre.

Telephone NOW for a detailed information package.
01-637 5551, or 01-636 9659 (24-hr. service). Or write to:
CAPITAL APPOINTMENTS LTD., 29-30 Windmill Street, London W1P 1HG

(1642)

SALARY RISES DISAPPOINTING?

Our client Companies tend to be more realistic!

AMBITIOUS CIRCUIT DESIGNER
26+ for new generation of data recording and display products based on Motorola, family of mpu. Technological and product snobbery appreciated. To £15,000. South Coast.

CONSULTANT PROGRAMMERS
For SW house with contracts in real-time process control. Experience must include one or more of Nova, PDP11, X16, 8080, 8086, Z80. To £16,000. London and Manchester.

HW & SW ENGINEERS
For TV and video products including digital standards convertors and real-time picture manipulators. Products based on PDP11 and several bit-micros. Assembler Pascal & Fortran. C.£10,500. Berks.

YOUNG DESIGN/DEVELOPMENT ENGINEERS
For communications network control systems based on C.A. mini and 8085 mpus. C.£7,000. Beds.

Whatever your experience, please send your c.v. to:

Charles Airey Associates
Tempo House, 15 Falcon Road, Battersea
London SW11 2PJ
Tel: 01-223 7662 or 228 6294

ELECTRONICS ENGINEER

– CALIBRATION

An opportunity exists in a small but thriving Nottingham-based company for a senior engineer to upgrade the company's calibration laboratory to BCS standards. Suitable applicants will therefore have knowledge of, and experience, with BCS procedures.

Prospects are excellent as the company is expanding rapidly and this position would suit a person wishing to develop his or her potential.

Apply for full details, enclosing your CV, to:

DMR LTD.
Unit 19, Salisbury Square
Ilkestone Road
Nottingham NG7 2AB

(1630)

www.americanradiohistory.com

ENJOY BEING SUCCESSFUL WITH QUANTEL

Quantel Limited has achieved a worldwide reputation as the foremost Company in Digital Video products for the Broadcaster. Due to our continual growth we now require further engineers to join our team in Newbury, Berkshire.

TEST ENGINEERS

We are looking for Test Engineers to be responsible for checking through and commissioning a wide range of advanced electronic assemblies. The ability to develop test procedures and additional test rigs is an advantage. Candidates should be qualified to at least HNC standard but candidates studying for a TEC qualification will be considered.

JUNIOR SERVICE ENGINEER

We require a young person with previous test or service experience to assist in servicing complex video and computer-based equipment to component level. A qualification at TEC level is useful but not essential, as one or two years' relevant experience is more important.

If you are interested in joining our team, please telephone or write for an application form to:

The Group Personnel Officer, Quantel Limited, 17-20 West Mills, Newbury, Berkshire. Tel: Newbury (0635) 48222, Ext. 308.

(1639)

QUANTEL

EAST SUSSEX COUNTY COUNCIL
SOCIAL SERVICES DEPARTMENT

TECHNICAL PRODUCTION ASSISTANT

BRIGHTON **£8,190-£9,528**

A newly created post in the Training/Development Section.
Part of the Section's work includes the production of audio/ visual training materials on subjects as diverse as child care practice, understanding mental illness, health and safety at work, the care of the mentally and physically handicapped, management techniques, etc. All these productions are designed specifically to complement ongoing training programmes for Social Services staff.
The Engineer will be part of a small team – and a high degree of commitment and energy is as essential as technical competence.
Tasks will include: i) the maintenance of near broadcast quality ENG video camera and recorder, editing suite and portapaks, as well as a pool of audio-visual equipment; ii) the operation of video and audio equipment as part of a small production team producing high quality video and tape-slide programmes.
Qualifications: Degree in engineering subject; Experience in broadcasting and education, both in an engineering and production capacity; Operational experience on VPR-1 machines would be an advantage.
Informal enquiries: Yvette Vanson, Brighton 606622 ext. 253. Please quote post No. 7060D.
Application forms immediately from Personnel Section, Social Services Department
East Sussex County Council
County Hall, St. Anne's Crescent
Lewes, Sussex BN7 1SG
Closing date for applications June 11, 1982.

(1654)

Development Draughtsman
£7,000-£8,500

Since MMS first took root, we have achieved an almost unbelievable rate of growth. Having quadrupled our turnover over the past four years we're now well placed to double it again over the next few. A member of the worldwide Mars Group, we are, in fact, one of Europe's fastest growing electronics companies with a range of highly sophisticated products which are both advanced in design and innovative in application.
With the recent setting up of a brand new company to develop, manufacture and market specialist marine equipment, we have an immediate need for an additional man or woman to join us.
For this position we're looking for someone in their early 20s, with a good design background in an electro-mechanical environment, and preferably a qualification or a keen interest in electronics as a hobby, perhaps in amateur radio. City and Guilds or HNC qualifications combined with two years' mechanical design experience is called for and a knowledge of fully automated production methods would be an advantage.
It's an exciting and challenging time and if you have it in you to develop your experience and make a really positive contribution to our growth, the future is bright for you, and for us.
We are offering an attractive range of benefits including non-contributory pension scheme and Christmas bonus.

(1648)

MMS

If you're looking for career growth, contact Nigel Purse, Personnel Officer, MMS, 226 Bath Road, Slough, Berks. SL1 4DE. Tel. Slough 70921.

THE QUEEN'S AWARD FOR EXPORT ACHIEVEMENT

FIELD SERVICE ENGINEERS

C£7,000 plus car, expanding dynamic group, computer peripherals. Various UK opportunities HNC (or ex-service) standard product training given.
For further information please phone:
03843-4436
Jonathon Lee Technical Recruitment
62 Hagley Road
Stourbridge

(1419)

R & D OPPORTUNITIES. Senior level vacancies for Communications Hardware and Software Engineers, based in West Sussex. Competitive salaries offered. Please ring David Bird at Rediffusion Radio Systems on 01-874 7281. (1162

BOX NOs.

Box number replies should be addressed to:

Box No.........

c/o Wireless World
Quadrant House
The Quadrant
Sutton
Surrey SM2 5AS

SITUATIONS VACANT

CIVIL AVIATION COLLEGE (GULF STATES)

requires

INSTRUCTORS – AVIATION ELECTRONICS

Qualified and experienced in installation and maintenance of modern aviation radio systems, extensive instructional experience at Technician Level Courses.

Salary and allowances up Dollars 3,400 per month.

Please enquire for details:

Civil Aviation College (Gulf States)
PO Box 4050
Doha Qatar

Attention: Principal – Mr. Jassim Al Nusf

(1436)

Technicians in Communications

GCHQ We are the Government Communications Headquarters, based at Cheltenham. Our interest is R & D in all types of modern radio communications – HF to satellite – and their security.

THE JOB All aspects of technician support to an unparalleled range of communications equipment, much of it at the forefront of current technology.

LOCATION Sites at Cheltenham in the very attractive Cotswolds and elsewhere in the UK; opportunities for service abroad.

PAY Competitive rates, reviewed regularly. Relevant experience may count towards increased starting pay. Promotion prospects.

TRAINING We encourage you to acquire new skills and experience.

QUALIFICATIONS You should have a TEC Certificate in Telecommunications, or acceptable equivalent, plus practical experience.

HOW TO APPLY For full details on this and information on our special scheme for those lacking practical experience, write now to

Recruitment Office
GCHQ, Oakley, Priors Road, Cheltenham
Glos. GL52 5AJ
or ring
0242 21491
ext 2269

(1530)

GCHQ

NATO HEADQUARTERS ALLIED FORCES CENTRAL EUROPE

Post Box 270 **6440 AG Brunssum**
The Netherlands

Applications are invited from qualified candidates for the permanent civilian posts of:

One FIELD SERVICE TECHNICIAN
(NATO Grade B-5)

in a travelling team maintaining an international microwave telecommunications system. Home base near Aachen, Germany.

One PRINCIPAL TECHNICIAN
(NATO Grade B-5) –
Computer-aided Message Processing Systems

duty station Birkenfeld.

Competitive international salaries/allowances and pension scheme.

Candidates should apply with short curriculum vitae, not later than 14 days after the publication of this advertisement, to Civilian Personnel Officer, HQ AFCENT.

(1631)

TRINITY HOUSE LIGHTHOUSE SERVICE, LONDON
ELECTRICAL ENGINEER
GRADE PTO II SALARY £8,607-£9,784 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 micro-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 6601 Ext. 289.

(1632)

HAMMERSMITH AND FULHAM
HEALTH AUTHORITY
CHARING CROSS HOSPITAL

MEDICAL PHYSICS TECHNICIAN GRADE 1

Salary scale: £8968-£10319 per annum incl.

An electronics technician with considerable experience of maintenance of Electronic and Bio-medical equipment is required to supervise the day-to-day work of nine technicians engaged in the repair, calibration and safety checking of a wide range of medical and laboratory equipment.

Applicants should have previous experience of personnel supervision and an extensive knowledge of the electrical safety aspects of medical equipment.

Opportunities will exist for the development of electronic instrumentation and a knowledge of microprocessors would be desirable. The successful candidate will be expected to participate in the activities of the medical electronics section of the Department of Medical Physics.

Ideally, the successful candidate will have an HNC or HND in Electronic Engineering.

For an application form and job description, please contact Mrs J. Cordery, District Personnel Department, Charing Cross Hospital, Fulham Palace Road, London, W6. Telephone: 01-748 2040 ext. 2992. (1622)

UNIVERSITY COLLEGE CARDIFF
DEPARTMENT OF PHYSIOLOGY

EXPERIMENTAL OFFICER OR SENIOR EXPERIMENTAL OFFICER
(ELECTRONIC INSTRUMENTATION)

Applications are invited for the above post – design experience essential, degree in electronics an advantage. Salary range: Either OR Gr. IA £6,070-£10,575 p.a. or OR Gr. II £10,160-£12,860 p.a. – duties to commence as soon as possible.
Applications (two copies), together with the names and addresses of two referees, should be forwarded to the Vice-Principal (Administration) and Registrar, University College, P.O. Box 78, Cardiff CF1 1XL, from whom further particulars may be obtained. Closing date: 10th July. Ref. 2399.

(1658)

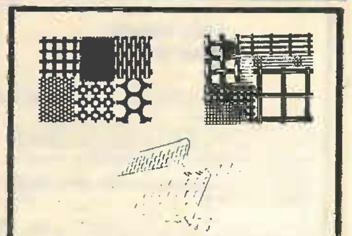
ARTICLES FOR SALE

PRE-PACKED screws, nuts, washers, solder tags, studding. Send for price list. A1 Sales (WW), PO Box 402, London SW6 6LU. (1253

PRINTED CIRCUITS. Make your own simply, cheaply and quickly. Golden Fotolak Light Sensitive Laquer – now greatly improved and very much faster. Aerosol cans with full instructions, £2.25. Developer 35p. Ferric Chloride 55p. Clear Acetate sheet for master 14p. Copper-clad Fibreglass Board approx. 1mm thick £1.75 sq. ft. Post/Packing 60p. White House Electronics, Castle Drive, Praa Sands, Penzance, Cornwall. (714

WORKBENCHES, secondhand. Ex-ITT TV factory. Open or cubicle style. Need space. Details: 042 486 3464. (1608)

ADVANCE OSCILLOSCOPE Type 250A dual trace 10Mhz-2mV. Little used £200. Mullard LP 1186 £3.75. Mainstrans 170v + 6.3v £2.25 db meters 400 va £1.25. Teleradio, 325 Fore Street, London N9 0PE. (1625



Perforated Metals – Screens, Plastics, Wire Meshes, Sifting Media, Cable Tray, Gratings, direct from Manufacturer's Stock. We can cut to size.

We specialise in one-offs or large quantities.

GRAEPEL PERFORATORS LTD.

Unit 1-B, Charles Street, Dept. WS, Walsall, Staffs WS2 9LZ. Tel. 0922 611644/611414. Telex 335291.

www.americanradiohistory.com

Classified

SITUATIONS VACANT

audix

ELECTRONIC DEVELOPMENT ENGINEER

Audix Limited manufacture a wide range of professional audio equipment used in radio and television studios and public address systems, worldwide. We wish to expand our design and development section by recruiting a young engineer, preferably with two or three years' practical experience. Ideally, we require a graduate with some audio engineering knowledge, having experience in analogue and digital circuit design and some familiarity with micro-processor applications.

For further information please write or telephone: Mr. J. S. Miller at Audix Limited, Station Road, Wenden, Saffron Walden, Essex. Tel. 0799 40888.

ARTICLES FOR SALE

TO MANUFACTURERS, WHOLESALERS BULK BUYERS, ETC.

LARGE QUANTITIES OF RADIO, TV AND ELECTRONIC COMPONENTS FOR DISPOSAL

SEMICONDUCTORS, all types, INTEGRATED CIRCUITS, TRANSISTORS, DIODES, RECTIFIERS, THYRISTORS, etc. RESISTORS, C/F, M/F, W/W, etc. CAPACITORS, SILVER MICA, POLYSTYRENE, C280, C296, DISC CERAMICS, PLATE CERAMICS, etc.

ELECTROLYTIC CONDENSERS, SPEAKERS, CONNECTING WIRE, CABLES, SCREENED WIRE, SCREWS, NUTS, CHOKES, TRANSFORMERS, etc.

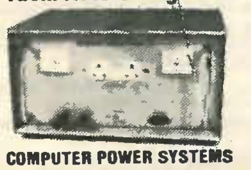
ALL AT KNOCKOUT PRICES — Come and pay us a visit ALADDIN'S CAVE

TELEPHONE: 445 0749/445 2713

BROADFIELDS & MAYCO DISPOSALS
21 Lodge Lane, North Finchley, London, N.12 (1613)
(5 minutes from Tally Ho Corner)

INVERTERS

High quality DC-AC. Also "no break" (2ms) static switch, 19" rack. Auto Charger.



COMPUTER POWER SYSTEMS
Interport Mains-Store Ltd.
POB 51, London W11 3BZ
Tel: 01-727 7042 or 0225 310916 (9101

WORLD'S BIGGEST INFORMATION SERVICE

By return post — service/workshop manuals. Over 2,000 Sony — over 300 different CTV plus huge stocks VCR/TV/Audio/foreign and UK.
Any single service sheet £1 + sae. Repair data named TV £6.50 (with circ. £8.50). SAE brings free—50p magazine/price lists/bargain offers/quotations — unique TV publications
TISWW, 76 Church Street, Larkhall (0698 883334), Lanarkshire ML9 1HE. (1637)

Brinell Tester, diamond, microscope, accessories £250. Tektronix 4-ch. plug-in £79, 5" CRT (boxed) £65. Marconi 450-1250 MHz £85, frequency meter £65. Laser £75. 30KV meter £35. Standard air cap £25. Transistor Curve Tracer £125. Centrifuge £59. 16mm reader £69. 35mm Aldis projector £25. Bolex Super-8 zoom auto cine camera £49. Flann attenuator £29. Marconi counter plug-in £15, range extension unit £15. Standby 4KVA diesel generator £199. **TEL. 04-037 6236. BALANCE OF LAB CONTENTS AVAILABLE.**

EQUIPMENT FOR coils, transformers, components, degassing silicone rubber, resin, epoxy. Lost wax casting for brass, bronze, silver, etc. Impregnating coils, transformers, components. Vacuum equipment low cost, used and new. Also for CRT regunning metallising. Research & Development. Barratts, Mayo Road, Croydon CR0 2QP. 01-684 9917. (9678

WAYNE KERR B642 AUTOBALANCE UNIVERSAL BRIDGES. Two bridges in good working order, ex-Water Authority Hydrologer. For sale by tender. For inspection Tel. Waltham Cross 23611 ext. 273. Tenders to be received by Wednesday, June 2nd in sealed envelope marked "Tender for Autobalance Bridges". Thames Water, Scientific Services, Aspen House, The Grange, Crossbrook Street, Waltham Cross, Herts. (1620

VINTAGE RADIO COLLECTOR? Full 1982 Catalogue now available £1.50 post paid from the Vintage Wireless Co., 64 Broad Street, Staple Hill, Bristol BS16 5NL. Tel. 0272 565472. (1638

REDUNDANT EQUIPMENT. Burroughs L5000 Business computer striped ledger version, fully maintained with service history. Singer Friden Computypers type 5126, suitable invoicing, etc. Complete with tape recorder, punch and desk. Offers phone 0822-66477 office hours; 0822-3896 evenings. (1621

BRADLEY MULTIMETER CALIBRATOR. Solartron voltmeters, five off LM 1420. Solartron voltmeters two off 1444. Muirhead Impedance Bridge, also bridge attachment plus various other test equipment. Any reasonable offer. Ring Pirton 425. (1635

BRIDGES, waveform/transistor analysers. Calibrators, Standards. Millivoltmeters. Dynamometers. KW meters. Oscilloscopes. Recorders. Signal generators — sweep, low distortion, true RMS, audio, FM, deviation. Tel. 040 376236. (1627

ARTICLES FOR SALE

QUARTZ CRYSTALS

- HIGH STABILITY GOLD ELECTRODES
- COLD WELD UNITS
- GUARANTEED 7-DAY SERVICE AVAILABLE
- ANY FREQUENCY 1MHz-70MHz

ALSO
200KHZ-70MHZ
CLOCK CRYSTAL
OSCILLATORS TTL
COMPATIBLE DIP PACKAGE

McKNIGHT CRYSTAL CO. LTD.
HARDLEY INDUSTRIAL ESTATE
HYTHE, SOUTHAMPTON. SO4 6ZY

HYTHE (0703) 848961
TELEX: 47506 — CRYSTL G (1407)

PARAMETRON 477 Spectrum Analyser Freq. 200KHz-50MHz £375
HEWLETT-PACKARD 350D Attenuator DC-1MHz 600 Ohm £75
MARCONI 868B Universal Bridge 1% 1KHz & 10KHz £100
WAYNE KERR B901/S261/R261 Admittance Bridge 50-250MHz £120
MARCONI TF.2424 VHF/UHF Freq. Meter 4 Digit DC-512MHz £180
GAUMONT KALEE Flutter Meter £45
MARCONI TF.893 Power Meter £65
MARCONI TF.2600 Sens. Valve Voltmeter 10V-300V f.s.d. ± 1% £95
WAVETEK 740 Phase meter 10Hz-2MHz £225
TEKTRONIX 564 Storage Scope DC-10MHz c/w 3A6 & 3B3 Plug-ins £275
ADVANCE SG.62B Signal Generator 150KHz-220MHz A.M. to 30% £30
ADVANCE H1E Signal Generator 15Hz-50KHz Sine/Sq. O/P £50
ADVANCE SG65A Oscillator 10Hz-100KHz Sine/Sq. O/P, 0-6V £65
MARCONI TF.2950 Mobile Radio Test Set £995
MARCONI TF.1066B AM/FM Signal Generator 10MHz-470MHz £500
MARCONI TF.1101 R-C Oscillator 20Hz-200KHz £60
PHILIPS PM.6456 Stereo Generator £185
PROSSER A100/A340 Wave Form Generator £375
TAYLOR SG.62A AM/FM Signal Generator £125
TEKTRONIX L09 Pulse Generator .... From £120
KÖRTING 82515 Colour TV Service Generator £280
I.C.I. ULV 2518 Ultra Sonic Cleaner, 3 Compartments, Filtration, Cont. distillation .... OFFERS OVER £2500
BPL CZ.457/4 Component Comparator and CZU 457/4 3 Channel Automator £125
FERROGRAPH RTS.2 Recorder Test Set £225

Send SAE for list to:

MARTIN ASSOCIATES
'PARTHIA', BECKHAMPTON
NEAR MARLBOROUGH, WILTS.
TEL AVEBURY (067-23) 219 (1384)

SCHLUMBERGER Synthesised single sideband signal generator. Type SSB30 with Amplitude Modulator MA30 and BMD500 Attenuator Freq. 300Hz to 32MHz **£495.** B & K LEVEL RECORDER type 2305 precision sound level meter 2203 (no microphone) Audio Freq. Spectrometer type 2112, the lot £398. HP Signal Analyser/Memory Display Unit type 5480B with two channel input unit type 5485A and Control Unit 5486B £495. Tektronix-spectrum Analyser type 1L5 50Hz-1MHz with 585A 'scope (80MHz) with 82 plug in unit and adaptor type 81 £598. Tektronix 'scope camera C12 £98. Tektronix sampling 'scope type 661 with 5T3 timing unit and 50 ohms dual trace sampling unit 452A £195. MF Attenuator DC-1MHz TF2162 £45. HP 'scope type 175A dual beam delay line 50MHz £125. Plug-in Units 1A5 £48. 1A2 £50. 82 £60. Adaptor type 81 £25. 82, less valves transistors thyristors £20. 1A2, as above, £20. Tektronix 'scope 581A with 82 plug-in unit (80MHz) £145. R & S RF Millivoltmeter 30Hz-30MHz £87. Valve characteristic meter Mark IV £95. Brandenburg EHT regulated power supply 0-5KV £75. Signal Generator TF1060 Freq. 450MHz-1.2GH £195. TF1066/2 FM Signal Generator Freq. 10MHz-470MHz £285. HP VHF Signal generator type 608E Freq. 10-480MHz £195. All items in basic working order. Private sale. P&P extra. Payment COD. All goods subject to availability. Tel. March 740886. Offers considered. (1647)

Racal RA66B panoramic adaptor, in excellent condition, housed in Racal cabinet, complete with MA282 adaptor, connecting leads and handbook, £265. Racal distribution amp, MA288, £35. Unused buffer amp, MA251, £15. Little used ferrograph tape recorder £45. Buyer to inspect/collect. Morris, Bolton 52384. (1634)

DVMs Solartrons, Dynamcos B&K Recorder 2305 HP Function Generator, Oscillators, Marconi Voltmeters, Electroflo temperature indicators, Eurotherm controller, Amplifiers. Various test gear. Send for list, open to offers. Contact Leo, Tel. 03708 5047 day, 03706 391 evenings. (1650)

RACAL COMMUNICATIONS RECEIVERS

500 Kc/s — 30Mc/s 1Mhz wide. **RA17L** — £175. **RA117E** — £225. A few sets available as new at £75 extra. All receivers are air tested and calibrated in our workshop, supplied with full manual, dust cover, in fair used condition. New black metal louvred cases for above sets £25 each. **RA980** — **ISB** — **SSB** — £75. **RA218** — **SSB** — ISB and fine tune for RA117 — £50. **TRANSMITTER DRIVE UNIT RA79.** 1.5mc/s — 30mc/s — **SSB** — **ISB** — **DSB** — **FSM** — **CW** — £150. **AERIAL TUNING UNIT** and protection unit **MA197B** — £25 to £50. **DECADE FREQUENCY GENERATOR MA350B** Solid state synthesiser for **MA79** or **RA117** — **RA217** — **RA1217** — £150 to £200. **MA250** — 1.6mc/s to 31.6mc/s — £150 (New). **MA259G** — precision frequency standard — 5mc/s lmc/s 100khz — £100 to £250. **RACAL MA152** — Standing wave ratio indicator. FX2mc/s — 25mc/s Power up to 1000watts — 50 ohms — Auto trip switch — Transistor mains 100 — 250AC, new and boxed — £40. **RACAL COUNTER** 836 (9036) 32mc/s **TTL** circuit design — tested with manual — £50 to £75. **OSCILLOSCOPES COSSOR COU150** — 35mc/s — Twin Beam — Solid State — £175 with manual. **TEXTRONIC OSCILLOSCOPE** 647 and 647A Solid State — 50mc/s and 100mc/s bandwidth — £250 and £350. Tested, circuit and instructions. **AERIAL MASTS** — we have three masts approx. 130ft high, complete with all fittings. Base — insulators, etc., Mast steel tube 8" all parts galvanised, supplied brand new, all items boxed — £1000 — or each complete mast — £400.

All items are bought direct from H.M. Government, being surplus equipment. Price is exworks. SAE for all enquiries. Phone for appointment for demonstration of any item. John's Radio, Whitehall Works, 84 Whitehall Road East, Birkenshaw, Bradford BD11 2ER. Tel. (0274) 684007. V.A.T. and Carriage extra.

80 x 24 VDU

All the electronics for a 24 lines by 80 characters visual display unit on one assembled and tested printed circuit board measuring 8.75 inch x 6.50 inch.
You provide: power supply +5v at 1.2 amps +12v/−12v at 25mA, ASCII encoded keyboard, video monitor.
The VDU-1 will talk to the R.S.232 serial port on your computer, at up to 19,200 Baud 56 features including cursor (X, Y) addressing.
VDU-1 Assembled and tested PCB £135
PSU-1 VDU-1 power supply £32
All prices subject to £2.50 registered delivery, plus VAT.

SIRIUS CYBERNETICS
Comyn Lodge, 66 Holly Walk
Leamington Spa, Warwickshire
Tel. (0926) 318110 (1645)

BARGAINS FOR CALLERS

Lancs and Yorks

ELECTRICAL, ELECTRONIC MECHANICAL

Vast range always in stock, includes small transmission equipment; diodes; thyristors; resistors; terminals; relays; switches; test and measuring equipment; wire and cable. Many items by mail order — send for free lists or browse and buy.

A. C. TOWNLEY LTD.
Harehill, Todmorden, Lancs OL14 5JY (1649)

www.americanradiohistory.com

Classified

ARTICLES WANTED

WANTED!

all types of scrap and
REDUNDANT ELECTRONIC & COMPUTER MATERIALS
with precious metal content

TRANSISTORS & PRINTED CIRCUIT BOARDS TO COMPLETE COMPUTERS

THE COMMERCIAL SMELTING & REFINING Co. Ltd.
171 FARRINGDON ROAD
LONDON EC1R 3AL
Tel: 01-837 1475
Cables: COMSMELT, EC1
Works: FLECKNEY, Nr. LEICESTER (205)

WANTED

Test equipment, receivers, valves, transmitters, components, cable and electronic scrap, any quantity. Prompt service and cash. Member of A.R.R.A.

M & B RADIO
86 Bishopsgate Street
Leeds LS1 4BB
0532-35649

WANTED: Heathkit SB-620 Scanalyser. Also Advanced SGG3E (SG63E) FM/AM Signal Generator. Details of condition and price, please, to: T. Hughes, Electronic Engineering Department, UCD, Merrion Street, Upper Dublin 2, Eire. Ph Dublin 761584, ext. 222 (office hours). (1649)

SERVICES

SMALL BATCH PCBs produced from your artwork. Also DIALS, PANELS, LABELS. Camera work undertaken. FAST TURNAROUND. — Details: Winston Promotions, 3 Hatton Place, London EC1N 9RV. Tel: 01-405 4127/0960. (9794

SHEET METAL WORK, fine or general front panels chassis, covers, boxes, prototypes, 1 off or batch work, fast turnround. — 01-449 2695. M. Gear Ltd., 179A Victoria Road, New Barnet, Herts. (812

DESIGN SERVICES. Electronic design development and production service available for digital and analogue instruments. RF Transmitters and receivers, telemetery and control systems. 20 years' experience. R.C.S. Electronics, Wolsey Road, Ashford, Middlesex. Phone Mr Falkner 5366]. (8341

ARTICLES FOR SALE

THE SCIENTIFIC WIRE COMPANY

P.o. Box 30, London, E.4

ENAMELLED COPPER WIRE

SWG	1lb.	8oz.	4oz.	2oz.
8 to 29	2.76	1.50	.80	.60
30 to 34	3.20	1.80	.90	.70
35 to 40	3.40	2.00	1.10	.80
41 to 43	4.75	2.60	2.00	1.42
47	8.37	5.32	3.19	2.50
48 to 49	15.96	9.58	6.38	3.69
SILVER PLATED COPPER WIRE				
14 to 30	6.50	3.75	2.20	1.40
TINNED COPPER WIRE				
14 to 30	3.38	2.36	1.34	.90

Prices include P&P. VAT and Wire Data
SAE for list. Dealer enquiries welcome.
Reg Office: 22 Coningsby Gardens. (9063)

CAPACITY AVAILABLE

TW ELECTRONICS LTD.

THE PCB ASSEMBLERS

More and more companies are investigating the advantages of using a professional subcontractor. Such an undertaking requires certain assurances.

TW are able to satisfy all of them — quality, competitive pricing, firm delivery, and close co-operation with the customer.

Assembled boards are 100% inspected before flow soldering and reinspected after automatic cropping and cleaning.

Every batch of completed boards is issued with a signed certificate of conformity and quality — our final assurance.

For further details, contact us at our new works:

Blenheim Industrial Park
Bury St. Edmunds
Suffolk IP33 3UT
Tel: 0284 3931 (1466)

BATCH PRODUCTION wiring and assembly to sample or drawings. McDeane Electricals Ltd, 19b Station Parade, Ealing Common, London W5. Tel: 01-992 8976. (169

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 Eva Road, Gillingham, Kent. Tel: Medway (0634) 577854. (9667

PCB ASSEMBLY/WIRING from drawings/sample. Fast turnaround. J. Forsyth. Tel. (0604) 65011. (1517)

SERVICES

BOARDRAVEN LTD.

PRINTED CIRCUIT BOARDS

Manufactured to your specifications. Single/double sided. Very speedy deliveries on prototypes and quantity. Master layouts if required.
Contact:
J. K. Harrison, Carnaby Industrial Estate, Bridlington, North Humberside YO15 3QY. Tel. (0262) 78788. (1168)

WANTED FOR CASH: 7F7, 7N7, 53, 6L6 metal, 304TL, 4CX1000A, all transmitting, special purpose valves of Eimac/Varian. DCO, INC, 10 Schuyler Avenue, North Arlington, New Jersey 07032, USA. (1625

PCB/equipment assembly/wiring from prototype/drawings. Fast turnround. Tel. 01-390 0424. (1626

SERVICES

CIRCOLEC

THE COMPLETE ELECTRONIC SERVICE

Artwork, Circuit Design, PCB Assembly, Test & Repair Service, Q.A. Consultancy, Prototypes, Final Assembly.
Quality workmanship by professionals at economic prices.
Please telephone **01-767 1233** for advice or further details.
1 FRANCISCAN ROAD
TOOTING, LONDON SW17 (1391)

Micro Processor Design

Our team of experts offer the complete service from Design to Manufacture

- Artwork
- Prototype Development
- Testing
- Board Manufacture
- Assembly
- Packaging

micro control systems

For more information contact Micro Control, 1 Cherrywood Drive, Aspley, Notts. NG8 3NN. Telephone 0602 298281 (24 hour service). (1597)

Dayville Services Limited

A complete P.C.B. service offered. We will work from your circuit diagram and produce the finished board.

Any type of board manufactured including double-sided and P.T.H. Legend and solder resist available if required.

Our rates are very competitive and we offer a FREE collection and delivery service on orders above £200. Turnaround can be as little as three days.

Telephone Colchester (0206) 71000/869514 with your P.C.B. requirements and we will be happy to oblige.

40 Military Road, Colchester CO1 2AN. (1490)

FACILITIES AVAILABLE
★ **Circuit Design & Development**
Digital and Analogue
★ **Artwork Layout**
Free prototype bd. (non PTH)
Supplied with orders over £100.
★ **Board Manufacture**
Prototype to semi-production.
★ **Wiring & Assembly**
PCB assembly, wiring and cable forming.
★ **Test**
Full test facilities available.
★ **Copper Clad Board**
D/S fibreglass 1000 Sq inches of assorted useful sizes. £6.00 inc. post.

One or all services available, no order too small. Please telephone Chelmsford 357935 or write to H.C.R., 1 Bankside, off New Street, Chelmsford, Essex. (1169)

DESIGN AND DEVELOPMENT. ANALOGUE, DIGITAL, RF AND MICROWAVE CIRCUIT AND SYSTEM DESIGN. Also PCB design, mechanical design and prototype/small batch production. — Adenmore Limited, Unit 103 Liscombe, Bracknell, Berks. Tel: Bracknell 52023. (656

BATCH/VOLUME, production/prototype, wiring/assembly, pcb/final assembly, service. Fast turnround. Youngtronic Ltd., 10 Kelvin Avenue, London N13 4TGY. Other associated specialist technical services — details available. Overseas clients welcome. (1614

30,000 SERVICE SHEETS IN STOCK COLOUR MANUALS ALSO AVAILABLE
TV Monos £2, Transistor Radios £2, Tuners £2, Tape Recorders, Record Players and Stereograms £2. Stamped addressed envelopes with all quotations. Also colours available. Car Radios £3 + stamped addressed envelope. All valve radios £2. Stamped addressed envelope please. Quote advert. no. with order.
C. CARANNA
71 Beaufort Park, London NW11 6BX
01-458 4882 (Mail Order) (1325)

CLASSIFIED ADVERTISEMENTS

Use this Form for your Sales and Wants

PLEASE INSERT THE ADVERTISEMENT INDICATED ON FORM BELOW

To "Wireless World" Classified Advertisement Dept., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS

- Rate £2.50 PER LINE. Average six words per line. Minimum £12.50 (prepayable).
- Name and address to be included in charge if used in advertisement.
- Box No. Allow two words plus £1.
- Cheques, etc., payable to "IPC Business Press Ltd." and cross "& Co."

NAME ....
ADDRESS ....

REMITTANCE VALUE .... ENCLOSED

PLEASE WRITE IN BLOCK LETTERS. CLASSIFICATION .... NUMBER OF INSERTIONS ....

COMPUTER APPRECIATION

86 High Street, Bletchingley, Redhill, Surrey RH1 4PA. Tel: Godstone (0883) 843221

RAYTHEON Model PTS 1200. Computer system comprising 64K byte MOS memory; 3 VDU terminals; 4 DIABLO Series 30 2.5 megabyte disc drives, cassette drive & numerous multiplexor & option cards. Processor test set with integral cassette drive is included. The whole system is contained in 2 rack cabinets & was manufactured 1977/8. .... £3,500
RAYTHEON Model 704 16 bit processor. With front panel & 12 KW memory. £250
DTC MICROFILE MICROCOMPUTER. Compact 8080 based system with 56K bytes, dual serial interfaces and programmable front panel display. Machines are available with one PERSCI dual drive (currently $1700 each). Software includes operating system, powerful BASIC, assembler and letter writer. NEW. £585
MEMOREX Model 277B VDU. These VDU's are supplied with a net interface operating via a single coaxial connector. Microprocessor controlled with internal memory for 24 lines × 80. Complete with keyboard and manufactured 1978/9. Further details on request. £120
LICON VDU Keyboards. High quality attractive cased keyboards with separate keypad for cursor controls etc. BRAND NEW & boxed. £18.50
DEC Model VT52 VDU. 24 × 80, RS232 interface etc. £350
IBM Model 1053 Golfball printer. Compact 15 cps high-reliability mechanical printer in fully refurbished condition. Exactly equivalent to 735 less keyboard. Can be driven from PIA (or similar) with addition of PSU and solenoid driver ICs (details available soon). Accepts standard office golfballs. £95
DRE Model 6330 matrix printer. 150 cps bi-directional printer for commercial duty. U/L case, parallel & serial interfaces. £550
TELETYPE Model RO390 Baud Printer £35
FACIT 4070 Paper Tape Punch. For 5-hole or 8-hole operation. Complete with feed and take up spools, chad box and perspex cover. Parallel interface. New cost in excess of £1,200. .... £175
DIABLO Series 30 removable DISC DRIVE. 2.5 megabyte with industry standard interface. These drives are hardware, software & media compatible with RK05, & PDP 11 interfaces are available from XYLOGICS at low cost £375
POWER SUPPLY for above. £50
DRE Model 24 Disc exerciser for Models 30, 32, & 4000. Current nes price £1,495. As new. £650
OKIDATA Series 3300 Winchester disc drives. Compact drive with standard CDC interface (SMD-9760). 7.97 Megabits/Sec. transfer rate; 38 ms average seek time. PDP 11 interface available. Manufactured 1979/80 & UNUSED. .... Model 3303 (40 megabyte) £450 .... Model 3306 (80 megabyte) £650
DOCUMATION Model M600L compact card reader. CR11 compatible. £350
DISCOM interface board for OLIVETTI ET121 electronic typewriter. Offers both Centronics parallel & RS232. BRAND NEW. £140
MOSELEY analogue X-Y plotter. A4 size. Without pens. £75
LASER ASSOCIATES Nd GLASS LASER. 1.06 micron wavelength. 1-2 J per pulse. A single pulse from this laser burns a hole through a steel rule. Complete with cooling system and output monitor. FULLY OPERATIONAL. £620
FACIT Model 4001. 1000 cps capacitative paper tape reader. £125
TREND Model HSR 500 optical paper tape reader. £175
EMS SYNTHESIZER Model SYNTHI. A complete AKS keyboard and DK2 keyboard. Current (Jan. 81) new price £1,921 .... £350

Please note:
★ VAT and carriage extra all items
★ Visitors welcome but by appointment please
★ We are keen to bid competitively for all good used equipment

INDEX TO ADVERTISERS JUNE

Appointments Vacant Advertisements appear on pages 114-127

OVERSEAS ADVERTISEMENT AGENTS:

France & Belgium: Norbert Hellin, 50 Rue de Chemin Veat, F-9100, Boulogne, Paris.

Hungary: Mrs Edit, Bajusz, Hungexpo Advertising Agency, Budapest XIV, Varosliget. Telephone: 225 008 – Telex: Budapest 22-4525 INTFOIRE

Italy: Sig C. Epis, Etas-Kompass, S.p.a. – Servizio Estero, Via Mantegna 6, 20154 Milan. Telephone: 347051 – Telex: 37342 Kompass.

Japan: Mr. Inatsuki, Trade Media – IBPA (Japan), B.212. Azabu Heights, 1-5-10 Roppongi, Minato-ku, Tokyo 106. Telephone: (03) 585 0581.

United States of America: Ray Barnes, IPC Business Press, 205 East 42nd Street, *New York*. NY 10017 – Telephone: (212) 867-2080. Telex: 238327.
Mr Jack Farley Jnr., The Farley Co., Suite 1584, 35 East Walker Drive, *Chicago*, Illinois 60601 – Telephone: (312) 63074.
Mr Victor A. Jauch, Elmatex International, P.O. Box 34607, *Los Angeles*, Calif. 90034, USA – Telephone (213) 821-8581 – Telex: 18-1059.
Mr Jack Mentel, The Farley Co., Suite 650, Ranna Building, *Cleveland*, Ohio 4415 – Telephone: (216) 621 1919.
Mr Ray Rickles, Ray Rickles & Co., P.O. Box 2028, *Miami Beach*, Florida 33140 – Telephone (305) 532 7301.
Mr Tim Parks, Ray Rickles & Co., 3116 Maple Drive N.E., *Atlanta*, Georgia 30305. Telephone: (404) 237 7432.
Mike Loughlin, IPC Business Press, 15055, Memorial Ste 119, *Houston*, Texas 77079 – Telephone (713) 783 8673.

Canada: Mr Colin H. MacCulloch, International Advertising Consultants Ltd., 915 Carlton Tower, 2 Carlton Street, Toronto 2 – Telephone (416) 364 2269.
* Also subscription agents.

Printed in Great Britain by QB Ltd., Sheepen Place, Colchester, and Published by the Proprietors IPC ELECTRICAL-ELECTRONIC PRESS LTD., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS, telephone 01-661 3500. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co, CANADA: The Wm. Dawson Subscription Service Ltd, Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd: William Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Distribution Inc., 14th floor, 111 Eighth Avenue, New York, N.Y. 10011.

ORYX

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 1 mm 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 TC 82 has features unique to any temperature controlled precision soldering iron. Available in 24 V, 50 V, 115 V and 210/240 V models, the TC 82 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 TC 82 is also **extra-safe**. Removing the handle automatically disconnects the iron from power source.
Other TC 82 features include: Power-on Neon indicator in handle; burn proof cable; choice of 13 tip styles.

And more good news

The Oryx TC 82 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 £3.95 (+VAT).

Greenwood Electronics

Greenwood Electronics Limited, Portman Road, Reading, Berkshire RG3 1NE. Telephone: (0734) 595844. Telex: 848659

WW—003 FOR FURTHER DETAILS

www.americanradiohistory.com