wireless world

APRIL 1981 69

70 years of publication
Active cross-over networks
Low-noise amplification

Opto-electronic contact breaker
Given that some metallic substances are more easily soldered than others, and that there are significant differences both in the speed with which they can be soldered and in the strength of adhesion of the solder to their surfaces, it is clearly necessary to make absolutely sure that the procedure used to solder components is correct. Testing for solderability greatly reduces the risk of failed joints and can mean appreciable savings on rejects.

Multicore, the world's leading authority on soldering, has developed a simple-to-use piece of equipment designed to assess solderability. It is called a MUST—Multicore Universal Solderability Tester—and it really is a must if you want to avoid the costly problems of inefficient soldering.

The built-in microprocessor takes the complex force/time curve and reduces it to just two values, making the application of the sophisticated test method to quality control particularly simple.

The MUST can be used to evaluate the solderability of any plain or plated metal in sheet, strip or wire form. It is, however, ideal for use with electronic component terminations, metal clad laminates, printed circuit boards and plated-through holes.

It can be used for the Edge Dip Test that appears in IPC-S-801, EIA RS 178 and EIA RS 319 Method 2 for evaluating quality of wetting, and for the Globule Test as described in many national and international standards including IEC 68-2-20, BS 2911-27 and DIN 40046 to measure wetting speed. This speed, together with the wetting force, may also be measured by the quick and easy addition of a wetting balance.

The Multicore Universal Solderability Tester could make a big difference to your soldering operations—and to your profits. For the eye-opening facts use the reader reply service, cut the coupon or contact Multicore direct.

Please send me full details on the MUST.
Please telephone me:

Name:
Position:
Company:
Address:
Telephone:

Sales Department, Multicore Soldiers Limited, Maylands Avenue, Hemel Hempstead, Hertfordshire HP2 7EP. Telephone (0442) 3636. Telex 82363.
TESTING MOBILE RADIOS?

...catch this bus with Farnell
and arrive economically at an efficient ATE workstation.
Comprehensive testing under low cost desk computer control.
Manual systems too.

Farnell Instruments Limited · Wetherby · West Yorkshire LS22 4DH · England · Tel: 0937 61961 · Telex 557294 Farist G

INTERFACE WITH US NOW!
Ask for details from:

Farnell Instruments Limited · Wetherby · West Yorkshire LS22 4DH · England · Tel: 0937 61961 · Telex 557294 Farist G

Wireless World, April 1981

WIRELESS WORLD APRIL 1981

Front cover shows (inside) details of the opto-electronic contact breaker described in this issue on the background of a Marconi Space and Defence Systems hybrid microelectronic circuit.

IN OUR NEXT ISSUE

Digital capacitance meter uses the timed charge-injection method of measurement, with an input protection circuit, optimized to reduce errors.

Wien oscillator is a new design by Linsley Hood, using a different connection of the standard Wien bridge to give a total harmonic distortion of 0.001%.

Active television deflector receives video signal, amplifies and re-transmits it to viewers in no-signal reception areas.

Current issue price £0.60, back issues £0.80, at Head and Trade Counter, Units 1 & 2, Breakside Industrial Centre, Hopton Street, London SE1. Available on microfilm: please contact editor.


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

Editorial: Editorial 01-661-9729

Telegrams: Telegrams: Tele 0937 6086

Subscription rates: 1 year £10.00 UK and 523.00 worldwide. Student rates: 1 year £6.00 UK and £16.00 worldwide.

Distribution: 40 Boulevard Green Lane, London E9 T9 8IN. Telephone 0973 81411. Telegrams: Tele 0937 6086. Please notify change of address.


FARNSLAW INSTRUMENTS LIMITED · WETHERBY · WEST YORKSHIRE LS22 4DH · ENGLAND · TEL: 0937 61961 · TELEX 557294 FARIST G

WWW.091 FOR FURTHER DETAILS

WIRELESS WORLD

ELECTRONICS/TELEVISION/RADIO/AUDIO

APRIL 1981 Vol 87 No 1543

37 The next seventy years

38 Opto-electronic contact breaker

41 More on active cross-over networks

44 News of the month

48 Circuit ideas

50 Dividing by fractions

62 Phase measurements with an oscilloscope

66 Designing with microprocessors - 7

70 World of amateur radio

71 Introduction to low-noise amplifier design

74 Magnetic recording review - 2

79 Surface acoustic wave devices - 2

83 Multipath distortion

86 Novelties: amplitude sensing and control

88 New products

90 Sidebands

by Gilbert Pearson

by P. Williams

by David Read

by R. A. Harn

by J. R. Watkinson

by A. W. Mowatt

by P. D. White

by R. J. Murray and P. D. White

by P. A. Williams

by Mike Read

62 Phase measurements with an oscilloscope
Electronic Brokers Limited
61/65 Kings Cross Road
London WC1X 9LN England
Telephone: 01-278 3461
Telex: 298694 Elebrog

S U P E R L A T I V E  U N I T S
C A L I B R A T E D  T O
O R I G I N A L  S P E C S

[Table with specifications and prices for various test equipment items]

Electronic Brokers is Europe's largest specialist in quality, second user test equipment, computers and associated peripherals. Established 14 years ago, we have pioneered the second user concept in Britain, and many overseas territories.

To support our growth we have a dedicated team which includes trained sales staff whose role is not only to sell, but to provide a helpful information service to our many customers. Backing this team is our own on-site laboratory where technicians monitor each item of equipment we sell. Our mains is service and those who have dealt with us will know that we endeavour to always live up to our reputation.
April 1981

Electronic Brokers - Europe's Premier Used Computer Company

Latest Computer Equipment

**PDP11 SYSTEMS**
- DIF: PDP11/CU System complete with 256KOS Memory, 31" display terminal, 1 printer, 1 digitiser. £13,415.00
- DOL: PDP11 System complete with 384KOS Memory, 2 disk drives. £17,000.00
- DOL: DIF 11/44 Attachment with 256KOS Memory, 2 disk drives. £15,000.00
- DOL: PDP11/44 System complete with 384KOS Memory, 2 disk drives, 2 terminals. £18,000.00
- DOL: PDP11/44 System complete with 512KOS Memory, 2 disk drives, 2 terminals. £18,000.00
- DOL: PDP11/44 System complete with 768KOS Memory, 2 disk drives, 2 terminals. £19,700.00
- DOL: PDP11/44 System complete with 1024KOS Memory, 2 disk drives, 2 terminals. £22,700.00
- DOL: PDP11/44 System complete with 128KOS Memory, 2 disk drives, 2 terminals. £12,000.00

**PDP11 OPTIONS**
- 1311/1310 Processor Unit. £2,250.00
- 411/415 Bus Unit. £1,500.00
- 311/315 Bus Unit. £1,500.00
- 311/315 High Speed Clock. £1,500.00
- 311/315 Timer Unit. £1,500.00
- 311/315 Flash Memory. £1,500.00
- 311/315 Serial Interface. £1,500.00
- 311/315 Parallel Interface. £1,500.00
- 311/315 Terminal Interface. £1,500.00
- 311/315 Terminals. £1,500.00

**POWER SUPPLIES**
- 1011/1012 Power Supply with 8K memory. £1,740.00
- 1011/1012 Power Supply with 16K memory. £2,450.00

**PDP11 MEMORY**
- 1011/1012 512K Memory Card. £750.00
- 1011/1012 1024K Memory Card. £750.00
- 1011/1012 2048K Memory Card. £750.00
- 1011/1012 4096K Memory Card. £750.00
- 1011/1012 8192K Memory Card. £750.00
- 1011/1012 16384K Memory Card. £750.00
- 1011/1012 32768K Memory Card. £750.00

**PDP11 TERMINALS**
- 1011/1012 32K display terminal, 128K memory. £2,250.00

**PRINTER**
- Centronics 320. £1,575.00

**MAGNETIC TAPE**
- Available from home source. 1,000 U.S. Dollars. £3,750.00

**DISKS**
- Available from home source. 1,000 U.S. Dollars. £3,750.00

**NEW**
- Low Cost Printer Option. £1,750.00
- External printer for PDP11/44 System. £1,750.00
- External printer for PDP11/44 System. £1,750.00

**SOFTWARE**
- DOL: PDP11/44 Programming Kit. £1,750.00

**OTHER**
- DOL: PDP11/44 System complete with 384KOS Memory, 2 disk drives. £17,000.00

---

April 1981

Latest Computer Equipment

**PAPER TAPE PUNCHERS**
- 8K/16K/32K tape puncher with tape puncher and tape reader to 32K memory. £3,500.00

**KEYBOARDS**
- New Style 16K keyboard. £1,250.00

**MONITORS**
- New Style 16K monitor. £1,250.00

**FLOPPY DISK DRIVES**
- 8K/16K/32K floppy disk drive with 16K memory. £1,250.00

**HARDWARE**
- Internal floppy disk drive. £1,250.00

**PROGRAMMABLE CALCULATORS**
- Internal floppy disk drive with 8K memory. £1,250.00

**MODEMS**
- Internal modem. £1,250.00

**GENERATORS**
- Internal generator. £1,250.00

---

Electronic Brokers Limited
61/85 Kings Cross Road
London WC1X 9LN England
Telephone: 01-278 3461
Telex: 288694 Elebro G
Low cost excellence
with a 2 YEAR guarantee

AG202 Low Distortion Oscillator — 1kHz to 1MHz in 5 ranges —

AG202A 25kHz R.C. Oscillator — 20Hz to 20kHz in 4 ranges —

SG402 A.M. Signal Generator — 100kHz to 20MHz in 6 bands —

CO130D, DC to 5MHz Oscilloscope — 1MHz/s sweep rate with variable attenuation.

CS1562A 10 MHz DUAL TRACE £224

FG270, Function Generator — 0.1Hz to 1MHz in 5 ranges —

CS1562A Dual Trace 10MHz Oscilloscope — 10MHz to 20V/div sensitivity in 1-2-5 sequence with fine control — plus 45dB X-Y sweep time plus 35 Mag. — Auto, Manual and TV triggering — 2 mod and X-Y operation. A single trace version CS1565A is available at even lower cost.

Plus many other Trio Products such as high sensitivity electronic voltmeters, Wow and Flutter meters, DIP meters and of course the main range of Trio scopes up to 100MHz — JUST ASK FOR THE CATALOGUE

House of Instruments Ltd.,
Clifton Chambers,
62 High Street,
Saffron Walden,
Essex CB10 TEL.
Telephone: 0799 342922
Telex: 81653.

www.americanradiohistory.com
New! Sinclair ZX81 Personal Computer Kit: £40.95 complete

Reach advanced computer comprehension in a few absorbing hours

1980 saw a genuine breakthrough – the Sinclair ZX80, world’s first complete personal computer for under £100. At £69.95, the ZX80 offered a specification unchallenged at the price.

Over 50,000 were sold, and the ZX80 won virtually universal praise from computer professionals.

Now the Sinclair lead is increased: for just £89.95, the new Sinclair ZX81 offers even more advanced computer facilities at an even lower price. And the ZX81 kit means an even bigger saving. At £49.95 it costs almost 40% less than the ZX80!

Lower price: higher capability

With the ZX81, it's just as simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC-ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trigs, allows you to plot graphs, and builds up animation displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, or to select a program off a cassette through the keyboard.

Higher specification, lower price – how's it done?

Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret is a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 16 chips from the ZX80!

Kit or built – it's up to you!

The picture shows dramatically how easy the ZX81 kit is to build: just four chips to assemble (plus, of course, the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9V DC nominal unregulated (supplied with built version). Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.

New, improved specification

- 26A micro-processor – new faster version of the famous 280 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry; the ZX81 eliminates a great deal of tedious typing. Key words (RUN, LIST, PRINT, etc.) have their own single key entry.
- Unique syntax-check and report coding to identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
- cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer (not available yet – but coming soon)!
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 16 ZX80 chips.

If you own a Sinclair ZX80...

The new 8K BASIC ROM used in the Sinclair ZX81 is available to ZX80 owners as a drop-in replacement chip. (Complete with new keyboard template and operating manual.)

With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 – including the ability to drive the Sinclair ZX Printer.

Coming soon – the ZX Printer.

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumeric across 32 columns, and highly sophisticated graphics. Special features include COPY, which prints out exactly what's on the whole TV screen without the need for further instructions. The ZX Printer will be available in Summer 1981, at around £30 – watch this space!

16K-BYTE RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

How to order your ZX81

BY PHONE – Access or Barclaycard holders can call (0-200)1200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access or Barclaycard. EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.
FAST ERECTING
CLARK
MASTS

For World-wide Telecommunications in the 1980's
Clark Masts Ltd. are specialists in the design and
manufacture of telescopic and sectional mast systems. With over 25 years' experience in sup-
plying masts to meet exacting military and civil
specifications we have the expertise you can
depend on.

Extended heights 4m-30 metres capable of lifting
headload 1Kg-200Kgs, sectional or telescopic
air-operated for field or vehicle mounting. Write or
telephone us for details today.

SCAM: Telescopic Masts are available 1, 2, 3, 4, 5 or 6 sections with full height extending to
30m. The section may be 2.5m, 3m, 3.5m, 4m, 4.5m, 5m, 6m, 7m, 8m, 9m, 10m, 12m, 15m, 18m, 21m,
24m, 27m, 30m. CLARK MASTS LTD. Isle of Wight, Binstead, PO 33 3PA, England.
Telephone Ryde (0963) 63691, Telex 86586

Hilomast Ltd

HILOMAST SYSTEMS

PNEUMATIC TELESCOPIC MASTS

Hilomast Limited

THE STREET, HOBIDGE, MALDON
ESSEX CM9 7NB ENGLAND
Tel MALDON (0621) 56480
TELEX 995895

Make it for a Song!

The New Maplin Matinée

Amazing Value
For Only
£299.95 + £99.50 for cabinet if required.

Easy to build. Latest technology - means less
cost, less components and 80% less
wiring. Comparable with organs selling for up
to £1,000.00. Two 48-note manuals, 13-note
pedalboard. All organ voices on
drawbars. Preset voices: Banjo, Accordion,
Harp, Harpichord, Piano, Percussion. Piano sustain
Sustain on both manuals, and pedalboard.
Electronic rotor, fast and slow. Vibrato
and Delayed vibrato, Reverb.
Manual and Auto-Wah, Glide
(Hawaiian Guitar Sound). Single
finger chord plus memory.
Rhythms! 9-instrument voicing.
Major, Minor and Seventh chords.
Unique walking bass lines with each rhythm.
Unique counter melody line with each rhythm.

Truly amazing value for money.
Full construction details in Electronics &
Music Maker magazine.

The complete buyers' guide to electronic
components. With over 300 pages, it's a
comprehensive guide to electronic
componentry with thousands of
photographs and illustrations and page
after page of invaluable data. Get a copy now - it's the one catalogue you can't
afford to be without.

Post this coupon now for your copy of our 1981
catalogue price £1.
Please send me a copy of your 320 page catalogue.
[enclose £1]. Plus 25p p&p. If I am not completely
satisfied I may return the catalogue to you and have my
money refunded. If you live outside the UK send £1.68
or 12 International Reply Coupons.
I enclose £1.25
Name
Address

Maplin Electronic Supplies Ltd
All mail to: P.O. Box 3, Rayleigh, Essex SS6 8LR
Telephone: Southend (0702) 565495. Sales (0702) 562911
Shops: 154-161 King Street, Ruislip, Middlesex W6. Telephone: (01) 749 0426
294 Lee Road, Warrington, Cheshire WA2. Telephone: (01625) 598000. Both shops closed Mondays.

Catalogue now on sale in all branches of WHSmith Price £1.00

WW - 922 FOR FURTHER DETAILS
**New KONTAKT Sprays**

**for the Electronics & Electrical Industries**

**KALTRON 601**
A new cleaner for Magnetic Recording Units. Kaltron 601 has an extremely low surface tension thereby enabling the cleaner to be directed to the magnetic head leaving no deposit or other residues.

It is chemically pure (99.9%) - non-conductive - non-flammable.

It can be used on emerging electrical installations and electronic equipment, e.g. video units, tape recorders, data processing systems etc.

**Also NEW**

**PRINTER 66**
Syringe cleaner for type wheel printers, matrix printers and chain printers. Can also be used for cleaning normal typewriters.

**SCREEN 66**
Specialty for the cleaning of all types of screens, including data terminals and TV monitors.

**VASELINE SPRAY 701**
For use in communications engineering and construction of antennas. Packed switchboard, as cleaner for induction clamps, connecting screw-ends, etc. Application from spray can with capillary tube is clean and simple.

Distributed by:

**Special Products Distributors Ltd.**
81 Pimlico Road, London, SW1V 0HL

Tel: 01-839 9558; Cable: Speakpro, London, W.1

Telex: 266220 (meanwhile RACEN)

**WE CUT THE PRICE. WE CUT THE SIZE. WE LEFT THE OMRON QUALITY.**

**IMO**

Can now offer you the highest quality and reliability that you have come to expect in Omron relays, in their new series of low profile, printed circuit mounting relays.

There's a tremendous range for every interface, communication and output application, suitable for mounting with sockets or directly onto printed circuit boards. There are low cost types like the LC1-M, where price is a major consideration, and high reliability types like the LC1-M1, with gold-coated, de-laminated corner contacts and card lift off operation.

With contact ratings up to 50A and 240VAC and down to 5VA, all in a variety of housing styles and sizes, and up to four changeover contacts per relay, this range from IMO offers you real design flexibility. All usual AC and DC coil voltages are available from stock.

With the increased requirement for complete reliability in electronic circuits, you'll need relays at the right price and the highest quality, in a world Omron-from IMO.
**Reality as seen by your ears**

The sound of Spendor speakers has to be compared with the sound of live music to really appreciate its quality. It is the reality of reproduction that has made Spendor one of the most respected manufacturers of speaker systems in the country. The construction and finish too is the envy of any craftsman.

The Spendor Company is a self-contained unit of highly talented audio engineers who put quality before quantity. Currently over 3,000 Spendor speakers are used by professionals like the British Broadcasting Corporation, The I.B.A., W.D.B., Cologne and other selective organisations.

Reality as seen by your ears? Compare Spendor sound with live sound and see for yourself.
CS1830 FROM TRIO

NRP 5 for receiving the discerning few.

Also
CS1577A Dual 300mHz 20m Signal Delay etc.
£410 + VAT

LOWE ELECTRONICS Ltd.
CHESTERFIELD ROAD, MATLOCK, DERBYSHIRE DE4 5LE
TEL. 0629 2430/2817

WWW - 64 FOR FURTHER DETAILS

WIRELESS WORLD APRIL 1981

ORDER BY POST OR TELEPHONE WITH BARCODE/Credit/Cash
ELECTRONIC TEST EQUIPMENT SPECIALISTS
ALL PRICES INCLUDE VAT

A range of Scopes in stock from 5mHz Single Trace to 50mHz Dualtrace. Maine and Battery/Maine portables.
Many on demonstration.

SCOPES

SINGLE TRACE £295.00 inc. VAT
£220.00 inc. VAT
£155.00 inc. VAT
£105.00 inc. VAT

DUAL TRACE

£295.00 inc. VAT
£220.00 inc. VAT
£155.00 inc. VAT
£105.00 inc. VAT

OPTIONAL PROBES (ALL MODELS)

£65.00 inc. VAT
£45.00 inc. VAT
£35.00 inc. VAT

GENERATORS

HF £948.75 inc. VAT
£518.00 inc. VAT
£320.00 inc. VAT
£200.00 inc. VAT

PULSE

£105.00 inc. VAT
£75.00 inc. VAT
£50.00 inc. VAT

DC £948.75 inc. VAT
£518.00 inc. VAT
£320.00 inc. VAT
£200.00 inc. VAT

LOGIC PROBES/ MONITORS

£55.00 inc. VAT
£35.00 inc. VAT
£25.00 inc. VAT

FREQUENCY COUNTERS

Handheld £484.75 inc. VAT
£284.00 inc. VAT
£178.00 inc. VAT
£115.00 inc. VAT

CHOOSE FROM UK'S LARGEST SELECTION
TV TEST GENERATORS

£177.00 inc. VAT

FREE CATALOGUE!

Send Stamp, SAT (60p), overseas send 10p, to:

Earthstar Sales, 4 Mappin Road, Southall, Middlesex, W4 6PP

WWW - 100 FOR FURTHER DETAILS

HR. 20 10 mm rectangular PDA with internal gratuice
Y Bandwidth:
DC - 30MHz
Sensitivity:
5mv/Div (20MHz)
2mv/Div (20MHz)
Input RC:
1M/230p
Resolution:
17ns
Beam Switch:
Chop/alternate
Monitor:
CH1, CH2, Dual, Add, Subtract
Time Base:
Triggered, auto, or single shot
Sweep Time:
0.5 to 20msec/div DC 15 stages in 1-2-5 sequence
Sweep Delay:
100nsec to 15us adjustable with trace bright out for delay location
Z Modulation:
77% compatible 10k impedance 5MHz bandwidth
Trace Rotation:
Technical
And the Price?
£455 + VAT (includes 2 probes)

NRP 5 SYNTHESISED HF MONITORING RECEIVER

NRP 5 MULTICHANNEL MEMORY UNIT

NVR 5 LOUDSPEAKER UNIT

CFL 260 600Hz CW FILTER

The NRP 5 is a PLL synthesised communications receiver of the highest class featuring advanced radio technology combined with the latest digital techniques. The new NRP 5 is full of performance advantages including general coverage, all modes of operation, PLL digital VFO for digital tuning, 24-channel frequency memory (option), direct mixing pass-band tuning, etc. JRC - 65 years of radio communications experience will put the world at your fingertips. The NRP 51 is a single item from the JRC product range which extends all the way to full marine radio installations for supercarriers.

LOWE ELECTRONICS Ltd.
CHESTERFIELD ROAD, MATLOCK, DERBYSHIRE DE4 5LE
TEL. 0629 2430/2817

WWW - 64 FOR FURTHER DETAILS

WIRELESS WORLD APRIL 1981
PM COMPONENTS LTD. VALVE & COMPONENTS SPECIALISTS
CONINGSBY HOUSE, WROTHAM ROAD, MEOPHAM, KENT. TEL. 0473 813325

NEW BRANDED VALVES

VIDEO TAPES

LOW PASS FILTERS

Now from 10kHz to 20MHz

TOKYO's recently expanded LPF series covers from the audio spectrum through to 20MHz in a series of LPFs for r.p.s., video, radio etc.

CERAMIC RESONATORS & PIEZO SOUNDELS

Audio buzzes now down to 1kHz - low cost 400-500kHz crystal replacements for MPUs, RISC etc. Low cost - wide range.

VIDEO FRAME STORES

• 525/625 operation
• 512 pixel/line
• 512 pixel/line control
• Top/bottom & L/R reverse
• Models available with digitized I/O

Chokes, block filters, ceramic filters, resonators, IFs, oscillator coils, audio filter blocks etc.

The LPFs are based on 76/10mm formats with up to 4 LC tuned elements per block. Many stock types available.

PHONES & RECEIVERS, WINDERS & RESISTORS

HARMONIC FILTERS

WIRE WOUND RESISTORS

DURA-CELL SATTERIES

4 & 3 elements available

Featuring low insertion losses - 40dB at the +/- 21MHz points. Ask for details.

Video frame stores are a new addition to TOKYO's memory product range. They permit easy analysis of low dose X-ray pictures, digital processing of picture information (including the VPHIDO with 8" disk drive) with much better resolution than available from VTR.
CARSTON ELECTRONICS

Quality Assured BLUE CHIP Value

As New Ex Stock delivery

These instruments offer

ONE YEAR FULL GUARANTEE

Bigger stock investment greater equipment range means wider choice

WIRELESS WORLD APRIL 1981

ALL PRICES LISTED ARE EXCLUSIVE OF VAT (Standard Rate)

Price

WIRELESS WORLD APRIL 1981

Temperature Measuring Equipment

INFRARED THERMOCOUPLES NOT INC.

COMARK

70-100°C - ±0.1°C at 10°C

100-130°C - ±0.2°C at 10°C

130-150°C - ±0.3°C at 10°C

150-180°C - ±0.4°C at 10°C

180-210°C - ±0.4°C at 10°C

210-240°C - ±0.5°C at 10°C

240-270°C - ±0.6°C at 10°C

270-300°C - ±0.7°C at 10°C

300°C - ±0.8°C at 10°C

VOLTOMETERS ANALOGUE

AVO

5 MV AC/DC

BOONTON

2 pF/1 pF

FIDELITY

1000 Hz/220 Hz 1.0 mV /10 mV

FIDELITY

2000 Hz/220 Hz 1.0 mV /10 mV

HEWLETT PACKARD

50 kHz/1 kHz 10 mV /100 mV

HEWLETT PACKARD

50 kHz/1 kHz 100 mV /1 V

HEWLETT PACKARD

1 MHz/100 kHz 10 V /100 V

HEWLETT PACKARD

500 kHz/1 MHz 100 V /1 kV

HEWLETT PACKARD

400 kHz/1 MHz 1 kV /10 kV

TEKTRONIX

40 MHz/20 MHz 100 mV /1 V

TEKTRONIX

100 MHz/10 MHz 1 V /10 V

TEKTRONIX

1 GHz/250 MHz 10 V /100 V

TEKTRONIX

500 MHz/100 MHz 100 V /1 kV

TEKTRONIX

50 MHz/10 MHz 1 kV /10 kV

TEKTRONIX

10 MHz/1 MHz 10 kV /100 kV

TEKTRONIX

1 MHz/100 kHz 100 kV /1 MV

TEKTRONIX

100 kHz/10 kHz 1 MV /10 MV

PHILIPS

10 pF/100 pF 10 mV /100 mV

PHILIPS

1 nF/100 nF 100 mV /1 V

PHILIPS

10 uF/1 kF 1 V /10 V

PHILIPS

100 uF/100 uF 10 V /100 V

PHILIPS

500 uF/1000 uF 100 V /1 kV

PHILIPS

5000 uF/5000 uF 1 kV /10 kV

BRYANS SOUTHERN

FM/AM

DYMAR

FM/AM

BROADCAST GENERAL

FM/AM

GOLDEN AUDIO

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKARD

FM/AM

HEWLETT PACKAR}
320 pages worth of the latest & best in signal processing components.

Write to Pascal for this new MRR catalogue which covers the complete Merrimac range of signal processing components and integrated networks from DC to 4GHz. It also provides reliability data in the form of MTBF calculations for each product range. Merrimac is one of the World's most technically advanced companies specializing in low frequency lumped element components and integrated networks, microwave sub-system components, subsystems, high power ferrite isolators and circulators. So write to Pascal today for your copy of the MRR on your company's note paper (or phone if you prefer) indicating your area of interest - we guarantee you'll find it one of the best.

Def Shon 05-31/ 890000/DCC approved

Pascal Electronics Limited
Newick House, Green Street
Sunbury-on-Thames
Middlesex TW15 5JG
Telephone: 03337/57111 Telex: 881436

How to get your hands on a signal success.

Quartz Crystals

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

This technology is available now from

Merrimac

Now there is one in signal processing

Pascal

the best in electronics

Wallradio

VALRADIO LIMITED BROWSELLS LANE FELTHAM MIDDLSEES TW13 7EN Telephone: 01-895 2572/2573

320 pages worth of the latest & best in signal processing components.
The AVO RM290 is a bench type megohmmeter with a resistance range that goes up to 10\(^{14}\) Ohms, making it ideal for those applications where there is a need to measure the electrical resistance of non-conducting materials accurately.

You can use the RM290 for tests on isolating components in electronic assemblies or on capacitor dielectrics. Resistance measurements can be made at test voltages of 100, 250, 500 or 1000 V. Readout from the single resistance scale on the meter is direct, irrespective of the test voltage selected.

You'll find the AVO RM290 a great asset. Get in touch with us today and we'll let you have the full facts.

---

**You'll never meet a better meter**

WW - 065 FOR FURTHER DETAILS

---

**CB RADIO ACCESSORIES**

**The Largest Distributors of CB Accessories in the U.K.**

Come and see the largest and best selection of CB Radio Accessories from all the leading manufacturers, including:

- **K40**
- **TELE**
- **TELE**
- **SIRTEL**
- **TURNER**
- **CB NATION**
- **MURA**
- **Mura Corporation-Sa**

Mura Electronics (UK) Ltd., 78 Church Rd, Hendon, London NW4 Tel: 01 203 5277

---

**AMCRON**

**Industrial Muscle**

Model — M600

- **POWER RESPONSE DC — 20kHz ± 1dB**
- **OUTPUT POWER IN EXCESS OF 1.6W INTO 2.75 Ohm LOAD (CONTINUOUS R.M.S.).**
- **D.C. OUTPUT 20 AMPS AT 100 VOLTS OR 2Kv.**
- **HARMONIC DISTORTION LESS THAN 0.05% DC-20kHz AT 1.6W 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.**

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

Kirkham Electronics

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

WW - 099 FOR FURTHER DETAILS
When SAFE ELECTRICAL INSTALLATIONS are your concern

We are pleased to offer the following electrical installation services:

- Installation of new electrical systems
- Repair and maintenance of existing systems
- Compliance with all local and national standards

Measures such as installing new circuits, replacing old wiring, and upgrading electrical panels are included. Our experienced electricians will ensure your installation is up to code and safe for use.

We also provide ongoing support to ensure your electrical system remains in optimal condition.

For more information or to schedule an installation, please contact us at (123) 456-7890.
A PROFESSIONAL TOOLCASE FOR UNDER £40

Designed for the professional Electronics, TV and Instrument Technician who needs to carry a large number of specialist tools.

The TL95 sets a standard as a low cost alternative to more expensive cases.

A PROFESSIONAL

THE TL99 sets a standard as a low cost alternative to more expensive cases.

Dimensions TL 95 17" x 12" x 6" split (shown) also available TL100 19" x 14" x 8" split

Tools NOT included. British made.
Money back guarantee. Allow 7-21 days for delivery.

ORDER FORM

Name
Mr...
Address
...
Telephone...

QTY REQUIRED

£

A ELECTRICAL TOOLS LTD

Post:...........

Figures

3 sided Reusable Multi-purpose tool pocket

Document area

50° opening lock back stays

Deep AISI lid and base

Twins handles with 6 fixing points on aluminium frames

Burst proof toggle locks with keys

Moulded adjustable tray in base

Heat sink for hot soldering iron

Global Specialties Corporation, Dept 75
Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex, England.

Medium return date.

Phone your order with Access, Bericard or American Express Card No...

Sound Investment

Replacement tape heads from Monolith could mean a big improvement in sound quality from your tape recorder. A full catalogue is available, price £6, which features a wide range of heads for cassette and reel to reel machines, as well as replacement motors, tape transports, etc.

Universal cassette heads to EIA standard, hole centres 17mm apart, 12mm from head face:

B12-02 Mome record/playback £6.42
B24-01 Stereo playback £6.42
B24-02 Stereo £7.96
B24-07 Stereo/sp fourth Density

A complete range of tape heads for chrome & metal faces.

C29PH4M Stereo/cap/glass fibre, the ultimate long life, high performance head £10.87

C24PP519 Stereo twin cap rip long life head for record monitoring £12.98

C243/Bl Mome/Unidirectional £3.13

Accurate, reliable, and long life.

C24PP514 Four channel track £15.10

C2226/34 Twin Hall track rate £5.40

Send details to:

Send for details to:

AEL LEADING EXPORTER

GLOBAL SPCIALITIES CORPORATION LTD

OATWICK HOUSE

MONOLITH ELECTRONIC PRODUCTS

ARROW, SURREY, ENGLAND

Tel: 0373 5533

Darrick 8111 (G) CABLES AERO G & TELEX HOREY

Permanent address for Monolith products.

COMMUNICATION TUBES — EX STOCK

4-65A 6159 GRO6-05A £1.99
4-125A 608B QRE670 £2.79
4-250A 6146/4/8Q VI86-10 £3.69
4-400A 6124 D40-125 £6.99
4-1000A 6156 D40-250 £7.99
4-2500B 7507 D40-400 £8.99
4-3500A 8042 QRY-3000A £4.59
4-1500A QRO3-10 £17.99
4-15000A QRO3-20A £4.59

R/P POWER TRANSISTORS — EX STOCK

2N3371 2N4102 BLX33 BLX98 £2.99
2N3553 2N4390 BLY34 BLY99 £2.19
2N6352 2N5951 BLY96 BLY91 £2.79
2N1033 2N5411 BLY33A BLY92 £3.99
2N4040 2N6424 BLY55 BLY93 £4.19
2N1047 2N6425 BLY93 £5.19
2N3460 2N6080 BLYB4 BLY14 £4.99
2N2070 2N6081 BLY85 BLY87 £6.99
2N2090 2N6083 £3.99

COMMUNICATION CABLES — EX STOCK

50 pair BNC, 300ohm 3000' £69.99
50 pair BNC, 900ohm 3000' £79.99
60 pair BNC, 300ohm 3000' £79.99
60 pair BNC, 900ohm 3000' £89.99
60 pair BNC, 1500ohm 3000' £89.99

SAVE ON KITTING UP

Products range from £2.13 to £179.99...

Electronic Brokers

61-65 King's Cross Road
London, WC1X 9LH
Tel: 01-278 3461 - Telex 298694 WW 002 FOR FURTHER DETAILS

Extended Range of NEW FLUX
DMM'S FROM FRENCH ELECTRIC BREAKERS

800A 1.4 Digit LCD DMM with true RMS on AC and DC voltage/current, 10µV resolution. DC volts 200mV-19V, AC volts 200mV-79V, low resolution. DC/AC current 200mA-1.85A resolution resistance 200Ω-3000Ω, low resolution. Also reads d.c. volts. Complete with 16 stored impedances, Conductance ranges 2mΩ and 2000-1Ω.

£129.99 mains model £129.99 battery. £249 mains model £139.99 mains battery. £129.99 mains model £249 mains battery.

8012 3.5 Digit LCD DMM Same spec as 8012A plus 10Amp AC/DC current range, but no low resistance range. £189.99 mains model £139.99 mains battery. £229.99 mains model £139.99 mains battery.

8012A 3.5 Digit hand held LCD DMM with peak hold, level detector and continuity tester, DC volts 200mV-19V, 10µV resolution. AC volts 200mV-79V, 10µV resolution. DC/AC current 200mA-2A, 0.1µA resolution. Resistance 200Ω-3000Ω, 0.01Ω resolution. Conductance 2000Ω. Peakhold of AC or DC current. Level detector operates around +0.8V reference. Audio tone on level and continuity £169.99, carrying case £27.99 extra.

8020A 3.5 Digit hand held LCD DMM spec as per 8020A with extra conductance range of 2mΩ but no peak hold, level or continuity ranges. Complete with carrying case £129.99.

8022A 3.5 Digit hand held LCD DMM spec as per 8020A but no conductance ranges and slight reduction in accuracy. £75.00 carrying case £7.99 extra.

Also available a range of accessories including test leads and current shunts, EHT probes, etc. Temperature probe and touch and hold probes. Full details on request. The warranty period on all items shown is 1 year other than the 8020A which is 2 years.
UNBEATABLE PM 5519 FROM PHILIPS, OF COURSE

PM 5519 CTV pattern generator
* Over 20 colour and b/w test patterns carefully selected for maximum versatility
* RF signals available in bands I, II, III, IV and V
* External video and sound modulation facility

PM 5236 RF signal generator
* 100 kHz – 125 MHz in nine overlapping ranges with 5 digit display
* Built-in 5 digit counter displays external frequencies
** Two versions available: 100 MHz (1 kHz resolution) — PM 5236X or
1 MHz (10 Hz resolution) — PM 5236
* 50 mV RF output at 75 Ω can be attenuated to over 100 dB
* Electronically stabilized output level
* Webulator facility for IF amplifiers, AM/FM radio and TV receivers
Reader inquiry number 221

PHILIPS

SIGNAL SUCCESS

PM 3207 dual trace oscilloscope
* Ideal for service and general purpose applications
* 45 MHz/5 mV
* Triggering from either channel or external input
* Auto TV triggering
* Same sensitivity on X and Y channels
* B-invert facility
** Full 8 x 10 cm screen
Reader inquiry number 222

PM 5202 passive analogue multimeter
* Accuracy at a low price
* Comprehensive measuring ranges
* High shock-resistant meter system
* Common linear scale for AC and DC
* Continuity check by sound signal
* 250 V overload protection on all ranges
Reader inquiry number 223

WITH LOW-COST, HIGH-VALUE OSCILLOSCOPE

PM 2505 electronic analogue multimeter
* 62 measuring ranges
* High V and A sensitivity
* 10 MΩ input impedance
* Continuity check by sound signal
* Linear resistance ranges to 30 MΩ
* Automatic polarity indication
* Unique movement for high accuracy and repeatability
Reader inquiry number 223

...AND THREE COUNTERS

PM 6661 80 MHz automatic frequency counter
* One control — ON/OFF
* Automatic triggering, noise suppression and leading zero blanking
* High 20 mV RMS sensitivity
* 8 digit LED display
Reader inquiry number 224

PM 2517 digital multimeter
* Full four digits
* Choice of LED or LCD display
* True RMS AC readings (AC coupled)
* Autoranging with manual override
* Current up to 10 A
* Options include temperature and data hold probes
Reader inquiry number 223

PM 6667 and PM 6668 high resolution counters
* 1 GHz (PM 6668) or 120 MHz (PM 6667)
* Reciprocal technique giving fast high resolution measurements down to 10 Hz
* Auto triggering on all waveforms and duty cycles
* 15 mV RMS sensitivity
* High stability X-tal oscillators: 10-year
* Microprocessor control
Reader inquiry number 225

WIRELESS WORLD APRIL 1981

PHILIPS
Get a great deal from Marshall's

The new Marshall's 80/81 catalogue is now available. A veritable treasure house of components, test gear, tools, etc. Especially interesting to the radio amateur are the following Leader instruments available from stock:

- Antenna Coupler LAC995
- Antenna Coupler LAC996
- TRU IMP Meter LDI 815
- Antenna Impedance Meter LDI 820A 1.8 MHz to 150 MHz
- RF Power Meter LPM 880 0.5 to 120W

SHV watt meter LBM 885 1.06 to 100W

Send a fax or phone Richard Kaiser 0247 3588 for specialist advice.

MORE SPEC. FOR YOUR MONEY

TYPE 747 UNIVERSAL COUNTER TIMER

- DC to 16.5MHz
- 5 DIGITS, 3 CHANNELS

MEASURES -

- FREQUENCY A & B and C
- PERIOD A
- TIME A / A + B
- PULSE WIDTH A & B
- COUNT A

AVERAGE 1 to 1000 events

£175

TYPE 745 COUNTER TIMER

- DC to 300MHz
- 5 DIGITS

MEASURES -

- FREQUENCY PULSE
- PERIOD
- COUNT

£116.30

& 13 carriage, ins. etc.

TYPE 746 AUTORANGING FREQUENCY METER £64.88

10Hz to 599.99Hz

TYPE 615 OFF-AIR STANDARD £97.13

10Hz, 50Hz and 1000Hz

ORDER ELECTRONICS PROVIDE SYNERGY VERT Kent OAS
Tel: Fareham 93221 883567

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

FROM OMR ELECTRONICS

WWW - 06 FOR FURTHER DETAILS
Hyperelliptical tip for audiably greater freedom from distortion

One of the critically acclaimed developments introduced in Shure's incomparable V15 Type IV pickup cartridge is its revolutionary distortion-reducing Hyperelliptical nuts/diamond tip. It established a new standard of sound purity through a dramatic reduction of both harmonic and intermodulation distortion. Now, the Hyperelliptical tip is also available in the world-famous V15 Type III-Super-Track Plus Cartridge, bringing together the sound purity and fine response of the tip at an extremely affordable price. It is truly second only to one other cartridge in the world—the V15 Type IV.

V15 TYPE III-HE
Stereo Dynetic® Pickup Cartridge

Fact:
we've put a NEW plus into the Super-Track Plus family of V15 Type III Cartridges

WIRELESS WORLD APRIL 1981

The artist Pablo Picasso once said: "Age only matters when one is ageing. Now that I have arrived at a great age, I might just as well be twenty." "Wireless World feels much the same. Being the oldest radio journal in the world and having reached this month the Biblical age of three score years and ten, we can justify consider ourselves — in terms of electronics journalism — to have arrived at a great age. And we might just as well be twenty because it is in the nature of a periodical publication to renew itself with each issue. It doesn't matter whether one has produced 1,500 or only 15 previous issues, the next edition is always a completely new book — a new product belonging uniquely to its own moment in history and reflecting its own world at that moment. We did our reminding about the past on our 50th and 60th birthdays. Now, already 15 years into the era of the integrated circuit, we are as curious about the future and what it holds for us as any young person just starting to look at electronics as a possible career.

If we survive the next 70 years, what could we be looking back on in 2051 AD? Here a little humility is called for. If the periodic table (and not necessarily on paper) it may well be a very different animal from what it is now. Electronics may no longer exist as a definable area of technology and industry. Just as radio spawned electronics, which then proceeded to absorb its parents, the same thing may happen again — several times over. On this principle one might look at other branches of science and technology with which electronics is already conjoint and speculate if they are capable of such absorption. Optics, perhaps, chemistry, biology.... Or one might even consider the complete fragmentation of electronics into a variety of other technologies and interdisciplinary activities, some of which don't yet exist.

Extrapolation from present trends does take us a little way — greater complexity and higher performance in electronic products, more devices on a silicon chip, changes in microprocessor architecture and so on. This is the gadgeteering approach which envisages a world increasingly full of clever robots, wrist-watch radios, flat TV screens and information centres in the home. But it doesn't allow for the possibility that a completely new, seminal device will be invented that will transform the technology — just as the valve transformed radio communication and the transistor opened the way to integrated circuits. Several laboratories are now exploring the possible use of biological structures as transducers and energy converters. Could this lead perhaps to a stochastic, rather than deterministic, principle of information processing and transmission, analogous to that in the animal central nervous system?

But it is unrealistic to consider a technology in isolation from the society which produces it. You can say with truth that scientists and engineers discover and invent things which change our lives. These individuals, however, are part of society and subject to its pressures. You can say with equal truth that the technology we have is a symptom of the kind of society we are: it develops in particular directions in response to our material, emotional and spiritual needs. Broadcasting, hi-fi and other electronic diversions are technological responses to the needs of the "nuclear family" for entertainment and even "company" in homes that are becoming socially isolated from communities. As in the past, technology will continue to be both cause and effect.
The conventional automotive contact breaker is still widely used in modern petrol engines despite its shortcomings. Superior alternatives have been available for several years, but car manufacturers have been slow to remove the weak link in the ignition system. This design is simple, cheap, reasonably easy to install, and provides a maintenance free unit which will drive almost all electronic ignition systems which operate with mechanical contacts.

Although many electronic ignition units are available, and several well designed constructional circuits have appeared, most of them are triggered by the existing contacts and use either inductive or capacitive discharge to improve spark and extend contact life. Some designs claim to eliminate the effect of contact bounce, but the effects of contact heel wear and timing scatter still remain.

The circuit in Fig. 1 provides an output which, for low currents, simulates the contact breaker and can trigger an electronic ignition unit without modification. The existing centrifugal and vacuum advance mechanisms are retained, and the only mechanical part which must be constructed with any precision is a chopper disc. The light source is an infra-red i.e.d. with a lens to give a well defined beam, which is received by a spectrally and physically matched phototransistor. Light passing between the two devices is interrupted by a chopper disc which produces a roughly square wave. This waveform is cleaned up before it is used for timing because electronic ignition circuits generally require a sharp edge to trigger an s.c.r. A conventional two transistor Schmidt-trigger was not used because the regenerative action only occurs if the input has a low source impedance and, in this design, the phototransistor is a current source. Instead, an open collector i.e.d.i.e. with two gates connected as a set - reset bistable is used. The inputs are driven in a complementary mode by using a third gate as an inverter, and the remaining gate is used as a buffer. The regenerative action of this circuit gives fast switching, and a conservatively rated series regulator provides reliable operation.

The complete circuit can be built on a glassfibre p.c.b. and mounted inside the distributor as shown in Fig. 2. The prototype Tr, was mounted underneath the board.

Why replace the contact breaker?

A conventional contact breaker consists of a cam, rotated by the engine, which opens and closes a moving contact held in place by a stiff spring. As the contacts are forced open by the cam and closed by the spring, the cam has an alternating torque acting upon it. The cam is turned about the main shaft by centrifugally operated weights which reach equilibrium with restoring springs to give different spark advance angles for different speeds. Therefore, there are two main compliance systems which cause a wide distribution of timing. This problem is made worse by manufacturing tolerances in the cam and general wear in the contact breaker. Although a new distributor with correctly adjusted contacts operates fairly well, this peak performance rarely lasts for more than 2000 miles, and most petrol engines spend a significant proportion of their working life with a sub-standard ignition system.

The two most common replacements for the contact breaker are a magnetic pickup, where a lobed rotor divides the flux through a coil, and an optical system, where a light beam is interrupted by a chopper disc. The magnetic system is attractive to a mass producer because magnetic components and coils are familiar, but the optical system is more attractive for conversion of an existing unit because fewer mechanical parts are required.

Both types use the existing centrifugal and vacuum advance systems and, in the amount of energy extracted from the shaft is small in either case, the nominal excitation of the advance mechanism is negligible. Both systems do, however, exhibit a slight hysteresis between acceleration and deceleration as the rotor advances to take up any backlash when the engine slows. This is a small penalty and normally of little consequence.
of the rotor arm is directly opposite a segment inside the distributor cap, with the vacuum advance at mid-travel-its condition is not achieved the engine may not run. Another important requirement is that the chopper blades are evenly spaced to avoid scatter. The angle between the blades is found by dividing 360° by the number of cylinders. Although this unit is suitable for any number of cylinders, the greatest improvement will be noticed on engines with six cylinders and above, where multi-lobed cams cause more scatter.

The disc does not need great strength, and the prototype was made of perspex. The centre hole has tabs which are alternately bent up and down to grip the cam as shown in Fig. 5. To construct the disc make a centre punch mark and scribe a straight line through it. Using a large transparent circular protractor with 0 and 180° marks on the line, mark the position of the blades and scribe lines to the centre. If an inductive discharge system is used, the angle between the chopper blades becomes the dwell angle, the angle through which the points remain closed, and must be the same for all cylinders. With a conventional contact breaker the dwell angle has to be short so that the points open a reasonable distance. Unfortunately, a short dwell angle limits the time available for primary current build-up at high revolutions. With this design, the dwell angle can be increased from the manufacturers specification to increase spark energy at high revolutions. If the unit is used with a c.d. ignition system, the angle between the blades is not important because the spark is controlled only by the leading edges of the chopper blades.

Cutting the disc shape is made easier if the template is clamped to a thin sheet of aluminium or plywood. After drilling the centre hole and fitting it to shape, cut the disc to the correct diameter, cut the blades to shape and finish with a fine file. Finally, bend the tabs for a good contact fit on the cam. The disc is then fixed to the cam with epoxy resin after checking that all the parameters are correct and that the disc revolves freely. When installation is complete, the disc can be tightened in the engine and adjusted for correct timing with a strobe light.

Although this unit will not produce a dramatic increase in performance from a correctly tuned engine, the firing at high revolutions should be smoother and tick-over should be very steady even when cold, which permits sparing use of the choke. However, the main benefit is a maintenance free ignition system. The prototype has now been in use for five years and the distributor cap is only removed to show dielectors.

**BOOKS**


Only a limited knowledge of electronics is assumed here. The author’s intention is to explain the basic digital technique to those who have no training in electronics, but who may have accumulated information on the active and passive components used in and around integrated circuits. He deals briefly with digital elements from switching devices, through small-scale systems such as counters, to microprocessors, through the chopper on micros, which occupies only fifteen pages, is rather too cursory to be of much practical value.

A complete beginner may find the lack of information on application a little worrying: elements are well described, but with little explanation of what their role in a system might be. A microprocessor, for example, is presented as a device whose program is capable of carrying out the action of a truth table as an alternative to a set of gates and registers, with no explanation of the advantages gained thereby.


This is not a technical approach to Prestel, but an explanation, primarily for business people, of what a videodisc system is, how information is provided and used, some costing and some of the background. This would be a good introduction to the service for those who know little more than the name and who suspect that it could be assistance to work. There is no technical description wherever.
the very lowest end of the range, they can generate considerable distortion.

I therefore set about making the necessary modifications to the active filter circuit, given as Fig. 6 in the December 1977 article, page 444 or, December 1977, page 575. The basis for the modified arrangement is the on-axis response (sine-wave input) published on page 157 of the 1979 Hi-Fi Choice, repeated here for reference as Fig. 1.

The part of the audio band of particular interest is that below 80 Hz and above 850 Hz. This range of frequencies can be divided into two regions: 10 Hz and 170-850 Hz. Considering the lower region first, the Quad electrostatic speaker response curve here shows a fall in output which has an average slope of about 7dB per octave. It has been suggested that the optimum rate of change of loudspeaker response in a crossover region is 18 to 20 dB/octave. I therefore decided that a different rate of change of about 15 dB/octave would be required so that, over this part of the band, the combined effect of filter and speaker responses would be a fall-off rate on the high side of optimum, because if energy below 10kHz produces second and third harmonic distortion in a Quad electrostatic speaker.

The power part of the response curve section being considered, from 170 Hz up to 850 Hz in Fig. 1, shows a slope in the same sense as before but at a more gentle rate of about 2 dB/octave. This slope does not contribute usefully to the desired effect as in the previous instance and has to be compensated by an opposing active filter characteristic to maintain the loudspeaker output reasonably constant down to the cross-over point of 170 Hz.

These two considerations suggest the general form of the required filter response curve. In addition, I decided to move the stereo/system change-over point further down the band, to 100 Hz instead of 160 Hz in the original system, which has two Kef B110 cone units for the mid-range with a single 139B bass speaker. The reason for the change is that in larger living rooms having floor dimensions in excess of six metres square the stereo effect is extended to lower frequencies. As the electrostatic speakers not only give good output to this lower point in the band but have a response shape which helps in the crossover arrangement, it seemed reasonable to make the change.

The filter response achieved to satisfy the three requirements detailed above is the full-line curve in Fig. 2. This shows the variation of voltage with frequency of the output labelled m.f. amp in the filter circuit diagram of Fig. 3. This output provides the feed for one Quad electrostatic speaker: an identical circuit serves the other channel. The mono bass speaker — a KEF 139B is suggested but any comparable unit with suitable power-handling capacity would do — is fed via a power amplifier from the channel combining and filter circuit drawn at the bottom of Fig. 3. The response of the output from this circuit is shown as the broken curve in Fig. 2 which is virtually flat or has a high-pass filter curve at the new mono/stereo change-over point of 100 Hz.

The active filter itself is a cut-down and modified version of the circuit as originally published in the 1974 article and needs little further description. Op-amp ICn provides the high-pass output with the bridged-T section between Tr3 and Tr4, giving the 200V/octave compensating tip-up between 1kHz and 1000Hz (with slope controlled by the choice of value for R5). Op-amp IC2 provides a missing point and a suitable low-pass response for feeding the common bass unit.

For people with the room space and the pocket money to suit, an improvement in their arrangement could be obtained by having four such units stacked in pairs. Frames specially designed for this purpose are now available! The resulting increased radiation "frontage" and power-handling capability should gladden the ears of any enthusiast. But you might need to make peace with the neighbours first!

At the other end of the scale, with cost an important factor, the Quad units could be replaced, using the original 0.33 cuf. ft boxes plus the original B10h with a pair of Japhson K108 tweeters, instead of T27s. For those interested in such a variation in the arrangement, the circuit of Fig. 4 gives the alternative components values (bracketed) which would produce a slightly different filter response curve, as shown in Fig. 5, suitable for feeding the line units. The applied volt curve for the KR108 and centre point to the B110 was adjusted to obtain the flat overall response similar to the curve the 1974 article.

Listening to the various systems with pink noise (i.e. constant energy per octave) and sweeping through the audio spectrum I have become aware that room acoustics significantly colours the results. Having used an anechoic chamber during the speaker development period, I realised that a wedge shape filled with sound absorbent material would be available to use by

![Fig. 4. Further modification of 1974 design for 0.33 cu. ft boxes and Japhson tweeters. For the 1 cu. ft boxes housing B110 and Japhson units, short R2, the battery, CR1, and capacitors should be inserted between Tr1 emitter and the 20K potentiometer.](image)

![Fig. 5. Applies voltage curve for 0.33 cu. ft box and Japhson tweeters. Broken line shows response with low-pass filter only.](image)
**Microcomputers in space**

British Aerospace, Space and Communications Division is developing a spacecraft microcomputer module and an integrated circuit standard unit suitable for general application in satellite systems. In addition to the hardware, the Division is also developing a number of software programs which includes all the basic executive routines needed to control the SMM system.

Each SMM is a totally self-contained microcomputer module. One of the desirable aspects of such a design is that it is the only 16-bit microprocessor wholly designed, developed and manufactured within Europe. Throughout the study, liaison was maintained with the European Space Agency (ESA) to ensure the technical solutions proposed were compatible with data handling requirements for systems specified by ESA.

Before the study began, British Aerospace Dynamics Group had already acquired considerable knowledge of the factors likely to influence spacecraft operations in space as a result of previous privately-funded technical evaluations. The Group is continuing to investigate the current research and development work, the cost of which is being shared by the Department of Industry as part of its European Technology Programme.

The Space and Communications Division will be incorporating SMMs in the next generation of satellite systems they build and have begun evaluating the equipment with its supporting components to qualify it for use in the space environment. In addition to space, it is envisaged that SMMs will be mastered uniquely for a wide variety of data handling applications.

---

**China standardizes in Industry**

From a previous policy of self-sufficiency, China has embarked on a comprehensive programme of modernisation including a number of product standards and a building and civil engineering code. Details are included in a report, 'Engineering to Chaos', prepared by the Standards Association of New Zealand and available from the British Standards Institute's Technical Help to Exporters service.

Chinese standards are divided into three grades — national, ministerial and enterprise — and the policy for each grade is explained. Details are given of the types of products covered by the mandatory National Standards. There are two Chinese standards covering laboratory requirements for shipped goods and the labels are clearly illustrated. The report includes full addresses of all relevant organisations, corporations and embassies.

As it is underlined that such trade is not economically feasible, Hsinchow has announced the signing of a contract for the establishment of a joint venture company with a French company, China for the production of television sets. Instead of taking sales and for export, the company expects to be producing 200,000 colour and 180,000 black-and-white sets per year.

---

**Computer in case**

Intended for the 'globe testing' reporter, salesmen, engineers, programmers, etc., model 8400 computers are fitted into a briefcase design.

Produced by Microdata Computers Ltd, in Hayes, Middlesex, the computer incorporates many features to make it not only one of the world's smallest of its type, but also of practical use; it can be connected to a wide range of power supplier's voltages and frequencies and so may be used almost anywhere in the world; it incorporates a real time clock which can display GMT and local time; it is microprocessor driven and incorporates no printed circuit board. A full ASCII keyboard, a fold-away dot matrix gas screen and a barcode reader are features; there is full text processing capability and the magnetic bubble memory does not lose data when the power is removed.

This cross-section illustrates the basic principle of IS-CMOS.

Isolated oxide CMOS, or IS-CMOS, can be used to produce integrated circuit devices of higher speed, lower power consumption, lower propagation delays, higher densities and lower cost per function, according to the new GEC company, Marconi Electronic Devices Ltd which has been set up to combine IS-CMOS with the established GEC microcomputer-aided integrated circuit design service, the combined service will also handle the addition of bigger and better computers and improvements in software.

The system will now be able to take a logic design, feed it into the computer which is fed to the microcomputer-aided system which can compute the output response to any given input waveform. It can then select the appropriate gate function and place them automatically in relation to each other to produce an optimised layout. The interconnection techniques can also be laid automatically. The layout is then analysed for circuit performance and checked for the effects of possible transistors. It is also checked against the design rule book.

All this has taken place within seconds of entering the original design into the computer. Two designers are producing one of the proposed layouts with wet diamonds. The other is a diagram of the chip in logic diagram form, allowing the customer to check it against his original specifications before the final layout circuit can be made to correct any error or to Keyboard research

It has long been known that the 'query' keyboard is not the most efficient way of arranging the letters. In fact it was originally designed to slow down the typewriting system and the mechanical systems of early typewriters could cope with the parallel keyboard. When the European Commission is investigating tenders for a universal keyboard layout suitable for the many languages used in Europe, the keyboard layout will be used in the Commission. Other European Economic and Social Committee organisations who need to deal with many languages will obviously have an interest in the design of keyboard layout or just a tidy-up exercise of the comparatively minor differences in the various national keyboards remain to be seen.

---

**Centre to study effects of technology on society**

The interaction of electronic systems such as computers and data processing equipment with society at large may well be one of the subjects to be studied in a new research centre now being set up in the UK. Called the Technical Change Centre, it is mainly concerned with the relationship of technology to economic well-being in the UK: it will develop a major project on the changing social and economic structures of a world-wide technological society. The Centre will seek to identify the trends, the economic and social effects and the economic and social linkages between technological changes and the effect of such changes on the world economy.

---

**Gallium arsenide invades Silicon Valley**

Harris Corporation is moving ahead on its first semiconductor operation in San Francisco's famed 'Silicon Valley' area by approving construction of a $4 million facility in Milpitas, near San Jose.

The company is moving the investment on behalf of its 80-per-cent-owned new company, Harris Microwave Semiconductor, Inc. The firm was established last June by Harris as a local semiconductor executive, specializing in the area of gallium arsenide technology.

Gallium arsenide is a compound of two elements, gallium and arsenic. As a base material for integrated circuits, it offers significant advantages over silicon applications in terms of very fast speed, high frequencies and extremely high power dissipation. It can be used to produce gallium arsenide transistors, microcircuit packages and IC. Harris is planning to support their communications and information handling equipment now under development.
Clive Sinclair of Sinclair Research Ltd. has recently announced the successful development of a flat television tube that could be incorporated into a miniature t.v. set. The set will include v.h.f. d.m.r. and radio and may be switched to mobile communication, making it a universal set.

The Sinclair tube measures about 2 x 2 x 4 x 4 in. and is three times brighter, exceeds between one quarter and a tenth of the power and is half the volume of the conventional c.r.t. with the same screen size. It is assembled from just two sheets of glass, a film, a phosphor and a metal formed backing plate. The phosphor screen is coated on the front of the backing plate and is viewed through the front face from the same side that the electrons strike. This gives a brightness of more than double that of a conventional c.r.t. with the same size screen. In addition to the horizontal and vertical deflection plates there is a third between the phosphor screen and the front face to focus the electron beam on to the screen.

The tube has been produced in Sinclair's pilot production plant at St. Ives, Cornwall and it has just been announced that a full production plant will be commissioned in December by the Times Corporation. Times were awarded the contract by Sinclair because of their expertise in automobile production. The deflection plates are at the end of the first phase the capacity will exist to produce the tubes at the rate of a million a year.

The Microvision t.v. set which will incorporate the tube is also to be produced by Times and should be on the market by mid-1982. Although the exterior design of the set has not been finalized, some design tests and have been produced to show that the set will be about 6 x 4 x 1 in. or about the size of a paperback book.

Further developments for the tube depend on the quality of the tube to be achieved. It leads this to suitability for use in projection systems. A monitor for the Sinclair personal computer is light on the application list, as a colour projection t.v. which would incorporate three tubes of the and the associated electronics in a projector of the size of a shoe box to produce a picture on a wall screen with a 50 M. diagonal.

Mr. Harrison believes that rationalisation will be beneficial to the British electronics industry. Although there are many opinions, much speculation, but few certain findings of exactly how do drivers their care.

When laid on the road the indicator looks like the rubber tubing used to count passing vehicles. Two tubes are laid parallel to one another across the carriageway and six feet apart. Between them is another set of tubes arranged like an arrowhead pointing in the same direction as the traffic flow. Each tube has a transmitter which converts the pressure of vehicle passing over them into an electronic signal to a micro-computer by the roadside. The micro converts the signals into the speed of the vehicle and its alignment on the road.

The equipment is compact and easy to use. It can be carried round in the smallest of cases. The Speed and Alignment Indicator is a prototype only at the moment, but it can be made and marketed. Mr. Harrison said: "We are right in the right on the right work so far. So far we have been shown to do something about one resource and getting together. We are going to face in the 'eighties the sights of Japan and America and these two countries are determined to dominate the world. They spend huge sums on research and development and the like of which we cannot imagine. The competition is going to be intense and it cannot be avoided." Referring to the rationalisation that had already taken place "I don't agree with Evans on that," he said, in reply to a question at a press lunch. "It's a good idea to scrap it, once and for all. But don't let us all be more efficient." Companies in the U.K. are perfectly prepared to bring it back together.

One exception, however, is Frank Chorley, "I don't want to agree with Evans on that," he said, in reply to a question at a press lunch. "I don't think it will be the best thing in the world. But don't let us lose sight of the fact that the balance of power is going to change. It's a good idea to scrap it, once and for all. But don't let us all be more efficient." Companies in the U.K. are perfectly prepared to bring it back together.

Mr. Harrison believes that rationalisation will be beneficial to the British electronics industry. Although there are many opinions, much speculation, but few certain findings of exactly how do drivers their care.

Fourth TV channel signal monitoring

The quality of the transmitted signal of the new fourth channel system is due to take over from the autumn of 1982 (News, January issue) will be monitored by automatic equipment. Information will be provided for the complete network of main stations. Each of these is under the supervision of a station controller which in turn is linked back to a computer at a regional operational centre. The automatic monitoring equipment, based on a Marconi Instruments

Electronics Laboratories, University of Kent at Canterbury, Dalsey from Fourth World, 24 Green Street, London NW1 (tel: 10-286 456).

More news from Sinclair

To be launched at the Microsystems '81 exhibition is a new Sinclair personal computer. It will incorporate a new, British-built microchip, have a 'sufficiently higher specification' than the successful 8 bit model and sold at a "substantially reduced price". Details are also expected to be announced of a low cost printer and supporting software libraries.

Dr. K. L. Smith of the Department of Electronics at the University of Manchester said: "We are too much in Defence."

Electronics bosses disagree on industry's priorities

Opposing views on the future of the British electronics industry were expressed recently by two of its prominent figures, Mr. Ernest Herrin, chairman and chief executive of Racal, and Mr. J. B. Chorley, chairman and managing director of Plessey Electronics Systems. Mr. Herrin believes that rationalisation will be beneficial to the British electronics industry. Although there are many opinions, much speculation, but few certain findings of exactly how do drivers their care.

Mr. Herrin believes that rationalisation will be beneficial to the British electronics industry. Although there are many opinions, much speculation, but few certain findings of exactly how do drivers their care.

Although, under the policies of the present Government (News, November issue) of providing telephones and other attach-ments to telephone lines, it is very much concerned that there will not be a free-for-all. At present the only equipment permitted is that certified by British Telecom as suitable for use as an attachment. This ensures that the equipment is technically compatible with the British network; it presents a minimal risk of injuring the system and is free of interference with other customers' use of the network. However, the operator is not continuously connected, to help diagnose failures. Even when British Telecom lose the monopoly, they will still be the sole supplier of the first telephone equipment to exchange the line entering a person's house, office, under new arrangements proposed by the Government. Certification of the suitability of attachments will continue but will no longer be carried out by British Telecom but by an independent body which would establish and publish standards for privately supplied attachments and test and certify the attachments conform to the standards. British Telecom warns that most telephone equipment now on sale in shops and mail order stores is not specially designed or modified for use on the British network, despite various claims that it is "meets British Post Office standards." It is merely made and designed for use abroad. If connected to the British network, it may not work properly. Phones designed for overseas use may satisfy the equipment's technical requirements, but that is not enough. British Telecom can then be the first supplier of the first telephone equipment to exchange the line entering a person's house, under new arrangements proposed by the Government. Certification of the suitability of attachments will continue but will no longer be carried out by British Telecom but by an independent body which would establish and publish standards for privately supplied attachments and test and certify the attachments conform to the standards. British Telecom warns that most telephone equipment now on sale in shops and mail order stores is not specially designed or modified for use on the British network, despite various claims that it is "meets British Post Office standards." It is merely made and designed for use abroad. If connected to the British network, it may not work properly. Phones designed for overseas use may satisfy the equipment's technical requirements, but that is not enough.

Although, under the policies of the present Government (News, November issue) of providing telephones and other attach-ments to telephone lines, it is very much concerned that there will not be a free-for-all. At present the only equipment permitted is that certified by British Telecom as suitable for use as an attachment. This ensures that the equipment is technically compatible with the British network; it presents a minimal risk of injuring the system and is free of interference with other customers' use of the network. However, the operator is not continuously connected, to help diagnose failures. Even when British Telecom lose the monopoly, they will still be the sole supplier of the first telephone equipment to exchange the line entering a person's house, office, under new arrangements proposed by the Government. Certification of the suitability of attachments will continue but will no longer be carried out by British Telecom but by an independent body which would establish and publish standards for privately supplied attachments and test and certify the attachments conform to the standards. British Telecom warns that most telephone equipment now on sale in shops and mail order stores is not specially designed or modified for use on the British network, despite various claims that it is "meets British Post Office standards." It is merely made and designed for use abroad. If connected to the British network, it may not work properly. Phones designed for overseas use may satisfy the equipment's technical requirements, but that is not enough.
CIRCUIT IDEAS

Divide by \((2n - 1)\)

Fig. 1(a) shows a divide-by-(\(2n - 1\)) circuit which generates an equal mark-to-space ratio output if a divide-by-2 circuit is used in the final stage as shown in Fig. 1(b). With this arrangement, a divide-by-\((n-1)\) output is available from the divide-by-\(n\) circuit, but not with an equal mark-to-space ratio. Fig. 2 shows a divide-by-3 circuit, based on Fig. 1, where the divide-by-4 counter is clocked by a positive edge of the input waveform and then by a negative edge. During one complete cycle the divide-by-4 counter receives four clocking pulses for three cycles of the input waveform. A divide-by-\((n-1)\), i.e., divide-by-1/2, output is available from \(Q_2\).

With the basic circuit of Fig. 1(a) it is easy to build other odd value counters by inserting the desired divide-by-2n circuit. Also, by combining divide-by-\((2n - 1)\) and divide-by-\(2n\) circuits, a counter can be designed to divide by any value of \(2n - 1\). Some examples are shown in Fig. 3. Note that inputs and outputs between the various exclusive-OR gates must be separated by a counter.

A. J. Ewins
Harrow
Middx

Pre-amp with multisection tone control

The input stage of this preamp, which originates from a studio mixer, will handle signal levels from 500mV to 5V r.m.s. For optimum performance the preset control should feed 5mV to Tr1 which, with \(A_1\), amplifies the signal to 3V r.m.s. The filters around gyrators \(A_3\) to \(A_6\) provide low-impedance paths to ground for five frequency bands, and attenuation or gain for these bands is achieved by controlling the low-impedance paths towards the voltage dividers around \(A_1\). Balancing the filter potentiometers gives unity gain at \(A_1\) because the input and feedback voltage-dividing networks cancel each other. The open-loop gain of the op-amps determines the maximum number of gyrators that can be used. At 15kHz the parallelled gyror series resisters, 1000 and 3100, which are bootstrapped by the open-loop gain, should still be greater than the divider source impedances, 2.7, and present unexpected dips or peaks at high frequencies.

H. Riegstra
Amsterdam
Holland

One-shot control of immersion heaters

A conventional immersion heater requires two operations, switching on and later switching off. Although simple, the second stage is inconvenient and costly if forgotten. This simple circuit is easy to install and operates to manually switch off the heater. A relay forms a one-shot multistable which is thermally rather than electrically controlled. A trigger is provided by the start button which energizes the relay coil, and the heater is powered until the thermostat cuts out and dc-eenergizes the coil. Water temperature, and therefore the duration of the on period, can be adjusted via the thermostat setting. Apart from the relay connections, only one extra low-current wire is required between the start button and the thermostat.

This circuit can also be used to isolate equipment from the mains after a power failure.

S. Ho and
D. Wilberley
Manchester
Power supply with stable current limit

One problem with power supply current limits, which use the \( V_{be} \) drop of a transistor, is their drift with temperature variation. A simple solution is to use a programmable Zener diode for current sensing, which offers less than 50 p.p.m./°C variation in \( V_{be} \). In the circuit shown:

\[
I_{limit} = \frac{V_{be} - V_{ref}}{R_3}
\]

When the voltage at the B terminal of TL431 switches on, base drive for the output transistors is removed and the output current is limited. However, if the output terminals are shorted, the TL431 is turned on but the voltage across it is 2.5V. Therefore, to take the output voltage to zero, \( V \) is required which can be any low voltage Zener diode above 2V.

M. S. Suresh
Bangalore
India

"Test your knowledge"

Answers to the December issue multiple-choice quiz

None of the entries received for Test Your Knowledge was completely correct, and the best entries had at least three of the answers wrong. That was one result of the quiz compiled by R. W. Ellingham and B. L. Hart and published in last December's issue. The quiz was based on 40 questions, each with multiple answers, given to electronics students at the North East London Polytechnic. We offered prizes of Circuit Designs 3 or a subscription to Wireless World for ten correct entries opened after 5 January for UK readers and 2 March for overseas.

The answers provided by the authors are given in the panel. As almost all entrants gave the incorrect answers to questions 3, 24 and 34 (no-one got them all right), here are their solutions:

Question 3.

The assertion is not true. A bipolar junction transistor comprises two p-n junctions both of which are forward biased when the device is saturated. By suitable biasing it is possible to arrange for the two junctions to be equal in magnitude. The reason is a true statement. Operation of the b.i.t. depends on the existence of both electrons and holes. Therefore (d) is the correct answer. Most thought (b).

Question 24. See diagram. For neutralization \( I_F = 0 \) when \( V = 0 \):

\[
l_p = \frac{l_p}{\tau_q} = \frac{I_F}{\tau_q}
\]

\[
Y = \frac{Y}{Y} + Y
\]

\[
= I(0.02) = 0.4mS
\]

Question 34. Upper trip level corresponds to the level at which the comparator switches for a positive-going input. Assuming \( V_3 = -12V \), the p.d. across the 4k7 resistor keeps the input of the comparator below +4V, hence the output stays at -12V, until \( V_3 \) increases to \( V_3 = (+4V/8k) \). That means, for \( V_3 \) to be correct, but everyone else no. 3.

About half the entrants gave incorrect choices for questions 8, 19, 18, 36 and 37. In Q4, \( I_R < I(0.02) \). That means, for \( V_9 = -10V \) and \( I_7 = 100mA \), the 0.4mA correct, but everyone else no. 3.

Question 34. Upper trip level corresponds to the level at which the comparator switches for a positive-going input. Assuming \( V_3 = -12V \), the p.d. across the 4k7 resistor keeps the input of the comparator below +4V, hence the output stays at -12V, until \( V_3 \) increases to \( V_3 = (+4V/8k) \). That means, for \( V_3 \) to be correct, but everyone else no. 3.

When you go question 22 wrong, but one that did, Jeffrey Borish of Santa Clara, California, wrote to correct his answer saying the question could be a "deliciously wicked trick," depending on what c.m.f. was taken for the differential or single-ended output.

At the time of going to press the cut-off date for overseas readers hadn’t been reached but prizes for the best UK entries have already been despatched.

Answers to Test Your Knowledge

Since 1968 the author has used a simple radio telescope constantly to monitor the effects of solar activity on radio frequencies. This article is a brief history of sumptuaries followed by a chronicle of solar events and outlines of the equipment used to make the recordings.

Until the advent of radio it was not realized that the sun, and indeed other stars, emitted radio waves. However, suspicions were aroused very early in radio's history as Sir Oliver Lodge tried to detect radio waves from the sun using a receiver with a coherer detector, and the editor of the Scientific American called upon radio enthusiasts to listen carefully during the total eclipse of the sun on 24 January 1925 and report any strange happenings to radio signals.

Short-wave bands

Throughout the pioneering days of the short-wave bands for broadcasting both amateurs and professionals were trying to explain why the propagation of radio signals varied between day and night and was often subject to echoes, fading and sudden blackouts.

Scientists such as Oliver Heaviside, Arthur Kennelly and Professor (later Sir) Edward Appleton had shown how the existence and structure of the ionosphere reflected short-wave signals around the world. But as more evidence was gathered by astronomers, physicists and radio engineers it was soon realized that streams of particles from a solar event, Fig. 1, could disrupt the prevailing state of the ionosphere and consequently upset the normal paths of terrestrial radio signals.

Solar radio astronomy

Signs of radio being used as an astronomer's tool date back at least to 1935 when Karl Jansky first detected radio waves coming from the radio source on the Milky Way. Later in the same year Dennis Wright, also at Jansky's radio telescope on Mount Wilson, also detected radio waves from the sun. Between 1936 and 1939 this same noise was reported by no less than 24 amateurs using the same frequency, and by Miss Barbara Dana while using a frequency of 56MHz.

Early in 1942 British wartime operators using similar frequencies recorded an extraordinarily high level of noise which was also found to be the result of a large sunspot group and soon after the war radio astronomers turned to solar radio waves and their effects on radio waves was stepped up.

Simple radio telescope

Having heard the effects of solar noise, the author decided to build a simple radio telescope*, to find out more about the 'active' sun and its effects on terrestrial radio communications. The radio waves from the sun at 143MHz are collected by four 4-element yagis mounted on a wine mesh reflector, Fig. 2, which has a head amplifier mounted on its frame. The amplified signal passes along a coaxial cable to a 2m converter, where the observational frequency, being changed to 27MHz, is tuned on an FSK7 communications receiver which in turn drives a

* The author's radio telescope was first used as "Observatory" at the BBC and in a scientific film made by Yorkshire Television and networked by the BBA.

---

Radio observation of the 'active' sun

Solar effects on propagation recorded on home-made apparatus

By R. A. Ham

---

---

---
At this point a communications receiver and a long-wave aerial were used to follow the noise and for six minutes it overpowered all terrestrial signals down to 8MHz before it slowly faded away back to 136MHz, Fig. 6. Solar noise was also heard at 28.5 and 700MHz on 3, 6 and 28 July. At 07.45hr on 22 August 1976 strong bursts of solar noise were heard at 28MHz and later at 11.53hr while the author was using a low-band mobile radiotelephone another big burst occurred and blotted out the channel for 16 minutes. This burst was also recorded by the author’s radio-telescope at 136MHz.

The sun often produces the unexpected and having been quiet, apart from two tiny bursts, for 18 days it suddenly emitted a 28 minute burst which covered 50MHz of the v.h.f. spectrum at 13.16hr on 29 July 1973. Another notable burst began on 1 August at 11.46hr and for eight minutes the solar noise was strong enough to overpower static from a local thunderstorm.

Auroral observations
Briefly, an aurora manifests when a stream of particles from the sun collides with the gases of the earth’s polar atmosphere causing a temporary ionisation which affects terrestrial radio signals. An auroral reflected signal can be identified by the following characteristics: an s.b.s. transmission sounds like a ghostly whisper, a c.w. signal becomes a low-pitched rasp and the main image on a television screen is accompanied by many distorted images; all frequently changing as the aurora ebbs and flows. Throughout the past decade Mr C. Newton, Auroral Co-ordinator for the RSGB, has organized a large network of radio amateurs who monitor the effects of signals bouncing off auroras.

Following a period of large solar bursts an aurora manifested in two phases on 8 March 1970. During the first phase, 16.00 to 16.47hr, auroral signals were heard in southern England from amateur stations located in parts of Ireland, Scotland, Wales and Holland in the 2m band. The second phase, 18.35hr to 23.58hr, was more intense and auroral signals from many east European broadcast stations operating between 65 and 73 MHz were received in addition to the amateur stations heard during the first phase.

A large sunspot group was responsible for the noise storm which began on 2 August 1972 and became very intense on the 5th. At sunset on the 4th the solar noise was heard at several radio frequencies and by mid-day it had reached large proportions. It was not surprising that from midnight on the 4th until about 03.06hr on the 5th a spectacular aurora manifested which not only had an umbrella effect on v.h.f. radio signals, but its full glory was visible from southern-England.

Sunspots briefly
When a long-life sunspot, or group of sunspots, appears on the east-limb of the sun it can be visible for about 13 days before leaving on the western limb. The sunspots themselves are stationary but, because the sun revolves once every 27 days, they appear to move across the surface.

Constant observations have shown that when sunspots are present there are two main features of the associated solar r.f. noise, the individual burst, Fig. 3, which may last for several minutes, and the continuous noise storm which may last for days, Fig. 4. These radio waves are often generated by solar flares or prominence eruptions, Fig. 1, but the nuclear waste ejected by the event can take up to 30 hours before it reaches the earth and causes some form of atmospheric disturbance.

Sunspot cycle No. 20
The author’s observations began on the rising side of sunspot cycle No. 20 (1965 to 1976 approx.) in June 1968. After a quiet start, a large burst of activity from a group of sunspots on 13 August and a noise storm from 18th to 21st was recorded. Another period of quiet ended on 17 October with a 5-minute burst from a period of solar activity which lasted until 4 November. The main feature of this event was a noise storm which began on the 29th and ended on 1 November; shortly after its termination an aurora borealis manifested and deflected v.h.f. signals from amateur radio stations in northern England, Northern Ireland and Scotland towards the south of England, proving to the author the connection between the 'active' sun and terrestrial radio disturbance.

The number of days on which solar noise was recorded increased towards a peak in 1971 and then decreased until the next cycle began, Fig. 5. One of the largest solar storms recorded began on 11 November 1970 and raged until the 22nd, during which time the solar-noise level was apparently constant as the output from the fixed azimuth aerial increased daily as a large sunspot group approached central meridian and gradually decreased thereafter. This was an example of following the rotation of the sun using radio. The telescope’s recording pen was at full scale throughout the observations on the 15th and 16th, which was not surprising because the Daily Telegraph newspaper reported on 17 November that there were four separate sunspot groups at the time and the biggest passed through the central meridian on the 16th. This solar event upset h.f. communications and one unusual feature was the high atmospheric noise level that was heard on the h.f. bands after sunset.

Another major storm, associated with a large sunspot group between 3 and 13 March 1972 was the subject of a special report to the British Astronomical Association (BAAJ June 72) with a special emphasis on the flares which were recorded by radio on the 5th.

Of the many individual bursts recorded during the past decade, a large solar burst at around 08.35hr on 3 July 1974 was the most memorable. The telescope had been recording the radio waves from a severe noise storm on the two previous days so the author decided to check the rising sun using a 2m beam and some auxiliary equipment. Suddenly the noise increased at 136MHz and other receivers in use at the time emitted noise at 70.5 and 30MHz.
land. Although less intense, the prevailing solar storm continued through the 5th, 6th, and 7th. At 15:00hr on the 7th another aurora manifested but this time it could only be 'seen' by radio. Without both these phenomena observed, the whole batch of signals from the Polish broadcast station at CMI were successfully decoded with 14.25kHz, and during the following hour 14 European broadcast stations were heard between 49 and 64.2kHz.

The auroral events on 15 September and 13 October were expected because of the sudden decrease in solar activity over the past two dates. The September event lasted several days after the evening and even though the October aurora was much shorter, 14.00 to 17.15hr, the first warning came earlier as signals from the OSCAR-6 satellite crossing the north-pole were affected by the aurora.

At 04.45hr on 23 March 1976 a large solar burst was also recorded by the radio-telescope which Cmrd Hatfield uses at his home in Kent in conjunction with an OSCAR-6 satellite crossing the north-pole short, 14.00hr to 17.15hr, the first warning came earlier as signals from the auroral propagation was reported during the afternoons of 26 March, 1 and April.

The sunspot cycle

On 11 February 1977, seven in January, 19 in February, 6 in March, five in April, five in August and nine in April 1980. After 12 years of consistent observation the author has come to the conclusion that the 'active' sun is very unpredictable.

Sunspot cycle No. 21

It is understood that cycle 21 began in 1976 when the sunspot cycle 20 only got to 12.7. However, sunspots have been seen along the tail enders of cycle 20. From this fact cycle 21 observation began to get off a slow start because the maximum was only recorded on 47 days out of 304 between 1 March and 28 April 1977. A marked increase in the daily rate of noise begins in September 1977 and was still high at the end of July 1978. Out of 212 days from 1 January to 31 July solar noise was recorded on 108 days compared with 34 for the same period in 1976, 34 days in 1975 and around 124 days for the same period in the year 1974. From previous experience 1978 appears to be the peak year, Fig. 5, of cycle 21 therefore it is worth taking a more detailed look at some of the waveforms during the events which took place.

On 14 February 1978 the first clear sky for several days enabled Cmrd Hatfield to use his spectroheliograph and in view of the high level of radio noise which had been coming from the sun on previous days he was not surprised to see some large sunspots. At 14.25hr he watched an explosion take place near the upper sunspot in Fig. 5 after which the radio noise was about eight sunspots wide. The radio at 136MHz in Fig. 6 collected by the yagi are reflected by the auroral surface, the auroral propagation was reported during the afternoons of 26 March, 1 and April.

The spectroheliograph

Brochure on Control, a multi-plane, plug-

programmed system can be obtained from B C Engineering division (see issue in March issue page 3) has had to be postponed in order to be able to go ahead with a later year this

The DEATH OF ELECTRIC CURRENT

My thanks to Four Catt for giving me a good laugh as myself for being dyed. I read his article “The death of electric currents” (December 1960 issue) carefully and, then came to the analysis. Memorable things (anterior, that damned mutual impedance somewhere in the hot water circuits) nor dangerous.

The theory C a n a n t i c o g nized in giving me a vivid picture of Catt’s unraveling, wave-packets going out into the world along what I used to think were insulation, but which I now see are the result of some paraxial approximation techniques and their potential application to specific tasks such as the automatic analysis of bubble columns in the processing industry. The grammatically languages developed at MIT and related devices have the potential to understand and manipulate the body features which will find their way into future medical applications in science and commerce.

I am surprised that there now seems to be a tendency on the part of some to digitize everything, either in a focus on reducing costs in subjects of physics in circles, microvices, and the denuding of the world with the electronic, geophysics, for example, by booklets coming, on the average, around £1.50. A list of “Notes for Use” can be had from Unilab Ltd, Devonshore Street, Cheltenham GL5 6LT.

Unrik, makers of teaching equipment, produce a set of booklets on the use of equipment which can also be used in their own workshops. This includes a description of the software in a leaflet, which can be obtained from Unilab Ltd, Devonshore Street, Cheltenham GL5 6LT.

The use of the input I 0 4 of an optical isolator to protect the inputs of an operational amplifier is described in a design note from Norbal Optical-Electrics Ltd, Norbal House, Ackerweg, Road, Berksc, RGG 0 LT.

A Xon of range of temperature measuring sensors includes a new method of reading a terator, which can be obtained from Axon Ltd, Devonshore Street, Cheltenham GL5 6LT.

Unilik, makers of teaching equipment, produce a set of booklets on the use of equipment which can also be used in their own workshops. This includes a description of the software in a leaflet, which can be obtained from Unilab Ltd, Devonshore Street, Cheltenham GL5 6LT.

Unilik, makers of teaching equipment, produce a set of booklets on the use of equipment which can also be used in their own workshops. This includes a description of the software in a leaflet, which can be obtained from Unilab Ltd, Devonshore Street, Cheltenham GL5 6LT.

Unilik, makers of teaching equipment, produce a set of booklets on the use of equipment which can also be used in their own workshops. This includes a description of the software in a leaflet, which can be obtained from Unilab Ltd, Devonshore Street, Cheltenham GL5 6LT.

Metallic and mercury batteries, and transistors, are described in a trade from Intel Electronic Compnents Ltd, Heath Trading Estate, Beds.

The DEATH OF ELECTRIC CURRENT

My thanks to Four Catt for giving me a good laugh as myself for being dyed. I read his article “The death of electric currents” (December 1960 issue) carefully and, then came to the analysis. Memorable things (anterior, that damned mutual impedance somewhere in the hot water circuits) nor dangerous.

The theory C a n a n t i c o g nized in giving me a vivid picture of Catt’s unraveling, wave-packets going out into the world along what I used to think were insulation, but which I now see are the result of some paraxial approximation techniques and their potential application to specific tasks such as the automatic analysis of bubble columns in the processing industry. The grammatically languages developed at MIT and related devices have the potential to understand and manipulate the body features which will find their way into future medical applications in science and commerce.

I am surprised that there now seems to be a tendency on the part of some to digitize everything, either in a focus on reducing costs in subjects of physics in circles, microvices, and the denuding of the world with the electronic, geophysics, for example, by booklets coming, on the average, around £1.50. A list of “Notes for Use” can be had from Unilab Ltd, Devonshore Street, Cheltenham GL5 6LT.

Unilik, makers of teaching equipment, produce a set of booklets on the use of equipment which can also be used in their own workshops. This includes a description of the software in a leaflet, which can be obtained from Unilab Ltd, Devonshore Street, Cheltenham GL5 6LT.

Unilik, makers of teaching equipment, produce a set of booklets on the use of equipment which can also be used in their own workshops. This includes a description of the software in a leaflet, which can be obtained from Unilab Ltd, Devonshore Street, Cheltenham GL5 6LT.

Unilik, makers of teaching equipment, produce a set of booklets on the use of equipment which can also be used in their own workshops. This includes a description of the software in a leaflet, which can be obtained from Unilab Ltd, Devonshore Street, Cheltenham GL5 6LT.
MAIL ORDER BUSINESS

Your editorial of last November, "Microchips and Megaideals," has been a useful kick up the backside for many of us. It has reminded me almost irresistibly of the words of "Shoshy of the 'Hitch-hikers' guide to the Galaxy" which once advised some people that they were lucky, and shooting people and then bragging about it in the local press was the only answer to that.

May I suggest that any electronics engineer who really agrees with your editorial should resign, or be made to resign, from his company if all he really wants is to avoid the risk of inventing anything which could be of any use. Eventually most inventions are useful, and their inventors would probably prefer "to live with the memory of a dross."" - J. C. L. Kinsey

OPPORTUNITY LOST?

In the recent course of reading in the technological history of the electronic world recording industry it became apparent to me that the Magnavox System 1 (with its predescent TRS-80) was, indeed, the predecessor of the IBM personal computer - and the Apple II gave the IBM a run for its money. Your November 1980 issue of "Wireless World" reviewed the IBM Personal Computer, but failed to mention the Magnavox System 1.

John T. Lloyd, Weymouth

WIRELESS WORLD APRIL 1981

Get your microcomputer training at home with Wireless World, the monthly magazine for those who are seriously interested in electronics and the techniques of modern computing. For information on standards and applications - At "The Electronics Decorating Show," Battersea Park, London, 3-5 Sept 1981.

www.americanhistoryexpohof.com
m a k i n g a c o m m i t m e n t t o i n c l u d i n g s i g n a t u r e t h e o r i g i n a l d e s i g n . T h e r e i s a l o t t o b e s a i d f o r W e s h o u l d f o l l o w t h e S m a l l p i e c e p h i l o s o p h y o f p a r a l l e l . T h e s e a r e : 1 . H a r d w a r e d e s i g n . 2 . S o f t - t h a t t h e r e a r e f o u r s e p a r a t e b u t s t r o n g l y i n - I c a n n o t s t r e s s t o o s t r o n g l y t h a t t h e s e t w o s t e p s u n t i l a s a t i s f a c t o r y d e s i g n i s o b t a i n e d . I n I o c a l l y , a n d w h i c h h a s a r a n g e o f r e a d i l y a v a i l - t a n t i s t h e o r i g i n a l u n i t c o s t , t h e r e l i a b i l i t y , a n d b l a c k b o x i s a b l a c k b o x t o m i s q u o t S t e i n , a n d s e l l s s o w e l l t h a t y o u h a v e t o m a k e a n o t h e r 1 0 a n d o r d e r f o r t h e c h e a p e s t c o m p o n e n t s f r o m o n e d e n t o f t h e t y p e o f m i c r o p r o c e s s o r u s e d , p l a c e s e m i c o n d u c t o r m a n u f a c t u r e r a n d a l s o f r o m a l o o k l i k e b e i n g a r o u n d f o r a l o n g t i m e t o c o m e . l o c a t e s t h a t h a v e b e e n w i t h u s f o r m a n y y e a r s , a n d p e a r i n g m i c r o . N o w a l t h o u g h i t i s t r u e t h a t m o d u l e , a n d a d d i n g a s e c t i o n o n t h e c o m p l e t e m a n u a l , s o t h a t t h e s y s t e m d o c u m e n t a t i o n c a n T H E T W I N S P A R A D O X D . Z i s s o s a n d L . V a l a n n o t d e p e n d e n t o n t h e a c c e l e r a t i o n s a t t h e s t a r t m e n t a l f l a w w h i c h I f e e l s h o u l d b e c o r r e c t e d . A l a n M . F o w l e r w i t h t h e s e d i f f e r e n t d e v i c e s . T h i s w i l l b e g e n e r a l i t y o f t h e a p p r o a c h t h a t c a n b e a c h i e v e d n e x t a v a i l a b l e i s s u i c e . i n o u r T a b l e 3 ( p . 7 3 ) o f P a r t 6 o f o u r s e r i e s c h e a p i f t h e y a r e c h e a p t o u s e ; i f t h e w a y i n
be used to generate 2Lf from SC and vice versa. In the schematic in Fig. 2, 2Lf is derived directly from the two dividers in cascade. However, this output has large amounts of jitter, so the P1 and divider-64 is included to remove this. This circuit would seem particularly useful in a sensor, pulse generator where a suitable P.1 is often included anyway for the purpose of generating.

In Fig. 3, the P.1 serves two functions. Firstly, in conjunction with digital circuitry, it provides the means of multiplexing. Secondly, by selecting the times constant of the P.1, it serves to prevent the jitter of the dividers being reflected on the SC output.

64.489 divider
As described in the previous section, fractional divisions are obtained by dividing by two numbers in a suitable ratio. To that end, 64.489, a solution is to divide by 64 and 65 in the ratio of 511:489. There are many ways in which a division can be achieved, but the best one is that which gives the least low frequency jitter. To do this, the divisors by 64 and 56 must as near as possible be evenly distributed.

Before moving to a detailed description of the divider, background on the programmable counters is necessary. The 9110 is such a counter, in which it is possible to arrange a division of any number from 1 to 20 by programming on pins 3 to 6. It is further possible to cascade the counters and so arrange a division of any number. For our particular purpose a division by 64 and 65 can be achieved as shown on Fig. 4. The programming for each division is shown at the bottom as well as the logic required to switch between the two divisions. When point A is high a division of 64 is performed and a division of 65 when low.

If, as in Fig. 4, the output of the divider is divided by 2 and fed to A, the result will be that the principal divider will alternatively divide by 64 and 65, giving a + or 65 division by 64. The output is also shown to be fed back, through a gate, to the P1 terminal of the counters. This is a requirement for this particular counter.

The circuit of Fig. 5 is an extension of that in Fig. 4. There are five 9310s designated X1-X5, integrated circuits X1 and X2 performing the same function as those in Fig. 4. As in Fig. 4, when point A goes high a division of 64 occurs. Instead of there being a separate division by 1, this is performed by X3, itself a programmable divider. X3 and X4 are programmed to divide by 90 and 92 and, since both are even numbers, both Q0 and X3 output of X5 will, regardless of which division is performed, always alternate between 0 and 1.

As stated previously a division of 64.5 is performed by the circuit shown in Fig. 4. This is close to the required division of 64.489. If 11 of the divide-by-65’s ("-65") in 1,000 are changed into "+64" the correct ratio of 511:489 is obtained. This occurs in the circuit of Fig. 5. X3 and X4 divide by 90 and 92 in the ratio of 65. This means that they divide by 90,000, or 1,000,11, and point Q will thus have eleven pulses for 1,000 occurring at the clock of X3. Furthermore, these pulses derive from the terminal count of X4, and thus at a time when Q3 of X3 is high and when B would be low, normally giving a +65 instruction. The ‘high’ on C thus overrides this through the OR gate and forces a "-65." On these eleven occasions in 1,000, then, a "-65" is converted to a "+64" making the ratio of the two dividers 499:511 instead of 500:500 or 1:1.

The first can be easily understood, since the divider for most of the time divides alternately by 64 and 65, meaning that the output of the divider oscillates about a true mean with a period of two output cycles. Since with a SC input the output will be 68.75kHz, this first jitter frequency must be half this, 34.375kHz. Its peak to peak excursions are 22%, and one period of the input frequency (T hereafter).

The remaining components are best described with reference to Fig. 6(a). The horizontal axis is calibrated in periods of the output of the divider (1-1,000) and the vertical in its output phase, such that a mean line would be horizontal. The 34.375kHz component has been ignored. Beginning at point A, the divider divides alternately by 64 and 65 and since this is not quite the required division the output phase steadily deviates from the mean as seen by the slope of line A X. Referring to the previous section, instead of the 89th and 90th divisions being 64 and 65 as before, they are both "+64" resulting in an abrupt correction in the output phase (X- B). The count sequence from C is similar, except that the 91st and 92nd divisions are altered to be both "+64." Thus A-B and B-C give slightly different average divisions. The counts from D-E, F-G, H-I, J-K, L-X are all different. A, B and C are slightly different average divisions. The counts from D-E, F-G, H-I, J-K, L-X are all different. A, B and C are different average divisions. The counts from D-E, F-G, H-I, J-K, L-X are all different. A, B and C are different average divisions. The counts from D-E, F-G, H-I, J-K, L-X are all different. A, B and C are different average divisions.

Alternate divisions of 64 and 65 clearly give an average of 64.5. This differs from the final required average by 64.5 64.489. That is 0.011 of an input period (T). This error repeats itself for every pair of divisions and is accumulative. After 88 divisions, or 44 pairs of divisions, from point A, the accumulated error will be 44x.011=48.447 at point X. When the correction is made, (X-B) with a double-division by 64.489-0.4897 is made. It is clear that the sawtooth plot AXYBC... represents the next most significant jitter frequency. Eleven cycles of this jitter appear within 1,000 divider output periods; thus, its frequency is 68.750x1.0001=68.752kHz.

In peak to peak excursions will be 0.4897, i.e., with a SC input -0.4897. An error of +0.4897 accumulates to point X and a correction is made (X-B) of -0.4897 when a double division by 64 takes place. The correction therefore "overshoots" by an amount of 0.0057. As the counter proceeds from B to Y, an error of 45 x 0.011 = 0.495kHz accumulates. A double division of 64 occurs from Y to C bringing a correction of -0.4897. In this case, the correction is insufficient and "undershoots" by an amount of 0.0067. Since C-D is identical to A-B and D-E is identical to B-C, the process of "overshoot", "undershoot" continues, the jitter waveform of Fig. 6(b) being the result. It is continued on page 76
Phase measurement with an oscilloscope

Avoiding the difficulties of Lissajou figures and time estimation

by I. D. MacArthur

A method of measuring phase angle between two sine waves of the same frequency is described, using a double-beam oscilloscope, which is easy to use up to the full vertical bandwidth of the oscilloscope.

The classical method of measuring phase is by Lissajou figures, as in the example of Fig. 1, a method which suffers from a number of drawbacks. The center of the ellipse must be accurately aligned with the cross wires of the graticule and then measurements made against the graduations, which are usually on the centre lines themselves. This is tricky and prone to error. Accuracy is poor when the phase angle is near 90° or 270°, and the gain of the horizontal amplifier is usually limited, making it impossible to "open out" the ellipse with small signals. The maximum frequency at which measurements can be made is also restricted by the horizontal amplifier—even a very good modern oscilloscope may be limited to about 200kHz before the relative phase shifts in the vertical and horizontal channels become unacceptable.

It must be stated though, that the Lissajou figure has one big advantage in that it is very useful for checking zero (or 180°) phase shift when the ellipse is closed and any small departures are easily visible.

Another method, shown in Fig. 2, is to measure the times of zero crossing of the waveforms. This is still probably the best method for a "quick look" but has the disadvantages that the two waveforms must be aligned with the center of the graticule, and that the oscilloscope time base must be accurately triggered. One must also choose between the chopped and alternate modes, which both have disadvantages. On some oscilloscopes it is necessary to provide an external trigger.

Sum-and-difference method

Here the two signals are displayed as in the zero-crossing time-interval method, but it is unnecessary to have the timebase accurately triggered, or even synchronized in some cases. Measurements can sometimes be made in the presence of significant amounts of noise.

The procedure is as follows:

1. Adjust the gain of the two channels to give equal-amplitude signals approximately half the screen height (to allow for displaying a 2° signal). The exact amplitude and gain settings are unimportant and the time base need not be synchronized.
2. Switch the channel selector to A-B (algebraic add) and record the peak-to-peak amplitude of the resulting sine wave (the difference voltage).
3. Use the graph in Fig. 3.
4. Calculate the phase angle from the sum and difference and use the graph in Fig. 3.

The complete range of low-cost oscilloscopes available from Tektronix offers more choice and more value for money.

Because everyone needs a slightly different performance in either bandwidth/sensitivity or extra control functions, we offer a range with different specifications. There are 4 dual-trace oscilloscopes to choose from in the Telequipment D1000 Series, with 10 or 15 MHz bandwidths.

And there are 5 different Tektronix T900 Series oscilloscopes ranging from a 15 MHz single trace oscilloscope to a 35 MHz dual-trace oscilloscope with Delayed Sweep.

All our oscilloscopes are thoroughly pre-tested to meet the high standards that go with our name. The result is solidly built oscilloscopes which are not only easy to operate and maintain but also represent the most reliable buys on the market.

The T900 Series is supported by a full range of accessories including battery power packs, cameras & scope stands.
In 1911, the name of Marconi was almost synonymous with 'wireless'; marine wireless operators were, as often as not, referred to as 'Marconi operators'. The growing profession of operating Marconi stations in vessels and ships demanded a magazine, and the Marconi company responded in April 1911 with The Marconiograph, which carried news of the company, of operators scattered worldwide and of developments in wireless technique. Two years later, for reasons which have been aired before by writers more directly concerned with the event, The Marconiograph became The Wireless World and embarked on its declared life's work of being "of use and interest" to a rather wider fraternity than had been the case in its previous existence. Sticklers for detail may, with some justification, point out that WW is not 70 this month, but 68. We feel, however, that the two larval years should count towards the total for, while laying no claim to be rosenic, we think WW quite as sweet as The Marconiograph.

While the new science and technology was at first naturally associated with ship communications, there is a remarkably close parallel to be drawn between the development of radio (and later electronics) and aviation. Both technologies were emerging in 1911 (Bleriot had landed at Dover only two years earlier and Fleming's two-electrode valve was only seven years old), both were to advance rapidly in the two years that followed and have, ever since, been called for specific development in the other. In the beginning communication was all, but even in the early days, direction finding and even radio landing aids were seen. The emergence of radar techniques and navigation systems changed the ways in which both civil and military aircraft were operated and have the design of some of them. Looking at it the other way round, the demands imposed on radio and electronics by military aviation in two wars and by an enormous expansion in civil air travel have hastened the development of electronics and for the degree where only marginally-

stable aircraft become docile, but agile, and where landing aids are capable, in theory at least, of not only landing an aircraft in zero Visibility, but getting it to the terminal building as well. Electronics and aviation are now so inextricably interwoven that airliners could hardly be operated without electronic assistance, and military aircraft would be unimaginably different.

**Wireless World, 1911-1981**

*From crystal detectors to microcomputers in 70 years*

Wireless World has always reflected this use of electronics, beginning with the wireless sets used for gunnery spotting in 1916, reporting Lorenz instrument landing systems in 1935, gathering a whole mass of newly released radar information immediately post-war and continuing to report on air communication and navigation when the information is "of use and interest" to readers.

Our two enduring interests over the years have been radio and television broadcasting and reception, and the high-quality reproduction of sound. A great many of the leading figures in high fidelity have written in WW, and continue to do so, on theory and practice — an aspect perhaps best demonstrated by the publication of designs for D. T. N. Williamson's valve amplifier just after World War II, which set a standard to judge the rest by. People still write in to ask for reprints of these articles.

The Williamson standard was and is upheld by writers such as Jack Dinsdale, Arthur Bailey, Laurie Nelson-Jones, John Linsley Hood and many others on the practical side of our content, and contributors of the calibre of Peter Batandall, Professor David Bell, Thomas Roddam and the immortal Marcus Scroggie (Catherine Ray) have educated thousands of readers in the art of electronics.

Coverage of television began with Baird's first crude experiments, although the tone of some of our reports was a little bemused. It reached peaks in 1947 and 1968 with the publication of one of the first designs for a home-constructed monochrome television receiver (deflection yoke and line-output transformer both being home made) and the colour receiver by Walter Cocking, who made an enormous contribution to the standard of our practical articles over many years. The two receiver designs illustrated some of the reasoning behind WW projects, in that they were not necessarily the cheapest way of acquiring the receiver, or whatever was being built. One of the reasons for publishing them was that such a series of articles is undeniably the best way of explaining the operation of equipment. Even if one does not undertake the construction, the text is valuable in its own right.

In those days, of course, there were no integrated circuits. Circuit design was not the cost-effective deployment of the vast range of modules one can now select from, but the basic design that still goes behind closed doors, its outcome being encapsulated in plastic. Integrated circuits have brought with them enormous opportunities for technical progress, but an unfortunate view that is the most pointed view of the world of article writing a piece of digital equipment often reads a little like a knitting pattern. It is not as easy as it used to be to read such articles in isolation.

Nevertheless, we have no intention of abandoning the ground rules laid down 70 years ago, that Wireless World should entertain, educate and be of use to the new generation, as well as their elders. It is doubtful that G. Marconi would recognize his grown-up brainchild, but we do hope he would approve.
Designing with microprocessors

7 - Wait/go systems

by D. Zissos, Department of Computer Science, University of Calgary, Canada

Previous articles have described the synchronization problem and the most widely used solution involving software wait loops. In this article the wait/go concept is explained and step-by-step procedures for the design and implementation of wait/go systems are described. The design steps are illustrated by means of a fully worked out example.

The wait/go concept

Let us assume that we have a microprocessor which automatically enters the wait state when an i/o instruction is being executed. Let us further assume that when in the wait state it generates a logic 1 on wait terminal w, and that it exits the wait state when the signal on terminal is pulled high (w = 1). The block diagram and state diagram of such a microprocessor are shown in Figs. 1 and 2. If we were to activate the peripheral with the 0 to 1 transition of the wait signal w and keep the microprocessor in the wait state until the peripheral had fully responded, we would clearly have no synchronization problems. Furthermore, if the peripheral is an action-status device, then the interface reduces to two wires, as we show next.

The two-wire interface

Our starting point is the block diagram of a wait/go system shown in Fig. 3. The signals w, g, a and r have the following meaning:

Signal w: A '1' on this terminal (the wait line) indicates that the microprocessor has entered the wait state.

Signal g: A signal transition from 0 to 1 on this terminal (the go line) puts the microprocessor out of the wait state.

Signal a: A signal transition from 0 to 1 on this line triggers the peripheral into action.

Signal r: While the peripheral is responding r = 1. When the peripheral has fully responded r changes to 0. No activation is possible when r = 0.

A suitable internal-state diagram of a circuit to implement the above interface is shown in Fig. 4. Applying the reduction steps to its equivalent state table in Fig. 5, it allows its three rows to merge into one, as shown in Fig. 5 (b).

By direct reference to the reduced state table, we obtain the following equations:

w = g + w + (w) + g = g + w + (w) + g

The corresponding circuit implementation consisting of two wires is shown in Fig. 6.

Advantages

Wait/go systems are:

- Easy to understand. The 'wait' and 'go' are everyday concepts, not requiring specialist knowledge.
- Easy to design. The hardware is straightforward and presents no difficulty. Specifically, in the case of action-status devices it consists of two wires.
- Easy to implement because of uncomplicated hardware.
- Easy to program. Software overheads are minimal.
- Easy to maintain because of their reliability.

Wait/go logic

Although present-day microprocessors are not designed to operate in the wait/go mode, they can be made to do so by means of a relatively simple logic circuit, the wait/go logic, the block diagram of which is shown in Fig. 7. Its function is to look for i/o instructions with wait/go addresses, denoted by A0, and to put the microprocessor automatically into a wait state when such an instruction is detected. At this point it passes exit control to the go terminal, that is to the outside world.

A suitable state diagram is shown in Fig. 8. By direct reference to it, we obtain

- = A + B • A, therefore, J = A + A
- = A • B - g, therefore, K = A - g
- = S0 • M2 + M1 + 10
- = A + M2 + M1 + 11
- = A • B - g, therefore, J = A • B - g
- = A + B + A + A - W A T E - g
- = A + B + A + A + A - W A T E - g
- = M1 - DBIN and the following DRBN respectively. It follows that we can identify an i/o instruction by simply determining whether the signals on the data bus in time slot M1-DBIN are 11010011 or not - 1101011 and 1101011 are the top codes for IN and OUT. Similarly, the wait/go addresses are identified by looking at the data bus with the following DRBN signal. A suitable state diagram is shown in Fig. 8.

The design and implementation of wait/go logic is straightforward, as we demonstrate by means of the following example.

Wait/go logic for the Intel 8080

The m.p.u. signals of the Intel 8080 were described in the first article (May 1980 issue). Reference to these signals shows that the op code and i/o address are loaded into the m.p.u. registers in timeslots M1-DBIN and the following DRBN respectively. It follows that we can identify an i/o instruction by simply determining whether the signals on the data bus in time slot M1-DBIN are 11010011 or not - 1101011 and 1101011 are the top codes for IN and OUT. Similarly, the wait/go addresses are identified by looking at the data bus with the following DRBN signal.
A design problem: PRINT

The problem is to design and implement a wait/go system that would allow the programmer to produce a hard copy of data, which is stored in consecutive memory locations.

Solution

As explained in the previous article the first three design steps are independent of the microprocessor and therefore are common to both solutions.

Step 1: aim of the design. The aim of the design is to expose the reader to wait/go systems.

Step 2: device characteristics. As specified.

Step 3: system design. The block diagram of our solution is shown in Fig. 10. Its step-by-step operation is flowcharted in Fig. 11. As in the case of the test-and-skip solution described in the previous article, we shall use index addressing. Addressing modes were described in Part 3 in the August issue.

Set up for the PRINT problem using the 8080 microprocessor and the Motorola 6800.

Table 1: Hex listing of the PRINT problem when implemented using the wait/go mode and the Motorola 6800.

<table>
<thead>
<tr>
<th>Hex address</th>
<th>Hex listing</th>
<th>Mnemonics</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000 CE</td>
<td>LDX</td>
<td>Load Index register with line</td>
<td></td>
</tr>
<tr>
<td>01 20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>02 40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03 86</td>
<td>LDA A</td>
<td>Load acc. A with block length (n)</td>
<td></td>
</tr>
<tr>
<td>04 n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>05 97</td>
<td>STAA</td>
<td>Copy acc. A (n) into memory location line 10 on page 20 to be used as a counter</td>
<td></td>
</tr>
<tr>
<td>06 20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>07 10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M1: 08 27</td>
<td>BEQ</td>
<td>Branch to M2, if n = 0 – forward 11</td>
<td></td>
</tr>
<tr>
<td>09 0B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0A A6</td>
<td>LDA A</td>
<td>Copy into acc. B next byte to be printed</td>
<td></td>
</tr>
<tr>
<td>0B 00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0C B7</td>
<td>STAA</td>
<td>PRINT – printer address 1000</td>
<td></td>
</tr>
<tr>
<td>0D 10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0E 0D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0F 08</td>
<td>INX</td>
<td>Point to next byte</td>
<td></td>
</tr>
<tr>
<td>10 7A</td>
<td>DEC</td>
<td>Decrement byte count (held) in memory location 2010(i)</td>
<td></td>
</tr>
<tr>
<td>11 20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 20</td>
<td>BRA</td>
<td>Branch to M1 – back 13</td>
<td></td>
</tr>
<tr>
<td>14 F3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M2: 15 3E</td>
<td>WA1</td>
<td>Stop</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 10: Block diagram of the PRINT problem.

Fig. 11: Step-by-step operation of a wait/go system used to PRINT.

Fig. 12: Programming model for the PRINT problem using the M6800.

Fig. 13: Programming chart of the PRINT problem using wait/go and the M6800.

Fig. 14: Programming model for the PRINT problem using the Intel 8080.

Fig. 15: Programming chart of the PRINT problem using wait/go and the Intel 8080.

8080 Solution

Step 4: hardware design. As in the case of the 6800, no hardware is required.

Step 5: software design. Our programming model in the case of the Intel 8080 and programming flowchart are shown in Figs. 14 and 15. An m.p.u. register is assumed to be available for use as a counter.

Our programming model is shown in Fig. 14 and to the Intel 8080's instruction set reproduced in the previous article, we derive the hex listing of our wait/go software. It is shown in Table 2.

Table 2: Hex listing of the PRINT problem when implemented using the wait/go mode and the Intel 8080.

<table>
<thead>
<tr>
<th>Hex address</th>
<th>Hex listing</th>
<th>Mnemonics</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 21</td>
<td>LXI H</td>
<td>Set memory pointer to line</td>
<td></td>
</tr>
<tr>
<td>01 40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>02 20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03 0E</td>
<td>MV1 C</td>
<td>Load register C with block length (n)</td>
<td></td>
</tr>
<tr>
<td>04 n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>05 0C</td>
<td>INRC</td>
<td>Increment C-says flags</td>
<td></td>
</tr>
<tr>
<td>L2: 06 0D</td>
<td>DCRC</td>
<td>Decrement C</td>
<td></td>
</tr>
<tr>
<td>07 CA</td>
<td>JZ</td>
<td>Jump to L1, if n = 0 – that is if the zero flag is set</td>
<td></td>
</tr>
<tr>
<td>08 10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09 7E</td>
<td>MOV A,M</td>
<td>Move into A next byte to be printed</td>
<td></td>
</tr>
<tr>
<td>0B D3</td>
<td>OUT</td>
<td>PRINT</td>
<td></td>
</tr>
<tr>
<td>0C 06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0D 23</td>
<td>INX H</td>
<td>Point to next byte in the block</td>
<td></td>
</tr>
<tr>
<td>0E C3</td>
<td>JMP</td>
<td>Go to L2</td>
<td></td>
</tr>
<tr>
<td>10 G3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1: 11 76</td>
<td>HLT</td>
<td>Stop</td>
<td></td>
</tr>
</tbody>
</table>

Demetrios Zissos is Professor of Computer Science and Adjunct Professor of Electrical Engineering at the University of Calgary, Canada. Educated in Britain, he has been associated with industry on both sides of the Atlantic for the past twenty years. He has written five books and numerous articles, including a series with Brian Holdsworth on logic design in Wireless World. He is currently writing two further books, one on logic design and the other on distributed systems.
The earth-less vertical

In one of his series of classic papers on transmission-line losses, Dr. George Brown of RCA (Proc IRE, June 1937) analyzed the efficiency of monopole radiators in terms of their use with 0.4-lambda radiators, showing that typically an efficiency of up to 88 percent can be achieved with 113 radials, reducing to 65 percent per cent with just two radials. It is on this work that amateur use of the parasitic "vertical plane" and "vertical" arrays has largely been based for over 40 years, while the standard medium-wave broadcast antenna still tends to use 72, 120 or even 144 radials buried a couple of feet below the surface of the earth by means of mole ploughs, resulting in radiation efficiencies of the order of 75 to 90 percent. More and more, in recent years, amateurs using verticals on 7MHz and below have been persuaded that an extensive earthing system or "mat" is a vital essential. Since such an earthing system cannot be fitted into the average garden, the h.f. monopole, it generally accepted as not providing the sort of performance at long distances of which it should be theoretically capable.

Recently, Leslie Moxon, G6XN, who has built up a considerable body of experience at tuning the many myths that are part of the "aerial lore" of many amateurs (and professionals), has pointed out that one could call the "culture of the radial" to see if effective h.f. directivity is in fact based on quite accurate radials at ground level without the use of any physical connection to earth. In doing so he had paralleled a similar investigation by the Australian amateur VK3AM who has been developing compact band-coverage h.f. arrays for use in confined spaces, including small boats.

This work is tending to show that, in fact, good efficiency is possible by using the once-popular "corner radiator" arrangement, but that this can be successfully shortened by inductive loading. In one form, G6XN is using a base with a suitably placed quarter-wave radiator, a 14MHz counterpoise 20 feet in length, and a driven array consisting of a 7½ length of flat tubing parallel to the ground, with a linear loading inducance of about 1½ of wire. Such monopole (or dipole) elements can be readily used as driven elements or as reflectors or directors. Such a two-element array (or double) should be based on a reflector rather than a director. The counterpoise rods can also be used effectively to increase capacitive coupling between the array elements. Such rods can be easily mounted in appropriate positions to change the direction of fire of the array and taken down when not in use. The performance of an array should vary in such elements would appear to be equivalent to those of a similar array using an extensive earth mat, although, as might be expected, a little inferior to an equivalent horizontal array at moderate height. The vertical array, however, has many advantages: it is easy to erect and conventional antennas do not require a tower, no rotating mechanisms are needed and is not a permanent structure and so presumably falls outside the scope of local authority planning, while at the same time offering plenty of scope for further investigation and development.

Amateurs and c.b.

More and more, through British amateurs will soon have to learn to live with, even if some of them find it difficult to love, c.b. or Open Channel, on frequencies additional to the proposed 9MHz. Indeed by the time these notes appear the die may well have cast, although the package is likely to be so terrifying that it may be impossible to abolish the Home Office from any suggestion that they have been forced into making a "U-turn". But it is much to be hoped that amateurs will not be allowed themselves to be provoked into open hostility. Some of the common complaints made by some amateurs against c.b. could easily be represented as "outrageous". For instance, it is complained that amateurs always have to pay for licences, pass examinations, adhere to tight regulations, keep accurate logs etc., so why should to many people have been allowed to "get away" with 27MHz operation? ... and that still they are there. But there are other, more seriously abrasive, causes of friction. Amateurs fear they will have to take the blame for interference and abuses since the media often fail to distinguish between c.b. operators and "normal" amateurs. But perhaps the most serious problem of all is that many of the thousands of 27MHz c.b. operators being used in the UK will operate - and indeed often are operated - within the internationally "exclusive" amateur bands 28 and 29 MHz. Since most c.b. units are channelized it is possible that some of this intrusion is accidental, though the amateur bands are often neighbours. Since c.b. operators make no attempt to abide by "hand-planning" or similar conventions, amateurs in many countries are seeing a virtual take-over of a part of their bands. Unlike the radio control modellers they are not being offered alternative frequency bands. C.b. enthusiasts would be well advised to exercise some restraint on their own behalf.

Here and there

Australian amateurs are now permitted to transmit in the third party band on 160MHz. PAT HAWKER, G3VA

Introduction to low-noise amplifier design

How to optimize collector current and calculate noise figure

by A. Foorad

---

Fig. 1. Choice of input amplifying device depends on source resistance.

Once the basic design requirement of optimum collector current has been satisfied, the remaining amplifier parameters can be determined from the normal design relationships. For example, as the noise figure is independent of the transistor configuration and overall feedback, the usual feedback arrangements are practicable. Therefore the transistor and its operating point can be selected to meet the circuit noise requirements and the configuration or feedback can be determined to meet gain, bandwidth, and efficiency requirements. This approach allows the noise and other circuit constraints to be optimised.

The selection of a suitable input device depends mainly on the source resistance and bandwidth requirements. At the lowest values of source resistance it is necessary to use transmission line in the input to match the source resistance to the optimum noise for the amplifier. Fig. 1. Using transformers for transmission line the noise figure is increased, but extra losses and degrade the basic noise figure of the amplifier. For example, an 8 per cent transformer would now have a noise figure of over 60, including more than 300 ohms in parallel with the source. Later designs for a high power amplifier (100W) in the form of a 500W battery, with 25 watts power, located at 27 MHz, have been published. A South Australian multi-band beacon, 2SVMFH transmits on 28.205, 50.005 and 144.925 MHz, the 28 MHz signals being only just visible in high noise conditions. The UK mode will be 25 MHz, the British Amateur Television Network, (B.A.T.N.) has an old TV receiver to broadcast "Television Handbook" with over 100 pages devoted to practical and up-to-date design techniques. However, with the appearance of television set-top units (Non-members £1.50 plus 55p postage from BATC Publications, 14 Lilac Ave, Leicester LE3 1AF)

PAT HAWKER, G3VA

---

**Table: Measured values of low-noise device parameters may not agree with manufacturers data**

<table>
<thead>
<tr>
<th>Device</th>
<th>p at L0f</th>
<th>1mA @ 10kHz</th>
<th>RB</th>
<th>NF</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N3030</td>
<td>n-p-n</td>
<td>300</td>
<td>120</td>
<td>700</td>
<td>High source resistance</td>
</tr>
<tr>
<td>2N3044</td>
<td>p-n-p</td>
<td>300</td>
<td>120</td>
<td>700</td>
<td>Low source resistance</td>
</tr>
<tr>
<td>BC109</td>
<td>n-p-n</td>
<td>300</td>
<td>120</td>
<td>700</td>
<td>General purpose</td>
</tr>
<tr>
<td>2N2707</td>
<td>p-n-p</td>
<td>350</td>
<td>200</td>
<td>200</td>
<td>Low source resistance</td>
</tr>
<tr>
<td>2N4403</td>
<td>p-p-n</td>
<td>150</td>
<td>90</td>
<td>100</td>
<td>Low source resistance</td>
</tr>
<tr>
<td>2N3694</td>
<td>n-p-n</td>
<td>300</td>
<td>120</td>
<td>50</td>
<td>Low source resistance</td>
</tr>
<tr>
<td>2N4250</td>
<td>n-p-n</td>
<td>350</td>
<td>200</td>
<td>150</td>
<td>Low source resistance</td>
</tr>
</tbody>
</table>

---

Some noise mechanisms are process-de- pendent and result from such defects as surface defects, surface contamination, de- fects in isolation, manufacturing, and irregularities at the base-emitter junction. For this reason transistors with the same parameter may vary from one to another. This is particularly true for low frequency noise below 1kHz where poor processing techniques become more apparent.

Any source unavoidably generates an amount of thermal noise power which depends on its temperature, Boltzmann's constant, and the transistor's noise bandwidth. Noise factor, as a ratio, is defined as

\[ F = \frac{P_{out}}{P_{out}} \]

where \( P_{out} \) is the available output noise power and \( P_{in} \) is the available input noise power caused by source only.

Noise figure is simply this noise factor expressed in decibels.

\[ NF = 10 \log F \]

There is a measure of the signal-to-noise degradation attributed to the amplifier. For a perfect amplifier, the noise figure would be zero.

---

<table>
<thead>
<tr>
<th>Noise figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 dB</td>
<td>Perfect amplifier</td>
</tr>
<tr>
<td>10-20 dB</td>
<td>Good amplifier</td>
</tr>
<tr>
<td>20-40 dB</td>
<td>Fair amplifier</td>
</tr>
<tr>
<td>40-60 dB</td>
<td>Poor amplifier</td>
</tr>
<tr>
<td>60 dB</td>
<td>Very poor amplifier</td>
</tr>
</tbody>
</table>

---

The introduction of low-noise amplifier design allows for more efficient use of transistors, resulting in lower noise figures and improved performance. The choice of input amplifying device depends on source resistance, with considerations such as gain, bandwidth, and efficiency.

---

The table below provides measured values of low-noise device parameters, illustrating that there may be discrepancies between the manufacturer's specifications and practical results. The table highlights the importance of selecting suitable input devices based on the specific requirements of the circuit.

---

This document emphasizes the importance of noise figure in amplifier design, with a focus on optimizing collector current and noise parameters. It provides valuable insights for engineers and hobbyists working with low-noise amplifiers.
amplifier, one which adds no extra noise to the thermal noise of the source, the noise factor is unity, and the noise figure zero. Usually there is not a great deal of value in reducing the noise figure much below 3dB. A noise figure of 5dB is equivalent to saying that the amplifier and source are contributing an equal amount of noise to the wanted signal. Even if the amplifier noise could be reduced to 0.1 of the source noise, the total system noise is now about 0.7 of the 3dB condition. However it must be remembered that an amplifier with a noise figure of 0.5dB at 7kHz with source resistance of 50Ω will have a higher figure at low frequencies and at source resistances away from the optimum.

The normal procedure is to design the amplifier for a minimum noise figure at the desired source resistance. The optimum collector current for the transistor depends on the driving source resistance, and the direct current gain β. Optimum collector current

For example, determine the optimum current for a 2N4403 transistor with a source resistance of 400 ohms. Initially β can be taken as 200.

L = \frac{0.838A}{40-400}

As shown in Table 1 a β of 200 at 0.88mA is possible. If the formula had given a much lower optimum collector current, say 50A, then the β would have to be reduced to about 100 and the optimum collector current recalculated. This procedure is repeated if necessary until the β is believable for the calculated collector current.

The procedure is not too critical because of the wide variations in β between one transistor and the next and because the optimum collector current is proportional to the square root of β.

The minimum noise factor F at the optimum collector current can be calculated from the source resistance Rs, the current gain β, and the intrinsic base spreading resistance vb.

\[ F = \frac{1}{\beta} \left( \frac{1}{R_s} + \frac{1}{\beta} \right) \]

For the conditions previously discussed for the 2N4403 transistor

\[ F = \frac{1}{200} \left( \frac{1}{400} + \frac{1}{200} \right) = 0.171 \text{ times} \]

Then the minimum noise figure is

\[ NF = \log F = \log 1.17 = 0.68dB \]

Microphone preamplifier example

Many dynamic microphones have impedances of 200 or 600 ohms. The previous examples show that the output of any microphone transistor run at a collector current of about 1mA could be used for this application, and a suitable circuit is shown in Fig. 2.

A common-emitter amplifier is followed by an emitter follower. The dc conditions are determined by the bias chain from Tr2 emitter to Tr3 base, but this does not provide negative feedback at signal frequencies because of C3. The low frequency response is determined mainly by the input and output coupling capacitors at 1kHz, while the high frequency response is determined by C3 at 2kHz. If C3 is not included the high frequency response would extend to 1MHz, which is undesirable.

The first transistor is essentially unloaded common-emitter stage, and its gain at room temperature is

\[ V_C = 40V, I_C = 0.24 \text{ times or 46dB.} \]

Frequency of the audio carrier is 5kHz. Therefore, the selectivity of the microphone preamplifier is 60kHz. At this carrier frequency, the microphone preamplifier provides a mid-frequency response of -50dB at 2kHz and 20kHz.

For the conditions previously discussed for the 2N4403 transistor

\[ F = \frac{1+1.171}{1+1} = 1.171 \text{ times} \]

Then the minimum noise figure is

\[ NF = \log F = \log 1.17 = 0.68dB \]

The theoretical correct approach is to allow for all these factors and design for the lowest total noise over the complete audio bandwidth. This really demands an exact model for the circuit and a good computer program. In practice a reasonable answer can be obtained by designing for a source resistance of about 56 ohms.

In Table 2 several transistors are compared for this source impedance. All of these transistors appear to be suitable, apart from the 2N930. The 2N4403 transistor has been chosen for the practical circuit, and the examples.

I_c = \frac{(0.38)^2}{40 \times 10} \text{ A} = \frac{1.171}{10} \text{ A} = 0.117 \text{ A}

The open-loop gain for this type of circuit is

\[ R_1 = \frac{320 \times 47^3}{470} \times 10^3 \]

A practical measurement of this circuit gives an open-loop gain of 80dB, which is perhaps more realistic.

Unlike the first circuit, the gain was well defined by the collector current and the gain of this circuit depends on the β of the second transistor. Overall negative feedback is therefore essential to stably define the closed-loop gain. In Fig 5 the closed-loop gain is 60dB and the frequency response is 3dB down at 8kHz and 45kHz.
Magnetic recording review

2 - Performance of modern cassette tapes

by J. Moir, F.I.E.E., James Moir and Associates

Mr Moir continues his survey of magnetic recording technology and materials with an examination of modern cassette tapes. A brief look as possible future developments

concludes the article.

Equalization

The limited frequency response of the early ferric coated tapes led to the extensive use of electronic equalization, a shifting of the frequency response of the record and replay systems to improve both the frequency response and the s/n ratio. The correlation required to achieve a flat overall record/replay response was divided between the record and playback systems in a way that eliminated the need for variable equalization in the user’s equipment. Standard replay calibration tapes were produced, having a closely specified response curve, and the recording engineer, having equalized his replay equipment to ensure that these standard tapes played with a flat frequency response, was required to vary the equalization of his recording system until the overall record/replay system response gave the same flat overall response.

However, the performance of tape coatings and our knowledge of record and replay head design has so far improved that the equalization originally specified is not only unnecessary but actually degrades the acquired performance of many of the recent types of tape.

The equalization to be applied to the system was specified indirectly as the relation between the signal voltage at the input of the recording chain and the resultant surface induction (now the short-circuit flux) on the tape. It was defined as the combination of two curves, one being the response of an RC circuit with a time constant of 350 microseconds, defining the low-frequency performance, and a second RC circuit with a time constant of 120 microseconds defining the performance at frequencies above about 800Hz. The combined frequency response can be read from

Table 1: Standard time constants

<table>
<thead>
<tr>
<th>Tape Speeds</th>
<th>Time Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>76.2 cm/s (20in/sec)</td>
<td>35 Infinity</td>
</tr>
<tr>
<td>38.1 cm/s (15in/sec)</td>
<td>70 Infinity</td>
</tr>
<tr>
<td>19.59 cm/s (7.75in/sec)</td>
<td>100 Infinity</td>
</tr>
<tr>
<td>9.53 cm/s (3.6in/sec)</td>
<td>300 Infinity</td>
</tr>
<tr>
<td>4.76 cm/s (1.1in/sec)</td>
<td>1200 Infinity</td>
</tr>
</tbody>
</table>

Table 2: Typical performance characteristics of cassette tapes

<table>
<thead>
<tr>
<th>Tapes</th>
<th>Bias level</th>
<th>MOL</th>
<th>Sensitivity</th>
<th>10kHz at</th>
<th>Noise</th>
<th>Print</th>
<th>FeCr tapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>120ps</td>
<td>1.26</td>
<td>5.14</td>
<td>0.03</td>
<td>-4.14</td>
<td>50.76</td>
<td>-53</td>
<td>1.34dB</td>
</tr>
<tr>
<td>70ps</td>
<td>3.13</td>
<td>7.3</td>
<td>0.7</td>
<td>-6.38</td>
<td>54.75</td>
<td>-48.5</td>
<td>5.33dB</td>
</tr>
<tr>
<td>pseudo-chrome</td>
<td>6.33</td>
<td>5.08</td>
<td>0.87</td>
<td>-6.12</td>
<td>54.32</td>
<td>-47.85</td>
<td>0.83dB</td>
</tr>
<tr>
<td>Metal tapes*</td>
<td>11.3</td>
<td>6.82</td>
<td>0.6</td>
<td>-5.56</td>
<td>54.48</td>
<td>-46.6</td>
<td>0.24dB</td>
</tr>
</tbody>
</table>

Notes
1. Cr sensitivity quoted with respect to DIN Cr sensitivity on optimum bias setting.
2. FeCr sensitivity quoted with respect to DIN Fe sensitivity.
3. Metal sensitivity quoted with respect to Nakamichi X2 metal tape.
4. @ Equalization problem on Nakamichi with FeCr tapes.
5. **The limited extended compared to Dolby extended in other words.
6. From an initial inspection of the Table it would appear that the high-frequency saturation level of metal tapes is little better than that of good-quality ferric tapes.

However, the tests carried out on the metal tapes were with 70us equalization whilst those in the ferric tapes were done using 120ps equalization. In absolute terms, the performance of the metal tapes relative to the ferric is little greater than 4dB, but because the manufacturers have chosen to use a different equalization arrangement, the benefits of improved high-frequency saturation are not realized by the user. As far as the average user is concerned, the main advantage of using a metal tape would be an improvement of 4dB in background noise level.

Fig. 8. Recording characteristics (BS1566)

Fig. 9. Using the appropriate curves. The low-frequency signal is boosted and the high-frequency signal attenuated in the recording process to minimize distortion arising from the limited signal handling capacity of magnetic tape at high frequencies. Table 1 provides data on the agreed correction curves for all the current standard tape speeds.

To obtain a flat overall record/replay response, the relay chain must have the inverse response, but to achieve this some additional high-frequency equalization must be included to compensate for the high-frequency losses in the replay head.

The standard replay calibration tapes are recorded with a carefully calibrated surface short-circuit flux/frequency relation that follows the specified recording response. When these tapes are used to obtain a flat replay system frequency response the losses in the replay system are automatically corrected and the desired flat response is obtained for the whole record/replay set.

During the few years following the standardizing of the 120µs equalization, the high-frequency signal-handling capacity of tapes has been greatly improved and designers have taken advantage of this by changing the recommended recording equalization time from 120µs to 70µs. This necessitates an equivalent change in the replay system frequency response, usually achieved by providing two or three alternative switch-selected frequency response curves. A 120µs equalization curve is used for all the ferric tapes and some of the early chromium and cobalt modified tapes, the 70µs equalization curve being employed with the later chromium and pure metal tapes.

Current semi-professional machines and the better domestic units now both bias and equalize simultaneously, generally using separate controls. Used with understanding, this ensures near-optimum performance with most tapes. Professional and semi-professional machines usually provide a step-less control of bias.

Current tapes

At this point it appears appropriate to change from outlining simple theory to looking at some examples of current practice in tape production. About 100 samples of current cassette tapes from 25 suppliers were examined, using a Nakamichi 582 disc-reel head machine, which is a good modern machine, with facilities for bias and equalization adjustment, and which is capable of handling metal tapes without saturating the recording head core.

The bias settings were chosen using the Nakamichi facilities for equalizing the signal outputs at frequencies of 400Hz and 15kHz and with the equalization set to 120µs for the ferric tapes and 70µs for the ferrichrome, chromium dioxide and metal tapes. The bias settings are quoted in dB with respect to the appropriate DIN sensitivity, but since there are as yet no metal reference tapes, the bias setting employed for these tests are quoted with reference to the Nakamichi metal tape.

The results of all examples of each type of tape coating are averaged and these are the values in Table 2. The limits given in the ‘Frequency Response’ column should only be taken as being generally indicative of the results, the complete curves being used for an equal comparison.

The advantage possessed by the metal-tape type of high saturation values at high frequencies is not immediately obvious from the data in the Table, being marked by the reduction of the high-frequency replay pre-emphasis from 120µs to 70µs. Table 1 shows that the increase in high-frequency signals that the metal tapes accept allows a reduction in the high-frequency attenuation of the standard recording amplifier and this in turn necessitates a reduction in the replay pre-amplifier high-frequency boost, with a corresponding improvement in the overall signal/noise ratio.

Table 11 shows response curves are provided for each type of tape in Fig. 10. Five separate bias levels are needed to obtain optimum performance from every type of bias. However, the person who buys a set of bias and special ‘offer’ tapes is unlikely to be interested in paying for a wide range of bias adjustment on his machine, so three levels of bias would be adequate for the majority. Few of the cheap machines provide bias adjustment so the best performance is to be obtained by the simple ferric tape.

The penalty for buying ‘special offer’ and ‘advertisement-postal circuses’ types of tape is illustrated by the frequency response of Fig. 11. This is measured fre-
An article discussing the frequency response of professional tape recording, and its effects on quality. It includes a section on tape jamming, and references to past work on magnetic tape coatings. The text also mentions the use of sawtooth waveforms and the importance of reducing distortion to improve performance. The article concludes with a discussion of the future of tape recording technology.
**Surface acoustic wave devices**

2 – More on bandpass filters, delay lines and oscillators

by R. J. Murray and P. D. White  
Philips Research Laboratories

The second part gives fuller information on the specifications, operation and performance trade-offs of bandpass filters, delay lines and oscillators.

**Bandpass filters**

There are two types of SAW bandpass filters. The first is the transversal filter, which consists of two or more interdigital transducers (see "principles") and is a travelling wave structure. These filters are wideband, with bandwidths of 0.2% to 10% of centre frequency. Centre frequencies in the range 10MHz-500MHz are readily achievable with a projected upper limit in excess of 1.5GHz. Design procedures are similar to those used for digital filters. The second type of bandpass filter is the resonator kind, which consists of one or more interdigital transducers in a cavity formed by two surface wave reflectors. This structure supports a standing wave. Bandwidths of 0.01% to 1% of centre frequency are feasible, with centre frequencies currently in the range 50-500MHz and ultimately greater than 1.5GHz. Design procedures are similar to those of conventional LC filters.

Transversal filters. Fig. 7 (a) shows a SAW transversal bandpass filter, which consists of two interdigital transducers on a piezoelectric substrate. An electrical signal is fed into one transducer, converted to a surface acoustic wave, reconverted to electrical energy at the other interdigital transducer and emerges as a filtered signal. An alternative structure is shown in Fig. 7 (b) which incorporates in the SAW propagation path a multistrip coupler consisting of a series of parallel uncongested metal strips. This acts to transfer the surface wave from one track to another, providing discrimination against unwanted bulk waves which are also launched by the i.d.t.s.

If two i.d.t.s have individual frequency responses \(H(f)\) and \(H(f')\), where \(f\) is the frequency, then the overall filter transfer function \(H(f)\) is given by:

\[
H(f) = H(f)/H(f')
\]

where \(c = v/\alpha\), \(v\) is the geometric centre-to-centre separation of the i.d.t.s, \(\alpha\) is the SAW velocity and \(\beta\) denotes complex conjugate.

---

**SAW devices from Mullard.**

Backed by many years of research and development at Philips Research Laboratories, surface acoustic wave devices are now available as production components.

* RF front end and IF filters  
* Oscillators  
* Delay lines  
* TV IF filters

Choose from a range of standard devices or let us make a customised design to your requirements.

For further details contact:  
Brian Buckingham ext 2679 or Jack Mcleroy ext 2767.

Mullard Limited, Mullard House, Torrington Place, London WC1E 7HD, Telephone: 01-580 6633, Telex: 264341.

Mullard manufacture and market electronic components under the Mullard, Philips and Signetics brands.
group delay responses of the filter. These spurious signals can cause quite large deviations from the ideal response and appropriate steps are usually taken to minimize them.

The most serious unwanted response is usually the triple transit signal which is illustrated in Fig. 8. This is caused by successive reflections from the output and input transducers before detection. If the main signal delay in \( \tau \), then the triple transit signal is delayed by \( 3 \tau \). In fact, the main signal delay is the same as the main signal. The period of ripples in the frequency response is thus \( 1/2\tau \).

The major contribution to the reflections which cause the triple transit signal is electrical and is a consequence of the three-port structure of the i.d.t. The i.d.t. has two acoustic ports and one electrical port as shown in Fig. 9. When used for launching surface waves an electrical input signal causes acoustic signals to be launched at both of the acoustic ports. If the electrical port is perfectly matched then half of the available power is delivered to each acoustic port. Conversely, if surface waves are incident on one acoustic port with the electrical port perfectly matched then half of the energy is delivered at the electrical port and one quarter is delivered at each acoustic port. Thus, for a filter consisting of two perfectly matched (electrically) conventional i.d.t.s, the minimum theoretical insertion loss is 6dB (never quite achievable in practice) and the triple transit signal is only 12dB below this level, which would result in an amplitude ripples of approximately 4dB peak-to-peak and a phase deviation from linear of approximately 25\(^\circ\) peak-to-peak.

For most applications ripples of this magnitude are totally unacceptable. The simplest technique for reducing the triple transit signal, and the most widely used in practice, is to operate the filter with a mismatched source and/or load impedance. This increases the insertion loss but drastically reduces the level of the reflected signals. Using this technique a typical insertion loss is 20dB with peak-to-peak ripples of less than 0.3dB in amplitude and less than 2\(^\circ\) from linear in phase. Therefore, when a filter has been designed to operate with mismatched terminations it is important to remember that any attempts to improve the match and thereby reduce the filter insertion loss will cause increased amplitude and phase ripple. Other, more complicated, methods of suppressing triple transit responses are available for use in filters with particularly difficult specifications.

There are several other spurious signals in s.a.w. devices which can be substantially reduced by suitable design of the i.d.t.s and substrate. Reflections from substrate ends are reduced by bevelling and applying acoustic absorber behind the i.d.t.s as shown in Fig. 10. Reflections within i.d.t.s are reduced by replacing each single electrode (a quarter of a wavelength wide) with a pair of polarized ‘double’ electrodes (each an eighth of a wavelength wide) as in Fig. 11. Spurious bulk wave responses can be attenuated by the use of a high coupling multistrip coupler on high tracking materials and/or by treatment of the lower surface of the substrate.

Resonator filters. A surface wave resonator consists of one or more i.d.t.s suitably positioned in a cavity between two efficient reflectors of surface waves as shown in Fig. 12. Unlike the more familiar bulk acoustic wave resonators employed in bulk wave devices, surface waves cannot be efficiently reflected by an abrupt discontinuity (e.g. a substrate edge) because this would cause a significant proportion of the energy to be mode converted into bulk waves. S.a.w. resonators consist of a number of large small impedance discontinuities in the form of metal strips or grooves spaced half a wavelength. This results in bandpass reflectors with peak amplitude reflection coefficients of typically 99% or higher. The resonant cavity will generally be capable of supporting several standing waves and the required mode is selected by careful design of the reflectors and the i.d.t.s.

The electrical equivalent circuit of a one-port s.a.w. resonator is shown in Fig. 13(a). This is similar to that of the familiar ‘quarter wavelength’ bulk wave resonator, consisting of an LCR resonant section (the cavity) and a short circuit capacitance due to the i.d.t. Two or more of these elements may be connected together to produce a coupled resonator. The equivalent circuit of a two port resonator is shown in Fig. 13(b).

For small lengths of the input/output i.d.t.s and \( N_2 \) is the length of the coupling i.d.t.

Normal coupled resonator behaviour is observed as \( N_2 \) is changed, as illustrated in Fig. 14. By appropriate choice of structure, including in some cases inductive tuning, various standard filter types may be realised (Butterworth, Chebyshev, etc.). In general, any number of resonators may be coupled together to form a multiple filter. A third-order filter is shown in Fig. 15.

S.a.w. resonator filters are low loss narrowband filters and are temperature stable if a quartz substrate is used. In the frequency range of application (50-1500MHz) there are very few suitable alternative filtering techniques and so the s.a.w. resonator allows narrowband filtering to be implemented at frequencies at which transmission lines are not only feasible. This has many implications in the design of modern systems where the filters may be implemented at the front end of communication systems and in the high frequency sections.

Design procedures for s.a.w. resonator filters are similar to those for LC filters and the filters are minimum phase. Unlike transversal filters, the phase response achieved for a given amplitude response is uniquely defined.

Further details of delay lines

S.a.w. delay lines consist of two i.d.t.s suitably placed on a piezo-electric substrate. Each i.d.t. is geometrically symmetric or anti-symmetric (about its geometric center) then the delay line frequency response is band-pass with a linear phase characteristic. Identical uniform transducers are usually used and the amplitude response is, therefore, (sin \( \pi L/2 \))/\( \pi L \) (see page on “Principles”). Alternatively, with a suitable asymmetric design of the i.d.t.s the delay line can be made to be dispersive (i.e. the delay varying as a controlled function of frequency).

Linear phase delay lines can be made with bandwidths of up to 100% of centre frequency over the frequency range of 10MHz - 1.5GHz. Delays ranging from 400 picoseconds to 30 microseconds or more can be achieved. Relative delays of less than 100 picoseconds can be achieved directly if electromagnetic breakthrough is not a problem, or as the differential delay between adjacent delay lines. The most attractive feature of s.a.w. delay lines is that relatively large delays can be achieved in a small volume. For an ST-X (temperature compensated) quartz substrate, a delay of 15\(\mu s \) can be obtained with an acoustic path length of 3.2mm.

Applications include radar systems, electronic countermeasure systems and target simulators. S.a.w. delay lines can also be used in discriminator circuits such as that shown in Fig. 16 where a signal is fed to a double balanced mixer via two paths, one direct and the other through a s.a.w. delay line. Provided the delay line has a linear phase response the output from the mixer is a cosine function of the input frequency and is approximately linear over the bandwidth. Linearity can be achieved over a wider bandwidth by limiting the signals at the mixer inputs to square waves.

Further details of s.a.w. oscillators

There are two distinct types of low noise, stable s.a.w. oscillators. The delay line oscillator and the feedback oscillator. The former is a conventional s.a.w. delay line in the feedback loop of an amplifier, the frequency may be linearly modulated by typically 0.1%. The latter, a s.a.w. resonator can be used in essentially the same oscillator circuits as conventional bulk wave resonators, or two port resonators can be used in an amplifier feedback loop. Resonator oscillators can only provide very narrowband linear frequency modulation but can provide better noise performance. Both types of oscillator can be used at fundamental frequencies in the range 10MHz-1.5GHz without additional multiplying circuitry. The devices are considerably smaller, cheaper and lighter than conventional oscillator techniques.
Delay line oscillators. Fig. 17 is a schematic representation of a s.a.w. delay line oscillator. The delay line consists of two i.d.m. sections separated by a distance L, with a delay line L/2 corresponding to a phase shift at a frequency of ωo, where:

\[
\phi = 2\pi L f_0^2 \text{ radians}
\]

where ω0 is the electrical phase shift around the loop (excluding the delay line and phase shifter but including the amplifier) and φ is the phase change due to the phase shifter. The loop would thus support a comb of frequencies separated by Δf, where:

\[
\Delta f = \frac{\omega_0}{2\pi L}
\]

The required mode (if φ) is selected by suitable design of the i.d.m. so that the frequency f is passed but frequencies f_n where n is a non-zero integer, are located at nulls of the response of the delay line. One simple way to achieve this is for one i.d.m. to be a uniform transducer with N periods while the other (L/2) makes the centre frequency f with traps of the six sin x responses at frequencies f_n. This technique is illustrated in Fig. 18.

Transducers with a proportion of electrodes removed are sometimes used to obtain a comb of frequencies separated by common v.f. The frequency comb may be modulated by variation of the phase in the pulse shape circuit or by a circuitly incorporated one or more varicap diodes. The output signal can be taken at any point around the loop (but not usually immediately after the modulator). For maximum power, this would normally be immediately after the amplifier; for minimum noise, immediately after the delay line is best. If a delay line amplifier used must be greater than the loss around the loop and it is common to operate the loop with the amplifier saturated. The delay line loss will typically be 10-20dB, depending on the electrical matching.

Resonator oscillators. S.a.w. resonators are used to introduce Q components operating at frequencies of 50MHz and above. Unloaded Qs in excess of 20,000 can be achieved at 250MHz. This makes it possible to use these devices as oscillator control elements to provide stable sources at fundamental frequencies in the range 50MHz to 1.5GHz.

A s.a.w. resonator may be used in an oscillator as either a one-port or two-port device. If a one-port is used, the Q component then the circuit becomes similar to that used for delay line oscillators, i.e. an amplifier and a s.a.w. device in a feedback loop. The advantage of a resonator over a delay line in this case is that the amplifier need only provide 4 to 5dB of gain since the resonator has a lower insertion loss than the delay line. However, the frequency response of a resonator is not linear phase, except over a very narrow range, and the Q component frequency will be less than potential for linear frequency modulation.

If the resonator is used as a one-port device then the circuit would be similar to that used for bulk wave crystal oscillators (c.f. Chapter 3), and because of the higher frequency (at u.f.h.) the construction could be based on a cavity or resonator stage, e.g. a quartz resonator. A single transistor can be used in some cases, giving a very compact oscillator.

Many broadcasting authorities have introduced, or are planning to introduce, vertical or circular polarization of transmitted signals to help reception on vertical aerials in cities and domestic reception. However, there is some correlation between polarization and an increase in the number of signals caused by retransmission of the signal from more than one source. Research in Japan and Germany has helped to analyse the problem.

A recent survey article - "How serious is multipath distortion?" (Ref 1) - drew attention to the lack of recognition in the UK that multipath propagation is probably the most serious cause of the degradation of quality when v.f.l.m stereo broadcasts are reproduced in the home through good quality equipment, even when reasonably careful regard has been paid to aerial installation.

The article stressed that over 25 years after the start of regular v.f.l.m. broadcasting in the UK (May 2, 1955) and about 13 years after the gradual introduction of phase-lone tone, there was still widespread lack of knowledge about the extent, and methods of mitigating multipath effects, induced to some degree by the unreliability of broadcasters, long cordon and with the problem of encouraging more listeners to use v.f.l.m. rather than m.f.m., to draw attention, except in the most empirical, terms, to this problem.

Since that article was written, several developments have taken place that do not necessarily consider the new interest in high-quality reproduction of broadcasts.

(1) While the original article drew attention to the work carried out by NRK in Norway, the information there available was limited to a short English-text summary. Full details of this valuable investigation have since been published by Mitsu Ohara in IEEE Transactions on Broadcasting (Ref 2). This paper makes it clear that multipath distortion is "far greater" on stereo than on mono transmission and also reduces stereo separation (although the early investigations in the US and UK between 1940-1960 were of course conducted in mono). Additionally it shows that multipath can be the cause of serious crosstalk into the broadcast programme of information carried on additional sub-carriers, including the SCA (subauditory channel) system widely used in the USA and, by implication, the ultrasonic tone signalling systems used in the UK, and the experimental 'programme labelling' systems, etc.

(2) Investigations carried out in the Cologne area of West Germany, including 212 site tests carried out live specially equipped vehicles, and reported in EBU Review-Technical Part (Ref 3) indicate that the addition of a vertical or circular polarization may reduce the horizontally polarized transmissions, that is any form of mixed polarization, significantly - which increases rather than decreases the extent of multipath distortion, even for listeners with good, outdoor horizontally polarized aerials. This report emphasises that from both the economic and purely technical points of view, the adoption of circular polarization in West Germany would be undesirable. This report has been published shortly after the BBC announced its intention (Ref 4) of adding a vertical component to its national v.f.l.m.m networks of Radio 1-4 (with Wrotham to be modified in 1981), on the grounds of providing a better service for listeners using car radios, although the German investigations question even this assumption.

(3) The vulnerability of digital systems (including teletext) or short as well long term echoes was noted in the earlier article. Since then it has become clear that British Telecom are experiencing more digital problems than they anticipated in the planning of high-speed digital networks (140 Mbit/s etc) even on strictly line-of-sight microwave links. The Post Office Research 1979 (Ref 5) notes that "(Analogus Lin (link) systems are relatively tolerant of the signal distortions produced by antenna polarization errors, but severe errors in the phase of the recovered carrier and timing signals which may be produced by multipath, can cause a degradation of signal quality in system performance."

To overcome multipath distortion one method is to use a system which provides a cross-polarisation diversity, both phenomena which in this context vary rapidly with both height and distance. In such cases, all such remedies as aerial height diversity, adaptive spectrum shape equalization, adaptive automatic gain control and selecting systems of some complexity, particularly when, as appears likely, it was initially expected that the 'regurgitation' of digital transmission would not require these added costs. It is now clear that well-planned multipath distortion - does polarization matter?

by Pat Hawker, Independent Broadcasting Authority

**Multipath distortion**

**Figure 1. The procedure used by Mitsui Ohara (Nikkei) for computing multipath distortion.**

![Image: www.americanhistoryshow.com]
NHK multipath study

The NHK work on distortion and crosstalk caused by multipath interference in their v.h.f. sound broadcasting constituted the first computer-assisted theoretical trial and error, the result of which raised the question of multipath distortion and the relevant parameters.

It provided a clearer picture of the characteristics of multipath distortion for both mono and stereo transmissions. It also included laboratory studies of a multipath simulator. Subjective listening tests were carried out using the simulator to investigate the relationship between distortion and the reproduced sound quality under the influence of multipath distortion. It should be appreciated that the Japanese and American pre-emphasis time-constants are 75 microseconds, whereas the European figure is 50 microseconds: this means that multipath distortion effects may be rather different in Europe than elsewhere. Nevertheless too much should not be made of this difference, since with 20 to 25 microseconds in frequency effects of multipath tend to show up intermittently and selectively rather than as continuous distortion. Mitsuao Ohara shows that distortion increases with low percentages of modulation, particularly in the strong long time delays on the reflected signals. A few examples of the results of this work are shown in Figs 5-6-5 and also in (Ref. 3).

Crosstalk—"monkey chatter" from a 67 kHz carrier in stereo AM is one of those peaks which define values for delay times of about 10 microseconds and about 20 microseconds. There is a hidden multipath channel in a multipathed channel can result in severe crosstalk to those listening on the main stereo programme or even worse, the experience noted by the BBC when experiments were carried out many years ago. The significance of the NHK work is that this can now be ascribed partly to multipath effects. Since it would be unrealistic to suppose that the type of interference from the experimental program, in the existing conditions reported by R. Camp in 'Wireless World' (Ref. 6) could arise other from receiver design or from multipath effects, though no indication of this could be gathered from the BBC comment.

Polarization and multipath

The measurements carried out jointly by the Institut für Rundfunktechnik and the Technical Deutscher Rundfunk is particularly interesting in view of the increasing use being made in the UK of mixed polarization. In the form of "slant" polarization, it is generally adopted by the BBC for their v.h.f. FM local radio stations, and by the IRL for IRL stations who use circularly polarized aerials (although a more familiar system is used in commercial broadcasting in the US). The main motivation for this was the 7 dB or so increase of signal strength obtainable with the use of vertically polarized car aerials (or on television, vertically polarized car aerials used out of doors in circumstances where there is little depolarization of the signal). There have also been some suggestions that cp may provide more homogeneous frequency coverage (through some reduction of multipath distortion).

The German work confirms that close to the transmitting antenna, cp transmissions result in much less than 4-6 dB more received car-aerial signal, even where the total power of the cp transmissions is unchanged from that of the horizontally polarized transmissions. However, it emphasizes that vertically polarized v.h.f. signals are not propagated as well as horizontally polarized signals, but in addition it strongly indicates in normal transmitter coverage that many more signals are generated over a long term with "echoes" with a vertically polarized system. Due to the horizontally polarized signal, the same technique is used in the NHK work. Unlike most previous studies, however, this work is confined to the sole criterion of receiving field strength, but also the quality of reception in terms of the subjective perception of the strength and sharpness of the received signal, the actual amount of distortion above this figure is likely to vary greatly between different receivers, depending on the equipment used to receive the signal.

Several years ago EBU Working Party K undertook a study of the work done by individual broadcasters on choice of optimum orientation for v.h.f. sound broadcasting. Their report (Ref 8) summarized the results of W. Fise (formerly IBA) differences, and in particular for U.K. work, in the results of his work. Although it is not in a perfect state of development, it is felt that this type of work is now at a stage where the collapse of the effective multipath radio propagation and polarization have on the transmission of high-quality stereo sound. Only if we really see the problems we are likely to overcome the worst effects, or at least minimize them.

We are all still in the learning stage, but it is important for quality-conscious engineers to be aware of the results of the German tests can be accepted as correct.

References

To conclude, it is necessary to stress that these comments are not intended as criticism of the work carried out or on the multipath issue or even for their decision to add a vertical component to their network. In the opinion of the Committee, the plan, in the light, in the case of the equipment, the plan is given to manufacturers of the equipment and the plan is given to the manufacturers of the equipment.
Amplitude sensing and control

by Peter Williams, Ph.D. Paisley College of Technology

There are two reasons for controlling the amplitude of a sinusoidal generator. The obvious one is that where amplitude affects the behaviour of some associated circuit or where its value is involved in consequent calculations. Less obviously any increase in amplitude changes the waveform because the output tends to lie more of the linear range of the active devices. The harmonics resulting are returned to the input where intermodulation due to the non-linearities produces new components to the fundamental frequency. These are equivalent to a phase-shift in the fundamental and have the same effect in shifting the frequency of oscillation as an equivalent phase shift. The amplitude control mechanism is essentially a negative feedback system in which some property of the output amplitude is sensed, used to modify the feedback and hence to set the amplitude to a desired level. The first two networks contain elements whose resistance is temperature- and hence dissipation-sensitive. Their time constant is made long compared with the oscillation frequency. Amplitude is then set to a value at which the heating effect (r.m.s. dependent) brings the element resistance to a level at which the oscillation is self-sustaining.

The r.m.s. methods involve elements that consume power and have of necessity a slow response. When to these factors the relatively high cost and possible temperature dependence are added, alternative solutions become increasingly attractive. One condition for sustained oscillation at constant amplitude is that the loop gain be identically unity. When a non-linear network is included in the feedback loop then the loop gain can exceed the critical value at low amplitude ensuring that oscillation build up. As amplitude increases the signal forces the non-linear elements into regions of their characteristics where the loop gain falls to less than unity. The amplitude stabilizes such that the mean value of the loop gain is at the critical level. Stabilizing action is instantaneous in that there are no time-constants involved other than strays. Disadvantage of the method is that it achieves its effect by deliberately distorting the feedback signal, though the remainder of the circuit may attenuate the harmonics as they pass through the frequency dependent network. The most common technique places a symmetrical pair of diodes (or series connected back-to-back zener diodes) so as to increase the feedback at higher amplitudes. A field-effect transistor having a low dynamic impedance at low voltages and then going into current limit would have the same effect placed in the other limbs.

A third method combines some of the advantages of the previous two. It uses only electronic devices, consumes negligible power and can introduce negligible delays. It has the disadvantage that a deliberate time constant has to be introduced into the sensing action, though this time constant can be such as to make the output and the oscillation frequency (a property not shared by thermistors of lamps whose thermal time constants must be long compared with the period of the lowest desired oscillation frequency). The output is then filtered and rectified and the direct voltage is applied to the gate of a field-effect transistor. The on-resistance of the drain-source path is varied and can form part of a potential divider feedback loop. As the positive peaks of the square wave rise, the reverse bias is increased which has the effect of reducing the current flow. The reverse bias also controls the conductance of the gate-source voltage, hence stabilizing the feedback at higher amplitudes. A field-effect transistor having a low dynamic impedance at low voltages and then going into current limit would have the same effect placed in the other limbs.

The methods above have the amplitude sensing mechanism in the passive network, and the assumption being that the amplifier is perfectly linear. It is equally feasible to incorporate the non-linearities in the forward path i.e. in the amplifier. The disadvantage is that the harmonics are then fully present at the output, the filtering due to the RC network only being effective in reducing the distortion present at the input. In both cases the distortion is minimized by arranging the loop gain for small signals to be only slightly greater than that required to sustain oscillation. This reduces the linear excursions needed to bring the overall gain back to unity and hence reduces the distortion. If the non-linearities are symmetrical about the quiescent point then harmonics are suppressed.

None of the above examples demand high-Q passive networks as the distortion introduced via the non-linearities or the sensing mechanisms need not be large. These methods are thus acceptable for simple RC oscillators even though the attenuation of harmonics offered by these networks is relatively small. With LC oscillators or certain RC oscillators based on high-Q active filters the constraint is removed. If a high-Q band-pass circuit is driven by a square wave whose fundamental frequency is the filter centre frequency, then the harmonics are so reduced that an almost pure square-sine wave results. It is difficult to maintain the drive frequency at the filter centre frequency since each time a harmonic is generated. If instead the square wave is passed through a squaring circuit then its input is a square-wave of the appropriate frequency and constant, the filter gain at the centre-frequency is constant then the constant amplitude square wave ensures an equally stable sinusoidal output. The square wave can be obtained either by a simple diode limiter or with greater accuracy using a comparator with precision dipling. Anphase feedback with diodes in the forward path of an amplifier are also found.

THEORY

- Networks are used as amplitude-controlled feedback. At low amplitudes the steady-state resistance is ~2R for the thermistor or ~R/2 for the lamp. Hence feedback ~1/3 and for standard Wien type oscillators the amplitude increases. Conversely at high amplitudes the feedback ~1/3 and amplitude decreases, stabilizing at the steady state level where the negative feedback just balances the positive feedback.

- These methods are mostly used where only approximate amplitude limiting is required, though they are instantaneous in their action while using little power. The non-linearity makes analysis difficult.

- The f.e.t. drain current (k = kV_D - V_S) for V_D > V_S = kV_D (i.e. conduction)

\[ i_D = \frac{k}{2} (V_D - V_S) \]

and is a linear function of the gate-source voltage. Hence varying the gate-source bias varies the conduction and hence the feedback.

For the second circuit

Substituting for V_D in the expression for i_D above

\[ i_D = \frac{k}{2} (V_C - V_S) \]

Hence the conductance

\[ g_D = \frac{k}{2} \frac{1}{V_C - V_S} \]

and is linear for all values of V_C while being a linear function of the new control voltage V_S. This modification allows control of the feedback without introducing any additional distortion into the system.

- For a second-order transfer function \[ V_o = k \cdot a \cdot V_i + k \cdot V_i \cdot V_o \] and a sinusoidal input the output becomes

\[ V_o = k \cdot V_i \cdot \sin(\omega t) \]

Hence there is a second harmonic term in the output which is expressed as a percentage of the fundamental term is proportional to the amplitude of the latter. Similarly higher-order terms result in harmonics of the nth harmonic in the output indicating the absence of the nth order term in the transfer function. Symmetrical transfer functions are preferred in the even-order harmonic terms are thereby cancelled so that the lowest harmonic is the third harmonic.

EXAMPLES

1. A thermistor has a maximum permitted dissipation of 3mW and sets the output of a Wien bridge oscillator to 1V r.m.s. Choose a suitable value of resistor to complete the bridge.

\[ \frac{1}{c^3} = \frac{3}{3} = 4.5 \text{ mW} \]

- Series resistor R = 1/3 (10^7) = 4.5 \times 10^4 ohms.

A suitable resistor might be 100k, to keep the thermistor well below its maximum dissipation.

2. At what output voltage does diode conduction commence in the simple diode amplitude control circuit?

Diode voltage at which current flows becomes ~0.9V. Diode voltage is 2/3 of peak output

\[ \text{Output voltage} = \frac{2}{3} \times (0.9V) \]

3. The peak sensing circuit has R = 1MΩ. If the frequency of oscillation is 1kHz, and the ripple across the capacitor is not to exceed 2% peak-peak, choose the corresponding capacitance.

For small ripple, then as in simple rectifier theory linear discharge is a reasonable assumption

\[ \frac{\Delta V}{\Delta t} = \frac{1}{C} \text{V} \]

At R = 1MΩ and V = 1V, the total voltage, the current is negligible.

\[ \Delta V \approx \frac{1}{1\times10^6} \times 1V = 10^{-6} \text{V} \]

4. The ringing resonant circuit uses a filter with Q = 10 a centre-frequency gain of 20 and an approximate square-wave of 1.2V peak-peak.

The fundamental and 3rd harmonic amplitudes are

\[ \frac{V_o}{V_i} = \frac{2}{3} \times 0.6 \times 10^{-6} \]

\[ \text{Fundamental output} = 2 \times 10^{-6} \]

\[ \text{3rd harmonic output} = 0.6 \times 10^{-6} \]

\[ \text{Output voltage} = 1.2V \]

\[ \text{Peak-peak} = 2 \times 1.2V = 2.4V \]

Hence the output is 1.2V peak-peak.
Cassette deck

Particulate audio and video cassettes are often used to minimize both direct and indirect sources of tape. The C8000 auto-tractor feeds paper up to 100 wide and can produce 80 columns, 60 dots/in and print rates of 100c/s max. Normal characters have a 5x7 dot matrix and graphics characters have a 6x7 matrix. A Centronics interface is standard, but other interfaces are available for the TRSI 200, Apple II and for RS-232C, M600 and IEEE 488. The price is £110 ex-vat. (e.g. Integrex Ltd, Church Gresley, Burton on Trent, Staffs DE3 1PT.)

Fibre-optic interfaces

A pair of small fibre-optic interfaces called S3C1-5 can be used to transmit digital signals across distances in excess of 10km and at data rates of up to 155Mb/s. These modules, one a transmitter and one a receiver, are manufactured by Lighteking and measure 30x20x15mm without the fibre-optic connector. The transmitter module operates on a 5V supply, but the receiver can be operated on 5.5 to 12V, to give a t.e.r. of 75 dB for c.m.os-compatible output. Connection is by fine-wire-wrap to fine-diameter fibre on the base of each module. Fibre-optic cables can also be supplied by this company to provide a complete data transmission system with a bit error rate of better than 1 in 10^8. Lightefing Fibre Optic Communications, 129 Lindsey St, Epping, Essex CM16 6RE.

Computer interfacing a to-d

Analog input data from sensors is processed to provide digital I/O data, for use with any computer or terminal which has a serial or RS-232C port, by the MG-PAC 4000 measurement and control system from Analog Devices. This system consists of a single 241x330mm board which provides sensor-signal conditioning, analogue multiplexers, analogue-to-digital conversion, digital I/O, serial communications lines and a p.s.u. Up to four of these boards, each of which accepts 4, 8 or 16 analogue inputs, can be used together to provide 48 channels. Expansion boards can be used to allow up to 884 channels. A variety of isolating and non-isolating signal-conditioning modules which plug directly into the p.s.u. are available for voltage and current sensing and for direct connection to thermocouples, r.t.lds (resistance temperature detectors), strain gauges, etc. For control functions, eight t.i.l-compatible outputs and eight t.i.l. or optically isolated inputs are provided on each board. Conditional signals are processed by a low-cost programmable-gain amplifier and 11-bit, integrating a/d-converter. An 802 processor with 4K t.r.m. and 1K r.r.m.  are used to scale, linearize, convert to engineering units and store the converted input data. The data update rate can be as low as 12 or 30 channels per second. A full display of all signals and test data is available over distances of up to 8000ft from the host computer, using 20mA loops (for data rates under 800). Readout rates of up to 9000 and 2000 or even per cent are switch selectable and the 20MA interface is isolated to 300V d.c. The two ASI-based provisions are compatible with assembly and high-level languages. Analog Devices Ltd, Central Avenue, East Melbury, Sherborne, Dorset DT13 9LE.

15in oscilloscope

Various face-plates and phosphors are available for the 15in c.r.t. of the 1350 data oscilloscope from Blackmore Technology. With this scope, its small spot size and high bandwidth, it can be used in a number of applications, including the measurement of waveforms from computer-based analysers, radars, sonars and most processing systems, including a t.e.r. within 0.5s/cm and one degree phase shift up to 3MHz are quoted for the identical X and Y amplifiers. An internal three-scope-application, external continuously variable attenuator, and input impedance- adjusting controls are provided for these amplifiers. The Z amplifier, with a range of 300mV, has differential inputs, with voltage ranges from 1 to 100. A p.r.c. control unit is also provided. The photo shows the oscilloscope displaying data from an i.f. spectrum analyser. Robot Electronics Ltd, Rose Industrial Estate, Core End Rd, Bourn End, Bucks SL5 5AS.

Zero insertion force sockets

Under conditions where occasional field replacement of L.c. is unavailable the Etron Zip from BFI Electronics can be used. These zero-insertion-force i.c. sockets are designed for production rather than test applications and the usual locating key is replaced by a screw head. Oliveira, however, between boards is similar to other such devices on the market but the cost per unit has been kept low. Six versions are available to take 16, 24, 28, 40, 48 or 64 pin i.c. and the ciruit is re-flowable gold-plated to 100um thickness. BFI Electronics Ltd, 10 Walton Rd, West Molsey, Surrey.

Magnet machining

Permanent magnets from stock or supplied by the customer can be machined by Magnet Developments Ltd. Their factory, as they say, is equipped with Citizen and Okuma vertical and horizontal machining centers, geared to machine and cut permanent magnets to the accuracy that is necessary for those applications. The types of magnets stocked by this company include sintered and bonded rare-earth types, uniaxial and flexible ferrites and cast-irons. A design advisory service is also available to customers. Magnet Developments Ltd, Unit 7, Hands Road, Trading Estate, Swin- don, Wilt SW1 4QJ.
Cycling still hurts.

My heart-rending experience with the bike (Feb. issue) did not go unnoticed. Keith Matthews, of the Wessex District Cyclists' Touring Association, writes to tell me it not to be so silly-livered and to have another go (although he is much too polite to put it in those words). It's all my fault, it seems - something to do with my not being "bike fit" and not having anything better to ride than a Moulton. Well, I'm quite ready to agree with him about my not being in shape for this sort of thing. He says Moultons were little bikes. Maybe that's the trouble. I ought to have one of those tidy-looking contraptions with a saddle like an emaciated razor blade and handlebars bent down to somewhere near the front hub.

I am considerably encouraged, however, by Mr. Matthews' assertion that most car drivers will give way to a bike (I am informed that I cannot be a cyclist until I graduate - maybe by riding the three miles without my feet touching the ground or being provided of personal abuse) because they realize that if they hit you, you will probably bleed all over the paintwork, which makes a point as well as a car wash, a matter of some inconvenience and expense.

The real point of his letter was not, however, all the above, but was contained in the last sentence. He assumes that I shall take up my cycling career after its disastrous start, and will want to try the bike computer this all started with in the February issue. When I do, he says, I shall discover that it is unnecessary above 30m.p.h. (say 60m.p.h.). That 'tactfully demonstratesthe gulf that separates us bikers from real cyclists. Thirty miles an hour is a mere trifle to the really serious heads down at the stonemonger's. All he wants is a couple of dozen primary arteries for the start of the bronco-shooting season and here was this character offering him unpen models to fit different shaft sizes: all equally well-chipped, mind you, but totally incompatibly.

I have released a bit, for now. For one thing, I don't want to drive my wife to school since the gave up the car, and, for another, I've learned more sense. The move to Sutton has helped, too. Now I take my mornings very gently, luxuriating over a leisurely bath, savouring a proper breakfast and invariably having a second cup of tea.

Even so, taking all this gracious living into account and making due allowance for the need to keep abreast of world affairs, I can see no possibility of television getting a look in that time in the morning. There are many things I want from life, but my razor-caked, crispy bacon and scrambled eggs in no one of them. As far as I am concerned, thanks, but no thanks. This is one of those completely irrational coincidences for orange juice, or Snappefables, or whatever. And that snazzy little johnny, or something. It is quite bad enough when printed in a newspaper, but I do not expect my morning, just like that, by a television person - well, it's enough to cut the milk.

Spont - quiet. Please, it's breakfast time.

When I was a bit younger, I used to have a fairly strenuous time in the morning. Everything was worked out to the nearest couple of microseconds, and a few seconds spent in putting a new blade in the razor or a serious lapse in concentration resulting in the soup getting itself in the bathwater could cause havoc. Many's the time I've been ejected from the house without a second cup of tea. Manners were fairly elementary then.

I've relaxed a bit, now. For one thing, I don't want to drive my wife to school since the gave up the car, and, for another, I've learned more sense. The move to Sutton has helped, too. Now I take my mornings very gently, luxuriating over a leisurely bath, savouring a proper breakfast and invariably having a second cup of tea.

Even so, taking all this gracious living into account and making due allowance for the need to keep abreast of world affairs, I can see no possibility of television getting a look in that time in the morning. There are many things I want from life, but my razor-caked, crispy bacon and scrambled eggs in no one of them. As far as I am concerned, thanks, but no thanks. This is one of those completely irrational coincidences for orange juice, or Snappefables, or whatever. And that snazzy little johnny, or something. It is quite bad enough when printed in a newspaper, but I do not expect my morning, just like that, by a television person - well, it's enough to cut the milk.

Thing-un-a-jig

O brahmin d'ay! Callof! Callay! The duallist Schottky is a real nosebleed. I do beg your pardon - I was so overcome by the arrival of a bit of paper announcing availability of the film that I felt a little outgrowing of the moment was permissible. But all right - it'll stop now, or Ed. will vorpal the page right here.

Isn't it lovely, though? Anyone whose imagination is untouched by a chance to use a dual stubbleless Schottky must be a cold fish indeed, I should think. Not just one, mark you, but a dual package of the odious little beans. Now that they're here, and not before time, if you ask me, we've got to find something really beamish to do with them, before some dummy square write in to say they're intended as rectifiers, or some such earthbound fare.

It's been rather thought to see that a dual stubbleless Schottky is not a device you can tie down to too anything too specific. It requires a bit of true rein - to be allowed to breathe and develop in an atmosphere of its own, look, there is going to be a lot more of this Ed.)

You have no idea how frustrating this job can be sometimes. I was only going to say that a d.s.s. could be the very thing for one of those electronic games, maybe running the Snake, each player being armed with a paddle-controlled vertical blade. Every time a v.h. went 'snickerack' the d.s.s. would light up, or something.

Well, it's only a thought. You can't give a device a name like dual stubbleless Schottky and expect people to use it for anything too serious.
Soldering equipment designed by specialists for professionals.

**ADCOLA 101 Soldering Unit**

- no moving parts
- no magnetic effect
- no tip voltage
- no mains interference
- no real maintenance costs (hit/tip changes only)
- variable lockable temperature 120°C — 420°C
- total 50 watt electronic control (± 2%) simple plug-in
- electrical safety approved 240V 24V
easy tool interchanging from one Unit to another

**FEATURES**

- variable lockable temperature 120°C — 420°C
- total 50 watt electronic control (± 2%)
- no moving parts
- no magnetic effect
- no tip voltage
- no mains interference
- no real maintenance costs (hit/tip changes only)

**-or complete 200I Soldering Station**

Soldering tool and control unit as Unit 101 but with the additional features:
- filtered two speed fume extraction
- built in bench lighting
- solder reel dispenser
- clear bench area
- Adiron® long life bits/tips the same range as that for Unit 101

---

**ADCOLA PRODUCTS LIMITED**
Gauden Road London SW4 6LH
Telephone Sales (01) 622 0291 Telex 21851 Adcola G

---

**DE LUXE EASY TO BUILD LINSLEY HODG 75W STEREO AMPLIFIER £85.00 + VAT**

This easy to build receiver of our worldwide acclaimed 75W amplifier kit based upon circuit blocks channelized with fully printed circuit assembly utilizing in-circuit wiring and five channel HEMT circuitry. The prototype was operated with excellent results. Fully finished frame and features include complete line filter, variable control, easy interchange, complete range of accessories and tape monitoring while vacuum tube output in excess of 237.2.

Above 2 kits are supplied with fully finished metalwork, neck assembled high grade tool kit, cabinet, cable, tools, bits, and full instructions — in flat-enclosed.

**BLACK HOLE CHORALIZER**

The *BLACK HOLE* designed by Ted Dr. is a powerful new musical effect device for producing both natural and electronic soundscapes. Designed with genuine VIBATO™ gain modulation and a CHORDAL mode which gives a wide range of new approaches to musical applications. An HEMT amplifier, introduced in the frequency response, helps up and down as the tone level is modulated by the change in frequency. An optional double change mode allows the new finishes effects to be emitted. The tone can then be varied with a four channel control. This ideal selection variable, has variable amplitude, has high, medium, and low cutoffs for frequency and changes in tonal level will not affect the original tone. The kit includes fully finished metalwork, 100% PCB, controls, wires, etc. — Complete down to the last nut and bolt.

**MARCH TRANS 5000**

This versatile unit contains as a conventional feature in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with audio level controls on each channel. Control of the filter comprises an envelope control and a set of five independent level control channels. The combination makes possible a wide range of soundscapes in that the frequency range and level can be set to suit the experiments. The filters are available in a choice of types to suit the needs of the user.

**COMPLETE KIT ONLY £49.80 + V.A.T**

De Luxe version (dual delay line system) also available for £99.80 + V.A.T.

**CHROMATIQUE 5000**

6 CHANNEL LIGHTING EFFECTS SYSTEM

This versatile unit consists of an integrated unit in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with audio level controls on each channel. Control of the filters comprises an envelope control and a set of five independent level control channels. The combination makes possible a wide range of soundscapes in that the frequency range and level can be set to suit the experiments. The filters are available in a choice of types to suit the needs of the user.

**COMPLETE KIT ONLY £49.50 + V.A.T**

**MARCH TRANS 200**

100 WATT (rms into 8Ω) MIXER/AMPLIFIER

Powerful 8Ω rated speaker output at 250W. MARCH 200 is an exceptionally low priced — industrial purpose high power amplifier. It is favourites most highly recommended for use in the internal digital circuits where it produces stereo sound with excellent listening and sequencing effects. Each channel handles up to 500W and the kit is a single box design wiring is minimal and the construction very straightforward. Kit includes fully finished metalwork, 100% PCB, wires, etc. — Complete down to the last nut and bolt.

**MATCHES THE CHROMATIQUE 5000 PERFECTLY!**

---

**SP-200 2-CHANNEL 100W AMPLIFIER**

The power amplifier section of the SP-200 100W amplifier kit very popular and reliable too. This new design incorporates all the necessary features to suit the needs of the user.

**COMPLETE KIT ONLY £64.90 + V.A.T**

---

**MANY MORE KITS ON NEXT PAGE!**

**OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!**

---

**POWERTRAN ELECTRONICS**
PORTWAY INDUSTRIAL ESTATE ANDOVER
ANDOVER HANTS SP10 3NN
(0264) 64455

---

**DE LUXE EASY TO BUILD LINSLEY HODG 75W STEREO AMPLIFIER £85.00 + VAT**

This easy to build receiver of our worldwide acclaimed 75W amplifier kit based upon circuit blocks channelized with fully printed circuit assembly utilizing in-circuit wiring and five channel HEMT circuitry. The prototype was operated with excellent results. Fully finished frame and features include complete line filter, variable control, easy interchange, complete range of accessories and tape monitoring while vacuum tube output in excess of 237.2.

Above 2 kits are supplied with fully finished metalwork, neck assembled high grade tool kit, cabinet, cable, tools, bits, and full instructions — in flat-enclosed.

---

**T20 + 20 20W STEREO AMPLIFIER £33.10 + VAT**

This kit, based on a design published in the Practical Electronics, enables a complete printed circuit board and uses as very low cost, state of the art electronics and the normal electronics found in most two channel amplifiers. A 20 watt, 20 watt amplifier is essentially a complete two channel amplifier that throws in two more. The kit includes fully finished metalwork, 100% PCB, controls, wires, etc. — Complete down to the last nut and bolt.

---

**1024 COMPOSER**

**READ ALL ABOUT IT!**

**IN ELECTRONICS TODAY INTERNATIONAL**

Programmed from a synthesizer, our latest design to be featured in ELECTRONICS TODAY INTERNATIONAL has 1024 COMPOSER capable of producing a wide range of soundscapes in that the frequency range and level can be set to suit the experiments. The filters are available in a choice of types to suit the needs of the user.

**COMPLETE KIT ONLY £49.80 + V.A.T**

De Luxe version (dual delay line system) also available for £99.80 + V.A.T.

---

**DE LUXE EASY TO BUILD LINSLEY HODG 75W STEREO AMPLIFIER £85.00 + VAT**

This easy to build receiver of our worldwide acclaimed 75W amplifier kit based upon circuit blocks channelized with fully printed circuit assembly utilizing in-circuit wiring and five channel HEMT circuitry. The prototype was operated with excellent results. Fully finished frame and features include complete line filter, variable control, easy interchange, complete range of accessories and tape monitoring while vacuum tube output in excess of 237.2.

Above 2 kits are supplied with fully finished metalwork, neck assembled high grade tool kit, cabinet, cable, tools, bits, and full instructions — in flat-enclosed.

---

**DE LUXE EASY TO BUILD LINSLEY HODG 75W STEREO AMPLIFIER £85.00 + VAT**

This easy to build receiver of our worldwide acclaimed 75W amplifier kit based upon circuit blocks channelized with fully printed circuit assembly utilizing in-circuit wiring and five channel HEMT circuitry. The prototype was operated with excellent results. Fully finished frame and features include complete line filter, variable control, easy interchange, complete range of accessories and tape monitoring while vacuum tube output in excess of 237.2.

Above 2 kits are supplied with fully finished metalwork, neck assembled high grade tool kit, cabinet, cable, tools, bits, and full instructions — in flat-enclosed.

---

**DE LUXE EASY TO BUILD LINSLEY HODG 75W STEREO AMPLIFIER £85.00 + VAT**

This easy to build receiver of our worldwide acclaimed 75W amplifier kit based upon circuit blocks channelized with fully printed circuit assembly utilizing in-circuit wiring and five channel HEMT circuitry. The prototype was operated with excellent results. Fully finished frame and features include complete line filter, variable control, easy interchange, complete range of accessories and tape monitoring while vacuum tube output in excess of 237.2.

Above 2 kits are supplied with fully finished metalwork, neck assembled high grade tool kit, cabinet, cable, tools, bits, and full instructions — in flat-enclosed.

---

**DE LUXE EASY TO BUILD LINSLEY HODG 75W STEREO AMPLIFIER £85.00 + VAT**

This easy to build receiver of our worldwide acclaimed 75W amplifier kit based upon circuit blocks channelized with fully printed circuit assembly utilizing in-circuit wiring and five channel HEMT circuitry. The prototype was operated with excellent results. Fully finished frame and features include complete line filter, variable control, easy interchange, complete range of accessories and tape monitoring while vacuum tube output in excess of 237.2.

Above 2 kits are supplied with fully finished metalwork, neck assembled high grade tool kit, cabinet, cable, tools, bits, and full instructions — in flat-enclosed.
The range grows bigger...better...

New Profile Amplifiers - Two New Series

**MOSFET**

**CHOOSE AN I.L.P MOSFET POWER AMP**

When power amplifiers are used in high-end systems, the overall sound quality is paramount. The new MOSFET power amplifiers by I.L.P offer a significant improvement in performance and reliability. They are designed to work with complex inputs without distortion and provide ample headroom for crossover. The I.L.P MOSFETs are specifically developed to address the needs of audiophiles, offering superior performance and efficiency. I.L.P MOSFETs are identical in performance to the costliest amplifiers in this market.

**BIPOLAR**

**CHOOSE AN I.L.P BIPOLAR POWER AMP**

With power amplifiers being used in high-end systems, the overall sound quality is paramount. The new bipolar power amplifiers by I.L.P offer a significant improvement in performance and reliability. They are designed to work with complex inputs without distortion and provide ample headroom for crossover. The I.L.P bipolar power amplifiers are specifically developed to address the needs of audiophiles, offering superior performance and efficiency. I.L.P bipolar power amplifiers are identical in performance to the costliest amplifiers in this market.

**NEW PRE-AMPS**

HY6 (mono) and HY66 (stereo) are the latest in I.L.P's range of advanced audio modules. These improved characteristics and styling ensure they are compatible with all I.L.P power amplifiers. Whether for home use or in professional situations, the HY6 and HY66 pre-amplifiers offer superior performance and reliability. The HY6 and HY66 pre-amplifiers are protected against short circuit and wrong polarity. Full assembly instructions are provided.

**NEW POWER SUPPLY UNITS**

Of the many power supply units on offer, these meet our current range. Some have identical transformers, and some have different transformers, which are made by leading transformer manufacturers. These are all made to I.L.P's specifications and are proven to be reliable. The new power supply units offer a higher overall design efficiency, making them ideal for use in high-end systems.

**FREE POSTAGE**

When ordering from the UK, I.L.P offers free postage on all orders over £100, and on orders under £100, postage is £5.00. This offer is valid on all products, excluding special orders.

**TO ORDER**

Send a completed order form with payment to I.L.P Electronics Ltd., located at 123 Old Road, London, SW10 9NP. Payment options include cheques, postal orders, and bank transfer. For further details or to place an order, please contact I.L.P Electronics Ltd. at 0207 123 4567.
S 100
Do You Have All These Facilities On Your S 100 System, With Just Two Boards?

1. Z80A CPU 2 and 4 MHz
2. 2406 CRT, 4 Channels
3. 2404 STO, 2-8 MHz
4. Disk Drive
5. Disk controller. Takes up to 8 disk drives, single or double density operation
6. 844 bytes of memory, expandable to 256K
7. Real time clock
8. Standard 2x Monitor CP/M Cost From Loader (CP/M 8010-1.4)

PORTABLE RADIO CASE

Last month's trip to the country was all the more enjoyable thanks to my new portable radio. It is so lightweight that I hardly noticed it was with me. The radio is always with me as I often listen to music on the way to work. In addition, it is very versatile because it can also be used as a distant receiver. The sound quality is excellent, making it a perfect choice for those who enjoy listening to music on the go.

LAST MONTH'S SNIP... STILL AVAILABLE

(Continued from page 5)

Your last chance for this bargain

100 watts only, regular price £239.99, now only £219.99! Don't miss your chance to own this fantastic piece of audio equipment. Order yours now and save big on this limited-time offer.

EMOTEC VOLTAGE SENSITIVE

Your 4th of July holiday will be complete with this voltage sensitive unit. It is the perfect addition to any audio setup, providing a unique and exciting sound experience. Order yours today and experience the wonders of voltage sensitivity.

SEMEL

MICROCOMPUTER - HARDWARE - SOFTWARE

3c Beverley Market Street, Tavistock, Devon PL19 0JF
Tel: Tavistock (0822) 8247. Telex: 45263

CLEF ELECTRONIC MUSIC

PIANOS SPECIALISTS SINCE 1950 COMPLETE & STARTER TYPES KITS FOR MANUFACTURERS

MASTER RHYTHM

The best and practical form of Music is found in Clef Electronic Music.

Write or Phone for full details of our Starter Kits, £250.00, complete with all components, or £125.00 as complete kit.

BRIDGE RECTIFIER

both for £29.00, 125v AC to DC, 5A.

SOLENOID WITH PLUGGER £1.99

MOTORISED DISCO SWITCH

Two main motors, £1.35 each. Two small motors, £0.85 each. One large motor £4.99

MINI MULTI TESTER

Free with your order. Only £4.50

LEVEL METER


J. BULL (Electrical) Ltd.

(Dept. WW), 34 - 36 AMERICA LANE, HAYWARDS HEAT, SUSSEX RH16 3OU.

ADVANCE ADVERTISING BARGAINS LIST

Our latest list of bargains includes a range of electronic products at discounted prices. If you are looking for a new electronic gadget, check out our list and save on the latest trends in technology.

THERMOMETER SURVEILLANCE

Keep track of your home's temperature with our digital thermometer. Perfect for monitoring the temperature in your home or office, this gadget is a must-have for anyone who wants to stay informed about the weather.

LIGHT CHANGER

Transform your home's ambiance with our light changer. This gadget is perfect for adding a touch of style to your home, with a variety of lighting options to choose from.

WIRE FLEX CABLE

Suitable for use with all types of electronic devices, this cable is durable and reliable. Order yours today and experience the convenience of our wire flex cable.

MODULAR INDICATOR

Our modular indicator is perfect for any electronic project. Available in a range of sizes and colors, this gadget is the perfect choice for anyone who wants to add a touch of style to their electronic project.
S-2020TA STEREO TUNER/AMPLIFIER KIT

**NEW HIGH PERFORMANCE TUNER**

A high-quality push-button FM Varicap Stereo Tuner with pilot cancel decoder combined with a 24W r.m.s. per channel Stereo Amplifier, using Bifet op. amps. front end, triple gang varicap tuning.

The unit is designed to decode not only UHF but virtually all other systems (Not CD4), including the new BBC HJ. 10 input selections.

Price £49.95 + VAT.

Nelson-Jones Mk. 2 STEREO FM TUNER KIT

A very high performance tuner with dual gate MOSFET RF and mixer ready built front end, triple gang varicap tuning, linear phase I.F. and 3 state MPX decoder.

Price £74.95 + VAT.

**S5050A STEREO AMP**

Kit with rela-channel 0.05% THD 3N 1008. Max. 86 dB. Output power using 3000 per channel.

Price £69.95 + VAT

(Included our 20w/ch BIFET S5030 Amp.)

**INTRUDER 1 Mk. 2 RADAR ALARM**

With Home Office Type approval

The original Wireless World published Intruder 1 has been re-designed by Intruder to incorporate several new features, along with improved performance. The kit is very easy to build. The internal audible alarm turns off after approximately 40 seconds and the unit re-arms. 240V ac mains in 72 hours later. Equipped as a hard backed book. Direction range up to 45 feet. Internal mains rated voltage free contacts for external alarm.

Complete kit £52.50 plus VAT, or ready built and tested £68.50 plus VAT.

Wireless World Dolby noise reducer

Trademark of Dolby Laboratories Inc.

<table>
<thead>
<tr>
<th>Component</th>
<th>Price: £49.95 + VAT (2-lead model available)</th>
<th>(Also available our 20w/ch BIFET S5030 Amp)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ex-warehouse ready built and tested</td>
<td></td>
</tr>
<tr>
<td>Calibration taps are available for separate use and for separate service. Single phase plug in BIFET</td>
<td>£67.85 + VAT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PROVIDING BOARD 52 x 37mm with gold plated contacts</td>
<td>Price £67.85 + VAT</td>
</tr>
</tbody>
</table>

We guarantee full after-sales technical and servicing facilities on all our kits. have you checked that these services are available from other suppliers?

INTEGREX LIMITED

Phone and S.A.E. for complete list and specifications

Portwood Industrial Estate, Church Gresley, Burton-on-Trent, Staffs DE11 9PT

Burton-on-Trent (0283) 215432

Tel: 377106
Cotswood Electronics
Toroidal Power Transformers
Budget range for the amateur and professional.

<table>
<thead>
<tr>
<th>Code</th>
<th>Volts</th>
<th>Current</th>
<th>Dimensions (mm)</th>
<th>Weight Kg</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>6010</td>
<td>100</td>
<td>20</td>
<td>150x100x50</td>
<td>0.6</td>
<td>£169</td>
</tr>
<tr>
<td>6011</td>
<td>150</td>
<td>30</td>
<td>200x150x50</td>
<td>0.9</td>
<td>£214</td>
</tr>
<tr>
<td>6012</td>
<td>200</td>
<td>40</td>
<td>250x200x60</td>
<td>1.2</td>
<td>£270</td>
</tr>
<tr>
<td>6013</td>
<td>250</td>
<td>50</td>
<td>300x250x70</td>
<td>1.5</td>
<td>£324</td>
</tr>
</tbody>
</table>

MODERN LABORATORY TOOL HOUSE
IN ATTRACTIONAL STEEL CASE

* HOLD SIX EPROMS
* SAFETY INTERLOCKED
* EPROM TRAY
* SEPARATE ERASE INDICATOR
* MONEY BACK GUARANTEE

£38.50 POST FREE
Including VAT

Low Cost Erasure

Electronic Measurement Services
REPAIR & CALIBRATION SPECIALISTS OF
TEST & MEASURING INSTRUMENTS

Happy Memories

<table>
<thead>
<tr>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>£2.25</td>
</tr>
<tr>
<td>£2.95</td>
</tr>
<tr>
<td>£3.95</td>
</tr>
<tr>
<td>£5.20</td>
</tr>
<tr>
<td>£5.25</td>
</tr>
</tbody>
</table>

Memorex Soft-sectoried mini-disks for PET, TRS-80 etc. Supplied in FREE
LIBRARY CASE, £19.95 per 10

Otari
World Leader in Duplicating
& Tape-loading Equipment

* C2 In-cassette Copier
High quality at low cost. Sierco, Expandable to 11 copies, Femire
heads. DC servomotors.

Sole UK Distributor:
ITA, 17 Harewood Avenue, Marylebone Road, London W1. Tel. 01-794 2497. Telex: 21879.

STRUTT LTD
ELECTRONIC COMPONENT DISTRIBUTORS
ETC
36 BARLEY MARKET STREET, TAVISTOCK
down, ENGLAND PL19 0JF

Memories

<table>
<thead>
<tr>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>£2.10</td>
</tr>
<tr>
<td>£1.89</td>
</tr>
<tr>
<td>£3.15</td>
</tr>
<tr>
<td>£4.99</td>
</tr>
<tr>
<td>£1.54</td>
</tr>
<tr>
<td>£1.54</td>
</tr>
<tr>
<td>£1.76</td>
</tr>
<tr>
<td>£0.74</td>
</tr>
<tr>
<td>£0.94</td>
</tr>
<tr>
<td>£1.26</td>
</tr>
<tr>
<td>£1.68</td>
</tr>
<tr>
<td>£2.10</td>
</tr>
<tr>
<td>£2.83</td>
</tr>
</tbody>
</table>

Please add 30 pence for carriage. All prices EXCLUDE VAT.

Please send s.a.e. for price list.

SAFGAN presents DT-400 series from £169 + VAT
HIGH-QUALITY DUAL TRAC SCICLOSCOPES
A BRITISH PRODUCT EVERYONE CAN AFFORD

<table>
<thead>
<tr>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>£2.20</td>
</tr>
<tr>
<td>£2.25</td>
</tr>
<tr>
<td>£2.95</td>
</tr>
<tr>
<td>£5.20</td>
</tr>
</tbody>
</table>

Orders to: SAFGAN ELECTRONICS LTD. (Orders + 15% or £3.50 P&H) Or 08555 postal service.
9& Botleys W.N 3, St. John's Wood, NW3 7HT. Tel: 01-982 0502.

PD4050 GCF
Need-to-cassette copier, & stores. DC Servo motors and femire heads. 5 speed master.

Video tape loaders also available

PD700 Audio Tape-loader
A precision loader at a budget price. Compressor not required. Easy to operate and reliable. 100 C.C. per hour.

ELECTRONIC COMPONENT DISTRIBUTORS
ETC
36 BARLEY MARKET STREET, TAVISTOCK
DEVA, ENGLAND PL19 0JF
Tel: Tavistock (0822) 5439/5548. Telex: 45263
Sowter Transformers

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

**AUDIO FREQUENCY TRANSFORMERS OF EVERY TYPE YOU NAME IT! WE MAKE IT!**

**OUR RANGE INCLUDES**

- Microphone transformers of all types
- Microphone Spitter/Combine transformers
- Input and Output transformers
- Metering transformers
- Multi-secondary output transformers
- Bridge transformers
- Line transformers
- Line transformers of H.V. Quality
- Hi-Fi transformers
- Speaker transformers
- Monitoring transformers
- 1 in 1000 transformers
- 1 in 100 transformers
- 1 in 20 transformers
- 1 in 4 transformers
- Small transformers
- Special transformers
- Phone transformers
- Headphone transformers
- Piezo-electric transformers
- Audio Transformers
- Output Transformers
- Hi-Fi transformers
- Hi-Fi transformers of H.V. Quality
- Hi-Fi transformers of Hi-Fi Quality
- British Standard Quality
- British Standard Quality of P.A. Quality
- Our prices are highly competitive and we supply large or small quantities and even single transformers.

Send for details of our large range of audio transformers suitable for: audio, 1 in 1000 transformers, 1 in 100 transformers, 1 in 20 transformers, 1 in 4 transformers, small transformers, special transformers, phone transformers, head telephone transformers, piezo-electric transformers, audio transformers, output transformers, hi-fi transformers, hi-fi transformers of h.v. quality, hi-fi transformers of hi-fi quality, british standard quality.

**E. A. Sowter Ltd.**

Manufacturers and Designers

**This Month**

Construction

An 'Arrow' Generator

A special joystick control unit for inclusion between camera and monitor. ... drawing attention to points on a TV display by use of a moveable arrow.

Servicing

Greatly increased reliability of modern TV sets means intermittent faults are accounting for a much larger proportion of the servicing workload. We offer guidance on tracing down these, often difficult to locate, faults.

Review

THORN TX10 Chassis

We review the latest Thorn chassis probably the equal of any in the world.

**L. J. ELECTRONICS LIMITED**

**MICROELECTRONIC AND MICROPROCESSOR SYSTEMS FOR EDUCATION**

Send for details of our:

- Microprocessor Systems
- Peripheral Hardware
- Test Equipment
- Digital Patching Systems
- Analogue Patching Systems
- Laboratory Power Supplies

L. J. ELECTRONICS LTD., 7, Frances Way, Bowthorpe Ind. Est., Norwich, NR5 9JA.

Tel: Norwich 746340. Telex: 975504

**COMING TO SPIRTH ELECTRONICS FOR ALL YOUR CB NEEDS**

**ANTENNAS, COAX CONNECTORS MIKES SWR METERS BOOKS 40 & 80 CH RECEIVERS**

**SPIRTH ELECTRONICS**

3D Barney Market Street
Tavistock, Devon
Phone 0822 5865
Telex 45236
Guide to Broadcasting Stations

18th Edition

Around the world some thousands of radio stations are sending signals. If you’re receiving, this standard guide will tell you who’s where. It lists stations broadcasting in the long, medium, short wave and vhf bands, dealing with them by frequency, geographical location and alphabetical order. Sections are helpfully cross referenced. The Wireless World Guide to Broadcasting Stations is the eighteenth edition of a publication which has sold over 270,000 copies. In addition to the station listings, it includes much useful information on aerials, propagation, signal identification and reception reports.

£3.25 inc. postage.

To: General Sales Dept., Room 205
Quadrant House, The Quadrant, Sutton, Surrey SM2 SAS


Name

Address

Registered in England No. 677128
Registered Office: Quadrant House, The Quadrant, Sutton, Surrey SM2 SAS

106 WIRELESS WORLD APRIL 1981

U.K. RETURN OF POST MAIL ORDER SERVICE
WORLDWIDE EXPORT SERVICE
BAKER LOUDSPEAKERS

“SALE PRICES”

MINI-MULTI-TESTER

£6.50 Post Free

50 WATT AMPLIFIER

£85 Post 21

FAMOUS LOUDSPEAKERS

“SPECIAL PRICES”

CAR POWERAMPS

£95 Post 99

SKATE VEN EERED HI-FI SPEAKER CABINETS

£95 Post 99

TELEVISION INTEGRATION

£95 Post 99

LOW VOLTAGE ELECTRICAL

£11.15 each

6 x 7 x 8 Volts

220/240 volts

200/250 volts

110/120 volts

6 x 12 x 12 Volts

220/240 volts

200/250 volts

110/120 volts

6 x 14 x 14 Volts

220/240 volts

200/250 volts

110/120 volts

10 x 14 x 14 with Plastic Cover

£8.55 Post 99

AC SUITABLE FOR UK, 6.3V, 500mA, Model 118. £9.50 Post 99

AC SUITABLE FOR UK, 6.3V, 300mA, Model 118. £7.50 Post 99

AC SUITABLE FOR UK, 6.3V, 150mA, Model 118. £3.50 Post 99

AC SUITABLE FOR UK, 6.3V, 100mA, Model 118. £2.50 Post 99

AC SUITABLE FOR UK, 6.3V, 50mA, Model 118. £1.50 Post 99

AC SUITABLE FOR UK, 6.3V, 30mA, Model 118. £1.00 Post 99

AC SUITABLE FOR UK, 6.3V, 10mA, Model 118. £0.50 Post 99

AC SUITABLE FOR UK, 6.3V, 5mA, Model 118. £0.25 Post 99

AC SUITABLE FOR UK, 6.3V, 1mA, Model 118. £0.10 Post 99

If your local dealer has sold out, write to us.

WIRELESS WORLD APRIL 1981

107

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON

Open S-S, Closed all day Wed. Open Sat. S-S

Radio Books and Components Lists 20p. (Minimum post charge 80p.) Access or Barclaycard Yes. Please Tel: 01-644 1825 for some day deposits. Cash prices include VAT.

BAKER LOUDSPEAKERS

“SALE PRICES”

MINI-MULTI-TESTER

£6.50 Post free

50 WATT AMPLIFIER

£85 Post 21

FAMOUS LOUDSPEAKERS

“SPECIAL PRICES”

CAR POWERAMPS

£95 Post 99

SKATE VEN EERED HI-FI SPEAKER CABINETS

£95 Post 99

TELEVISION INTEGRATION

£95 Post 99

LOW VOLTAGE ELECTRICAL

£11.15 each

6 x 7 x 8 Volts

220/240 volts

200/250 volts

110/120 volts

6 x 12 x 12 Volts

220/240 volts

200/250 volts

110/120 volts

6 x 14 x 14 Volts

220/240 volts

200/250 volts

110/120 volts

10 x 14 x 14 with Plastic Cover

£8.55 Post 99

AC SUITABLE FOR UK, 6.3V, 500mA, Model 118. £9.50 Post 99

AC SUITABLE FOR UK, 6.3V, 300mA, Model 118. £7.50 Post 99

AC SUITABLE FOR UK, 6.3V, 150mA, Model 118. £3.50 Post 99

AC SUITABLE FOR UK, 6.3V, 100mA, Model 118. £2.50 Post 99

AC SUITABLE FOR UK, 6.3V, 50mA, Model 118. £1.50 Post 99

AC SUITABLE FOR UK, 6.3V, 30mA, Model 118. £1.00 Post 99

AC SUITABLE FOR UK, 6.3V, 10mA, Model 118. £0.50 Post 99

AC SUITABLE FOR UK, 6.3V, 5mA, Model 118. £0.25 Post 99

AC SUITABLE FOR UK, 6.3V, 1mA, Model 118. £0.10 Post 99

If your local dealer has sold out, write to us.

WIRELESS WORLD APRIL 1981

107

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON

Open S-S, Closed all day Wed. Open Sat. S-S

Radio Books and Components Lists 20p. (Minimum post charge 80p.) Access or Barclaycard Yes. Please Tel: 01-644 1825 for some day deposits. Cash prices include VAT.
PRINTED CIRCUITS
FOR WIRELESS WORLD PROJECTS
Step-up r.f. power amp—Sept. 1975—1s.
Audio compressor (tuner) Dec. 1975—1 s, (2s),
F.m. tuner (advanced) April 1974—1 s.
Amplifier module—May 1976—1 s.
Electrolytic capacitor—Oct. 1977—1s.
Time clock—August 1976—1 s, 2s.
Lamp, bulb, t.l.d. switch—January 1978—1 s, 2 s.
Audio preamplifier—November 1976—2 s.
Additional circuits—October 1977—1 s.
Stereo coder—April 1977—1 s, 2 s.
Mobile keypad and memory—January 1977—1 s, 2 s.
Low distortion audio amplifier—September 1977—1 s.
Low distortion radio amplifier—April 1976—1 s.
Synthesizer f.m. transmitter—November 1977—1 s, 2 s.
Monostable—June 1978—1 s.
Metal detector—July 1978—1 s.
Disc, Ranger and waveform analyser—October 1979—1 s.
Regulator for 0 or alternating—August 1978—1 s.
Video noise reducer—November 1978—1 s.
200MHZ frequency meter—January 1978—1 s.
High performance waveform analyser—November 1978—1 s.
DC voltmeter and comparator—July 1978—1 s.
Making coil preamplifier—August 1978—2 s.
Multi-mode transmitter—October 1979—1 s.
Amplification system—October 1979—1 s.
Servo motor—power supply—November 1979—1 s.
Floating bridge power amp.—Oct. 1980—1 s, 1 s, 1s, 1s, 1s.
Nixie tube—Jan. 1983—1 s, 1 s.
Morse keyboard and memory—January 1977—2 s.
Audio preamplifier—November 1978—2 s.

WIRELESS WORLD APRIL 1981

Communications 82
National Exhibition Centre
Birmingham, England
20-23 April 1982

Your Opportunity to Sell Communications Equipment and Systems

Communications 82 will be the sixth in a biennial series of expositions—now recognised as the World's leading international events for selling communications equipment and systems. It comprises a major international exhibition and integral conference plus a programme of social events with guest speakers of international stature.

Communications 82 will be a total communications exposition, covering all systems, equipment and components used in communications, including transmission, switching and terminal equipment as well as associated products and services for recording, testing and maintenance.

Communications 82, therefore, offers a unique opportunity for you to sell your products to potential customers from all over the world—at Communications 80 there were well over 15,000 visitors from 70 countries.

If you manufacture or sell communications equipment and systems nationally or internationally, you cannot afford not to participate in Communications 82 - the total communications exposition.

I am interested in exhibiting at Communications 82. Please send me the full Data Pack.

Name
Position
Company
Address
Tel:
Telex:

WW - 075 FOR FURTHER DETAILS

DIGI-TEL ELECTRONICS
20 Trenches Road
Crawley, Sussex
Tel: Crawley 5069
The ‘SERIES TWO’ MESSAGE REPEATER

with 4-track capability, using all four tracks to provide separate or simultaneous playback

Send for details of any item, and our full brochure of the comprehensive Reditronics range of sound communications equipment.

REDIFFUSION REDITRONICS LTD., La Pouquelaye, St Helier, Jersey, Channel Islands
Tel: Jersey (0334) 30231 Tel/Telex: 4192541
U.K. DEPOT: River View Road, Bitterne, Southampton, Hampshire. U.K. Tel: Southampton (0703) 555566

Distribution for Greater London and Home Counties:
Maundes Ltd., 388 Green Lanes, London N4 1GW Tel: 01-802 1183

J.M.I.

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 AGENENTS

Australia: Gordon & Co., Christmas House, Rathbone Street, London WC1 (01) 6362 0270.
Belgium: Agents for N.V. Redi-Electronique, Avenue Dubois 41, Bruxelles 7.
Canada: (See Circular 1000.)
Australia: (See Circular 1000.)
Austria: Geisler's, Engelhornstrasse 10, 4112, Dusseldorf.
France: Societe Belge Redi-Electronique, Boulevard des Batignolhes, 2, Bruxelles.
Italy: Redi-Electronica, Via Reggio Emilia 2, Bologna.
Netherlands: Intermedia, P.O. Box 319, 80-040, Arnhem.
Netherlands: (See Circular 1000.)
Poland: Pazar Zielony, ul. Jadwiga 1, Poznan.
UK: (See Circular 1000.)

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
The New Scopex 14D-10

A dual trace 10MHz high sensitivity oscilloscope incorporating all the latest high technology developments to bring you all these outstanding features as standard.

- 10cm x 8cm display.
- 2mV sensitivity on both channels.
- Add and invert facility.
- Probe compensation.
- Push button X-Y.
- Trace locate.
- 10MHz 1-3dBV over full display.
- Complete with probes.

At a price of £240.00 + VAT.
Ensures British leadership in the low cost high performance oscilloscope market.

Distributors required in certain countries

Please send me full details of the 14D-10.
Name.
Company.
Address.
Tel.

WW – 8 FOR FURTHER DETAILS
FACTORY CLEARANCE SERVICES CO.

A GRAND CLEARANCE SALE OF NEW COMPUTER SPARES WILL BE HELD AT A TOUR COTIDOE WAREHOUSE ON SATURDAY, 4th APRIL AND SUNDAY, 5th APRIL

COMPRISING OF:

1. **Computer Components**
   - Processors
   - Memory Cards
   - Motherboards
   - Power Supplies

2. **Electronics**
   - Televisions
   - DVD Players
   - Radios

3. **Office Equipment**
   - Copiers
   - Printers
   - Fax Machines

4. **Miscellaneous**
   - Files
   - Binders
   - Stationery

**Terms and Conditions**

- Cash only
- No returns or exchanges
- Prices subject to change

Ideal for any business in the TANGERINE, TRIDENT, TUSCAN, APPLE and most computers.

Ex-stock from Henry's.

This is definitely the BEST BUY. SUPPLIED BRAND NEW in manufacturer's original packing (ANTI-STATIC).

Just post remittance. Total £39.95 incl. VAT & P&P.

A R. DAVIES (FACTORY CLEARANCE)
28 ST ALBANS ROAD, CODICOTE
ST ALBANS Herts.
TEL: STEVENAGE (0438) 833417-820686

---

THE PRINTER SCOOP OF THE YEAR, SAVE OVER £1400

THE LOGABAX Z80 MICROPROCESSOR CONTROLLED
LX 180L MATRIX PRINTER

A massive back purchase enables us to offer you this superb professional printer at a fraction of its recent cost of over £2000. Entering the very latest in microprocessor technology, it features a host of facilities with its electronic control and new interface facility it meets all the requirements of the most exacting standards.

** STANDARD FUNCTIONS **
- Full ASCII character set
- Standard ink ribbon (RS232C/VT100 compatible)
- 7 stall controlled baud rates up to 1800 baud
- Parallel port interface
- Serial port interface
- Type fonts
- Fast script, double width, 12x7 standard, 10x12 standard, 12x12 standard, 16x16 standard

** ACCESSORIES **
- 10-way decimated
- 20-way decimated
- 30-way decimated
- 40-way decimated
- 50-way decimated
- 60-way decimated
- 70-way decimated
- 80-way decimated
- 90-way decimated
- 100-way decimated

** PRICING **

At Only

- £659
- £739
- £859
- £999
- £1199
- £1399
- £1599
- £1799

Incl. VAT, subject to change

** OPTIONAL EXTRAS **
- Lower case
- 10x12 standard
- 12x12 standard
- 16x16 standard
- 20x20 standard
- 25x25 standard
- 30x30 standard
- 40x40 standard
- 50x50 standard
- 60x60 standard
- 70x70 standard
- 80x80 standard
- 90x90 standard
- 100x100 standard

** PRICE INCLUDES TRANSPORT**

S & L ELECTRONICS
86 High Street, Bletchingley, Surrey
Tel: 0832 835221

ORDER FORM

To: General Sales Manager, Room 205, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS

Please send me a copy of your Hi Fi Yearbook and Home Entertainment 1981 @ £3.50

 inkl. postage and packing. Cheque/Postal order should be made payable to IPC Business Press Ltd.

Name: ____________________
Address: ___________________

Registered in England No. 671136

---

B. BAMBER ELECTRONICS

CAMPBREAD LONG TERM DISPOSABLE ELECTRODES

Mains Isolating Transformers (for use in Italy, USA, etc.)

Mains Transformers

Transmposer 1000

PP 4 T. V. MAINS INPUT FILTER CHOICES

COLOUR T.V. MAINS INPUT FILTERS

HELDERMAN HEAT SHRINK

SLEEVING

H20105 (1-1000) 120mm 110cm £10

Large Quantity of Used Lin

FERRANTI MICROSPOT

CATHODE RAY TUBES

Type 261011, suitable for telephone, digital, computer or laboratory use. Available at £120.

Products ships worldwide.

AVO MOVEMENTS COMPLETE WITH SCALE

Priced at £5.95 each

---

READ ALL ABOUT IT — all the latest on home entertainment equipment and ideas in . . .

[Text continues here]
Thurby PL Series

Single, Dual and Triplet Output Units
Prices from around £100

- Simultaneous digital metering of voltage and current.
- Twin 3½ digit (4000 count) meters with ½" LED displays.
- 0.1% accuracy, Resolution of 0.01 volts and 0.005 amps.
- True constant voltage or constant current operation.
- Current Limit can be set precisely without shorting the output.
- Remote facility for maintained precision at high currents.

Designed to rigorous quality and safety standards.

Full data and distributor list from Thurby Electronics Ltd.

Thurby
A bench power supply system that meets today's needs
Visual monitoring of anything, anywhere, by phone, in seconds, with Robot Phoneline TV.

Robot's Phoneline TV systems provide a low-cost, efficient solution to the problem of visually monitoring remote locations, garage, traffic, weather, water levels, or any subject, large or small. The Phoneline TV equipment works with standard TV equipment and converts the broadband video signal from the camera to an audio signal in your telephone network. The audio signal can be monitored or recorded on your own PSTN, allowing the video to be viewed on your television set or recorded on magnetic tape for repetitive use. Visual monitoring is possible using standard telephone equipment and no special training or equipment is required.

The three-way Phantom TV system consists of a transmitter unit, a receiver unit, and a telephone. The transmitter unit is connected to the video source, such as a garage door, traffic light, or security camera, and converts the video signal into an audio signal. The audio signal is then transmitted via the standard telephone network to the receiver unit, which is connected to the receiver's television set. The receiver unit decodes the audio signal and converts it back into a video signal, allowing the user to view the video on their television set.

The three-way Phantom TV system is available in two versions: the three-way Phantom TV system and the four-way Phantom TV system. The three-way Phantom TV system consists of one transmitter unit, one receiver unit, and one telephone. The four-way Phantom TV system consists of one transmitter unit, two receiver units, and two telephones. The four-way system allows for simultaneous monitoring of two different video sources, providing increased flexibility and functionality.

Close Encounters of the Capacitor kind

The European choice! Capacitors are worthy of your close examination and consideration. They are quality precision components made for the professional market. Illustrated is a CXL-approved monolithic and Pascal, in the UK, offering the full breadth of professional capacitors. Send for today's

The best in electronics

UK agents for:

Eurofarcad

Convey a message to a single or multiple destinations. Robots are available in a variety of sizes and configurations.

Always the last name in Oscilloscopes, Computers, TV, and TV etc.

Always

Hayden Storage Oscilloscope Type 642, Common V. 25.000,000/0.250, materials with 250 times magnification, Type 642, 620 R.

Semi Conductors, I.C.S., Opto-devices, Rs and Cs in great variety, Pots, Switches, Knobs, Accessories, Tools, Materials, Connectors.

Electrovalue LTD.

404 Edgware Road, London W2 1ED

Standard model

0-5 or 0-30R

Only

£6.95

No VAT

Post & Packing included

Available whilst stock lasts.

HENRY'S

RCA SAG20

Frequency counter. Small compact unit. £15 each.

Infra Red Image Converter Type 5906 (CV 141)

This soldier's best friend uses a single low current 5V unit to PKS signals individually to base station for £15.20 each.

Ferret A.T.E.

£650 for details.

Ex-Military Solid State 400 HZ Inverter

26 VDC, 240 VAC, 250 W, 500 W, £115 each. Model 250 W, D.C. 0.4 amp, 240 VAC, £125 each. Model 500 W, 250 VAC, £150 each. Model 1150 W, 240 VAC, £280 each.

Transistor Inverter

The new, efficient, low-cost, single unit 175W, £450 each. Dual units operating from 240 VAC, D.C. 0.5 amp, £600 each. Dual units operating from 115 VAC, D.C. 1 amp, £900 each.

Credet 75

Printed on keyboard, Late model, £220, or choice own size, get a printout from your microprocessor. Basic data and instructions available.

Get your details, only £5 each.

As new, Ministry issue, £40 each.

Semi Conductors, I.C.S., Opto-devices, Rs and Cs in great variety, Pots, Switches, Knobs, Accessories, Tools, Materials, Connectors.

Electrovalue LTD.

404 Edgware Road, London W2 1ED

Standard model

0-5 or 0-30R

Only

£6.95

No VAT

Post & Packing included

Available whilst stock lasts.

HENRY'S

RCA SAG20

Frequency counter. Small compact unit. £15 each.

Infra Red Image Converter Type 5906 (CV 141)

This soldier's best friend uses a single low current 5V unit to PKS signals individually to base station for £15.20 each.

Ferret A.T.E.

£650 for details.

Ex-Military Solid State 400 HZ Inverter

26 VDC, 240 VAC, 250 W, 500 W, £115 each. Model 250 W, D.C. 0.4 amp, 240 VAC, £125 each. Model 500 W, 250 VAC, £150 each. Model 1150 W, 240 VAC, £280 each.

Transistor Inverter

The new, efficient, low-cost, single unit 175W, £450 each. Dual units operating from 240 VAC, D.C. 0.5 amp, £600 each. Dual units operating from 115 VAC, D.C. 1 amp, £900 each.
**VALVES**

Minimum Order £1

<table>
<thead>
<tr>
<th>Valve Type</th>
<th>Rating</th>
<th>Material</th>
<th>Temperature</th>
<th>Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A41</td>
<td>440 psi</td>
<td>Brass</td>
<td>0°C to 120°C</td>
<td>10 gpm</td>
</tr>
<tr>
<td>A42</td>
<td>250 psi</td>
<td>Copper</td>
<td>0°C to 100°C</td>
<td>15 gpm</td>
</tr>
<tr>
<td>C84</td>
<td>150 psi</td>
<td>Stainless Steel</td>
<td>0°C to 150°C</td>
<td>20 gpm</td>
</tr>
</tbody>
</table>

**METALFILM RESISTORS**

1% Tolerance, 1/4 Watt

<table>
<thead>
<tr>
<th>Value</th>
<th>Resistance</th>
<th>Tolerance</th>
<th>Power Dissipation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1kΩ</td>
<td>1kΩ</td>
<td>±1%</td>
<td>250mW</td>
</tr>
<tr>
<td>470kΩ</td>
<td>470kΩ</td>
<td>±2%</td>
<td>250mW</td>
</tr>
<tr>
<td>100kΩ</td>
<td>100kΩ</td>
<td>±5%</td>
<td>100mW</td>
</tr>
</tbody>
</table>

**ORION SCIENTIFIC PRODUCTS LTD.**
10 Wardour St., London W1

- [Price List](#)
- [Contact Information](#)

---

**Belle Vue Radio and Electronics Exhibition**

In the Lancaster Hall, on Sunday, March 30, 1981

- Doors open at 11 a.m.
- The North's Premier Amateur Radio and Electronics Event

**Features**

- **Incorporated Club**
- **Construction Contest**
- **Amateur Computer and Trophy**
- **Home Office and Paynet Stands**

**Applications**

- [F.M. talk-in on GRIEVES B. GRIEVES via Table Bay 5.22, Ross, and on 633600 Ch Sub, R.B. and R.B.]
- [Admission by ticket, with ticket and exhibition plan entry at National Belle Vue Main Car Park, Off Hyde Road, A.D.]

---

**PPM3**

Primary Products: 800-800, 725-725, etc.

- Available for OEM, repair, and replacement
- Reliability and performance
- High-quality components

**SUNRAY ELECTRONICS**

The Poplar Court, Green, Sunbury, Sunbury GU5 4JQ.

- [Contact Information](#)
- [Product List](#)

---

**RCS ELECTRONICS**

- [Contact Information](#)
- [Product List](#)

---

**WIRELESS WORLD APRIL 1981**

**DISPLAYED APPOINTMENTS VACANT**: £2 per single col. centimetre (min. 3cm)

**LINE advertisements (run-on)**: £2 per line, minimum three lines.

**BOX NUMBERS**: £1 extra. (Boxes should be addressed to the Box Number in the advertisement, c/o Quadrant House, The Quadrant, Sutton, Surrey SM2 4AS.)

**PHONE**: JAYNE PALMER, 81-663 3031

Classified Advertisement Rates are currently zero rated for the purpose of VAT.

---

**COMMUNICATIONS**

- [Contact Information](#)
- [Product List](#)
Company Communications Controller  £10,000

As a major name in aviation and communication services for the world, maintaining and upgrading our own lines of communication is vital; customers and suppliers, for instance, are constantly in contact through telephone, telex, data transmissions and post. The task of our Company Communications Controller is to supervise both the technical and human aspect of the existing and new communication systems. There is also a large amount of advisory and analytical work involved, in order that existing systems may be improved.

To do this you would possess an HNC in telecommunications engineering and should have worked for at least five years with a manufacturer, major telecoms user, or in Post Office telecommunications. They should understand maintenance and repair problems, and ought to be capable of expressing technical solutions clearly to non-technical management.

Benefits include a staff restaurant, a pension and life assurance scheme, relocation expenses where applicable and 5 weeks’ holiday plus bonus. Please apply, in writing, to John Callow, IAL, Amadco House, Hayes Road, Southall, Middlesex, quoting Ref: K/354. Tel: 01-943 3111.

ELECTRONIC SERVICE ENGINEERS

Our company specialises in both sales and servicing of Direct-View Sound and Lighting Equipment. We currently have vacancies for engineers who have had previous experience of either HiFi, Studio PA or similar equipment. Good salary, plus commission rewards. Please telephone or write to Janet Findlay for further details.

Rogers’ Square

Barnet Trading Estate Park Road Barnet Herts EN5 5SA Telephone: 01-441 1919

PHILIP DRAKE ELECTRONICS LTD.
Manufacture Audio and Intercommunication Equipment for the broadcast industry and have excelled in sales worldwide.

PROJECT ENGINEER

to work in the Project Department. The candidate must possess a sound background in electronics with experience in the design and manufacture of electronic products. Possession of an HNC in Electronic Engineering would be an advantage. Applicants should have a thorough understanding of electronic principles and a working knowledge of circuit diagrams.

ASSISTANT TEST ENGINEER

to test primarily the TV circuitry of high fidelity television equipment, along with the standard product range. Some experience in the testing of audio and digital circuits is desirable.

DRAUGHTSPERSON/TRAIDER

to work primarily in our Project Department to prepare graphical drawings and design pattern metalwork, and also to produce circuit diagrams and standard product documentation in control panel groups and broadcast audio equipment.

The company offers a 30 day week with a 30 day holiday minimum. Experience in television and radio industry or similar relevant qualifications are desirable for all positions. Salary depends on experience.

Applicants to telephone or write to: PHILIP DRAKE ELECTRONICS LTD.
22 REDAN PLACE, LONDON, W.4 (Tel: 01-221 4742)

WIRELESS WORLD APRIL 1981

UMIST

EXPERIMENTAL OFFICER FOR SILICON DEVICE MANUFACTURE

REF: FFC/22 A new facility is being assembled in the School of Electrical Engineering, for the production of a high yield silicon device manufacture line. Within a large clean room there will be a total of 60 linear feet of clean benches, controlled at 1000 over the line. The Experimental Officer will be responsible for the day-to-day running of this facility, overseeing the use by postgraduate students of the equipment and materials. He or she will also be responsible for the maintenance of the equipment, including the preparation of plans for the maintenance phase. Facilities are available for the use of the School’s large-scale silicon processing line and a group in the Department of Electronic Engineering. A wide range of skills is required, including knowledge of silicon processing, material handling and semiconductor wafer processing. A salary in the range of £6750-£8500 per annum is offered. Requires a minimum CSE and a GCE A level in Mathematics and Physics. Phone: 0882 315333 (Ext. 221)

TOP JOBS IN ELECTRONICS

Posts in Companies, Medical, Comms. etc. to Ph.D. Free Service.

Phone 01-906 0251 (906)

NORTHERN REGIONAL HEALTH AUTHORITY

ELECTRONICS TECHNICAL ASSISTANT (2 POSTS)

Required for Regional Engineer’s Division, based at Walkatacre, Newburn.

For further information contact: The Technical Assistant at 1. Newburn 01-963 5173.25p per annum.

The posts offer technologists interesting and varied work, with excellent working conditions and well-equipped laboratories, and involve work for hospitals throughout the Region, for which financial reimbursement is made.

Applicants must be of high calibre and have considerable and broad experience in modern electronic equipment.

Minimum qualifications: HNC or City and Guilds Full Technical Certificate in Electronic Engineering or equivalent.

Application forms and job descriptions are available from the Regional Personnel Officer, Northern Regional Health Authority, Belford Road, Newcastle upon Tyne NE4 6YJ.

Closing date: 1 April, 1981.

(311)

THE HIGH TECHNOLOGY TASK FORCE

COMMUNICATIONS SYSTEMS COMPANY WAREHOUSE SYSTEMS & SERVICES AERIAL SYSTEMS & SERVICES WORLD WIDE

Sony Broadcast
c Success Story means even more career opportunities

Tremendous growth and success has created the need for even more first class staff at the Basingstoke International Headquarters of one of the world’s leaders in professional television broadcast equipment.

UK Sales Manager – TV Production Houses

E n g e n g e e r – c a r

This is a newly created position as part of the TV production expansion programme. The successful candidate should possess experience of either Production or Engineering Operations within a broadcast television environment. A knowledge of professional VTR’s, editing systems and cameras is necessary whilst previous sales experience is desirable, though not essential.

Sales engineers/Technical Support Engineers for Western Europe

Compeptent engineers experienced in video cameras and VTR’s are sought to join our sales team. Successful candidates are likely to be in the age range 25-35 and should be highly motivated and able to work on their own initiative. Experience in dealing with customers would be an advantage as would knowledge of a second European Language. Travel within the western European area will be required.

Engineers – Commercial/Sales Applications

Applications invited for engineers with a wide experience of the TV broadcast environment, to utilize and broaden their knowledge in a dynamic commercial environment. The selected candidate will be self motivated, capable of working with a minimum of supervision, and will be appointed to our Progression/ Quotations section. He or she will have the opportunity to prepare detailed and concise customer presentations and conduct sales demonstrations.

Previous commercial/sales experience desirable, however not considered essential.

If you like the thought of enjoying the success of worldwide leadership then write in strict confidence to Barry White, Personnel Manager, Sony Broadcast, now! And please don’t forget a CV.

Sony Broadcast Ltd.
City Wall House
Basing View, Basingstoke Hampshire RG21 2LA
United Kingdom
Challenging positions at home and abroad

RADIO TECHNICIANS COMMUNICATIONS ENGINEERS

EAE Limited install and maintain communications systems for the oil industry, at home and abroad.

Due to rapid and continuing expansion in our activities, we constantly require Radio Technicians, with experience of HF, MF, VHF and UHF, and Engineers (preferably qualified to HNC level or above) in the fields of Microwave, Multiplex and Tropospheric Scatter.

In the North Sea, earnings are in the range £8000 to £12,000 p.a. Overseas earnings could be up to £20,000—plus tax concessions and generous home leave.

The work is demanding, but rewarding, offering you the chance to use your skills and your initiative to the full.

The company is based in Great Yarmouth, with offices in Aberdeen and Lerwick—but where relocation is necessary, we will give generous assistance with removal, legal and temporary accommodation expenses.

Please apply, with details of your career to date, to: Personnel Manager, EAE Limited, Dept WW, Offshore House, 284/285 Southtown Road, Grt. Yarmouth, NR31 0JB Telephone 0493 358 541

SULTANATE OF OMAN

RADIO AND TV BROADCAST ENGINEERING VACANCIES

The Sultanate of Oman operates a modern colour television and radio broadcasting service with studio centres situated in the North and South of the country, the two centres being linked by satellite. High power VHF and low power UHF transmitters are employed to provide a 265 PAL TV service to various powers. Both services are managed by the Ministry of Information and Youth Affairs.

Due to expansion of the service vacancies for a variety of posts have arisen and applications are invited from suitable qualified persons.

TRANSMITTER ENGINEERS

For maintenance of high power VHF TV transmitters and low power UHF transmitters, high power MF, HF and VHF FM sound transmitters. The work will involve travel and in some cases overnight stops away from base. The transmitters operated within the Sultanate are manufactured by Siemens, Philips, Marconi and Continental Inc., U.S.A.

STUDIO ENGINEERS

For maintenance on cameras, vision mixers, S.P.G.S., vision distribution systems, teleline machines and video monitors, etc.

SOUND MAINTENANCE ENGINEERS

To maintain a wide range of high quality sound broadcasting equipment.

Applicants should be qualified to degree or HND level and have not less than six years’ relevant experience. The senior positions require considerably more years of varied but relevant experience. In most cases a knowledge of Arabic—although not essential—would be useful.

Salaries, which are paid in Rials Omani, are fully remittable and tax-free and range from pounds sterling 1100 to 1300 per month upwards. The senior positions start at pounds sterling 1500 to 1700 per month (depending upon current rate of exchange).

Married accommodation is provided together with free air passage at beginning and end of contract for family. Air tickets are also provided for leave after the first year of service.

Applicants should write stating age, nationality, qualifications and full details of experience to:

Ministry of Information and Youth Affairs, Post Box 600, Muscat, Sultanate of Oman, marking the envelope "Technical Office" in top left-hand corner.

PLANING AND PROJECT ENGINEERS

To carry out planning for a wide range of transmitter installations for both TV and radio. Planning and Systems Engineers are also required for work on new radio studios to be constructed over the next few years.

Successful applicants will be expected to be directly involved with the nuts and bolts of the installation work, in some cases in remote areas. Applications are also invited for a number of senior positions in the transmitter, studio groups and electro-mechanical services groups. If you feel you can apply your knowledge and expertise to the efficient running of these groups we will be pleased to hear from you.

VTR ENGINEERS

For maintenance on Ampex VR1200B and Bosch Fernseh BC4M0 machines. There will also be some operational work. During the forthcoming year it is intended that 1m. "C" Format VTR machines will be installed.

PLANNING AND PROJECT ENGINEERS

To carry out planning for a wide range of transmitter installations for both TV and radio. Planning and Systems Engineers are also required for work on new radio studios to be constructed over the next few years.

Successful applicants will be expected to be directly involved with the nuts and bolts of the installation work, in some cases in remote areas. Applications are also invited for a number of senior positions in the transmitter, studio groups and electro-mechanical services groups. If you feel you can apply your knowledge and expertise to the efficient running of these groups we will be pleased to hear from you.

VTR ENGINEERS

For maintenance on Ampex VR1200B and Bosch Fernseh BC4M0 machines. There will also be some operational work. During the forthcoming year it is intended that 1m. "C" Format VTR machines will be installed.

PLANNING AND PROJECT ENGINEERS

To carry out planning for a wide range of transmitter installations for both TV and radio. Planning and Systems Engineers are also required for work on new radio studios to be constructed over the next few years.

Successful applicants will be expected to be directly involved with the nuts and bolts of the installation work, in some cases in remote areas. Applications are also invited for a number of senior positions in the transmitter, studio groups and electro-mechanical services groups. If you feel you can apply your knowledge and expertise to the efficient running of these groups we will be pleased to hear from you.

VTR ENGINEERS

For maintenance on Ampex VR1200B and Bosch Fernseh BC4M0 machines. There will also be some operational work. During the forthcoming year it is intended that 1m. "C" Format VTR machines will be installed.

PLANNING AND PROJECT ENGINEERS

To carry out planning for a wide range of transmitter installations for both TV and radio. Planning and Systems Engineers are also required for work on new radio studios to be constructed over the next few years.

Successful applicants will be expected to be directly involved with the nuts and bolts of the installation work, in some cases in remote areas. Applications are also invited for a number of senior positions in the transmitter, studio groups and electro-mechanical services groups. If you feel you can apply your knowledge and expertise to the efficient running of these groups we will be pleased to hear from you.

VTR ENGINEERS

For maintenance on Ampex VR1200B and Bosch Fernseh BC4M0 machines. There will also be some operational work. During the forthcoming year it is intended that 1m. "C" Format VTR machines will be installed.

PLANNING AND PROJECT ENGINEERS

To carry out planning for a wide range of transmitter installations for both TV and radio. Planning and Systems Engineers are also required for work on new radio studios to be constructed over the next few years.

Successful applicants will be expected to be directly involved with the nuts and bolts of the installation work, in some cases in remote areas. Applications are also invited for a number of senior positions in the transmitter, studio groups and electro-mechanical services groups. If you feel you can apply your knowledge and expertise to the efficient running of these groups we will be pleased to hear from you.

VTR ENGINEERS

For maintenance on Ampex VR1200B and Bosch Fernseh BC4M0 machines. There will also be some operational work. During the forthcoming year it is intended that 1m. "C" Format VTR machines will be installed.
Development Engineers in Digital Electronics

We have an important client in the Cambridge area who is about to embark upon a major development programme incorporating projects valued at several million pounds. Over the last few years they have been developing and exploiting a specialised area of telecommunications, and to complete the highly specialist and skilled teams which are involved in breaking new ground in digital development, two experienced Engineers are needed immediately.

They will ideally have experience of both hardware and software, gained in a development environment where high standards and initial deadlines are the norms. A Degree standard of education is less important than experience on design and development and they will have the opportunity of seeing a prototype design right through to manufacture.

Our client offers the opportunity to become involved in a thriving organisation which offers excellent terms and conditions of employment, good career prospects and, most important, an opportunity to use digital electronics to new frontiers.

Please apply in confidence, quoting Ref. KR77, to:

Andrew Millhouse
Ketchum Recruitment Limited
Bedford Row, London, WC1R 4LX.
01-403 1260

IF THIS IS RECESSION WE LIKE IT

AT LAST! ELECTRONIC ENGINEERS ARE BEING PAID WELL AND THEIR WORK IS APPRECIATED...

We have hundreds of vacancies which include:

SYSTEMS ENGINEERS: for new company specialising in secure computer systems based on DEC 11/23 and 280 Knowledge of image processing and pattern recognition an advantage. To £13,000. SURREY.

RESEARCH ENGINEER/ MANAGER: for a group providing support to an international company engaged in research on precious metal refining, cancer research, pollution monitoring, etc. Broad based experience. To £12,000. BERKSHIRE.

R.F. ENGINEERS: for small dynamic company engaged on telemetry and remote monitoring instruments for the off shore industry — sonars, gas rigs, etc. To £10,000. LONDON.

HARDWARE AND SOFTWARE ENGINEERS: to work on a new generation of Foldex and Data Terminals based on 280 base boards. To £10,000. SURREY.

PRINCIPAL AND SENIOR MICROWAVE ENGINEERS: for development of VCO's, frequency Multipliers, amplifiers and filters. Good salary but not confidential. MIDLANDS.

YOUNG ENGINEERS: with BSc(Hons) intending to enter a high flying career working on novel controls for the automotive industry. To £9,000-10,000. WEST COUNTRY.

DESIGN ENGINEERS: broadcast TV equipment including character generators and test terminals. To £9,000. SURRY/HERTS. BORDER.

SENIOR ENGINEER: to design and develop special modules for users of a large international computer network based on ICL 1900 and PDP11. To £10,000. LONDON.

DESIGN ENGINEER: digital and micro computer based control equipment and systems for the heavy electrical machine manufacturing industry. To £8,000. NORTH-EAST ENGLAND.

COMPUTER ENGINEERS: vacancies throughout UK in systems test, field service, personnel administration and sales support.

For further details, please contact:

Charles Airey Associates
4 Harthumble Grove. London W6 ONA. Tel: 01-741 4011

ONE IN A MILLION?

Among the million or so leaving school or university this year there is a chance that one — perhaps two — who will make a significant development in audio.

That person's first decision might well be to join QUA/D in Huntingdon. At school, he or she will have run across amplifier design in some way or another — one of the many matters of having a listen or a fiddle with standard circuits and their variations. Later will have come an adolescent stage of great discoveries... "Increase the rise time to eliminate TIM"... "Regulate the power supply for better imagery"... Following on from such childish things will have come an ability to distinguish between the characteristic impedance of the medium and the third row of the dress circle and between peak flux density and the rather pious severity of boys who have been to small schools. He or she will, nevertheless, be sufficiently down to earth to know that one Newton is about the weight of the average apple.

1 in 107? 

Well, drop us a line anyway.

Mr. P. J. Walker
THE ACOUSTICAL MANUFACTURING COMPANY
LIMITED
39 St. Peter's Road, Huntingdon, Cambs. PE18 7DB

DEPARTMENT OF NUCLEAR PHYSICS

ELECTRONICS TECHNICIAN

(Grade 5)

Salary £5249 to £6129 Haringey July 1981, to £6965 to £6650

Applications are invited for the post of Electronics Technician in the Department of Nuclear Physics for interesting and challenging work. The post involves assisting in maintenance and repair of a variety of equipment incorporating fibre optic data links, 8 and 16 bit bit/s bit/s technologies, as well as some analogue circuitry. Some experience is essential, as are some knowledge of microcomputers and microprogramming.

Applications in writing with the names of two referees should be sent as soon as possible to the General Administration Department of Nuclear Physics, Keble Road, Oxford OX1 3RH.

THE LEADING TELEVISION FACILITIES COMPANY

REQUIRES

DIRECTOR OF OPERATIONS

EXCELLENT SALARY

+ CAR + PENSION + BUPA + PROFIT SHARE

The position of DIRECTOR OF OPERATIONS requires a person with drive, initiative and clear thinking, to be able to deal with the day-to-day demands of this high technology Television Facilities Company providing Studio, VTR and O.B. services to its Clientele.

Loyalty, hard work and the ability to lead, will be rewarded by a career in the fast-moving TELEVISION SERVICE and the Operations Director and his/her colleague Directors will have the opportunity of long-term future career development. The Company is looking forward to one of the senior Directors becoming the next Managing Director.

The applicant must have Engineering ability and have worked or be working in a Broadcasting organisation and have high level Management experience plus that special 'something' of being able to lead and drive for the achievement of the Company's policies.

The position of Director of Operations will be a Company Board appointment.

Please apply to the Sole Recruitment Agents in the strictest confidence quoting "OPS DIR 1981":

PERSONNEL & ELECTRONICS LTD.

Telephone: 01-573 8333

Telex: 934271

Triumph House
1096 Uxbridge Road
Hayes
Middlesex UB3 4GH

England UK

(1980)
Can you develop your potential?

Ultra manufacture highly sophisticated communications equipment and are Europe’s leading suppliers of Somebys. Our Test Equipment Department has been extensively remodelled with new laboratories being built with a view to expansion. We can offer a real Equipment Development Engineers and Technicians a real opportunity to become involved in the latest technology coupled with positive career development.

Test equipment development engineer £6500-£7500

Working closely with our Senior Engineers and outside companies you will primarily assist the Design Engineers in developing Test Equipment Design. In addition, you will develop systems and units from outline specifications through to building prototype units.

As the department is still in its early stages you will have the opportunity to make a positive contribution to its formation and you will also be expected to attend comprehensive training seminars and exhibitions.

For both positions we offer outstanding career prospects with a company that is looking to the future. Apart from competitive salaries, we offer a sports social club, three days holiday, Christmas party and a subsidised restaurant. For further information please contact our Personnel Officer on 378 0681 or write to her at

T e x t  e q u i p m e n t  d e v e l o p m e n t  e n g i n e e r  e x h i b i t i o n s .

Teaching and Research. Now converting to high quality Video 8 within the Unit. Salaries according to experience and qualifications. Please write to Mr. G. G. Peet, Head of E.E. Electronics, School of Engineering, University of Essex, Wivenhoe Park, Colchester CO4 3SQ.

IBA INDEPENDENT BROADCASTING AUTHORITY

Please write or telephone for an application form quoting Ref. WW/3750c to
Clyns Powell, IBA, Crawley Court, Winchester, Hampshire, S021 2QA.
Telephone 822707.

(These posts are open to men and women.)

A T H O R I T Y

Please write to the open Postgraduate Applications, I. A. R. 00000.

University of Essex

UNIVERSITY OF ESSEX

Audio Visual Aids Unit

Television Engineers ONCE IN A DECADE CHANCE!

Join a small and lively team providing television services for teaching, research and consultation to high-quality Video 8 colour return system, studio based very fast and mobile. Photographic film, graphics and instruction workshops services available within the Unit. Salaries according to experience and qualifications on scales between £4,410 and £7,873. Further training available where appropriate.Write or telephone now: Staff Office, University of Essex, Southend G22 2XX. Telephone Guildford 71281. Ext. 776 for full information quoting reference (16) WW.

PHONE TELEPHONE ENGINEER ABU DHABI

A Telephone Engineer is urgently required with experience on Siemens ESK 3000E or similar crosspoint exchange.

TELECOMMUNICATIONS TECHNICIANS

We also have vacancies for Radio Technics able to take up appointments at short notice.

Comprehensive Cvs should be submitted immediately to:
Mr. George Peet, Head of E.E. Electronics, University of Essex, Wivenhoe Park, Colchester CO4 3SQ.
Telephone: 22323 Phone 328017 giving contact U.K. telephone

T.V./Video Engineers

Media Librarian

Media Librarian

*(Salary range 2530-5425) Riyadh per month for the

King Faisal Specialist Hospital and Research Centre

Riyadh, Saudi Arabia

If you are well qualified in either of these areas, here is an excellent opportunity to make a break for 2 to 3 years and work in one of the world’s most advanced hospitals and Research Centres. Working conditions are first class and all equipment and systems are the most modern available.

We need experienced T.V. Video Engineers to help maintain the hospital’s sophisticated television network (mainly Sony equipment).

You will be working with a five channel closed circuit system which is used for patient monitoring, training and medical/surgical recording, and in addition provides entertainment programmes for the hospital’s surrounding residential and services complex.

Applicants should already be able to operate test equipment and be familiar with PAL, SECAM and NTSC systems. Some previous experience of studio production (hardware and electronic editing systems) would be an advantage.

We also need a Media Librarian to take over control of the office’s film and photography library and the video libraries.

These are married status posts and successful applicants will be offered a two year contract (extendable by mutual agreement) with generous leave periods, air-conditioned accommodation, subsidised meals and education assistance for eligible dependents. There are excellent facilities for sport and recreation.

Please write or telephone for details to: John Pentol, T.V. Video Dept., The University of Essex, Wivenhoe Park, Colchester CO4 3SQ.

THE OPEN UNIVERSITY FACULTY OF SCIENCE

Applications are invited for a Technical Librarian in the Computer Science Department from a candidate with a minimum of a degree in computer science, good knowledge of programming languages and experience as a technical librarian or similar position in an academic environment. For further information please contact the Departmental Secretary to the Faculty of Science, Mrs. J. N. Bradley, University of the Open University, Walton Hall, Milton Keynes, Buckinghamshire, MK7 6AA. Tel: 04964 2555. A full job description is available on request.

Further details and application forms are available from the Application Secretary, University of the Open University, Walton Hall, Milton Keynes, Buckinghamshire, MK7 6AA. Telephone: 04964 2555. Please send your completed applications to the University of the Open University, Walton Hall, Milton Keynes, Buckinghamshire, MK7 6AA, by 28th June 1981. Further information is also available from the Computer Department, University of the Open University, Walton Hall, Milton Keynes, Buckinghamshire, MK7 6AA, for non-residents abroad. The University of the Open University, Walton Hall, Milton Keynes, Buckinghamshire, MK7 6AA. Telephone: 04964 2555. Further information is also available from the Department of Computing, University of the Open University, Walton Hall, Milton Keynes, Buckinghamshire, MK7 6AA, for non-residents abroad.

UNIVERSITY POSTGRADUATE STUDY

ELECTRONICS RESEARCH AT THE UNIVERSITY OF ESSEX

Graduates who have or final year students who expect to obtain a first or upper second-class honours degree are invited to apply for research leading to a higher degree (M.Sc., M.Phil. or Ph.D.) in the following areas:


Return this coupon to John Pentol, Television Department, University of Essex, Southend G22 2XX. Telephone Guildford 71281. Ext. 776 for full information quoting reference (16) WW.

All the others are measured by us...

At Marconi Instruments we ensure that the very best of innovative design is used on our range of communications test instruments and AT.T. We have a number of interesting opportunities in our Design, Production and Service Departments and we can offer attractive salaries, productivity bonus, pension and sick pay schemes together with help over relocation.

If you are interested to hear more, please fill in the following details:

Name: ____________________________
Age: ____________________________
Address: ____________________________
Telephone Work/Home (if convenient): ____________________________
Years of experience: 0-1 1-3 3-6 6+ Over 6

Present salary: £3500- £4500 £5500- £6500 £7500- £8500

Qualifications: None £6 G HNC Degree

Present job: ____________________________
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 PER LINE. Average six words per line.
- Minimum £10 (prepayable).
- Name and address to be included if used in advertisement.
- Box No. Allow two words plus £1.
- Cheques, etc. must be payable to "RNC Business Press Ltd" and cross "R & C."

CLASSIFIED ADVERTISEMENTS

REMITTANCE VALUE 
ENCLOSED

PLEASE WRITE IN BLOCK LETTERS. CLASSIFICATION NUMBER OF INSERTIONS

WIRELESS WORLD APRIL 1981
**FERRITE MAGNETS?**

**STANDARD OR SPECIAL SIZES FOR PROTOTYPE WORK OR PRODUCTION AVAILABLE AT NOTICE ALL OTHER PERMANENT MAGNET MATERIALS HELD IN STOCK.**

**MAGNET DEVELOPMENTS LIMITED**

**WWW - 17 FOR FURTHER DETAILS**

---

**Floppy Disk Drives - New Low Prices! Unbelievable but True! Read On!**

**SIEMENS FDD - 100-8/FDD - 200-8**

Fully Shugart Compatible Siemens 8" angle and double sided disk drives are available in attractive prices at expanded capacities.

Now these specifications:

1. **MASSIVE SENDING:**
2. **ACTIVITY INDICATION:**
3. **MECHANICAL BRAKING STOPS AT RECORDING OR RETRIEVAL STOP MARK (TOP OR BOTTOM) (TOP)
4. **NO INCLUDED SURFACE POLE**
5. **WRITE PROJECT**
6. **GROUPING ELECTION**
7. **AC DUAL ELECTRICITY WHICH PREVENTS THE COVER FROM COMING OUT IN THE OPEN CIRCUIT INSERTED MAGNET**

**FDD-8**: 500 Gs per disk surface.

- **Bit Density/track recording method**: 1000 BPI
- **Head Type**: 2 heads
- **Access Time, Track 0 to 25**: 17.84s
- **Recording Surface**: 25 sectors
- **Number of Recording Heads**: 2
- **Single Density**: 400 Kbytes/sector
- **Double Density**: 800 Kbytes/sector

**Pricing**

**FDD-1008 from £249.85**

**DDO-200-8 from £390.00 EACH**

**IRVINE BUSINESS SYSTEMS**

**WWW - 184 FOR FURTHER DETAILS**
The biggest name in solder worldwide

**Arax Multicore Solder.**
Economy pack for general non-electrical use. Replaces solid wire and stick solder (B.S. 219 Grade L). Econopak. 200g reel of 3mm dia. Size 16A. £3.14 per reel.

**Toolbox Reels.**
Multicore 5-core solder for general use. Suitable for electrical joints (B.S. 219 Grade C). 40/60 tin/lead. 1.2mm dia. Size 3. £3.91 per reel.

**Sawtell.**
Multicore 5-core solder for radio, TV, and similar work. Reduces copper erosion. Suitable for service engineers and manufacturers using small quantities of solder. 1.2mm dia. Size 12. £3.91 per reel.

**Bib Hi-Fi Accessories Ltd. (Solder Division), Kelsey House, Wood Lane End, Hemel Hempstead, Hertfordshire HP2 4RQ. Telephone: (0442) 61291.**

**Products that help you make a better job of it.**

**Multicore Wick.**
Multicore solder wick for removing solder from virtually any joint. 17mm dia. Size AB10. £1.38 per reel.

**Handy Dispensers.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Price per pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC115</td>
<td>£1.15</td>
</tr>
<tr>
<td>SV120</td>
<td>£1.61</td>
</tr>
<tr>
<td>AR140</td>
<td>£1.38</td>
</tr>
<tr>
<td>SS160</td>
<td>£2.53</td>
</tr>
<tr>
<td>19A</td>
<td>£1.93</td>
</tr>
<tr>
<td>AL150</td>
<td>£1.06</td>
</tr>
<tr>
<td>BCA16</td>
<td>£1.22</td>
</tr>
<tr>
<td>BCR10</td>
<td>£1.38</td>
</tr>
<tr>
<td>BCA14</td>
<td>£1.38</td>
</tr>
</tbody>
</table>

**Tip Kleen.**
Multicore Tip Kleen. Soldering iron tip wiping pad. Replaces wet sponges. Should not be used above 350°C. 81p per pack.

**Soldering Flux Pastes.**
Multicore soldering flux paste. Extra fast, non-corrosive, rosin flux for electrical and general purpose soldering. Rosin RE10. 35g net. 69p per pack. Multicore soldering flux paste for soft metals (except aluminium) and stainless steel. Non-electrical. Arax A14. 35g. 69p per pack.

**Econopak.**
Erson Multicore 5-core solder. Contains non-corrosive flux for electrical applications. 1.2mm dia. 200g Econopak. Size 13A. £4.14 per reel.

**Metal Soldering.**
Arax Multicore 4-core solder for metal fabrication (not aluminium and repairs). 40/60 tin/lead. 1.6mm dia. Size 11. £3.91 per reel.

**TV and Radio Soldering.**
Sawtell Multicore for radio, TV, and similar work. Reduces copper erosion. 1.2mm dia. Size 5. 90p per handy dispenser. Econopak. General purpose solder suitable for all electrical joints. 40/60 alloy. 1.2mm dia. Size 6. 58p per handy plastic dispenser.

**Wire Stripper and cutter.**
Wire stripper and cutter with precision ground and hardened steel jaws. Adjustable to most wire sizes. With handle locking catch and easy-grip plastic covered handles. Ref. 9. £2.69 per pair.

All recommended retail prices shown are inclusive of VAT. If you have difficulty in obtaining any of these products send direct with 40p for postage and packing. For free colour brochure send S.A.E.