wireless world

MARCH 1981 60p

Range of counters
Magnetic recording
S.a.w. guide
Products that help you make a better job of it.

- **Econopak:** Offers Multi-core 5-core solder for non-electrical uses for ease of application. 1.2mm dia. 2.5kg per pack. £6.90 per pack.

- **Handy Dispensers:**
  - Size A11: £3.91 per reel.
  - Size A10: £4.14 per reel.
  - Size A9: £9.60 per reel.
  - Size A8: £1.38 per reel.
  - Size A7: £1.61 per reel.
  - Size A6: £1.15 per reel.

- **Multi-core Solder Wick:**
  - Size 11: £3.91 per reel.
  - Size 12: £3.91 per reel.
  - Size 13: £1.93 per pack.

- **Metal Soldering:**
  - Multi-core soldering for radio, TV and similar work. 1.2mm dia. 2.5kg per pack. £6.90 per pack.

- **Tip Wipe:**
  - Multi-core Tip Wipe: £1.38 per pack.

- **Soldering Flux Pastes:**
  - Metal Soldering Flux Paste: £1.38 per pack.

- **Wire Strippers and cutters:**
  - Wire strippers and cutters with precision ground hardened steel jaws. Adjustable to every size. With handle locking catch and easy grip plastic covered handles. Ref. 9. £2.69 per pair.
...off the shelf

For more details circle the appropriate numbers on the enquiry card

905 3½ digit handheld DMM
936 3½ digit handheld DMM
938 3½ digit handheld capitance meter
940 Hand held thermometer
1350 3½ digit low cost bench DMM
1351 As above to 26A
175 3½ digit portable DMM
1760 3½ digit bench DMM
240 4½ digit portable DMM
258 4½ digit portable DMM
2450 4½ digit bench DMM
3400 4½ digit DMM
3500 5½ digit bench systems
7500 5½ digit systems DMM
3505 Single range DVMs
6100 Dual output dc volts standard
565 8½ digit portable frequency meter 250MHz
5800 8½ digit bench frequency meter 250MHz
5740 7½ digit multifunction timer-counter

Solo UK Agent:

Farnell International

data precision
digital instruments...

MULTIFUNCTION TIMER-COUNTER

Data Precision 5740
Frequency 6kHz to 100MHz
Pulse 0 to 10µs
Single period 1 to 200,000µs
Period average 0.99999 to 999,999
Totalizing (event counting) 0 to 9,999,999 and beyond
Sensitivity 10mV
Accuracy ±0.01%/sec
Stability ±0.01%/sec ±0.01%/month ±0.01%/year
Mains powered
Optional bcd output, electrical start-stop, external clock input
UK price £195 delivered ex VAT

Current issue price 60p, back issue (if available) £1.00, at Royal and Trade Centre, Units 1 to 3, BanksideIndustrial Centre, Haymarket, London SE1. Available on microfilm, please contact editor

Editorial & advertising office: Practic House, 537 High Street, Harrow, Middlesex, HA2 2BE. Telephone: 01-848 4455. Telex: 981916 WIRELESSW W

37 The dream of objectivity

38 Surface acoustic wave devices by R. J. Murray and P. D. White

42 Modular frequency counters by M. Vojnak

47 World of amateur radio

48 News of the month

52 Circuit Ideas

54 Magnetic recording review by J. Moir

59 Letters to the editor

65 Linear modulator for radio control

71 Unified circuit theory

75 Secondary breakdown oscillation

79 Wind speed and direction meter – 2

83 An appreciation of James Clerk Maxwell

86 A decimal Gray code

88 Books

99 New products

Wireless World March 1981 Vol 87 No 1542

37 The dream of objectivity

38 Surface acoustic wave devices by R. J. Murray and P. D. White

42 Modular frequency counters by M. Vojnak

47 World of amateur radio

48 News of the month

52 Circuit Ideas

54 Magnetic recording review by J. Moir

59 Letters to the editor

65 Linear modulator for radio control

71 Unified circuit theory

75 Secondary breakdown oscillation

79 Wind speed and direction meter – 2

83 An appreciation of James Clerk Maxwell

86 A decimal Gray code

88 Books

99 New products

Front cover shows piezoelectric Rochelle salt crystals, photographed by Paul Briery in polarized light.

The dream of objectivity

David Read's modification to his active crossover network allows Quad electrostatic loudspeakers to be used with a common bass unit.

Opto-electronic contact breaker is a compact circuit which directly drives an electronic ignition unit and overcomes the heat wear and timing scatter inherent in mechanical contacts.

Wireless World March 1981 Vol 87 No 1542

37 The dream of objectivity

38 Surface acoustic wave devices by R. J. Murray and P. D. White

42 Modular frequency counters by M. Vojnak

47 World of amateur radio

48 News of the month

52 Circuit Ideas

54 Magnetic recording review by J. Moir

59 Letters to the editor

65 Linear modulator for radio control

71 Unified circuit theory

75 Secondary breakdown oscillation

79 Wind speed and direction meter – 2

83 An appreciation of James Clerk Maxwell

86 A decimal Gray code

88 Books

99 New products

Wireless World March 1981 Vol 87 No 1542

37 The dream of objectivity

38 Surface acoustic wave devices by R. J. Murray and P. D. White

42 Modular frequency counters by M. Vojnak

47 World of amateur radio

48 News of the month

52 Circuit Ideas

54 Magnetic recording review by J. Moir

59 Letters to the editor

65 Linear modulator for radio control

71 Unified circuit theory

75 Secondary breakdown oscillation

79 Wind speed and direction meter – 2

83 An appreciation of James Clerk Maxwell

86 A decimal Gray code

88 Books

99 New products
### Latest Test Equipment

#### Power Supplies
- **Advanced Research** 50W Source Measure Unit
- **Brick** 50W Source Measure Unit
- **Marconi** 300W Source Measure Unit
- **Philips** 300W Source Measure Unit

#### Oscilloscopes
- **Philips** PM6604 Time Counter
- **Marconi** WT370 Digital Chart Recorder
- **Tektronix** 465 Dual Trace Portable Oscilloscope
- **Hewlett Packard** HP35670A Frequency Counter

#### Analysers
- **Hewlett Packard** HP35670A Frequency Counter
- **Philips** PM6604 Time Counter
- **Marconi** WT370 Digital Chart Recorder

#### Signal Sources
- **Rohde & Schwarz** 1072A AM/FM Generator
- **Rohde & Schwarz** 1072A FM Generator
- **Rohde & Schwarz** 1072A FM Generator
- **Rohde & Schwarz** 1072A AM Generator

#### Transmission Measuring Equipment
- **Rohde & Schwarz** 1072A AM/FM Generator
- **Rohde & Schwarz** 1072A FM Generator
- **Rohde & Schwarz** 1072A FM Generator
- **Rohde & Schwarz** 1072A AM Generator

#### Miscellaneous
- **Rohde & Schwarz** 1072A AM/FM Generator
- **Rohde & Schwarz** 1072A FM Generator
- **Rohde & Schwarz** 1072A FM Generator
- **Rohde & Schwarz** 1072A AM Generator

### Original Specs

#### Electronic Brokers—Europe's Premier

**March 1981**

**GUARANTEE**

UNLESS OTHERWISE STATED, ALL TEST EQUIPMENT SOLD BY US CARRIES A 12 MONTH WARRANTY. FOR VDUs AND TELETYPES WE OFFER A 90 DAY WARRANTY AND COMPUTERS ARE OFFERED WITH SITE ACCEPTANCE AND DIAGNOSTIC TESTS (WHICH MAY QUALIFY THEM FOR INDEPENDENT ONGOING MAINTENANCE).

When you buy from Electronic Brokers you know the equipment is in 'top notch' condition. It is refurbished in our own service laboratories and checked to meet the original manufacturer's specifications. And it's serviced by our own highly skilled technicians.

A copy of our Trading Conditions is available on request.

---

**Electronic Brokers**

61/65 Kings Cross Road
London WC1X 9LN England
Telephone: 01-278 3461
Telex: 298684 Elebrag
E l e c t r o n i c  B r o k e r s - E u r o p e ' s  P r e m i e r  U s e d  C o m p u t e r  C o m p a n y  o f f e r

P D P 1 1  S Y S T E M S

• DEC 11/03 compatible with 4-kbyte System Unit
• DEC 11/40 compatible with 4-kbyte System Unit
• DEC 11/40 compatible with 8-kbyte System Unit
• DEC 11/40 compatible with 16-kbyte System Unit
• DEC 11/40 compatible with 32-kbyte System Unit
• DEC 11/40 compatible with 64-kbyte System Unit

M I N I M E M O R Y  • M I N I M E M O R Y  • M I N I M E M O R Y

Paper Tape Punch

H 1000
cable

MAGNETIC TAPE

* Standardized drive units are available on request.

Electronic Brokers

61/65 Kings Cross Road
London WC1X 9LN, England
Telephone: 01-278 3461
Telex: 298694 Elebro G
AMCRON
INDUSTRIAL MUSCLE

* POWER RESPONSE DC - 20kHz ± 1dB
* OUTPUT POWER IN EXCESS OF 1.6kW 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 1kW INTO 6 OHMS
* PLUG-IN MODULES: CONSTANT VOLTAGE/CURRENT PRECISION OSCILLATORS * UNIPOLAR AND BIPOLAR DIGITAL INTERFACES, FUNCTION GENERATORS, AND MANY OTHERS.
* OUTPUT MATCHING TRANSFORMERS AVAILABLE TO MATCH VIRTUALLY ANY LOAD.
* FULL OPEN AND SHORT CIRCUIT PROTECTION GUARANTEED STABLE INTO ANY LOAD.
* TWO UNITS MAY BE CONNECTED TO PROVIDE UP TO 4kW.
* INTERLOCK CAPABILITY FOR UP TO EIGHT UNITS.
* 3-YEAR PARTS AND LABOUR WARRANTY.

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

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

** Model - M600 **

Tests bipolar transistors, diodes and zener diodes. Measures leakage down to 0.5 nA at 2V to 150V. Current gains are checked from 1µA to 100mA. Breakdown voltages up to 100V are measured at 10µA, 100µA and 1mA. Collector to emitter saturation voltage is measured at 1mA, 10mA, 30mA and 100mA for Ic/Ib ratios of 10, 20, 30. The instrument is powered by a 9V battery.

** TRANSISTOR RANGES (PHR OR NPN) **

- Ic/fBfRBO: 10nA, 100nA, 1µA, 10µA and 100µA f.s.d.
- Ic/BfRBO: ±2%, ±1% at voltages of 2V, 5V, 10V, 20V, 30V, 40V, 50V, 60V, 80V, 100V, 120V, and 150V acc. ±3% ±100µV up to 10µA with fall at 100µA ±5% ±250mV.
- BVfBO: 10V or 100V f.s.d. acc. ±2% f.s.d. ±1% at currents of 1µA, 10µA and 1mA ±20%.
- Ic/IcBO: 10nA, 100nA, 1µA, 10µA f.s.d. acc. ±2% f.s.d. ±1% at fixed Ic of 1µA, 10µA, 100µA, 1mA, 10mA, 30mA, and 100mA acc. ±1%.
- VFB: 3 inverse scales of 2000 to 100, 400 to 30 and 100 to 10 converted into log readings.
- VBE: 1V f.s.d. acc. ±20mV measured at conditions on log test.
- VCE: 1V f.s.d. acc. ±20mV at collector emitters of 1µA, 10µA, 100µA, 1mA, 10mA, 30mA and 100mA with Ic/IcBO selected at 10, 20 or 30 acc. ±20%.

** DIODE & ZENER DIODE RANGES **

- Zpr: As fRBO transistor ranges.
- Zv: Breakdown ranges as BVfBO for transistors.
- Vdf: 1V f.s.d. acc. ±20mV at Ic fRBO of 1µA, 10µA, 100µA, 1mA, 10mA, 30mA, and 100mA.

** DON'T GAMBLE WITH PERFORMANCE BUY LEVELL TESTERS **

A logarithmic scale covering 6 decades is used to display either insulation resistance or leakage current at a fixed stabilised test voltage. The current available is limited to a maximum value of 3mA for safety and capacitors are automatically discharged when the instrument is switched off or to the CAL condition. The instrument operates from a 9V internal battery.

** RESISTANCE RANGES **

- 10MΩ to 10Ω (10Ω) at 250V, 500V, 750V and 1kV.
- 1MΩ to 1Ω at 25V, 50V and 100V.
- 10kΩ to 100Ω at 2.5V, 5V and 10V.
- 10kΩ to 1Ω at 1V.

Accuracy ±1% ±800Ω on 6 decade logarithmic scale.

** MEASUREMENT TIME **

- < 3s for resistance on all ranges relative to CAL position.
- < 10s for resistance of 10Ω across 1Ω on 50V to 500V.

** RECORDER OUTPUT **

1V per decade ±2% with zero output at scale centres. Maximum output ±3V. Output resistance 1kΩ.

** DIODE & ZENER DIODE RANGES **

- Type: T162 £160
- Type: T614 £170

Optional extras are leather cases and mains power units. Prices are ex works, V.A.T. extra in U.K.

** LEVELL ELECTRONICS LTD. **

MOXON STREET, BARNET, HERTS. EN5 5SD
TEL: 0-449 5028/440 8686

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

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

** WW — 85 FOR FURTHER DETAILS **

** WW — 85 FOR FURTHER DETAILS **
You could do with a Helper on your test bench.

Helper low cost instruments are specially designed for "fiddle-free", instant bench testing or mobile servicing of two-way radio equipment.

They'll make life easier for the busy technician whilst giving extremely reliable, lasting service.

The Autopulse Modulation Monitor.

For reading peak modulation and modulation density on any FM receiver whose 2nd I.F. is 400, 455 or 555KHz. Other frequencies may be accommodated on special order.

The Snadder 3...

Ideal for bench or mobile service van use, with 3 functions in one. Automatic S/N ratio meter with audio monitoring plus a 1000Hz tone generator. Sensitive A/C voltmeter, 1MΩ input impedance, with audio monitor for tracking down distortion and locating defective stages. These are just two of our Helper range.

Write now for a product guide and free copy of the mobile radio desk reference.

Incredible Quality
Incredible Performance
Incredible Price!!!
**INDUCTION AUDIO**

**WIRELESS WORLD MARCH 1981**

**Danavox (GT, Britain) Ltd.**

1 Cheyne Walk,
NORTHAMPTON NN1 5PT

TEL. NORTHAMPTON (0604) 26351

**TRANSFORMERS IN A RANGE OF 75 TYPES**

We use advanced winding technology to make our toroidal transformers. They have only half the weight and half of our specified requirements and are appreciably more effective. Our winding core combined with the size of the output is approximately the same as the older types, which are rarely replacing. Induction level is reduced to a fraction of an ampere for our suppliers with design features which require low-level outputs.

**SOME SIZES**

**DANAVOXD**

- **Stethoscopes**
- **Junior Headsets**
- **Senior Headsets**
- **Microphone Headsets**
- **Plastic Earpieces**
- **Standard & Sub-Minor Earpieces**
- **2.5 mm and 3.5 mm Jack Plugs & Sockets**
- **Danasound Headsets**
- **Danasound Induction Audio Loop Receivers**
- **Subminiature Switches**

**Choose from 3 PRIMARY INPUTS**

- **Type**
- **Secondary**
- **Current**

**AC volts**

- **200V-700V, 100V resolution, AC/AC current, 10A resolution, Resistance 200-20M, 0.1% resolution, Conductance 200n, Peak load of AC and DC volts, Current, Level directly operates around 0.6% reference, Audio tone on level and continuity, £140.00, carrying case £70.00 extra.**

**802A 3**

- **Digit hand held LCD DMM, spec 802A with extra conductance range of 2ms but no peak hold, level on continuity range. Complete with carrying case £125.00.**

**802A 3**

- **Digit hand held LCD DMM, spec 802A with extra conductance range of 2ms but no peak hold, level on continuity range. Complete with carrying case £125.00.**

**Electronic Brokers**

61-65 King's Cross Road
London, WC1X 9LN
Tel: 01-278 3461 - Telex 298694

**FREQUENCY DISTRIBUTION ROYAL TELEPHONE CABLES**

Phone 01-278 3461 - Technical 01-278 4773 - Telex 298694

**WW-824 FOR FURTHER DETAILS**
ONE UP ON THE COMPETITION.

Introducing the first 4½ digit handheld DMM in a market that’s been the exclusive domain of 3½ digit models. Until now.
The new Keithley 176.
Combining outstanding specification with impeccable performance, and continuing Keithley’s position as a major innovator in D.M.M. technology:

- 0.05% DCV accuracy
- Five functions
- Low battery indicator
- Full overload protection:
  - 1000V max DCV
  - 1000V peak ACV
  - 300V max Ohms
  - 10 amp range
  - ACV bandwidth to 20 kHz

The price – only £139 + VAT

Need a bench unit? Then take a look at the new Keithley 176. Five functions, 4½ digits, ±0.05% DCV accuracy, and full function annunciators. Built up to a standard – not down to a price.
Yet at only £179 + VAT, the 176 gives quality 4½ digit performance at a cost some 3½ digit manufacturers would dearly love to match.

To find out more, fill in the coupon. And see what keeps Keithley one step ahead.

---

**HAMEG OSCILLOSCOPES**

Top Performance In Every Range

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Function</th>
<th>Additional Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>HM 312</td>
<td>£225</td>
<td>100 VDC, 300 VAC</td>
<td>20 kHz bandwidth, 2,000 to 10 MΩ, Built-in Oscilloscope</td>
</tr>
<tr>
<td>HM 412</td>
<td>£350</td>
<td>100 VDC, 300 VAC</td>
<td>20 MHz bandwidth, 2,000 to 10 MΩ, Built-in Oscilloscope</td>
</tr>
<tr>
<td>HM 612</td>
<td>£580</td>
<td>100 VDC, 300 VAC</td>
<td>20 MHz bandwidth, 2,000 to 10 MΩ, Built-in Oscilloscope</td>
</tr>
<tr>
<td>HM 812</td>
<td>£1,458</td>
<td>100 VDC, 300 VAC</td>
<td>20 MHz bandwidth, 2,000 to 10 MΩ, Built-in Oscilloscope</td>
</tr>
</tbody>
</table>

**For further information:**

Keithley Instruments Ltd
The Kemistry, Reading Berks RG2 8NL
Telephone (0734) 861287
Telex 647104

---

**HEWLETT PACKARD**

HP.85

£1,750 + VAT

The HP85 is designed for personal use in business and industry by professionals such as engineers, scientists.

The keyboard, video display, printer, cartridge type unit and operating system are all built into one desktop unit.

For further details and our 24 page colour brochure and full price list, please ask.

---

**MICRODIGITAL**

Microdigital Limited
25 Brunswick Street, Liverpool, L2 3AF
Tel: 051-227-2535/67

---

WIRELESS WORLD

MARCH 1981

- WW - 88 FOR FURTHER DETAILS
- WW - 900 FOR FURTHER DETAILS
NEW FROM
THE ONE-OFF SHOP

3M SCOTCHFLEX
IT'S CLICKED

Verospeed now offers a choice of four Scotchflex P.C.B. mounted headers from 10 to 60 ways. A new pin length (3.94 mm.) covers all P.C.B. requirements and both the right angle and straight pin versions are available with long or short ejector ears. A full complement of Ribbon Cable mounted Sockets, Polarising Key and Strain Relief Clips completes the range.

The DIN 41612 compatible range of Connectors has also been expanded to include the 64/64 Cable and Frame mounting Plugs and Sockets. The components and tooling are all available "by return" from Verospeed.

EQUIPMENT WIRE

Mains Cables, Ribbon Cables, Uniradio, Coax, Miniature and Standard Multicores. The widest selection at the most competitive prices. 154 product lines devoted to equipment wires and cables manufactured to BS and DEF Standards. Equipment Wire section includes a 7.0/12 mm. PVC covered wire for small P.C.B. applications and E.T.F.E. Wire - a 120°C Tefzel insulated wire which offers a low cost alternative to P.T.F.E. All are manufactured by the world's biggest manufacturer of Cables - B.I.C.C. — and are available via Verospeed's famous "by return" service.

Look for these - and lots more in THE ONE-OFF SHOP

Send for your copy. Test our service by phoning 0703 018525 before 3.00 p.m. — and your catalogue will be in the post tonight.

V E R O S P E E D

Equipment Wires and Cables manufactured to BS and DEF Standards. Equipment Wire section includes a 7.0/12 mm. PVC covered wire for small P.C.B. applications and E.T.F.E. Wire — a 120°C Tefzel insulated wire which offers a low cost alternative to P.T.F.E. All are manufactured by the world's biggest manufacturer of Cables — B.I.C.C. — and are available via Verospeed's famous "by return" service.

For quick signal tracing and circuit modification
For quick circuit analysis and diagramming
With or without built-in regulated power supplies
Use with virtually all parts — most plug in directly, in seconds.
Ideal for design, prototype and hobby.

Now circuit designing is as easy as pushing a lead into a hole...
No soldering
No de-soldering
No heat-apit components
No manual labour
No wasted time

The Proto-Board®

For quick signal tracing and circuit modification
For quick circuit analysis and diagramming
With or without built-in regulated power supplies
Use with virtually all parts — most plug in directly, in seconds.
Ideal for design, prototype and hobby.

Tomorrow's tools for today's problems

CONTINENTAL SPECIALTIES CORPORATION

C.S.C. (UK) Limited,
Dept. 7U Unit 1, Shire Hill Industrial Estate,
Saffron Walden, Essex. CB11 3AQ
Telephone: Saffron Walden (0799) 21682
Telex: 917477

Name

Address

I enclose Cheque/PO for £ or debit my Barclaycard, Access, American Express card no. exp. date

FOR IMMEDIATE ACTION — The C.S.C. 24 hour 3 day a week service telephone (0799) 21682 and give us your Barclaycard, Access, American Express number and your order will be in the post immediately.

For Free catalogue

C.W. — 94 FOR FURTHER DETAILS

WIRELESS WORLD MARCH 1981
Why the Sinclair ZX80 is Britain's best-selling personal computer.

Built: £99.95
Including VAT, post and packing, free course in computing, free mains adaptor

Kit: £79.95
Including VAT, post and packing, free course in computing.

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

Massive add-on memory. Only £49.95.
The new 16K-BYTE RAM pack is a complete module designed to provide you — and your Sinclair ZX80 — with massive add-on memory. You can use it for those really long and complex programs — or as a personal database. (It will cost as little as half the price of competitive add-on memory for other computers.)

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

Or you can store a whole database perhaps in a fairly simple program — such as a name and address list, or a telephone directory. And by linking a number of separate programs together into one giant, but modularity, you can achieve the same effect as loading several programs at once.

We're also confident that it won't be long before you can buy cassette-based software using the full 16K-BYTE RAM. So keep an eye on the personal computer magazines and brush up your chess perhaps!

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

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

To: Science of Cambridge, FREEPOST 7, Cambridge CB2 1YY.
Remember: all prices shown include VAT, postage and packing. No hidden extras. Please send me

We reserve the right to refuse to accept any order for the ZX80, ZX81 or ZX82.

<table>
<thead>
<tr>
<th>Item Code</th>
<th>Item Price</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>79.95</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>99.95</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>8.95</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>49.95</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>5.00</td>
<td></td>
</tr>
</tbody>
</table>

If we receive your order before 12 noon on the 3rd day of publication, we will endeavour to deliver your ZX80 to you exactly when you want it. You can also order your ZX80 by phoning Science of Cambridge Ltd. (0223) 311488.

Please check that your ZX80 is correctly packed before you return it for a refund or replacement.

Thank you for your order.

WIRELESS WORLD MARCH 1981
There are 9 new features on this THRULINE® RF Wattmeter. And one familiar one: the Elements

Forward Power in watts - with 120% overrange and with the decimal point in place.
The same for Reflected Power.

Push for Peak Envelope Power of SSB, AM in Forward or Reflected directions in watts

Push to read CW power in dbm

Portable or AC Line operation with battery charger (included)

Uses the same Plug-In Elements you may already own with your model 43 Wattmeter

Push here to read SWR Instantaneously and watch it change

And % Modulation

And Return Loss in dB

And while tuning or tweaking, the memory buttons recall min and max values of any chosen quantity - and Δ shows if it is rising or falling

AND NOW: Rackmounted models for 2-way mobile, FM and TV broadcasters, portables with built-in or remote line sections, compatibility with T830 and RG-232 (options). Write for Series 4300 RF Power ANALYST.

---

A PROFESSIONAL TOOLCASE FOR UNDER £40

Designed for the professional Electronics, T.V or Instrument Technician who needs to carry a large number of specialist tools.
The TL 1.99 sets a standard as a low cost alternative to more expensive cases. It offers strength with a practical use of space and many other features.

Order Form

- Side Reversible Multi-purpose tool pallet
- Document area
- 90° opening lock back stays
- 3" deep ABS lid and base
- Twin handles with 8 fixing points on aluminium frames
- Burst proof toggle locks with keys
- Moulded adjustable tray in base
- Heat sink for hot soldering iron

Features

Dimensions TL 1.99 17" x 12" x 6" split (shown) also available TL 1.100 19" x 14" x 6" split

Tools NOT included. British made. Money back guarantee. Allow 7-10 days for delivery.

---

GET YOUR HANDS ON A KEITHLEY 130

The pocket Digital Multimeter by which others are judged.

£79 PLUS VAT

And generous discounts start at 10 units: 5%

Everything about the 130 is right.

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

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

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

How do you get one?

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

The Keithley 130 — the DMM. that won't stretch your pocket!

---

KEITHLEY

Keithley Instruments Ltd
Thabloon Road Reading Berkshire RG2 0NL
Tel: 0734 451561

---

Please print clearly and legibly.

I enclose a cheque/postal order for

Keithley Instruments Ltd
140/142 Boulton Road, Reading, Berkshire RG2 0NL
Tel: 0734 451561

Name: ________________________________
Address: ______________________________
Telephone: ___________________________
Postcode: _____________________________
**FAST ERECTING**

**CLARK MASTS**

For World-wide Telecommunications in the 1980s

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

**WIRELESS WORLD MARCH 1981**

**Make it for a Song!**

The New **Maplin in Matinée**

**Amazing Value**

**For Only** £299.95 + £99.50 for cabinet if required.


The complete buyers' guide to electronic components. With over 300 pages, it's a comprehensive guide to electronic components 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.

**Catalogue now on sale in all branches of WHSMITH** Price £1.00

**WW—007 FOR FURTHER DETAILS**
AHO Assurance

- insulation breakdown testers you can rely on

The Health and Safety at Work Act means that you now carry a much greater responsibility to protect your customers. So, the insulation breakdown testers you choose must be used more than ever both in the factory and on site and must perform efficiently and reliably.

On-site

The RM215-L/2 is an AC/DC Breakdown Leakage and Ionisation Tester designed for use in both Quality Assurance and Development Laboratories. The instrument offers a wide range of AC and DC output voltages, the voltage and leakage current being displayed on two meters. The RM215-L/2 has been designed to meet BS, VDE and EC safety requirements and can be used for the general function testing and non-destructive measurement of breakdown voltage of electrical insulating materials.

In the lab

The RM215-L/2 is an AC/DC Breakdown Leakage and Ionisation Tester designed for use in both Quality Assurance and Development Laboratories. The instrument offers a wide range of AC and DC output voltages, the voltage and leakage current being displayed on two meters. The RM215-L/2 has been designed to meet BS, VDE and EC safety requirements and can be used for the general function testing and non-destructive measurement of breakdown voltage of electrical insulating materials.

You'll never meet a better meter

Avo Limited, Archcliffe Road, Dover Kent CT17 9EN Tel: 0504 202620. Telex: 96265

HIGH QUALITY/Low COST

KIKUSUI 5520 20MHz SCOPE

ONLY £230+VAT - FREE DELIVERY

- 20MHz, 5mV
- 1mV, 10MHz
- One Touch X-Y Operation
- TV Sync, Separator (Trigger)
- Single Sweep Function
- High Brightness CRT

Orders to Teledonic Berkeley

Tv Mavor and Co. Ltd.

HIGH EFFICIENCY — HIGH QUALITY

SINE WAVE INVERTERS

—from CARACAL

200 to 1000 VA

DC Input: 12, 24 or 48 V

AC Output: 220/240V or 110/120V

50/60 Hz

CARACAL sine wave inverters are modern replacements for older tuned-type (ferroresonant) inverters. They are widely used where a reliable source of standby or continuous AC power is essential, or for mobile or marine use where only a D.C. source is available.

- Very stable output voltage (+/- 2 %) and frequency (+/- 0.3 Hz) under all load / battery conditions
- High efficiency on ALL loads, plus the option for internal loading
- Low distortion sine wave — only 3% T.H.D.
- Very low input current on no-load
- Competitively priced, state-of-the-art technology
A range of scopes in stock from SmHz Single Trace to 50MHz Dualtrace. Many on demonstration.

**SCOPES**

**SINGLE TRACE**

- 4030 7½ digit 100MHz (£28.95)
- 4035 7½ digit 200MHz (£31.95)
- 4040 7½ digit 500MHz (£33.95)
- 4060 7½ digit 1GHz (£37.95)

**DUAL TRACE**

- 4032 7½ digit 100MHz (£32.95)
- 4034 7½ digit 200MHz (£35.95)
- 4044 7½ digit 500MHz (£39.95)
- 4064 7½ digit 1GHz (£43.95)

**OPTIONAL PROBES (ALL MODELS)**

- 4080 7½ digit 1GHz (£9.95)
- 4082 3½ digit 1GHz (£4.95)

**GENERATORS**

- 2401A 50Hz £60.00
- 2402A 50Hz £80.00
- 2403A 50Hz £100.00

**DIGITAL MULTIMETERS**

- 6G20 3½ digit £5.00
- 6G30 3½ digit £6.50
- 6G40 3½ digit £8.50
- 6G50 3½ digit £12.95

**SW/SWS/F/FS/FSW**

- 3½ digit LCD 10Hz to 200mHz (£4.65)
- 4½ digit LED 5Hz to 100mHz (£6.60)
- 6½ digit LED 0.2A AC/DC (£9.25)
- 8½ digit LCD 0.2A AC/DC (£16.50)

**FREQUENCY COUNTERS**

- 100MHz £29.95
- 200MHz £39.95

**MULTIMETERS**

- 7709 3½ digit £8.50
- 7710 4½ digit £12.95

**CLAMP METERS/INSULATION TESTERS**

- 3490 3½ digit £4.95
- 3491 4½ digit £7.55

**HELPFUL CABLES**

- 3493 30 AMP £10.00
- 3494 50 AMP £15.00
- 3495 100 AMP £25.00

**RECHARGEABLE BATTERIES**

- 145s £5.00
- 145m £6.00

**METALFILM RESISTORS**

- ±1%, 1%, ±5%

**FREE CATALOGUE**

- Large range SAE, Schупker, etc. (Call for price)

**WIRELESS WORLD MARCH 1981**

**MORE SPEC. FOR YOUR MONEY!**

**WIRELESS WORLD MARCH 1981**

- **TYPE 217 DUAL POWER SUPPLY**
  - £34.88 (incl. carriage, No. 1)
- **METALFILM RESISTORS**
  - ±1%, 1%, ±5%
- **FREE CATALOGUE**
  - Large range SAE, Schупker, etc. (Call for price)

**The Advertising Standards Authority.**

If an advertisement is wrong, we're here to put it right.

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

- **Circuit boards**: Crystal Filter IC's, Custom Filter IC's, Mechanical filters, Power amplifiers, External filters, Ceramic / Yageo crystals.

**Special offers**
- 26444 - B Chassis FM receiver with high quality ceramic filters, complete with case £16.10
- 44696 - Channel FM receiver, based on ETI October 1982 section £14.26
- 2412 - Complete transceiver case, complete with two psychometric converters £9.50
- 201 - N654 based circuit driven electronic kit (no hardware) £2.38

**Radio Control Systems**
As well as the parts for constructing sophisticated digital proportional radio control systems, we offer kits of parts for complete receiver and transmitter units including hardware only state of the art FM, high fidelity output transistors and fully adjustable control systems. Buy three and save 15%

- **H - 1000 series**: Direct bus drivers with high performance (both HVM7 + 91600 = £6.94 inc. with far greater ease and accuracy than can be achieved with mechanical systems)

**The Mark III Series of DIY HIFI**
- Single input, 'universal' power supply units for any amplifier
- 12 piece crystal kit

**The Mark III Series of DIY HIFI**
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit

**Radio Control Systems**
As well as the parts for constructing sophisticated digital proportional radio control systems, we offer kits of parts for complete receiver and transmitter units including hardware only state of the art FM, high fidelity output transistors and fully adjustable control systems. Buy three and save 15%

- **H - 1000 series**: Direct bus drivers with high performance (both HVM7 + 91600 = £6.94 inc. with far greater ease and accuracy than can be achieved with mechanical systems)

**The Mark III Series of DIY HIFI**
- Single input, 'universal' power supply units for any amplifier
- 12 piece crystal kit

**The Mark III Series of DIY HIFI**
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit

**Radio Control Systems**
As well as the parts for constructing sophisticated digital proportional radio control systems, we offer kits of parts for complete receiver and transmitter units including hardware only state of the art FM, high fidelity output transistors and fully adjustable control systems. Buy three and save 15%

- **H - 1000 series**: Direct bus drivers with high performance (both HVM7 + 91600 = £6.94 inc. with far greater ease and accuracy than can be achieved with mechanical systems)

**The Mark III Series of DIY HIFI**
- Single input, 'universal' power supply units for any amplifier
- 12 piece crystal kit

**The Mark III Series of DIY HIFI**
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit
- 12 piece crystal kit

**Radio Control Systems**
As well as the parts for constructing sophisticated digital proportional radio control systems, we offer kits of parts for complete receiver and transmitter units including hardware only state of the art FM, high fidelity output transistors and fully adjustable control systems. Buy three and save 15%

- **H - 1000 series**: Direct bus drivers with high performance (both HVM7 + 91600 = £6.94 inc. with far greater ease and accuracy than can be achieved with mechanical systems)

**The Mark III Series of DIY HIFI**
- Single input, 'universal' power supply units for any amplifier
- 12 piece crystal kit

**Radio Control Systems**
As well as the parts for constructing sophisticated digital proportional radio control systems, we offer kits of parts for complete receiver and transmitter units including hardware only state of the art FM, high fidelity output transistors and fully adjustable control systems. Buy three and save 15%

- **H - 1000 series**: Direct bus drivers with high performance (both HVM7 + 91600 = £6.94 inc. with far greater ease and accuracy than can be achieved with mechanical systems)
## SALESA NALYSIS

<table>
<thead>
<tr>
<th>Component</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tektronix 340A RMS Voltmeter 10Hz-1MHz</td>
<td>£95.00</td>
</tr>
<tr>
<td>Dynatrol 340A Voltemeter</td>
<td>£85.00</td>
</tr>
<tr>
<td>Marconi TT 7510 3190 Servo Deviation Meter</td>
<td>£185.00</td>
</tr>
<tr>
<td>Marconi TT 7200A 2 MHz Power Meter 100W 10kHz</td>
<td>£185.00</td>
</tr>
<tr>
<td>Marconi TT 7600 Sensitive 150MHz Power Meter</td>
<td>£135.00</td>
</tr>
<tr>
<td>Marconi TT 7340/44 2 GHz Meter and 2 Oscillators 100kHz-25MHz</td>
<td>£125.00</td>
</tr>
<tr>
<td>Heathkit-CC 225L</td>
<td>£125.00</td>
</tr>
<tr>
<td>Siemens 3984a Thermal Millivoltmeter 1MHz 12.0GHz</td>
<td>£135.00</td>
</tr>
</tbody>
</table>

## Bridge wood box £300.00

**Oscilloscopes**

- *Cosma* C100 D/Beam DC-35MHz £295.00
- *ECL 82* £325.00
- *El 90* £255.00

**Diode Multimeters**

- *Keithley 125 2A D.C. Voltmeter 0.1%| 185.00 | 125.00 |
- *Philips 60/12 10 Digit DC-Amp Voltmeters and Resistance| 85.00 | 85.00 |

## Beginner's Guides

- *Martín Associates* 5K 50W £115.00

## Digital Multimeters

- *Marcon* TT 2013 31 Dig 150MHz | £205.00 |
- *Marcon* TT 2013 Dig 150MHz | £205.00 |

## Digital Oscilloscopes

- *El 90* £255.00

## POWER SUPPLIES

- *Philips 60/12 10 Digit DC-Amp Voltmeters and Resistance| 85.00 | 85.00 |

## REPAIRS

- *Philips 60/12 10 Digit DC-Amp Voltmeters and Resistance| 85.00 | 85.00 |

## VIDEO COMPONENTS

- *Philips 60/12 10 Digit DC-Amp Voltmeters and Resistance| 85.00 | 85.00 |

## SEMICONDUCTORS

- *Philips 60/12 10 Digit DC-Amp Voltmeters and Resistance| 85.00 | 85.00 |

## DIODES

- *Philips 60/12 10 Digit DC-Amp Voltmeters and Resistance| 85.00 | 85.00 |

## WIREWOUND RESISTORS

- *Philips 60/12 10 Digit DC-Amp Voltmeters and Resistance| 85.00 | 85.00 |

## NEW BRANDED VALVES

- *Philips 60/12 10 Digit DC-Amp Voltmeters and Resistance| 85.00 | 85.00 |

**Autostore**

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

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

The solution: the new Racial Recorders Autostore.

**Simplicity**

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

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

**Versatility**

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

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

**Racial Recorders**

Racial Recorders Limited, Hardley Industrial Estate, Hythe,Southampton, Hampshire S04 6ZT, England. Tel: (0703) 850265 Telex: 47600
The AIRAMCO Mikro 1000
— The Scottish Solution.

The Mikro 1000 is a Scottish built micro-computer which combines State of Art technology with simplicity and durability to give to a powerful small business system at a very competitive price. Driven by a 2.5 MHz or 4 MHz 280 processing unit constructed around Industry Standard 8080 Bus, the Mikro 1000 is designed to provide the ease of expansion necessary in a modern growing business or industry - memory is expandable from 32K to 256K, with up to 4 Megabytes of on-line disk storage.

The integral VDU has an 80 cols. x 24 lines screen, and incorporates a green phosphor CRT, whilst the 117 key keyboard can be used remotely from the main body of the machine, and may be programmed for user functions such as word processing commands. As well as supporting all CP/M based languages, the Mikro 1000 has a full range of business software, including Sales, Purchase and Nominal Ledger, Inventory Control, and Payroll, as well as Word Processing (which is available at even lower cost as a separate system on the Mikro 1000 WP).

For further information on either Mikro 1000 system, please contact:

Unit A2, Longford Avenue, Kilwinning Ind. Est.,
Kilwinning, Ayrshire, KA22 8N.
Tel: 0294 57755
Telex: 79908

PAGING PAGING PAGING

SEQUENTIAL TONE GENERATOR
— A PARAGON WITH MANY VIRTUES

This single instrument provides all the signals necessary for testing Pocket Pagers. Selective calling systems, C.T.C.S., Tone Burst Systems as well as R.C.C. systems using PGMF, MTS, IMTS, Interrupt and F.S.K. The memory also has additional capacity for tomorrow's communications needs. For further information contact Mike Taylor

FieldTech Ltd
Heathrow Airport
London
Hounslow TW1 2AF
Tel: 01795 2841
Telex: 23734 FLOTEC 0

THE AIRAMCO MICRO 1000
WE OFFER INCREDIBLE FEATURES
AND EVEN MORE INCREDIBLE VALUE

50+ CASES FOR SPECIALISTS
referred by JENSEN

JTK 17
Available in 12 different case models
Specially suited for maintenance of electronic equipment, communications, radios, computers and allied machines.
50 professional tools. VOM Test Meter optional.
See these cases together with more than 20 other complete specialist tool kits in a compact package in the Jensen catalogue available on request from

Special Products Distributors Limited
81 Piccadilly, London W1V OHL
Tel. 01-629 9558
Cables: Speciprod, London, W.1

The AIRAMCO MIKRO SYSTEMS

WIRELESS WORLD MARCH 1981
WWW - 85 FOR FURTHER DETAILS

WIRELESS WORLD MARCH 1981
WWW - 88 FOR FURTHER DETAILS

BULK EPROM PROGRAMMING

This unit provides simple, reliable programming of up to 12 EPROMS simultaneously. It has been designed for ease of operator use — a single 'program' key starts the self check — blank check — program — verify sequence.

Independent blank check & verify controls are provided along with mode, pass/fail indicators for each copy socket and a sounder to signal a correct key command & the end of a programming run. Any of the 3704/2708/2712 (3 rail) & 2764/2758/2516/2716/2523/2732 single rail EPROMS may be selected without hardware or personality card changes.

PRICE £545 + VAT. Postage paid.

BULK EPROM ERASING

MODEL UV141 EPROM ERASER

Genuine Ersagers Ltd.

MODEL UV140 EPROM ERASER

Genuine Ersagers Ltd.

MODEL UV141 EPROM ERASER

Available in Model UV141 last without memory. Price £61.50 + VAT paid.

BULK EPROMS

2716 (450ns) £6.00 £5.50 £5.00 £4.50 £4.20
2708 (450ns) £3.90 £3.50 £3.10 £2.90
2716 (450ns) £10.24 £9.40 £8.80 £8.20 £8.00
2708 (450ns) £5.30 £4.80 £4.50 £4.20

Postage and Packing is included in all prices. ADD VAT at 15%. All our EPROMS are manufactured by leading companies and are fully guaranteed, branded and to full specification.

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

GP INDUSTRIAL ELECTRONICS LTD.
Unit 6, Burro Road, Totnes Industrial Estate, Totnes, Devon
Telephone: Totnes (0666) 853360 sales, 863380 technical
Fax: 4250

DISTRIBUTORS REQUIRED — EXPORT ENQUIRIES WELCOME

PLEASE NOTE NEW ADDRESS & TELEPHONE NUMBER

WWW - 86 FOR FURTHER DETAILS

WWW - 89 FOR FURTHER DETAILS

www.americanhistoryhistory.com
**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, III, IV and V
  - Variable video output
  - (with 1 volt fixed position)
  - External video and sound modulation facility
  - Composite sync output for triggering — includes the line frame and blanking pulses to the local TV standard
  - Versions available for non-British TV systems

**SIGNAL SUCCESS**

**PM 5326**

- RF signal generator
  - 100 kHz — 125 MHz in nine frequency ranges with 5 digit display
  - Built-in 3 digit counter displays external frequencies
  - Two versions available: 100 MHz (1 MHz resolution) — PM 5326X or 1 MHz (10 Hz resolution) — PM 5326
  - 50 mV RF output at 750 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 220

**PM 2519**

- Digital multimeter
  - Full four digit
  - 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 holds probes

Reader inquiry number 223

**PM 3050**

- Electronic analogue multimeter
  - Gigahertz 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

**PM 2502**

- Manual analogue multimeter
  - Accuracy at a low price
  - Comprehensive measuring ranges
  - Highly 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

**AND THREE COUNTERS**

**PM 6661**

- 80 MHz automatic frequency counter
  - One control — ON/OFF
  - Automatic triggering, noise suppression and leading zero blanking
  - High 20 V RMS sensitivity
  - 8-digit LED display

Reader inquiry number 224

**PM 6641**

- 80 MHz automatic frequency counter
  - Frequency range: 10 Hz — 100 kHz
  - Distortion 0.02%
  - Sine and square wave signals

Reader inquiry number 227

**PM 6307**

- Wav and flutter meter
  - X-tail controlled oscillator
  - High accuracy and frequency stability
  - 31.5 Hz or 3000 Hz switchable
  - Separate drift and flutter indication

Reader inquiry number 229

WHERE TO BUY YOUR PHILIPS AUDIO AND VIDEO SERVICE EQUIPMENT

The entire range is available from the Philips Stores, branch or nearest branch on request. Alternatively, phone Cambridge (0223) 35886 and speak to our Commercial Office on extension 145 or 148.

**PM 5519 CTV pattern generator**

**PM 5326 RF signal generator**

**PM 3070 oscilloscope**

**PM 2517, 2505, 2520 counters**

**PM 6661 80 MHz frequency counter**

**PM 6641**

- 4 MHz frequency counter
  - Separate L and R signals
  - External modulation facility
  - X-tail controlled pilot
  - Adjustable multiplex signal and tunable 100 MHz RF signal

Reader inquiry number 229

**PM 5501**

- Colour bar pattern generator
  - Ideal for mobile maintenance
  - Test patterns for colour and b/w
  - RF signal switchable between VHF, Band III and UHF Band IV
  - 1 kHz tone for sound checks

Reader inquiry number 225

**PM 6307**

- Wav and flutter meter
  - X-tail controlled oscillator
  - High accuracy and frequency stability

Reader inquiry number 227

**PM 6307**

- Wav and flutter meter
  - X-tail controlled oscillator
  - High accuracy and frequency stability

Reader inquiry number 227

**PM 6456**

- Stereo generator
  - Complete stereo signal with low crosstalk

Reader inquiry number 229

**PM 2517**

- 2505, 2502 multimeters

**PM 6661**

- High resolution counters
  - 1 GHz (PM 6668) or 120 MHz (PM 6667)
  - Reciprocal technique giving fast resolution measurements down to 10 Hz
  - Auto triggering on all waveforms and duty cycles
  - 15 mV RMS sensitivity
  - High stability X-tail oscillations: 10°/month

Reader inquiry number 225

**PM 5001**

- Colour bar pattern generator

**PM 5070 LF generator**

**PM 6307**

- Wav and flutter meter

**PM 6456**

- Stereo generator

**Pye Unicam Ltd**

Philips Electronic Instruments Dept York Street, Cambridge CB1 1DR, England

Tel: Cambridge (0223) 358866, Telex 817331
fact: the SM63 looks (and sounds) great in front of people... and cameras!

Take it from the professionals

A top quality Shure microphone makes a measurable difference in upgrading sound. Now, Shure has added a new microphone designed to upgrade the appearance of your act, as well as the sound. The SM63 is a top-quality omnidirectional microphone with high output and crisp, clear sound quality — an innovative blending of smaller size, handsome appearance, and truly noteworthy broadcast-quality performance. Highly effective pop protection, low handling noise and very low profile (so it won’t obscure the performer’s face) make it the perfect choice for on-camera applications. The SM63 omnidirectional dynamic microphone measures just 5 1/4 in. long, 1 3/4 in. in diameter and weighs only 2.8 ounces with no compromise in Shure’s standard of reliability. It offers twice the voltage sensitivity of our own SM61 (6 dB) and features a humbucking coil for superior rejection of electromagnetic hum (up to 20 dB better than competitive units) and an easier isolation shock mount for minimized handling noise. The new SM63 also features the Shure-developed VERAFLEX® dent-resistant grille and a smooth satin finish perfect for on-stage and on-camera applications. Send for complete literature on all Shure professional microphones — including the new SM63. (Please let us know your microphone application.)

SM63 Omnidirectional Dynamic Microphone

PROFESSIONAL MICROPHONES... BY

Shure Electronics Limited, Eccleston Road, Maidstone ME15 6AU — Telephone: Maidstone (0622) 59861

Editor: TOM WALL, M.I.R.E.
Deputy Editor: FRED DARRINGTON
01-661 3500 X3586
Technical Editor: GEOFF SHORTER, B.Sc.
01-661 3500 X3598
Projects Editor: MIKE SADIN
01-661 3500 X3589
News Editor: MARTIN ECCLES
01-661 3500 X3599
Drawing Office Manager: ROGER GOODMAN
Technical Illustrator: BETTY PALMER
Production & Design: ALAN KERR
Advertisement Manager: BOB NIBBS, A.C.I.I.
01-661 3130
DAVID DISLEY
01-661 3500 X3593
BARBARA MILLER
01-661 3500 X3592
Classified Manager: BRIAN DURBANT
01-661 3106
JOHN GIBBON (Make-up and copy)
01-661 3500 X3581
Publishing Director: GORDON HENDERSON
Surface acoustic wave devices
A practical guide to their use for engineers
by R. J. Murray and P. D. White
Philips Research Laboratories

This article, intended specifically for professional applications engineers, covers three common types of surface acoustic wave devices: bandpass filters, delay lines, and oscillators. The main part of the article summarizes their performance limits, specification and application. Subsectionary sections give the basic principles of S.A.W. devices (and much more) fully detailed information on the specification, operation and performance trade-offs of the three types of components.

Among the many signal processing techniques available to today’s engineer it is easy to lose sight of one of the more versatile and yet lesser known technologies—that of surface acoustic waves.

Surface acoustic wave (S.A.W.) devices are now being incorporated into advanced electronic systems in both the professional and consumer markets and can, in many cases, implement signal processing functions that are not easily achievable with alternative technologies. The following sections describe three types of device from the wide range of available S.A.W. components: bandpass filters, delay lines and oscillators.

Bandpass filters
The range of S.A.W. components includes both transversal filters, which are broadband, and resonant filters, which are窄band. In a transversal filter, filtering is achieved by passing the signal through a number of delay paths and adding these delayed signals. In the passband the various signals add constructively while in the stopband they add destructively. Thus, S.A.W. transversal filters use traveling waves while, in contrast, S.A.W. resonators employ standing waves and have properties similar to LC and quartz crystal resonant filters. The range of realizable filter bandwidths is shown in Fig. 1.

The best known example of this type of S.A.W. device is undoubtedly the television i.f. filter. Work on the S.A.W. i.f. filter began more than ten years ago and has resulted in the development of devices which are now in large-scale production in England, France, West Germany, Japan and the U.S.A.

This surface wave filter replaces an LC filter which uses adjustable inductors and one adjustable resistor (all of which need setting at the factory) as well as several other components, all assembled on a printed circuit board and occupying a volume of 50cm³. The surface acoustic wave replacement needs no alignment and is mounted in a TO-8 package occupying a volume of less than 2 cm³. The two types of filter are shown in Fig. 2.

Unlike LC filters, S.A.W. transversal filters are not usually constrained to minimum phase filters. This means that, to a large degree, the amplitude and phase responses may be designed and specified independently of one another. If required, a linear phase response may be achieved while simultaneously achieving a steep, flat topped, or equiripple amplitude response.

S.A.W. filters have many potential applications in communications and radar systems which can take advantage of their small size and weight. Table 1 lists the performance which might currently be achieved by filters of this type.

The ranges quoted in Table 1 are not intended to suggest that all of these extremes may be met simultaneously. For example, it would not be reasonable to expect a filter with a very narrow bandwidth at 10MHz to fit into a TO-8 package. Moreover, the values shown are typical and not necessarily firm limits. Wide bandwidths (>50%) can only be achieved with high insertion loss.

Frequency range and bandwidth. There are two main restrictions here: physical size and fabrication considerations. The maximum acceptable substrate size determines the obtainable steepness of the filter skirts, while the available pattern definition determines the upper frequency limit.

- Low frequency/bandwidth limitation. The device length is determined by the transducer bandwidth, which is the rate of cut-off (expressed in dB/Hz) of the filter amplitude response, and is independent of centre frequency. Shape factors (i.e. bandwidth at 3dB divided by the bandwidth at ~3dB of better than 2:1) can be achieved.
- High frequency limitation. For routine device fabrication, current photo-lithographic techniques set an upper frequency limit for filters of approximately 500MHz (although some higher frequency devices have been made to suitably relaxed specifications). However, with the increasing use of electron beam lithography this limit is expected to rise in the near future to 1.5GHz.

Group delay and insertion loss. There is an absolute delay through the filter which is usually in the range of 1-5 ps, although it may be more for filters with very steep skirts. In a subsidiary section it is shown that there is a trade-off of insertion loss against amplitude ripple and group delay ripple.

A loss of 2dB is typical for most S.A.W. filter applications. This might give an amplitude ripple of less than 0.5% and a group delay ripple of less than 2%.

Transversal filter example. Fig. 3 shows the amplitude response of a transversal filter that has been developed as an i.f. filter. Fig. 4 shows the response of the same filter measured over a wide bandwidth. The specification that is achieved is:Centre frequency 124MHz
Bandwidth (–3dB) 3.7MHz
Amplitude ripple <0.5dB
Insertion loss 20dB
Stopband (close in) –51dB
Stopband (ultimate) better than –70dB
Package TO-8

Bandwidths less than 1% (resonant filters). This type of S.A.W. filter has a bandwidth range of 0.01% to 1% of centre frequency. These filters are normally suitable for communications channels of bandwidth 12.5kHz (or less). Because these are resonant devices they have a much restricted range of parameter values than do transversal filters. They are usually specified in the same way as low-frequency LC filters with requirements of frequency, loss, bandwidth, response type (e.g. Butterworth) and order of filter.

Table 2 summarises achievable resonator filter characteristics.

The ranges quoted in Table 2 are again not intended to suggest that all of the extremes of range can be met simultaneously. For example a very narrow bandwidth filter (say 0.02% of centre frequency) at 500MHz with a third order response would have more than 6dB of loss.

Frequency range. The lower frequency limit is determined by the maximum substrate size. The upper frequency limit is set, as with transversal filters, by lithographic techniques—currently about 500MHz for demanding specifications and up to 1.5GHz for class-A specifications.

Bandwidth. Within the range quoted (in Table 2) the filter loss decreases significantly as the bandwidth is increased. With narrow filters a bandwidth of 0.01% of centre frequency may have 6dB of loss, if the bandwidth is increased to 0.03%, the loss may be reduced to approximately 2dB. Above 0.1% the loss is mainly due to external components and stray capacitance (approximately 1dB).

Bandwidths of up to 0.05% can be achieved using a quartz substrate without any external temperature compensation but for broader bandwidth filters it is necessary to use a different material which means that controlling (of the filter temperature) is usually required.

Response type and order of filter. Standard response types such as Butterworth, Chebyshev etc. can be synthesised. Higher order filters can be produced but, for very narrow band filtering at frequencies above about 150MHz, there is likely to be a severe insertion loss penalty with orders of three and above.

Resonator filter example. Fig. 5 shows the response of a resonator filter which has been developed for an i.f. application. The specification that is achieved is:Centre frequency 149.5MHz
Bandwidth (–3dB) 308kHz
Insertion loss 3.5dB
Stopband level (–5.5MHz) 60dB
Order third
Package d.i.

Delay lines
Using surface acoustic wave techniques it is possible to make delay lines (tapped or fixed) with delays in the range 400ns to 100μs in which novel scattering (1 spin) to 30 ns to 50microseconds which are accurately defined and highly reproducible. The substrate length required is of the

Table 1: Surface wave broadband transversal filter capabilities

<table>
<thead>
<tr>
<th>Centre frequency range</th>
<th>Bandwidth ( –3dB )</th>
<th>Minimum %</th>
<th>Maximum %</th>
<th>Transition bandwidth</th>
<th>Group delay</th>
<th>Group delay ripple</th>
<th>Insertion loss</th>
<th>Passband amplitude ripple</th>
<th>Stopband</th>
<th>Package size</th>
</tr>
</thead>
<tbody>
<tr>
<td>10MHz–1.5GHz</td>
<td>~50kHz</td>
<td>0.01%</td>
<td>0.2%</td>
<td>~50kHz</td>
<td>Typically 1.5 µs</td>
<td>Typically ~2%</td>
<td>3.5dB</td>
<td>Typically ~0.5dB</td>
<td>Typically 50dB closed to passband</td>
<td>Usually ~700µm further out from passband</td>
</tr>
</tbody>
</table>

Table 2: Surface wave resonator filter capability

<table>
<thead>
<tr>
<th>Centre frequency range</th>
<th>Bandwidth ( –3dB )</th>
<th>Minimum %</th>
<th>Maximum %</th>
<th>Transition bandwidth</th>
<th>Group delay</th>
<th>Group delay ripple</th>
<th>Insertion loss</th>
<th>Stopband level</th>
<th>Package size</th>
</tr>
</thead>
<tbody>
<tr>
<td>50MHz–1.5GHz</td>
<td>~50kHz</td>
<td>0.01%</td>
<td>0.2%</td>
<td>~50kHz</td>
<td>Typically 1.5 µs</td>
<td>Typically ~2%</td>
<td>3.5dB</td>
<td>Typically ~0.5dB</td>
<td>Typically 50dB closed to passband</td>
</tr>
</tbody>
</table>

Fig. 1. Range of frequency and bandwidth achievable with surface acoustic wave filters.

Fig. 2. Comparison of conventional LC (left) and surface acoustic wave (right) television i.f. filters showing the considerable size reduction.

Fig. 3. Measured frequency response of a 124MHz S.A.W. transversal filter highlighting the excellent stopband properties of these filters.

Fig. 4. Measured bandwidth frequency response of 124MHz S.A.W. transversal filter highlighting the excellent stopband properties of these filters.

www.americanhistorichistory.com
order of 3mm per microsecond. Bandwidths of up to 100% can be achieved at centre frequencies from 10MHz to greater than 1GHz. A limited phase response can be achieved within the passband.

Oscillators
For low noise stable oscillators operating at high frequencies, quartz is rapidly becoming recognised as the best control element available. Using S.A.W. resonators or delay lines is possible to make oscillators operating at fundamental frequencies between 50MHz and 1.5GHz, eliminating costly multiplier chains and spurious modes of oscillation.

A typical surface wave oscillator might have a fundamental frequency of 400MHz, a long term stability of better than ±50ppm/year and a temperature coefficient of ±50°F (Allen Variance) of ±10°C. Frequency variation with temperature is small (illustrated in Fig. 6) and it is possible, with compensation or beating to improve this still further. A typical oscillator noise figure at 400MHz is ~140dBm/10kHz from carrier. Some f.m. capability may be provided (sufficient for most audio communications purposes) using a voltage controlled oscillator.

The small size and weight of S.A.W. oscillators are two of their particularly attractive features and, if the oscillator is made as a module (including S.A.W. component and amplifier), the entire device will usually fit into a volume of approximately 2cm x 2cm x 1cm. Recent developments have resulted in modules which fit into a volume of 5cm x 5cm x 5cm.

Typical applications include local oscillators for telemetry applications (follows etc.) and fixed frequency, low noise oscillators for communication purposes.

Environmental considerations
Temperature characteristics. In general the centre frequency and delay of a S.A.W. device are temperature dependent. There are several materials that are used to make surface wave substrates and the choice of material depends on the required temperature characteristics, bandwidth and insertion loss. Substrate materials suitable for narrowband devices generally have a better temperature dependence than those for wideband devices. However, it is possible to have temperature stable wideband devices if high insertion loss is acceptable.

Two of the most popular substrate materials are quartz (with good temperature stability), which is usually used for microwave devices, and lithium niobate (with a linear temperature coefficient of frequency and delay), which is used for wideband devices.

Typical temperature variations of frequency and/or delay are: the resonant frequency with bandwidth greater than approximately 5%: 5 parts per million/°C (ppm/°C), and the fundamental frequency is less than approximately 5%: less than 80 ppm per °C, over range ±5°C (q is reference temperature).

Principles: surface acoustic waves and the interdigital transducer
The most commonly used surface acoustic wave is an elastic wave which travels on a piezoelectric substrate with some of the energy confined close to the surface, the motion of which is caused by the propagation of the volume of the material. Usually, more than 95% of the energy is contained within one wavelength of the central high frequency and the propagation is essentially linear.

The surface wave velocity is typically 3000m/s. This is five orders of magnitude smaller than the electromagnetic wave velocity and therefore relatively large delays can be achieved with a small path length. This allows evaluation of complex tapped delay lines and the many signal processing applications which result from them.

The most basic technique for launching and detecting surface acoustic waves on piezoelectric substrates is the interdigital transducer (I.D.T. illustrated at A). It consists of two sets of interdigitated fingers, each having about 1000 in a 'nose' or 'bistable'. The electrodes are photo-etched

Dr Phil White was born in rural Oxfordshire where he lived until 1989. He went from there to the University of Kent at Canterbury and obtained a B.Eng. degree in Electronics in 1992. After experience in a microwave development group he returned to University in 1973 to do research into microwave dielectric waveguide. He joined Philips Research Laboratories' Surface Acoustic Wave (SAW) group in 1976 where he has worked on various aspects of surface acoustic wave devices. Dr White is a member of the IEEE, the IEE and the IET.

Brian Murray was born in London in 1952. He attended Southamptom University where he obtained a B.Eng. degree in Electronics in 1974. He then joined the GEC-Hirst Research Centre and worked on the physics of bulk and surface acoustic wave devices. In 1976 he joined Philips Research Laboratories where he has worked on the application of surface wave devices in a variety of communications systems. His hobbies include bridge, squash and gardening.
Modular frequency counters

Flexible instrumentation based on the ICM7216 i.c.

by M. Voznjak

With the introduction of the 7216 family of i.c. frequency counter's, the design of a counter/timer has been greatly simplified. However, construction of a high quality instrument still requires a number of important external circuits. This article describes a frequency counter module based on the 7216, and provides a selection of add-on modules which can be combined in one instrument or built as separate units.

There are four devices in the 7216 family, which are identified by suffixes A to D. Types A and B provide frequency measurement and most other features found in a modern frequency counter, while C and D are for frequency measurement applications only. The pin connections and general features for types A and B are shown in Fig. 1.

All versions of the 7216 have 28 pins, and 25 of these are used for inputs, outputs, reset and hold. The remaining three pins select six different modes, four different gate times and a number of other features. The function pin selects frequency counter, period counter, frequency ratio counter, time interval counter, unit counter or crystal oscillator test. The range pin selects four different gate times, and the control pin activates display blank, display test, crystal select, external oscillator enable and, for C and D versions, external decimal point enable.

All of the circuits to be described use the 7216B and associated components shown in Fig. 2. This module can be connected to various preamplifiers, shapers and scalers to form an instrument with as many facilities as required. If a 1MHz crystal is used D1, should be connected, and if an external crystal oscillator is to be used, D7 should be connected. Alternatively, the internal oscillator can be used, but care must be taken to ensure stability. Both fixed capacitors should be silvered and the trimmer capacitor should be a multi-turn air dielectric type for improved temperature stability.

Decimal point display with the 7216B is achieved by connecting pins 23 to all of the decimal points in parallel. i.e., automatically places the decimal point in the correct position for function and range so that frequency is displayed in kHz and period in us. An overflow condition is indicated when the decimal point of digit 7 turns on. If the counter is used with a

---

**Fig. 1. Pin connections for the 7216B and D. The i.c. operates as a frequency counter, period counter, unit counter, frequency ratio counter and time interval counter. Four gate times from 10μs to 10s are provided in the count mode and 1 to 1000 cycles in period, frequency ratio and time interval modes. Frequencies up to 10MHz and periods from 600ns to 10s can be directly measured, and the i.c. will directly drive a BCD digital multiplexed i.e.d. display. A 1MHz or 10MHz crystal can be used with an internal oscillator, or the device can be controlled by an external oscillator. Other facilities include leading zero blanking, overflow indication, display off, hold and reset, and a test speed-up function.**

---

**Fig. 2. Main counter module and internal oscillator connections. Pin 1, via D3 to D2, selects interval counter, display test, external oscillator enable, and 1MHz external oscillator respectively. Break-before-make switches should be used for function and range, non-latching push-to-make for reset and display test, and single-point toggle for hold and display blank. The voltage regulator must be insulated and mounted on the chassis.**

---

**Fig. 3. Decimal point switching, Precalers 1 and 2 are wired for divide-by-10 and divide-by-100 respectively.**

---

**Fig. 4. Amplified signal is shaped by a 74LS17 Schmidt-trigger to obtain a square wave. Because the signal from IC2 is not large enough to trigger IC5, dc is added by a resistive network and R4 sets the threshold of triggering. To improve shaping, the output of IC5 is buffered by IC6.**

---

**Fig. 5. Provisions for a 5MHz input are made. The 5MHz crystal oscillator is fed to the amplifier stage and is used to calibrate the 1MHz crystal, with which it is to be operated. The amplifier stage is based on the LM733 audio power amplifier, and has an adjustable gain, bandwidth, and the 0.01Ω load is normally set to minimum attenuation.**

---

**Fig. 6. Transistor T1 is necessary to improve the signal shape at higher frequencies and without this transistor the 7216 will not operate above about 5MHz. The complete circuit has a separate 5V**
supply to ensure maximum isolation from the main counter module.

Correct grounding is important to ensure reliable operation. An input ground lead must be provided from the front panel input socket, and an output ground lead must be provided to the counter module. Grounding connections are also necessary for inputs 2 and 3 of the switching logic. There is also a ground lead which goes with +12V to the power supply on the main board. In all cases it is best to use two single wires and not assembled cable.

For frequency ratio and time interval measurements, input B of the main counter is used, which also requires a logic signal. As the frequency limit is 2MHz, a simpler preamplifier is shown in Fig. 7. It can be used. Input sensitivity is around 200mV and the input impedance is around 100kΩ. This module has a separate 5V regulator.

**Prescalers**

If frequencies above 10MHz need to be measured, a prescaler must be used as shown in Fig. 8. The Plessey SP6629 divide-by-100 prescaler i.e. is used which comprises a e.c.l. divide-by-ten circuit followed by a t.t.l. divider. The i.c. also contains a differential preamplifier which gives a sensitivity of around 500mV peak to peak. Because this sensitivity is not sufficient, an LM733 is used in the maximum bandwidth mode which increases the sensitivity to 20mV at 160MHz and approximately 80mV at 200MHz. This circuit must be built on a board with an earth plane which is insulated from the chassis, and i.c. sockets should not be used.

For higher frequencies a 500MHz prescaler can be used as shown in Fig. 9. This design is based on a Philips hybrid amplifier, type OMS30, which provides a gain of 25dB from 40 to 800MHz. The input circuit of the prescaler uses a Shottky-diode bridge as an input limiter which is biased with a 10 turn potentiometer. After amplification, the signal is fed into an e.c.l. divider which brings the signal to 50MHz. This is followed by a high-speed transistor level translator which feeds a t.t.l. divider to bring the signal to 3MHz.

**PLL frequency multiplier**

In some circuits it is necessary to accurately measure low frequencies. Although a longer gate time, e.g. 10ns, can be used, this method is very time consuming and not very precise because the frequency under measurement may change. Frequency multiplication is a superior method because the gate time can be relatively short without losing accuracy. Fig. 10 shows a suitable p.i.l. frequency multiplier which uses the simple preamplifier/driver described earlier.

This preamplifier operates satisfactorily because the maximum frequency to be multiplied is about 350kHz. A c.m.o.s. 4046 p.i.l. is fed by a flip-flop which provides a symmetrical square wave at half the input frequency. The remaining half of the 4043 is used to divide the comparison signal by two. The v.c.o. output from the p.i.l. is fed to the counter and also to a chain of dividers. Frequency multiplication is achieved by dividing the compari-
son frequency by 10,100 or 1000, which produces an error signal and causes the VCO to give an output of 10,100 or 1000 times the input frequency. Therefore, a 1kHz signal could become 1MHz and any frequency error would be multiplied by 1000.

The maximum frequency and range are limited by the 4046. Most devices will operate at 3.5MHz, which allows a 5.5kHz signal to be multiplied by 1000 in about one second. However, if the range capacitor of the p.n.l. is chosen incorrectly, the input range and output of 3.5MHz, there will be a low-frequency limit which will prevent operation over a large part of the audio spectrum. One solution is to use a second set of contacts on the range switch and connect appropriate capacitors. Alternatively, a compromise can be made by restricting the maximum frequency to obtain a reasonable true over-frequency.

Although there are 4-digit multiplexed counters, such as the NS8811, their decimal points are wired in parallel and therefore cannot be separately switched. A better solution is to use four dual-digit 0.6mm common cathode displays emulated on a printed circuit board type C, BY9749 (Maplin supplies). This provides a large display with decimal points that can be switched as necessary for correct placement.

The modules are used here are quite a few interconnections to be made, especially for the decimal point wiring. Shielded twisted-pair ribbon cable is a great help and makes the wiring much neater. Although the construction of each module is necessarily straightforward, it is important to have separate ground connections from each module to the main circuitry, and to provide the modules with separate regulated power.

A 1MHz for the electronic display and a display will be available for £55, including the full UK postage from R. Bots, 23 Kayes Rd, Upton, N.W. 3.

R. M. Frost, Trecarne, Alexandra Palace, London. The Radio Club has set up a Morse test of perhaps 5 to 6 words per minute and a "conditions of licence" type of technical examination to find that the RSGB, in proposing such a facility to the Home Office, has added the off-putting rider that all operation should be under the direct supervision of a fully licensed amateur. This would reduce the system virtually to club or family stations and, on the lines proposed, would cost the novice as much as a Class A or Class B licence.

**Typical enthusiast**

The club, one has held amateur licence, the more convinced some of us become that there is no such person as a "typical" amateur - seven words, if interesting in trying to put together such a composite being. The Cornish Amateur Radio Club recently attempted to analyse by over 80 replies to 200 questionnaires sent to their members. It produced the following picture of their "typical member":

- About 42 years old and has held an amateur licence for 5 years and is an interested shortwave listener for about five years.
- Became interested in amateur radio as a result of listening to fellow amateur bands from 1.8 to 432 MHz.
- Has aАМт@44 МHZ for mobile use and 144 MHz for mobile operation, often using the local repeater on his journey to and from work.
- Initial transmitter was a new factory built rig used with a dipole aerial but has subsequently become interested in home construction and now has a transceiver.
- Has roughly 5-6 hours per week on his hobby, including preparing reports for the club.
- The club's general atmosphere is described as friendly and the spirit of the hobby is applauded by the bad manners and discourtesy of a small minority of operators... also interested in music, hi-fi, household do-it-yourself, sailing and fishing... although clearly beyond the scope of this magazine.
- He would welcome more Morse classes run by the club... feels Raynet (emergency) scheme is "for the younger ones"... feels he is a good amateur and club member.

**From near and far**

The propagation mode that enabled the Canadian station VE1AS in St John, New Brunswick to make contact 500MHz contacts last November/December with at least four British 70MHz amateurs is still uncertain: F2 layer reflection, ionosphere forward scatter, and "double-hop" sporadic E all have their supporters, although a patch of intensive F2 layer ionisation seems the most likely. Crossband 500MHz contacts were made during December by British stations with VS8BE and VS6FX in Hong Kong. The Irish amateur EI6HS, who is licensed to use 50MHz, made two-way contact on the band with VS6BE.

Six radio-equipped Land Rovers, each with a Raynet operator as a member of the crew, spent about a fortnight in the Italian earthquake-disaster area during December to help rescue operations. An Italian "young lady" operator (BYCT) maintains a domestic radio contact with the Land Rovers during the outward journey and German amateurs also rendered assistance.

It came as a shock to those of us who have for long advocated the introduction in the UK of a "novice" licence (akin to those available in the USA and many other countries) that would permit limited operation on some segments of the h.f. bands after passing a Morse test of perhaps 5 to 6 words per minute and a "conditions of licence" type of technical examination to find that the RSGB, in proposing such a facility to the Home Office, has added the off-putting rider that all operation should be under the direct supervision of a fully licensed amateur. This would reduce the system virtually to club or family stations and, on the lines proposed, would cost the novice as much as a Class A or Class B licence.

In brief

The 1981 National Amateur Radio Exhibition is now scheduled for May 28 to 30 inclusive in the Palm Court Hall at Alexandra Palace in North London. The Sunday hall escaped damage in the fire last year.

The Home Office has raised the amateur licence fee from £8.40 to £8.60 per annum and a new licence was issued from January 1. Members of the Cornish Amateur Radio Club have formed the Computer Club which meets monthly at Pool between Redruth and Camborne (details R. M. Frost, Trecarne, Alexandra Road, Illogan, Redruth (Tel: Portreath 842553). RSGB membership by December 1, 1980 had risen to 27,335 including over 60 per cent of all British amateur licence holders.

PAT HAWKER, GVA
Britain ahead in computer networking

According to a recently published report, Britain probably leads the world in linking its university computers and in the introduction of sophisticated, compatible data communications facilities among universities and research establishments. The report is the first of a series of the Joint Network Team (JNT) which was established by the Computer Board and the Research Councils in April 1979, and covers the period from its inception to August 1980.

Consequences of the team’s programme is the adoption of standards for computer to computer and terminal to computer communications to ensure the greatest possible integrated use of equipment by universities and research establishments. International standards are applied where available but where no formal standards yet exist the team is ensuring that a uniform approach is adopted. The following is a list of standards to which the academic community will adhere:

- X25, X1, X2 and X9 (as defined in the Technical Guide to the Packet-Switched Service (PSS) of British Telecom).
- The Network Independent Transport Service (from Study Group Three of the PSS User Group).
- The Network Independent Job Transfer and Manipulation Protocol (both published under the auspices of the Department of Industry’s Data Communication Protocols Unit).

The report notes that the activities described have resulted in extensive co-operation among computer users in universities and other institutions. That degree of collaboration “is probably unique elsewhere in other countries and may be regarded as a measure of the lead which the British research community has in implementing communication facilities among heterogeneous machines.”

Is VLSI just too much?

Semiconductor manufacturers are likely to face severe difficulties not only in making very large scale integrated circuits (v.l.s.i.), but also in persuading people to buy and use them, according to one senior man in the industry. Leslie Yudacov, president of Intel’s Microcomputer Division in the USA, stated at an IEEE conference that by 1990 the v.l.s.i. device will have over a million transistors on a chip. “The question really is what do you do with all that complexity? This will pose a serious software crisis as well as a marketing problem. As our products get more complex the software needed to develop and market them will grow exponentially. Unless we can put a million software people into the workforce by the mid-1980s I don’t see how we can really exploit our capabilities.”

On the question of manufacturing the v.l.s.i. devices in the future, Yudacov said: “Where are the engineers who will do the design and the backward programming? The semiconductor industry has a relatively small base of key technical talent and limited shortage of such talent — and the predicted future shortages are worse for both our industry and the education system.”

Speakers at the conference on circuits and components sponsored in the December 1980 issue of the IEEE’s newspaper The Spectrum — also discussed the future of the industry and what sort of products it will offer as a result of further development in v.l.s.i. V. J. Visicfeld felt that the new developments in parallel data and the central processing systems obtained from the v.l.s.i. devices will be of much use in the future. “We must provide more complex solutions for our customers. We don’t need a different chip for every job.” One way of achieving this, according to Bernard L. Horn, chairman of the v.l.s.i. department, was to standardise the output of the machine. There are two main areas of v.l.s.i. devices, to make standard pieces of silicon that could be programmed by on-chip software to perform different functions for different users. L. Sarah of Siemens felt that the increasing variety of integrated circuits would change semiconductor firms into systems firms, and be a threat to the International Business Machines Corporation, because of the need for software compatibility.

The council says that the experts must raise in users’ minds the question of how far the process of integration will go in the present time. Presumably there is some physical limit to the size of the chip, but also to the complexity of the circuits. The question above, in fact, may be regarded as a measure of the lead which the British research community has in implementing communication facilities among heterogeneous machines.

European business satellite

Plans for a business satellite communications service with Europe, with messages beamed direct to small satellites close to users’ premises, were outlined by Peter Benson, Managing Director of British Telecom.

The service, due to start in 1985, is intended primarily for large businesses, with their own internal telecommunications networks, for other businesses with special requirements.

Mr Benson said that “The service will exploit the very latest transmission technology, and you or your satellite can be used quickly in adding more advanced services, such as video conference, high-resolution facsimile, high-speed and multi-channel broadcast. Whenever the customer wants them.”

At the conference on communications and electronic systems at an agreement reached at a meeting in Paris of the European ETS Council, of which British Telecom is a member. The council decided to modify four European communication satellites (ECS) so that all the first five being built will be able to link up with small dish antennas.

This function will augment their original role in providing new communications links through large earth station codes like Madrid.

British Telecom will install small earth station earth small earth stations — about 4m in diameter — at locations appropriate for the users. They will also install ground-level links (conventional telephone cable, optical fibre, or microwave) to connect the earth station to a user’s internal communication system.

Earthquake simulator uses p.c.m. data links

Connecting of a 6 x 6 metre vibration platform which is capable of measuring the structural response at 50 sensors and weighing as much as 50 tonnes, the seismic simulator at the University of Madingley is used to simulate real earthquakes on a much larger scale.

The hydraulic actuators can reproduce the full frequency range required by the chart, with vertical acceleration of 1.5g and horizontal acceleration of 1.25g throughput. Double these values can be achieved with lighter test pieces. The platform is moved in the chosen lateral and rotational modes of freedom by twelve actuators operating under digitally programmed control. Each channel of the corresponding system accepts seismic data in analogue form from the test pieces and from a seismic lever, paper tape or card reader. Signals from magnetic sensors detected by a network of seismographs can be used to control inputs. The effects of seismic shock on the structure are sensed by strain gauges and seismographs, and are collected by two independent 104-channel high speed data acquisition systems, each comprising thirteen John & Radmore 8-channel p.c.m. links, based on high resolution 16-bit System K81 modulators and demodulators, with associated 8-channel analog input signal conditioners, filters and output interfaces.

Each 8-channel p.c.m. signal is recorded on a single magnetic tape track by a thirteen-track instrument tape recorder, having the capacity to record the data from all 104 input channels. The outputs from the recorder are converted by John & Radmore demodulators to 12-bit parallel data which are scanned by a computer for analysis. Each of the 104 analogue systems can have frequency components up to 800kHz involving a scanning rate of 1.3MHz and an ultimate scanned bit rate of 7.3MHz.

The seismic simulator was designed and built for the Hydroproject Institute by Servest Ltd. Both ECS and Telecom 1, the French satellite system, will have extra transponders fitted to operate at the internationally accepted small-dish frequencies of 12 and 14 GHz, supporting transmissions at 2MHz.

Fifteen years of Pioneer 6

Originally designed to have a working life of six years, NASA’s Pioneer 6 interplanetary spacecraft is still sending back useful data after 15 years of circling the sun in a planetary orbit. The craft has made the sun’s coma, the turned data on solar storms and measured the sun’s corona. It has made discoveries about the sun and about the solar wind, solar cosmic rays and the solar magnetic field, all three of which extend far beyond the orbit of Jupiter.

Since the launch in December 1965, the 64kg Pioneer has circled the sun 375 times, covering just over nine billion miles and has sent back over 13 billion bits of data. Together with Pioneers 7, 8 and 9, a network of solar weather stations circling the sun was set up, sending back data to many sun-watchers.

In August 1980 it was found that Pioneer 4 had turned itself off due to a memory power shortage. Mission controllers at the Ames Research Center were able to control it back on again by radio signal and the instruments continued their observations. The Mission Manager, Richard Finnell believes that they may get another ten years data from Pioneer 6.

New minister

In the editorial comment in our February 1981 issue, it was pointed out that information technology would be given "official" status by the appointment of a Minister of Information Technology. The appointment has now been made within the Department of Industry. Mr Kenneth Baker has been given the post and has responsibilities for telecommunications, computer systems, microelectronics applications, robotics and all aspects of information technology.
In an attempt to boost the present message use of Prestel by the public, the British Telecom heads of this national viewer service have revealed their earlier decision not to impede editorial control on the material offered by the information providers. For some time British Telecom and the information providers have been worried by the poor response of the public to this new service (News, November 1980 issue, p.34). However this has been blamed on the slow availability of the Prestel television sets which turn the users' terminals. But now there are plenty of sets available, and some retailers are inviting people into their shops to see Prestel demonstrations, attention has been switched to another loophole — the alleged unattractiveness of the information on offer.

Recognising that "the real product being sold is the information", Frank Burgess, the head of Prestel's UK marketing organisation, writes in our sister journal Vicon and TV Use (Janurary issue) that although British Telecom remains committed to the principle of editorial freedom for the information providers, nevertheless "for commercial reasons" its studio-based editorial position will not be continued. "In future database pages will not be allocated on a first come first served basis but will only be leased to organisations that can demonstrate the ability to set up information services which will increase local interest and set usage. Conversely, information providers who have shown little inclination to provide an acceptable standard of service may not be given the opportunity to continue renting space once contracts expire."

But British Telecom intends to exercise the authority as a monopoly, as a sort of instead of being just a common carrier, which is essentially a service provider. To this extent it will be performing more completely the function of a multimedia publisher and audience, which was the original idea motivating the development of its worldview system. Indeed, Mr Burgess confirms in his article that Prestel's aim in the 1980s continues to be to develop a "multimedia player" as the database system of the future.

In the last year Prestel has offered a material incentive to the form of rebates on their charges to the information providers — £25 for every directly attributable sale to a business customer for every 10 pages for each such sale to a residential customer.

**Prestel terminal specification**

A joint programme of work between the private and public sectors of industry has resulted in the publication of the Prestel terminal specification. The specification draws together the three technologies involved in the Prestel worldview service — television, telephone and computer. By specifying the safety, interworking protocols and display requirements of the Prestel terminal, it hopes to maximise the minimum freedom of design to allow those working on new Prestel terminals to take advantage of the flexibility. The specification is the result of more than 20 years work involving correlation between engineers from all over the world. The three organisations involved are: British Telecom Engineering and Prestel's own technical staff.

The standard, PEC 416, is specified for pre-real and cassette recorders in all six television standards. Specifically it defines in detail the electrical and mechanical parameters for the professional "segmented field" video recording system on one-inch tape. The recording format in the standard is known commercially as the BCN recording system which can be accepted by IEC member countries as the international standard. Its application will ensure the interchangeability of recording be it for the 525-line, 625-line or 50-field system.

The standard TV video signal is recorded in segments of 52 lines which leads to 6 segments for each of both video heads for complete television frame in PAL or SECAM. For NTSC only 5 segments are needed. For CCIR the 525-line is not applicable. The three tracks are available of which the third has been standardised at that for time code recording.

**World standard for video recorders**

To unify the recording conditions of the three broadcasting systems, PAL, SECAM and NTSC, the EBU has issued an internationally agreed standard for high-quality video and sound recording in real time.

The standard, IEC Publication 6012, is suitable for real-time and cassette recorders in all six television standards. Specifically it defines in detail the electrical and mechanical parameters for the professional "segmented field" video recording system on one-inch tape. The recording format in the standard is known commercially as the BCN recording system which can be accepted by IEC member countries as the international standard. Its application will ensure the interchangeability of recording be it for the 525-line, 625-line or 50-field system.

The standard TV video signal is recorded in segments of 52 lines which leads to 6 segments for each of both video heads for complete television frame in PAL or SECAM. For NTSC only 5 segments are needed. For CCIR the 525-line is not applicable. The three tracks are available of which the third has been standardised at that for time code recording.

**Transponders for small communities**

A new television transponder will be much used for the transmission of u.h.f. television service to small communities down in population groups as small as 200. At this level the cost per head can be critical and the new BBC design sets out to achieve a high level of performance for use with lower cost transmitters. In this case, eventually supersede the previous BBC transponder, still entering service at the cost of 140 a year, and which will remain operational at about 80 relay stations.

Until now, all the BBC stations, like the rest of transmitters, have been equipped with a single transponder. The new transponder uses the latest components and techniques to reduce the overall cost of providing television coverage. The basic manufacturing cost has been reduced by about 30% in cost and size and the weight of the transponder, which will be significantly lower installation costs. As a result, the equipment can be used in larger service areas with an add-on power amplifier. Many stations are still in the process of fitting a transponder to the BBC's national TV service. Although specifically designed with small communities in mind, the equipment can be used in larger service areas with an add-on power amplifier. Many stations are still in the process of fitting a transponder to the BBC's national TV service. Although specifically designed with small communities in mind, the equipment can be used in larger service areas with an add-on power amplifier. Many stations are still in the process of fitting a transponder to the BBC's national TV service. Although specifically designed with small communities in mind, the equipment can be used in larger service areas with an add-on power amplifier. Many stations are still in the process of fitting a transponder to the BBC's national TV service. Although specifically designed with small communities in mind, the equipment can be used in larger service areas with an add-on power amplifier. Many stations are still in the process of fitting a transponder to the BBC's national TV service.
MSF pulse recognition

This circuit is an adaptation of the design by A. F. Cross in Feb. 1976. By using an unorthodox form of monostable, only one 4081 i.c. is used with one inverter. The pulse timings are shown in microseconds from the carrier on-off transition which marks each second and minute. The 470pF/100pf networks at the gate inputs produce short pulses at the times shown. Operation of the RC networks depends on the protection diodes at the gate inputs.

Because monostable A is not retriggerable, it protects the following circuit from noise signals for 95% of each second. The pulse durations must be measured to determine the values of the monostable timing resistors at these as they will vary with the regulated supply voltage and the particular 4081 used.

G. Jackson
Cardiff

X-Y plotter time-base

With S2 closed, S1 is closed and the circuit operates as a standard unipolar triangle-wave generator which is controlled by R4 and CV2. When S2 is opened, the output of IC1 stays at approximately 9V until S1 closes. IC1 then ramps up and sets the Schmitt-trigger output, IC2, to 9V which holds S2 closed. The output of IC3 remains high until the output of IC1 ramps below the reference level set by R2. At this point the output of IC3 goes to ~9V and opens S1. The output of IC3 then remains at 9V until S2 is momentarily pressed again. The ramp can be halted at any point in the cycle by closing S4, and the cycle can be completed by opening the switch. Resister R16 is adjusted for minimum zero-output level before oscillation starts.

S. Kirby
York

Fast a-to-d converter

By cascading several of the comparator circuits shown, fast conversion times, 8us for an 8-bit word, can be achieved, and no convert command is required because continuous ripple conversion is used. The design can have any word size and can be extended without alteration to the existing circuit, and the full-scale input voltage can be any required value through one input. Each block has a reference and an analogue input, together with one digital and one analogue output. The reference input is fed from a R-2R-4R ladder and if the analogue input voltage is less than this reference, the digital output goes to zero and the analogue output becomes equal to the input voltage. However, if the analogue input is greater than the reference, the digital output goes high, and the analogue output becomes equal to the analogue input minus the reference voltage.

F. McChesney
Wirral
Merseyside

Audio sweep generator

A useful sweep generator can be built by combining the voltage controlled generator by J. W. Howden in Nov 1972, with the simple i.c. function generator by J. W. Richter in Nov 1976.

Op-amps IC2, IC3 and the c.m.o.s. switch form a voltage controlled triangle-wave generator which operates over three ranges by switching C2. The triangle wave is shaped by IC4 to produce a sine wave which is then buffered. An oscilloscope time-base signal provides a convenient sweep input and IC5 converts this to a positive ramp which can be clamped at any point. Frequency range and shift controls are also provided so the sweep range can be set, for example, to 1-100Hz or, by altering the shift control, 10-100Hz. The complete circuit operates from ±6V.

K. Padmanabhan
Madras
India

Simple a.c. lamp flasher

A flashing l.e.d. can be used to produce negative trigger pulses for a full-wave triac switch. To prolong the life of the lamp, a small quiescent current can be provided by IC1. M. J. Bounier
Folkestone
Middlesex
Magnetic recording review

Recent developments in tape recording in general, and cassettes in particular

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

The storage and processing of information on magnetic tape or magnetic films is one of the fastest growing industries throughout the industrialized world. Since the introduction of magnetic tape recorders in the early 1960s, the tape recorder industry has paralleled by an equally rapid growth in the performance of recording/replication equipment. It is interesting to review the developments of recent years, paying particular attention to improvements in Tape recordings.

Information. In this senses, means both data and audio signals, but the audio aspect takes precedence in this discussion. However, there are differences in the hardware, problems of storing analogue signals on tape does not follow the same basic way from the problems of storing information in digital form on magnetic disc. The review commences with a summary of the fundamentals of magnetic storage.

For those readers with only a limited involvement in magnetic recording, a resume of the subject may be useful.

Basics. The recording process is outlined in Fig. 1. The magnetic coated tape passes across the gaps of three ring-type heads in sequence. The first head is energized by a high frequency 'carrier' waveform which magnetically saturates the tape coating. The second head then creates a signal on any previous recording. The second head carries the signal to be recorded, plus a high frequency bias waveform that linearizes the intrinsically non-linear magnetic recording process. The third head provides a replay signal.

Signals in either analog or digital form are impressed on the magnetically clean tape coating by a ferrous head, which has a narrow gap to produce an external field through which the tape passes. The data is read off the tape by replay heads of the same basic design; indeed, many domestic tape recorders use the same head for both record and replay. The tape/head relationship results in a linearization being stored as variations in the density of magnetization along the tape, a sinusoidal signal leaving a variable density of magnetization pattern rather like that in Fig. 2. Though the primary variations in tape magnetization exist along the tape it will be appreciated that there is a small component normal to the tape surface. This is of little significance when recording low signal frequencies, but it is one of the factors that limits the achievable performance when recording high-frequency signals or digital inputs at a high bit rate.

Magnetic information storage of this general type was proposed by Proctor in 1900 and applied practically by Sull in the late 1930s, using steel wire or tape, but the techniques had no real commercial significance until Telefunken in Germany developed ferrous-coated PVC tape as the recording medium, a development that did not become widely known until the end of the last war.

In the thirty years since the commercial appearance of magnetic recording, tape speeds have fallen from the 8000 (76cm/s) used in the original professional equipment to 5.4mm/s (4.7cm/s) in domestic cassettes. The performance of a professional cassette recorder is, in most respects better than that of the 50s' professional recorder of 1945-50. Using the appropriate tape, a good example of a modern cassette recorder/replication machine will have a frequency response that is flat within ±1dB between 20Hz and 15kHz with harmonic distortions in the region of 2%, a signal/noise ratio of around 50dB and speed modulation distortions of under 0.1% at a tape speed of 4.7cm/s. Professional N/In tape recorders of current design have a frequency response flat within ±2dB from 20Hz to 22kHz, harmonic distortions in the range around 1%, a signal/noise ratio in excess of 75dB and speed modulation distortions of less than 0.05% in the 35% class. Domestic recorders will comfortably exceed these performance figures, the speed-related distortions being almost negligible. If the maximum amount of data is to be stored in the minimum length of tape at the maximum cost (the logical commercial target) it is obvious that the wavelength of the signal recorded on the tape must be as short as can be achieved. This implies, among other aspects, that the tape speed is below.

The lower limit to the wavelength that can be recorded and reproduced is set by the practical difficulties in producing heads with gaps in the region of 2 microns (about 0.0001in) and on the molecular scale by the dimensions of the smallest magnetizable particle that is possible to produce for the tape coating. These limits are being approached in television and data recordings, where signals of 15MHz and bit-storage densities of 4-8kbits per mm in now use.

The use of a low tape speed obviously minimizes the cost of the tape, it focuses attention on the transport mechanics. Lack of contact between tape and replay head introduces a high-frequency loss of 55dB per wavelength of separation. At a tape speed of 4.7cm/s, a 10Hz signal has a wavelength of approximately 0.0047mm: a head-to-tape spacing of this amount would result in a loss of 55dB, an intolerable loss even in a machine having no particular pretension to high fidelity.

This is a convenient point at which to outline the changes in the magnetic state of the tape during the recording process. Neglecting the effects of the high-frequency bias in linearizing the recording process, the flux variations in the tape coating follow the usual BH relation for a magnetic material. The resultant performance of a modern recorder and its replay head is shown in Fig. 3, the flux in decreasing along the curve as the magnetizing force H is increased, but falling back along a different path as the magnetizing force decreases. This is due to the permeability of the tape, and it will be seen that the flux still has the value B0, the remanence expressed in gauss (in SI units). To reduce this residual flux to zero, the magnetizing force has to be reversed and increased to H1, the value being known as the coercivity (expressed in oersteds).

Remanence and coercivity are of primary importance in indicating the performance of recording tape. The remanence is significant in indicating the flux amplitude that remains in the tape coating after magnetization. Under the record head, the signal obtained on replay is directly proportional to it. The importance of high coercivity is less obvious. It indicates the extent to which the recorded tape coating will resist demagnetization, in the record head gap, by the high-frequency bias field and by the low-frequency signal field that extends well beyond the point in the tape path at which the higher-frequency signals are impressed on the tape. From this aspect, high coercivity is essential in enter- 

A similar relation applies if the head gap is not at right-angles to the edge of the tape, the first zero in the response occurring at the frequency at which one edge of the recorded track is a half wave ahead of the other edge. Thus the basic design requirement for a good frequency response is a narrow and dimensionally uniform gap which is at right-angles to the guided edge of the tape. Small sizes, high resistance to abrasion by the tape coating and of course, high efficiency obtained by a magnetic design that ensures that a high percentage of the available short circuit tape flux passes through the head core are all desirable design targets. A high degree of rejection of external magnetic fields is an additional practical advantage in minimizing hum pickup.

The same general requirements apply to the design of the record head, to some extent by the need to dissipate several watts of power without undue temperature rise. Recent developments in tape coatings have generally increased the power required to produce magnetic saturation of the coating, and have thereby increased the head designer's problems. Achieving gap widths of around 10 microns in record heads is not quite as important as in replay heads, because it has been shown that the magnetic signal remaining on the tape following passage over the record head is due to the combination of record and bias fields that exist at a point beyond the record head gap. Thus, the recorded frequency response is largely a function of gap unformity rather than mean gap width. However, it is common practice in domestic machines to use a single head for both record and replay and to accept the compromises that are then necessary.

Apart from the need to achieve narrow and uniform gaps in the heads, there is an obvious requirement to minimize hysteresis, eddy currents, and acoustic noise. A high degree of linearity by impressing a varying magnetic field onto the heads from one of the recording tracks is essential. Bias It is necessary to 'linearize' the basic magnetic recording process, because the variations in the magnetic field and the resultant flux density is non-linear. The basic relation between the applied magnetic force H and the resultant magnetic flux B in an iron circuit has the familiar form shown in Fig. 3. As for all practical purposes, these remedial measures were taken this would result in the transfer characteristic, the input/output relation outlined in Fig. 3.

The gross non-linearity of this relation is not acceptable in an analogue system, so it is standardized for linearity, and the transfer characteristic by applying a high-frequency (80-15kHz) bias waveform to the record head, in parallel with the signal. The linearizing process is very effective, for the overall distortion generated by the system non-linearity can be in the region of 3%-5%, with a signal/noise ratio exceeding 55dB in the case of domestic tape recorder equipment. Experience suggests
that head saturation is frequently responsible for much of the residual distortion found in magnetic tapes. The machines hastily modified to use the high-c

coercivity metal tapes that have recently become available.

It is a little unfortunate that practically all of the tape characteristics are functions of the amplitude of this high-coercivity bias, the performance at high audio frequencies is limited by the). The approach is thus rather critically dependent upon the radio of signal to bias amplitudes.

Though the actual bias frequency is not important, provided that it is high enough to make the tape readable, the waveform of this bias signal is very significant. Any waveform asymmetry implies the presence of a stationary magnetic field, which results in some residual magnetization of the tape and an increase in the noise and the magnetic characteristics of the total system. It appears almost impossible to avoid some increase in noise due to this residual magnetization, bulk erased tape generally being at least 2dB quieter than tape erased on the recorder.

Finally, notice the question of the noise generated by the tape systems. There are two main sources of noise that; generated by the electronic circuitry in the early stages of the tape amplifiers, and secondly by the influences on the magnetic characteristics of the tape.

Circuit noise will not be considered in any detail, for the residual head noise is so large that it masks the noise from producing that noise in any amplifiers. Some types of magnetic machines, the thermal agitation and 1/f noise due to the amplifier is at least 10dB below the magnetic noise resulting from the noise due to the tape coating, and is therefore of no great consequence.

The basic system signal/noise ratio can be improved either by an increase in the amplitude of the signal to the head, or by a decrease in the residual "magnetic" noise that results from the passage of magnetic tape through the tape reader head gap. An increase in the amplitude of the recorded signal can be achieved by choosing a tape with a lower coercivity. The increase in the magnetic flux density that is available at the output of the tape head. However, this can be achieved only by a decrease in the magnetic amplitude and noise, being a random phenomena, is proportional to the square root of the head gap width. Consequently halving the head gap width decreases the signal level by a factor of 4. The consequence halving the tape track width decreases the signal level by a factor of 4. The consequence halving the narrower gap width decreases the signal ratio by a factor of 4. However, halving the track width reduces the signal level by a factor of 4. The consequence halving the narrower gap width decreases the signal ratio by a factor of 4. However, halving the track width reduces the signal level by a factor of 4.

In summary, the simplest way designers are attempting to achieve magnetic media that has high remanence, 'higher' coercivity and a 40% lower tracking spectrum called 'thin-film coating'. The ideal tape coating would have a "square" BH curve, the remanence value of flux density at the remanence flux density, and the signal ratio value at a small signal ratio value. --an ideal that is being approached by recent efforts--designed to improve the signal ratio value at a small signal ratio value. This aspect has been greatly improved in the coated tape of today. While the basic oxide is highly abrasive and indeed is the cleaning medium used, the coated oxide has a high head-clearing heads, tape head has proved to be of little significance in programme tape applications. With regard to the amount of coating content in most coatings and the use of lubricants and various surface smoothing agents, the amount of coating content is limited. The coated tape is designed to minimize the amount of coating content to avoid problems with lubrication and surface smoothing agents.

Two-layer tapes have been developed in which the top layer is a single layer thick, over a 3mm coating of ferric oxide. This initiates the expensive chromo
teristics of this gamma-phase oxide, the grinding process being modified to remove the material. It is important to note that not only the track width but also the high audio frequencies are limited by the intertrack noise generated at the high audio frequencies, but experience suggest that the boundary of the two layers appears to be magnetic

Weather effects on orthogonal polarization

Finding ways of making satellite communications efficient for use in various applications is the major objective of the research laboratories of British Telecom, where they have shown that if we assume that the signal is not attenuated, then the amount of power needed at the receiving antenna is reduced. The two main factors affecting this are the atmospheric conditions and the height of the satellite above the Earth. The atmospheric conditions can be divided into two main categories: those which affect the propagation of the signal, and those which affect the reception of the signal. The height of the satellite above the Earth is also an important factor, as it affects the amount of power that is needed at the receiving antenna.

Orthogonal polarization is a technique used to increase the capacity of a satellite system. It involves using two orthogonal polarization states for each channel, allowing multiple channels to be transmitted simultaneously over the same frequency band. This increases the capacity of the system and reduces the amount of power required to achieve a given signal-to-noise ratio.

The relative importance of these factors in determining the quality of the received signal is shown in the figure. The figure shows the percentage of the signal that is lost due to atmospheric effects, compared to the signal that is lost due to the height of the satellite above the Earth.

In conclusion, the study has shown that atmospheric conditions have a significant impact on the performance of a satellite system. The use of orthogonal polarization can help to reduce the impact of these conditions, and therefore improve the capacity and reliability of the system. However, the height of the satellite above the Earth is also an important factor, as it affects the amount of power that is needed at the receiving antenna.

SATELLITE ORBIT PREDICTIONS

I was interested to read the brief article by M. L. Rosenberg on page 21 of the February issue concerning orbit predictions from satellite images in view of our experiences in this field at the University of Surrey.

We have been involved for several years in the study of orbit predictions, and our work on the theoretical aspects of the problem has been extensively supported by experimental results. Our research has been focused on the study of the motion of natural satellites, and we have also made use of the results of observations of artificial satellites.

In conclusion, I would like to express my appreciation to Mr. Rosenberg for his article. It has provided valuable insights into the field of satellite orbit predictions, and I believe that his work will be of great value to those interested in this area of research.
sid of µ and J. The first sentence of this paragraph could straight out of Osbourne or Berkeley, and is discussed by Popper under the title "The Science of Galileo and its new bearer" (E. Popper, "Conjectures and refutations", RKP 1962, page 134, ed. Polak, 1962. "Personal knowledge", RKP 1958, pages 145-147). I agree with Kepler that "It is added a most absurd fiction to explain natural phenomena by false causes." But I was born alive for this truth against the medieval church and (Lamb).

Regarding paras. 3, as with Lamb, my work on alternative, matters even led me to question Theory N. However, my work on high speed logic I. 3. I have not said that electromagnetic theory has been ignored and suppressed. As to the suppression of Heisenberg, you will not find mention of him in books on electromagnetic theory published during the last fifty years. It is scandalous the way he has been ignored and suppressed, in view of the contribution he made to the subject. (Lamb) seems to call Theory N "the current model" and "Theo. V 1. "on theory.

Regarding paras. 3, I am perfectly happy to let people use O. Low and current meters for into the future. I shall do this myself. This is not the same question as fundamental theory. Theory H has been re-discovered and found valid in digital electronics. Theory C has only recently been discovered.

SAWTOOTH KEYING FOR ORGANS

The Colin Parker's article on organ-stop filters (October, December 1980) have been inter- esting and informative. The conventional scheme ought to be the most direct way of getting com- plete tunes, but no one seems to have tackled the problem systematically. I'm not sure that though my filters were a little better than his.

He mentions the difficulty of keying a saw- tooth without crossing the limits of a typical d.c. controlled keying circuit takes successive slices, so that during attack and decay the output has the shape of Fig. 1. Once a pulse of square-wave keeps its shape, and an attempt to key a sine- wave results in heavy clipping. Nevertheless, some constructors have used this form of keying for sawtooth sources, and it may be interesting to look at it more closely.

Please note all harmonics are present in the sawtooth, clipping it can introduce no new ones (as it does with a rounded waveform), but can only alter their proportions. One method of analyzing the Fig. 1 waveform is to consider it as the sum of pulses of decreasing width, all foreclosing together, and use the standard pulse formula. I conclude that the amplitude A of the 2nd harmonic in a trancendent sawtooth of height B is

\[ A_{2} = \frac{A_{1}}{\sqrt{3}} \sqrt{B_{2}} \]

where \( A_{1} \) is the fundamental amplitude, and the ratio of the two is \( \sqrt{3} \approx 1.732 \). Fig. 2 shows this relationship in detail. The harmonics continue the same pattern, having the same amplitude of the 2nd harmonic, doubling the 2dB of the sawtooth amplitude. Thus it seems likely that the amplitude of the odd harmonies, will not be much affected during attack and decay; the initial delay of the fundamental represents a kind of cutoff at an extra cost. The effect on flutes and flute dispa-

MENTS may be more noticeable.

The concept can lead to considerable econom-

ics, and Fig. 3 shows a possible circuit using a single transistor to split (or the emitter) the com-

ponents of a sine-wave, and key them into the common baser load. More information on this form of keying is given in part 2 of my recent series on the subject. RKP Nov. 1978. Using a transistor for each square-wave frequency (base and collectives combined) would preserve the true sine-wave shape during keying: the single tran-

sistor produces truncation, as it would if the emitter source were a true sawtooth from 0 to 5V absolute.

Unbalanced transistor (or diode) gates output a d.c. component as well as the signal. For a square-wave input, the d.c. is proportional to the keying input, in a (a), Fig. 4, and this input applies to a transistor keyed by separate tran-

sistors. For a single transistor with sawtooth input its growth is parabolic, curve (b), reaching twice the slope; this is also vertically true of Fig. 3, and might limit the stable rate in some cases; however, the final d.c. is the same as for a square-wave input giving the same a.c.'s levels for odd harmonics.

Further inputs, possibly useful in the lower octaves, can be added to Fig. 3, doubling the input resistor each time; adding Hf for example gives all the sawtooth harmonics in the right proportions except for 33.34 kHz, etc.; building a synthetic key design which to add a sawtooth for Py-

iant "Shifting", should find its possible to mini-

mize the Fig. 3 outputts in the d.c. spaced positions. Preferably the staircays input should be taken from the third harmonic computer, cross-keyed (W'T March 1979), so unlocking the tones from the rest of the system: a separate speaker channel might be considered.

Rudolf Baldo

WIRELESS WORLD MARCH 1981

WIRELESS WORLD MARCH 1981

DIGITAL ELECTRONICS

Fig 3

GRAPhICS AND MICROCOMPUTERS

I feel that Dr. Witten's article "Graphical commu-

nication with micro-computers" in your August 1980 issue is worthy of some comment. I have just completed a work on the display of detail which enables simultaneous display of graphics and text on an oscilloscope screen. A photograph of the display during development is shown here.

GRAPHICS AND MICROCOMPUTERS

MY experience of Wireless World is a paying

customer is not quite as long as that of Mr. Pearson (December 1980 letters), though I have read back numbers going back to 1915 or so, but I cannot remember any previous attempt at politicizing its editorial and correspondence columns.

The trouble about people with the wet-

terrestrial output is that they readily respond to and propagate the propaganda put out by the interests of the USSR. What a letter from the Campaign for Nuclear Disarmament is doing in your pages is far from clear. Has it not occurred to you that the wet-terrestrial output is no longer fashionable? Philip Scott, "Wireless World March 1981"

PickAmplifiers

B Hội

PackAmplifiers

SPARK GAPS

In his article "Spark Gaps" in the November issue Mr. J. H. L]))) states that the pressure drop is produced when carbon "to avoid a change in ambient temperature will cause a corresponding change in breakdown voltage (because temperature variation of 40°C is caus-

ing a change of 2.8 V in breakdown voltage)." Where the important parameter is determining the breakdown voltage of a gap of given length and gas density, I find this decides the number of collisions made by an electron in traversing the gap. The density is proportional to the pressure as a fixed temperature, but in a sealed gap does not change with temperature.

MY opinion of Wireless World is a paying

customer is not quite as long as that of Mr. Pearson (December 1980 letters), though I have read back numbers going back to 1915 or so, but I cannot remember any previous attempt at politicizing its editorial and correspondence columns.

The trouble about people with the wet-

terrestrial output is that they readily respond to and propagate the propaganda put out by the interests of the USSR. What a letter from the Campaign for Nuclear Disarmament is doing in your pages is far from clear. Has it not occurred to you that the wet-terrestrial output is no longer fashionable? Philip Scott, "Wireless World March 1981"

PickAmplifiers

B Hội

PackAmplifiers

SPARK GAPS

In his article "Spark Gaps" in the November issue Mr. J. H. L ))) states that the pressure drop is produced when carbon "to avoid a change in ambient temperature will cause a corresponding change in breakdown voltage (because temperature variation of 40°C is caus-

ing a change of 2.8 V in breakdown voltage)." Where the important parameter is determining the breakdown voltage of a gap of given length and gas density, I find this decides the number of collisions made by an electron in traversing the gap. The density is proportional to the pressure as a fixed temperature, but in a sealed gap does not change with temperature.
A new generation of Thandar LCD Multimeters

DESIGNING WITH MICROPROCESSORS

Readers of Part 6 of "Designing with Microprocessors" by Zissos and Valian in the December 1983 edition of RF Design may have been able to solve some of the PRINT problem too seriously, since apart from minor errors in the program listing of table 3 (p.73), the program would appear not to print a single character.

Consider first the instruction MV1 at hex address 1083. If you load any non-zero character in register C, the program will simply appear to jump to location L1 and Halt. Or will it? As a matter of interest, the instruction MV1 affects no flags and even if you replace JNZ with JZ, it will be a waste of time trying it out.

Furthermore, since you manage to patch this part of the code and somehow make the program jump to L1, the program will stop printing garbage (unless man-handled) as the program error handler endless loop for virtue of the JMP instruction at hex address 1013.

The authors are certainly not considering an alternative machine with a hypothetical instruction set but exemplifying the Intel 8080 with its well defined instruction set. How can we known authors produce such a piece of code? Perhaps they did not. One possible clue is the equivalent 8080 solution of table 1 and the authors' conclusion above the extreme technical solutions applying all present-day microprocessors, and to all their modes of operation.

The authors certainly believe in non-compatibility with their competitors' products and a men dictionary translation of mnemonics from one instruction set into another, or, changing, for example, one modulator of the 6800 to register C in the 8080, will not produce the same or even similar results, however trivial the program may be.

D. M. Vaidy
Weston School of Electronics
University of London
London N3 6BS

COMMUNITY DATABASE

While considering a possible format for data transmission on an fm broadcast channel, it occurred to me that in order to control the three beam, a receiver already contains a detector and a signal shaper. If the 1960s signal were modulated at the transmitter as only a simple switch "Bake-Tack-off" over the i.r.d beacon the program could be directly converted to a small layout part of a microcomputer. This extremely cheap system would offer simple front panel connection and complete operational isolation.

We thus have a method for program marking, and to cater for the thousands of home computer owners, we could have a 'Computer Programmes' with comments and programmes. We could also have community data bases (cf. Community Memory Project in San Francisco) transmitting either on dedicated channels or perhaps 'page-look' boards on local radio stations. Home links could be placed on the database via the telephone network. Access would be cheaper for Prestel and the service would be more interactive than Carfax or Oracle.

However, the premium beam would depend on the reaction time of the beacon circuit and could be prohibitively slow. I cannot find any reference for this, perhaps somebody can help.

James Kidd
Warrington

WIRELESS WORLD MARCH 1981

OVER 3000 HOURS BATTERY LIFE

OTHER PORTABLE TEST INSTRUMENTS IN THE THANDAR RANGE

T220 LCD Frequency Counter

Portable frequency counter. £145.00 + £11.75 VAT (inc. hire)
T220A 220V/110V Power Supply £50.00 + £4.15 VAT (inc. hire)
T2620 Prescaler

100 MHz prescaler with T220 or PM2X0/PM20X £30.00 + £2.40 VAT (inc. hire)
T9105 Pulse Generator

lms, 0.1% basic accuracy £151.00 + £12.13 VAT (inc. mains lead)
SC110 Single-Trace Portable Oscilloscope

£300.00 plus VAT. 50 MHz bandwidth, 0.5% basic accuracy £225.00 + £18.00 VAT (inc. mains lead)
DM450 4 1/2 Digit LED Multimeter

3 year guarantee. Basic accuracy 0.1% + £19.40 VAT (inc. mains lead)
DM350 3 1/2 Digit LED Multimeter

1 year guarantee. Basic accuracy 0.1% + £18.88 VAT (inc. mains lead)
DM235 3 1/2 Digit LED Multimeter

1 year guarantee. Basic accuracy 0.1% + £18.88 VAT (inc. mains lead)
PDM35 PDM35 Pocket Frequency Meter

0.1 Hz to 2.000 MHz pre-selector £141.00 + £11.27 VAT (inc. mains lead)
SC110 Single-Trace Portable Oscilloscope £300.00 + £24.00 VAT (inc. mains lead)
DM235 3 1/2 Digit LED Multimeter

1 year guarantee. Basic accuracy 0.1% + £18.88 VAT (inc. mains lead)
PDM35 PDM35 Pocket Frequency Meter

0.1 Hz to 2.000 MHz pre-selector £141.00 + £11.27 VAT (inc. mains lead)
DM235 3 1/2 Digit LED Multimeter

1 year guarantee. Basic accuracy 0.1% + £18.88 VAT (inc. mains lead)

For full technical details together with price list and sample stock please contact

SINCLAIR ELECTRONICS LTD

8 R맛ы Avenue, St. Ives, Cambs. PE17 4HL, Tel: St. Ives (0480) 64646. Telex: 32250

All Thandar products carry a FULL 1 YEAR WARRANTY.

Sinclair Electronics Ltd: this rise in the air and depend on the Thandar sponsor equipment unit. W PROD FOR FURTHER DETAILS

www.americanhistory.org
TOP QUALITY REBUILT TV TUBES

Rebuilt on the most modern equipment to original manufacturers' specifications

- HIGH FOCUS
- LONG LIFE
- FULLY TESTED
- FULLY GUARANTEED

These top-class rebuilders cover the country — phone your nearest one now for details and prices — and first-class service.

GLASGOW—RENOU Tubes Tel: (041) 883 8772

COLEHAMS—PE Tubes Tel: (0292) 20277

DUBLIN—PE Tubes Tel: 860447

STOKE-ON-TRENT—BAREX Tubes Tel: (0782) 232746

BIRMINGHAM—VUSEBEE Tubes Tel: (021) 358 7777

NEWPORT—OMSPEC Tubes Tel: (0632) 672596

NOTTINGHAM—TRENT TUBES Tel: (0602) 613325

COVENTRY—TEL TUBE Tel: (0202) 610977

RUGBY—VISIONEX Tel: (0785) 62628

SOUTHAMPTON—WICO Tubes Tel: (0703) 309185

PENZANCE—WICO Tubes Tel: (0737) 30895


Linear modulator for radio control

Proportional 'digital' control with improved characteristic

by W. J. Hornsby, M.I.E.R.E.

The story of this venture began when a friend of mine (who was building a model yacht) asked if I was aware of a suitable circuit for a model control system. I remembered having seen something a while ago, and a search in the archives of the local library turned up the item. Not having given much attention to this subject before, the principles interested me, and, having most of the components to hand I decided to build the circuit. I found that it worked quite well, although it was rather large, occupying several circuit boards. I found also that although the control was proportional, it was not linear.

Having now become more enthusiastic, I decided to explore the commercial field to see what was on offer and how the control was effected in proprietary equipment. My findings were encouraging in some respects. I was able to buy control sticks with potentiometers in kit form and also the necessary basic items to produce small receivers. Servo mechanisms and the basic items for the servo decoders and amplifiers were also available. I was disappointed, however, to find that the transmitter modulators still produced proportional but not linear control. I thought, therefore, that it would be an interesting exercise to try and develop an inexpensive, linear, proportional modulator, using readily available components, which was not expensive and occupied a relatively small space.

The use of integrated circuits sprang immediately to mind. I was advised to proceed with caution, however, since others had tried before and the problem had been to produce an economically priced unit consistent with the required performance. Whilst things could be done with t.t.i. i.c.s., the current consumption was high and several devices were needed. On the other hand, the use of c.m.o.s. devices offered much lower power consumption, but there were snags here because charge storage in certain devices defeated the object of accurate control. Special timing devices such as the 555 were then considered, but these too proved unsuitable for direct control because, although they do have a modulation terminal, a very low impedance modulating voltage is required and this adds to the circuit complexity.

There had to be a compromise though, so the devices were permuted and several circuits tried until the arrangement shown evolved. It is a hybrid type, of small size and low power consumption, but it does produce extremely linear pulse-width modulation. The limiting factors are the quality of the timing capacitor, the linearity of the control and the regulation of the supply voltage.

Circuit requirements

The modulator is required to produce a sequential train of pulses, each of which can be altered in width between 1 and 2 ms, in a linear fashion, under the control of a manual actuator (control lever moving a linear potentiometer). A synchronising pulse is needed to ensure that the correct pulse is fed to the appropriate servo at the receiving end, and each pulse should be separated from the next (and the sync pulse) by a well-defined inter-pulse pause.

Types of circuit. Two methods are generally used. In one, the modulator consists of a number of individual timing circuits in series, each one triggering the following one. In the other, it consists of a single circuit, with a modulating signal driving it and all timing circuits connected in parallel. The former arrangement is used here as the input pulse is not constant in amplitude and the use of a single circuit made it impossible to achieve the required linearity of the output.

Fig. 1. Complete circuit diagram of 9-channel modulation control unit. Capacitor C, should be polystyrene or, more economically, polyethene.
one after the end of its own cycle. The sync. pulse is derived from a multivibrator, which acts as the overall control section. The interconnection of the circuit is produced by an individual element triggered by pulses produced when one timing element switches to the next. The i.p.p. therefore inhibits part of the next pulse and allowance must be made for this. This circuit in its usual form is not linear because it relies upon simple RC time constants. In addition, for a large number of channels it uses a considerable number of the components and occupied a great amount of space. It is, however, economically on power.

The second common method uses only one timing element, and the various controls are offered to it in sequence (including one for the sync. pulse). This is known as the commutation method: it generally uses less components in larger systems, but a method of producing the i.p.p. must still be provided. Disadvantages of this method is that a very high timing circuit and comparator are required and that extreme care must be taken to ensure that there is no interaction between one control element and another. The modulator to be described shown in Fig. 1, uses the second method.

Devices

The ideal device for providing commutation is the 4017B. It was found, however, that it was used directly to drive the timing element, the 'on' and 'off' times of one channel were influenced by what was happening for one of the sync pulses. In an examination it was discovered that only the 'on' time of the timing pulses was affected, due to possible due to charge storage. The 4017 does have much to recommend it: it is however a very good timing circuit and comparator is required and that extreme care must be taken to ensure that there is no interaction between one control element and another. The modulator to be described shown in Fig. 1, uses the second method.

Circuit operation

Assume for the moment that the circuit is already running and that we are looking at the start of one timing pulse. One of the control outputs of the circuit will affect the supply to the appropriate control potentiometer. (This is called the 'on' time.) If the output of the 4017B is 'high', the pulse will be 'low'. The slider of the selected control will connect the control voltage, via its transistor, to one of the comparator Tr's. The comparator is comprised of Tr4, Tr5 and a current conveyor. The first action is to provide fast switching between Tr4 and Tr5. At the end of the time constant, and, in case (b), will cause Tr7 to conduct, raising the current to supply to potential. (This is ineffective at present but if the device were used as a triggering circuit, this would require two devices. The answer is to use the device for complementary time in the constant directly connected to the timing circuit. This is arranged by allowing it to change its output state during the i.p.p. It now has time to settle down before it is required to provide the voltage for the next control action and also to mention its voltage ampli-

tude is reliable.

To operate the i.p.p. a 555 is ideal. It uses little current and few additional components to produce a reliable output pulse. It can be used in the monostable (triggered) mode and its output can source or sink considerable current. This makes it ideal for the overall controlling element and it will provide the output modulating voltages.

The remainder of the circuit consists of an element which charges a capacitor linearly from a constant current source and a voltage comparator. Discrete components appear to be the only reasonable answer here but advantage was taken of the CA3046 in view of its compact form. Two discrete p-n-p transistors and an n-p-n voltage regulator are the only other active components.

Control adjustment

The control graph of Fig. 3 shows the graph as a line A to D, the slope of which is determined by the value of charging current by V1h.

The voltage at which the comparator trips is set by the control potentiometer and is limited to only about one fifth of the po
tentiometer range. The control range can be made correspondingly small by only one angle of the charging potential so that it is the same for voltages in the range range required. It was found that, in practice, using transduced component values, the slope is set as close to the cut-off point mentioned ear-
ner. Also, since the 555 has been changed, not to mention the control voltage, this is possible only if the voltage of the triangular wave is 1200V, which is not possible in the next control potential applied to Tr5.

The modulating output circuit is designed to reduce distortion and is therefore a set of electronic switches, each of which will be a suitable power transistor. Leads connecting to other circuits, will be operated by a further microswitch to switch the output on and off. Control for each channel must charge up to supply potential, Tr5 will remain connected to the circuit operation will cease. Tr5 emitter potential is now so high that even if Tr5 potential is now increased it will not affect the circuit operation in the same manner.

This poses the question of how the circuit will perform. The answer is that it will work. It is fortunate that the 555 has a 'high' output potential of 10V that it always produces an output pulse at switch on of the condition of the timer 1.5V output is one of the normal conditions for a high output from the i.p.p. and this condition is the correct one of the control of the circuit. So, providing the output of the base the output will be an input, the circuit, all function. Capacitor C4 is included to pro-

WIRELESS WORLD MARCH 1981

Two of the circuits described have been in use for over 12 months by the one which I have used. Although in recent times some dedicated SLC's have appeared, and this is a significant improvement over the 4017, which was used by amateurs only a few years ago, the 4017 is still a very good part. In many cases where a large number of channels are being used, the 4017 is still the most economical and reliable circuit. It is possible to use this circuit as a basis for a wide range of applications, from simple switching circuits to more complex systems, such as those used in industrial control systems. The 4017 is a very versatile and reliable component, and it is likely to continue to be used for many years to come.
The current damping technique, as presented by P. I. Walker, is a very elegant solution to the problem of reducing the crossover distortion in class B audio power amplifiers, because it eliminates the requirement of a quiescent current on the output transistors, and the thermal problems associated with biasing. However, the amount of crossover distortion that followed Mr. Walker's article denotes that the current damping principle has not received a complete treatment. The purpose of this work is to show, by means of a more complete analysis, that current damping reduces the crossover distortion more than conventional feedback but it is not able to totally cancel this distortion on the output stage, even with a "theoretically perfect balance" or infinite feedback factor.

In Fig. 1, the general arrangement of the current damping technique, the class A amplifier has a finite gain $A$, and it is shown later that the balance condition does not require $A$ to be infinite. This configuration is general in the sense that all the current damping circuits are possible realizations of it. The flow-graph of this configuration is presented in Fig. 2, and helps to understand how both feedback and feed-forward are employed.

The two basic equations for the amplifier in Fig. 1 are:

$$V_I = AV_O - AV_4$$

$$V_4 = V_2 - V_3 = V_1 - V_5 = \frac{1}{R_4}$$

where $R_4 = R_2 / R_3$. These equations cannot be solved for $V_2$, $V_3$, unless a third equation is introduced, if any particular values for $R_3$ and $R_4$ are assumed. The action of the dumper gives this equation.

$$V_1 = BV_3$$

where $B$ can be a highly non-linear factor, in which are present crossover effects. With this relation equations 1 and 2 become

$$V_1 = AV_5 - AV_4$$

$$V_4 = V_2 - V_3 = V_1 - V_5 = \frac{1}{R_4}$$

$$V_3 = R_3$$

$$V_1 = BV_3$$

which, combined, finally lead to

$$V_1 = BV_3$$

with output voltage. (Remember that $A$ is the gain of a class A amplifier, and hence free from crossover effects.)

The results of equations 6 and 7 were already known in different forms but with the same meaning; that was well defined in an assertion by Mr. Walker: "... there is a theoretically accessible state where the output stage distortion will cancel to zero, without calling upon infinite loop gain ..." Is this really true? Can one get the power of an amplifier (in this case, the dumper) without getting its distortion, too?

In fact, the situation is not so good as it may appear at first sight. A very important point was missed out of the analysis so far, and it was also missed from previous analyses of current dumping. The distortion of the class A amplifier. This low-power amplifier must have a very low distortion level, because its distortion will appear at the output, which is clear from equation 7. Because it operates in class A, a very low distortion is not so difficult to achieve, and this problem was left out.

However, if the gain $A$ is distorted, even...
by a small amount, the balance condition of equation 6 will not hold for all signal levels, and the term $1/k\alpha$ in equation 5 will not be perfectly cancelled.

To clarify the situation, the distortion of both amplifiers must be considered in the analysis. In fact, if one is looking for a distortion reducing scheme, all the distortion factors must be taken into account. A simple way to introduce these distortions is to write the gain of the low-power amplifier as $A+D_A$, and that of the dumper as $B+D_B$, where $A$ and $B$ are fixed constants and $D_A$ and $D_B$ are random variables with unknown distributions that represent the distortion of the class A amplifier and the crossover distortion of the dumper, respectively.

Hence, equation 5 becomes

$$\frac{V_{A}}{R_1} = \frac{1}{k\alpha} + k\alpha (A+D_A) + D_B$$

From this it is clear that there are no finite values for $A$ and $R_4R_0$ that can cancel the effects of $D_s$ on $V_{2'}$, (remember that $R_4R_0G_{1}(A+D_A)$ cannot be written, because converting the low-power amplifier into a balanced feedback arrangement, the output will be free from both $D_A$ and $D_B$). This is not the case with the dumper, where the series of the feedback factor $T$ is not sufficient to cancel $D_B$. This is shown in equation 11 below.

$$\frac{V_{A}}{R_1} = \frac{1}{k\alpha} + k\alpha (A+D_A) + D_B$$

This shows that even with an infinite loop gain, crossover distortion will be present at the output. It is interesting to note that if $I_{2'}$ is the gain stability of the battery, then $k\alpha$ is the infinite loop gain. Therefore, the $k\alpha$ is the infinite loop gain. Hence, the series of the feedback factor $T$ can be cancelled by $k\alpha (A+D_A)$, which shows that current dumping generates high-order distortion, as does conventional feedback.

At this point, it is useful to separate the analysis in two cases, corresponding to the off and on conditions of the dumper, i.e., as $I_{2'}$. It is easy to see, from equation 8, that

$$\frac{V_{A}}{R_1} = \frac{1}{k\alpha} + k\alpha (A+D_A) + D_B$$

So, when the output power amplifiers are off from the transmission from $V_2$, it is useless, which breaks the feedback loop. Therefore, as the output signal is supplied by the class A amplifier only, with no feedback, the distortion factor $V_{2'}$ must be $D_{B}$ as stated in equation 12.

Dumper on. When the dumper is on, i.e., one of the output power amplifiers conducting, it has little distortion, because it is acting as an emitter-follower, which is implied in $D_{B}$. As $k\alpha (A+D_A)$ (which follows from the fact that $R_2$ must be much greater than $R_s$, the balance condition is $R_2-k\alpha R_s$ and $A)\Pi_{n=1}^{a}$), hence the series of the feedback factor $T$ can be cancelled by $k\alpha (A+D_A)$, which shows that current dumping generates high-order distortion, as does conventional feedback.

These considerations lead to

$$\frac{V_{A}}{R_1} = \frac{1}{k\alpha} + k\alpha (A+D_A) + D_B$$

So, the output has two main distortion components: one due to the distortion of the class A amplifier, which is $k\alpha (A+D_A)$, and the other due to the intermodulation of the two distortions, which is $D_B$.

$D_B$ is reduced by an amount greater than the feedback loop gain $k\alpha$. Therefore, the current dumping technique can reduce the effects of the crossover distortion more than conventional feedback, given the simple conditions on the transfer through the loop $D_B$ cannot be total any way.

Hence the current dumping allows the dumping of a power amplifier with output transistors in class B, avoiding the well-known distortion problems in conventional AB output stages. Further, it is also correct to say that the performance of a low-power amplifier is dictated mainly by two factors: the linearity of the low-power amplifier (see equation 13) and the precision of the balance.

Another important point is the effect of the feedback factor $T$ on both the input and output impedances of the dumper, the last two being highly dependent on the current in the emitter of $V_{2'}$. The voltage $V_{2'}$ is not affected by the distortion factor $D_B$, and then does not affect the results. But its input impedance will affect the term $D_A$, as the amplifier cannot have zero input impedance. Therefore the transistors of the dumper must have a high input impedance, to minimize the effect of the loading of the low-power amplifier, i.e., by the distortion factor $D_A$, and then does not affect the results.

To make the matter more general, Fig. 3(c) has been redrawn as Fig. 10 with its internal resistances, whilst Fig. 3(b) shows the same cell in series with its internal conducts, the terminals A and B defining the battery V $V_{1}$ and $V_{2}'$. These are, of course, equivalent; and the same low-ohm figure can be obtained across the terminals A and B of either figure, whether it is reckoned in ohms or siemens, will give exactly the same result. Hence, the feedback factor $T$ on the terminals A and B is shown in Fig. 3(a), and the voltage across the terminals is now $V_{2'} = V_{2}' = V_{2}'$. Similar conditions apply, and the outcome is the same, in the circuit of Fig. 3(c) in which the battery has been replaced by the voltage generator — with its internal impedance in series — in series. Then, as $V_{2} = V_{2}'$, that is, $V_{2} = V_{2}'$, the internal admittance of the voltage generator, Fig. 3(d) with its internal admittance in series is equivalent to Fig. 3(c).

It can be shown by experiment, but not so easily as might be imagined, that if two different cells are connected in series, as in Fig. 4(a), the resulting battery can be depicted simply as in Fig. 4(b), with the admittance $V_{2}$ of the generator, Fig. 3(d) with its admittance in series, and the admittance of the individual, a simple enough operation on a pocket calculator, with a reciprocal key.

What happens if the cells are connected in parallel instead of series? Well, again, current dumping will not help in certain conditions. The separate internal conductances of the two battery cells are $G_{1}$ and $G_{2}$, and the common current will flow directly to the total conductance; and as long as the voltages are the same or the same battery is used, the conductances are the same, the total e.m.f. will always be the mean of the individual e.m.f.'s. However, if they are different, the conductances may still leave one other possibility, whether both the cells e.m.f. or $G_{1}$ and $G_{2}$ are unequal. In this case the answer is less straightforward; one would have to be a Prince to resist the temptation to denote the battery by a different symbol.

The following is a simple experiment: the total e.m.f. in Fig. 5 is the same, but the conductances of the individual cells are unequal. The difference in the conductances is as shown in Fig. 5.

It can be easily deduced, however, that the expression for the total voltage of the two cells shown in Fig. 5 is correct. Remember that the internal conductances of the cells are given in series with a small e.m.f. which were defined to be perfect voltage sources, and which is the same as the series internal conductor of the two cells.

To make the matter more general, Fig. 5 has been redrawn as Fig. 10 with its internal conductances $G_{1}$ and $G_{2}$ are included respectively in the series conductances $G_{1}$ and $G_{2}$.
The proof is as follows. There are $n-1$ loops formed by the parallel arms. Let the currents in each of these loops, in accordance with Maxwell's cyclic-current rule be $I_1, I_2, \ldots, I_n$, as shown. Note that in each of these loops, except the first and nth, there are two currents acting, the one shown on the left adding to the generator voltage by its action with the associated admittance, and the one on the right subtracting by a similar action from the generator voltage. The first and last branches will be acted on by only one current each, $I_1$ and $I_n$ respectively.

As the voltage $V_{AB}$ is the same whichever terminals A and B happen to be connected to their respective rails, Ohm's law applied to each of the $n$ arms will give the following equations for the resultant loops currents through the branches:

$$I_1 V_1 + I_2 V_2 + \ldots + I_n V_n = V_{AB}$$

By substitution of the individual terms on each side

$$I_1 - (I_2 - I_1) - (I_2 - I_3) - \ldots - (I_{n-1} - I_n) = 0$$

i.e. $V_1 + V_2 + V_3 + \ldots + V_n = V_{AB}$

or

$$V_{AB} = \sum_{i=1}^{n} V_i$$

Absence of a voltage source in any one of the branches implies that a generator of zero volts is in series with the admittance in that branch. The term containing their product in the numerator is therefore zero and need not be present, although the admittance will appear in the denominator. For example, if all the generators except $V_1$ in Fig. 7 are reduced to zero, the terminal voltage becomes

$$V_{AB} = \sum_{i=1}^{n} V_i$$

Fig. 6. How the rail voltage $V_{AB}$ is calculated. Considering it as two simple voltage dividers each with a single voltage source, $V_i$ gives rise to a rail voltage $V_{AB} = V_i(G_1 + G_2 + G_j + \ldots + G_n)$, and $V_j$ gives rise to a rail voltage $V_{AB} = V_j(G_i + G_2 + G_3 + \ldots + G_j)$

Total voltage $V_{AB} = V_{AB} + V_{AB}$

Fig. 7. Circuit having $n$ parallel arms each with a voltage generator and series admittance. Terminal voltage is given by Millman's theorem, $V_{AB} = \sum_{i=1}^{n} V_i$.

Fig. 8. In the compensation corollary, admittance $Y_{m}$ of Fig. 7 is changed by $\pm Y_{m}$ in such a way that $V_{AB}$ to $V_{AB}$. Change in current through any arm is given by (b).

Equations 2 and 3 express the principle of superposition:

In a network containing two or more sources of electrical energy the voltage across, or the current in, any branch may be found by setting in turn all sources except one to zero, and calculating the voltage or currents due to this single source, afterwards adding the results algebraically.

Corollary 4. Suppose it is desired to find how the current through a particular branch, say containing $V_1$ and $Y_1$, is altered if an admittance in any other branch is altered.

The current through a branch containing $V_j$ and $Y_j$ is $I_{j'} = V_{AB}/(Y_j + Y_{j'})$. Suppose now that one of the other admittances is changed by a small amount, say $Y_{j'}$ is changed to $Y_{j} + \delta Y_j$, causing $I_{j'}$ to change to $I_{j''}$. The current now flowing in the $j$th branch is

$$I_j = V_{AB}/(Y_j + \delta Y_j)$$

The change of current in the $j$th branch is therefore

$$\Delta I_j = I_{j''} - I_{j'} = V_{AB}/(Y_j + \delta Y_j) - V_{AB}/(Y_j + Y_{j'})$$

$$\Delta I_j = V_{AB}/(Y_j + \delta Y_j) - V_{AB}/(Y_j + Y_{j'})$$

$$\Delta I_j = V_{AB}/(\delta Y_j + Y_{j'})$$

which after a little manipulation becomes

$$\Delta I_j = V_{AB}/(\delta Y_j + Y_{j'})$$

Hence the current produced in any branch ($m$th) of the network by an e.m.f. $V_m$ in any other branch (opposite the current in the other branch) which would arise if the e.m.f. $V_m$ was transferred to the first branch, i.e. the $m$th. This result is usually known as the admittance theorem.

Corollary 6. The rail voltage in Fig. 7 was found by Millman to be

$$V_{AB} = \sum_{k=1}^{n} V_k$$

Suppose an (+1)th parallel branch consisting of an admittance $Y_{m}$, is added across the rails of Fig. 7. The new rail voltage becomes

$$V_{AB} = \sum_{k=1}^{n} V_k$$

hence

$$V_{AB} = \sum_{k=1}^{n} V_k$$

which is the same as

$$V_{AB} = \sum_{k=1}^{n} V_k$$

Fig. 7, with its added admittance $Y_{m}$, can therefore be represented by the circuit of Fig. 10(a).
If $V_{AB}$, the voltage between terminals $A$ and $B$, were before $V_{Y}$ added, and the sum of the admittances $2Y_1 + Y_2$, while $V_{Y}$ itself is denoted by $V_Y$. Fig. 10(b) can now be redrawn as Fig. 10(c). From the two-terminal admittance $V = \frac{V_{AB}}{I}$, as the voltage across the terminals.

Therefore, if a parallel admittance $Y$, where $V = \frac{V_{AB}}{I}$, in the new voltage across the terminals.

The corollary 7. The numerator $\sum_{i=1}^{n} V_i$ in equation 6 is the current that would flow as a consequence of a generator voltage $V_{generator}$ placed directly across the rails of the Millman circuit of Fig. 7, when all the voltage sources are zeroed, and this alone is drawn to show the terminal voltage $V_{AB}$ that is derived from a current source operating a circuit $I_0$, and if the same changes in voltage and admittance are made as in the case of $V_{AB}$, the general equation of Fig. 10(d) is obtained. Clearly Figs. 10(a) and (b) are equivalent to Figs. 10(c) and (d) with respect to the conditions just stated, that the current $I_0$ through $Y$, is $V_0$ in both cases, and $I_0 = \frac{V_{AB}}{Y + Y_Y}$ as in the first case.

Therefore a Thévenin-equivalent circuit may be converted into the constant-current form shown. This is usually known as Norton's theorem, stated as:

The circuit of Figs. 7 and 8, that is to form a circuit consisting of a current source developing the short-circuit current in parallel with an admittance equal to the admittance of the individual admittance, the voltage across the terminals being the same. Corollaries 6 and 7 are sometimes known as the Helmholtz equivalent-source theorems.

All these corollaries have been enunciated as a way of getting rid of the impedances of the generator in the back of our minds, and of thinking instead of what the generator is doing to the circuit.

The question arises as to just how general are all the results derived from Millman's theorem above. It would be hardly surprising for them to apply to the Millman circuit of Fig. 7 as they would to any other circuit. The Appendix shows, however, that any two-terminal active network reduces to a Millman circuit.

Appendix

Any two-terminal active circuit reduces to a Millman circuit. In an circuit containing admittances and voltage sources, any single voltage source or combination of such sources can be replaced completely or partially by another single pure voltage source or sources, provided any sources dispensed with have their internal admittances behind. New sources retain the admittances of the superseded sources, whilst any new sources are placed in series with pre-existing sources or admittances or other admittances, in general and in no new form can be found. Now consider a circuit, represented below, that possesses admittances and voltage sources to any degree of complexity (the branches shown may consist of either a combination of both). By the first principle, stated above, all the voltage sources that are present can be replaced by one. Therefore, let all the voltage sources be transferred to the branch $P$ to be taken out. The voltage $V_0$ is then taken as the voltage across the terminals, that is with the voltage sources short-circuited. The theorem as in the case of the terminal source, $A_0$, is included in the 25 admittance, and remains there throughout. A voltage source cannot be placed in parallel with an admittance, say across $A_0$ in Fig. 10(a). Any point then became infallible when this source was shorted out. The figures show just five of the infinite variations possible.

A second proposition is a theorem due to J. L. La Cour, which states that to any two points as to be inaccessible terminals any positive linear network may be replaced by a two-terminal network, and in general no new form can be found.

Now consider a circuit, represented below, that possesses admittances and voltage sources to any degree of complexity (the branches shown may consist of either a combination of both). By the first principle, stated above, all the voltage sources that are present can be replaced by one. Therefore, let all the voltage sources be transferred to the branch $P$ to be taken out. The voltage $V_0$ is then taken as the voltage across the terminals, that is with the voltage sources short-circuited. The theorem as in the case of the terminal source, $A_0$, is included in the 25 admittance, and remains there throughout. A voltage source cannot be placed in parallel with an admittance, say across $A_0$ in Fig. 10(a). Any point then became infallible when this source was shorted out. The figures show just five of the infinite variations possible.

Although secondary breakdown exhibits a negative resistance characteristic, its application has been limited by the destructive nature of the phenomenon. This article describes some investigations carried out by mainly predecessor Zener diodes in oscillator circuits.

If the graph of collector current versus voltage for a transistor is considered beyond the normal working range, there are two areas of interest as shown in Fig. 1. The first, known as the primary breakdown region, is where a slight increase in voltage causes a large increase in current, which can damage a transistor. However, Zener diodes operate in this region and a special manufacturing process insures their safe operation.

The secondary breakdown region is catastrophic and normally causes the destruction of a semiconductor in a similar way to the discharge through a dielectric. Although it is imperative that a semiconductor never operate at or near this point, the area is interesting because it exhibits negative resistance and could therefore be used to oscillate or amplify. For secondary breakdown experiments, Zener diodes are preferable to transistors because they already operate safely in the first region. After much inspiration and desperation I finally concluded that Zener diodes can be operated in the second region provided that a certain procedure is observed. All low-power transistors seem suitable as low-resistance diodes above 12V. Below 12V it is increasingly difficult to obtain correct operation, and without proper equipment use is impossible. This shows that the phenomenon is due to avalanche breakdown and not the true Zener effect.

For correct operation, certain permanent changes must be made in the circuit. Generally, 16V diodes, type IN566, or 18V type 1N967 were used as a compromise between ease of operation and the manner for the use of a lower voltage. The diode is fed from a constant current generator, see Fig. 3. The current is slowly increased so that the device has time to warm up.

At about 30% above the normal Zener voltage the potential drop across the junction starts to decrease and the temperature reaches about 200°C. At this point the diode is left for at least 10 minutes, which seems to insure a certain confidence in the modified devices, and the temperature coefficient changes from negative to positive. During the preparation period there are occasional and spontaneous bursts of high frequency oscillation, therefore monitoring with an oscilloscope is advisable.

An alternative method for preparing a diode is to use a variable power supply connected across the Zener and a 150Ω resistor in series. The voltage is increased until the diode is in the secondary breakdown region and then the voltage is quickly decreased. With some practice a diode can be safely prepared and then tested as shown in Fig. 3. A supply of about 18V is initially required for a few seconds to bring the junction to the operating temperature of over 200°C. This temperature is critical and any metal clips holding the leads can be used as adjustable heat sinks to achieve maximum efficiency, which reached 10% in the audio oscillator shown in Fig. 4. Prepared diodes were tried as amplifiers, but the amplification factor was generally just above unity and, although one sample exceeded 10, it did operate for very little time. A tendency for the semiconductor to oscillate rather than amplify made measurements difficult and frustrating. The high frequency circuit shown in Fig. 5 was tried successfully, but an intrinsic parasitic in parallel with the Zener was difficult to estimate because the samples varied considerably. The frequency limit was found by using the circuit in Fig. 6, and during experiments frequencies up to 100MHz were observed. Oscillation takes place with a gain between 70 and 250 mA. At this point the normal power dissipation of 300 mW is exceeded, but this should not cause any problems. The oscillation stops if the current is increased, and then returns from 0.5 to 1A. This secondary oscillation is at a higher frequency and careful control of temperature and current is required to obtain steady operation. With a current above 1A the junction glows in darkness.
and a third oscillation region occurs, but operation is extremely difficult and sporadic. Once the junction has been subjected to the higher current range it will not operate reliably in the lower range, probably due to irreversible changes taking place at the higher temperature. However, the current has been increased until a voltage drop of only 1V was present without destroying the junction. It should be noted that with very high currents the glass case starts to melt and physical breakdown can occur before junction breakdown.

In most samples, when secondary oscillations were triggered, a change of state took place at 3.3ms interval. The junction oscillates at a certain frequency, then changes to another for the next 3.3ms, followed by a state of self-modulation where the modulating signal is similar to noise. The sequence then repeats and produces a cycle with four different states. Once steady operation is achieved, the 3.3ms interval appears to be independent of temperature and current, but differs between samples. This behaviour has not been investigated further and cannot be explained. Although it is unlikely that a standard

The Cosmic Ecosystem, by Alan Johnston, gives one the impression of having been written by a desperate man, frustrated because the scientific establishment cloaks reality at the right of him. It contains many ideas which are quite likely to good 'reproducible' science in a few of the vapours, a reaction which, however often the ideas are repeated, never seems to bring intelligible responses.

One of the notions put forward by Johnston is the one about gravitational repulsion, in which the force of gravity is due to radiation pressure, two bodies screening each other from the pressure and being forced together. This is not a new idea (Alan Jones came up with it a long time ago) but it has yet to receive any kind of considered reply, positive or negative. The author points out in his preface that those students of sound recording who approach the subject from a musical background often understand how to use studio equipment, but are unclear on how it works. Since, however, there is little 'basic' information in the book on electronic circuitry, one feels that such students will continue to be unclear, at this level at least.

At a more peripheral level of description, the book is excellent. It begins with two chapters on sound and hearing, in 50 pages, and two more on stereo and surround sound (called 'quad') which describe more of the systems known, although there are no references later than 1973. The rest of the book covers all the techniques and equipment employed in a studio, from microphones to monitor loudspeakers, with chapters on audio control systems, tape and disc recording, signal processing and a section on digital techniques. The final chapter advises on the economics and technical aspects of establishing a low-cost recording studio. Published at £16.45 by Van Nostrand Reinhold.

Unified circuit theory

either the voltage at the terminals, or the admittance looking into the terminals. It may therefore be removed to leave the Millman circuit of Fig. (2b) which has a generator of zero voltage in one of its branches (but which by the first principle could easily be furnished with a more active generator).

References
**The Automatic Choice.**

In the Plasma Therm RF range of Generators, you will find all the features of reliability and innovation that make them absolutely essential for modern production lines and the high degree of sophistication necessary for automation. Somewhere in the range, you will find the right generator for you.

That's why Plasma Therm Generators are the automatic choice.

- Robust construction — designed for production use
- Will accept PT, automatic power controller and voltage controller
- Can be remotely situated
- Built-in fault diagnostic systems/spares readily available
- Designed for ease of maintenance
- Either rack or cabinet design

Plasma Therm are to Generators what Generators are to you.

For more details on the technological advantages of the Plasma Therm range of generators, contact us anytime at the address below:

**Plasma-Therm, Ltd**
6 Station Road, Penge SE20 7BO. Tel: 01-778 6798 Telex: 89544410

Sales and Service for: RF Generators and automatic matching networks and controllers, IPC's Plasma Etching and Deposition, End Point Detection, Vacuum Accessories and Energy Control.

---

**Colour, variety, price... a case for consideration.**

Do you have a requirement for two-tone polystyrene cases? Consider the comprehensive BOCON range from West Hyde. Prices of these cases have been reduced by over 25% across the board on standard colour options and they are available in a variety of colour schemes and sizes, a selection of which are suitable for Eurocards. The lower sections of these housings contain threaded inserts for component or PCB mounting, and quick, easy access is possible by means of BOSNAPS, a unique feature supplied solely by West Hyde.

**WEST HYDE**
West Hyde Developments Limited
Unit 5, Park Street Industrial Estate, Petersfield, Hants. HP10 1ET.
Telephone: (090) 204410, Telex: 83775 W HYDE G.

WW — 82 FOR FURTHER DETAILS

---

**Wind speed and direction meter**

2 — Display circuitry and testing

by N. Pollock

Circuits to show wind direction by both analogue and digital displays, and to indicate wind speed conclude the two-part article.

**Display**

For maximum ease of use, a digital direction display in the form 'port or starboard, 0 to 180°' was considered best. To obtain this display format, three decades of 4029 pentastable, up-down, b.c.d. counters were used as in Fig. 9. The PRESET ENABLE pulse preset the counters to 180 and sets them to count down at the start of each encoding cycle. The GATED CLOCK × 40 pulses then cause the counters to decrement. If the counter output reaches 000, the counters are set to count up and further GATED CLOCK × 10 pulses increment the counters. This pulse train, which contains from 0 to 360 pulses, therefore causes the counter output to go from 180 to 0 to 180. The port/starboard information is given by the counters counting either up or down at the end of the pulse train. The middle and high-order decades and the count-up/down information is latched with two 4042s to drive the 'analogue' direction display, which is described later.

To keep the cockpit uncluttered and to minimize power consumption, it was decided to use a single digital display and switch it between direction and speed. To facilitate this switching, the direction counter outputs drive a display bus via two 4563 tri-state buffers.

The speed measuring system (Fig. 10) is quite straightforward. The CLOCK signal is gated by the LM 336 timer into three decades of b.c.d. counter, whose outputs drive tri-state buffers. A 4042 latch, a 74035 digital comparator and an RS flip flop are used to generate the SLOW/FAST signal required by the clock-frequency multiplying phase-look loop in Fig. 8 of part 1 of the article.

The prototype used 7-segment i.e.d. displays, as shown in Fig. 11, because of their low cost. Leading-zero blanking logic was included to conserve power and to make the display more easily readable. Red and green i.e.d.s, which only operate in the direction mode, are used to indicate port or starboard. The displays and the segment dropping resistors (R) will depend on the size and brightness required.

---

**Colour, variety, price... a case for consideration.**

Do you have a requirement for two-tone polystyrene cases? Consider the comprehensive BOCON range from West Hyde. Prices of these cases have been reduced by over 25% across the board on standard colour options and they are available in a variety of colour schemes and sizes, a selection of which are suitable for Eurocards. The lower sections of these housings contain threaded inserts for component or PCB mounting, and quick, easy access is possible by means of BOSNAPS, a unique feature supplied solely by West Hyde.

**WEST HYDE**
West Hyde Developments Limited
Unit 5, Park Street Industrial Estate, Petersfield, Hants. HP10 1ET.
Telephone: (090) 204410, Telex: 83775 W HYDE G.

WW — 82 FOR FURTHER DETAILS

---

**Wind speed and direction meter**

2 — Display circuitry and testing

by N. Pollock

Circuits to show wind direction by both analogue and digital displays, and to indicate wind speed conclude the two-part article.

**Display**

For maximum ease of use, a digital direction display in the form 'port or starboard, 0 to 180°' was considered best. To obtain this display format, three decades of 4029 pentastable, up-down, b.c.d. counters were used as in Fig. 9. The PRESET ENABLE pulse preset the counters to 180 and sets them to count down at the start of each encoding cycle. The GATED CLOCK × 40 pulses then cause the counters to decrement. If the counter output reaches 000, the counters are set to count up and further GATED CLOCK × 10 pulses increment the counters. This pulse train, which contains from 0 to 360 pulses, therefore causes the counter output to go from 180 to 0 to 180. The port/starboard information is given by the counters counting either up or down at the end of the pulse train. The middle and high-order decades and the count-up/down information is latched with two 4042s to drive the 'analogue' direction display, which is described later.

To keep the cockpit uncluttered and to minimize power consumption, it was decided to use a single digital display and switch it between direction and speed. To facilitate this switching, the direction counter outputs drive a display bus via two 4563 tri-state buffers.

The speed measuring system (Fig. 10) is quite straightforward. The CLOCK signal is gated by the LM 336 timer into three decades of b.c.d. counter, whose outputs drive tri-state buffers. A 4042 latch, a 74035 digital comparator and an RS flip flop are used to generate the SLOW/FAST signal required by the clock-frequency multiplying phase-look loop in Fig. 8 of part 1 of the article.

The prototype used 7-segment i.e.d. displays, as shown in Fig. 11, because of their low cost. Leading-zero blanking logic was included to conserve power and to make the display more easily readable. Red and green i.e.d.s, which only operate in the direction mode, are used to indicate port or starboard. The displays and the segment dropping resistors (R) will depend on the size and brightness required.
If reasonably priced liquid-crystal displays were available their use would be preferred because of their lower power consumption and superior visibility under varying lighting conditions. If i.c.d. displays were used, the drivers would have to be changed from 4511s to 4543s and a display oscillator added.

The display control logic is shown in Fig. 12. The LATCH ENABLE signal is derived from the direction circuit and the SPEED and SPEED CLK signals from the speed circuit. The 556 timer is used to disable the display updating so that the reading is updated at a maximum rate of about 2 Hz. Without this update disabling, the direction update rate would vary directly with windspeed and at high speed the flickering of the display would make reading difficult.

Analogue display. The analogue-type direction display discussed earlier is provided by a circle of 36 i.e.d.s driven by the circuit shown in Fig. 13. The display operates continuously, independent of the digital display mode selected. If this display, and the digital direction display, have port and starboard interchanged this can be overcome in one of two ways. Either the anemometer cups can be mounted the other way up to reverse their direction of rotation or the UP/DOWN and UP/DOWN inputs can be interchanged in Figs. 11 and 13.

Speed calibration

The wind-speed calibration can be carried out by comparison with an anemometer of known accuracy or by mounting the unit on a long pole in front of a car. Failing this fair estimate can be made based on the geometry of the anemometer rotor using the information in Ref. 3. This report suggests that for a three-cup anemometer with the geometry typical of commercial units and a 36-hole timing track, the clock calibration factor (K) should be given by:

$$ K = \frac{1032}{\text{speed in knots}} $$

where r is the mean radius of the cups in mm. For the anemometer used with the prototype, this expression gave K=23.2, whereas the measured value was 21.5. The required period T of the speed clock in Fig. 10 is given by:

$$ T = \frac{10}{K} \text{seconds} $$

Performance

The prototype instrument operated satisfactorily over a speed range from 0.7 knot to 99.9 knot, the higher speeds being simulated with an electric motor drive to the anemometer disc. Below 0.7 knot the speed indication continued to function but the phase-lock loop in the direction system lost lock. The maximum error of the direction indication was ±2° with a periodic error function which exhibited one cycle for 360° direction change. This error was thought to be due to a slight eccentricity of the clock track. Any two or four cycle per
An appreciation of James Clerk Maxwell, 1831-1879

Have we got the allocation of honours between Einstein and Maxwell right?

by M. G. Wellard

In the introduction to his book Electric Waves, Hertz wrote "...we can best characterise the result of our experiments by saying: The object of these experiments was to test the fundamental hypothesis of the Faraday-Maxwell theory, and the result of the experiments is to confirm the fundamental hypothesis of this theory." The fundamental hypothesis of the Faraday-Maxwell theory was that space was not empty. This article attempts to explain why we should turn our clock hands back to Maxwell and start again.

Twice in 1979, BBC television broadcast a long programme celebrating the centenary of Einstein's birth. The programmes had serious intent at education, included a scene of several eminent scientists touring "Einstein, the hero." A more lightweight musical tribute was also broadcast. Both programmes highlighted two facts about Einstein's world. It is because beyond our experiences on this planet, most of us can not understand it; we can form no ideas. Furthermore, his world is one source of the modern fantasies of science fiction books and films. Once the size or space and the life-span or time of an atom depend on its velocity, the imagination is freed from the constraint of commonsense.

That year was also the centenary of James Clerk Maxwell's death, a fact largely ignored. He died in the prime of life aged 49, leaving science a legacy: his laws of electricity and magnetism and his Theory on the same subjects. His laws are companions to Newton's laws of gravitation... Maxwell's laws, governing the behaviour of the only three forces capable of acting across a distance, are based on Newton's laws of motion, governing the dynamic behaviour of all forces. They represent all the laws of conservation of energy which Helmholtz first derived mathematically from Newton's laws of motion.

Considering the magnitude of Maxwell's contribution was still a scientific mystery. Even from his theoretical interpretation of data and equations derived from thousands of experiments, while Einstein's fame rests on his theoretical interpretation of data and equations derived by his predecessors from a single experiment -- a theory that is safe from experimentation. He naturally assumed that the allocation of honours between Maxwell and Einstein is difficult to substantiate.

If Ampere is the Newton of electricity, Maxwell is the Newton of electromagnetism. His treatise, written by Maxwell the teacher, master of the understanding, for the benefit of trainees of electrical engineering, can, with a little perseverance, take anyone into the mind of this man of genius. Obviously not everyone's choice today. Maxwell's world is basically one of flat commonness and geometry, a world filled by a gifted accountant of engineering with the actions and reactions of Newton's bodies in space, where the paramount scientific law is the principle of the conservation of energy.

The tone of Maxwell's treatise is one of confident optimism that physics was on the verge of a complete understanding of all laws of nature. A far cry from the attitude today. Physics is filled with statistics, the analysis of countless opinion polls of energy. The strict principle of conservation has given way to the Uncertainty Principle of Heisenberg, and a particle of today may or may not be a wave tomorrow. Energy has a choice and is un-governable.

Looking back, the curse of the lawlessness can be traced to the theoretical interpretation of three experiments: Michelson and Morley's unsuccessful attempt to measure the velocity of the "ether wind," the source of Einstein's Special Theory of Relativity, Thomson's experiment with a form of television tube interpreted as confirmation of Lorentz's theory that electricity is carried by positively and negatively charged particles; and Planck's experiment with a black box, the "ultra-violet catastrophe"... which took the wave out of Maxwell's waves and led to the quantum theory. These theories are unified by a common belief that the laws of electricity, magnetism, gravity and motion have a few loopholes. And therefore by inference the law of the conservation of energy which unifies all the laws of physics, and if ignored disintegrates physics.

When Maxwell died, the physical nature of his achievements was still a scientific mystery. While the theories of modern physics were in their infancy on the turn of the century, for some atoms were found that emitted electromagnetic waves they were radiators. When Planck discovered that a body caused an atom to disintegrate, the data he collected showed that an atom was a form of electricity. He naturally assumed that the constituent parts of an atom were particles, and his planetary model of electricity was amalgamated with the particle theory of Lorentz and the packet theory of Planck to form the basis of the present quantum theory. This theory is used in the investigation of the state of electricity and magnetism, and by those concentrating on the electromagnetic actions confined to the microscopic spaces between the atoms of solids, liquids and gases. Where electromagnetic energy is transmitted across greater distances, Maxwell's equations without bin theory are used.

The ultimate role of science in any society is to forecast mathematically the result of the interaction between two or more identified and specified forms of energy. Scientists are the natural successors to those who consulted the oracle. The scientists' oracle is the principle of the conservation of energy, a principle fundamental to all laws and the operation of physics, and every scientific law from Archimedes' law of the lever to Hubble's law of the galaxies fulfills this role of science. Einstein's theory and the quantum theory were developed to explain the action of identified and specified forms of energy which Newton's and Maxwell's laws could not describe mathematically. The quantum theory has stuck fast for nearly fifty years, and if the curse of its lack of progress is due to faulty theoretical interpretation of data, clearly the interpretation and its associated equations will not satisfy the principle of the conservation of energy. Any attack on modern theory must use the principle as its major weapon deployed under the guidance of Newton and Maxwell.

This principle says that there is a fixed and finite amount of energy in the universe, and therefore energy cannot be generated, destroyed or wasted, and that an interaction of energy cannot be concentrated in one finite volume in space. Maxwell defined energy as something with the capacity to perform work. If energy cannot be wasted, all interactions between the various forms of energy must take place at 100% efficiency. If two Newton bodies always act equally and in opposition, the magnitude of forces of their equal and opposite actions cannot increase indefinitely because an infinite amount of energy cannot be concentrated in one point in space. There must therefore be a safety valve, a limit to the magnitude of the two equal and opposite forces, and when that limit is reached, a transformation of energy from one form to another takes place. The objective being to stop the activity of the forces involved in the interaction.

Early in his treatise, Maxwell em-
plished that an infinite concentration of electricity is impossible, and that when the concentration reached a certain limit, something snapped. He quoted the breakdown of capacitors, various glows and discharges as examples. These phenomena must be the result of the forces of equal and opposite actions exceeding a certain limiting value, the transformation of a local electric charge into a wave, for instance. This safety valve, the point of evolution, is the past catastrophe of Thomson's theorem, the two bodies acting equally and in opposition to usu "masses." There is even more to the close affinity between the minds of Max- well and Thomson; a fascination with maps, or perhaps the purported geometrical pictures of abstract algebra.

If energy operates at 100 percent efficiency it will always be the line of least action of strain during the interaction of forces, wasting nothing. The attractive forces of gravity always act in a straight line between two centres of force, the line of least action. Although the forces of Electricity and magnetism must also be taking the line of least action, that line is often far from straight. The lines of least action in the space surrounding a magnet take some explaining. The fact that Maxwell did explain them through the bending of a straight line mathe matically is indicative of his genius and the validity of his principles. Whether or not they offer any explanation, whatever of the lines of least action surrounding a magnet. In the case of gravity, there can only be one straight line of least action between centres of force. Energy does not have a choice if it is to conserve itself. A line of least action is not the manifestation of an uncertain principle. If the line follows the changing energy levels of a half cycle of a wave, that line is exactly what the line is describing.

The loophole found by Planck is not difficult to repair if the principle is applied to his theory and experiment. An infinite amount of energy cannot be concentrated in a single volume in space.

Planck's theory that electromagnetic energy is emitted in packets or quanta rather than as waves grew from his theoretical and mathematical interpretation of the results of a single experiment, the ultraviolet catastrophe. Because the frequency of Maxwell's waves is a function of the energy to be radiated, the higher the concentration of energy at source the higher the frequency, Planck thought he could introduce an infinite amount of electromagnetic energy into a black box simply by increasing the frequency of the waves he pumped into it. He was surprised to find that when the frequency of the waves reached the ultraviolet region, an interesting thing happened. The wave energy in the box began to disappear. Planck had made himself a cavity resonator. What is the cavity resonator? Let's be fair, Planck was always dubious about the whole principle by making sure that an infinite amount of active energy could not be concentrated in the finite volume of his box. There is no sign of little packet of energy in his box, only the resonance of Maxwell's waves, an evolution of energy.

Planck concluded that electromagnetic energy was emitted not as a wave, but as individual packets of energy. The cyclic nature of the energy level on a Maxwell wave can be followed from its point of divergence. The energy of the wave gradually alternates from nothing to a maximum, and then to zero again. If Planck's concepts do not work themselves out until they are completely full, and the amount of electromagnetic energy is always the same. This quantity, Planck's constant, fixes the experimental unit, the packet the packer should perform by the expenditure of its whole energy. Planck's packet was later translated into a particle, the photon, the unit of the electromagnetic energy of light or to be more precise, the quantum of energy of a photon. The frequency of a Maxwell wave, data not available to Max weIl, Planck did not know there was a box there but two "bodies" acting and reacting, and one of them is Maxwell's ether.

Planck's work is very important if the data he cleverly collected from his experiment is interpreted correctly and applied to the phenomena of Nature. To be fair, Planck was always dubious about the whole principle by making sure that an infinite amount of active energy could not be concentrated in the finite volume of his box. There is no sign of little packet of energy in his box, only the resonance of Maxwell's waves, an evolution of energy.

Planck concluded that electromagnetic energy was emitted not as a wave, but as individual packets of energy. The cyclic nature of the energy level on a Maxwell wave can be followed from its point of divergence. The energy of the wave gradually alternates from nothing to a maximum, and then to zero again. If Planck's concepts do not work themselves out until they are completely full, and the amount of electromagnetic energy is always the same. This quantity, Planck's constant, fixes the experimental unit, the packet the packer should perform by the expenditure of its whole energy. Planck's packet was later translated into a particle, the photon, the unit of the electromagnetic energy of light or to be more precise, the quantum of energy of a photon. The frequency of a Maxwell wave, data not available to Maxwell, Planck did not know there was a box there but two "bodies" acting and reacting, and one of them is Maxwell's ether.

Planck's work is very important if the data he cleverly collected from his experiment is interpreted correctly and applied to the phenomena of Nature. To be fair, Planck was always dubious about the whole principle by making sure that an infinite amount of active energy could not be concentrated in the finite volume of his box. There is no sign of little packet of energy in his box, only the resonance of Maxwell's waves, an evolution of energy.

Planck concluded that electromagnetic energy was emitted not as a wave, but as individual packets of energy. The cyclic nature of the energy level on a Maxwell wave can be followed from its point of divergence. The energy of the wave gradually alternates from nothing to a maximum, and then to zero again. If Planck's concepts do not work themselves out until they are completely full, and the amount of electromagnetic energy is always the same. This quantity, Planck's constant, fixes the experimental unit, the packet the packer should perform by the expenditure of its whole energy. Planck's packet was later translated into a particle, the photon, the unit of the electromagnetic energy of light or to be more precise, the quantum of energy of a photon. The frequency of a Maxwell wave, data not available to Maxwell, Planck did not know there was a box there but two "bodies" acting and reacting, and one of them is Maxwell's ether.

Planck's work is very important if the data he cleverly collected from his experiment is interpreted correctly and applied to the phenomena of Nature. To be fair, Planck was always dubious about the whole principle by making sure that an infinite amount of active energy could not be concentrated in the finite volume of his box. There is no sign of little packet of energy in his box, only the resonance of Maxwell's waves, an evolution of energy.

Planck concluded that electromagnetic energy was emitted not as a wave, but as individual packets of energy. The cyclic nature of the energy level on a Maxwell wave can be followed from its point of divergence. The energy of the wave gradually alternates from nothing to a maximum, and then to zero again. If Planck's concepts do not work themselves out until they are completely full, and the amount of electromagnetic energy is always the same. This quantity, Planck's constant, fixes the experimental unit, the packet the packer should perform by the expenditure of its whole energy. Planck's packet was later translated into a particle, the photon, the unit of the electromagnetic energy of light or to be more precise, the quantum of energy of a photon. The frequency of a Maxwell wave, data not available to Maxwell, Planck did not know there was a box there but two "bodies" acting and reacting, and one of them is Maxwell's ether.
observers dimensions were being changed. All units of dynamics such as mass, velocity, acceleration, density, force, work and energy, can be expressed simply in terms of Newton's fundamental and absolute or universally constant units of time (T) and length (L). The density of a mass (M) described in units of time (T) and lengths (L) is M/LT, an acceleration LT². A force is the product of a mass and an acceleration, and if the concrete units of time and length are reduced, so are all forces applied to an atom's mass, and the total amount of work the atom will perform, its total energy, is also reduced. Where does the lost energy go? In Einstein's theory, nowhere. When his moving observer approaches the "constant" speed of light, its total energy is almost destroyed; it is a physical wreck. Einstein could not reduce the equal and opposite reactions of Maxwell's ether to the actions of the light wave, because his idea, Lorenz, in his other theory, the electron, had already forbidden the ether to perform work. Two equal and opposite laws for the one ether. Lorenz will one day find his way into the Guinness Book of Records as a greater destroyer of energy than King Canute.

Einstein was forced to limit the velocity of an atom to the speed of light because once his moving observer mathematically exceeded the "constant" speed of light, he would mathematically become a centre of negative energy and vanish down a black hole, proof that you can prove anything with figures. Einstein found himself with mass that tended to shrink when it moved by the value of his equation. To balance his books and satisfy the principle of the conservation of energy, he discovered rest mass, which allowed him to undrink mass by the same value. He called his theory relativistic because the total energy of each atom in the universe depended on the atom's velocity relative to a fixed and motionless point in space, all atoms being connected by bendable springs and flex-time clocks to conserve energy. Maxwell would have immediately dismissed Einstein's theory using the argument in Article 852 of his treatise, that the force acting between two "bodies" must be a function of their distance apart only, and if the force is a function of time or the velocity of the bodies, theory would not satisfy the principle of the conservation of energy.

Einstein's favourite occupation was performing what he called thought experiments. In the portable laboratory of his mind he could prove, without fear of contradiction, that scientific history was bunk. His laboratory was the envy of a few second rate accountants in a hurly. An analysis of debits and credits and their equal and opposite actions can be very time consuming, far easier to cook the books and make yourself a quick profit. They returned Newton's laws the three laws of non-movement. If it moved you either sabotaged it or multiplied it by Lorenz's equation. Never in the understanding of a field of force, so was little owed by so many, to so few.

To be continued

A decimal Gray code
Easily converted for shaft position coding
by K. G. Barr, Faculty of Natural Sciences, University of the West Indies

For some incremental measurements, such as shaft position coding, the Gray scale has advantages over b.c.d. coding as it changes by one bit only between adjacent codes.

Unfortunately, it needs to be converted back into b.c.d. to give a read-out. Gray scale is difficult and therefore expensive to convert and this decimal Gray scale overcomes the difficulty.

The author has recently designed equipment to monitor wind speed and direction. The wind vane drives a slotted disc whose position is sensed by i.e.d./photo-transistor pairs. A code is required to sense the position of the disc and transmit this position to the display and recording equipment. The reflected binary, or binary Gray code shown in Table 1 has the required property that only one bit changes in adjacent codes, but it is an expensive code to convert to a decimal for display.

The decimal Gray code also shown in Table 1 is much cheaper to convert. It is "reflected" after each decade, and the lowest bit of the next higher digit (h) is required for conversion. The b.c.d. digit (b) corresponds to the decimal Gray digit (g) corresponding to the decimal Gray digit (g) is b = gᵢ + gᵢ₊₁ and for Table 2, Dᵢ = 0 and the last value of Dᵢ the digit (g) = 1 was 00 or 35. The logic required for the complete conversion is shown in Figure 1.

It should be noted that the zero point logic is more likely to be simple if a decimal rather than binary based code is used. For example, in the example described D₀ is reflective because the transition occurs at 360° which is an even multiple of ten.

Table 1: It will be noted that the most significant bit in the first column changes to 1 at a count of 10 whereas in the decimal Gray code it changes at a count of 10. In Table 2, D₀ to D₃ represent the decoded decimal number, while gᵢ to gᵢ₊₁ is the decimal Gray coding.

<table>
<thead>
<tr>
<th>Binary Gray</th>
<th>Decimal Gray</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0000</td>
</tr>
<tr>
<td>1</td>
<td>0001</td>
</tr>
<tr>
<td>2</td>
<td>0011</td>
</tr>
<tr>
<td>3</td>
<td>0010</td>
</tr>
<tr>
<td>4</td>
<td>0110</td>
</tr>
<tr>
<td>5</td>
<td>0111</td>
</tr>
<tr>
<td>6</td>
<td>0101</td>
</tr>
<tr>
<td>7</td>
<td>0100</td>
</tr>
<tr>
<td>8</td>
<td>1100</td>
</tr>
<tr>
<td>9</td>
<td>1110</td>
</tr>
<tr>
<td>10</td>
<td>1111</td>
</tr>
<tr>
<td>11</td>
<td>1010</td>
</tr>
<tr>
<td>12</td>
<td>1011</td>
</tr>
<tr>
<td>13</td>
<td>1001</td>
</tr>
<tr>
<td>14</td>
<td>1000</td>
</tr>
<tr>
<td>15</td>
<td>1110</td>
</tr>
<tr>
<td>16</td>
<td>1100</td>
</tr>
</tbody>
</table>

Table 2: A decimal Gray code for the digit 0 is 360 ° into a B.C.D code (b). The elements on the left removes the ambiguity at the zero point.
Myth of the Mice, by Rodney Dale and Ian Williamson. 95pp, paperback. 89p.

Reasoned, restrained and responsible treatment of microcomputers. ...}


After 35 years of watching television programmes on a take-it-or-leave-it basis, the mass medium is no longer to be captured as it was even five years ago or so. A TV set is no more a crystalline mass that one can plug in and...
D.i.l. rotary switch

Contact ratings of the FEME 5940 D.I.L. 12-position rotary switch are 100 mA, 125V a.c./d.c., and 200VA maximum resistance. These flat-pack switches are available from Quiller Components Ltd. in either 1,2 or 4 pole versions with shorting or non-shorting gold-plated contacts. The 5940 switch is said to be suitable for applications involving automatic soldering and ultrasonic cleaning and is claimed to have a life of 50,000 operations when switching low power levels. Quiller Components Ltd, St Leonards Rd, Bournemouth BH3 8PA.

WW305

Encoder/decoder

With a single 5V supply, power consumption of the HD64409 c.m.o.s. 'Manchester' encoder/decoder is typically 5mA. Harris Semiconductor, the manufacturers, say that the device has a performance of 1MHz from 40 to +85°C. The 'Manchester' encoder/decoder is intended for low-noise, high-speed serial data communication and eliminates d.c. and r.f. components while allowing for clock recovery from the received signal. In 100+ quantities the US 20 pin d.p.n version costs £4.73 per unit. Harris Systems Ltd, Semiconductor division, 145 Farmham Rd, Snogd, Berk.

WW306

Microcomputer boards

Any combination of standard 24-pin compatible memory devices can be accepted by the latest addition to the Mentor MUX 380 range of microcomputer boards via six sockets. The 380 based MUX-CPU 2, from VSI Electronics Ltd, can be strapped to accept any combination of pin compatible memory banks, c.m.o.s. and e.p.r.o.m.s and a decoder p.r.o.m, supplied with the board, programmed to implement them. Flexible memory decoding enables the memory device to be configured within any 1K boundary of the 64K memory map. The CPU 2 contains a 4-channel counter/timer circuit, the trigger inputs and zero count outputs of which are externally accessible. For long counting sequences, the four counter/timer circuits can be cascaded. Address, data and control buses of the board are bi-directional. The CPU 2 has a 2.5MHz clock and the 2.4 & a

4MHz clock. VSI Electronics (UK) Ltd, Romindby Industrial Park, Hartwell Rd, Harlow, Essex CM19 3BD.

WW337

Digital multimeter

Capacitance, temperature and conductivity ranges are included on this touch-opened digital multimeter from Non Linear Systems Inc. The Touch Test 20 has a 0.55in high 3Vd.c. f.e.d. display and can measure 10 parameters, 20 functions on 44 ranges. Audible continuity and diode test facilities are included. Some measuring limits of the multimeter are 100V:1kV (0.2%) d.c., 1mA:750mA c.m.o.s., 0.1µA:10µA d.c., 10µA:100µA c.c., 100μA:200mA resistance, 1µV:200mV F capacitance, 40 to +150°C temperature and 0.01s:1.999ms conductance. The main-only version of the TT20 measures 2.9x6.8x7.3in, weight less than 3lb and costs £195. A version with rechargeable batteries and charger is available for around £220 extra. Lawrence Ltd, 129 High St, Edmibridge, Kent TN8 5AJ.

WW308

P.c.b. guillotine

Designed for cutting, the 22in and 36in, the Carusite guillotine can handle workpiece widths of up to 10in and incorporates an acryl

4 MHZ 200 52 A (V) 118 5 20 20 20

a 10MHZ 6 5 2 1

Speedy 100 5 5

10 MHZ 5 5

Oscilloscopes

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 family, with 10 or 20MHZ bandwidths. And there are 5 different Tektronix T900 Series oscilloscopes ranging from a 15 MHz single-trace oscilloscope to a 55 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, camera & scope stands.

Tel: 071-978 0687

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 family, with 10 or 20MHZ bandwidths. And there are 5 different Tektronix T900 Series oscilloscopes ranging from a 15 MHz single-trace oscilloscope to a 55 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, camera & scope stands.

World Oscilloscopes are sold & serviced worldwide by Tektronix. Please send me more information on Tektronix Oscilloscopes

W-WW-074 FOR FURTHER DETAILS
The Sullivan range of decade resistance boxes offer many superb advantages. For a start, they have very low self-inductance and will operate up to about 100kHz. Ruggedly constructed, each decade box contains 4 or 5 switched decade resistors according to requirements.

Through the use of switches with laminated copper brushes and silver faced contacts, the contact resistance uncertainty has been reduced to ±0.000022Ω per decade, with a d.c. accuracy of ±0.05% for most decades. Which means you can actually use a Sullivan Decade Resistance Box to form a standard resistor against which other resistors could be judged for accuracy of value.

And the range goes further still. Our Dual Dial Decade Resistance Box No. AD1049, for instance offers eight decades in a compact 4-dial box with a range of 0.01Ω to 1MΩ—again with an accuracy of 0.05%. Such a system allows you to save space and reduce residual resistance and inductance.

Want to know more about dialling-an-ohm? Then simply dial the number below for full details.

Dial-an-Ohm

H. W. Sullivan Limited, Dover, Kent.
Tel: Dover (0304) 202620  Telex: 96283

DE LUXE EASY TO BUILD LINDSAY HOO 72W STEREO AMPLIFIER £65.50 + VAT

This way to build version of our world-famous经典! 72W amplifier to build open frame, with an output stage capable of delivering a minimum of 50W, with good power and distortion figures. The design was published in WIRELESS WORLD March 1981 issue. It can be used in a variety of applications, from a hi-fi stereo system to a public address system. The kit includes a fully printed circuit board, all necessary components, including a matching transformer. Complete kit only £65.50 + VAT.

BLACK HOLE

MUSIC EFFECTS DEVICE — AS FEATURED IN ELECTRONICS TODAY INTERNATIONAL!

The BLACK HOLE music effects device is a compact, easy to use unit which allows the music enthusiast to create a wide range of effects. The unit comes complete with a variety of switches and controls which can be reconfigured to suit the user. A built-in 12 channel mixer allows for easy integration with other equipment. The BLACK HOLE device is perfect for the home music enthusiast or the professional musician.

POWERTRAN

CHROMATHEQUE 5000 5 CHANNEL LIGHTING EFFECTS SYSTEM

This 5 channel effects system features a wide range of controls and is ideal for use in lighting effects and live sound reinforcement. It includes a built-in mixer, a 5 channel fader control, and a variety of other features. The system is perfect for use in a home theater or for live events such as concerts and parties. Complete kit only £49.90 + VAT.

MPA 200 100 WATT (rms into 8Ω) MIXER/AMPLIFIER

Features a compact design and is perfect for use in a home entertainment system. It includes a built-in mixer, a 5 channel fader control, and a variety of other features. The system is perfect for use in a home theater or for live events such as concerts and parties. Complete kit only £49.90 + VAT.

SP-200 2-CHANNEL 100W AMPLIFIER — NEW KIT!

The power amplifier section of the SP-200 has proved to be very popular, but the mixer section had been overlooked. Now, with the introduction of the SP-200 mixer amplifier, you can enjoy full control of the sound in your system. Complete kit only £64.90 + VAT.

T20 + 20W STEREO AMPLIFIER £33.10 + VAT

This amplifier, based on a design published in Practical Electronics, uses a single, printed circuit board and offers a very low noise level. It is easy to use and can output up to 20W of power. Complete kit only £33.10 + VAT.

WIRELESS WORLD MARCH 1981
Did you know that Elektor is the only monthly electronics magazine to supply printed circuit boards for featured projects? At present over 300 different boards are available with designs covering many aspects of the hobby, ranging from microcomputers to electronics in the car. A novel sound generator is featured in the March issue together with constructional articles for a logic analyser and a medium waveband receiver. Some further notes on software for the Junior Computer are also included.

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

SIEMENS

The all-standard TV aerial tester — for both the professional and enthusiast

The Siemens S43002-M-CTV Antenna Level Meter is a portable, self-contained unit which greatly simplifies antenna orientation to receive TV signals including those of foreign transmission. Signals are visibly monitored on the integral 70mm diameter screen, giving the facility of detecting ghosting, unlike meters relying on directional pointers.

The unit is very accurate, yet remarkably simple to operate and embodies all the technological sophistication allied with supreme reliability for which Siemens is recognized.

Contact Telecommunications Test Equipment Department at Siemens Limited, Siemens House, Windmill Road, Sunbury-on-Thames, Middlesex. Tel. Sunbury-on-Thames 85691 Telex 6951091

A Siemens tester for all standards
NEW PRE-AMPS

HY (metal) and HY6 (aluminum) are now to I.L.P.'s range of advanced audio modules. These improved characteristics and efficiency in building them provide a whole new range of all-I.L.P. power-amps both MOSFET and BIPOLAR giving you the chance to get the best possible reproduction from your system. HY and HY6 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.

- HY for use with 1 MOSFET HY 60p, HY120p
- HY60p for use with 1 HY120p
- HY120p for use with 1 HY200p
- HY200p for use with 1 HY300p
- HY300p for use with 1 HY400p
- HY400p for use with 1 HY600p

BIPOLAR

(Standard O/P Transistors)

CHOOSE AN I.L.P. BIPOLAR POWER AMP when low distortion and highpower output are your major requirements. HY200p and HY60p are new I.L.P. power-amps which combine with their complete internal thermal efficiency and improvement on new construction techniques, to give you trouble-free and with without output and power requirements, it becomes easier than ever to have a system layout based on the way you want it.

NEW POWER SUPPLY UNITS

Of the eleven power-supply units which comprise our complete range, nine have toroidal transformers giving the highest efficiency. These transformers are bi-phase driven, with two separate windings putting in the higher efficiency you would expect from a modern high quality power supply. The remaining two units use an output transformer at 100W and the other I.P. transformer for the lower power requirements. All units are carefully selected from a range of suitable units. To order, please contact your local dealer or write to our main office.

* Freepost facility

When ordering, please quote: 1. Name of module
2. Module code
3. Module number
4. Module type

TO ORDER

Send name and address to: I.L.P. ELECTRONICS LTD., Thame, Oxfordshire, OX9 3GG.

BRITAIN'S FOREMOST QUALITY MODULE SUPPLIERS

The new HY200p is designed for the more demanding applications, where the highest possible performance and reliability are essential. It is capable of delivering up to 200W into 4 and 8Q, with a very low distortion and good transient response. The HY60p is designed for the more demanding applications, where the highest possible performance and reliability are essential. It is capable of delivering up to 60W into 4 and 8Q, with a very low distortion and good transient response. The HY40p is designed for the more demanding applications, where the highest possible performance and reliability are essential. It is capable of delivering up to 40W into 4 and 8Q, with a very low distortion and good transient response.
HERE'S HOW TO TALK TO 
ALL OF THE PEOPLE ALL OF THE TIME 
with a communications system built up from the 
all-embracing, constantly expanding range of 
REDITIONS EQUIPMENT 

The latest addition to that range – 

‘SERIES TWO’ 
MESSAGE REPEATER 
with 4-TRACK CAPABILITY 
for four-message or four-language simultaneous or 
selective tape playback through external amplifiers, plus 
one selected track through an optional device: – 
slide-synchronizer, monitor loudspeaker, associated 
multi-channel amplifiers.

When it comes to SOUND communications, REDITIONS EQUIPMENT 
does more for LESS. REDITIONS is the one name that says it all. 

Send for details of any item, and our full brochure, of a range of equipment that can provide every integrated link in the 
chain of a tailor-made sound communications systems.

REDIFUSION REDITIONS LTD., 
La Pouilelave, St. Helier, Jersey, Channels Islands 
Tel: Jersey (05) 302211, 8211341 
U.K. DEPOT: River View Road, Briston, Stevenage, Hertfordshire, U.K. 
Tel: Stevenage (0705) 585858 
DISTRIBUTORS FOR GREATER LONDON & HOME COUNTIES: 
MURSDALE LTD., 389 Green Lanes, London N4 10V Tel: 01-802 1163 

B. Bamber Electronics 
Dept. WW, 5 Station Road, Littleport, Cambs. CB6 1OE 
Telephone: ELY (0353) 600181 [2 lines] Tuesday to Saturday 

Campore Long Term Disposal Facilities 
Packed boxes of 100: 6 oz cans, approx. 60,000 in stock. 
MONITOR CATHODE RAY TUBES 
15 inspectors, 250-275 ft. barrel, 30West, 80m, 30m, 300m, each instrument and control. 
Transistors 
24,000 in 204 or 254 output. Ideal for broadcasting or blank supply. 
COLOUR T.V. MAINS INPUT 
All types at 1,000. 
FILTER CHOKING BASE 
All types at £1 per set. 

HOLLWOOD HEAT SHIRTS
Three types, Colour black, 10-5 cm. 
£10 each

LARGEST QUANTITY OF USEFUL BINS
At best possible prices.

PYE ATRU TUNER UNIT
We supply them in 100's. 

FERRARI MICROSCOPE CATHODE RAY TUBES
These are 30, 50, 60, 100, each £8. 

FERRARI MICROSCOPE CATHODE RAY TUBES
Type 30, 50, 60, 100, suitable for photographic multipurpose. 

TELEVISION DATE MODEL AS393
With paper tape reader/punch and stand, ideal for printing.

WIRE 206 MOVEMENTS COMPLETE WITH SCALE
As new, £9 each.

RIBSON CABLE
5 metres for £1.25
TELESCOPIC RADIO AERIALS
Price £1 each
VIDICON SCAN COILS
(Transmitting type, but no data) 
£2.50 each

PYE WESTMINSTER
W35AM, low band, only one, not the correct price. 
£55
PYE WESTMINSTER 
UHF band, andcombe and a geographically 
(SI, 39W, 39G, 39A) and 6 (51, 69, etc. in each of the 6 bands). 
£70 each

HEAVY METAL PLINTHS
Called for in next Editor's Campore deal.

Baker Loudspeakers

£65

Baker 50 Watt AMPLIFIER

£65

Famous Loudspeakers

£65

Baker 150 Watt MIXER/POWER AMPLIFIER

£89

DRAINAGE VALVES

£9

BATTERY ELMUATOR MAINS TO 8 VOLTS

£5

BATTERY ELMUATOR GEN TO 8 VOLTS

£5

CROSSOVERS

£2.50

B&H VICTORIAN ELECTRIC HORN TWEETER

£5.60

B&H ECHO AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H HIFIDT VIBRATION AMPLIFIER

£5

B&H ECHO AMPLIFIER

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5

B&H AMPLIFIER WITH CROSSOVERS

£5

B&H VIBRATION MOTOR AMPLIFIER

£5

B&H CERAMIC HORN AMPLIFIER

£5

B&H BAND-WIDEBAND AMPLIFIER

£5
CT 4s we now are delighted to be able to record/play head is fitted and we can 'Gives instant indication even for peaks of only 5 microseconds duration. Unit uses CMOS electronic speed controlled motor and auto stop read.

4499 top loading decks fitted with stereo R/P head, 3 digit re-settable counter, 12 volt bias and equalisation for different tape formulations. All wiring is terminated with plugs behind a narrow finger trapping slot. Easy to use, robust.

Orders £10 to £49 - £1 Please send 9 x 4 SAE for lists giving fuller details and price breakdowns.

The very latest amplifier design to be published and in our opinion the best 'yet. All parts can be bought separately at a total cost of £79.12 but complete kits are available.

- Complete Kit for fully integrated 35watt MOSFET amplifier
- Dynamic range. Board layouts have been altered and improved but retain the door. Latching record button for level setting. Dual concentric input level controls. Phone H561 Special Erase Head for METAL tape to out perform on a side-by-side comparison the bulk of amplifiers available today, even

H M90 H S16 Very latest Sendust Alloy Super Head with even better output than Ferrite. Fantastic frequency response. Complete with data.

Permalign R/P head for replacement uses in car player, etc.

Cassette Heads

CASSETTE HEADS


HE16 1551 50W with 0-9 in. pick-up. Star Standard Mfg. Mfg. All parts are finished with the highest quality of materials that we all the complete kit.

LINSLEY-HOOD CASSETTE READER 2

are the designated Approved suppliers of this kit for the microwave design. The Author's instructions tell us to know about the depression and expansion characteristics of one of the most important design features. Alternative materials used. All parts are new and are finished with the highest quality of materials that we all the complete kit.

LINSLEY HOOD CASSETTE READER 1

We are the designated Approved suppliers of this kit for the microwave design. The Author's instructions tell us to know about the depression and expansion characteristics of one of the most important design features. Alternative materials used. All parts are new and are finished with the highest quality of materials that we all the complete kit.

ORDER FORM

To: General Sales Manager, Room 205, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS
Please send me, copies of the Hi Fi Yearbook and Home Entertainment 1981 at £35.50 including postage and packing. Cheque/postal order should be made payable to IPC Business Press Ltd.

RENT ALL ABOUT IT — all the latest on home entertainment equipment and ideas in... HI FI YEARBOOK AND HOME ENTERTAINMENT 1981

Published again in November, this new 1981 edition in larger magazine size means more comprehensive coverage of the whole range of home entertainment equipment, from aerials to headphones, from microphones to video recorders and from radios to electronic organs. Backed by authoritative articles on developments in the world of Hi Fi, plus details of stockists, Hi Fi Yearbook and Home Entertainment 1981 is essential reading for enthusiasts and buffs. Available from leading newsagents and bookshops from 1st November 1980. Price £3.00. If you have difficulty in obtaining your copy order direct from the publishers @ £3.50 inclusive.

DC POWER SUPPLIES

KAPT 1049/8, 12/14V @ 5 Amps £23 (2) RACK 1409/8, 24V @ 5 Amps £36 (2 p) can supply the above power supplies at 230 volt between 57 and 59V at 5A. RACK 1209/8 @ 6A. RACK 1009/8 @ 6A. RACK 7x5x0. Following types available: 13-17 Vols @ 4.15 A. 22-23 Vols @ 4.17 A. (1-50 each post pack). The above power supplies are 230V AC and are stabilised and regulated and housed. All are fully tested and checked for performance in all our equipment there is a money-back guarantee that they are completely satisfactory.

AIMERS IN STOCK — PLEASE RING*

MODULATION METERS

RACK KALEE 1742 W & Flutter Meter. RANK HEO 1735 Audio/Video Waveform analyser 852 & 248A. DUAL 100V Power Amplifier with special equipment for vibration testing etc.

H-EWELL-PACKARD 713A per cent. H-EWELL-PACKARD tuned amp & null detector. TM 5800 Variable 1ms-1000ms.

RADIO FREQUENCY Generator Modular kit K12 735.

LAMARR TV/PATTERN GENERATORS 625-line crosshatch/div grey scale display £64 (4) each.

RANK SIGNAL STRENGTH METERS 20 channels 20.60. Battery operated £20 (1 each post pack).

1300 MHz Generator £100. SODOK I 2.5-100MHz, AM/FM.

RACK KALEE 1743 W & Flutter Meter. RANK HEO 1735 Audio/Video Waveform analyser 852 & 248A. DUAL 100V Power Amplifier with special equipment for vibration testing etc.

H-EWELL-PACKARD 713A per cent. H-EWELL-PACKARD tuned amp & null detector. TM 5800 Variable 1ms-1000ms.

RADIO FREQUENCY Generator Modular kit K12 735.

LAMARR TV/PATTERN GENERATORS 625-line crosshatch/div grey scale display £64 (4) each.

RANK SIGNAL STRENGTH METERS 20 channels 20.60. Battery operated £20 (1 each post pack).

1300 MHz Generator £100. SODOK I 2.5-100MHz, AM/FM.

RACK KALEE 1743 W & Flutter Meter. RANK HEO 1735 Audio/Video Waveform analyser 852 & 248A. DUAL 100V Power Amplifier with special equipment for vibration testing etc.

H-EWELL-PACKARD 713A per cent. H-EWELL-PACKARD tuned amp & null detector. TM 5800 Variable 1ms-1000ms.

RADIO FREQUENCY Generator Modular kit K12 735.

LAMARR TV/PATTERN GENERATORS 625-line crosshatch/div grey scale display £64 (4) each.

RANK SIGNAL STRENGTH METERS 20 channels 20.60. Battery operated £20 (1 each post pack).

1300 MHz Generator £100. SODOK I 2.5-100MHz, AM/FM.

RACK KALEE 1743 W & Flutter Meter. RANK HEO 1735 Audio/Video Waveform analyser 852 & 248A. DUAL 100V Power Amplifier with special equipment for vibration testing etc.

H-EWELL-PACKARD 713A per cent. H-EWELL-PACKARD tuned amp & null detector. TM 5800 Variable 1ms-1000ms.

RADIO FREQUENCY Generator Modular kit K12 735.

LAMARR TV/PATTERN GENERATORS 625-line crosshatch/div grey scale display £64 (4) each.

RANK SIGNAL STRENGTH METERS 20 channels 20.60. Battery operated £20 (1 each post pack).

1300 MHz Generator £100. SODOK I 2.5-100MHz, AM/FM.

RACK KALEE 1743 W & Flutter Meter. RANK HEO 1735 Audio/Video Waveform analyser 852 & 248A. DUAL 100V Power Amplifier with special equipment for vibration testing etc.

H-EWELL-PACKARD 713A per cent. H-EWELL-PACKARD tuned amp & null detector. TM 5800 Variable 1ms-1000ms.

RADIO FREQUENCY Generator Modular kit K12 735.

LAMARR TV/PATTERN GENERATORS 625-line crosshatch/div grey scale display £64 (4) each.

RANK SIGNAL STRENGTH METERS 20 channels 20.60. Battery operated £20 (1 each post pack).

1300 MHz Generator £100. SODOK I 2.5-100MHz, AM/FM.

RACK KALEE 1743 W & Flutter Meter. RANK HEO 1735 Audio/Video Waveform analyser 852 & 248A. DUAL 100V Power Amplifier with special equipment for vibration testing etc.

H-EWELL-PACKARD 713A per cent. H-EWELL-PACKARD tuned amp & null detector. TM 5800 Variable 1ms-1000ms.

RADIO FREQUENCY Generator Modular kit K12 735.

LAMARR TV/PATTERN GENERATORS 625-line crosshatch/div grey scale display £64 (4) each.

RANK SIGNAL STRENGTH METERS 20 channels 20.60. Battery operated £20 (1 each post pack).

1300 MHz Generator £100. SODOK I 2.5-100MHz, AM/FM.

RACK KALEE 1743 W & Flutter Meter. RANK HEO 1735 Audio/Video Waveform analyser 852 & 248A. DUAL 100V Power Amplifier with special equipment for vibration testing etc.

H-EWELL-PACKARD 713A per cent. H-EWELL-PACKARD tuned amp & null detector. TM 5800 Variable 1ms-1000ms.

RADIO FREQUENCY Generator Modular kit K12 735.

LAMARR TV/PATTERN GENERATORS 625-line crosshatch/div grey scale display £64 (4) each.

RANK SIGNAL STRENGTH METERS 20 channels 20.60. Battery operated £20 (1 each post pack).

1300 MHz Generator £100. SODOK I 2.5-100MHz, AM/FM.

RACK KALEE 1743 W & Flutter Meter. RANK HEO 1735 Audio/Video Waveform analyser 852 & 248A. DUAL 100V Power Amplifier with special equipment for vibration testing etc.

H-EWELL-PACKARD 713A per cent. H-EWELL-PACKARD tuned amp & null detector. TM 5800 Variable 1ms-1000ms.

RADIO FREQUENCY Generator Modular kit K12 735.

LAMARR TV/PATTERN GENERATORS 625-line crosshatch/div grey scale display £64 (4) each.

RANK SIGNAL STRENGTH METERS 20 channels 20.60. Battery operated £20 (1 each post pack).

1300 MHz Generator £100. SODOK I 2.5-100MHz, AM/FM.

RACK KALEE 1743 W & Flutter Meter. RANK HEO 1735 Audio/Video Waveform analyser 852 & 248A. DUAL 100V Power Amplifier with special equipment for vibration testing etc.

H-EWELL-PACKARD 713A per cent. H-EWELL-PACKARD tuned amp & null detector. TM 5800 Variable 1ms-1000ms.
Happy Memories

4116 200ns £2.25
4114 200ns £2.95
2708 450ns £3.95
4115 450ns £2.20
2716 5 volt £6.25

Memorex Soft-socketed mini-discs for PET, TRS-80 etc. Supplied in FREE LIBRARY CASE £1.95 per 10

Low Profile I.C. Sockets by "Texas"
First 8 14-16 18-20 22 24 28 40
Price 10 11-12 14 17 20 21 26 37
Memory Upgrade Kits for Apple, 2020, TRS-80 etc. from £18, please phone. Quantity prices available on request. Government and Educational Orders welcome. Trade accounts opened.

All prices include VAT. Postage FREE on orders over £15, otherwise add 30p Access and Barclaycard welcome.

HAPPY MEMORIES, DEPT. W.W. GLADESTED, KINGSTON HEREFORDSHIRE HR5 3NY Tel: (054422) 618

Cut costs and speed trouble shooting

with the Huntron Tracker

This easy to use test instrument displays shorts, opens, and leakage in solid state components. Check diodes, transistors, thytors, transistors, FETS, MOSTETS, LEDS, and electrolytics etc. - [IN CIRCUIT!]
Test your diode or analogue hybrid boards - WITHOUT CIRCUIT POWER!
Current limited to protect laser diode in the MOS-CMOS family.
Saves 30% of trouble shooting time and recover your investment fast! Exclusive 24 months warranty, available from -

MTL Microtesting Limited
195 Bure Road, Alton, Hampshire Telephone Alton (0420) 8822

www.mtl.co.uk

S-2020TA STEREO TUNER/AMPLIFIER KIT

NEW HIGH PERFORMANCE TUNER
A high-quality push-button FM/AM VHS Color Stereo Tuner with pilot cancel decoder included. With a 24W RMS, per channel Stereo Amplifier, using Bifet op. amps.
Brev Spec: Amplifier Linear Tonal response transformer, Mg, input Transformer built-in factory for U.K. Standard, etc; 14400 see 0.1% at 20kHz in 0.1% division, 50 Hz to 20kHz 0.1% division, High Gain Rats: Low impedance amplifiers have a theoretical gain of 70dB, Bifet op. amps 80dB. Tuner: IF 10.7MHz, IF10.7MHz, IF100kHz, IF1kHz, Lowpass filter 300kHz, pilot cancel. Tuning range 50MHz to 108MHz (with face of adjustment screws, Mounting brackets, etc.)

PRICE: £69.95 + VAT

NELSON-JONES Mk. 2 STEREO FM TUNER KIT

A very high performance tuner with dual IF stages, 1kHz phase locked line, pilot cancel, tuned pilot filter, IF and 3 state MPP decoder.

PRICE: £74.95 + VAT

NRDC-AMBISONIC UHJ SURROUND SOUND DECODER

The first ever to specially produced by Trangos for the NRDC-AMBIZONIC surround sound decoders which is the result of 7 years' research by the Ambisonic team W. W. July, Aug. 1977. The unit is designed to decodle only 90 degree and virtually all other "ambisonic" systems. Box (CAD), including the box (CAD) which is your ideal box. Very highly recommended. With NRDC-AMBIZONIC, the decoder does not rely on listener training high performance techniques. Ask for new brochure. Complete with mains power supplies, sophisticated switching equipment, complete with. Complete kit, including licence fee £57.95 + VAT or ready built and tested £74.95 + VAT

S5050A STEREO AMP

Very high performance kit

50 watt continuous, 0.01% Total Distortion, 0.03% distortion, 40 dB/8 ohm. 90 dB, 20W/8 ohm stereo.

Tone equal switch, 2 tape monitor switches. Metal case - completely hermetic.

Complete kit £69.95 + VAT

(Also available our 20w/ch BIFET 52020 Amp)

INTRUDER 1 Mk. 2 RADAR ALARM

With Home Office Type approval

The original "Wireless World" published Intruder 1 has been re-designed by Imagis to incorporate several new features, starring improved performance. This kit is very easy to build. The internal audible alarm turns on after approximately 40 seconds and the unit is armed. 2400 as mains or 12v battery operated. (Deguiset as a hard-back book. Detection range up to 45 feet. Internal mains rated voltage free contacts for external bells etc.

Complete kit £65.50 plus VAT, or ready built and tested £68.50 plus VAT.

Wireless World Dolby noise reducer

Trademark of Dolby Laboratories Inc.

S-1003A Sound fieldremainder

S-1003A Sound fieldremainder

Complete kit: PRICE: £49.95 + VAT (at least 6 model available)

Also available nearly built and tested

Complete kit: £39.95 + VAT (at least 6 model available)

Complete kit: £29.95 + VAT (at least 6 model available)

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

All kits are carriage free

INTEGREX LIMITED

Portwood Industrial Estate, Church Gresley, Burton-on-Trent, Staffs DE11 9PT
Burton-on-Trent (0283) 216432 Telex 371001

www.americandigitalhistory.com
108
WIRELESS WORLD MARCH 1981

FYLDE

TRANSDUCER and RECORDER
AMPLIFIERS and SYSTEMS

reliable high performance & practical controls, individually powered modules mainly or dc option single cases and up to 17 modules in standard 19" crates small size low weight realistic prices.

Fylde
Electronic Laboratories Limited.

49/51 Fylde Road Preston
P62 2XQ
Telephone 0722 57560

40 - £12.95

post service. Send cheque, P.O. or phone your ACCESS or BARCLAYCARD number.

Memories

2114-300ns 1k x 4 SRAM £2.25
4116-200ns 16k x 1 DRAM £1.89
2708-450ns 1k x 8 EPROM £3.48
2516-450ns 2k x 8 EPROM £4.62
2716-450ns 2k x 8 EPROM £4.62
74L240 £1.54
74L243 £1.54
74L244 £1.54
74L245 £1.70

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

STRUTT LTD.

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

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

LOW VOLTAGE POWER DRILLS AND ACCESSORIES

Illustration shows Titan Drill and Stand (Price £27.60 inc. VAT and Package) which is one of the combinations which can be purchased from our comprehensive range of Drills and Accessories.

A. D. BAYLISS & SON LTD.
Physix Works, Redmarley
Gloucester GL19 3XG
Tel. Bourton-on-the-Water (0253) 264 or 273

ONLY £14.95

JOIN THE KEYBOARD REVOLUTION!

A remarkable new concept in electronic keyboard instruments using totally new technology. Rich, cosmic and harmonic of a larger than natural range ... included in our complete line-up of keyboards and stored in electronic chip memory for faithful and exact reproduction.

NEW CASIOTONE

401 £259

PSF CM-15

A total of 15 different sounds can be selected. The Polyphonic playing of 16 instruments, Casio Auto-Chord allows you to perform single finger accompaniment. Just press the key with a single finger and it will create a chord and lead accompaniments automatically. A wealth of simple-to-use operation panel contains simple, definable and easy to understand the instruments. 24 or 12 notes with range C4 to C5. A range of 128 notes to 512 notes with range C4 to C7. 16 bit sound generator of 16 bit ADC filters and 16 bit D/A converter and of 16 bit digital signal processor.-

TEMPUS

Dep. WW, Raymond Centre, 34-57 Euston Road, Cambridge CB1 1HD. Tel. 0222 32886

M. E. M. : WANTED!

All Types Receiving, Transmitting, Industrial

Phone / write to:
PYE HAYES RADIO LTD.
806 Kingsbury Road
Birmingham B42 9PJ
021-373 4942

WW — BS FOR FURTHER DETAILS

WIRELESS WORLD MARCH 1981

CS1830 FROM TRIO

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

C.R.T.
120 x 95 mm rectangular PDA with internal grille
Y Bandwidth:
DC — 30MHz
Sensitivity:
5mV/div (50MHz)
2mV/div (20MHz)
Input IC:
1M/22pF
Bandwidth:
1.7 nS
Beam Switch:
Choice of alternates
Mode:
CH1, CH2, Dual, Add, Subtract
Time Base:
Triggered, auto, or single shot
Sweep Time:
0.55 sec, 200u sec, 5 div (40ns using X5 mag) 20 ranges in 1-2-5 sequence
Sweep Delay:
100msec to 1.5s adjustable with trace bright up for delay

Z Modulation:
TTL compatible 10k impedance 5MHz bandwidth
Trace Rotation:
Electrical
And the Price?
£455 + VAT (includes 2 probes)

LOW ELECTRONICS Ltd.
CHESHERFIELD ROAD, MATLOCK, DERBYSHIRE DE4 5LE
TEIL 0629 2430/2817

WIRELESS WORLD MARCH 1981

WANT ED

VHF 27MHz / 2m Signal Delay eq.
£140 + VAT

NDR 515 receiving for the discerning few.

NDR 515 SYNTHESISED HF MONITORING RECEIVER

NHD 515 MULTICHANNEL MEMORY UNIT

NVA 515 LOUDSPEAKER UNIT

CFL 260 600Hz CW FILTER

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

- Antenna Coupler: LAC925
- Antenna Coupler: LAC915
- Antenna Coupler: LAC950
- TROF Meter: LDM 185
- Antenna Impedance Meter: LDM 175
- Antenna Impedance Meter: LDM 150
- Step Recovery: LPR BB D 0.5 to 120 Hz
- Shift/Linear: LPR B 10 Hz to 100 Hz

Send SAS for details or phone Richard Keizer 02407 3566 for special advice.

Sends for care use:
- Call for further details.

Marshall's (London) Ltd.
King's Road House
King's Road
London SW14 4TA
Industrial Sales: 01-328 1009
Mail Order: 01-246 0924
For service
A. Marshall (London) Ltd.

$3.25 inc. postage.
To obtain further details of any of the coded items mentioned in the Editorial or Advertisement pages of this issue, please complete one or more of the attached cards entering the reference number(s). Your enquiries will be passed on to the manufacturers concerned and you can expect to hear from them direct in due course. Cards posted from abroad require a stamp.

These Service Cards are valid for six months from the date of publication.

Please Use Capital Letters

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

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

OVERSEAS SUBSCRIPTION

AGENTS

Australia: Gordon &
80 Lonsdale Street
19-21 Market Street
Brisbane, Qld. 4000

Belgium: Agent
108, Boulevard du Jour, B-1030, Bruxelles

Canada: Canadian
901-204 West Georgia Street
Vancouver, B.C. V6B 4N6

Eire: Agent
P. O. Box 5, Dublin 2

France: Agent
9, Rue des Mathurins, 75008 Paris, France

Germany: Agent
K.Z. Postfach 325800, 61020 Darmstadt

Japan: Agent
4-5, 2-Chome, Shibuya-ku, Tokyo, 150

New Zealand: Agent
30 Business Park, Auckland City

Netherlands: Agent
Postf. Box 79, 2500 GD, Den Haag

Portugal: Agent
Rua de Portugal 126, 1100-069 Lisboa

Spain: Agent
Avenida de la Victoria, 15, 28040 Madrid

Sweden: Agent
4, Abram Ohlssons Gatan, 112 54 Stockholm

Switzerland: Agent
Postf. Box 1010, 3048 Winterthur

U.S.A. (East Coast): Agent
P. O. Box 416, New York, N.Y., 10127

U.S.A. (West Coast): Agent
1700 N. Brand Blvd., Los Angeles, Calif. 90021

U.S.A. (Florida): Agent
1725 S. 7th Street, West Palm Beach, Fla., 33401

Wallace: Commercial
P.O. Box 270, 240-244, City de Chino, 91710-270

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,
P.C. Business Press,
Oakfield House, Perrymount Road,
Haywards Heath, Sussex RH16 3DH, England

WIRELESS WORLD: Reader Enquiry Service
429 Brighton Road
South Croydon
Surrey CR2 9PS
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 (1-3dB) over full display.
- Complete with probes.

At a price of £230.00 + 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: __________________________

Please send me further details.

WW — 906 FOR FURTHER DETAILS
**NEW! Thurby1503**

A lot more multimeter for your money

The Thurby 1503 provides more resolution and more effective accuracy, than any other meter in its price category. It's 10mV, 100mA, 1nA sensitivity is ten times greater than the best 3½ digit meters, whilst its resolution exceeds even 4½ digit meters. Mains or battery operation, manual controlled frequency function and current measurement up to 25A give it even greater versatility.

**WIRELESS WORLD MARCH 1981**

**SUNITA ELECTRONICS LTD.**

Sunita Introduces You To Its New Range of Low-Cost Professional Monochrome Video and Data Display Monitors

Our comprehensive range consists of the following Standard Units:

- **MPM1/8in.**
- **MPM1/6in.** These are available in either Mains/MPM1/8in. Powered or Wire-Framed Versions.
- **MPM1/12in.**

But we also manufacture a special VDU Monitor for computer applications. This unit illustrated above has spare capacity for additional P.C.B.s, etc. These are only available with 8in. or 12in. CRTs.

For further information ring Staines (0784) 67007/55220 or write to:

Unit 18, Staines Central Trading Estate, Staines, Middx. TW18 4EX

**DATA TERMINAL DEVICES**

**Honey's**

- **TERMINAL ELECTRONICS INC.**
- **DIGITAL EQUIPMENT CORP.**

**FOTOLAK**

Positive Light Sensitive Aerosol Lacquer

Enables VDU to produce perfect printed or written work. Suitable for monochrome or colour. Can be used on clear or white background. Suitable for light or dark text. Suitable for use in industry for prototyping work.

- **FOTOLAK** £2.00
- **Developer** £1.35
- **Ferro Oxide** £2.50
- **Paint** £2.50

Price £139 + £20.85 VAT including test leads, mains adaptors, and postage.

**Thurby Electronics Ltd.** (0489) 63570Coach Mews, St. Ives, Huntingdon, Cambs. PE17 4BN

Please supply 1503 multimeters at £159.95 inc. VAT

*We enclose cheque/PO for deposit only and send remittance and instructions.*

WWW - 987 FOR FURTHER DETAILS
The Art of Electronics
P. HOROWITZ and W. HILL
This is a textbook on electronics and design techniques. It is aimed at a broad audience, from students to professionals, and covers topics such as circuit design, signal processing, and electronic devices.

Oxford University Press, 1945

WIRELESS WORLD MARCH 1981

INSIST ON VERSATOWER
BY PROFESSIONALS-FOR PROFESSIONALS

The VERSATOWER range of telescopic and tilt-over towers covers a range of 250 to 1200 (7.5M to 35M).

Designed for Wind Speeds from BS5mph to 11.7mph conforming with CP3 Chapter V, part 11.

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

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

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

VERSATOWER
THE PROFESSIONALS' CHOICE

PORTLAND HOUSE, COPPICE SIDE
BROWNWELL, WEST MIDLANDS
TEL (091) 221 2251 TLEX 333243 S1

WIRELESS WORLD MARCH 1981

TV TUBE REBUILDING

Faircast Engineering Ltd., manufacture a comprehensive range of equipment for professional radio and TV technicians, including high performance, solid state, colour and monochrome receivers.

For full details of our service contact Neil Jupp
FAIRCAST ENGINEERING LTD.
Wills Road, Croydon, CR02XX
01-684 1421/01-684 0246

WIRELESS WORLD MARCH 1981

Memories

BDS Microsystem Designs Ltd.
20 Plowden Close, Chilworth, Titchfield, Hants, PO16 7EG
Telephone: St. Albans (0727) 31831

WW---B FOR FURTHER DETAILS

WIRELESS WORLD MARCH 1981

FERRET A.T.E. £550 Phone for details

EDDYSTONE RECEIVERS Model 1981 UK: 1.5-AM £160 each
Model 7201-AM/PM £250 each
Some models eight wavelengths. Price no Special Price.

INFRA RED IMAGE CONVERTER Type 9606 (CV 144)
£12.50 each
Check latest price and availability.

VARIAN RUBIDIUM STANDARD
Small, thin, stable £600

EX-MINILOGY SOLID STATE 4000 WATT INVERTER
30VDC input, 110V output. Size 2 x 24 x 5. £250 each.
For further details please write to: Ex-Miniology, Unit 11, 750-1500 Higham Lane, Bromley, Kent.

MINIMUM ORDER £3 VALUE OF GOODS. MINIMUM P&P £1. TO WHERE P&P not stated please see own discretion—access refunded.

BARCLAYS CARD AND ACCESS ACCEPTED. OFFICIAL orders only.

SILHOTMEAD
NORWOOD ROAD, READING
TELEPHONE NO, READING 669656

www.americanhistory.com
If you are seeking enlightenment about word processing, then the March issue of Britain's leading microcomputer magazine is the place to start. Some popular word processing packages are surveyed and Wordcraft, which is used on the Jo, is examined, giving you an idea of the facilities to look for when undertaking word processing on your system.

Also in this issue:
- Reviews of the RAIR 320, a powerful system with multi-user capabilities. And of the new generation of printers - some giving typewriter-quality print at less than £500.
- How a professional photographer is using a Tandy to help him run his business.
- Logic and Computing in Schools, with some ideas on the design of teaching programs.

All this, plus a voucher worth 50p, which halves the admission fee for the Microsystems '81 Exhibition being held at the Wembley Conference Centre from March 11-13.

It all adds up to unbeatable value in Practical Computing. Still only 60p. From your newsagent or post this coupon now.

TO: Marketing Services Dept., Room 316, IPC Electrical-Electronic Press Ltd., Quadrant House, The Quadrant, Sutton, Surrey SM2 5XS
Please send me a copy of Practical Computing every month for a year at the cheaper P.O. rate (£1 UK/£14 overseas, payable to IPC Business Press Ltd.)

Name:
Address:

STEREO PLAYBACK SYNTHESIZER PS 2001
(Europat. Pend.)

We are German importers and suppliers of electronic goods and work for a reliable dealer to sell in U.K. of this product. This item is produced also in the U.S.A. and the price in U.K.

Features:
- Powerful sound from all stereo equipment blocks.
- Volume, treble, and bass control.
- AC/DC adapter included.
- JSX: 60000 V, 50 V, 400 V
- I A: 50 V, 400 V
- THYRISTORS:
- Voltage: 1.50
- Current: 1.80
- 6 W

ANY MAKE-UP
OR COPY
QUERIES CONTACT
JOHN GIBBON
01-661 3500
extension 3561

PURE GOLD!
Top-quality, low-profile, gold-plated contacts.

IC SOCKETS
8 pin
14 pin
16 pin
18 pin
20 pin
24 pin
28 pin
26 pin
40 pin

Unbeatable value
Any 5 or more. Minimum order £10. Add 15% P & P
Special Offer: 10 x 14 pin, 10 x 16 pin. 5 x all others. Total 55 sockets, only £1.20 + £1.50 P & P

ORION
Oxion Scientific Products Ltd., 15 Wardour St., London, W.1
**WIRELESS WORLD MARCH 1981**

**A MATTER OF LIFE OR DEATH**

When an accident occurs involving severe electric shock, people on the spot may suffer from a kind of shock themselves. That's why Electrical Review has completely re-styled its Electrical Shock Chart. The new chart, prepared in consultation with St. John's Ambulance Brigade, highlights the main points in red, and explains and illustrates the actions to be taken so clearly that they can be grasped instantly even in an instant. It also includes vital instruction on what to do if the casualty does not respond to artificial respiration—with a section on external heart compression. Action this second could save a life. Post this coupon NOW.

**VIVID RED AND BLACK. PLASTIC, CARD OR PAPER.**

**SIZE 19 in x 13 in (474 mm x 346 mm)**
HIGH ACCURACY, PERFORMANCE, RELIABILITY AT A LOW PRICE. THE HFCC-60 HIGH FREQUENCY COUNTER IS BASED ON THE VERY LATEST LSI TECHNOLOGY.

- HIGH PERFORMANCE
- RELIABILITY
- LOW PRICE

DELIVERY ON REQUEST

NEED A METER? CALL US NOW ON...)

ORME SCIENTIFIC LIMITED
P.O. Box 3
Station Road Industrial Estate
Middlesex
Tel: 01-622-9133/5, 6
Telex:669846

For only 75c + VAT
SOFT CARRYING CASE £7 extra

Price £25

Even more sophisticated is the Fluke 520A

A hand-held self-carrying case is included (this model only)

Price £45.00

Special quotations on quantities

UNIVERSAL INSTRUMENTS
are now main distributors for FLUKE

digital multi-meters

IN STOCK NOW:

UNIVERSAL INSTRUMENTS
Large Range of Fluke Multi-Meters

FREE COPY OF OUR 20 PAGE CATALOGUE

WIRELESS WORLD MARCH 1981

WWW.90 FOR FURTHER DETAILS

LOW COST, AUTORANGING MULTI-FUNCTION COUNTER

MODELS 1960A

- AUTOMATIC MEASUREMENT CAMERAS
- HIGH PRECISION
- DIGITAL DISPLAY
- backlit display
- LOW COST

Prices

1960A £250
1961A £325
1962A £425

UNIVERSAL INSTRUMENTS are now main distributors for FLUKE

digital multi-meters

Do you Have All These Facilities On your own System, With Just Two Boards?

1. 20DA CPU-2 or 4 MHz
2. 20DA C1-1 or 8 Channels
3. 20DA C1-2 or 16 Channels
4. 20DA C10
5. Task controller: take up to 4 disk drives, single or double drives operation
6. 666 RAM or memory
7. 6660 Programmed
8. Real time clock
9. Software
10. Universal Instrument CP/M Cold Start Loader

Prices

CP/ M £125.00

MICROCOMPUTER - HARDWARE - SOFTWARE

SEMEL

3c Barley Market Street, Taunton, Devon PL19 OJF
Tel. Taunton (0822) 5247. Telex: 45263

WWW.90 FOR FURTHER DETAILS
ENTRANCE TO THE EXHIBITION IS BY REGISTRATION ON A TICKET WHICH IS *FREE IF OBTAINED IN ADVANCE OR 220 BFr IF OBTAINED AT THE DOOR.

For your *FREE advance tickets write to:—
Compec Europe Tickets
IPC Exhibitions Ltd Surrey House
1 Throwley Way Sutton Surrey SM1 4QO

*Please note applications received after April 6 cannot be accepted.
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 PHF (or equivalent) 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 £9,000 to £12,000 per 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 the opportunity to live in a stimulating environment.

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, GT Yarmouth, Norfolk NR31 0JB Telephone 04935 58541

EAE Limited

AN OPPORTUNITY IN ELECTRONICS

A vacancy exists in the Electronics Section of the above International Company situated in North West England. The position is a challenging one in the design, development and manufacture of a wide range of Radio and Communications based equipment.

Experience with both digital and analogue circuits is a very real asset.

The appointment may be made to a Senior Technician for the person with the appropriate skill and experience. Minimum academic qualifications are G.C.E. Ordinary Level or equivalent, but O.N.C. or B.Eng. in Electronics or an Allied subject would normally be expected. For further details, please either write to the above address or apply, with full details of previous work experience and qualifications, to: Mr. R. H. Jones, Personnel Officer, EAE Limited, Offshore House, 284/285 Southtown Road, GT Yarmouth, Norfolk NR31 0JB. Telephone 04935 58541

— have you a background of

BROADCASTING VIDEO ENGINEERING?

are you thoroughly at home with

DIGITAL AND MICROPROCESSOR TECHNIQUES?

— have you considered the benefits to you and your family, of a rural environment within easy reach of London, with first-class schools and other sporting opportunities?

— could you get involved with a young successful company already in the growth?

Screen Electronics have established substantial international sales in advanced character generators and graphics display products and are now looking for a

DESIGN AND DEVELOPMENT ENGINEER

with ideas and flair to help them produce the next generation.

Please write with an outline of your career, or phone for an application form if you prefer. Assistance with relocation and a salary appropriate to your experience would be negotiable.

SCREEN ELECTRONICS LTD.
19 Avon Road, Marple Bridge, Stockport SK4 3HR
Tel. (061) 622748
Electronic Engineers — What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior-Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £20000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you. All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL PERSONNEL SERVICES, 12 Mount Ephraim, Tunbridge Wells, Kent. TN4 8AS.

Tel: 0892 39358

Please send me a TJB Appointments Registration form.

Name: __________________________________________________________

Address: _________________________________________________________

Appointments

Wireless World March 1981

CANTERBURY & THAMEST HEALTII DISTRICT KENT & CANTERBURY HOSPITAL

ELECTRONIC AND BIO-MEDICAL ENGINEERING TECHNICIAN

GRADE III

for the maintenance of electronic and associated equipment. 25 hours 5-day week. Salary scale £2200-£6300 p.a.

Further details and application form from: Director Engineer, 5 Royal Crescent, Ramsgate, Kent (Tel/TH 45373). Closing date: March 81.

Digital Experience? Field, support and production, vacancies in computers, N.C. medical, medical, video, etc.

Free for registration.

01-464 7714 ext. 502 24 hours

Logex

Electronics Recruitment Service

Teachers, Lecturers, Engineers, Science

The Commissioner of Northern Lighthouses

Take your pick

HF-VHF-UHF—Microwave Optics & Acoustics

A challenging and full career in Government Service. Minimum qualification — HNC. Starting salary up to £7,999. Please apply for an application form to the Recruitment Officer (Dept. WW 3/81), H.M. Government Communications Centre, Hanslope Park, Milton Keynes MK19 7BH.

Assistant Radio Engineer

The post is based in Edinburgh but entails some travelling throughout Scotland and the Isle of Man including offshore and distant islands.

Applicants, who should be under 35 years of age, must be Chartered Engineers and corporate members of the Institution of Electrical Engineers, Institution of Radio and Electronic Engineers or have passed examinations necessary for attaining such membership together with relevant experience.

The Assistant Radio Engineer will assist senior engineers and be involved in the acceptance, installation and maintenance of equipment including VHF links, radio beacons, radar beacons, remote control and monitoring and shipboard navigational aids.

Salary scale from £7000 per annum rising to £8100 by annual increments with placing according to qualifications and experience. 4 weeks’ 2 days’ paid annual leave on commencement rising to 6 weeks by service related increments, plus 11 days’ Bank/public holidays. Sick pay and non-contributory pension scheme to Civil Service.

Assistance with certain removal expenses may be payable.

For application form and further particulars please write to the Personal Officer, Northern Lighthouse Board, 64 George Street, Edinburgh EH2 3DA.

The University of Surrey

Electronics Technician

Salary £6020-£7191

An Electronics Technician Grade 6 is required to run the Department of Chemistry’s electronics workshop. Duties include development, construction and application of electronic equipment for research and teaching purposes. Modification, maintenance and repair including fault diagnosis, testing and calibration of such equipment. Teaching and demonstration of a range of electronic equipment including basic electronic/electrical equipment, electronic circuits and systems, computer and microprocessor equipment, etc. Training and construction of microprocessing equipment; for research and analytical systems.

For an informal visit and further information ring Dennis Ashby on Guildford 75218. Alternatively write to the University of Surrey, Guildford GU2 5XX, quoting reference (UW).

Further reading

Foreign and Commonwealth Office

University of Surrey

Assistant Radio Engineer

The Commissioner of Northern Lighthouses
The Art of Electronics
P. HOROWITZ and W. HILL

This is a text/reference book that emphasizes circuit design techniques and scientific measurements. It begins at a level suitable for those with no previous exposure to electronics and takes the reader to a fairly sophisticated level of design proficiency, emphasizing the techniques used in the design and analysis of electronic circuits. It focuses on simplicity and practicality, and there are numerous design examples with particular reference to the choice of circuit configurations and components.

Hardcovers £35.00 net Paperback £12.50 net

CAMBRIDGE UNIVERSITY PRESS

ARTICLES FOR SALE

The Art of Electronics
P. HOROWITZ and W. HILL

This is a text/reference book that emphasizes circuit design techniques and scientific measurements. It begins at a level suitable for those with no previous exposure to electronics and takes the reader to a fairly sophisticated level of design proficiency, emphasizing the techniques used in the design and analysis of electronic circuits. It focuses on simplicity and practicality, and there are numerous design examples with particular reference to the choice of circuit configurations and components.

Hardcovers £35.00 net Paperback £12.50 net

CAMBRIDGE UNIVERSITY PRESS

ARTICLES FOR SALE

The Art of Electronics
P. HOROWITZ and W. HILL

This is a text/reference book that emphasizes circuit design techniques and scientific measurements. It begins at a level suitable for those with no previous exposure to electronics and takes the reader to a fairly sophisticated level of design proficiency, emphasizing the techniques used in the design and analysis of electronic circuits. It focuses on simplicity and practicality, and there are numerous design examples with particular reference to the choice of circuit configurations and components.

Hardcovers £35.00 net Paperback £12.50 net

CAMBRIDGE UNIVERSITY PRESS
**Products that help you make a better job of it.**

**Arax Multicore Solder.**
Economy pack for general non-electrical use. Replaces solid wire and stick solder (BS 219 Grade L).

- **Econo pak** 200g reel of 1.2mm dia. Size 16A. £4.14 per reel.

**Toolbox Reels.**
Multicore 5-core solder for general use. Suitable for electrical joints (BS 219 Grade C).

- 40/60 tin/lead, 1.6mm dia. Size 3. £3.91 per reel.

**Multicore Wick.**
Multicore solder-wick for removing solder from virtually any joint.

- 1.2mm dia. Size 12. £3.91 per reel.

**Aluminium Soldering.**
Arax Multicore 4-core solder for soldering most types of aluminium. No extra flux needed.

- 1.6mm dia. Size 4. £6.90 per reel.

**Handy Dispensers.**

- **PC115** for printed circuits. £1.15 per pack.
- **SV130** for radio and TV repairs. £1.61 per pack.
- **AR140** for non-electrical applications, except aluminium. £1.38 per pack.
- **SS160** for stainless steel and silver soldering. £2.53 per pack.
- **19A** for all electronic joints. £9.93 per pack.
- **AL150** for aluminium. £1.93 per pack.
- **BCA16** for stainless steel, jewellery and house hold products (non-electrical). £3.22 per pack.
- **BCR10** for multicoresoldering. £1.38 per pack.
- **BCA14** for non-electrical jointing. £1.38 per pack.

**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.

- **Rostin R.F.10, 35g net.** 69p per pack.
- **Multicore soldering flux paste for soft metals (except aluminium) and stainless steel. Non-electrical.** Arax A.F14, 35g, 69p per pack.

**Wire Stripper and cutter.**
Wire stripper and cutter with precision ground and hardened steel jaws. Adjustable to most wire sizes.

- Ref. 9: £3.69 per pair.

**TV and Radio Soldering.**
Savbit Multicore for radio, TV and similar work. Reduces copper erosion.

- 1.2mm dia. Size 13A. £4.14 per reel.

**Econo pak.**
Arax Multicore 5-core solder. Contains corrosive flux for electrical applications.

- 1.2mm dia. 200g Econo pak. 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.

**Bib Hi-Fi Accessories Ltd.**
Solder Division, Kelsey House, Wood Lane End, Hemel Hempstead, Hertfordshire HP2 4RQ.

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.