Microcomputer survey

Heating energy saver

Robot control
THE D RANGE . . .

• Digital meters
• 1mA resolution of current
• 10 turn voltage control
• Measure external voltages
• Output on/off switch
• CV or CI operation

Four models:
- D30-2  0-30 volts at 2 amps single
- D30-2T  0-30 volts at 2 amps twin
- D30-4  0-30 volts at 4 amps single
- D100-1  0-100 volts at 1 amp single

Send for new colour leaflet now to:
FARNELL INSTRUMENTS LIMITED - SANDBECK WAY, WETHERBY - WEST YORKSHIRE LS22 4DH
TEL. (0937) 61961  TELEX 557294 OR HARPENDEN TEL. (09527) 66123

NEXT MONTH

Digitally controlled x-y plotter uses curtain rails and bicycle bearings to provide accurate drawings from computer software. Behind the Micro continues our microcomputer survey, looking at standard interfaces for connection to the outside world. Signal generator for the home workshop covers 6 to 30MHz in five bands, featuring constant-amplitude i.e. oscillator, facilities for external or internal modulation, and a calibrated attenuator. Sampling-frequency meter based on 6805 microprocessor samples inputs repetitively and builds up distribution of maximum or average values in 21 memory channels.

Send for new colour leaflet now to:
FARNELL INSTRUMENTS LIMITED - SANDBECK WAY, WETHERBY - WEST YORKSHIRE LS22 4DH
TEL. (0937) 61961  TELEX 557294 OR HARPENDEN TEL. (09527) 66123

FARNELL INSTRUMENTS LIMITED - SANDBECK WAY, WETHERBY - WEST YORKSHIRE LS22 4DH
TEL. (0937) 61961  TELEX 557294 OR HARPENDEN TEL. (09527) 66123
**COMPUTER WAREHOUSE**

**'THE ALADDIN'S CAVES OF COMPUTER AND ELECTRONIC EQUIPMENT'**

![Image of computer equipment]

**HARD DISK DRIVES**

- **IBM** 5317 £375.00
- **IBM** 5318 £400.00
- **IBM** 5319 £450.00
- **IBM** 5320 £500.00
- **IBM** 5321 £550.00
- **IBM** 5322 £600.00

**SOFTWARE AND WORKING CONDITIONS WITH DATA PERMISSION**

Join the communications revolution with our

£6.25 or 110 volts at £4.95 or BRAND NEW 240 volts very quiet running 240 volts operation. NEW £6.95 with our range of EXTELECOM data modem. Made to ETRI 99XU01 Dim. 92 x 92 x 25 mm.

**COOLING FANS**

- **Cooling fans** £110.00
- **Cooling fans** £125.00

**MAIN FILTERS**

- **Main filters** £175.00

**COOLING FANS**

- **Cooling fans** £110.00
- **Cooling fans** £125.00

**MAIN FILTERS**

- **Main filters** £175.00

**BRADE NEW CASSETTE WORD PROCESSOR KEYBOARDS**

- **New cassette word processor keyboards** £99.99

**DRE 7100 8" Disk Drives**

New 8" disk drives £99.99 + VAT.

**DRE 7000 8" Disk Drives**

New 8" disk drives £125.00 + VAT.

**VIDEO MONITORS**

Designed for continuous duty in a digital or microcomputer system. Off-brightness and contrast controls are available. All monitors are individually calibrated for brightness and contrast. All monitors are available in a range of formats, including 2016, 2532 variety.

**MICRONET**

- **Micronet** £99.99
- **Micronet** £110.00

**3 NEW SOFTWARE PRODUCTS**

- **3 new software products** £42.95

**SELECTION OF SPECIAL OFFERS**

- **Selection of special offers**

**THERMAL BRAZER TRANSFORMER**

- **Thermal brazer transformer** £95.00

**POCKET RADIATION DETECTORS**

- **Pocket radiation detectors** £25.95

**DECORATOR'S TROJAN**

- **Decorator's trojan** £25.99

**MEMORICA 3000**

- **Memorica 3000** £25.99

**MANUFACTURED CATALOGUE**

- **Manufactured catalogue** £25.99

**PAPER CARDS**

- **Paper cards** £25.99

**PERFECT LASER CARDS**

- **Perfect laser cards** £25.99

**ALL PRICES PLUS VAT**

- **All prices plus VAT**

**DISPLAY ELECTRONICS**

32 Biggin Way, Upper Norwood, London SE19 3XF
Telephone 01-679 6418 Tele 27922

**HEINNY'S AUDIO ELECTRONICS**

- **Audio electronics**

**DIGITAL MULTIMETERS**

- **Digital multimeters**

**FREQUENCY COUNTERS**

- **Frequency counters**

**SIGNAL GENERATORS**

- **Signal generators**

**MULTIMETERS**

- **Multimeters**

**OSCILLOSCOPES**

- **Oscilloscopes**

**VARIABLE POWER SUPPLIES**

- **Variable power supplies**

**HIGH VOLTAGE METERS**

- **High voltage meters**

**FREE CATALOGUES**

- **Free catalogues**

WIRELESS WORLD DECEMBER 1983
NEW: an exciting range of projects to build on the EXP300 breadboards.

NOW anybody can build electronics projects; it's as easy as A.B.C. with G.S.C.!

EXPERIMENTER BREADBOARDS

The largest range of breadboards from G.S.C. Each hole is identified by a red and white number system. Each nickel silver contact carries a life time guarantee. Any experimenter breadboard can be 'snap locked' to others to build a breadboard of any size.

1. EXP 325 £2.00 The ideal breadboard for 1 chip, or 2 via flip up. It has 16 point binding including two 10 point bus bars.
2. EXP 350 £2.50 £2.50 Excellent for wiring with up to 40 pin IC's. Perfect for 5.1 14 pin DIPs has 770 contacts including two 20 point bus bars.
3. EXP 360 £6.00 The widest range bought individually. With 120 pins, it can house an entire microcomputer. Has a variety of buses, solder lugs, and test points.
4. EXP 400 £12.00 Use this breadboard with Adafruit in Microcircuits.
5. EXP 650 £2.25 Has 6 centre positions on a perfect for MICROPROCESSOR applications.
6. EXP 650 £2.80 Has two new faces in 'snap on' style.

PROTO-BOARDS

The ultimate in breadboards for the most complex two neatly assembled bits.
1. PROTO-BOARD 150 KIT £1.95 50 contacts, four 5-way binding posts up to 5 14-pin DIPs.
2. PROTO-BOARD 150 KIT Complete with 700 contacts, sockets and sockets, four 5-way binding posts up to 5 14-pin DIPs.

For further details of our full PROTO-BOARD RANGE, please send for our free catalogue.

GLOBAL SPECIALITIES CORPORATION

G.S.C. (UK) Ltd. Dept. 7B
Unit 1, Shire Hill Industrial Estate, Saltford Weston, Bristol BS11 3AQ
Telephone: Saltford Weston (0799) 21682

Free project:

AUTO-DICE

A handheld game with this sophisticated electronic dice circuit when the 'throw' switch is pressed, a numerical display appears on readily changing numbers. After a few seconds, the 'roll and stop' display is shown. After a few seconds, the final result is displayed any number, randomly selected from 1 to 6. A few seconds later the display turns off to conserve your battery, letting the games go on uninterrupted forever.

HOW DO YOU MAKE IT?

A simple circuit and project to create for you a large, clear diagram of the components layed out on an EXP 300 breadboard. Each component is labelled, and the values are given in a component list. Even the 'how and column' lettering of our EXP 300 is shown to make the location of the correct holes, in which to push the components, easy to read. There's no soldering involved; it couldn't be easier! As an extra bonus, there's a full circuit description, and the details of a regulated power supply on the other side of the sheet.

"Clip the coupon" and get your FREE project sheet with each EXP 300 bought AND a free catalogue! Just ask about our other free projects too.

G.S.C. S.U.K. Limited, Dept. 7B, Unit 1, Shire Hill Industrial Estate, Saltford Weston, Bristol BS11 3AQ. Prices include P.P. and 15% VAT.

<table>
<thead>
<tr>
<th>1 Qty</th>
<th>2 Qty</th>
<th>3 Qty</th>
<th>4 Qty</th>
<th>5 Qty</th>
<th>6 Qty</th>
<th>7 Qty</th>
<th>8 Qty</th>
<th>9 Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>£3.19</td>
<td>£4.69</td>
<td>£5.00</td>
<td>£5.39</td>
<td>£5.79</td>
<td>£6.19</td>
<td>£6.59</td>
<td>£6.99</td>
<td>£7.39</td>
</tr>
</tbody>
</table>

G.S.C. (UK) Ltd., Dept. 7B, Unit 5, Shire Hill Industrial Estate, Saltford Weston, Westbury, Bristol BS11 3AQ.
Get started in Fibre Optics

... with our new fibre optic experimental kit.

Features include:
- 0-10Mbit/s (NFZ) guaranteed to 15m with Polymer Cable. (Can be extended by using a glass fibre).
- TTL Compatible.
- No tools required to terminate cable.
- Fully tested and includes:
  - Complete with transmitter, receiver connectors and 5m of Polymer Cable.
  - Also a full range of components for glass systems available.

Electrooptic Ltd.
Hayward House, Northcote, West Sussex, GU28 9HL.
Tel: (042 878) 611/2. Telex: 858966.

WIRELESS WORLD DECEMBER 1983

WWW - 041 FOR FURTHER DETAILS

The Connection Collection

- Video Mux-BNC. Mini-Quick Probe, Loop or Muxa Monitoring Points.
- Comprehensive Range of Audio & Video / Audio Combinations.
- Earth Free.
- Audio & Video Patch Cords.

Brabury Limited

5 Bute Lane, Newbury, Berks RG14 1PG, England.
Tel: (0635) 33433/848 7460 BRABURY

WWW - 042 FOR FURTHER DETAILS

TOROIDALS

The toroidal transformer is now accepted as the standard in industry, offering the following advantages compared to other types. Industry has been able to recognize the advantages primarily offered in size, weight, lower-reluctance field, and, therein to I.L.F., PRICE

Our large standard range is complemented by our SPECIAL DESIGN service which can cater for specific needs within 7 days if equipped with a short lead time on quantity orders which can be programmed in your requirement with no price penalty.

WWW - 052 FOR FURTHER DETAILS

NEW PHASE-MODULATION SYSTEMS

- Until recently, atomic time and data information was only available on I.S. transmissions using amplitude modulation. The RCI 800AM series of equipment uses these transmissions to offer high noise immunity and high accuracy, particularly at very long range. The new RCI 800FM series of equipment, for the first time, replaces the amplitude-modulated power of up to 2 Megawatts to offer long range, excellent noise immunity and no scheduled maintenance periods.

WWW - 044 FOR FURTHER DETAILS

NEW OPTIONS

A continuously expanding range of fully integrated software and hardware for all series of Radiocode Clock equipment. Standard options now include:
- Time code generators
- Intensity decoder, interpreter, controller
- Time code decoder
- Standard frequency output
- Stopclock operation
- Calculated systems for increased accuracy

WWW - 045 FOR FURTHER DETAILS

WWW - 102 FOR FURTHER DETAILS
The new microprocessor controlled EP8000 Emulator Programmer will program and emulate all EPROMs up to 8k x 8 sizes, and can be extended to program other devices such as 16k x 8 EPROMs, Bipolar PROMs, single chip microprocessors with external modules.

Personality cards and hardware changes are not required as the machine configures itself for the different devices. The EP4000 with 4k x 8 static RAM is still available with EPROM programming and emulation capacity up to 4k x 8 sizes.

**FEATURES**
- Software personality programming/emulation of all EPROMs up to 8k x 8 bytes including 2704, 2706, 2716(3), 2608, 2764, 2768, 2516, 2716, 27C16, 2532, 2732, 27C32, 2732A, 68732-0, 68732-1, 68766, 68764, 2564, 2764, 27C64. Programs 25128, 27128 with adaptors.
- No personality cards/characterisers required.
- Uses as stand alone programmer, slave programmer, or EPROM development system.
- Checks for misplaced and reversed insertion, and shorts on data lines.
- Memory mapped video output allows full use of powerful editing facilities.
- Built-in LED display for field use.
- Powerful editing facilities include: Block/Byte move, insert, delete, match, highlight, etc.
- Comprehensive input/output — RS232C serial port, parallel port, cassette, printer, O/P, DMA.
- Extra 1k x 8 scratchpad RAM for block moving.

**FROM STOCK**
- Checks, Programs, Compares up to 8 devices simultaneously
- Handles all EPROMs up to 128K with no personality modules or characterisers — See list
- Easy to use, menu driven operation for blankcheck, program, verify, illegal bit check, checksum, self-test
- Constant display of device type, mode and fault codings
- Individual socket LED indicators for EPROM status
- Comprehensive EPROM integrity checks — Illegal bit check, data and address shorts, constant power line monitoring
- Full safeguard protection on all sockets
- Automatic machine self-test routine
- RS232C interface supplied as standard
- Powered down sockets
- Cost effective price — £695 + VAT
- Available from stock

**DISTRIBUTORS REQUIRED**

**GP Industrial Electronics Ltd.**

Tel: Plymouth (0752) 332961
Telex: 42513

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

Write or phone for more details

**DISTRIBUTORS REQUIRED**

**GP Industrial Electronics Ltd.**

Tel: Plymouth (0752) 332961
Telex: 42513

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

**WIRELESS WORLD DECEMBER 1983**

WW - 917 FOR FURTHER DETAILS
FULL ORDERED DURING NOVEMBER on EURO CUBE, provides an environment in which languages are best for form, with 4 KB RAM fitted for workspace, a BBC BASIC category with the entire range of CUBE/Acorn cards.

BEEBEX, serial interface, in addition to any other cards connected to the CUBE expansion bus.

- A C I A provides a bidirectional RS-232/423/422 serial port.
- Dual CPU clock mode-2 Mhz for memory, 1 Mhz for I/O, I/O, PROM programming, disks, etc.
- Memory sockets, each 28 pin. Supports RAM, ROM, EPROM-from 2K to 32K each.
- Battery Backup for OSRAM.
- Dual CPU clock mode-2 Mhz for memory, 1 Mhz for I/O.
- I/O provides 32 digital I/O channels.
- ACIA provides a teedirectional RS-232/423/422 metal port.
- On-board programmable baud rate generator.
- PROM address decoder.
- Modulate Operating System includes time of charge.

EuroCUBE - EuroCUBE with BASIC. The MOS included on EuroCUBE provides an environment in which languages can be run, and is available in a two main versions.

MO5 A - supports ATOM BASIC

MO5 B - supports BBC BASIC

EuroCUBE fitted with MO5 B can run BBC BASIC. In its amplified form, with 4238 RAM fitted for most space, a BBC BASIC program in EPROM could control the two-bit ports and the world interface, in addition to any other cards connected to the CUBE expansion bus.

BEETEX, another recent addition to the CUBE range, is a simple, low-cost EuroCUBE which integrates the MOS bus connection on the CUBE Microcomputer, enabling it to communicate with the entire range of CUBE/Adcom Eurocards.

FREE CASE with each Digital Meter ordered during November

ARLOW ELECTRONICS LTD.
Cottrell House, 53-63 Wembley Hill Road
Wembley, Middlesex HA9 1HR, England

For easy of construction we recommend the use of modules HILP-1412, C13, VTA, and the use of blocks C13-PDL/0916, 1239, 2/4, VAT.

AMPLIFIERS

WE'RE INSTRUMENTAL IN MAKING A LOT OF POWER

In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimised for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology, ILP are recognised as world leaders.

STEROE STABILIZER

- Rack mounting frequency shifter for howl reduction in public address and sound reinforcement
- Mono version and box types also available

SURREY ELECTRONICS, The Forge, Luck's Green Cranleigh, Surrey GU6 7BG Telephone: 0483 270907

Over the last few years we have received feedback via the general public and industry that our products are from Taiwan, Singapore, Japan, etc... ILP are one of the few All British electronics companies manufacturing their own products in the United Kingdom. We have proved that we can compete in the world market during the past 12 years and currently export in excess of 65% of our production to over twenty different countries - including USA, Australia and Hong Kong. At the same time we are able to invest in research and development for the future, ensuring security for the personnel, directly and indirectly, employed within the UK. We feel very proud of all this and hope you can reap some of our success.

I. L. Peets - Chairman

ILP Electronics Ltd.
Graham Bell House, Roper Close Canterbury CT2 7EP, Kent, England Telephone: (0227) 54778. Telex: 965780
**SAREL'S 8000 SERIES SET THE STANDARD**

- Protects against ingress of dust and liquids IP55 (BS5490 1977, IEC 529 1976).
- 1.5 and 1.75mm steel bodies and 2mm steel doors.
- Smaller sizes fitted with advanced polyurethane gaskets. Larger sizes (600 × 600 and above) fitted with neoprene gaskets.
- Wide range of chassis systems including plates DIN rail, selfquick and gland plates.
- Standard finish is textured beige polyester powder paint.
- Glazed doors — wide choice from stock.

**E. A. Sowter Ltd.**

Manufacturers and Importers

E. A. Sowter Ltd. (Established 1941), Raynham Rd, England 35256


P.O. Box 118, Ipswich, Suffolk, England

Telephone: 0473 62794 and 621939

Telex 097705 Sowter

6FT. PARABOLIC DISHES

FROM ONLY £85 PLUS VAT.

**HBED**

6ft. dia. dishes, feed horns and electronics for use in 4GHz satellite reception. GaAs Fet transistors, SMA connectors, P.T.F.E., etc. available.

Please send s.a.e. for full details and data sheets.

Harrison Bros.

Electronic Distributions

22 Milton Road, Westcliff-on-Sea, Essex SS0 7JX

Tel. Southend (0702) 332338

WW - 013 FOR FURTHER DETAILS

---

**Until now, finding out about home computers was about as simple as**

focusing your right eye here and your left eye here.

---

**WIRELESS WORLD DECEMBER 1983**

---

**WIRELESS WORLD DECEMBER 1983**
**FLOPPY DISC INTERFACE**

- **Floppy Disc Interface** £95 & £15 installation

**BBC COMPATIBLE DISC DRIVES**

All drives are supplied with necessary cables

- Single Drive without PSU: 100k £15; 200k £21; 400k £25; 800k £30
- Single Drive with PSU: 100k £180; 200k £200; 400k £230; 800k £280
- Dual Drives with PSU: 2x100k £205; 2x200k £305; 2x400k £390

**These drives are switchable 40/80 drives**

40/80 Switch Module for £1 x400k and £2x400k Drive £32

**DISKETTE**

- 40 track £12; 80 track SSD £22
- 80 track SSD £26

**BBC FLOPPICENE DRIVE HEAD**

Cleaning kit with 50 disposable discs £17

---

**TWO PORT SWING**

- £18

**SWITCHES**

- £7.50

**SWITCHES**

- £9

---

**PLUGS & SOCKETS**

- **Paraflex** 32p
- **Centronics** £1.25
- **110V** £1.25
- **240V** £1.25
- **USB** £1.25

---

**BASIC EPROM PROGRAMMER**

- A fully self contained EPROM programmer with its own power supply, able to programme 27C256/27C64 family of EPROMs.
- Provides theiring level output at the programmer's output pins.
- Preprogramming is possible for existing EPROMs.
- Fully automatic and completely set up.
- Programmers come in a portable case for easy transportation.
- Can be used with all major microprocessors.

---

**BOOKS**

- Accessory & Plug Out Fugure and Show
- BBC Micro... Programming and Projects

---

**EVASERS**

- **150p**
- **50p**
- **25p**

---

**SPECIAL OFFER**

**BCP**

- **£15**
- **£10**
- **£5**

---

**GENEROUS**

- **£1800**
- **£1000**
- **£500**

---

**SOFTSHELLS**

- **£15**
- **£10**
- **£5**

---

**WIRELESS WORLD DECEMBER 1983**
The AMAZING LANE ELECTRONICS

PLANAR CABLE PRICE LIST

<table>
<thead>
<tr>
<th>GREY</th>
<th>COLOUR CODED</th>
<th>PRICE LIST</th>
<th>APPROX WT.</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PART NO.</td>
<td>CONDUCTORS</td>
<td>NO.</td>
<td>PRICE PER 100' FT.</td>
<td>WT.</td>
</tr>
<tr>
<td>454-240-9</td>
<td>10</td>
<td>0</td>
<td>7.15</td>
<td>0.75</td>
</tr>
<tr>
<td>454-240-10</td>
<td>10</td>
<td>0</td>
<td>7.15</td>
<td>0.75</td>
</tr>
<tr>
<td>454-240-16</td>
<td>16</td>
<td>0</td>
<td>9.02</td>
<td>1.10</td>
</tr>
<tr>
<td>454-240-25</td>
<td>25</td>
<td>0</td>
<td>13.98</td>
<td>1.40</td>
</tr>
<tr>
<td>454-240-50</td>
<td>50</td>
<td>0</td>
<td>20.98</td>
<td>1.80</td>
</tr>
<tr>
<td>454-240-100</td>
<td>100</td>
<td>0</td>
<td>28.98</td>
<td>2.20</td>
</tr>
<tr>
<td>454-240-200</td>
<td>200</td>
<td>0</td>
<td>42.98</td>
<td>2.70</td>
</tr>
</tbody>
</table>

STEERING WHEELS

<table>
<thead>
<tr>
<th>GREY</th>
<th>COLOUR CODED</th>
<th>PRICE LIST</th>
<th>APPROX WT.</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PART NO.</td>
<td>CONDUCTORS</td>
<td>NO.</td>
<td>PRICE PER 100' FT.</td>
<td>WT.</td>
</tr>
<tr>
<td>454-240-9</td>
<td>10</td>
<td>0</td>
<td>7.15</td>
<td>0.75</td>
</tr>
<tr>
<td>454-240-10</td>
<td>10</td>
<td>0</td>
<td>7.15</td>
<td>0.75</td>
</tr>
<tr>
<td>454-240-16</td>
<td>16</td>
<td>0</td>
<td>9.02</td>
<td>1.10</td>
</tr>
<tr>
<td>454-240-25</td>
<td>25</td>
<td>0</td>
<td>13.98</td>
<td>1.40</td>
</tr>
<tr>
<td>454-240-50</td>
<td>50</td>
<td>0</td>
<td>20.98</td>
<td>1.80</td>
</tr>
<tr>
<td>454-240-100</td>
<td>100</td>
<td>0</td>
<td>28.98</td>
<td>2.20</td>
</tr>
<tr>
<td>454-240-200</td>
<td>200</td>
<td>0</td>
<td>42.98</td>
<td>2.70</td>
</tr>
</tbody>
</table>

KEEP THIS PRICE LIST
SAVE MONEY ON CABLE

Beware of imitators, who appear competitive, until you include carriage & packing charges.

Lane Electronics Ltd.,
Flat 34, 123 High Street, Weymouth, Dorset, DT4 1SR.
Tel: (0202) 790911 Fax: 877502

Why Pay More?

Discounts Available

- 30% discount on 100' rolls. (Min. 100' rolls)
- 50% discount on 1000' rolls. (Min. 1000' rolls)
- 75% discount on 5000' rolls. (Min. 5000' rolls)
- Additional discounts for bulk orders. (Min. 1000' rolls)

Cable & Packing

- Cable is supplied in standard 100' rolls. (Min. 100' rolls)
- Additional cables can be supplied on request. (Min. 1000' rolls)
- Standard packing includes 100' rolls. (Min. 1000' rolls)
- Additional packing can be supplied on request. (Min. 5000' rolls)

For further details, please contact Lane Electronics Ltd.

18 WIRELESS WORLD DECEMBER 1983

hi! reliability service hi! quality service hi!

CS 1060
dual timebase 60MHz

- 1 mV/cm sensitivity - 5 nsec sweep speed
- 6 inch, rectangular CRT, 12KV
- 3 channel, 6 trace capability
- Delayed Sweep
- Light, Compact, Easy to Use
- FULL 2 YEAR GUARANTEE

House of Instruments
Clifton Chambers, 62 High Street, Saltsfield, Weymouth, DT4 1EE
Tel: (0202) 444222 Tele: 829792

TRIO hi! competitive price hi! House of Instruments Ltd.

WIRELESS WORLD DECEMBER 1983

- 042 FOR FURTHER DETAILS
E.M.S. POWER SYSTEMS

Solve all your Power Problems by contacting E.M.S.
E.M.S. specialise in systems to eliminate your power problems.
Products range from 35VA switched square wave Power Packs to 1kVA fully uninterruptible sine wave systems.
E.M.S. also manufacture chargers which range up to 60 amps.

For further details please contact:

E.M.S. Manufacturing Limited
Chairborough Road
High Wycombe
Bucks
Tel: (0494) 448484

WW - 411 FOR FURTHER DETAILS

£180: A RECORD FOR DISC DRIVES?

Opus are able to offer a limited quantity of 3¾" Slimline Double Sided 40 Track Drives. Formatted single density 200K, density 400K.

And record value at only £179.95 and that includes everything - VAT, carriage and all necessary leads.

You can order by post (see coupon below) or direct at our showroom.

WW - 203 FOR FURTHER DETAILS
An engineer's motivation is, if nothing else, to innovate. Given his head and an unlimited supply of money and facilities, a good engineer is happy to spend his time producing designs for new equipment that either demonstrate his skill in circuitry, or perform their function with a greater finesse, or both — the two not necessarily going hand in hand. The job satisfaction is present, whatever the eventual purpose of the product, in the design process.

Taking a wider view is the manager and, such is the effect of technology, the politician, whose brief is to formulate policy after taking advice from those who are experts and who will carry out the development policy.

These two fields of activity currently appear to exist almost separately: the engineer and the politician pursue their interests with no great awareness of larger problems. Advice from a committed engineer is inevitably biased — he must take a positive view of his project, or it would never reach a satisfactory conclusion, so that it is reasonable to expect that the only guidance supplied by engineers to policy makers will be favourable to continued development of any given project. Politicians are not, in the main, technically competent, and it must be only too easy for them to be seduced by technologists, with their promises of magical new developments.

Although engineering itself cannot be accused of possessing the attributes of either good or evil 'inten', events of the last few years have shown that it can produce results that are extremely difficult to forecast. There may be unexpected side-effects; a failure may cause knock-on effects that would only have been foreseen by a great deal of research; people's health might suffer; all by the application of 'innocent' technology in response to market pressure or to the excited lobbying of technologists who have discovered another solution to a demand which has yet to be created.

Recent history illustrates all this profusely: Three Mile Island, Seveso, oil spillage, nuclear waste protestations, pollution, asbestos, the aerosol fluorocarbon scare, and the most devastating of all — the possibly fatal development of nuclear weapons from an innocent enquiry into the structure of the atom.

In the US, there is the Technology Assessment Act of 1972, which is intended to provide the information needed by Congress to formulate policy. In the 11 years since it was enacted, it is not clear what effect it has had on US technology, but at least the problem is perceived. In the UK, Government still gives the impression of naively embracing all that technology has to offer, with never a second thought of unlooked-for effects on society. Its belated fascination with technology shows little sign of any concern about the possible ancillary effects of its wholesale adoption.

Ideally, there should be an international technology assessment organisation, which would receive information from engineers on what is possible, and from social scientists on the probable results of applying the possible and would then reach a consensus on how to avoid disaster: technology will not be unknown, so there will never be a way of suppressing it for ever, even if that were desirable.
The decision by the Ministry of Defence to place a substantial order for a military version of MEL's "Call" vehicle transceiver brings back both third-method s.s.b. generation/demodulation and direct-conversion techniques to the forefront of the communications scene. D. C. Weaver first described his innovative "third method of generation and detection of s.s.b. signals" as long ago as December 1956 in the Transistor...也不错，in one issue on the same side. In the same issue J. P. Comsa drew attention to the value of direct-conversion, but then transceivers for synchronous communications.

but the first two s.s.b. methods — the first by a conventional h.f. amplifier were more generally accepted, and in recent years the filter approach has been almost universally employed. A fourth method, based on phased networks and developed by M. J. Gingell of STL, has similarly never found wide use, although all four approaches have been used by police transceivers. The popular filter method requires a fixed i.f. and cannot be used in direct-conversion or direct-generation equipment. In 1981, W. A. Painter, describing the MEL Callpac s.s.b. transmitter, claimed that THA and amplifier bands could make possible the efficient implementation of homodyne and third-method systems in an entirely new generation of product with microprocessor control and a frequency-synthesizer system. The MOS chips can cover 1 to 5 MHz in steps of 100 Hz, with s.s.b. as the prime mode.

Hot words
It is a long time since the hope that, with broadcast companies in the USA now thinking about new ways to speak peace to nations, our Prime Minister has made it clear that she sees need to hear from all interested. In the UK the Prime Minister is already intending to use the first two s.s.b. methods — the first by a conventional h.f. amplifier were more generally accepted, and in recent years the filter approach has been almost universally employed. A fourth method, based on phased networks and developed by M. J. Gingell of STL, has similarly never found wide use, although all four approaches have been used by police transceivers. The popular filter method requires a fixed i.f. and cannot be used in direct-conversion or direct-generation equipment. In 1981, W. A. Painter, describing the MEL Callpac s.s.b. transmitter, claimed that THA and amplifier bands could make possible the efficient implementation of homodyne and third-method systems in an entirely new generation of product with microprocessor control and a frequency-synthesizer system. The MOS chips can cover 1 to 5 MHz in steps of 100 Hz, with s.s.b. as the prime mode.

Hot words
It is a long time since the hope that, with broadcast companies in the USA now thinking about new ways to speak peace to nations, our Prime Minister has made it clear that she sees need to hear from all interested. In the UK the Prime Minister is already intending to use the first two s.s.b. methods — the first by a conventional h.f. amplifier were more generally accepted, and in recent years the filter approach has been almost universally employed. A fourth method, based on phased networks and developed by M. J. Gingell of STL, has similarly never found wide use, although all four approaches have been used by police transceivers. The popular filter method requires a fixed i.f. and cannot be used in direct-conversion or direct-generation equipment. In 1981, W. A. Painter, describing the MEL Callpac s.s.b. transmitter, claimed that THA and amplifier bands could make possible the efficient implementation of homodyne and third-method systems in an entirely new generation of product with microprocessor control and a frequency-synthesizer system. The MOS chips can cover 1 to 5 MHz in steps of 100 Hz, with s.s.b. as the prime mode.

Hot words
It is a long time since the hope that, with broadcast companies in the USA now thinking about new ways to speak peace to nations, our Prime Minister has made it clear that she sees need to hear from all interested. In the UK the Prime Minister is already intending to use the first two s.s.b. methods — the first by a conventional h.f. amplifier were more generally accepted, and in recent years the filter approach has been almost universally employed. A fourth method, based on phased networks and developed by M. J. Gingell of STL, has similarly never found wide use, although all four approaches have been used by police transceivers. The popular filter method requires a fixed i.f. and cannot be used in direct-conversion or direct-generation equipment. In 1981, W. A. Painter, describing the MEL Callpac s.s.b. transmitter, claimed that THA and amplifier bands could make possible the efficient implementation of homodyne and third-method systems in an entirely new generation of product with microprocessor control and a frequency-synthesizer system. The MOS chips can cover 1 to 5 MHz in steps of 100 Hz, with s.s.b. as the prime mode.

Hot words
It is a long time since the hope that, with broadcast companies in the USA now thinking about new ways to speak peace to nations, our Prime Minister has made it clear that she sees need to hear from all interested. In the UK the Prime Minister is already intending to use the first two s.s.b. methods — the first by a conventional h.f. amplifier were more generally accepted, and in recent years the filter approach has been almost universally employed. A fourth method, based on phased networks and developed by M. J. Gingell of STL, has similarly never found wide use, although all four approaches have been used by police transceivers. The popular filter method requires a fixed i.f. and cannot be used in direct-conversion or direct-generation equipment. In 1981, W. A. Painter, describing the MEL Callpac s.s.b. transmitter, claimed that THA and amplifier bands could make possible the efficient implementation of homodyne and third-method systems in an entirely new generation of product with microprocessor control and a frequency-synthesizer system. The MOS chips can cover 1 to 5 MHz in steps of 100 Hz, with s.s.b. as the prime mode.

Hot words
It is a long time since the hope that, with broadcast companies in the USA now thinking about new ways to speak peace to nations, our Prime Minister has made it clear that she sees need to hear from all interested. In the UK the Prime Minister is already intending to use the first two s.s.b. methods — the first by a conventional h.f. amplifier were more generally accepted, and in recent years the filter approach has been almost universally employed. A fourth method, based on phased networks and developed by M. J. Gingell of STL, has similarly never found wide use, although all four approaches have been used by police transceivers. The popular filter method requires a fixed i.f. and cannot be used in direct-conversion or direct-generation equipment. In 1981, W. A. Painter, describing the MEL Callpac s.s.b. transmitter, claimed that THA and amplifier bands could make possible the efficient implementation of homodyne and third-method systems in an entirely new generation of product with microprocessor control and a frequency-synthesizer system. The MOS chips can cover 1 to 5 MHz in steps of 100 Hz, with s.s.b. as the prime mode.
The Fowberry energy saver

A device to help reduce the effects of a crude on-off thermostat on the cost of running a central-heating boiler.

by J. A. MacIarg

All boilers demonstrate inertia, and inertia means a time-lag in the feedback of information from the thermostat to the burner. By the time the burner has heated the water-jacket, and the water jacket has heated the water, and the water has heated the thermostat sensor, the burner finds out too late that it should have turned off, and burns too long by the length of the time delays. The result is what is called "overtemperature," and it occurs every time the boiler cycles on and off. Because it is essentially a time function occasioned by the thermal mass of the system, it does not matter how efficient the boiler may be, nor how little back-lash the thermostat may have, over-temperature must inherently occur unless a crafty means is used to prevent it. If the system is used, extra time-delays make things worse.

Over-temperature wastes energy in precisely the same way as an over-heavy foot on the loud pedal of a motor car - it causes too much acceleration in the system: we must try to make the boiler do a constant 56 m.p.h. rather than simulate driving in town!

The Fowberry Energy Saver operates along entirely different principles to the multitude of proprietary timer-programmers which merely tend to stop the boiler working at all for certain periods of time, so tending to make you a slave to them: they also let things cool down so that the boiler has to work hard to bring temperatures back to normal. This effect will be well known to those who have used a holiday cottage or farmhouse at weekends only - the boiler goes like the clappers from Friday night to Sunday night, and the place is just beginning to get warmed through when it is time to go home!

With the device described, the effects of insulation and normal operational thrift are actually increased, and the saving available is even greater if there is a secondary form of heating such as a back-boiler to a solid fuel fire, or solar panels or whatever, because under these circumstances the boiler is literally allowed to tick-over rather than give the minimum burn length (caused by the time delays) each time it cycles.

Figure 1 demonstrates the manner in which the boiler output temperature is reduced (i.e. cutting out over-temperature) with increased setting of the control knob on the device but the thermostat set fixed.

Figure 2 demonstrates the way that the boiler cycling is reduced with an increase of temperature from a secondary source of heat fed into the system.

Principle of operation

Essentially, what the device does is pulse the burner during the on-periods of the thermostat, the rests between the pulses giving time for the heat to transfer towards the thermostat sensor, the last pulse tending to "just" turn off the thermostat rather than have it kicked off by a mighty over-burn of energy.

The thermostat off-time is a fair measure of demand in the system: this is sensed by the device and the length of the first pulse is modified accordingly in order to cope with demand if it exists: if there is only low demand, perhaps from system losses, the first pulse will be short. Whatever the demand may be, subsequent pulses reduce in length so that the thermostat is "just" tripped off.

If the thermostat is not tripped off within about a quarter of an hour, an over-ride comes in to increase gradually the length of the pulses, so to cope with unexpectedly high demand.

Circuit description

The stabilised power supply light's LED through R17 whenever the device is powered by the system thermostat: this led therefore announces "Thermostat On!".

The relay, with its coil shunted by R19 as a warning that the over-ride is in operation.

The dual switch S1-S2 is only used for testing purposes and serves to shorten the otherwise very long time-constants: test point TA allows testing of the follower, while test point TB allows testing of the left half of IC2. The operation of IC2 may be heard through the clicking of the relay.

Components not discussed, such as the two Zener diodes, D5 and D7, are merely level-shifters to ensure correct operation of the circuit.

Connection and adjustment

Connection to the boiler is extremely simple - the lead supplying power to the burner from the system thermostat is broken. The lead from the thermostat is fed to the "Live-in" terminal, while the "Live-out" terminal is connected to feed the burner. Neutral and Earth may be picked up from any convenient point.

To adjust, the knob should be turned as far clockwise as possible that D6 only lights under conditions of unusually high demand. As the secondary heat source is increased, the boiler "on" time is reduced accordingly.

The relay in accordance with the time taken to charge the twin timing capacitors C1-C2, the relay reset times being set through R9 and the manual control R10 when the output of the timer is low. During the discharge of C1-C2, the charging voltage is cut off because IC1 is fed with power through D3.

The right half of IC2 is a level-controlled Schmitt trigger whose input is determined by the voltage across C6. Each time the device is turned off by the thermostat, C6 is discharged through D12 so that it may start to charge from scratch each time the device is turned on. This is the over-ride: if the device is not turned off within about a quarter of an hour, the Schmitt output goes high, and slowly recharges the memory capacitor C3 through D12 and R1, at the same time lighting D15 through...
Microcomputer robot control

Morris Driels describes the microcomputer control of stepper motors, using a 6522 v.i.a. and SAA1027 motor-drive circuit

It is now relatively inexpensive to purchase small, non-servo-type robot manipulators for a variety of educational, research and small assembly activities. These machines are invariably activated by means of stepper motors and have the facility for movement in several degrees of freedom. Although the manufacturers usually supply the necessary interfaces to control their manipulators, there are good reasons for serious users to consider the use of custom-made controllers: the incorporation of feedback sensors to assist in an assembly task requires intimate knowledge of the manufacturers' hardware and software designs; existing controllers are not flexible enough to allow for the control of auxiliary machinery, whether it be additional manipulators or "hard" automation; and the implementation of more sophisticated robot movements such as straight-line motion or joint-interpolated motion again require detailed knowledge of the hardware/software interface.

The work described here is an attempt to illustrate one solution to the problem of integrating both hardware and software aspects of controlling a stepper-motor-driven robot. It is hoped that the description will be sufficiently detailed to allow the construction of a specific device, yet be general, so that the design can be implemented in a wide range of manipulators and microcomputers. Indeed, the design can be easily modified so that it will drive devices that are not strictly robots, for example numerically controlled machine tools, programmable data acquisition systems, etc.

A functional block diagram of the system components is shown in Fig. 1. Flexibility in the computer/robot link is achieved by means of an interface adapter, essentially any device that will make available one eight-bit output port. This article is based on a specific device, the Rockwell 6522 versatile interface adapter, which allows any 6002 based microcomputer to control the robot. Those familiar with the device will know that it can do a lot more than provide one output port, even though in this application that is all that is required of it. 6000 based systems could utilize the 6821 p.i.a., while those who prefer a Z80 system would implement the interface using the Z80 p.i.o.

Figure 2 is a diagram of the 6522, indicating the required connections to the external computer. Of the two ports provided by this device, only port A is used, allowing the remaining lines to be used for additional I/O; for example, to feed back the arm joint positions. The chip-select lines on the v.i.a. can be enabled either by directly decoding the address bus using nand gates and inverters, or by using a combination of decoding devices and switches to memory-map the 6522 anywhere between 0 and 64K in the computer memory. This method is discussed fully in the reference.

Stepper motor control

Most major suppliers of stepper motors will supply information on how motors work and also circuit boards to drive them. The drive of a single stepper motor, however, has been considerably simplified by the introduction of a 16 pin d.i.l. package known as the SAA1027. Figure 1 shows how this device is connected to a stepper motor operating from around 12V.d.c., requiring only two input signals. The direction pin (3) determines in which direction the motor will step; logic high will produce a clockwise rotation while logic low produces anti-clockwise rotation. With the direction specified, the motor will perform one step on the positive going edge of a single pulse applied at pin 15. The set pin (2) is used to restore the stepper motor shaft to a known orientation. Unfortunately, since the input voltage levels must be in the range 7.5-18V, they are not directly TTL compatible.

Although the SAA1027 will drive motors much larger than those found in any educational robots, even larger motors are handled by incorporating a power amplifier stage in the four phase lines Q1-Q4. Figure 3 indicates that the complete motor-driver combination may be treated as a "black box" requiring only a d.c. level and sequence of pulses to produce a movement.

Six-channel drive

This circuit, shown in Fig. 4, uses port A of the 6522, although only part of this port is actually used. The basic operational philosophy is that the six 74LS175 latches Fig. 5. Table showing set of numbers needed to operate joint motors.

Fig. 4. Six-channel motor drive. T

Fig. 6. Flow chart of "teach" part of program, using keyboard to store movements in A.

Fig. 7. Flow chart for "run" mode, where A or AR control motors.
are loaded sequentially with data relating to the six motors. Buffers are then enabled, allowing those motors which should move to step accordingly. The process is then repeated until the required manipulation sequence has been completed.

In a more detailed look at the operation, it can be seen that the motors are moved by placing a series of binary numbers on port A of the 6522, which is defined as an output. This three-bit number consists of three address bits and two data bits. The data bits are buffered to separate latch groups, and only the latch enabled by the addressed address bit stores the data. One bit of the data relates to the direction of movement, the other determines whether the motor will step (high) or not (low). Once six numbers have been used to command all the latches, the CA2 line is enabled to toggle the buffers connecting the latch groups with the stepper motors. The data relating to the direction is connected to the motors through the buffer, allowing the buffered data, all buffers output passes through the ULM 2003N. This sequence enables the necessary voltage levels required by the motor drivers. By considering the range of addresses accepted by the 74LS138 decoder, it can be appreciated that the decimal numbers shown in Fig. 5 represent all the movements of the robot one step and that by placing a succession of such numbers on the output port, the manipulators will execute a sequence of operations.

Software

The program to operate the robot is menu driven and can be called 'Robot Control'. The first twelve options allow each motor to be driven directly from the keyboard by firstly identifying which of the eight can be accessed and then keying in the appropriate number from Fig. 3 to the output port of the 6522. For example, if 'Q' or 'O' should be commanded, a zero would be entered in the PA bus before pressing the appropriate key.

A remaining eight options are program control characters. The first is 'R', which is a reset option, and the second is 'S', which allows the program to be executed. The 'line finished' command allows simultaneous movement of several motors by moving them sequentially and then typing F, indicating that the preceding operation or group of operations is complete.

Next month

X-Y plotter, Super stepper motors, bicycle ball bearings and coated curtain rails are all adapted to provide motion in both directions and is available for different applications by changing stored values.

Published 1989 by Business Press International Ltd.

Index and binding

The index for Volume 88 (1989) of Wireless World is now available, providing a complete listing of all the articles published. Our publishers also offer a service in providing copies of Wireless World, each complete with the appropriate index. If you wish to use this service send your copies to Press Binders Ltd, 4-4a Liffey Yard, Groompton Street, London SE17 with your name and address enclosed. Confirm your order to the General Sales Department (address above) and with the number of issues you require and the remittance of £13.80 for each volume (price includes v.a.t. and dispatch costs). In both cases cheques should be made payable to Business Press International Ltd.

Information is derived and generated from a multitude of different sources, but undoubtedly the largest volume of new information is generated from research activities, the object of which is to solve some of the problems that confront society. Of course it is also possible to produce new information from existing material through the application of a variety of hardware and software techniques. These simply transform information in one form to another in a format available for viewing. Unfortunately, information produced in this way is often both costly and time consuming to produce. Because of its cost, new information has to be stored in appropriate archives and libraries for use by others. Each year the volume of stored information increases substantially. It has been estimated that the volume of recorded knowledge doubles roughly every 20 years. This effect is seen by examining the graphs shown in Fig. 1. The first curve, indicated by open circles, represents the physical volume of the collective documental index from a research publication called Chemical Abstracts, produced by the American Chemical Society. The graph covers the period 1907 through 1976. The second curve, indicated by filled circles, is the number of computer journals for the period 1940 to 1969. Although each curve covers a different period and relates to different subject matter, both show a similar exponential shape. One of the main objectives of research and development in information technology is to produce an information system which is capable of helping to control this 'information explosion'. Some of the most important areas of current research interest are briefly outlined below.

Potential of the video disc

When combined with a suitably designed computer and video display equipment, this new technology will provide a valuable addition to existing educational facilities and will have many potential applications in education, commerce, leisure and entertainment, particularly within the home. Indeed, to combat the rising cost of travel and office accommodation, as well as ever-crowding within cities, working from home through the use of appropriately designed workstations is likely to become increasingly important in the future development of home-based educational systems.

The role of education

Education is not just concerned with information, its dissemination and assimilation by individuals, groups, societies, and nations. As an inherent part of the educational tool, education thus has a vital part to play. In its role in relation to the production of information, research is depicted in Fig. 2, which illustrates the type of information/knowledge transfer processes that are exchange schemes to operate; they are not to try to meet some demand from society, they are usually much more difficult to author. Currently, there is much research being devoted to solving each of these problems, but the technology is located in a vacuum. The video disc will undoubtedly provide several new applications and new opportunities for designers of information systems. Development of the 'intelligent video disc' is likely to be of great significance to those who are involved in the construction of novel i.e. products for use in the home, industry and within education.

Satellites and fibre optic networks

Two types of communication resources are very likely to significantly influence developments in information technology over the next decade: optical fibres and satellite systems. Recently, there has been much discussion regarding the potential of the UK's fibre networks to provide high bandwidth communication channels to both allow interactive retrieval, e-mail, shopping, meter reading, home security systems and other computer-based services for use at home. Within many parts of the world the use of satellite data communlinks is well established and there are now several worldwide data transmission networks in which satellites play a significant role.

Combining both of these technologies is likely to produce a complete new range of possibilities in terms of information and educational technology. Heterogeneous systems could combine both of these resources-based optical fibres and global communication possibilities.

Provided suitable selection mechanisms, information filters, and security procedures are developed, then the educational and entertainment potential of accessing to video information on a satellite channel is likely to offer a significant contribution toward solving some of the problems with which information technology is concerned.

"Much future learning must take place in the home if government expenditure on education is to be reduced in a non-harmful way."

by Philip Barker

Electronic journals

There is much to be said for information that is available in a very simple form, not only for being compact, it is also easy to disseminate and simple to use. Because of the importance of holding information in this way, much research has been devoted to investigating the use of electronic databases and books as a means of distributing reference documents and the results of research.

The basic idea behind the electronic journal is fairly straightforward and depends on the availability of appropriately designed communication networks, database support software and text/image processing equipment. Essentially, contributors enter their source material suitable computer terminal equipment. Once a document has been entered into the electronic journal system (a database distributed), document identification may be updated in various ways prior to submission to the journal's editorial panel. An electronic version of the document is usually provided it is accepted for publication. This is stored in the centrally accessible portion of the distributed data base. Potential users of the final report are then made aware of the latest research work and access to it by means of interrogative terminals linked to the host database with appropriate communication links to the nearest appropriate terminal. Provided suitable selection mechanisms, information filters, and security procedures are developed, then the educational potential of accessing to video information on a satellite channel is likely to offer a significant contribution toward solving some of the problems with which information technology is concerned.

Photographic representation of the electronic journal system is shown by Waytek in Fig. 1, which illustrates the type of information/knowledge transfer processes with which the system is concerned. Clearly, the user interacts with the host computer system to obtain the electronic journal system (a database distributed), document identification may be updated in various ways prior to submission to the journal's editorial panel. An electronic version of the final report is produced when the document has been accepted for publication. This is stored in the centrally accessible portion of the distributed data base. Potential users of the final report are then made aware of the latest research work and access to it by means of interrogative terminals linked to the host database with appropriate communication links to the nearest appropriate terminal. Provided suitable selection mechanisms, information filters, and security procedures are developed, then the educational potential of accessing to video information on a satellite channel is likely to offer a significant contribution toward solving some of the problems with which information technology is concerned.

Photographic representation of the electronic journal system is shown by Waytek in Fig. 1, which illustrates the type of information/knowledge transfer processes with which the system is concerned. Clearly, the user interacts with the host computer system to obtain the electronic journal system (a database distributed), document identification may be updated in various ways prior to submission to the journal's editorial panel. An electronic version of the final report is produced when the document has been accepted for publication. This is stored in the centrally accessible portion of the distributed data base. Potential users of the final report are then made aware of the latest research work and access to it by means of interrogative terminals linked to the host database with appropriate communication links to the nearest appropriate terminal. Provided suitable selection mechanisms, information filters, and security procedures are developed, then the educational potential of accessing to video information on a satellite channel is likely to offer a significant contribution toward solving some of the problems with which information technology is concerned.

Photographic representation of the electronic journal system is shown by Waytek in Fig. 1, which illustrates the type of information/knowledge transfer processes with which the system is concerned. Clearly, the user interacts with the host computer system to obtain the electronic journal system (a database distributed), document identification may be updated in various ways prior to submission to the journal's editorial panel. An electronic version of the final report is produced when the document has been accepted for publication. This is stored in the centrally accessible portion of the distributed data base. Potential users of the final report are then made aware of the latest research work and access to it by means of interrogative terminals linked to the host database with appropriate communication links to the nearest appropriate terminal. Provided suitable selection mechanisms, information filters, and security procedures are developed, then the educational potential of accessing to video information on a satellite channel is likely to offer a significant contribution toward solving some of the problems with which information technology is concerned.
Instability at high frequency in feedback amplifiers

Simple mathematical analysis of the conditions for high frequency instability in a feedback amplifier or any abstract control system

by Philip Ratcliffe

Electronic amplifying devices, valves, bipolar or field-effect transistors, rely for their operation on the drift of electrical charge in controlling mechanisms. The speed of drift of the geometrical size of the device defines the ‘cut off’ line to the high frequency response.

In practice, this cut off frequency depends on the time taken for the drift of physical elements or energy bands across the base region. For any useful gain at high frequencies the base region is made very thin, but this has the disadvantage that the device has a very low collector-emitter ‘punch through’ voltage.

For valves and f.e.t. the main current is composed of charges travelling through a homogeneous medium (ignoring the electrode interfaces) but is controlled by electric fields whose influence can propagate faster and so gives a much better h.f. response.

A simple switching analysis is used. The time taken for a control effect to propagate from input to output will be assumed to be considerable.

A more sophisticated analysis would consider the electronic drift currents as a diffusion of charges. Suppose that the abstract amplifier has an open-loop gain in Fig. 1

where, by definition of the causal relation, assume that

\[ v_i(n) = \mu v_i(n-1) \quad (1) \]

and is positive or negative. Apply voltage feedback by a simple resistance network, Fig. 2

\[ R_1 + R_2 v_i = v_i(n) \quad (2) \]

\[ \frac{v_i}{v_i} = \frac{v_i}{v_i} \]

The current in the resistive network, assuming negligible neglecting the amplifier input, gives

\[ v_i = v_i(n) \quad (3) \]

The current at the amplifier output can be calculated as

\[ v_i = v_i(n) \quad (4) \]

Electronic amplifying devices, valves, bipolar or field-effect transistors, rely for their operation on the drift of electrical charge in controlling mechanisms. The speed of drift of the geometrical size of the device defines the ‘cut off’ line to the high frequency response.

In practice, this cut off frequency depends on the time taken for the drift of physical elements or energy bands across the base region. For any useful gain at high frequencies the base region is made very thin, but this has the disadvantage that the device has a very low collector-emitter ‘punch through’ voltage.

For valves and f.e.t. the main current is composed of charges travelling through a homogeneous medium (ignoring the electrode interfaces) but is controlled by electric fields whose influence can propagate faster and so gives a much better h.f. response.

A simple switching analysis is used. The time taken for a control effect to propagate from input to output will be assumed to be considerable.

A more sophisticated analysis would consider the electronic drift currents as a diffusion of charges. Suppose that the abstract amplifier has an open-loop gain in Fig. 1.

where, by definition of the causal relation, assume that

\[ v_i(n) = \mu v_i(n-1) \quad (1) \]

and is positive or negative. Apply voltage feedback by a simple resistance network, Fig. 2

\[ R_1 + R_2 v_i = v_i(n) \quad (2) \]

\[ \frac{v_i}{v_i} = \frac{v_i}{v_i} \]

The current in the resistive network, assuming negligible neglecting the amplifier input, gives

\[ v_i = v_i(n) \quad (3) \]

The current at the amplifier output can be calculated as

\[ v_i = v_i(n) \quad (4) \]

Electronic amplifying devices, valves, bipolar or field-effect transistors, rely for their operation on the drift of electrical charge in controlling mechanisms. The speed of drift of the geometrical size of the device defines the ‘cut off’ line to the high frequency response.

In practice, this cut off frequency depends on the time taken for the drift of physical elements or energy bands across the base region. For any useful gain at high frequencies the base region is made very thin, but this has the disadvantage that the device has a very low collector-emitter ‘punch through’ voltage.

For valves and f.e.t. the main current is composed of charges travelling through a homogeneous medium (ignoring the electrode interfaces) but is controlled by electric fields whose influence can propagate faster and so gives a much better h.f. response.

A simple switching analysis is used. The time taken for a control effect to propagate from input to output will be assumed to be considerable.

A more sophisticated analysis would consider the electronic drift currents as a diffusion of charges. Suppose that the abstract amplifier has an open-loop gain in Fig. 1.

where, by definition of the causal relation, assume that

\[ v_i(n) = \mu v_i(n-1) \quad (1) \]

and is positive or negative. Apply voltage feedback by a simple resistance network, Fig. 2

\[ R_1 + R_2 v_i = v_i(n) \quad (2) \]

\[ \frac{v_i}{v_i} = \frac{v_i}{v_i} \]

The current in the resistive network, assuming negligible neglecting the amplifier input, gives

\[ v_i = v_i(n) \quad (3) \]

The current at the amplifier output can be calculated as

\[ v_i = v_i(n) \quad (4) \]
The 1/6 factor shows that the singularity is a simple pole.

We can analyse what is happening at the amplifier input vi using equation 8b and the normal solution 10 for v(0). From R, v(0) is

\[ v(0) = k_i v_i + k_o v_o \]

(11)

where the terms k_i contain no gain so must both be positive, less than one by definition 7, for real resistances and the direction of change of v(0) is always in the same sense as v(0), and the general solution is

\[ v(t) = v(t,0) + \int_0^t v(t) dt \]

(12)

from 10, which is curiously in that it says v(0) depends on the future value of v, but as a repetitive causal process it is quite sensible. The limiting condition if k_i < 0 and k_o < 1 is

\[ v(t) = k_o v(t-1) - k_o v(t-2) \]

(13)

11 and in accordance with 1. Further if u_o = v(t) tends to zero, the direction of approach depends on the sign of u_o and is a dumping effect, and we obtain the condition for the so-called 'virtual earth amplifier'.

A graphical analysis makes this algebraic description meaningful in considering two special cases, for k_i < 0 and k_o < 0 with k_i < 0 assumed throughout this analysis. First, if v(0) is zero then following an input ramp u_o = u(t) up to t we may also suppose v(t) has been zero, say. At the input voltage jumps to a constant level for the rest time. Fig. 4(a).

In the second case k_i > 0 we can obtain finite extremes in the same way as under the condition 0 < k_i < 1. i.e. R_o/R_i > 1. The diagrams for the graphical analysis are easier to construct using equation 9.

This illustrates the second type of convergence of mathematical sequences, it can saturate to a finite value or increase indefinitely. The condition is positive feedback stability for k_o < 1 + R_2/R_1.

Further investigations

The behaviour of an implemented control can be studied mathematically in computer simulations on the way the system reacts to more varying input functions than a mere step. Results show that the behaviour of the system depends on the character of the signal being processed - look at the response to square waves, sinusoids, etc. which can induce 'resonances' in the am

amplitude to model behaviour near discontinuities. The conditions for stability in negative feedback is

\[ k_o < 1 \]

The condition for switching oscillation is when

\[ u_o = -(1 + R_o/R_i) \]

and then the closed-loop gain is finite.

16 line p.a.b.x with Options

Incoming and outgoing exchange calls and call transfer are functions of the flexible electronic/electromechanical p.a.b.x described in this second article.

by J. H. Kuiper

RT from again starting the R.T. oscillator in the event of T1 disengaging before B.R. This completes resetting and the system is now ready for accepting and processing the next call.

Both pull-up resistors and the capacitor around IC36 and 4014 (forking from the 401601 counter when dialling takes place. The ringing-tone oscillator/intermitter is an adaption version of a circuit published FRG. 1981, 16(1):63) and subsequently employed on-ground to produce a 'double tone' which provides clear distinction between internal calling and an incoming exchange calling employing single-tone signalling (one interruption as opposed to two provided by RT). The 401601 counter is not applicable then the ringing-tone oscillator should be omitted and the 555 delay circuit (produced by a 555 timer IC) to the second half of which produces single interruptions for driving the RT relay. Ringing tone is then taken to be a 100kHz capacitor from the new dial-tone oscillator. The 401601 counter is then replaced by a B.B relay and contacts is shown separately.

Table 1 lists the 16 outputs of the 4514 latched/decoded circuit. Note the outputs 1, 2 and 3 are not to be dialled to obtain the required output. As a telephone dial will only produce digits one, two, and three, causing contacts to close and to open respectively, and the decoder has 16

outputs, two digits must be dialled to make all 16 calls. Should the telephone having digits marked zero to nine will produce one pulse when dialling zero and one pulse for each digit. Basically the combined number of pulses produced after dialling determines the final output of the decoder. Since digit di
dials to have the first accessible output will be output two when dialling 1 (1+1 pulses). To access outputs zero and one the counter has to overflow, or dialling 60 and 79 respectively (6+10 and 7+9 pulses) produces output zero while dialling 70 or 89 (17 pulses) results in output one because of the one. Any appropriate number of pulses will switch the corre

The line interface primarily consists of a remotely controlled telephone in which the cradle switches es, muting contact and interruptor contact etc. are replaced by relay contacts. The contact line is fully iso
dated from the internal system. The cradle switches which would normally be operated when lifting the handset are now re
cently operated by ground key GK from each of the individual stations through the Ground in and hold relay arrangement G/G/G which is a toggle switch, switching on when closing the station's ground key initially and switching off when the ground key is released, and GK/GK which is a muting key (elimination of ln and l_in the momentary). The switch l_in and l_out are also available in the normal, so switching occurs when the toggle input at n. Contact 1 is connected to V+ (by operating the ground key). This energizes

www.americanheritagehistory.com
After switch on of GI at the start of the bell signal, contacts of GI control G active through GI and G1. The station's GI contact will break the original connection between this station and the internal control which now results as if the final discharge path is replaced as outline earlier, allowing the internal call to be made.

Termination of the BDT pulse to the toggle now takes place either by G1 resetting or the actual end of the bell signal which disconnects bdtg, whichever occurs first. This allows GI to be reset for the moment in parallel with G1. Meanwhile G1 is prepared for switch on and disconnects G1 as an inhibit of the hold oscillator as Ic2 will release before long. Contact GI which initializes resetting of the internal control now connects the external interruption relay EI into the line interface to the answering station. Contacts GI bypasses its G contact thus securing operation of Gt/HGH toggle from the answering station ground key. Action of GI is immanent in this stage. In the line interface Ic1 doubles while in the external control, Ic1 provides power for the external reset relay ER. In cooperation with GI, it also energizes the cradle switch relay ESC. Contact Ic3 operates ESCS in the line interface Ic1, connecting the primary transformer coil and 2次级 coil, then activating the cradle as a make-before-break switch. Contact Ic3 duplicates Ic2 in providing power to the cradle and GI, which (switched previously) operates S which in turn connects the transformer secondary to the ringing switch. Thus establishing a speech path between the answering station and the exchange line through a capacitor and M2. At the same time Ic3 holds the lead-switch relay LS on so as to cause the internal control to be continuously lit through h2 and Ic3 in common.

Making outgoing calls

Access to the exchange line is manually accomplished by inserting the ground key into the ground key as detailed earlier. Upon reception of external dialling tone from the exchange, dialling begins. If a user's telephone number is dialed, the line interface is basically a remotely operated telephone. The relevant dialed digits are transmitted to the exchange which provides a dial tone for the line interface between the ground key, contact GI; secures a hold line against 2s, bdtg and Ic3 which now performs an 'on hook' operation in the line interface by disconnecting the external dialling line and reconnecting the ground key, contact GI. LS extends the lines by virtue of Ic3 which also switches off S. Contact Ic1 and the reset Ps disconnects the Gt/HGH toggle thus releasing G while GI reconnects all contacts in readiness for the next line call.
Three-to-one cable applications

According to figures issued by the Department of Trade and Industry and the Home Office, there have been 27 applications to provide up to 12 cable tv pilot projects. Each application is to be assessed by an EIU Informational, a subsidiary of the Economist Intelligence Unit. Their report will be considered by independent advisers who will submit their findings to the appropriate Secretaries of State. The pilot schemes are a limited experimental phase to be put into action before the full legislation for proposed cable authority can be enacted. Applications had to be submitted twice; to the DTI for telecommunications licences to install and run the systems, and to the Home Office for a licence to provide programme services.

National Consumer Council

A letter sent to all the applicants for cable television licenses by the National Consumer Council, stresses the need for such services to meet the needs of ordinary consumers and suggests that to be a successful cable operator, skill must be used to interpret what the consumer wants from cable, providing entertainment using the services at a price that represents value for money.

Five specific points are presented that the applicants are urged to take into account. The plans and proposals submitted are made public so that consumers could have the opportunity to discuss the programme content; the operator may be helped in interpreting the need of the local community by forming a local consumer advisory group; a useful part in the local community could be played by allowing access to local voluntary organizations; the provision of a local database and 'notice board' should be taken into account in the medium term development of the company's strategy; interactive services, home banking and shopping for example, seem to offer advantages to the majority of consumers, and especially to the housebound and disabled; such a service should also be part of the medium-term strategy.

As a national body, the NCC cannot comment on the appropriateness of any plans to meet the needs of a specific local community, but their experience is that the consumers can do it themselves.

BT to sell tv cables

British Telecom is negotiating multi-million pound contracts with British industries to supply the advanced technology needed for cable tv. The orders are for 'switched' star systems, favoured by the Government for longer term franchises. BT expects to be able to offer the system in the second half of next year, in time for the introduction of the first new networks.

Customers will be able to dial the service they require with a possible selection from the channels of broadcasts and satellite tv and radio programmes; a pay-as-you-view channel; a selection of programmes available on demand from a video disc library, security locks; cable videotelegram; Prestel and remote banking and shopping. Expansion could provide electronic mail, alarm services, remote meter readouts, home shopping, polling and home computer and video games programmes.

The system is being offered by BT Cable, an organisation created by BT specifically for marketing in this area. They are involved with supplying the system to ten potential operators.

Mr Roy Fairhurst, formerly a commissioner with the Canadian Radio-Television and Telecommunications Commission, is to join BT as a special adviser on cable tv. He will advise BT top management on the market potential for cable tv and related services, and on the preparation of franchise applications. Mr Fairhurst has had considerable experience with cable tv companies in Canada and the US and was Managing Director of CJOH-TV, a cable tv network in Ottawa.

Stolen yacht caught in the net

When the 40ft ketch Frisele was stolen from Alicante it was reported to the local amateur radio maritime network. Such reports are repeated twice a day and the news spreads worldwide through various relay stations. About two weeks later, a member of the network spotted a boat matching the description of the Frisele in Arrecife, Canary Islands. Registration and engine numbers confirmed it to be the stolen yacht which was probably on its way to South America, where incidentally another sailing 'hams' had already been alerted.

Industrial robots with an integrated vision system are being introduced by the company, ASEA.

The one shown identifies the workplace, visually inspects it and orients it. Its 'eye' is a c.c.d. tv camera in conjunction with grey-scale image processing, claimed to be much better than binary systems as it does not need special lighting.

Programming involves a 'learning' procedure in which the object is placed in front of the camera and the image is processed. The system then collects data on the orientation of the object and checks it to show that it really 'recognizes' the object. Defining the robot's grip position is included in the programming mode. ASEA are at 721 83 Vasteras, Sweden.

125 years ago, HMS Agamemnon went through considerable difficulties when laying the first complete transatlantic cable in June 1868 there was one of the severest gales ever reported. The cable was inaugurated when Queen Victoria sent a 90-word telegram of congratulations to the President of the United States which took 16 hours to transmit.

The new transatlantic cable, TAT-7, was inaugurated in October, exactly 125 years after the first one. It can carry more than 4,000 simultaneous phone calls and can handle computer data and telex messages. It boosts Britain's transatlantic cable capacity by more than 50%, and raises the cable to satellite ratio to 50:50. An historic link between the two cables is that STC provided the new one and its predecessors, Glass, Elliot & Co. provided a proportion of the original. The next cable, TAT-6, already at the planning stage, is likely to offer digital transmission along glass fibres.

New role for BTG

The principal role of the British Technology Group (the amalgamation of the National Research Development Corporation and the National Enterprise Board) is to assist the translation into commercial products of new research ideas, particularly those from the public sector. The Government is the ultimate owner of the industrial property. The idea is to bring together the researcher who has made the discovery, companies who are looking for new products, and venture capital institutions who are willing to finance new ideas. There is often a gap between a research idea emerging and its commercial exploitation and the object of the BTG will be to act in collaboration with and in support of private initiative.

The services of the BTG will include: matching the researcher's work, particularly in universities; helping to evaluate the 'marketability' of new ideas from both public and private sources; assistance with their development and with their protection through patents; helping industry and financiers to identify research work of potential interest to them by means of a database or through active search, particularly for the smaller companies; support for new companies to start up where other means of exploitation cannot be found, particularly those based around the researcher.

The BTG no longer has the right of first refusal to publicly funded research. New guidelines to govern future exploitation and the involvement of the BTG are being drawn up in consultation with those concerned, including the Research Councils who will use the guidelines when setting out the terms and conditions of any new research grants.

Business software directory

The Department of Trade and Industry is to finance the setting up of directory of business software for microcomputers. This is intended to provide a showcase for the "thousands of software authors in this field." The directory is to be compiled by the NCC Microsystems Centre, 11 New Fetter Lane, London ECA IPU. When the project was announced, John Bunce, MP said: "British programmers are the most talented in the world but many of them, particularly the one-man bands and home enthusiasts, have difficulty in marketing their products. I am determined to give them an opportunity to gain national exposure and take advantage of a domestic installed user base which is the highest, per head of population, in the world." He hoped that the creation of the directory would give the programmers the boost they needed so that they would become able to beat any international competitors. We hope to see and look forward to similar directories in the fields of science and industry.

The NCB's investment programme is to be concentrated on this "technology transfer" activity; existing portfolio is to be disposed of. The BTG will be permitted to retain all income arising from its activities with the objective of becoming self-financing. The present Chairman of the BTG, Sir Fredrick Ross, is to retire early, as soon as the role of the Group has been fully formulated.

Martin Schimmer and Tim Lyons are the producers and presenters of Radio West's Datarama programme on microcomputers. The Datarama programme which in addition to reviews of the latest equipment and software, and news, actually broadcasts computer programs. The signals are taken from the cassette outputs of a number of popular micros.
Zilog 32-bitter
Some details have been revealed of the Zilog Z8000, a 32-bit microprocessor which has on-chip cache and memory management. The instruction set, internal and external data paths, and data are all 32-bit. The c.p.u. is compatible with the 16-bit Z8000 but has greater computing power due to its 32-bit design. The single chip supports 4GBYTE of directly addressable memory and runs at a clock speed up to 25MHz. "Pipelineing" allows more than one instruction to be executed at the same time and prototype performance tests have yielded an average of 2.2 cycles to execute all instructions, including jumps and multiplication and division.

The high speed is partly due to the inclusion of a 256-byte cache memory on the same chip. This stores copies of the memory locations most recently referred to. If a memory location is accessed again, the cache is checked first and the contents may be read indirectly without needing to access the main memory. The c.p.u. has two main operating modes: Normal, for user programs; and System, for internal operating systems functions. This separation protects the critical parts of the operating system from user access and takes care of all the time-critical or background tasks in multi-tasking applications. The chip has 16 32-bit general purpose registers to hold addresses or data and there are two arithmetic and logic units, one of which is used for address calculation, the other for program execution.
The Z8000 has about 150,000 transistors on the chip and is made using Zilog's 242 process, producing an n-ep chip with 2-micron geometry. Samples of the processor, housed in a 68-pin leaded package will be available in spring 1984 with production quantities to be available in summer.

New frequency for Southern Sound
The 41st Independent Local Radio station opened in Brighton with the title of Southern Sound. Two new transmitters will cover an area along the southern coast from about Goring by Sea in the West to Penzance in the east, and inland as far as Haywards Heath. One interesting feature is that the station has been allocated the v.h.f. frequency of 103.4MHz, very near the end of the scale on most v.h.f. receivers. This band is usually contaminated by emergency communications services. By international agreement, v.h.f. broadcast frequencies are to be released for public broadcasting. So ILR now has a toe-hold in this part of the spectrum.

Disband in the socks
London's first satellite earth station is to be built in the heart of dentist dockland. Planned to be operational early in 1984, the station is to have two dishes, each of 18m diameter operating in the 11140 MHz frequency band. One dish will be in conjunction with ECS the European communications satellite, the other with Institut V. d. Weste in the Atlantic Ocean. With a quick substitution of a few components, either will be able to be used for sending the signals of the other. The antenna and transmission equipment is to be supplied by Marconi Communications Systems and the station itself built and operated by British Telecom International.

No v.h.f. tv after 1984
Following the report of the Merriman Review of the spectrum, the BBC and the IBA have issued a joint statement that the 405-line v.h.f. tv service is to be progressively shut down during 1984 with the last stations being closed during the first week of 1985. They estimate that 99% of the population already receive the 625-line u.h.f. service from BBC1, BBC2 and ITV and 90% also receive Channel 4. U.h.f. stations are being installed at about 60 a year to cover the remaining areas. However it has been admitted that some small remote communities will be without u.h.f. by the end of 1986, and if affected, they can easily identify themselves as those at present unable to get BBC-2, which is u.h.f. only, can get free-to-air information from the Engineering Information Departments of both broadcasting authorities.

Zigol's subwoofer design
This add-on active filter design was matched to a pair of LS3/5a loudspeakers but is easily modified to match other small high quality speakers. The box is designed to be an on-the-shelf one and the power amplifiers. The stage must be an active filter having second-order complex zeros with identical resonance frequency and Q at the poles of the closed box. Such filters ordinarily require either four op-amps or are difficult to tune. A specially designed three-op-amp filter which can be tuned easily to equalize the resonance of a subwoofer in a closed box.

b Y J. Sokol
The box can be built with only rough consideration of enclosed volume and then its parameters can be measured electrically. My box, of about 60 litres capacity, doubled as a subwoofer and a 180W amplifier, was designed using the method shown in Fig. 1. The measurements yielded 48Hz and Q=0.71. Using these parameters the equalizer is easily tuned.

The equalizer works as follows. A convenient subsonic frequency was chosen for the filter pole (it must have two poles or its output would become infinite as input frequency approached zero). The frequency chosen was 7.2Hz, the factor of coincidence being standard component values. Two inverted filters were built with that pole frequency one a low-pass and one a bandpass, each at Q=0.5. The two filter outputs are added with adjustable weighting factors to the original signal. The result is a biquad filter with complex zeros easily adjusted for both frequency and Q. The mathematics to prove this is simple using complex frequency (s). One need only know the forms of second-order high-pass and bandpass functions and that the quadratic expression of A+Bs/C is related to resonance parameters by B=ω0/C, and Q=(1-ω0/C)/ω0.

When the transfer function is signed passed straight through:

\[ H(s) = \frac{s^2 + A\omega_0 s + B}{s^2 + A\omega_0 s + B} \]

The sum \( H+K+K\) will have a numerator
\[ s^2 + C\omega_0^2 + D \]
where C is tunable by k, and D is tunable by k without interaction. Thus we have an "orthogonal" means of tuning C and D, which provides an easily adjusted pair of zeros.

Practically, the equalizing filter is adjusted as follows:

1. Measure k and Q for the closed box woofers as in Fig. 1.

2. Point A in Fig. 2, apply input signal to f, at input and adjust p for minimum output.

3. Measure k, k, and D, and add the characteristic frequency of the speaker (H). Next determine the frequency for the closed box (100×k) is maximum, \( F_{res} \)

\[ R_{res} = \frac{1}{2\pi}\sqrt{\frac{S}{F_{res}}} \]

Find the two frequencies f and \( f_2 \) above and below f, where the relative power measures \( R_{res} \) are closest (F=V/100).

\[ R_{res} = \frac{1}{2\pi}\sqrt{\frac{S}{F_{res}}} \]

\[ Q = \frac{f}{f_2} - \frac{f_2}{f} \]

Fig. 1. How to find f, and 1D, of a closed box speaker (ref. page 199).

First measure the resistance to the speaker R.

Next determine the frequency f at which the resistance (100×k) is maximum, \( F_{res} \)

Calculate \( R_{res} = \frac{1}{2\pi}\sqrt{\frac{S}{F_{res}}} \)

Find the two frequencies f and \( f_2 \) above and below f, where the relative power measures \( R_{res} \) are closest (F=V/100).

Calculate \( Q = \frac{f}{f_2} - \frac{f_2}{f} \)
Butterworth filter shown in Fig. 4 has a high-pass 3dB point variable from 22 to 340Hz. Below its set frequency it flattens the equalizer output and allows the closed box output to roll off at –12dB/oct. The Butterworth filter (Q=0.707) produces no peaking, but a Bell filter (Q=0.5) will produce less phase change at the cost of some bass output. If you want to try that simply remove the 47kΩ resistor in the filter shown. I did not hear an improvement with that change. Be sure to earth the case of the dual pot, and make its shaft available from outside the subwoofer enclosure.

Finally the crossover must be designed. Here a lively debate is in progress, with current arguments presenting the all-pass or double Butterworth crossover functions as best.

It is instructive to see why this is not so for subwoofer crossover. The main advantage of the all-pass crossover is good spatial dispersion in spite of non-coincidence of the crossed-over units. This is hardly significant when the wavelengths in question are commensurate with the size of the listening space. The price of this crossover, uneven power response, could produce boombiness, the mutual feedback of bass speakers. Its one remaining advantage, rapid fall-off in output for both units, can be compensated in other ways.

Fig. 2 In closed box equalizer stage R2 adjusts f, and R1 adjusts Q.

So the all-pass crossover functions
\[ f = \sqrt{f_0^2 + \left( \frac{Q}{2} \right)^2} \]

were rejected for my design. A good thing, as they cannot be realized in the desired add-on system because the side speakers, unmodified, do not have double Butterworth characteristics! In fact, the characteristics of my side speakers are of the second-order filter type, because they are closed boxes. Published graphs show that \( f_p = 74 \text{ Hz} \) and \( Q = 0.67 \). (Many older small speakers are of similar type, and their parameters can be determined by the method of Fig. 1.) The delightfully simple solution to the crossover problem I chose is to subtract an analogue to the response of the side speaker from the total signal and to provide that difference signal (the missing sound) to the subwoofer. The realization of this design is shown in Fig 3 together with equations needed to modify it for other side speakers. Such a crossover, the asymmetrical constant-voltage type, has a well-known problem. That is the difference function sent to the subwoofer has a single real zero

\[ z = 1 - \frac{A}{B} \]

\[ \frac{2}{z^2} + \frac{A}{z} + B \]

\[ z = 0 \text{ at } B = A = 1 \]

The consequence is that the subwoofer rolls off at only –6 dB/oct beyond this zero. The B139 can in fact reproduce higher frequencies as its cone doesn’t resonate until about 800Hz, but if the third ‘channel’ were allowed to deliver output at mid-frequencies it would muffle the stereo image. My solution was to add two additional single-order sections (one capacitor in each summing stage in Fig. 4) so that there is finally a 18 dB roll-off for the subwoofer.

This solution sounds excellent. In fact the musical effect of the subwoofer is sometimes uncanny. Purcell’s Funeral Music for Queen Mary was played during testing when the subwoofer was off to the side away from both side speakers, and yet the great kettle drums seemed to come right out of the tiny LS15a speakers. Evidently, the side speakers provided the transient and higher harmonic information by which the ears determine sound origin.

Two practical notes complete the description of the system. The summing of the stereo channels is achieved using 500Ω resistors at the signal end of twisted-pair cables. As the input impedance of the subwoofer is set to 10 ohms long cables produce no hum pickup. In setting up, ps is used to match the subwoofer output to the efficiency of the side speakers—it need not be readjusted when the variable low-end control is used. If the stereo preamp were separate from the amp the signal could have been taken from its (post volume control) output. Then another summing op-amp would be needed and the speaker terminals would have to be reversed to restore phase.

Finally let me explain the rather elaborate anti-chump relay shown in Fig. 4. It has two time constants to delay signal half a minute after switch-on and also turn signal off milliseconds after power down. This protects the expensive driver. Enjoy the restored missing octave!

References
CIRCUIT IDEAS

Z80 reset without memory loss

Generating short pulses synchronized with the processor M1 signal, this circuit overcomes the problem of loss of data in dynamic RAM which is caused by resetting a Z80 microprocessor used to generate refresh signals.

Section A of the 74C221 dual monostable I.C. is triggered by a deasserted signal from the reset push button for around 10µs. Monostable circuit B is triggered by negative M1 transitions during this period, ensuring at least one reset pulse at a time when the processor is executing its longest instruction. Under normal conditions when no reset is taking place, section B is held in its reset state. Spare gates provide power-on reset.

G. K. Dare
Perton
Wolverhampton

MIM tunnel junction measurements

Breakdown voltages of metal-insulator-metal junctions are measured to obtain information about their work function characteristics, but methods previously described (see page 79) have been destructive and have not allowed breakdown measurements in both directions on the same junction. This circuit switches off less than 5µs after breakdown occurs, leaving the junction intact, and allows repeated measurements to be made on the same junction.

A Schmitt trigger is coupled to a bistable multivibrator through a differentiating network which applies a negative pulse to the base of one of the multivibrator transistors to switch it on when breakdown occurs. The second multivibrator transistor switches on and the emitter voltage of the series-pass transistor falls to zero, cutting off the supply to the junction. Breakdown voltages of less than 0.4V could be measured by setting the Schmitt trigger threshold at about 0.2V. After each breakdown reading the potentiometer wiper is grounded and the reset button pressed. Resistor R1 should have a high value.

Ijaz ur Rahman
Quaid-e-Azam University
Islamabad
Pakistan

Thunderstorm protection

Having lost two I.C. transistors in a recent thunderstorm I designed this simple means of protection which, in the event of a storm, will cost at worst a half capacitor - short of a direct hit of course.

R. G. Young
Newhaven
Sussex

High-speed, high-c.m.r. isolator

Designed for triggering thyristors, this circuit using inexpensive Fairchild opto-isolator units exhibits low delays and fast switching times at operating frequencies greater than 10kHz. During normal operation, only one of the isolators transmits pulses, since a led connection of the second is left open. Common-mode noise would normally cause false triggering through the coupling capacitance of the isolator, but in this case the second isolator also turns on and shorts the emitter resistor of the first isolator. Both isolators are now on, but no pulse is transmitted. Waveforms shown are at 10kHz with 50% duty cycle.

S. K. Biswas
Indian Institute of Science
Bangalore

Programmable current loop

An accurate current loop that can be varied between 4 and 20mA is often required for control system calibration and automatic test equipment. This 12-bit digital 4-20mA loop is easily calibrated, is TTL compatible and has a fast settling time. It uses a 10V reference to set the op-amp/BC184 current sink to 1mA. With all-zero digital input, the 10kHz potentiometer is used to set output of the multiplying mirror to 4mA. When all digital inputs are at one, the d-to-a converter sinks 4mA, so with the 1mA standing current, the multiplied output is 20mA.

Though 12-bit accuracy may not be needed - few transducers are accurate or repeatable to within 0.2% - the converter's 4mA full-scale current is useful. One or both adjustment potentiometers may be omitted if 0.5% error is acceptable, provided that accurate resistors are used. Output compliance is -25 to +14V.

G. R. Nimmo
Bourns Electronics Ltd
Hounslow
Middlesex
Low-pass filter design

Many situations occur in electronic engineering where a second-order low-pass filter is required, having amplitude and phase-frequency responses that can be selected by careful design. The simplest way to design a second-order, low-pass filter is to arrange for two RC lag networks to have the same corner frequency with the transfer function

\[ \frac{E_o}{E_i} = \frac{1}{1 + \frac{1}{sR_1C_1} + \frac{1}{sR_2C_2}} \]

where \( w = \frac{1}{\sqrt{R_1C_1}} \). An active filter of this form is shown in Fig. 1 and the frequency response, where the corner frequency is 1kHz, is given in Fig. 2.

To vary the filter response by controlling the rate of change of gain and phase one needs to specify a particular value of damping factor, \( \zeta \). The damping factor can be varied over a wide range without significantly affecting the filter's bandwidth as shown in Figs. 3 and 4, these diagrams show the circuit and frequency response of a second-order filter having the same nominal bandwidth of 1kHz but with a damping factor of 0.15. The transfer function is now

\[ \frac{E_o}{E_i} = \frac{1}{sC_1\frac{1}{\zeta} + \frac{1}{sR_1C_1} + \frac{1}{sR_2C_2} + \frac{1}{1 + \frac{1}{sR_3C_3}}} \]

Calculations can be based on the following design equations.

\[ C_1 = \frac{1}{\zeta^2}, \quad C_2 = \frac{1}{\zeta^2}, \quad C_3 = \frac{1}{\zeta^2} \]

where \( \zeta \) is 0.15, \( A \) is unity passband gain, \( R_1 = 2\, \Omega \), \( R_2 = 1\, \Omega \), \( R_3 = 1\, \Omega \), and \( R_4 = 1\, \Omega \). Applying these design equations, the values given are obtained. Standard values have been selected.

\[ R_1 = 1\, \Omega, \quad R_2 = 2.4\, \Omega, \quad R_3 = 2\, \Omega, \quad R_4 = 0.01\, \Omega \]

D. Carter

Thorn-EMI Dated Ltd

Somerset
TECHNOLOGY AND PEOPLE

If, as J. A. MacHarg (’W’ letters, October), asserts to his advocacy of Professor Campbell’s theories, “everything we do is done ultimately for stimulation of the pleasure areas which have evolved out of the ‘small brain’ of the fish” why is it then such a common observation of human life, that those who do what they like rarely seem to like what they do?

S. C. Elliston
Hemel Hempstead
Hertfordshire

DESIGN COMPETITION

To remove background noise when a person is speaking (Letters: G. Barnes, October 1983) might consist of an amplifier whose frequency response envelope matches that of the human voice. In a more advanced design (i.e. where an amplifier is required to discriminate between an unusual kind of sound and its noisy background) a variable frequency response, preset or manual might be provided.

If the background noise is weaker than the signal, one could also arrange for the sound to be amplified more than soft others. After this initial contrast expansion (by a non-linear circuit) the signal could be clipped at its lower energy level and finally returned to its original amplitude range (by an inverted non-linear circuit).

The above two selection “modes” of an amplifier (frequency discrimination and amplitude discrimination) could be combined with a third selection-mode, namely, signal discrimination in which the opposite-polarity-paint microphones are used in anti-phase.

A. H. Waterford
Maxwell Hill
London N10

CURRENT DUMPING

Wireless World of September and October contain no less than 12 pages by Mr. McLoughlin, analyzing very thoroughly the contributions to current dumping that have appeared in this publication.

I will agree at once with Mr. McLoughlin’s analysis. Yes indeed the presence of $R_2$ does affect the balance condition exactly as it states. His mathematics, as one would expect, are quite precise and perfectly acceptable. Yes again, we are quite prepared to accept $\pi \times 10^{-5}$ error in the balance condition and still achieve a major advantage over a non-current damping amplifier of the same configuration and the same overall feedback.

If I may summarize Mr. McLoughlin’s conclusions they are, I believe, that of the balance condition is perfect all works as it should, but that there is no error in the balance condition as there must be, then one is better off without the current damping circuit. This does conclude the entirely loop gain and the necessity to meet the Nyquist criteria. Indeed we have twelve overall steps without a single step to right.

If we take the simplified model repeated as Fig. 1 for convenience and assuming $A$ to have very high (call it infinite) gain, then indeed removing C and shoring L produces a perfect conventional amplifier—a amplifier with conventional feedback and very high (call infinite) loop gain. But such an amplifier is impossible.

In the simplified circuits, we have used the concepts of ‘virtual earth’ to define the gain of the class A amplifier. This seems to cause some confusion, so let us redef it as an integrator of defined gain, filling in the other values to suit, as in Fig. 2.

The balance condition is met and the overall feedback is 48dB at 10kHz and falling with frequency—just about what is required for a good stable amplifier, and we’re all agreed an ‘unnecessary’ distortion.

Next, assume an unbalance of 10% by changing any one of the constants, let’s say by changing X 10%. At once a small risk appears in the transfer characteristic. It distorts. So following McLoughlin we now get rid of the current dumping by shortening L completely. The distortion is now much worse and we find we have to interfere with the integrator gain to remove the situation. But what do we have? We have in fact just added more overall feedback. How else could our life would be but interfered feedback ad infinitum.

Peter Walker
Acoustical Manufacturing Company
Huntingdon

I have read with much interest the articles by Michael McLoughlin in the September and October issues. Setting that my name is mentioned several times in them, I would like to make the following comments.

The exploitation of the basic principle of the Quad 405 amplifier given in my Letter of July 1976 is described by Mr. McLoughlin as ‘inactivating’, and my dictionary gives the meaning of anti-inactive as ‘immediate apprehension without reasoning’. Now it seems to me that my explanation involves rather rigorous reasoning as far as goes, and in several hundred pages of notes on the topic I have used a good deal of simple algebra. But I thought it best for the July Letter to omit the algebra and let the essential simplicity of the idea stand out unadorned.
In the grey-background editorial insert on page 51, the author points out that the amplifier works by feed-
forward, another method to improve performance. The feed-forward technique is described as a method of not only correcting for errors but also providing a partial correction of the overall feedback loop. The feed-forward amplifier is said to be more effective than the classic amplifier and is capable of providing lower distortion. The feed-forward amplifier is particularly useful in high-fidelity applications, where the performance of the amplifier is critical. The author concludes that the feed-forward amplifier offers a significant improvement over the traditional amplifier approach, and it is likely to become more widely used in the future.
Our competition closed with numerous completed entries: an impressive response in view of the many distractions of the summer months. They range from simple domestic items up to complex computer-linked projects; and one of the judges' hardest decisions will be in finding where lies the greatest benefit to the disabled. This page shows a selection, though mention here should not be taken to imply endorsement.

Arrangements for the judging and presentation of awards have yet to be finalised, but we have fixed a date of 30th January and will announce full details soon. A short-list of the most promising entries will be compiled by the Wireless World editorial staff, to reduce the task of the judges to manageable proportions; and in the case of short-listed entries which have been submitted in paper form only, we shall then request the devices themselves for demonstration.

To select the prize-winners we have invited the following:

- Mr Bill Bond, Principal Lecturer in the Mechanical Engineering Department of the Polytechnic of the South Bank in London, Mr Bond runs Britain's only degree course in engineering product design. He is also involved in work for the handicapped.
- Miss Elisabeth Fanshawe, Director of the Disabled Living Foundation. The Foundation is a charitable trust; it operates an information service and conducts research connected with aspects of ordinary life that present problems to disabled people. Miss Fanshawe is an occupational therapist and is herself disabled.
- Mr David Gneissell, Managing Director of Possam Controls Ltd, which manufactures a range of electronic aids for the disabled.
- Professor Meredith Tring, former head of the Department of Mechanical Engineering at Queen Mary College, and author of many books on engineering in theory and practice.
- Professor Heinz Wolff, head of the new Brunel Institute for Bioengineering at Brunel University, Uxbridge. Part of the Institute's work is connected with technological aids for the elderly and disabled.

One of the first parcels to arrive, and physically one of the smallest, brought us the Talking Box from Mr Ian Mitchell of Hull. Scarcely larger than a pack of cards, this contains a speech synthesiser and a tiny loudspeaker. At a touch on the keypad, a pain-inhibiting pulser from Mr Ray Lightwood, who works at the Queen Elizabeth Hospital in Birmingham. This is a small battery powered stimulator, complete with skin electrodes, and is intended to give relief to sufferers from severe intractable pain. According to many authorities, electrical stimulation can relieve neural pain or nerve pain relievers.

Distress alarms are a common need for the elderly or disabled, and we have received several. One of these uses a portable infra-red transmitter: this sets off an alarm via a remote pick-up point feeding signals through the mains wiring. Another alarm for multi-occupied housing, employs low-power h.f. radio links giving seven separate alarm circuits. Remote control techniques have been adopted by several other entrants to provide easy operation of household electrical items.

On the lighter side, one intriguing little entry is an aid for computer games players. Computer games, believe it or not, have a useful function in developing co-ordination; though for disabled children the average zap-the-aliens game often runs much too fast. But with the 'Slow'chess' board in the competition, they're in with a chance. For this tetraplegic computer programmer, a computer interface designed by Dr Michael Bolton and Mr Lester Taylor means full-time employment.

Out comes your choice from a couple of dozen phrases of everyday usefulness (please can I go to the toilet?), for greater versatility an external keyboard can be plugged in.

The problem of communications for the handicapped seems to invite solutions in electronic form and has been a theme in the competition. Another entry connected with speech difficulties was brought to Quadrant House by one of its co-designers in person. The Hector Speech Aid is a gadget to help overcome stammering: hidden on the body, it discreetly provides a stabilising 'feedback' to the ear. We hope Mr Ron Turrell won't mind if we reveal that his stammer is ordinarily quite severe, because with his device in action it seemed to vanish altogether.

An unusual entry in the medical field is a computerised diagnostic aid. For this tetraplegic computer programmer, a computer interface designed by Dr Michael Bolton and Mr Lester Taylor means full-time employment.

Having shown how the address interpreter executes addresses of execute program commands and that threaded code is compact, I will now explain how Forth builds these lists, i.e., how it compiles. Each list representing an action is rather like a verb in a natural language and in Forth is known as the dictionary. The outside world in Forth breaks input text down into character strings, then searches for in the dictionary. (Spaces are important, for instance, "1-1" is treated as a negative number, whereas '1' is treated as the arithmetic subtraction operator followed by the positive number.) If the string is found, it is executed, otherwise an error message is generated. The dictionary also needs a mechanism to allow the search to occur. Searching involves a traversal of all the words in the dictionary. Each entry has a pointer to the previous link (field), which makes the dictionary a linked list. To enable matching of the source text each word also has its name in ASCII form (name field). Dictionary entries for each word, List 1, have four fields - name field, link field, code field and parameter field. The name field also contains pointers for use by the compiler (precedence and smudge bits) as will be explained, and it includes the length of the name to allow variable name lengths of up to 31 characters.

Language expansion is important to be able to build dictionary entries for new words. This is done by invoking the compiler. When the compiler is invoked (Forth word "execute"), the language state is switched from execution to compilation. Next, input text is scanned forward for the next text string which is used to build a newly created name field. The name is 'smudged' so that during the building of the incomplete definition, the same name cannot be found. This normally prevents recursion, but again in Forth, this rule can be overcome, List 2. Then the linked list of the dictionary is updated by copying it into the dictionary link and the address of DOCALL, i.e., a pointer to this new word's code field. Next, input text is scanned for character strings. As these character strings are matched with words that already exist in the dictionary, the code field of each word found is copied into the parameter field of the word being compiled. Finally, as the word to terminate compilation is encountered, SEMIS is copied as the last word of the definition and the Forth program is returned from the compiled state to the code routines which ultimately have to be compiled are at the bottom, in a long search. No speed up algorithms such as hashing have been employed. The complete process can be quite long as many dictionary searches have to be made. As the dictionary is a linear list and the
CONSTANT full when the code will be placed in.

The original top element is now second and all other elements move down.

Space and time

I have shown how the Fort rectangular dictionary is created (i.e., its form), how it may be extended and compiled, and how any processor may readily implement the virtual Fort rectangular machine by means of indirect threaded code. The Fort rectangular compiler, by introducing the concept of threaded code, execution speed is traded for code space. So one can expect that the code will be as fast as the host processor's own code although it may approach where many subroutines call are made. Execution of a process defined by the source language divides into two parts; one is the examination of source text to find out what action is to be taken and the second is execution of the actions by the processor. The first part is carried out by compiling source text in the machine code of the host machine. In this manner the machine code of the hypothetical machine is synthesized in turn run in Fort in the address interpreter.

Memory-time benefits are illustrated by the list of memory required for a Fort system, and the virtual-machine code (may be run) for virtual-machine simulation, the processor, i/o drivers, etc., and 8K for stacks, virtual-memory buffers and the user dictionary.

### Table 1. Relative speeds of various processors and languages

<table>
<thead>
<tr>
<th>Processor/language</th>
<th>Time</th>
<th>8190 Constant Size</th>
<th>8190 Variable Size Allot</th>
<th>DO-PRIME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CRAY-1 Fortran</strong></td>
<td>1.8</td>
<td>1.1</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>IBM 3081</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3082</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3083</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3084</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3085</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3086</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3087</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3088</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3089</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3090</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3091</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3092</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3093</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3094</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3095</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3096</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3097</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3098</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3099</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3100</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>IBM 3101</strong></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Fort is also fast because of the explicit use of the stack and the use of languages using the assignment operator, data normally resides in the local buffer, and the actual size of the stack, operated on, and finally placed back in the store. If the next statement uses the same variable it is again accessed from the store and placed on the stack.

When computing partial results this causes excess memory traffic. Unless optimization is used this redundant memory activity costs some time. This paradox is resolved because normally data only resides on the stack. No unnecessary memory space or time is required for the variables.

It is interesting to compare Fort's performance with the commonly used languages for microprocessors. BASIC systems using BASIC have little compiler actions, some not even compiled. The virtual-memory code, although the key words are converted into internal tokens. During program execution each variable is accessed and stored in turn so the source of BASIC's execution-time interpreter is close to that of the source processor. Fort's source for the running-time interpreter is close to the language of the host computer. As all the work in a BASIC system is done while the program is running the speed penalty may be up to 100 times.

Further, since Fort comprises object code into 16-bit addresses (code-addressability) instead of words (code-addressability) it is as efficient as BASIC in terms of memory space.

### Processing speed

Processing speed is an eminently issue without benchmark tests and benchmark benchmarks are notoriously difficult to produce. Table 1 was derived using the Seize of 1980s (see List 5) and area above. Unfortunately, it is not known what one could expect — assembly-language performance, compiled languages with interpreted BASIC well behind. The table also shows how well the 6809 compiler performs, and more properly shown in the analysis of Fort word number in that one may not compare the instruction set does not necessarily lead to a more effective processor. This has been shown to be effective within a large scale device.

### References


In learning assembly language programming one must also know how to write programs to suit different microcomputer systems. In his eighth tutorial, Bob Coates looks more closely at elements of Picotutor and describes its use as a stop watch to demonstrate the hardware timer.

In this article I describe Picotutor in more detail, looking in particular at how the keypad and display operate. To demonstrate the hardware within a microprocessor a description of how to program Picotutor as a stop-watch is included. A disadvantage of an assembly language is that the microprocessor has to have its own unique language so to demonstrate the subject one has to choose a particular processor. To complement this series I designed a small microprocessor trainer based on an eprom version of the 6805 — the 68070 — which was described in the December 1982 and January 1983 issues of WFF. The 68070 is primarily intended for small industrial and consumer-chip control applications, as opposed to microprocessors such as the Z80 and 6502 which are intended for use in larger computers, and can only be programmed at assembly language level.

Two main reasons for designing Picotutor were low cost and simplicity. As a result, it is not possible to enter programs in a high-level assembly language; they must be converted to machine code by hand. For beginners hand assembly has the advantage that it gives one a greater appreciation of the subject and for small programs the examples given in this series have been hand assembled.

Reading the keypad
Operation of the keypad and display was described in the December 1982 issue. To recapitulate, peripheral ports B and C of the 68070/6805 microprocessor are used to interface the keypad and display. Reading of the keypad and driving of the display are performed by software in the monitor program and four sub-routines can be used in user programs to provide these functions. KEYIN scans the keypad and returns a code in the accumulator (A) for the key currently being pressed. If no key is being pressed (or more than one key) the accumulator is cleared.

KEYOUT performs a dynamic refresh of the multiplexed display with data contained in six ram registers (one for each display digit). The number of the ram register byte indicates whether its associated segment in the display should be lit or not. When the display function is complete, KEIN is executed before the subroutine returns. DISGET repeatedly calls DISKEY (giving a value of 0 to the continuous refresh of the display until a new key is pressed, then returns with its code.

DISHEX calls DISGET and if the key pressed is a hexadecimal key, converts the key code to the appropriate hexadecimal code.

I will first explain what keycodes are and how they are formed. The Texas keypad used is a 4 by 4 matrix of keys, i.e. six columns and four rows, with a switch at each row/column junction (see circuit diagram). Closing a row or column switch completes a circuit and row and line switches are shorted together. So with only ten connections to the keypad, the microprocessor is able to determine which one of the 24 keys is being pressed. The six columns go to port B and the four rows to IC2, but which connections go to which pins was determined by the easiest p.c. layout. When it detects a column/row short, KEYIN software produces a unique 8-bit code which may appear to be random. When a code is produced doesn’t matter, as long as it is unique. See what code a key produces with the following program.

<table>
<thead>
<tr>
<th>030</th>
<th>BD0 BD9 JSR DISGET 032</th>
<th>BS 5W1</th>
</tr>
</thead>
<tbody>
<tr>
<td>033</td>
<td>This program when run will refresh the display (which will show the last key in the go commands) until a new key is pressed. It will then execute the software interrupt, with the accumulator containing the key-code. The accumulator can now be examined using the reg key and it will give the key-code for the key you have just pressed. Try this program with each key of the keypad and build up a table of the key codes. Now change the subroutine call from DISGET to DISHEX (address 8c) and it should covert the hexadecimal code to the correct machine code (00 - 0f), but leave other codes unmodified. Check also that the C bit in the condition-code register is clear if a hexadecimal key, but set otherwise. This is to inform the calling program as to whether or not a hexadecimal key was pressed.</td>
<td></td>
</tr>
</tbody>
</table>

Drilling the display
The basic subroutine for driving the display is DISKEY, which also scans the keypad. Digits in a multiplexed display can only be lit one at a time to give the impression of a multi-digit display, each digit is lit in turn for a short period and when the last bit has been lit, the first is lit again, and so on. In PICOTUTOR, the looping period is about 20ms, so a slight flicker may be noticeable in the display. As segment data cannot be latched in the display, it has to be stored in ram and retrieved when required. Six bytes of ram are used to store six of the display digits. Each digit starts at address 010 which is given the label DISBUFF (display buffer). To effect a display, appropriate segment data is stored in the six bytes of DISBUFF and then DISKEY is called repeatedly, in a loop. Each bit of a DISBUFF byte drives a particular segment of the appropriate digit, a one bit causing the segment to be lit, a zero bit causing it to be extinguished. Bisegment allocations are shown in Fig. 1. A display is generated in a particular sequence, e.g. the display will be in the on position first, followed by the off position second, then the on position third, etc. The sequence determines the pattern to be displayed. For example illustrates how to drive the display.

<table>
<thead>
<tr>
<th>020</th>
<th>BD0 JSR JSR CLRDIS 022</th>
<th>A5 BD86</th>
</tr>
</thead>
<tbody>
<tr>
<td>030</td>
<td>This program performs a software interrupt when the timer goes over, and afterwards the cathode is disabled before the segment is altered to prevent a ghosting effect in the display. First, ports B and C are set as outputs, then the same pattern (PP) is stored in an address label CATH (port C data register) since all ones to IC5 disables all outputs. The index register is used as a pointer to DISBUFF ram and is initialized to set to zero.</td>
<td></td>
</tr>
</tbody>
</table>

Now look at List 1 to see how Picotutor performs this. Note that segment data is set in PP from the monitor program, and after this is cleared, and afterwards the cathode is disabled before the segment is altered to prevent a ghosting effect in the display. First, ports B and C are set as outputs, then the same pattern (PP) is stored in an address label CATH (port C data register) since all ones to IC5 disables all outputs. The index register is used as a pointer to DISBUFF ram and is initialized to set to zero.

The accumulator is loaded with data from the DISBUFF ram for the first digit.

<table>
<thead>
<tr>
<th>030</th>
<th>BD0 BD9 JSR DISKEY 032</th>
<th>2C 10FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>033</td>
<td>This is stored in label SEG (port B data register). Next a value is loaded into the accumulator from the DISGET table (digit select) which is a table of 6-bit patterns for driving port C to select each of the six digits. The table contains 8 entries, one for each digit, which is why DISGET requires 6 bytes of data. In CATH and at this point, the left-most display digit with the 'go' command is now entered to display the 1st digit. This delay loop is a little odd because it is designed to exit with PP in the accumulator.</td>
<td></td>
</tr>
</tbody>
</table>

A value which determines the period of the delay is initially loaded into the accumulator and it is in fact set with the maximum delay value causing 256 iterations of the loop to DISK2. When the delay loop is left, the accumulator contains 00h which is stored in CATH (Port C), disabling the digit cathodes. The index pointer is then incremented and if all digits have not been set (X<6), the program loops back to DISK1. This second time round, the index register contains 80h so the two LDS, in-indexed instructions load the second value in DISBUFF and DISGEL followed by the new accumulator.

The main loop is executed six times, lighting each of the digits in turn for about 30mS. When refresh is complete, this subroutine scans the keypad, the display is not required so it is cleared, but remember that the accumulator is modified by the refresh.

6805 timer
The above display driver routine uses a software loop delay, but the 6805 has an inbuilt delay which is even more suitable for this kind of work. It works as follows:

When the timer has been set, it causes an interrupt at a predetermined time, which allows accurate time to be determined, while allowing the processor to function normally in between.

Clock source for the timer can be either the internal system clock or an external clock, selected with the timer input pin. Getting of the internal clock by the external TIMER input allows pulse-width measurements to be made. A variable prescaler may also be used to extend the range of the timer to any number of bits, to give the equivalent of 15 bits and a maximum count of 32768.

There are two registers associated with the timer, the timer data register (t.d.r.) and timer control (t.c.c.). Input pulses decrease the data register and when it reaches zero, an interrupt is caused. The timer interrupter may be programmed with an initial value to give the required timing period. The control register is used to set up the various operating modes and timer control interrupts. Page 29 shows the two possible configurations for the control register, one to provide correct emulation of the ram versions of the 6805 and the other to allow software programming of the timer, which is the one applicable to Picotutor.

To operate the timer the mode of operation and the prescaler value is first set, the program then loads the required count stored in the data register and the timer interrupt mask cleared. Program execution may then proceed, but will be interrupted when the count in the timer data register reaches zero. The interrupt-service routine in which the timer interrupt has occurred will be performed until it finishes and then return from the interrupt to execute the next line of the main program. This gives very brief one way in which the timer may be used. I do not intend to cover all the details of the timer as these are adequately covered in the manufacturer’s data.
Stopwatch

Figure 3 is the flow diagram, but there are considerable difficulties involved. Figure 2 is the flow diagram for a software timer. It is important that the loop takes an exactly known and constant amount of time to execute. If it took 100ms for instance, the time display would increment exactly every tenth of a second. Although DISKEY takes a fixed amount of time to execute (if no key is pressed), time increments will vary according to whether a carry between digits is required. For instance, if the least significant digit is nine, then it must be cleared rather than incremented and the next digit incremented instead, or if that is nine, cleared and the next one incremented, and so on. If no carry function has to be performed, one operation can be skipped and operation will be much quicker. To ensure that exactly the same time is taken each time around the loop, blocks of non-operating instructions or some other form of delay must be introduced for the shorter execution paths to ensure that all possible paths are exactly the same length. This is difficult and time consuming to program correctly.

A much better solution is to use an independent hardware timer to keep track of time precisely so that time taken to perform software loops no longer matters. Figure 3 gives the flow diagram for such an operation. The main program merely has to keep refreshing the display, and every so often it is interrupted in the middle of its task by the timer, which causes an interrupt at regular intervals. When an interrupt occurs, the c.p.u. pushes the current contents of all registers including the program counter on the stack to save them. Then it gets the address of the interrupt-service routine, that in the program counter register then carries on processing from the new program-counter

Stopwatch flowchart

Figure 4 is the full stop-watch flow diagram. This stopwatch uses three port A inputs to provide start, stop, and zero functions for the two-digit display which counts in tenths of seconds. Three of the eight dual-line-in-line switches are used for this function. The stopwatch itself is divided into two entirely separate parts. After an initialization section, the main program goes into an infinite loop, the execution of which will occasionally be interrupted by the timer. The timer interrupt-service routine is then executed and after the return-from-interrupt instruction, main program execution resumes from where it left off. An interrupt is caused by the timer when its data register is decremented to zero, providing both the figure 2 interrupt (c.c.r.) and timer interrupt (t.c.r.) mask bits are clear. This can occur anywhere in the main program as the timings are not related, and when it does the c.p.u. completes the instruction in progress before servicing the interrupt. Because seven-segment codes used by the display are in no way connected to the hexadecimal digits they display, a separate two-byte register giving in this case the b.c.d. equivalent value of the character in the display is used.

Main program

List 2 shows assembly language for the stopwatch program. This list was produced by a Motorola development system assembler. Before the start of the program proper, some setup to be defined as they are not defined in the program by the assembler, and then the list. The first three EQU instructions give the addresses of system calls used within the monitor program. Addresses within the 6800 memory map of port A data register and the timer control register (t.c.r.) and its bit numbers within the t.c.r. of the interrupt mask and request bits are given. Remaining REQU instructions are r.r. registers.

The ORG statement tells the assembler the address of the first line of data. First the time flag in the condition-code register is cleared to allow interrupts to take place. The time counter is then set to divide the clock source from the internal system-clock by 51, the time interrupt-request bit cleared, the prescaler cleared and the timer interrupt-mask bit set, all by storing 01000101 in the timer control register.

Next the register TIMEV is set with the
When a timer interrupt occurs this routine loads the index register with the contents of the timer start address and the event time with the value of the current time. The timer interrupt routine must be called every time the interrupt occurs, with the 24-bit time value being decremented by 32.

The timer interrupt routine is called by the hardware interrupt service routine when the timer is active. The routine is responsible for decrementing the timer counter and checking for the end of the timer period. If the end of the timer period has been reached, the routine can trigger an interrupt to the system software.

### Timer-control routine

#### Configuration

The timer-control routine is configured using the TCR (Timer Control Register). The TCR contains several bits that control the operation of the timer.

- **TCR bit 1**: This bit enables the timer. When bit 1 is set, the timer is enabled and starts counting down from the initial value.
- **TCR bit 2**: This bit selects the timer mode. It can be set to select either the clock mode or the timer mode.
- **TCR bit 3**: This bit selects the clock source. It can be set to select either the internal clock or an external clock source.
- **TCR bit 4**: This bit selects the prescaler divisor. It can be set to select a prescaler divisor of 1, 2, 4, 8, 16, or 32.

The timer counter is decremented every clock cycle if bit 1 is set. If bit 2 is 0 and bit 3 is set to select an external clock source, the timer counter is decremented every clock cycle.

### Timer-control routine implementation

The timer-control routine is implemented in the system software. The routine is called by the hardware interrupt service routine when the timer interrupt occurs.

```assembly
; Timer-control routine
; Configuration
movlw b'0001'; ; TCR bit 1: enable timer
movlw b'0000'; ; TCR bit 2: select clock mode
movlw b'0000'; ; TCR bit 3: select external clock
movlw b'0000'; ; TCR bit 4: select prescaler divisor of 32
```

### Timer-control routine usage

The timer-control routine is used to configure the timer for various applications. The routine can be used to configure the timer for a variety of purposes, including real-time clock, event timer, and interrupt timer.

#### Example usage

- **Real-time clock**: The timer can be configured to count down from a starting value and generate an interrupt every time the count reaches zero.
- **Event timer**: The timer can be configured to count down from a starting value and generate an interrupt every time the count reaches zero. The interrupt can be used to trigger an event, such as a pulse output or a change in a digital output.
- **Interrupt timer**: The timer can be configured to count down from a starting value and generate an interrupt every time the count reaches zero. The interrupt can be used to trigger an interrupt service routine, which can be used to perform a variety of tasks, such as updating a display or updating a sensor.
Behind the micro

Putting the microcomputer to work: a guide to computers for laboratory or workshop

Choosing a microcomputer—rather than letting one be chosen for you—is a difficult task for those who want to experiment, write programs and interface and control their own circuits. There is information enough for people who want to buy a microcomputer for office use or to play games on. But there are many potential users between these two groups who want a microcomputer which they can develop to suit their needs or catered for by off the shelf hardware or software. Among these people are engineers, technicians, designers, teachers and home-computer users. Our survey concentrates on the needs of potential microcomputer users in these areas, in particular on interfacing.

For a journal such as ours there are different ways of approaching a microcomputer survey, the two extremes being to talk about four or five computers in depth or to give very brief details about as many as possible. The first method is the easy way out but it is unlikely that one will find the computer best suited to one's needs from the four or five discussed. The second approach is more helpful in that it allows one to compile a list of computers that potentially suit one's needs.

Here we present a table to allow you to compile a short-list, and give further information about the computers mentioned to supplement it. We have biased supplementary information towards that relevant to the technically-minded computer buyer.

A supplementary article appearing in next month's issue provides further information for potential microcomputer buyers and a list of addresses and telephone numbers of manufacturers mentioned here. Popular interfaces are discussed as are a few computer boards to give you an idea of what computers without cases are for, and their advantages and disadvantages.

About the computers


Acer BBC Microcomputer: Paged rom feature permits up to 16 resident languages, utilities, applications programs. Two parallel ports, 8-bit port, RS232, four-channel analogue input. Second processors on the way, Z80 (for CP/M), 16032 (for UNDOS and 6502). Optional rom cartridge port, speech synthesizer, networking, Viewdata and teletext/television adaptors. Easy mixing of Basic and assembly languages other languages include Forte, Basic, S-Pascal. Widely used in schools and colleges. Eleson, stripped-down version of BBC micro using the same BBC Basic. Upgrades promised.

ACT International Sirius 1: for technical applications, scientific word-processing, product design and manufacturing. Interfacing to existing computers. Optional d.m.a. board for expansion port. Apron: aimed mainly at the businessman, but with many features of wider interest.

Action Instruments PAC personal automation controller: ten-slot expansion bus for maker's range of analogue and digital I/O boards. Extensive interface possibilities.

Advance 86a: 'compatible' with IBM personal computer. Separate keyboard stores in base unit for portability. Upgradable to 869, which has two disc drives.

Alpha Micro AM1000: business computer with i/o expansion module option: video interface allows fast serial data transfer. Other models available.


Aston Technology Crystal 68000 range: bigger machines are multiple-user Winchester-based. R series for RS323 communications, C series for networking through high-speed coax links. PUCK operating system said to be easy for first-time users. Fooram, C, Pascal, Cobol, APL. Can support CP/M indirectly.

Atari: range is aimed largely at home games players, but there is much software for more serious purposes. Shop around. Type writer compatible. 600XT has 256 colours, four-voice sound, cartridge slot, 16K ram expandable by 64K. Data storage is on special cassette machines (not included) or disc. Add-ons include joysticks and trackball controllers.

Beadesdale BDC806A: d.m.a. controller as standard, internal IEEE-796-1981 bus with six slots free, ten RS232 ports. Options include 10MHz processor, multi-user capability, case back-up. Intermediate system named 'MISTRESS' relational database management system. Maker supplies interesting UNIX benchmark comparisons.


British Micro Mimi 801: modular design, 50-pin bus connector, internal Winchester connector. CP/M-compatible operating system. Allows conversion of Superbrain format discs to Mimi format. High-resolution graphics option.

Bromcom Superstar 10: $100 bus, CP/M (2.2 version for 280 or 86 for 8086 proces- sor). No disk drives provided. Options include MS-DOS, integral Winchester storage, multi-user capability (with up to 16 processors).


Computer Games Ltd CGL MS: joystick port, cartridge port, 36-way expansion bus. Character set includes Greek symbols. Also available as Sord MS.

Comart Communicator range: numerous Z80, 8086 models, good choice of operating systems. Keyboard not included. Modular design, multi-processor option.

Commodore: range includes scientific, business and home computers. Good software availability. VIC/20: primarily a games computer, but IEEE interface available. 65 second processor, networking. Viewdata options, educational software. 550 for scientific applications. UX 500, 1K ram. Optional CP/M, MS-DOS using second processor.

WIRELESS WORLD DECEMBER 1982

FORMULA ONE

Word and Formula Processor

FOR COMERCIAL AND TECHNICAL TEXT TYPESET WORK FROM YOUR TYPIST

First for simplicity

The new Formula One system makes it easy to create complex scientific notation and quite simple to do the display of different typesizes or special text in a complex format. To obtain superscripts, subscripts, a different typeface or enhancement to computer enlargement or design to be embedded in the text.

Formula One is a new and simple approach to word and formula processing made possible by the development of a very high resolution full page display. It is possible to prepare text in a number of different typefaces which can be in various point sizes and styles covered with a wide range of technical symbols.

The display is an exact replica of the printed output. This includes true on-screen proportional or monospaced typeface and representation and spacing, page line shifts and character enhancements. As last it is possible for the word processing operator to feel confident that if the text is correct on the screen it will be correct when printed.

Formula One the most powerful and flexible system available.
WIN

HOW TO ENTER: BUY JUST ONE OF THESE PRODUCTS TO RECEIVE YOUR ENTRY FORM BUT HURRY — CLOSING DATE FOR ENTER IS 31.1.84 AND YOU CAN'T BUY BETTER

1st Prize: A 14" COLOUR TV WITH TELETEXT AND FULL REMOTE!

2nd Prize: SHARP PC1500 PORTABLE COMPUTER!

3rd Prize: £50 VOUCHER to spend on any product on this page!

3rd Prize: £50 VOUCHER to spend on any product on this page!

Don't waste money!
ON OTHER COMPUTERS: COMPARE THE TiM WITH OTHERS TO COME OUR LAST!

FROM £599
Publicans, garages, schools

PUBLIC INN

TMS SYSTEM
PROCESSOR
CHOICE OF 32K, 48K OR 80K CORE RAM


Apple

PROJECTOR COED

Special Offer until January 1, 1984
LOGIC SELECT

English

On our F11 set, this looks like a breath of fresh air in the world of hi-fi connections.

FREEBIE

If your F11 has a tape deck, it comes with a built-in 24-bit PCM decoder, and this works wonders with your hi-fi equipment.

APPENDICES

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)

FREEBIE

A high-quality date while printing anti-UV marking, while checking other features for the latest VDU memory reads, tone back off (printing)
was pleasantly surprised to receive your parcel yesterday only 2 working days after I first wrote to you - not many suppliers in the small computer market manage such a fast turnaround time.

1L. London

Once again, many thanks for your speedy and efficient service.

H Y. London

We didn't learn by our mistakes.

Since its inception in 1979 Midwich has specialised in the educational market and is probably now one of the most widely recognised suppliers of microcomputer products.

From the outset our educational policy has been one of preferential pricing, service, supply and support.

As a result many departments in most of Britain's universities are regular customers. The majority of technical colleges and hundreds of schools are supplied and serviced by Midwich.

Complex new systems such as Econet are supported by fully trained engineers and the very latest equipment. And every system is thoroughly checked and tested before installation.

We didn't want to learn by our mistakes, so we've tried not to make them.
A single card computer for only

THE IBS 750 S.B.C.

NEW BUDGET ACCOUNT
£1,000 Instant Credit on Any Products

VISIT US AT COMPEC Stand 2976

SWITCH MODE POWER SUPPLY
+ 5V @ 7 amps
+ 12V @ 3 amps
+ 12V @ 1 amp
- 5V @ 1 amp

80W £79.95

Subject to Yen fluctuation

FROM IBS 750 £25.00

£423.35 Depreciation Per Month £48

4 MEG 280 CPU
64K RAM
14K PROM
5" & 8" DISK CONTROLLER
80 x 24 VIDEO GEN
2 x SERIAL I/O
4 x PARALLEL I/O
IEEE 488 INTERFACE
KEYBOARD PORT
HARDWARE RTC
MONITOR IN PROM
BARE BOARD

FINANCE AVAILABLE @ £99.95
Above price excludes £32 400

IVRINE BUSINESS SYSTEMS LTD
1 Montgomery Place
Irvine, Ayrshire KA12 8NP

Tel: 0294 75000

10% Deposit + 24 x Monthly Payment Credit Limit. A.P.R. 30.6%

HAND MADE BY HUMANS IN IRVINE, SCOTLAND

ww - 086 FOR FURTHER DETAILS

WRITING WORLD DECEMBER 1983

A Real-Time Winner

polyFORTH gives you flexibility, efficiency and programming productivity hitherto undreamt of - it is fast to develop programs and fast to execute them.

polyFORTH multi-tasking means multiple task organisation within one application, and multi-terminal access to a shared system.

polyFORTH target compiler with full system source facilitates creation of customised embedded systems as well as complete regeneration of polyFORTH itself.

polyFORTH options include database management, screen editor, floating point and screen debug.

Recent Upgrades include HELP screens for all utilities, on-line access to extensive source documentation, name length increased to 31 characters, 400 page manual.

polyFORTH - the professional software system for the professional user.

Get the full FORTH story from Computer Solutions Limited
1 Gogmore Lane, Chertsey, Surrey KT16 9AP
Telephone: Chertsey (0933) 65292
Telex: 8954029

WW - 087 FOR FURTHER DETAILS

WIRELESS WORLD DECEMBER 1983
MEMOTEX TX series: ram expandable to 512K; up to two expansions (ram or communications) can be fitted internally; joystick and cartridge port; separate sockets for keyboard; networking not possible; assembler/disassembler included, third party and Pacal available as

Miconix MX range: CP/M system, ram expandable to 128K. Two RS232 ports, parallel buffer; RS-232C subinterface available. Ready keypad. Four models; single-board available separately.

Modcomp Zora 2000 series: transportable with 9-inch screen. Can read and write to various disc formats. Maximum 16K.

Modulator VME/10: designed for scientific and engineering uses, software development. Various configurations possible. VME bus with additional I/O channel to serve peripherals. EXONET interface.


Modularised design; two expansion boards, sound and pro-multiprocessor synthesiser boards, mini-printer. MFPI M-150

NEC APC (Advanced personal computer): colour or monochrome with high resolution graphics; lin disc drives; sound card; software; assembler; communications facilities. Range also includes some 8-bit models, including the PC-XG(8K/128K), a portable similar to the Tandy 100 but with 16K ram.

Newbrain: was almost adopted as the BBC microcomputer. Two serial ports, one parallel; two cassette interfaces; optional built-in fluorescent display. Full RS-232 connection. Following the recent demise of Grundy Business Systems, the Dutch distributor Tradecom has taken responsibility for the Newbrain and it will now be distributed in the U.K. by Brainware.

Oriol O1: moving eyes, right, back-sound generator, teletext display mode; add-ins include colour plotter, lin disc drives; communications options for RS-232C; sound card; graphics. Maximum 512K ram, mechanical interlocks, 48K eprom.

Osborne Executive: portable with 7 inch screen, can read/write numerous disc formats. Also Osborne 1B at £1495.

A list price of £299.95...


Microm: DMS-60-D: parity checking, local-area networking facility as standard. Ethernet gateway, multi-user, communications options. Range includes several other models; upgrade kits available.

Haywood 9000: CPM: computer. Serial output is prom-programmable in five modes for special applications.


Hotel Microsystems Micro: new configuration allows complete freedom from Z80A CP/M system up to 68000-based model, including 256006 range. Ten S-100 bus slots.

Hynek Prelude 20: CP/M computer can be upgraded to hard disc. Network interface processor option. MS-DOS personal.

IBM Personal Computer: colour and hard-disc options available. Standard o.s. is MS-DOS but others available; MS-DOS limited to BBS and Unix "being looked into". Five expansion slots are available internally. Printer and scanner software included in price.

ICL Personal Computer: two models with CP/M and Basic, two with CP/M and Basic. Hard disc except on Model 15. Design will accommodate 88888K to 128K of memory. Basic/CP/M communications, much software. Maximum memory 512K, four channel disc drive.


Integrated Micro Products IMP-68: multi-user operating system, C compiler, Pascal compiler, terminal interface, and CPM, RT-11 and UNIX discs. Up to 1MB ram with parity-checking. 5100 i/o and on-board i/o can be mapped to any 48K block d.m.a. Maximum of ten serial ports. Cartridge tape backup available. Requires keyboard.

ITCS: range of five machines including three multi-user peripherals (with c.r.t. and disc drives). Andromeda Alpha-D3: parity checking in memory (expandable to 128K), d.m. expansion bus slots. Takes up to four RS232, four IEEE-488 and four Centronics ports. Andamala Zia-E4 portable, telephone battery pack, c.r.t. set, etc. Optional RS232 network interface and modem, colour graphics terminal, Winchester disc. Wide range of other machines available.

Jaguar M5 multi-system processor, mixed 8/16-bit. One 5100 i/o per processor. Multi-user, up to 16 printers. Numerous options include interfaces, tape back-up, slave processors, hi-res, colour graphics, Ethernet, Vaxdata, telex, mainframe links. Requires keyboard.

Jupiter Ace: the only home microcomputer to have forti as standard, on Winchester disc, expandable to 151K. Relatively little software. The manufacturer called in a receiver at the beginning of November, but machines may still be on sale.

Kemiron KIN80: technical microcomputer. Suitable for industrial and scientific use; memory measurement and control interfaces available, including 12-bit analogues, six-channel RS232C boards. Keypad required. KM1000 is similar, but with 5½ discs instead of mini-flipper and two programmable RS232C ports as standard. Programmable four-channel counter/timers.

LSI Gruppo: business with wider applications. Up to 32K eprom, two RS232 ports, disc interface with d.m.a., quad interface expansion boards. Options include 8078 maths co-processor, graphics board, four more RS232 ports, outboard, modem, network, bus expansion, Winchester disc interface with d.m.a.

Leasahome VCT999/10: two RS232C ports, four parallel ports, up to 48K eprom. User-programmable screen formats; 64 formats and 64 sound colours; 16 of a range of colour terminals.

Logicus VTS Visual personal computer: CPM/86, MS-DOS, BOS. Languages available include Pascal, Fortran and Cobol. D.m.a. expansion up to 512K is also available, directly to 1MB. Removable Winchester cartridge back-up and colour graphics also available.


MEMOTEX TX series: ram expandable to 512K; up to two expansions (ram or communications) can be fitted internally; joystick and cartridge port; separate sockets for keyboard; networking not possible; assembler/disassembler included, third party and Pacal available as

Miconix MX range: CP/M system, ram expandable to 128K. Two RS232 ports, parallel buffer; RS-232C subinterface available. Ready keypad. Four models; single-board available separately.

Modcomp Zora 2000 series: transportable with 9-inch screen. Can read and write to various disc formats. Maximum 16K.

Modulator VME/10: designed for scientific and engineering uses, software development. Various configurations possible. VME bus with additional I/O channel to serve peripherals. EXONET interface.


Modularised design; two expansion boards, sound and pro-multiprocessor synthesiser boards, mini-printer. MFPI M-150

NEC APC (Advanced personal computer): colour or monochrome with high resolution graphics; lin disc drives; sound card; software; assembler; communications facilities. Range also includes some 8-bit models, including the PC-XG(8K/128K), a portable similar to the Tandy 100 but with 16K ram.

Newbrain: was almost adopted as the BBC microcomputer. Two serial ports, one parallel; two cassette interfaces; optional built-in fluorescent display. Full RS-232 connection. Following the recent demise of Grundy Business Systems, the Dutch distributor Tradecom has taken responsibility for the Newbrain and it will now be distributed in the U.K. by Brainware.

Oriol O1: moving eyes, right, back-sound generator, teletext display mode; add-ins include colour plotter, lin disc drives; communications options for RS-232C; sound card; graphics. Maximum 512K ram, mechanical interlocks, 48K eprom.

Osborne Executive: portable with 7 inch screen, can read/write numerous disc formats. Also Osborne 1B at £1495.

A list price of £299.95...


Microm: DMS-60-D: parity checking, local-area networking facility as standard. Ethernet gateway, multi-user, communications options. Range includes several other models; upgrade kits available.

Haywood 9000: CPM: computer. Serial output is prom-programmable in five modes for special applications.

**The Wessex Wyvern system for development and turnkey systems**

**SOFTWARE SUPPORT:**
Wessex Microcomputers is committed to continuing a programme of service and support upgrades to the Wessex line. Various products are available as add-on boards, including 512K, serial, timer, memory expansions. Also a low-cost wire-wrap prototyping board.

Phillips P3500: mainly for the office, but software available for telecommunications control etc. Launched as an 8-bit multi-user, multi processor system but 16-bit upgrades are to follow.

Phoenix CPM/80 business computer with 16K disc drives. D.m.a. WW55

Plessey System 19, PC-16: networking personal computer. User ram expandable to 128K, two RS232 ports, d.m.a. and optional colour display, hard discs. The company also offers a range of fast minicomputers for real-time control applications.

Powertran Cortex kit: also available read-y-made (no soldering required). Powerful Basic for scientific and other applications: 48-bit floating-point arithmetic, 11-digit 23-bit integer, 16-bit screen memory. Machine-code monitor, assembler and monitor available. PRW/010 is a fully expandable system.


Powertran also produces a laboratory kit.

Positron 900: base instruction set Flexibel System. Launched as an 8-bit single-board computer, memory expansion up to 256K. Also in single-board form. 3000 series: for scientific and industrial applications. Models available. All machines supported by 'Indomitable Energy generated by Great Britain on "Witchfinder General"' (see). The Softex M5 home computer is also available from Softex Computers Ltd as the "Palladium".

Portico DP 400: palm-sized computer.

Rediffusion Teleplan: business computer with modem and autodialler for Viewdata etc., PS, networking. WW56

Research Machines Link 480Z: parallel port, graphics, CP/M, printer port, ISA. Also disk-based RML 380Z, with IEEE-488 interface at about £900; 160K disk, parallel port. Both machines bought by secondary schools through the Government's microelectronics education programme. D.m.a. also available. stocking computer is interesting.

Rockwell AIM 65: 44-pin expansion connector accepts five-slot single-board for expansion memory. D.m.a. models based on AIM 6540 in an advanced version with improved keyboard and graphics printer and fully expandable. Many expansion modules are available, including colour monitor, multiple floppy drive, and additional RAM. D.m.a. also available with optional keyboard, monitor, and multiple floppy drive.

Rediffusion Teleplan: business computer with modem and autodialler for Viewdata etc., PS, networking. WW56

Research Machines Link 480Z: parallel port, graphics, CP/M, printer port, ISA. Also disk-based RML 380Z, with IEEE-488 interface at about £900; 160K disk, parallel port. Both machines bought by secondary schools through the Government's microelectronics education programme. D.m.a. also available. stocking computer is interesting.

Rockwell AIM 65: 44-pin expansion connector accepts five-slot single-board for expansion memory. D.m.a. models based on AIM 6540 in an advanced version with improved keyboard and graphics printer and fully expandable. Many expansion modules are available, including colour monitor, multiple floppy drive, and additional RAM. D.m.a. also available with optional keyboard, monitor, and multiple floppy drive.

Rediffusion Teleplan: business computer with modem and autodialler for Viewdata etc., PS, networking. WW56

Research Machines Link 480Z: parallel port, graphics, CP/M, printer port, ISA. Also disk-based RML 380Z, with IEEE-488 interface at about £900; 160K disk, parallel port. Both machines bought by secondary schools through the Government's microelectronics education programme. D.m.a. also available. stocking computer is interesting.

Rockwell AIM 65: 44-pin expansion connector accepts five-slot single-board for expansion memory. D.m.a. models based on AIM 6540 in an advanced version with improved keyboard and graphics printer and fully expandable. Many expansion modules are available, including colour monitor, multiple floppy drive, and additional RAM. D.m.a. also available with optional keyboard, monitor, and multiple floppy drive.

Rediffusion Teleplan: business computer with modem and autodialler for Viewdata etc., PS, networking. WW56

Research Machines Link 480Z: parallel port, graphics, CP/M, printer port, ISA. Also disk-based RML 380Z, with IEEE-488 interface at about £900; 160K disk, parallel port. Both machines bought by secondary schools through the Government's microelectronics education programme. D.m.a. also available. stocking computer is interesting.

Rockwell AIM 65: 44-pin expansion connector accepts five-slot single-board for expansion memory. D.m.a. models based on AIM 6540 in an advanced version with improved keyboard and graphics printer and fully expandable. Many expansion modules are available, including colour monitor, multiple floppy drive, and additional RAM. D.m.a. also available with optional keyboard, monitor, and multiple floppy drive.

Rediffusion Teleplan: business computer with modem and autodialler for Viewdata etc., PS, networking. WW56

Research Machines Link 480Z: parallel port, graphics, CP/M, printer port, ISA. Also disk-based RML 380Z, with IEEE-488 interface at about £900; 160K disk, parallel port. Both machines bought by secondary schools through the Government's microelectronics education programme. D.m.a. also available. stocking computer is interesting.

Rockwell AIM 65: 44-pin expansion connector accepts five-slot single-board for expansion memory. D.m.a. models based on AIM 6540 in an advanced version with improved keyboard and graphics printer and fully expandable. Many expansion modules are available, including colour monitor, multiple floppy drive, and additional RAM. D.m.a. also available with optional keyboard, monitor, and multiple floppy drive.

Rediffusion Teleplan: business computer with modem and autodialler for Viewdata etc., PS, networking. WW56

Research Machines Link 480Z: parallel port, graphics, CP/M, printer port, ISA. Also disk-based RML 380Z, with IEEE-488 interface at about £900; 160K disk, parallel port. Both machines bought by secondary schools through the Government's microelectronics education programme. D.m.a. also available. stocking computer is interesting.

Rockwell AIM 65: 44-pin expansion connector accepts five-slot single-board for expansion memory. D.m.a. models based on AIM 6540 in an advanced version with improved keyboard and graphics printer and fully expandable. Many expansion modules are available, including colour monitor, multiple floppy drive, and additional RAM. D.m.a. also available with optional keyboard, monitor, and multiple floppy drive.
Improving colour television decoding

by David Read
B.Sc.(Hons.), M.I.E.E.

Viewing pictures over extended periods of time, it is apparent that different methods of decoding are suited to different types of pictures. A simple one-line comb filter decoder that can be applied to a home TV receiver is described in this series.

In the present colour television systems luminance and chrominance information shares the spectral space available within band limits set by international agreement. On receivers decoding PAL or NTSC signals and using a common notch, the picture is degraded by residual subcarrier, seen as moving dots on vertical coloured edges (cross luminance), and by residue colours produced by luminance components being demodulated as chrominance (cross colour). These system imperfections are detailed and ways of reducing their visual effect suggested, together with a procedure for obtaining wider luminance bandwidth by removing the luminance notch filter.

The first part shows spectral energy distribution of the component PAL signals the quadrature subcarrier phase relationships across adjacent line, field and picture periods, and alternative methods of decoding that enhance some performance parameters at the disadvantage of others. Viewing pictures over extended periods it is apparent that the different methods of decoding are suited to different types of pictures.

The parameters of the PAL system will establish themselves in the following text, but an understanding of the basic television waveform is needed.

To decode using a comb filter, which relies on the spectral distribution, luminance and chrominance relationships must be established. Figure 1 illustrates the spectrum of a video signal operating on PAL standard video while Fig. 2 shows the luminance components of the scene and how the periodic scanning system produces frequency interleaving. The diagram explains the Nyquist structure (jargon of line frequency). Fig. 3 shows the U (weighted B-Y) chrominance spectrum with a note explaining f04 (colour subcarrier) derivation. In this diagram the frequency of the subcarrier used is 7.5 MHz, and forms the centre for the new chrominance spectrum sidebands, which decay in amplitude as shown and repeat either side of the subcarrier frequency at 15.625 kHz spacings — but always offset by one-quarter of line frequency lower than the line spectral luminance centres.

Fig. 3 shows that the groups of energy forming the V (weighted R-Y) spectrum would overlap the U-chrominance but for the PAL (squarewave) 7.5 MHz squarewave which is added in the V-chrominance modulator in the PAL codec. The spectrum is thus shifted by 5.25 MHz line frequency, Fig. 4. Combining the spectral diagrams of Y, U and V with the aid of vectors, Fig. 5(a) provides a representation of V-axis switching, shown in Fig. 5(b). This would represent an adjacent line in the field compared with the line in 5(a), where the V-axis has been switched to the opposite direction. To understand how these spectral diagrams are derived and to assess some of the decoding techniques it is worthwhile explaining the PAL encoder of Fig. 6.

PAL encoding

Incoming signals representing the red, green and blue primary colour components of the scene (R, G, B) containing frequencies up to 5.5 MHz are first reproduced by a residue matrix (inverting amplifier) to provide the negative contributions. The resulting signals are a luminance Y signal (black and white scene detail) and two colour difference signals B-Y and R-Y.

After amplification these components become the U and V signals where

\[ U = 0.493 (B-Y) \]

\[ V = 0.877 (R-Y) \]

This re-arrangement is required to produce a transmittable PAL subcarrier waveform and is not directly concerned with the process of decoding to be discussed. The colour difference signals from the PAL encoder are applied to the PAL decoder. PAL decoder

U is used to modulate the phase of the squarewave subcarrier, Fig. 7. V is used to modulate the amplitude of the subcarrier squarewave, Fig. 8. The subcarrier squarewave is derived from the line reference (line frequency) oscillator and the output is applied to the chrominance modulator, which produces the colour subcarrier signal.

The PAL squarewave is derived from a clock output, which is used to generate the subcarrier reference signals. The subcarrier reference signals are then applied to the modulator, which produces the colour subcarrier signal.

Subcarrier phase relationships across lines, fields and pictures

The subcarrier phase relationships over four adjacent lines of a television field, Fig. 9, show that lines N and N+2 cannot be used, whereas the luminance components which are predominantly in-phase across the lines (vertically) add. Equally, taking the difference between the line two, the chrominance components largely cancel. This is one method of decoding. The summing action incidentally results in a 3dB noise reduction.

Fig. 10 shows line N as before but the next line down shows the energy emerging from a delay line 56ns (i.e. 90% of the subcarrier) short of the 64us one-line period of the line. N emerges a quarter of a line early with respect to line N+1. Thus, the chrominance sidebands from line N+1 and the signal from the delay line are amplitude and phase shifted, and added in the chrominance modulator. Operating across adjacent lines in a field is better than operating across two lines as shown in Fig. 9 because vertical resolution loss is visibly less on pictures.

As PAL encoding involves quadrature modulation of the subcarrier such that the U components cancel and the switched quadrature V components add, it is better to draw the two vectors representing the quadrature modulation in the form shown in Fig. 11(a). This diagram shows an analog decoding technique in which line N, N+2 and N+4 are added and subtracted using weighting factors of 1, 1/4 1/4, to enhance either the chrominance or luminance components. A circuit using this technique was built and the block diagram explaining this arrangement is the lower part of Fig. 11(b). Fig. 11(c) gives a mathematical derivation for the output of 1/4-1/4 adder, indicating the shape of the comb filter response.

This method involves decoding over five adjacent lines in each field. But this represents ten lines per picture, so the vertical resolution is much impaired, with diagonal luminance errors and horizontal edge changes producing strange effects on pictures.

The right-hand part of Fig. 11(a) shows the signal in vector form when a chroma delay is used. Chroma-length delay is the delay of one television line (64us) minus the quarter-line offset (56.393us), equivalent to 283.5 cycles of 1/50, with this
of the predominant vertical luminescence signal but it does not produce cancellation of the predominant vertical luminance because the picture points are not aligned vertically, being horizontally staggered by 56s. This technique can therefore be used in the chroma circuit (56s is small in terms of chroma resolution) and three lines are combined in the amplitude ratio 56s:56s:56s for enhancing both U and V components. Fig. 12(a) which shows the oscilloscope display of a horizontal colour bar signal indicating reduced horizontal resolution; and (b) is a colour picture with only chroma present (see also colour point 1, to follow). The chroma comb filter reduces the amount of luminance that enters the two chroma demodulators, and so reduces the fine cross-colour i.e. luminance at 4.43MHz by a half (6dB). When the chroma channel length delays are used, signals subtract across adjacent lines. Spatially, there is a vertical shift in the scene, but there is also an horizontal shift by 56s (11.3ns for two lines). The result of using these delays and arranging the comb filters to operate across three lines to enhance luminance are shown in Fig. 12(c). This shows that chroma is removed well, but the loss of diagonal luminance is evident with some pictures. To obtain signals relating to positions on the screen that are spatially coincident, they must be taken from adjacent pictures (two fields apart). To illustrate this, Fig. 13 shows the U and V chrominance phase relationships over an eight-field period (i.e. a complete change of the subcarrier phase-to-line relationship).

Luminance and chrominance enhancement across field or picture

In considering timing relationships which compare adjacent lines, the 25Hz term in the subcarrier expression has been ignored. But when shifting 625 lines between the fields, the effects of adjacent lines which represent 40ms time shift the 25Hz term is significant and is included in the calculations of Fig.13(b). Adding picture 1 (P) and picture 3 (P3) causes the chrominance to cancel and the luminance to enhance, see the block diagram, part of Fig.13(d).

Because these picture-sampled video signals are exactly overlaid there are unwanted effects from luminance components at frequencies in the subcarrier region, or at any angular position (i.e. diagonals), such as occur with adjacent line comb decoders. These cause discrepancies in the chrominance and luminance separation. Decoding across picture delays, luminance and chrominance signals can be separated with more of the individual sidebands combined. There will be no bandwidth limitation as would occur with a notch, and the individual sidebands in the luminance channel will be even lower as the sideband sidebands are taken from...
When comparing between adjacent lines or adjacent pairs of lines the luminance signal is only losing its vertical resolution in the high frequency energy areas above 3.5MHz. It is therefore difficult to detect the loss of vertical resolution on luminance; in fact it shows up on diagonals, Fig.12(c). It may appear a simple matter to look at the picture delay for temporal components and subtract, look for the differences detecting movement and then switch back to adjacent line decoding to prevent temporal effects marred the decoding. But in coded PAL the coded subcarrier is a moving pattern on stationary coloured parts of the scene and the detecting methods are not straightforward.

The subcarrier only returns to its original phase after eight fields, Fig.13(a). This moving subcarrier can be instrumented as picture movement and adds to the locality of movement detection.

Changing subcarrier frequency by 6.25Hz

If the subcarrier frequency is reduced by 6.25Hz, both the U and V chrominance signals are in amplitud e over one picture period, Fig.14. Comb filtering can be carried out by addition and subtraction of these spatially coincident points. Thus picture decoding is again achieved on still pictures where movement occurs the impulse.

Howard Steele

Howard Steele, television engineer, died on October 11th. After a meteoric rise through an apprenticeship with Marconi, via Alpha Television Studios and ABC Television, he became, at 36 years old, Chief Engineer of the Independent Television Authority and supervised the preparation for the launch of ITA's 625 line colour tv service. He had earlier been involved with colour tv research at the ITA Research establishment and was involved in the early development of colour system transcoders. In 1978 he was appointed Managing Director of Sony Broadcast Ltd. In addition to his working career, Howard Steele was deeply involved with the Institution of Electrical Engineers and served on several committees and boards.

Howard Steele was also involved in several international institutions including the EBU and the CCIR. He was awarded a Special Citation at the 1969 Monteux International television symposium for his work on tv systems and in May this year, the Gold Medal of the Royal Television Society for outstanding services to television engineering, a more than a quarter of a century. His particular contributions included the planning and design of television studios, the introduction of the u.f.l colour service to the ITV network and his role with national and international organisations on the formulation of technical standards.
A microcomputer bus standard – at last

As an electronics engineer faced with developing a microprocessor-based system, which computer databus will you choose? Tim Roberts, managing director of High Technology Electronics, explores the story, development and scope of IEEE696.

If your answer is S100, you are in good company. Many developments in the microcomputer field - especially 16-bit microprocessors, direct memory access, cache memory, hard disk drives and even the mighty CPM operating system itself - have become available on S100 systems first. Though the Altair, the S100 bus has achieved high respectability in the United States, having recently been adopted as an official standard by the influential IEEE, as IEEE696.

At last designers trying to put together 'intelligent' systems will be able to rely on an official S100 standard which will eventually take over from the several variations of the bus that are in widespread use.

S100 has become a de facto standard largely because it was the first microprocessor databus in the field. It remains both effective and flexible, giving full scope to experimenters or developers wanting some later up-grade capability, but equally to the builders of top-level high-integrity systems. It has won a large following in the USA and with the presence of British specialist suppliers of S100 products, it is finding greater favour with British designers.

The S100 bus came about at the birth of the microcomputer industry as a result of a publishing initiative. When in 1974 the US magazine Radio Electronics launched its March 8 hour computer, Popular Computers - responded by commissioning the Altair bus 8000 from a small company, MITX. In many ways the Altair was modular and the computer's functional circuit boards plugged into a 'motherboard'. The Altair bus was made over a group of common lines; that is, a small number of lines. The designers obtained a 'loop' of backplane 80-pin connectors that had 100 pins. Onto the lines went buffer control, address and data lines from the 8080 microprocessor which had recently been launched by Intel, and then a little electronics.

In contrast to the more tightly coupled systems in which several processors share a common bus. The bus may be global, allowing processors to share the available memory and input/output on an arbitrary priority basis. Otherwise a mixture of global and local bus wiring is used and a local bus with its own block of program and data memory. Local buses are connected globally and organised in a hierarchical fashion.

All microcomputer busses provide a format for the connection of data, address and control lines. Some busses, such as STD, simply provide a pathway between processors and memory and i/o lines, and have no priority or inter-processor signal to the backplane. Other buses achieve a higher functional capability with some microcomputer priority. S100, VME, Versa/68000 and PortaPorta/VME are in this class. Higher-level buses still, such as Eurocard, have special chip sets and communication protocols, while the proposed Futurebus may have a more software-oriented approach. Yet another backplane interface, providing a high-level fault-tolerant backplane interface, is the PCI backplane interface.

Efforts are being made to roll back the tide of bus anarchy. The Eurocard version of the STD bus (P96), for example, has strong support, but the handful of manufacturers who have made direct memory access boards can't card their cards on the older card size and using a direct connector have so far provided an effective barrier to the standardisation. The STD appeals to the 'keep it simple' school. The signal set is a derivative of the 8080/80 transistor class of processors but because of its simplicity it can be difficult to interface other processors such as the 8089 or 6502 to it without penalising them on timing. Most of these problems can be overcome with care.

Multibus (AP760) has been plagued by differences of opinion over standards, the IEEE Multibus committee members wanting consistency in nomenclature, but each wanting that consistency to be in line with his own habitual notation. Nevertheless recent progress has been made in this area, and over changes to power supplies, the advanced acknowledge signal, 16-bit addressing techniques, and board sizes. Multibus is an 8-bit module originally developed by Intel for its SBC series of cpu, memory, i/o, communications, high-speed plug-in card and backplane busses. The bus lends itself to multimaster operation with multiple processors, controllers, bus controllers and disc controllers.

Versa/68000, based on Motorola's need to accommodate its own VMEbus (P78) and STD family of data busses, provides a local bus with its own block of program memory and data memory. The Versa/68000 is a microprocessor standard which is growing in size and being developed by large consortia.

In contrast to the more tightly coupled systems in which several processors share a common bus. The bus may be global, allowing processors to share the available memory and input/output on an arbitrary priority basis. Otherwise a mixture of global and local bus wiring is used and a local bus with its own block of program and data memory. Local buses are connected globally and organised in a hierarchical fashion.

All microcomputer busses provide a format for the connection of data, address and control lines. Some busses, such as STD, simply provide a pathway between processors and memory and i/o lines, and have no priority or inter-processor signal to the backplane. Other buses achieve a higher functional capability with some microcomputer priority. S100, VME, Versa/68000 and PortaPorta/VME are in this class. Higher-level buses still, such as Eurocard, have special chip sets and communication protocols, while the proposed Futurebus may have a more software-oriented approach. Yet another backplane interface, providing a high-level fault-tolerant backplane interface, is the PCI backplane interface.

Efforts are being made to roll back the tide of bus anarchy. The Eurocard version of the STD bus (P96), for example, has strong support, but the handful of manufacturers who have made direct memory access boards can't card their cards on the older card size and using a direct connector have so far provided an effective barrier to the standardisation. The STD appeals to the 'keep it simple' school. The signal set is a derivative of the 8080/80 transistor class of processors but because of its simplicity it can be difficult to interface other processors such as the 8089 or 6502 to it without penalising them on timing. Most of these problems can be overcome with care.

Multibus (AP760) has been plagued by differences of opinion over standards, the IEEE Multibus committee members wanting consistency in nomenclature, but each wanting that consistency to be in line with his own habitual notation. Nevertheless recent progress has been made in this area, and over changes to power supplies, the advanced acknowledge signal, 16-bit addressing techniques, and board sizes. Multibus is an 8-bit module originally developed by Intel for its SBC series of cpu, memory, i/o, communications, high-speed plug-in card and backplane busses. The bus lends itself to multimaster operation with multiple processors, controllers, bus controllers and disc controllers.

Versa/68000, based on Motorola's need to accommodate its own VMEbus (P78) and STD family of data busses, provides a local bus with its own block of program memory and data memory. The Versa/68000 is a microprocessor standard which is growing in size and being developed by large consortia.

In contrast to the more tightly coupled systems in which several processors share a common bus. The bus may be global, allowing processors to share the available memory and input/output on an arbitrary priority basis. Otherwise a mixture of global and local bus wiring is used and a local bus with its own block of program and data memory. The Versa/68000 is a microprocessor standard which is growing in size and being developed by large consortia.

All microcomputer busses provide a format for the connection of data, address and control lines. Some busses, such as STD, simply provide a pathway between processors and memory and i/o lines, and have no priority or inter-processor signal to the backplane. Other buses achieve a higher functional capability with some microcomputer priority. S100, VME, Versa/68000 and PortaPorta/VME are in this class. Higher-level buses still, such as Eurocard, have special chip sets and communication protocols, while the proposed Futurebus may have a more software-oriented approach. Yet another backplane interface, providing a high-level fault-tolerant backplane interface, is the PCI backplane interface.

Efforts are being made to roll back the tide of bus anarchy. The Eurocard version of the STD bus (P96), for example, has strong support, but the handful of manufacturers who have made direct memory access boards can't card their cards on the older card size and using a direct connector have so far provided an effective barrier to the standardisation. The STD appeals to the 'keep it simple' school. The signal set is a derivative of the 8080/80 transistor class of processors but because of its simplicity it can be difficult to interface other processors such as the 8089 or 6502 to it without penalising them on timing. Most of these problems can be overcome with care.

Multibus (AP760) has been plagued by differences of opinion over standards, the IEEE Multibus committee members wanting consistency in nomenclature, but each wanting that consistency to be in line with his own habitual notation. Nevertheless recent progress has been made in this area, and over changes to power supplies, the advanced acknowledge signal, 16-bit addressing techniques, and board sizes. Multibus is an 8-bit module originally developed by Intel for its SBC series of cpu, memory, i/o, communications, high-speed plug-in card and backplane busses. The bus lends itself to multimaster operation with multiple processors, controllers, bus controllers and disc controllers.

Versa/68000, based on Motorola's need to accommodate its own VMEbus (P78) and STD family of data busses, provides a local bus with its own block of program memory and data memory. The Versa/68000 is a microprocessor standard which is growing in size and being developed by large consortia.

In contrast to the more tightly coupled systems in which several processors share a common bus. The bus may be global, allowing processors to share the available memory and input/output on an arbitrary priority basis. Otherwise a mixture of global and local bus wiring is used and a local bus with its own block of program and data memory. The Versa/68000 is a microprocessor standard which is growing in size and being developed by large consortia.
Each S100 circuit board measures 10 by 5.3in overall, and plugs into a 10-pin edge connector (5 pins per row) on a motherboard. An offset ensures that boards cannot be inserted wrong way round. The bus supplies unregulated voltage to the boards which therefore carry their own power regulators. This arrangement reduces noise coupling between modules.

One change brought about by the IEEE standard is to allocate to all S100 cards the status of bus master or bus slave. A master is a device, such as a processor or controller, which controls the bus and a slave is a peripheral or block of memory that is controlled. The bus allows for an elaborate architecture where, while there is a single permanent bus master, there may also be up to 16 plug-in bus masters. The temporary bus masters are given control on request according to a priority system that is arbitrated by the permanent master. This architecture gives flexible multi-user, multi-processor capability.

The temporary master is typically a device such as a disc controller or secondary processor, and obtains access to the bus under a temporary master access (TMA) system. To request, a t.m. signals its priority on one of four arbitration lines. Unless it has to defer to a higher priority user already on the bus, the t.m. will control the bus, and may then perform any type of cycle (not just a memory cycle).

Until the IEEE revision, memory slaves used to respond only to 16 address bits, giving the system a priority of one on four arbitration lines. The IEEE allows for 6809 plus 16-bit processors like the 8086, LST-11, 9900, 1080, 8Z000 and 68000. There is a matching array of operating systems CP/M, TurboDOS, MS-DOS, NS-DOS, CP/MP, Unix, etc. — and all the major computer languages are catered for. S100 is powerful; no other microcomputer system has direct addressing of up to 16Mbytes of memory, 64K i/o ports, up to 16 three-state interrupt lines, support for up to 25 plug-in slots.

Software and hardware developers prefer S100 because the latest technology seems to appear first. Even a new processor has been available on the bus before it has been ready for other systems. All the major M.C. manufacturers, such as Intel, AMD, and Cyrix, had floppy discs. While it is true that S100 systems might now appear nearer to market, the true economy lies in the speeding up of development and manufacture.

In one example, a contracting company had just a few months to construct and install a prototype system handling and display system. S100 was chosen as the basis because of the immediate availability of modules required — backplane, processor, 64K memory, disc controller and drives, colour display controller and extensible i/o to host mainframe computers. Numerous assemblers for the Z80 processor were available so that software development could start at once. Using this approach with S100, the system was completed from concept to commissioning in less than six months, and is now being evaluated by the MoD as part of an air defence network.

The contractor is secure in the knowledge that any system extensions ordered later can also be S100-based, giving good system integration and economy.

The number of S100 building blocks is steadily increasing and the technology of bus mastering is becoming more capable. Whereas a year or so ago a single system might have had a single processor, i/o disc controller and four static ram cards, the same functions can now be realised on one or two 8K i/o-port modules. And currently popular configuration of Z80 micro-running CP/M with a separate floppy disk for software is already a way to a recently introduced package combination - with four floppy drives, a single processor, interrupt controller, counter timer, two serial i/o ports — typically for a single printer, a simple floppy disk and a graphics terminal, all on one card. Other configurations have 16-bit processors or eight or 16-bit processors both master and slave, with device drivers and disk controllers. Other configurations have bus mastering fully complemented by 12K, 25K and even 1M cards. S100 bumble memory is available for special applications and the addition of storage is a common addition to conventional 31/4 or 5 1/4 floppy discs.

One of the major advantages of S100 is its flexibility. It is processor and manufacturer independent and can accept 8-bit or 16-bit i/o (such as the S080A, 882S, 1800, 2600, 4052, 6809 plus 16-bit processors like the 8086, 6801 digital meter. It also incorporates a 'break' bus, displayed beneath the digital readout, which runs or contracts in proportion to the reading. Incorporating a microprocessor, the complete controller can be programmed to serve as a multimeter covering several different measurement functions and ranges. One sector of the I.E.D. can display the function or range in use.

There are several computer manufacturers who have been working on S100 products, some of which are described below.

**Signal testing**

The compact disk has engendered a new mass of equipment for the hobbyist, with some models marketed in the UK, and there is no shortage of documentation. The 5D10 is a memoryless test set which can give a quick preliminary test on any memory system. The T510 is a wave-form and spectrum analyser with a built-in spectrum analyser. It has a digital output which can be used for test purposes.

**New products**

A single board computer incorporating the 16-bit 68000 processor has been produced by Apollo Software. The processor runs at 30MHz and has 17 internal 32-bit registers and a 24-bit address space. The processor can provide access to a range of software applications. The processor board can program the 68000 to simulate any of the many programs that are available for the 68000, and it can be used in conjunction with a wide range of transmission rates.

**Scope for colour**

Addition of colour to an oscilloscope display has been made possible with the use of a special digital colour shutter. The display has inherent advantages over a black-and-white type, but, at a much cheaper to produce, has no colour component, and the display is more suitable for use with the memory capacity of the system. The display is a simple-to-operate device suitable for clerical work.

An 800 caption generator provided the answer. A Z80 processor with 32K ram and disc drive permit simultaneous connection to an external video signal for subtitling and caption generation. Line and field are independently controllable to produce a sync generator. The card features 75-ch line drivers providing an RGB output and CVBS levels, and automatic interface selection.

This 100-based system can be expanded simply whenever a requirement arises. Two logical developments would be the addition of another ram card to permit automatic unattended cycle additions, and a single-card modem allowing the system to download captions from other systems via telephone lines. An electronic time and date display could be added to give a 1024 character total capacity and allowing for leap years. A further display card and slave processor would give multi-user capability. The BBC, however, as it currently exists, has proved inexpensive, effective and easy to use, providing good studio, field and teletext-type functions. Software to allow teletext pages to be displayed on the large screen is available from many sources, and there are no demands on disc storage capacity.

One similar development requires a new generation and the Norwegian Broadcasting Authority. The Norwegians heard of the unit the BBC were using, recognised the potential in the project, and, later on, the BBC’s Norwegian equivalent, and came to the UK to buy the same card. In the end they bought a full S100 system, completed with peripheral drives and interfaces: eight sub-stripping units can replace no more than a single highly skilled operator on a dedicated device designed to do the same job. If they wished the Norwegian could now increase their storage capacity 100% by adding another card and substituting a microcomputer system, which is easy to open for the sake of any additional serial and parallel card interface units, and is simple to fit. The BBCs are designed for use with a personal computer and an 8253 interface card which, within a wide range of transmission rates, can provide an addressable range.

**External connectors**

One of the key developments of the past few years has been the advent of high-speed external connectors for the S100 bus. The 5D10 is a memoryless test set which can give a quick preliminary test on any memory system. The T510 is a wave-form and spectrum analyser with a built-in spectrum analyser. It has a digital output which can be used for test purposes.

The 5D10 is a memoryless test set which can give a quick preliminary test on any memory system. The T510 is a wave-form and spectrum analyser with a built-in spectrum analyser. It has a digital output which can be used for test purposes.

**A and D on same meter**

The Sharp KX-A10 in the Interscope Brighton last month, Italian are claiming a "world's first" for their combining digital and analogue panel meter. Resembling a conventional c.1.

**Mains r.f. filters**

A range of r.f. supression filters conforming to the VDE Class 3 Standard is marketed by Apollo Software, Gloucester Alley, Gold Ash, New York.

**WIRELESS WORLD DECEMBER 1983**
NEW PRODUCTS

Cmos logic in small Packages

Thirty of the 74-series logic components have been produced in small flat packages suitable for surface mounting (see also News). The package occupies about half the space of conventional ICs, on a p.c.b. and are less than half the thickness and a fifth of the weight. The Toshiba logic packs are made in a 'New HC M78' which is claimed to be 20 to 30 times as fast as regular cmos. This, combined with the small size of the package which makes p.c.b. track lengths much shorter, can lead to both very high speed and accuracy of operation, says Toshiba. Toshiba U.K. Ltd, Finley Road, Finley, Camberley, Surrey WW5 8AQ.

Cross-compiler for software

When a program has been developed for use with a particular processor it can be difficult to translate it for use on other processors. Not so, if the software is developed on a Codina 1330 or a running Unix as it can be used on the 6800, 8085, 8086, 2850, 6809, and TM5700 and other processors. The cross-compiler is based around the C-language, which provides high-level commands and structures while manipulating data normally associated with low-level languages. C-enables applications software to be rapidly developed on the Codina and the cross-compilers can subsequently be used to generate the native code for the processor to be used, without modification. If required a systems interface library can give access to the commands of a variety of operating systems, such as CP/M, VAX/VMS and RSX-11. Programmers who would prefer to use Pascal can have their source code translated into C and thence into the various processor-specific codes. Translators from Fortran and Basic are being developed. Cambridge Micro Computers Ltd, Cambridge Science Park, Milton Road, Cambridge CB4 8DH.

Optical power meter

A hand-held, lightweight power meter for light measurement could be useful for taking readings in awkward places. The Anritsu ML-96A is in such a meter with autoranging and switching between Watt and dBm displays. The meter uses different sensors to cover wavelengths from 0.4 to 3.0 μm with a sensitivity from 500μW to 30dBm. It has an accuracy of 1%. The meter was designed for use in research and development, particularly in the area of optical communications, video and audio digital links. The unit comes complete with internal rechargeable batteries, capable of operating for 20 hours, and a battery charger unit. Anritsu Europe Ltd, Thame Road, Windmill Trading Estate, Thame, Oxfordshire OX8 1JX.

Photodiode for microwaves

A photodiode made of a compound of indium, gallium, atomic and phosphorus is sensitive to light in the wavelength range 1 to 1.5 μm and has a maximum quantum efficiency of about 70%. Developed by Hitachi, the HR101 is thought to be of particular use in long-distance fibre optic communications because at these wavelengths the transmission loss along an optical fibre are known to be minimum. Up to now, avalanche photodiodes have been used but the new diodes offer higher speed, higher sensitivity, one tenth of the 'dark' current and between a quarter and an eighth of the operation voltage. Hitachi Electronics Components (UK) Ltd, Hine House, J31 Station Road, Harrow, Middx HA1 2XL.

TV test chart

For the instant testing of tv camera and auxiliary equipment almost anywhere, Crow of Reading have produced a double test chart with the BBC62F colour bar chart and a nine-amp log reflectance grey scale reflectance chart. They are mounted together in a folder and incorporate a black matt screen to cover the chart when the grey scale is in use. When folded the charts are sealed against light and dust and fit into a nylon carrying case. The colour chart devised by the BBC research department with W. R. Boyle and Sons uses specially developed pigments which give a high saturation colour image. Crow of Reading Ltd, PO Box 36, Reading, Berks RG1 2NB.

No Contest!

The SC61 waveform analyser from Sencore stands head and shoulders above any other oscilloscopes for speed, accuracy and versatility even from semi-skilled operators—and we're prepared to come round and prove it.

For an on-site test and more information: Mike Dawson 01-897 6446.

NEW MODELS!

Immediate delivery!

New from Hitachi are three low-cost bench scopes with bigger screens and extra features in a new slimline ultra-lightweight format. The range now extends to 13 models:—

- 4 dual trace single timescale models: 20MHz to 40MHz
- 2 dual trace sweep delay models 20MHz and 50MHz
- 2 dual timescale multi-trace models 50MHz and 100MHz
- 2 miniature field portable models, 20MHz and 50MHz
- 3 storage models, one tube storage, two digital storage

Prices start at £295 plus vat (model illustrated) including 2 probes and a 2-year warranty. We hold the range in stock for immediate delivery.

For colour brochure giving specifications and prices ring (0480) 63269.

Fieldtech Instruments, 6 High Street, Sollersh, W. Midlands, B91 3TB

To order call: 091-225 7444

Optical power meter

In view of the extremely rapid change taking place in the electronics industry, large quantities of components become redundant. We are cash purchasers of such materials and would appreciate a telephone call or a list if available. We pay top prices and collect.

If you would like more information on any of the items featured here, write the appropriate WW reference number/subject on the mausé reply-backcard in this issue. Overseas send requiring a stamp.

In view of the extremely rapid change taking place in the electronics industry, large quantities of components become redundant. We are cash purchasers of such materials and would appreciate a telephone call or a list if available. We pay top prices and collect.

If you would like more information on any of the items featured here, write the appropriate WW reference number/subject on the mausé reply-backcard in this issue. Overseas send requiring a stamp.

In view of the extremely rapid change taking place in the electronics industry, large quantities of components become redundant. We are cash purchasers of such materials and would appreciate a telephone call or a list if available. We pay top prices and collect.

If you would like more information on any of the items featured here, write the appropriate WW reference number/subject on the mausé reply-backcard in this issue. Overseas send requiring a stamp.

In view of the extremely rapid change taking place in the electronics industry, large quantities of components become redundant. We are cash purchasers of such materials and would appreciate a telephone call or a list if available. We pay top prices and collect.

If you would like more information on any of the items featured here, write the appropriate WW reference number/subject on the mausé reply-backcard in this issue. Overseas send requiring a stamp.

In view of the extremely rapid change taking place in the electronics industry, large quantities of components become redundant. We are cash purchasers of such materials and would appreciate a telephone call or a list if available. We pay top prices and collect.

If you would like more information on any of the items featured here, write the appropriate WW reference number/subject on the mausé reply-backcard in this issue. Overseas send requiring a stamp.

In view of the extremely rapid change taking place in the electronics industry, large quantities of components become redundant. We are cash purchasers of such materials and would appreciate a telephone call or a list if available. We pay top prices and collect.

If you would like more information on any of the items featured here, write the appropriate WW reference number/subject on the mausé reply-backcard in this issue. Overseas send requiring a stamp.

In view of the extremely rapid change taking place in the electronics industry, large quantities of components become redundant. We are cash purchasers of such materials and would appreciate a telephone call or a list if available. We pay top prices and collect.

If you would like more information on any of the items featured here, write the appropriate WW reference number/subject on the mausé reply-backcard in this issue. Overseas send requiring a stamp.
ACCOUNCES available to approved companies with minimum order charge £10. Carriage and packing £1.50 on credit orders.

Terms of business: CKS, Purchase and packing values and semiconductors 60p per order, OT is 15% OTV. Please allow up to 2 weeks for delivery. Please note that all items are subject to availability. Payment will be accepted by all major credit cards. Account facilities available to approved companies. E and O.E.
Please Note: New Phone Number: 0691-652894

Personal callers are always very welcome but please note that we are closed all day Saturday.
CABLE T.V. HEAD END AND REPEATER AMPLIFIERS

**DISTRIBUTORS**

**QUALITY AT LOW COST**
TAYLOR BROS (OLDHAM) LTD
LEE STREET, OLDHAM - TEL. 061-652 3221 - TELEX 669911

WWW - 479 FOR FURTHER DETAILS

**ELECTRONIC POWER UNITS**
FOR XENON ARC AND MERCURY ARC LAMPS
UNITS AVAILABLE FOR LAMPS RANGING FROM 15 TO 1000 WATTS.

K. T. Mannors Design Ltd.
P.O. Box 526, London, W1V 8NY
Telephone: 01-984 7133. Telex: 28466

WWW - 021 FOR FURTHER DETAILS

**FLUKE**

**HAMEG**

**New Fuke 70 series**

**Antenaire for P.M.R.**

**Antennas**

**Gain antennas for P.M.R.**

**Values**

**Values at...**

**Hameg HM-103 10MHz Oscilloscope £158**

**Hameg HM-204 20MHz Oscilloscope £335**

**Hameg HM-205 20MHz Oscilloscope £335**

**I.C.E. Microset 80 Multimeter £19**

**Electronic Brokers Ltd., 61/65 Kings Cross Road, London WC1X 9LN. Tel: 01-833 1166. Telex 288694**

**Test Equipment**

**DISTRIBUTORS**

**PHILIPS**

**Philips PM 2517 Handheld DMM £172**

**Philips PM 3007 15MHz Oscilloscope £383**

**Philips PM 5077 Function Generator £295**

**Distributed for audio and educational applications. Low distortion LF generator 10Hz to 1KHz, sine and square waves. TTL output.**

**Philips PM5050 Pattern Generator £139**

**Small, light-weight for TV servicing. Five different test patterns for color and monochrome. Tone for audio checking. Video output.**

**Electronic Brokers Ltd., 61/65 Kings Cross Road, London WC1X 9LN. Tel: 01-833 1166. Telex 288694**

**WWW - 89 FOR FURTHER DETAILS**

**WIRELESS WORLD DECEMBER 1983**
NEW PRODUCT

BX80 COLOUR MATRIX PRINTER
£495 + VAT

Especially designed for use with the BBC Microcomputer

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

Prints in 7 colours on plain paper. Colour screen printing in 16 LL modes (incl. mode 7 Teletext). Uses RS423 output (cable supplied). Printer RS423 input has 2.5k bytes buffer. In mode 7 Teletext, printer has a 2 page store with printout size option, 125 cps primary colour speed for listing, etc. Screen dump listing supplied.

NEW model VRX80 black/white viewdata printer, 3.5K byte buffer, £425 + VAT

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

B. BAMBER ELECTRONICS

Rank Railin Airport Weapon Detector Type 30 through Coaxial. Complete and good working order.

Also, Browning Type 30 and H D Matic Type 50, complete with Frequency Generator Type TD 24AF and mounted on stand. M/O £200 (incl. VAT).

For information and further details, please contact Bamber Electronics, 89/97 Haddington Road, London N19 293 (01) 840 2530.

PLEASE NOTE: All products are subject to prior reservation by other customers. Orders are accepted for delivery in stages as products become available.

CRICKLEWOOD ELECTRONICS LTD

All products first grade franchised source. All items available through

(1) MAIL ORDER (2) CALLERS (3) TELEPHONE CREDIT CARDS (4) CUSTOMER ACCOUNTS

Access, BankAmerica, American Express, Official Orders from Schools, Govt. Dept., Local Authorities etc.

In stock list: please call at least two working days in advance. 80% VAT. Please add VAT at 15%. No VAT for overseas orders but min. £100 p.a. Stocking parts other stores cannot reach.
### Integrated Circuits

| Code | Description | Quantity | Price
|------|-------------|----------|-------
| 74AC00 | 74A Series TTL IC | 100 | £0.50
| 74HC00 | 74HCMOS IC | 100 | £0.20
| 74HC125 | 74HCMOS IC | 100 | £0.20

### Diodes

| Code | Description | Quantity | Price
|------|-------------|----------|-------
| 1N4148 | Rectifier Diode | 100 | £0.10
| 1N4149 | Rectifier Diode | 100 | £0.10
| 1N4158 | Rectifier Diode | 100 | £0.10

### CRT Tubes

| Code | Description | Price
|------|-------------|-------
| 6B4 | CRT Tube | £0.50
| 6A1 | CRT Tube | £0.40

### PM Components Ltd

- **Telephone:** 0474 813225
- **Address:** Selection House, Wrotham Road, Meopham Green, Meopham, Kent DA13 0QY

### Wirewound Resistors

- **Serie:** 0.1%
- **Values:** 100, 91, 82, 74, 68, 63, 58, 54, 50, 47, 44, 41, 38, 35, 32, 30, 28, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1

### Batteries

- **Types:** 6V, 12V, 24V
- **Counts:** 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

### Callers Welcome

- **Entrance:** A227
- **Car Parking Available:** Open Monday to Friday, 8 am to 5.30 pm.
- **Adjacent:** Car Park Available to Customers
- **Many Other Items Available:** For Further Details

### Export Orders Welcome

- **Carriage Post at Cost**
If you know the name Dwight Cavendish a number of things may spring to mind — television distribution equipment for hotels, tape copying equipment, or advanced audio perhaps.

But were you aware that we have produced a range of other 19" rack mounted boxes for a wide range of diverse applications. Each unit has been designed from scratch by Dwight Cavendish and with all modules having across-the-board electronic and mechanical compatibility, configuration to your own system is easy.

As you can imagine all of this adds up to a somewhat formidable systems capability, so, if your job demands speed within the bounds of a strict budget, our engineering commitment and commercial awareness using off-the-shelf modules may be the answer.

We are also pleased to talk about OEM supply in your own house colours or formats if you wish. For the facts speak to Peter Ford on 0480 215753.

To obtain further details of any of the quoted 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

Australian: Gordon &  Domherd Ltd, 48-50 Finsbury St, London EC2A 1JY, Tel: 071-237 7500

Canadian: Brian M. Cooper, 9991 Yonge St., Thornhill, Onttario, L3T 6H1

Japanese: Hiroshi Suzuki Co. Ltd, 3-1-1, Chuo-ku, Tokyo, 104-0058

New Zealand: Dragonfly Distributors Ltd, P.O. Box 4420, Auckland

Spanish: Distribuciones PB, P.O. Box 296, Madrid

U. S. A.: Intercontinental Publishers Co., 333 W. 42nd St, New York, NY 10036

U. K.: Hanson Publications Limited, 5 Ryder St, London W1R 1DF

If you require further details of the products listed, please complete the reference numbers of which have been inserted in the space provided.

OVERSEAS SUBSCRIPTION AGENTS

Australian: Gordon &  Domherd Ltd, 48-50 Finsbury St, London EC2A 1JY, Tel: 071-237 7500

Canadian: Brian M. Cooper, 9991 Yonge St., Thornhill, Onttario, L3T 6H1

Japanese: Hiroshi Suzuki Co. Ltd, 3-1-1, Chuo-ku, Tokyo, 104-0058

New Zealand: Dragonfly Distributors Ltd, P.O. Box 4420, Auckland

Spanish: Distribuciones PB, P.O. Box 296, Madrid

U. S. A.: Intercontinental Publishers Co., 333 W. 42nd St, New York, NY 10036

U. K.: Hanson Publications Limited, 5 Ryder St, London W1R 1DF

If you require further details of the products listed, please complete the reference numbers of which have been inserted in the space provided.

OVERSEAS SUBSCRIPTION AGENTS

Australian: Gordon &  Domherd Ltd, 48-50 Finsbury St, London EC2A 1JY, Tel: 071-237 7500

Canadian: Brian M. Cooper, 9991 Yonge St., Thornhill, Onttario, L3T 6H1

Japanese: Hiroshi Suzuki Co. Ltd, 3-1-1, Chuo-ku, Tokyo, 104-0058

New Zealand: Dragonfly Distributors Ltd, P.O. Box 4420, Auckland

Spanish: Distribuciones PB, P.O. Box 296, Madrid

U. S. A.: Intercontinental Publishers Co., 333 W. 42nd St, New York, NY 10036

U. K.: Hanson Publications Limited, 5 Ryder St, London W1R 1DF

If you require further details of the products listed, please complete the reference numbers of which have been inserted in the space provided.

OVERSEAS SUBSCRIPTION AGENTS

Australian: Gordon &  Domherd Ltd, 48-50 Finsbury St, London EC2A 1JY, Tel: 071-237 7500

Canadian: Brian M. Cooper, 9991 Yonge St., Thornhill, Onttario, L3T 6H1

Japanese: Hiroshi Suzuki Co. Ltd, 3-1-1, Chuo-ku, Tokyo, 104-0058

New Zealand: Dragonfly Distributors Ltd, P.O. Box 4420, Auckland

Spanish: Distribuciones PB, P.O. Box 296, Madrid

U. S. A.: Intercontinental Publishers Co., 333 W. 42nd St, New York, NY 10036

U. K.: Hanson Publications Limited, 5 Ryder St, London W1R 1DF

If you require further details of the products listed, please complete the reference numbers of which have been inserted in the space provided.

OVERSEAS SUBSCRIPTION AGENTS

Australian: Gordon &  Domherd Ltd, 48-50 Finsbury St, London EC2A 1JY, Tel: 071-237 7500

Canadian: Brian M. Cooper, 9991 Yonge St., Thornhill, Onttario, L3T 6H1

Japanese: Hiroshi Suzuki Co. Ltd, 3-1-1, Chuo-ku, Tokyo, 104-0058

New Zealand: Dragonfly Distributors Ltd, P.O. Box 4420, Auckland

Spanish: Distribuciones PB, P.O. Box 296, Madrid

U. S. A.: Intercontinental Publishers Co., 333 W. 42nd St, New York, NY 10036

U. K.: Hanson Publications Limited, 5 Ryder St, London W1R 1DF

If you require further details of the products listed, please complete the reference numbers of which have been inserted in the space provided.

OVERSEAS SUBSCRIPTION AGENTS

Australian: Gordon &  Domherd Ltd, 48-50 Finsbury St, London EC2A 1JY, Tel: 071-237 7500

Canadian: Brian M. Cooper, 9991 Yonge St., Thornhill, Onttario, L3T 6H1

Japanese: Hiroshi Suzuki Co. Ltd, 3-1-1, Chuo-ku, Tokyo, 104-0058

New Zealand: Dragonfly Distributors Ltd, P.O. Box 4420, Auckland

Spanish: Distribuciones PB, P.O. Box 296, Madrid

U. S. A.: Intercontinental Publishers Co., 333 W. 42nd St, New York, NY 10036

U. K.: Hanson Publications Limited, 5 Ryder St, London W1R 1DF

If you require further details of the products listed, please complete the reference numbers of which have been inserted in the space provided.

OVERSEAS SUBSCRIPTION AGENTS

Australian: Gordon &  Domherd Ltd, 48-50 Finsbury St, London EC2A 1JY, Tel: 071-237 7500

Canadian: Brian M. Cooper, 9991 Yonge St., Thornhill, Onttario, L3T 6H1

Japanese: Hiroshi Suzuki Co. Ltd, 3-1-1, Chuo-ku, Tokyo, 104-0058

New Zealand: Dragonfly Distributors Ltd, P.O. Box 4420, Auckland

Spanish: Distribuciones PB, P.O. Box 296, Madrid

U. S. A.: Intercontinental Publishers Co., 333 W. 42nd St, New York, NY 10036

U. K.: Hanson Publications Limited, 5 Ryder St, London W1R 1DF

If you require further details of the products listed, please complete the reference numbers of which have been inserted in the space provided.

OVERSEAS SUBSCRIPTION AGENTS

Australian: Gordon &  Domherd Ltd, 48-50 Finsbury St, London EC2A 1JY, Tel: 071-237 7500

Canadian: Brian M. Cooper, 9991 Yonge St., Thornhill, Onttario, L3T 6H1

Japanese: Hiroshi Suzuki Co. Ltd, 3-1-1, Chuo-ku, Tokyo, 104-0058

New Zealand: Dragonfly Distributors Ltd, P.O. Box 4420, Auckland

Spanish: Distribuciones PB, P.O. Box 296, Madrid

U. S. A.: Intercontinental Publishers Co., 333 W. 42nd St, New York, NY 10036

U. K.: Hanson Publications Limited, 5 Ryder St, London W1R 1DF

If you require further details of the products listed, please complete the reference numbers of which have been inserted in the space provided.
OVERSEAS ADVERTISEMENT AGENTS


Italy Sig. C. Epsi Etas-Kompas, S.p.a. - Servizio Estero, Via Mantegna 6, 20154 Milan - Telephone : 347051 - Telex : 37342 Kompas

Japan Mr. Itatsuki, Trade Media - IBPA, B212 Azabu Heights, 1-5-10 Roppongi, Minato-Ku, Tokyo 106 - Telephone : (03) 585-0581


Victor & Jauch, Elmex International, P.O. Box 34607, Los Angeles Calif. 90034 U.S.A.

Telephone : (213) 621 8581

Telex : 18-1059.

Jack Mentel, The Fairley Co., Suite 605, Hanna Building, Cleveland, Ohio 44115 - Telephone : (216) 621 1919

Ray Rickles, Ray Rickles & Co., P.O. Box 2008, Miami Beach, Florida 33140 - Telephone : (305) 532 7301

Jim Parks, Ray Rickles & Co., 3116 Maple Drive N.E., Atlanta, Georgia 30305. Telephone : (404) 237 7432

Mike Loughlin, Business Press International 15066 Memorial Dr., Suite 118, Houston, Texas 77079 - Telephone : (713) 783 8873

Canada Colin H. MacCulloch, International Advertising Consultants Ltd. 915 Carlton Tower, 2 Carlton Street, Toronto 2 - Telephone (416) 364 2269

*Also subscription agents

HIGH QUALITY GREEN SCREEN VIDEO MONITORS

CHECK THESE FEATURES:

- ANTIGLARE SCREEN
- P31 GREEN FOR MINIMUM FATIGUE
- VIDEO RESPONSE 10Hz - 222Hz ± 3db
- SUPERB RESOLUTION - UP TO 132 CHAR/LINE
- EXCELLENT GEOMETRY/LINEARITY
- HIGH STABILITY
- 230 VOLT 50Hz MAINS OPERATION
- COMPOSITE VIDEO 0.3/0.2V INPUT
- FLICKER FREE DISPLAY

THE LOWEST PRICE ANYWHERE

FOR A PC WITH THESE FEATURES . . . LOOK AT THE SPEC. OF THE AMAZING UNITRON 2200

Dual processors - 6502 and Z80

- 64K of RAM
- 24K ROM with softswitch control
- Selectable 80 or 40 column text display
- Detachable keyboard
- Apple II compatible
- CP/M compatible
- High and low resolution graphics capabilities
- Two disk I/O for your disk drives
- Game paddles/cassette/video interfaces

Prices exclusive of VAT

DEALER ENQUIRIES WELCOME

CHARLTON ELECTRONICS
HIGH STREET, CHALFONT ST. OILES, BUCKS. HP8 4QH
TELEPHONE : 0294 32934
TELEX : 36229M
Z8 BASIC in Control

Arcon's 40-series board level products have been designed to make life easy for the engineer. We don't just sell CPU cards either; Arcon's complementary range of interface products can help you solve any system development or control problem. The 40-series CPU cards are based on Zilog's advanced Z8 family - whose on-chip BASIC makes applications quick and easy to implement.

CPU cards

In many cases, you can go from problem formulation to a firmware (EPROM) solution in just thirty minutes! Priced from £85 to £152. The I/O boards cost from just £81 - and can even be used with our high-performance Z8000 development system.

Professionally designed and robustly constructed, Arcon have the range to do the job - reliably. Write or phone for details now.

Peripheral cards

Available from
Arcon Control Systems Ltd
Unit B, Cihon Road
Malvern, Worsenh WR13 6EP, England
Tel: (0684) 219001
Telex: 39447 INSIGHTC

This self-contained black and white camera has been developed for use in situations where space is at a premium but the need for high quality is of paramount importance. Features include:

- LOW POWER CONSUMPTION
- AUTOMATIC VIDEO BLACK LEVEL
- MOTORISED VIDEO RACKING
- UNPROCESSED VIDEO
- CUT TO EZ LENS
- INTERNAL LOCK
- HIGH RESOLUTION, LOW NOISE VIDEO
- INBUILT IRIS DRIVE SERVO
- 10 TO 32VOLT DC OPERATION
- EDGE ENHANCEMENT
- PLUG ON BATTERY AND 
  REMOTE CONTROL
- CORRECTION MODELS

We believe this is the smallest self-contained black and white TV camera available. Contact Andrew Smith on (0984) 310000.

Wallace and Manufacturing of
HIGH QUALITY CCTV CAMERAS & SYSTEMS

ZENETEK VDU PRINTERS

These famous disks are well known for their reliability and high engineering standards. Cartridge is easily exchangeable, standard disk interface. U ntested but believed working OK.

Our price to clear £120 - VAT
Carr. £10

CHILTERN ELECTRONICS

SURPLUS EQUIPMENT SALE

9 inch VIDEO MONITORS

Once again we are able to offer these superb Motorola monitors at a fraction of the list price.

Mains and composite video input, ideal for any micro. High-resolution 80 column display, complete with circuit. Used but tested OK.

£34 + VAT
Carr. £6.50

8 inch FLOPPY DRIVES

Galoop 8 inch single/double density disk drives, 115v or 50Hz operation, but no read/write electronics.

Ideal for the experimental, schools etc.

Only £27 + VAT
or £50 for two
Carr. £4.50

COOLING FANS (230v)

Brand new surplus: twin 4 inch whisper-quiet extractor fans, mounted on rack panel (19") with mains lead. Ideal for cooling your micro; save £50 +

Our price £11 + VAT
Carr. £1.20

TWIN-CASSETTE DRIVES

DEC TALL twin digital cassette drives, intended for PDP11 but adaptable for use on micros.

Complete with circuits. As new.

Our price £199 + VAT
Carr. £9

RIBBON CABLES

40-way standard ribbon cable, 8 foot long, complete with two Berg connectors at either end.

In sets of three cables. As new. Save £10 or more!

£10 + VAT for 3
Carr. £1

DEC PDP-11/03 COMPUTERS

We have a few surplus PDP 11/03's complete with box power supply, and LS111/1 Processor card. A real 16-bit computer that usually costs thousands of pounds. Not just brand new.

at only £320 + VAT
Carr. £10

FOODING DRIVES

DEC TALL twin digital cassette drives, intended for PDP11 but adaptable for use on micros.

Complete with circuits. As new.

Our price £199 + VAT
Carr. £9

ZENTEK VDU TERMINALS

Beautiful 8080 - controlled terminals that can also function as stand-alone micro. Large 14" screen, attractive case, detachable keyboard with numeric pad, 2 pages of 25 lines/90 char.

List £2K+. Ours our sold "as-is" but probably OK, with circuits.

Only £99 + VAT
Carr. £14.50

M I C R O - P O W E R

SUPPLIES

Compact 5v 3amp regulated power supplies, mains input.

Used but tested OK.

Only £11 + VAT
Carr. £2

Also available 5v 6amp version at
£16 + VAT Carr. £2.40

A.S.C.II KEYBOARDS

Scoop purchase allows us to offer a real professional keyboard (49-key ASCII), with Hall-effect keys and attractive case for a ridiculous price. Circuits supplied. Used but tested. Cost £300+.

Only £15 + VAT
Carr. £8.50

DRI-30 DISK DRIVES

(2.5Mb)

These famous disks are well known for their reliability and high engineering standards. Cartridge is easily exchangeable, standard disk interface. Untested but believed working OK.

Our price to clear £120 - VAT
Carr. £10

LAB. POWER SUPPLIES

Professional heavy duty power units from mainframe computers, beautifully made.

Outputs 5v 33a, ±12v 4a, ±15v 4a.

Mains 240v input. Fully regulated and protected.

List price over £300. Used but fully tested.

£34 + VAT
Carr. £8.50

W W - 014 FOR FURTHER DETAILS

CONNECTIONS & CABLES

BIRKENHEAD B24 9PJ

WO R L D  —  W W  —  0 7 8  F O R  F U R T H E R  D E T A I L S
TWO IMPORTANT WORKS ON THE S100 BUS YOU CAN'T AFFORD TO MISS.
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 £5000-£15000.

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.

Please send me a TJB Appointments Registration form:

Name

Address

TJB ELECTRICAL PERSONNEL SERVICES, 12 Mount Ephraim, Tunbridge Wells, Kent. TN4 8AS.

Tel: 0892 29368 (24 Hour Answering Service)

£7,000-£20,000

£12,5K –

Leading Video Facilities House offers truly unique position to artistic electronics engineers.

Call Richard Butcher NOW! 01-549 6441 (24 hrs.) or at home 01-337 4600.

Townley Emporium, Banbury

Electrical, Electronic & Mechanical Components

You must hold a Higher National Certificate, HNC, HND, BSc in electronic engineering, TV, A level Physics, Chemistry, Mathematics, Electronics, iPods, Sensors, Ks, Tasts.

Woolery Street off Barnaby Road, Northwich, Cheshire CH2 3DT.

102

LOGEX ELECTRONICS RECRUITMENT

Specialist in Field & Control Engineering appointments at all levels. Join a large and well established company, give your CV, Telephone: 01942-320056, Fax: 01942-320057 (24 Hours)
**PIONEER**

**A VIDEO ENGINEER**

The successful applicant will carry out varied and interesting work on new high technology products including the Laser Disc player. In a well-equipped Service Department, he/she will be responsible for the repair of Laser Disc player. Training will be given in our technical training school.

Candidates should be qualified to City and Guilds in radio and television electronics or HNC in electronics or equivalent, and be able to perform to at least five years’ experience in colour television and video recorders. Some experience in microprocessors would be an advantage.

**A TECHNICAL LIAISON ENGINEER**

The successful applicant will be expected to answer dealers’ and consumers’ correspond and telephone enquiries relating to all Pioneer products.

The person selected for this very important position will have at least five years’ experience in repairing Hi-Fi equipment and should be qualified to City and Guilds in audio and video electronics and/or HNC in electronics or equivalent, and must have experience in dealing with technical correspondence. Benefits include four weeks’ annual holiday, staff restaurant, honorary pension scheme and private health cover.

For further information, do not hesitate to contact Mr. C. A. Budden, Pioneer High Fidelity (SIB) Limited, Field Way, Windlesham, GU8 6EZ. Telephone: 01-676 5767

---

**FIELD SERVICE ENGINEER**

- **Broadcast TV industry**
- **£60,000 plus car**

An excellent opportunity has arisen within the Service Department of Sony Broadcast, one of the world’s leaders in professional broadcast television equipment.

The successful candidate will be engaged in the servicing and repair of broadcast equipment. This will involve travel throughout our market territory which covers Europe, Africa and the Middle East. Training opportunities are given where necessary.

Applicants should have several years’ engineering experience gained in the broadcast television industry and knowledge of ITV and a video camera is essential.

This position carries an excellent remuneration package which includes: Company Car and Relocation expenses if appropriate. An attractive pension is also included should these be sought. Contact: Mike Jones, Personnel Officer, Sony Broadcast Limited, City Wail House, Basingstoke. Telephone 0256 55011.

---

**ACOUSTIC SIGNAL PROCESSING SPECIALIST**

**London**

An experienced graduate electronics or computer hardware specialist is required to join a team working on a variety of challenging projects.

Activities involve the design, specification and use of electronic and computer equipment to process acoustic data; technical liaison with Government R&D establishments and with industry; and the provision of advice to non-technical personnel.

Applicants should be under 30, hold a good Honours Degree or equivalent in Electronics or Computer Systems Technology, and be capable of designing in the acoustic communications/signal processing field. An ability to liaise effectively with senior technical staff is essential.

The starting salary will be in the band £7,000 to £11,000 per annum, depending on qualifications and experience, and the post will initially be based in London, although career progression will probably take you to our Communications Centre at Hamslope Park.

For an application form please write to Dr. D. Orr, Recruitment Officer, HM/GCC, Hamslope Park, Hamslope, Buckinghamshire MK19 8BZ.

---

**DEVELOPMENT / EXECUTIVE SELECTION**

**MANAGEMENT & EXECUTIVE SELECTION**

**DEVELOPMENT & SYSTEMS**

**TECHNICAL ENGINEERS**

To £9K

Supporting a design team producing true state of the art electronic systems and sub-assemblies, your strengths could be utilised in defect investigation, environmental testing, "breadboard" assembly and test or quality assurance. In any of these areas you will enjoy the satisfaction of seeing equipment go from research to development and finally into production.

You will liaise both with project teams and the production area to ensure that the equipment meets the agreed technical specifications and is practical to operate. The test gear used to check the equipment is of the most recent and sophisticated design which means that you keep at the forefront of the science. Every unit passes through your department which guarantees a wide variety of interesting work.

The equipment uses digital, electro-optical and analogue technologies, with frequencies up to microwave level, most incorporate microprocessors or minicomputers.

Based West of London, your benefits will include competitive salaries, paid overtime, 23 day holiday, career opportunity for career enhancement, Group Membership of BUPA, contributory pension scheme and generous relocation assistance where applicable.

For an informal discussion phone Kirk Blackmore or Philip Joline on 01-637 9611.

 Suite 201/6 Albany House 324 Regent Street London W1 MANAGEMENT & EXECUTIVE SELECTION

---

**WIRELESS TECHNICIAN**

**SCOTTISH OFFICE**

**DIRECTORATE OF TELECOMMUNICATIONS**

**£6,251 - £8,450**

Invited for the above post based in East Kilbride, near Glasgow. Candidate should be a young theoretical or practical knowledge of Radio Communications and systems, and the ability to provide the necessary technical support to the operational Headquarters. Knowledge of Radio Communications Systems, both fixed and mobile, in the frequency bands 1 to 2 GHz are essential. They should be able to understand and interpret diagrams related to the operation and use of various radio and mobile communications equipment to assist in the assets of radio communications and mobile radio equipment. Some experience of mobile radio equipment and ability to wireline be a distinct advantage to be considered.

**R.T.M SYSTEMS RADIO TELEPHONE TESTING**

**R.F. ENGINEER DESIGN AND PRODUCTION**

We are a Division of a large Electronics Group with considerable experience of test equipment, with a strong electronics design and testing programme area.

To assist in these activities we require additional R.F. technicians to work with our existing team.

**DESIGNER / PROJECT CONTROLLER**

Must have sound understanding of small design, applied to a practical understanding of R.F. Engineering to 1.5 GHz or above. Must have degree level in Electronic Engineering, with experience in design, development and production of test equipment. Must be self motivated and results orientated. Being a driven individual would be essential.

**PRODUCTION MANAGER**

Must have experience of project control, quality control, testing and calibration of equipment particularly in the communications field. Must have an understanding of the ability to assemble and build electronic equipment. The successful candidate should have experience in the field of radio communications and radio frequency equipment. Must be capable of motivating staff and supervising with skill.

**APPLICATIONS**

Applications only from people wanting to enjoy the freedom and opportunity to work as part of a dynamic team.

Benefits include: company car, substantial salary, bonus plans, and normal pension entitlements. Send your career details or phone for an appointment to: R.J. West, R.T.M. Wireless, 87 St. Leonard's Road, Weybridge, Surrey. Telephone: (0391) 81110.

---

**CLIVEDEN**

**PROGRAMMER**

Relay ladder logic

Modicom or any other PLC.

Carol Lynnon 01-948 9922

**CLIVEDEN**

---

**CAPITAL APPOINTMENTS LTD**

**THE UK’s No. 1 ELECTRONICS AGENCY**

If you have HNC/TEC or higher qualifications and are looking for a job in design, test, customer service, technical or similar fields.

Telephone now for our free jobs list

We have vacancies in all areas of the UK.

Salaries to £10,000 pa

01-637 5551 or 01-636 9559 (24 hours)

---

**CAPITAL APPOINTMENTS LTD**

**29-30 WINDMILL STREET, LONDON W1 1HP**

---

**APPRENTICES**

- **ELECTRONICS APPOINTMENTS**
  - **£6,000 - £16,000**

- **ANALOGUE, RADIO, MICROWAVE**
- **DIGITAL, MICROPROCESSOR, COMPUTER**
- **DATA COMMUNICATIONS**

- **Design, Test, Sales and Field Service Engineers**
- **to use our free, confidential service and improve your salary and career prospects, UK and overseas, contact:**

  11 Westbourne Grove, London W2 TEL: 01-229 4929

---

**Appointments**

---
NEW DIMENSIONS IN TEST TECHNOLOGY

NEW CHALLENGES FOR ELECTRONICS ENGINEERS

Honeywell

Appointment

It’s more by design than accident that Honeywell is already an advanced instrument manufacturer worldwide. The Test Instrument Division based at Bracknell, is responsible for the effective operation of Industrial Tape Systems, Video Graphic Camera Systems and Oscillograph recorders countrywide in industrial, medical and R & D establishments.

We now need experienced Electronics Engineers, who offer a brief product familiarisation period, will be able to work to maximum effectiveness in trouble-shooting hi-tech equipment. Ideally, you will have a minimum of three years experience in fault-finding and maintaining “state-of-the-art” equipment.

The position also involves a high degree of customer contact and you will be expected to work on your own initiative to assist in expanding our customer base.

By joining us you can expect all the rewards of working for a highly successful International company, and in addition to an excellent salary, company car and worthwhile fringe benefits, there is every opportunity for career advancement.

Write with full career data to Richard Gould, Personnel Department, Honeywell Control Systems Limited, Honeywell House, Charles Square, Bracknell, Berkshire RG12 1TB. Telephone: Bracknell (0344) 24555.

Please quote Ref. WW/10/7TD.

TEST ENGINEERS (AUDIO)

We are a world leader in the design and manufacture of Computer-assisted sound mixing Consoles for the Record and Broadcast industries. To meet increasing demand we require experienced Audio test engineers to expand our existing test facilities.

Applicants should have at least two years’ relevant experience and have the enthusiasm to work in a self-motivated environment. A knowledge of digital circuits would be useful.

Please write or telephone for an application form to Solid State Logic Churchfields Stonessfield Oxford OX7 2PQ.

Tel. 099 389 8282

Solid State Logic
Stonesfield-Oxford-England

TECHNICIANS
Opportunities in Advanced Telecommunications

Our Technicians have wide-ranging responsibilities and can make full use of comprehensive and unique facilities. They are required to provide an excellent service to our customers from different locations and there is the opportunity for service overseas, medical and R & D establishments.

We are capable of supporting the promotion of British television with a well-timed selection of different, distinctive programmes.

We are equally capable of expanding the lives of our Technicians with a stimulating career environment.

Applicants should normally have 4 years’ relevant experience (7 years for more senior posts), and must hold one or more of the following qualifications:

★ ONC in Engineering (with pass in Electrical Engineering ‘A’);
★ ONC in Applied Physics;
★ TEC/SCOTC certificate;
★ City & Guilds Telecommunications Technicians Certificate Part II (Course 2711) or Part I plus Maths ‘B’; telecommunications Principles ‘B’ and one other subject;
★ pass in the Council of Engineering Institutions Part I examination;
★ an equivalent or higher relevant qualification.

Ex-Service personnel who have had suitable training and at least 2 years’ appropriate service (as Staff Sergeant or equivalent) will also be considered.

Salary: Salary will rise from a minimum of £6,262 p.a. to a maximum of £9,080 p.a. for the Junior Grade and from a minimum of £8,420 p.a. to a maximum of £9,522 p.a. for the Senior Grade. Starting salary in the Junior Grade may be above minimum for those with additional relevant experience.

Relocation assistance may be available.

For an application please write indicating the position desired to Foreign & Commonwealth Office, Hanslope Park House, Milton Keynes MK17 8BH, or for information contact Channel Four Television, 60 Charlotte Street, London W1P 2AX quoting reference (23/1).

HANSLAPE PARK (MILTON KEYS) AND CENTRAL LONDON

CROWNBOROUGH, SUSSEX

for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment, telephones, telephone subscribers apparatus, PMBXs, PAXs, PABXs and ancillary equipment including all using analogue and digital techniques and equipment.

One post is in the Test Department of an electronics manufacturing group in Hanslope Park involved in the small batch production of a wide range of electronics and communications equipment.

CROWNBOROUGH, SUSSEX

for maintenance and operation of high power, medium and shortwave broadcasting transmitters and associated equipment. Opportunities also exist for posting to other Broadcast stations at Oxford, Cyprus and Malta.

Applicants should normally have 4 years’ relevant experience (7 years for more senior posts), and must hold one or more of the following qualifications:

★ ONC in Engineering (with pass in Electrical Engineering ‘A’);
★ ONC in Applied Physics;
★ TEC/SCOTC certificate;
★ City & Guilds Telecommunications Technicians Certificate Part II (Course 2711) or Part I plus Maths ‘B’; telecommunications Principles ‘B’ and one other subject;
★ pass in the Council of Engineering Institutions Part I examination;
★ an equivalent or higher relevant qualification.

Ex-Service personnel who have had suitable training and at least 2 years’ appropriate service (as Staff Sergeant or equivalent) will also be considered.

Salary: Salary will rise from a minimum of £6,262 p.a. to a maximum of £9,080 p.a. for the Junior Grade and from a minimum of £8,420 p.a. to a maximum of £9,522 p.a. for the Senior Grade. Starting salary in the Junior Grade may be above minimum for those with additional relevant experience.

Relocation assistance may be available.

For an application please write indicating the position desired to Foreign & Commonwealth Office, Hanslope Park House, Milton Keynes MK17 8BH, or for information contact Channel Four Television, 60 Charlotte Street, London W1P 2AX quoting reference (23/1).

HANSLAPE PARK (MILTON KEYS) AND CENTRAL LONDON

CROWNBOROUGH, SUSSEX

for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment, telephones, telephone subscribers apparatus, PMBXs, PAXs, PABXs and ancillary equipment including all using analogue and digital techniques and equipment.

One post is in the Test Department of an electronics manufacturing group in Hanslope Park involved in the small batch production of a wide range of electronics and communications equipment.

CROWNBOROUGH, SUSSEX

for maintenance and operation of high power, medium and shortwave broadcasting transmitters and associated equipment. Opportunities also exist for posting to other Broadcast stations at Oxford, Cyprus and Malta.

Applicants should normally have 4 years’ relevant experience (7 years for more senior posts), and must hold one or more of the following qualifications:

★ ONC in Engineering (with pass in Electrical Engineering ‘A’);
★ ONC in Applied Physics;
★ TEC/SCOTC certificate;
★ City & Guilds Telecommunications Technicians Certificate Part II (Course 2711) or Part I plus Maths ‘B’; telecommunications Principles ‘B’ and one other subject;
★ pass in the Council of Engineering Institutions Part I examination;
★ an equivalent or higher relevant qualification.

Ex-Service personnel who have had suitable training and at least 2 years’ appropriate service (as Staff Sergeant or equivalent) will also be considered.

Salary: Salary will rise from a minimum of £6,262 p.a. to a maximum of £9,080 p.a. for the Junior Grade and from a minimum of £8,420 p.a. to a maximum of £9,522 p.a. for the Senior Grade. Starting salary in the Junior Grade may be above minimum for those with additional relevant experience.

Relocation assistance may be available.

For an application please write indicating the position desired to Foreign & Commonwealth Office, Hanslope Park House, Milton Keynes MK17 8BH, or for information contact Channel Four Television, 60 Charlotte Street, London W1P 2AX quoting reference (23/1).

HANSLAPE PARK (MILTON KEYS) AND CENTRAL LONDON

CROWNBOROUGH, SUSSEX

for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment, telephones, telephone subscribers apparatus, PMBXs, PAXs, PABXs and ancillary equipment including all using analogue and digital techniques and equipment.

One post is in the Test Department of an electronics manufacturing group in Hanslope Park involved in the small batch production of a wide range of electronics and communications equipment.

CROWNBOROUGH, SUSSEX

for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment, telephones, telephone subscribers apparatus, PMBXs, PAXs, PABXs and ancillary equipment including all using analogue and digital techniques and equipment.

One post is in the Test Department of an electronics manufacturing group in Hanslope Park involved in the small batch production of a wide range of electronics and communications equipment.

CROWNBOROUGH, SUSSEX

for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment, telephones, telephone subscribers apparatus, PMBXs, PAXs, PABXs and ancillary equipment including all using analogue and digital techniques and equipment.

One post is in the Test Department of an electronics manufacturing group in Hanslope Park involved in the small batch production of a wide range of electronics and communications equipment.

CROWNBOROUGH, SUSSEX

for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment, telephones, telephone subscribers apparatus, PMBXs, PAXs, PABXs and ancillary equipment including all using analogue and digital techniques and equipment.

One post is in the Test Department of an electronics manufacturing group in Hanslope Park involved in the small batch production of a wide range of electronics and communications equipment.

CROWNBOROUGH, SUSSEX

for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment, telephones, telephone subscribers apparatus, PMBXs, PAXs, PABXs and ancillary equipment including all using analogue and digital techniques and equipment.

One post is in the Test Department of an electronics manufacturing group in Hanslope Park involved in the small batch production of a wide range of electronics and communications equipment.

CROWNBOROUGH, SUSSEX

for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment, telephones, telephone subscribers apparatus, PMBXs, PAXs, PABXs and ancillary equipment including all using analogue and digital techniques and equipment.

One post is in the Test Department of an electronics manufacturing group in Hanslope Park involved in the small batch production of a wide range of electronics and communications equipment.

CROWNBOROUGH, SUSSEX

for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment, telephones, telephone subscribers apparatus, PMBXs, PAXs, PABXs and ancillary equipment including all using analogue and digital techniques and equipment.

One post is in the Test Department of an electronics manufacturing group in Hanslope Park involved in the small batch production of a wide range of electronics and communications equipment.

CROWNBOROUGH, SUSSEX

for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment, telephones, telephone subscribers apparatus, PMBXs, PAXs, PABXs and ancillary equipment including all using analogue and digital techniques and equipment.

One post is in the Test Department of an electronics manufacturing group in Hanslope Park involved in the small batch production of a wide range of electronics and communications equipment.
The Technical Manager will have the major responsibility of setting up engineering policy for the operations of TV and Radio and for the State of Bahrain and the maintenance of its electronic equipment and studio plant facilities. Duties will include determining additional replacement/equipment, administering engineering budget and representing the Minister or Director as required in international matters and national technical committees.

Appropriate education/training and related experience are required.

State of Bahrain is reputed as a commercial and communication centre in the Gulf. It is well governed and prosperous. It has a big expatriate community of Western and Eastern nationals enjoying excellent modern facilities and services.

Salary shall be negotiable depending on over all suitability. An initial 2 years married (or bachelor's) status contract will be offered with benefits among others as follows: free accommodation, free annual family passage, setting-in allowance, paid leave, educational assistance, and free medical coverage.

Please enclose detailed C.V. quoting reference P-055-6/1, to:

Chief of Recruitment and Placement, Civil Service Bureau, P.O. Box 1066, State of Bahrain, (Arabian Gulf).

*At current exchange rate.

Ministry of Information
Radio and Television
Technical Manager
Salary c.£25,000 Tax Free*

The Technical Manager will have the major responsibility of setting up engineering policy for the operations of TV and Radio and for the State of Bahrain and the maintenance of its electronic equipment and studio plant facilities. Duties will include determining additional replacement/equipment, administering engineering budget and representing the Minister or Director as required in international matters and national technical committees.

Appropriate education/training and related experience are required.

State of Bahrain is reputed as a commercial and communication centre in the Gulf. It is well governed and prosperous. It has a big expatriate community of Western and Eastern nationals enjoying excellent modern facilities and services.

Salary shall be negotiable depending on overall suitability. An initial 2 years married (or bachelor's) status contract will be offered with benefits among others as follows: free accommodation, free annual family passage, setting-in allowance, paid leave, educational assistance, and free medical coverage.

Please enclose detailed C.V. quoting reference P-055-6/1, to:

Chief of Recruitment and Placement, Civil Service Bureau, P.O. Box 1066, State of Bahrain, (Arabian Gulf).

*At current exchange rate.
**NETWORK PLANNING ENGINEERS**

**NEWBURY, BERKSHIRE**

**ATTRACTIVE SALARIES**

**RELATIONSHIP ASSISTANCE**

Cabletime is a new member of the U.E.I plc group which includes Quantum, Link Electronics and Micron Consultants.

Cabletime is involved with the design, development and installation of cable TV and data communications networks using optical fibre. Cabletime's advanced cable television system uses a carrier switched interactive network with head end computer control using DEC VAX computers. Cabletime also designs and install data networks for large computer systems.

**NETWORK PLANNING ENGINEERS** to assist in the design of large communications networks for high speed computer data communication, and for broadband cable television distribution networks.

The job involves: interpreting customer requirements in conjunction with area mapping information to produce suitable network designs, providing technical support to the sales and project engineers installing electronic distribution equipment to be used within the networks.

Essential requirements are: a knowledge of data communication networks, a knowledge of television transmission, the ability to communicate with customers at a technical level, and some skill in technical writing. You should be qualified to BSc or HND/HTC level.

These positions require engineers with a high degree of self-motivation, and the ability to follow projects from their conception through to commissioning. We offer you an excellent opportunity to get in at the start of this exciting new venture.

Send your cv to, or contact: The Personnel Officer, Cabletime Limited, 17 West Mills, Newbury, Berkshire. Tel: Newbury (0635) 48222.
YOU HAVEN'T SEEN ANYTHING LIKE THIS ON A COLOUR MONITOR BEFORE.

An RGB monitor from JVC offering a resolution of 370 x 470 pixels for less than £150.

We guarantee you won't see another bargain like that in this or any other micro mag—or in any other supplier's showroom.

For we've managed to acquire the sole distribution rights to these superb machines and we are able to offer them at an unbeatable price.

There are two models available: medium resolution (370 x 470 pixels) at £149.95; and high resolution (580 x 470 pixels) at £229.95. (Both excluding VAT.)

The units have a 14” screen and are suitable for the BBC Micro, Lynx, Oric, Apple, and most other leading micros.

They are robustly constructed in a handsome cream casing. And come with a full year's guarantee.

Delivery is good: your monitor should arrive by courier service within ten days of our receiving your order.

You can order by filling in the coupon below and posting to: Opus Supplies Ltd., 158 Camberwell Road, London SE5 0EE. Or by telephoning 01-701 8668 quoting your credit card number. Or, of course, you can buy in person at our showroom between 9am-6pm Monday-Friday, 9am-1.30pm Saturday.

---

To Opus Supplies Ltd., 158 Camberwell Road, London SE5 0EE.
Please send me ______ Medium Resolution Colour Monitor(s) at £149.95 each (ex. VAT).

______ High Resolution Colour Monitor(s) at £229.95 each (ex. VAT).

______ Connection lead(s) at £6.00 each.

I understand carriage per monitor will cost an extra £7.00.

(N.B. A Medium Resolution Monitor including VAT, lead, and carriage costs £187.39. A High Resolution Monitor including VAT, lead, and carriage costs £279.39.)

I enclose a cheque for £_____. Or please debit my credit card account with the amount of £_____. My Access/Barclaycard (please tick) no. is ________.

Please state the make of your computer.

Name:

Address:

Telephone: ________

Opus Supplies Ltd.

WW - 003 FOR FURTHER DETAILS