Uprated micro trainer
Digital speech
Long-distance television
Low-loss coaxial cable
The TL99 and TL100 are designed for the Professional Electronics, TV or Instrument Technician who needs to carry a large number of specialist tools. Constructed from hard-wearing ABS with strong aluminium frames, twin handles and toggle locks. They offer a moulded tray in the base, a comprehensive 2-sided tool pallet that's reversible with space for up to 40 tools. The TL100 will take suite a few more. There's space for documents and a heat sink for a hot soldering iron to prevent any damage being caused.

TL99 Tool wallet measures 11" x 14" x 2½" when closed. Made from reinforced PVC with a heavy-duty industrial zip. The TLW4 Tool wallet is a compact alternative when only tools are needed to be carried.
Autostore.
Low-cost voice-logging for people with more important things to do.

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

The solution: the new Racial Recorders Autostore.

SIMPLICITY
With its automatic cassette-loading and fully automatic changeover from one deck to another, Autostore can—quite literally—be operated by whoever happens to be around. And it provides over 24 hours of unattended continuous recording on eight channels.

VERSATILITY
Able to log radio and telephone messages simultaneously, Autostore can form part of a new— or fit just as easily into an existing one. And its uses vary from ambulance, fire, police and security applications to the recording of financial transactions, conferences, oil installation communications and taxi services.


Tel: (0703) 84-2565 Telex: 875600

RELIABILITY
Available in 4 or 8 channel versions, and with integral micro-processor controlled automatic TimeSearch capability to enable rapid message retrieval, Autostore is engineered to the very highest standards by the company which pioneered air traffic control recording techniques.

FULL DETAILS
For full details of Autostore send off the coupon today.

I am interested in recording my communications accurately and reliably. Please:
☐ send me full details of Autostore
☐ arrange for a demonstration at my own premises

Name: ____________________________
Position: __________________________
Company: _________________________
Address: __________________________
Tel: _______________________________

Racial Recorders Limited, Hardy Industrial Estate, Hythe, Southampton, Hampshire SO4 6D1, England

WWW-001 FOR FURTHER DETAILS
The Professionals

VALVES SEMICONDUCTORS & COMPONENTS for:

Communications, Displays, Radar, Computer, Audio etc.

Hall Electric Limited,
Electron House,
Croy Avenue, St. Mary Cray,
Orpington, Kent BR5 1QJ.
Telephone: Orpington 21099
Telex: 99141

MIN DEF APPROVAL 0529/0531

DON'T GAMBLE
WITH PERFORMANCE
BUY
LEVELL OSCILLATORS

<table>
<thead>
<tr>
<th>Frequency</th>
<th>TG200D, DM &amp; DMP only. TV peak down to &lt;200 μV. Rise time &lt;150ns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>±2% up to 1MHz</td>
</tr>
<tr>
<td>Sinewave output</td>
<td>TV r.m.s. down to &lt;200 μV with Rs = 6000.</td>
</tr>
<tr>
<td>Distortion</td>
<td>&lt;0.02% from 50Hz to 15kHz, &lt;0.1% from 1kHz to 30kHz, 0.3%</td>
</tr>
<tr>
<td></td>
<td>from 30kHz to 50kHz, &lt;1% at 1kHz and 0.1kHz.</td>
</tr>
<tr>
<td>Square Output</td>
<td>TG200D, DM &amp; DMP only. TV peak down to &lt;200 μV. Rise time</td>
</tr>
<tr>
<td>SYNC Output</td>
<td>&lt;1V r.m.s. sine in phase with output</td>
</tr>
<tr>
<td>SYNC Input</td>
<td>0.1% from 1kHz to 30kHz, 0.2% from 30kHz to 50kHz, 0.3%</td>
</tr>
<tr>
<td>Meter Scales</td>
<td>0.1% from 50kHz to 100kHz, 0.5% from 100kHz to 200kHz, 1%</td>
</tr>
<tr>
<td>Size &amp; Weight</td>
<td>260 x 120 x 120mm, 0.4kg with batteries.</td>
</tr>
</tbody>
</table>

TG200 £108 £125 £130 £135

<table>
<thead>
<tr>
<th>Frequency</th>
<th>3Hz to 300kHz in 5 decade ranges.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>±2% up to 300Hz</td>
</tr>
<tr>
<td>Sinewave output</td>
<td>Increasing to ±3% at 300kHz</td>
</tr>
<tr>
<td>Distortion</td>
<td>2.8V r.m.s. down to &lt;200μV</td>
</tr>
<tr>
<td>Square Output</td>
<td>&lt;1% from 10Hz to 20kHz, 2.8V peak down to &lt;200μV</td>
</tr>
<tr>
<td>SYNC Output</td>
<td>0.2V r.m.s. sine</td>
</tr>
<tr>
<td>Meter Scales</td>
<td>0.2V r.m.s. sine</td>
</tr>
<tr>
<td>Size &amp; Weight</td>
<td>260 x 120 x 120mm, 0.4kg with batteries.</td>
</tr>
</tbody>
</table>

TG152D £80

<table>
<thead>
<tr>
<th>Frequency</th>
<th>0.2Hz to 222MHz on a four decade control.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>±0.02% from 6Hz to 300kHz</td>
</tr>
<tr>
<td>Sinewave output</td>
<td>&lt;0.3% from 6Hz to 15kHz, 0.1% from 15kHz to 30kHz, 1%</td>
</tr>
<tr>
<td>Distortion</td>
<td>1% from 30kHz to 100kHz, 1% above 500kHz, ±3% above 300kHz</td>
</tr>
<tr>
<td>Meter Scales</td>
<td>5V r.m.s. down to 20μV with Rs = 6000.</td>
</tr>
<tr>
<td>Size &amp; Weight</td>
<td>260 x 180 x 180mm, 0.4kg with batteries.</td>
</tr>
</tbody>
</table>

TG152DM £99

<table>
<thead>
<tr>
<th>Battery model</th>
<th>£265</th>
</tr>
</thead>
</table>

LEVELL ELECTRONICS LTD

MOKON STREET, BARNET, HERTS. EN5 8SD.
TEL: 01-440 028/440 8686

Prices are ex works with batteries. Carriage, packing and VAT extra.
Optional extras are leather cases and mains power units.
Send for data covering our range of portable instruments.

WW - 027 FOR FURTHER DETAILS

WWW. AMERICAN RADI AlJHIS TORY.COM
July 1981

Latest Test Equipment

**ANALOGUE VOLTMETERS AND MULTIMETERS**

<table>
<thead>
<tr>
<th>Brand</th>
<th>Model</th>
<th>Specifications</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluke</td>
<td>7600</td>
<td>Digital Multimeter</td>
<td>£295.00</td>
</tr>
<tr>
<td>Hewlett-Packard</td>
<td>3953A</td>
<td>Digital Multimeter</td>
<td>£245.00</td>
</tr>
<tr>
<td>Tektronix</td>
<td>350A</td>
<td>Digital Multimeter</td>
<td>£215.00</td>
</tr>
<tr>
<td>Brookdeal</td>
<td>1660</td>
<td>Digital Multimeter</td>
<td>£195.00</td>
</tr>
</tbody>
</table>

**GENERAL RADIO**

<table>
<thead>
<tr>
<th>Model</th>
<th>Specifications</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1426</td>
<td>0.1µA to 200mA Current</td>
<td>£271.00</td>
</tr>
<tr>
<td>1425</td>
<td>0.1µA to 200mA Current</td>
<td>£235.00</td>
</tr>
</tbody>
</table>

**FREQUENCY COUNTERS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Specifications</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP 3450B</td>
<td>10 MHz</td>
<td>£525.00</td>
</tr>
<tr>
<td>HP 3450A</td>
<td>1 MHz</td>
<td>£500.00</td>
</tr>
<tr>
<td>HP 3450</td>
<td>100 kHz</td>
<td>£475.00</td>
</tr>
</tbody>
</table>

**OSCILLOSCOPES**

<table>
<thead>
<tr>
<th>Model</th>
<th>Specifications</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tektronix 475B</td>
<td>100 MHz</td>
<td>£3,300.00</td>
</tr>
<tr>
<td>Tektronix 455B</td>
<td>250 MHz</td>
<td>£4,500.00</td>
</tr>
<tr>
<td>Tektronix 475</td>
<td>400 MHz</td>
<td>£5,200.00</td>
</tr>
</tbody>
</table>

**METERS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Specifications</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP 3470A</td>
<td>600 V, 5 A</td>
<td>£2,600.00</td>
</tr>
<tr>
<td>HP 3470</td>
<td>300 V, 100 A</td>
<td>£2,200.00</td>
</tr>
</tbody>
</table>

**SOUND LEVEL METER**

<table>
<thead>
<tr>
<th>Model</th>
<th>Specifications</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP 370</td>
<td>20 Hz - 8 kHz</td>
<td>£2,500.00</td>
</tr>
</tbody>
</table>

**SPECS**

- Accuracy: ±0.5% of reading + 0.5% of full range.
- Resolution: 0.1 µA.

**GUARANTEE**

We guarantee that all our test equipment is calibrated to industry standards and is fully functional. We also offer a 12-month warranty on all equipment.
### Latest Computer Equipment

#### July 1981

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC</td>
<td>£750.00</td>
</tr>
<tr>
<td>PDP8A C.P.U.</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>PDP8A MEMORY</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>TERMINALS</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>DISKS</td>
<td>£1,395.00</td>
</tr>
</tbody>
</table>

#### July 1981

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC</td>
<td>£750.00</td>
</tr>
<tr>
<td>PDP8A C.P.U.</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>PDP8A MEMORY</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>TERMINALS</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>DISKS</td>
<td>£1,395.00</td>
</tr>
</tbody>
</table>

### Latest Computer Equipment

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC</td>
<td>£750.00</td>
</tr>
<tr>
<td>PDP8A C.P.U.</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>PDP8A MEMORY</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>TERMINALS</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>DISKS</td>
<td>£1,395.00</td>
</tr>
</tbody>
</table>

### Latest Computer Equipment

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC</td>
<td>£750.00</td>
</tr>
<tr>
<td>PDP8A C.P.U.</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>PDP8A MEMORY</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>TERMINALS</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>DISKS</td>
<td>£1,395.00</td>
</tr>
</tbody>
</table>

### Latest Computer Equipment

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC</td>
<td>£750.00</td>
</tr>
<tr>
<td>PDP8A C.P.U.</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>PDP8A MEMORY</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>TERMINALS</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>DISKS</td>
<td>£1,395.00</td>
</tr>
</tbody>
</table>

### Latest Computer Equipment

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC</td>
<td>£750.00</td>
</tr>
<tr>
<td>PDP8A C.P.U.</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>PDP8A MEMORY</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>TERMINALS</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>DISKS</td>
<td>£1,395.00</td>
</tr>
</tbody>
</table>

### Latest Computer Equipment

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC</td>
<td>£750.00</td>
</tr>
<tr>
<td>PDP8A C.P.U.</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>PDP8A MEMORY</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>TERMINALS</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>DISKS</td>
<td>£1,395.00</td>
</tr>
</tbody>
</table>

### Latest Computer Equipment

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC</td>
<td>£750.00</td>
</tr>
<tr>
<td>PDP8A C.P.U.</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>PDP8A MEMORY</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>TERMINALS</td>
<td>£1,395.00</td>
</tr>
<tr>
<td>DISKS</td>
<td>£1,395.00</td>
</tr>
</tbody>
</table>
CX80 COLOUR MATRIX PRINTER
At last a low-cost Colour Matrix Printer for Text, Graphics, Histograms, Colour VDU Dumps, etc.

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

Compatible with most microprocessors, prints in 7 colours — sophisticated internal programmes make the CX80 easy to use.

Dot Addressable + 15 user programmable characters, 96 ASCII and 64 graphics characters in rom. Centronics interface with RS232 and IEEE488 options.

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

NRDC-AMBISONIC UHJ SURROUND SOUND DECODER

The first ever to specifically cater for the hearing for the British NRDC-based surround sound home market, this model of a wider research by the Ambisonic team. W. J. Aug., '77

The unit is designed to decode the NRDC UHJ bus virtually all other 'spacelike' systems, including the new 8020A. The precision of lower frequencies and deep bass is an inherent feature of the unit.

The complete kit, including licence fee £97.79 + VAT or ready built and tested £168.50 + VAT.

INTRUDER 1 Mk. 2 RADAR ALARM
With Home Office Type approval

The original "Wireless World" published Intruder 1 Mk. 2 has been redesigned by Defence to incorporate several new features, along with improved on TV battery operation. Disguised as a hand bagged glove, the unit is activated by either infra-red or ultrasonic emitters. 240 volt mains powered, mains supply.

Complete kit £125.50 + VAT, or ready built and tested £180.50 + VAT.

Wireless World Dolby noise reducer
Trademark of Dolby Laboratories Inc.

Complete k. PRICE: £49.95 + vat (Medium model installed)

Also available built-in units and test units.
Callibration signals are available for open-loop use and for cassette repetion with IT.... Price £2.15 + VAT.

EXTENSIVE RANGE OF NEW FLUKE IMMEDIATE DELIVERY

0802A 3½ Digit LCD DMM with true RMS on AC volts and current DC volts 200mV-1kV, 10µA resolution AC volts, 200mV-750V, 10µA resolution DC/AC current 20mA-2A, 0.05µA resolution Resistance 200Ω-20MΩ, 0.1% resolution. Also reads dB direct referenced to 16 meter impedences. Conductance ranges 2mS and 20mS.

£238.00 mains model
£244.00 mains battery.

0801A 3½ Digit LCD DMM Same specs as 0802A plus a 10mA AC/DC current range, but no low resistance range.

£176.00 mains model
£193.00 mains battery.

0824A 3½ Digit hand held LCD DMM with peak hold Level Detector and continuity tester.

DC volts 200mV-1kV, 10µA resolution.

Conductance 200S. Peak Hold of AC and DC volts. Low battery alarm operating sounds ±0.1% from set range. Automatic power off to 4 50mA. Internal mains powered, mains contacts for external battery use.

Complete with carrying case £89.00 + VAT.

8024A £193.00 basic.

Also available a range of accessories including current shunts, EHT probe, HFE probe, Temperature probes and hand held probe.

Full details on request.

0802A 3½ Digit hand held LCD DMM, spec as per 8024A but no conductance ranges and slight reduction in accuracy. £99.00 carrying case £8.05 extra.

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

FROM OMB ELECTRONICS

WW - 049 FOR FURTHER DETAILS

EXTRA SPEC. FOR YOUR MONEY

TYPE 631 FILTER OSCILLATOR
£132.50 & 2.50 carriage, etc. includes:
COVERS THE RANGE 0.mV to 1000V.

MODES —

REJECT 0.4 from less than 1 to over 300
90 dB each
Hi and LO PASS 10 dB per octave
OSCILLATE Sine wave and squarewave.

TYPE 631LF £116.13 & 2.50 carriage, etc.

Low frequency version: 0.75mV to 10mV.

AOL ELECTRONICS LIMITED, EYNFIELD, HUNT DUNME AD
Tel: Farmington (0232) 85507

Prices, which are £123.50 and ex. VAT, are correct at the time of going to press and are subject to change without notice.

WIRELESS WORLD JULY 1981
**New! Sinclair ZX81**

**Personal Computer.**

**Kit:** £49.95 *complete*

Reach advanced computer comprehension in a few absorbing hours

1980 saw a genuine breakthrough - the Sinclair ZX80, world's first complete personal computer for under £100. At £99.95, the ZX80 offered a specification unchallenged at the price. Over 50,000 were sold, and the ZX80 won virtually universal praise from computer professionals.

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

**Lower price; higher capability**

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

It uses the same micro-processor, but incorporates a new, more powerful 8K BASICROM - the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and build up animated displays.

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

**Higher specification, lower price - how's it done?**

Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so to 21. The ZX80 reduces the ZX81 to 21! The secret lies in a totally new master chip. Designed by Sinclair, it is custom-built in Britain, this unique chip replaces 15 chips from the ZX80.

![Diagram of ZX81 components](image)

**New Sinclair teach-yourself BASIC manual**

Every ZX81 comes with a comprehensive, specially-written manual - a complete course in BASIC programming, from first principles to complex programs. You need no prior knowledge - children from 12 upwards soon become familiar with computer operation.

![Example pages from ZX81 manual](image)

**Built:** £69.95 *complete*

If you own a Sinclair ZX80...

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

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

**Coming soon - the ZX Printer.**

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphametrics across 32 columns, and highly sophisticated graphics. Special features include CPA, which prints out exactly what is on the whole TV screen without the need for further instructions. The ZX Printer will be available in Summer 1981, at around £50 - watch this space!

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

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

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

How to order your ZX81

BY PHONE - Access or Barclaycard holders can call 01-200 0200 for personal attention 24 hours a day, every day.

BY FREEPOST - use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access or Barclaycard.

EITHER WAY - please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt - and we have no doubt that you will be.

**To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Code</th>
<th>Item price</th>
<th>Total £</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZX81 Personal Computer Kit</td>
<td>49.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZX81 BASIC manual</td>
<td>9.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZX81 B2 BASIC card</td>
<td>19.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZX81 B2 BASIC card</td>
<td>19.95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Please tick if you require a VAT receipt.**

*Please do not enclose a cheque/postal order payable to Sinclair Research Ltd, for.*

*Please change to my Access/Barclaycard account no.*

*Please delete or complete as applicable.*

**Address**

Name: Mr/Mrs/Miss

Address: \__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\__________\_____
The EP4000 is not just an EPROM Programmer

Not only does the EP4000 copy, store, program and duplicate the 2704/2708/2716(3)
/2508/2758/2716/2516/2532
and 2732 EPROMs without personality cards or modules, but also includes a video output for memory map display to make the powerful editing facilities really useful (and this is in addition to the in-built LED display for stand-alone use), but it also comes as standard with comprehensive input/output — RS232, 20mA loop, TTL, parallel handshake, cassette, printer and direct memory access. Now the programming power can be expanded with our range of add-on accessories listed below.

... but also a Real Time EPROM Emulator

Real time EPROM Emulation is the second major function of the EP4000. This facility allows the machine to directly replace your in-circuit EPROMs during the process of program development — the EP4000 can be configured to look like any EPROM it is capable of programming. The press of a button isolates the external system so that data changes, entries, editing and downloading can be implemented. When the program is complete and working, the simulator cable can be replaced by an EPROM programmed by the EP4000.

... with real technical back-up and service.

The EP4000 comes with a technical manual describing every aspect of the machine — its purpose, its use, and how to use it. It also has a section describing the whole process of program development. And if you ever need technical help or advice, you can now dial direct to our technical department for instant attention — Tel. (0803) 863380.

Finally, a full range of accessories in now available — these include Bipolar programming modules, multi-EPROM simulator adaptors, buffer pods, EPROM Erasers, video monitors, 2764/2564 programming satellite, printer and production programmers. The EP4000 is ex-stock. Price — £545 + VAT (+£12 for DATAPOST delivery). Telephone, telex, write or call for full data and Distributor list, or place your order for immediate despatch — Overseas customers, please telex or write for quotation and terms. Agents in some countries, and distributors in Britain required.

G.P. Industrial Electronics Ltd.
Unit 6, Totnes Industrial Estate Totnes, Devon TQ9 5XL
Tel. Sales (0803) 863360. Technical (0803) 863380
Telex: 42596 GPELEC

Made in the U.K.
FIVE NEW SENSES FOR YOUR MICRO

_AFTI 1500 Automatic Fault Isolation Tester_
A low cost complete PCB tester designed for quality control or service/repair work. Its powerful self-contained microprocessor provides rapid in-circuit fault isolation on complex digital PCBs.

MTL’s comprehensive Programming Service will provide all the expertise required. 96% confidence level recorded in service applications. Worry ‘wired’ problems.

MTL Microtecning Limited
1-15 Butts Road, Alton, Hampshire Telephone, Alton (0420) 60022

W W – 019 FOR FURTHER DETAILS

_Acoustic & Vibration_
BRUEL & KJAER
2225 Soundthorne Inc. Octave Filter
1095
2226 Soundthorne Inc. 1/3 Octave
688
2300 Level Recorder
688
420B Sound Level Meter
92
420N Noise Dosimeter
376
2690-M A-weighted 1/3 Octave
260
ABLET
110 S/N Septa Monitor 24 Hour
180
S/N Septa Monitor 24 Hour
180

_CASTLE ASSOCIATES_
CASA 50 Sound Level Meter 250 Class
182
A111 Class 2 Sound Level Meter 400 Class
182

_BRIDGES & VOTS 1 STANDARDS_
FLUKE
341 DC Voltage Calib. 1990
11
CALIBRATORS
DAW-OIL Calib. Calibrator 111 V-Hz
500
HEWLET PACKARD
5622 A Calibration System 111 V
150
MARCONI
112 Class A/Duopod 250 Class
112
111 Class 10 Duopod 1990
80
112 Class 10 Duopod 250 Class
112
WAYNE KERR
8232 LA Bridge 112
12
8232 LC Bridge 1990
12
8241-1990 Bridge 112
12

_COMMS & CABLE TEST EQUIPMENT_
CHASE
394 Cable Test Meter 1990 Class
66
DYMAR
2810 M 1/16 Calibrator Telephone – Portable
250
3821H Radio Telephone – Portable
250
82216B Set Changes for 500 MHz
60
HEWLET PACKARD
354B Frame Test Set 1990 Class
60
MARCONI
17200 Test Set B 300 Class 1990
80
PVE
1110-01990 MF Bridge Telephone – Portable
12
STC
174 500 Voice Noise Calibrator 1990
174
TEKTRONIX
150 100 320 Class 100 Class
150

_COUNTERS & TIMERS_
FLUKE
1511 100 111 MHz 1 Digit Counter
28
1511 100 111 MHz 2 Digit Counter
28
1511 100 111 MHz 3 Digit Counter
28
1511 100 111 MHz 4 Digit Counter
28
1511 100 111 MHz 5 Digit Counter
28
HEWLET PACKARD
5301B 5 Digit Counter
15
5301B 6 Digit Counter
15
HEWLET PACKARD
5350B Dual Digit Counter
15
5350A Dual Digit Counter
15
5350A-1500 Dual Digit Counter
15
5350A-4000 Dual Digit Counter
15
5350A-8000 Dual Digit Counter
15
RCA
9244 100 MHz Du 7 Digit Counter
25
9244 100 MHz Du 8 Digit Counter
25
9244 100 MHz Du 9 Digit Counter
25
SYSTIM DONNER
1512 100 111 MHz 1 Digit Counter
28
1512 100 111 MHz 2 Digit Counter
28
1512 100 111 MHz 3 Digit Counter
28
1512 100 111 MHz 4 Digit Counter
28
1512 100 111 MHz 5 Digit Counter
28

_DIGITAL TESTING EQUIPMENT_
HEWLET PACKARD
1805 Logic Analyzer 25 MHz
20
1805 Logic Analyzer 25 MHz
20
1805 Logic Analyzer 25 MHz
20
1805 Logic Analyzer 25 MHz
20
TEXTRONIX
7415 Logic Analyzer 125 MHz
20
7415 Logic Analyzer 125 MHz
20
7415 Logic Analyzer 125 MHz
20
7415 Logic Analyzer 125 MHz
20

METER PROBLEMS?

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

Full Information from:

HARRIS ELECTRONICS (London)
136 GRAYS INN ROAD, W.C.1
Phone: 01/637/7937
Telex: 892301 HARTRO G

ONLY £48.50 post free, inc VAT

LOW COST ERASABLE PROGRAMMABLE READ ONLY MEMORY

Holds up to six programs
Selects interlocked
Fast erase time
Quality steel case
Money-back guarantee

O N L Y  3 p E A C H
Money-back guarantee

Minimum 5 pcs per value

CERAMIC RESISTORS & TRIMMERS

Only £3.00 post free for up to 40 pieces

Hurtado Scientific Products Ltd.
10 Wardour St., London W1

WW - 041 FOR FURTHER DETAILS

METALFILM RESISTORS

1% Tolerance, 1/4 Watt

ONLY 3p EACH

High Quality High Stability, Huge Selection.

ORION SCIENTIFIC PRODUCTS LTD.
38 Rosemont Road, Perivale, Wembley, Middlesex

Phone: 01-902 5941. Telex: 923455.

NEW LINE OF WAVE SOLDERABLE HEAT SINKS

Thermalloy International offers 35 different styles of wave solderable heat sinks for TO-3 and plastic packages. Styles include board mounted stampings and flat sided extrusions.

Solderable Stud Heat Sinks allow the heat sink/device to be preassembled and treated as a single component on your production line. It is dropped into plated thru holes in the PCB. Board and wave soldered with other components. Eliminates hand soldering and extra inspections to reduce your production steps by 50%. All work can now be done from one side of the board, and less mounting hardware is required.

For product samples and full technical literature contact MCP Electronics.

MCP Electronics Ltd.
38 Rosemont Road, Alperton, Wembley, Middlesex

Phone: 01-902 5941. Telex: 923455.

LOW PASS FILTERS

Now from 10kHz to 20MHz

TOKO's recently expanded LFF series covers from the audio spectrum through to 20MHz in a series of LFFs for mp3, video, radio etc.

HELICAL FILTERS for VHF and UHF

2 & 3 elements available

Featuring low insertion losses, -80dB at the +/−21.4MHz points. Ask for details.

CERAMIC RESONATORS & PIEZO SOUNDERS

Audio buzzers now down to 1kHz - low cost 400-600kHz crystal replacements for MP3, RCs etc.

Low cost - wide range.

VIDEO FRAME STORES

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

AMBIT international

200 North Service Road, Brentwood, Essex

Telex: 89593 AMBIT 9

POSTAGE 50p DISCRED UNDER £2. FIRST OVER £2.

THE LOWEST PRICES FOR PRIME CMOS/TTL/74C IN THE UK.

AMBIT international

200 North Service Road, Brentwood, Essex

Telex: 89593 AMBIT 9

POSTAGE 50p DISCRED UNDER £2. FIRST OVER £2.

The lowest prices for prime, leading-edge devices. UK stock on all products and components. Shop on the internet, or call us to order.

For the lowest price on all micros, DIPs, SOICs, narrow band tactical, high endic MUXIC, EBD, duals, or any other component, call or visit. PS extra. All prices exclude VAT unless otherwise stated. The largest range of PC components in Europe and all major brands. Pay by credit card, cheque or bank transfer. Cheques must be made out to AMBIT international, Brentwood. Wages will be withdrawn all bank transfers and all cheques cleared. Cheque must be in UK sterling or US dollars.

www.americanradiohistory.com
If you are experiencing random faults and failures in your microprocessor-based equipment, they are probably caused by voltage irregularities. Even dedicated supplies may not be the answer—they will still suffer from momentary voltage transients and power supply breaks.

Galatrek have the simple answer. A plug-in VOLSTAB Constant Voltage Transformer. Reliable, efficient and economical, the Galatrek VOLSTAB offers you:

- Output stabilisation to ±1% from mains input fluctuations of ±20%
- Transient attenuation
- Momentary power back-up

Available ex-stock from regional stockists in a choice of power ratings from 250VA to 3kVA; the Galatrek VOLSTAB will keep your sensitive electronic equipment running smoothly. Both the factory and the regional stockists throughout the UK will assist you technically to ensure you match the VOLSTAB unit exactly to your requirements.

Mr K. Krif, Galatrek International, Scotland Street, Lainrwd, nr Colwyn Bay, Gwynedd LL26 0AL, North Wales, Great Britain. Tel No: 0492-64031 | 1641296 Right Service. 0492-30592.

Tel: 617114 AB Galatrek

VOLSTAB is the Registered Trademark of Galatreek International

Please send me the 18 page Galatreek VOLSTAB catalogue, which includes details of your Mains Filters and Standby Power Supplies:

Name: ____________________________
Position: __________________________
Company: __________________________
Address: __________________________
Tel: __________________________
Trade "OEM" (please tick where appropriate) www

OUR
OFF THE SHELF RANGE
OFFERS
...any combination and sequence of
Red(GaP), Green(GaP) or Yellow
(GaAsP)/GaP) colours incorporated in one
array,
...fully end-stackable, 2, 3, 4 or 5
segment options thereby enabling displays
encouraging any number of segments to be
created,
...black bezels as standard with white
bezels to special order,
...push-fit mounting into correctly
dimensioned panel cut-out,
...wide operating temperature range of
-40°C to +80°C.

So if you are into TREND INDICATORS
BAR GRAPHS
or
EVENT DISPLAYS
Look at our
MULTI-LED ARRAYS
Our prices won't make your eyes water
Zaerix Electronics Limited
46 Westbourne Grove, London W2 5SF, England
Tel: 01-221 3643. Telex: 261386

WW - 614 FOR FURTHER DETAILS

WHO'S
LOOKING....
FOR
MULTI-LED
ARRAYS

WHIRELESS WORLD JULY 1981

For personal service visit one of our stores. Our new store at Hammersmith is conveniently situated near the end of the M4 and the North and South Circular Roads. There is excellent street parking on meters a few steps away and Hammersmith Underground Station is nearby. Call in and see us soon.
WEIGHTED HEAVY DUTY SOLDERING IRONS TO CATER FOR MOST TYPES OF JOBS FOR HOBBIES, PROFESSIONAL & INDUSTRIAL USE.

**MODEL K200**
The largest standard soldering iron in our range.
- Power: 220 Watts
- Bit size: 1/16"
- £19.55 inc. VAT
- Postage: 93p extra

**MODEL K800TC**
A temperature controlled version of the Model K200.
- Power: 500 Watts
- Bit size: 1/16"
- £25.30 inc. VAT
- Postage: 93p extra

**MODEL H70**
Our medium sized general purpose soldering iron with interchangeable bits.
- Power: 70 Watts
- £11.50 inc. VAT
- Postage: 93p extra

**MODEL H150TC**
A temperature controlled version of the H70.
- Power: 150 Watts
- £17.36 inc. VAT
- Postage: £6.60 extra

**SOLDER**
- Savi bit 22 S.W.G. 20k: 70p 12p
- Savi bit 22 S.W.G. 10k: 40p 8p
- Low Melt: 145°C: 20 S.W.G. 10k: 80p 12p
- £4.49 inc. VAT
- Postage: 80p extra

**GLOBAL SPECIALTIES CORPORATION**
G.S.C. (UK) Limited, Dept. 7R, Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

**MODEL 4401**
Two short-circuit protected 50-ohm BNC outputs are capable of driving 10 TTL loads into matched 50 ohms, providing square waves from 0.1Hz to 10MHz in 9 decade steps, with LED indication of the decade in use. And a frequency multiplier switch (1x, 2x, 5x) enables you to select fractional frequencies in each decade.

O ur new 4401 Frequency Standard sets a new value standard.

new SM 85 PRO TECH SOUND
brings a new dimension to a hand-held condenser microphone

This new high technology Shure microphone will change the way people think of condenser microphones. The SM85 is designed especially for on stage, hand-held use. Its sound is uniform—far more accurate to the spectral needs of the vocalist; a sizzling highs and a shaped mid-range for superior vocal reproduction, and a gentle bass roll-off that minimizes handling noise and 'boominess' associated with close-up use. Ultra-low distortion electronics make the SM85 highly immune to stray hum fields. An integral, dual-density foam windscreen provides built-in pop protection.

What's more, the SM85 Condenser Microphone must pass the same rigourous and dependability tests required of Shure dynamic microphones. As a result, the SM85 sets a new standard of reliability for hand-held condenser microphones.

The SM85 is extremely lightweight, beautifully balanced—it feels good, looks good on-stage, on-camera, on-tour. Ask your dealer for a demonstration of the new SM85 PRO TECH Sound, or write to us for full details.

SM85
Cardioid Condenser
Hand-Held
Professional Microphone

---

Decline of the philosophical spirit

Ampère’s Théorie mathématique des phénomènes électro-dynamiques (1825) is still worth reading. It is known as the principal founding source of electrodynamics, but other features are just as instructive. It begins with an extensive homage to ‘Newtonian philosophy’, and continues with a long mixture of physical theory, mathematical analyses and reports of experimental procedures. Ampère sought not merely methods of explaining and calculating effects; he wanted to find out how the phenomena actually occurred. Indeed, in the naive tradition sometimes followed at the time, he thought of his theory as a truth, ‘uniquement déduite de l’expérience’, to complete the title of his book.

Ampère is remembered now only for this work, but in fact it was a small part of his output. He was a polymath, whose activities were unified by his philosophical spirit. This spirit informed all his writings and came to its zenith in his Essais sur la philosophie des sciences (1844). But he was also a pioneer in philosophical thought, for the 1830s also saw the rise of positivism in the hands of some of his former students at the École Polytechnique: Auguste Comte, and engineer-scientists such as Dupin and Poncelet. Associated closely at that time with educational and social causes, positivism became one of the dominant philosophies of the 19th century and has maintained its influence, directly and indirectly, until today. Knowledge without metaphysics; rejection of abstract intellectual objects; even a lack of attention to the way in which mathematics is used in physics. It is a strange contrast to read Ampère’s Essais, with its Kantian concern with phenomena and their causes, with man’s knowledge and his cognitive power to know.

It was through movements such as positivism that philosophy and science became separated. Positivism and its cousins (mechanism, materialism, instrumentalism, behaviourism, and so on) do not solve philosophical problems so much as ignore them. Yet scientists accept positivist tenets without much thought: facts are facts are facts; theories are useful only for predicting new facts; mathematics is just a fiction which in principle has nothing to do with physical reality; the aim of science is consensus (as a noted FRS contentedly put it on television recently); the history of science is bunk — and, above all, philosophising about science is time-wasting nonsense. At the same time philosophy itself has become an encloséd profession, largely concerned with fooling ‘pundits’ in ordinary language; its practitioners rarely know anything beyond the writings of their professional colleagues. There are exceptional figures in the communities of both science and philosophy, but they stand out as such, often nervously.

Meanwhile the real world seems to have remained the same as it was in Ampère’s day, especially with regard to the phenomena studied in physics. Thus the objects of scientific study remain basically unchanged, and so does the need for philosophical as well as technical skill. We now know far more about the technicalities of electricity and magnetism than did Ampère and his contemporaries; but we no longer bring to our theoretical studies the sensitivity to philosophical questions which Ampère, and others of his time, could show. He and his contemporaries were not real scientists in the way that we understand the term; they often called themselves “natural philosophers” enquirers into the nature around them and into the powers of man to think up theories about it. They may have fallen into optimistic naiveties such as the already immediate deduction of theories from facts; but they did not succumb to our reflex dismissals of the non-experimental and our inattention to the place of mathematics in scientific knowledge. The imperatives which informed not only Ampère but also his contemporaries such as Faraday and Ohm, and successors like Kelvin and Maxwell, have faded; the traditions of natural philosophy have long been broken; reflection has given way to ‘research’. 
New development in h.f. coaxial cable

Structure offers lower losses and improved power handling

by S. G. Carter, M.Sc., Cable and Wireless and H. M. Barlow, F.R.S., University College, London

Recently it has become possible to make a high-frequency cable which is a cross between the conventional coaxial design and waveguides, a type of structure that exhibits much lower losses than is usual when based on attenuation per unit of cross-sectional area. This cable transmits in the dipole mode, well known for its application in optical fibres, and consists of an outer screen, as in the ordinary coaxial cable, with a group of parallel wires forming a concentric cylindrical structure for the inner in place of the more usual solid metal wire or tube.

At very low frequencies the guided transmission of electromagnetic signals over long distances can be carried out by a single wire, using an earth return, or by pairs of parallel wires in space. However, as the frequency is increased the lack of electrical balance of the wires and the unrestricted spread of the field from them begins to present interference problems and a change has to be made to a screened transmission system. Up to the present, this has almost invariably taken the form of either TEM transmission in a coaxial cable or propagation in a hollow metal waveguide. Both of these arrangements have their own advantages and disadvantages but, as expected, signal attenuation has always been a major factor influencing system design. Any reduction of attenuation can lead to lower transmitted powers, small cables, an improved system noise performance and increased repeater spacing, either separately or in combination, according to design needs.

In the structure shown in Fig. 1, the currents set up in the inner multi-wire structure are such as to provide for electric field across a diameter as well as a circumferential field; thus the arrangement supports a wave in the dipole mode. As a rule, a large part of the transmitted power is located within the wire-grid structure while, for the sake of clarity, the field diameter is reduced. In these circumstances the outer metal tube functions primarily as a screen and does not produce any serious distortion of the field, even when its radius is reduced to about double that of the inner wire grid. Consideration of the operating conditions show that the inner multi-wire structure at a h.f. behaves very much like the optical fibre at infra-red frequencies, where transmission is in the same Heaviside mode, the power largely confined to the field and a rapid decay of field in the cladding. Furthermore, like the large core diameter optical fibre, the dipole mode cable can in principle support many different modes of propagation (as many as there are separate conductors) but, in practice, provision is made to ensure that only the lowest order dipole mode is carried. There is, however, one significant distinction between the behaviour of a multi-conductor coaxial cable and optical fibre. Any attempt to screen a dielectric rod transmitting in the dipole mode in the u.h.f. region results in destruction of the field and introduction of propagation in that mode. This is because the boundary conditions on the inside of the screen cannot be satisfied at such frequencies. The wire-grid coaxial cable suffers no such limitation. As with ordinary TEM transmission in conventional coaxial cables (unlike tubular metal waveguides), the dipole-mode cable does not exhibit frequency cutoff and, in principle, can therefore be operated at any part of the spectrum down to d.c. However, it is in the high u.h.f. and h.f. regions that the losses are so much lower than those obtainable with current-day coaxial cables.

Cable structure

While Fig. 1 shows the basic structure of the dipole-mode cable, comprising a number of parallel wires to form a cylindrical grid, coaxial with an outer metal screen which is necessary to protect the inner conductors and separate them from the outer. Although regularly spaced parallel wires or strands may, when the cable is straight, keep the wires of the inner in position and also help to reduce the amount of dielectric employed, the need for a flexible cable tends to demand a continuous dielectric tube to support the wires. So far two different types of dipole structure have been developed experimentally and these are illustrated in Fig. 2. The cylindrical cable is shown in Fig. 2(a) and the group of parallel wires attached either to the outside of the inside of the tube and this inner structure is then, as a whole, located within the outer screen by one of the methods employed in the construction of ordinary low-loss coaxial cables; for example, a dielectric membrane helically wound over the inner or, alternatively, a carded wheel-type dielectric spacer. For experimental purposes the method chosen was to support the inner structure by thin tin t.f.e. discs with a hole in the centre through which the inner cable structure was inserted. These supports were spaced approximately every 8 cm.

The cable attenuation is dependent not only on the number of wires included in the inner structure but also on their diameter. In general, the loss decreases as the number of wires increases and as more of the circumference of the inner is covered by metal. However, capacitive circumferential current is necessary for Heaviside mode propagation and consequently the number of wires must always be spaced far enough apart to maintain this dipole mode at an adequate power level. Clearly, there are practical problems in fabricating a cable with a large number of very thin wires or strips of metal and therefore the experimental work was limited to structures having not more than 16 wires.

Cable terminations

Instruments and components available today for measurements all employ conventional, coaxial connectors and cables, so that the introduction of this new form of multi-conductor, dipole-mode cable requires special arrangements. Not only is a connector required to maintain the continuity of the multi-wire system, but transducers are necessary to convert the TEM waves of the supply system to a dipole-mode configuration prior to launching the wave on the cable. This operation has to be carried out without introducing either wide or narrow bands of frequencies as possible.

One method of launching into a dipole-mode cable is to take the output from a conventional coaxial supply and, using a power divider, split it into many parallel paths. There are separate wires in the inner structure of the dipole-mode cable. At the same time the amplitude and phase of each input is adjusted so that when superimposed they comprise the required dipole mode field distribution. This has been tried experimentally but it was found to be difficult to adjust and maintain the precise amplitudes and phases required.

A more practical method of launching the required dipole mode from a TEM source is to use either electric or magnetic coupling into the multi-conductor cable. In general, transverse electric field coupling as shown in Fig. 3 gives more effective transfer of power but this tends to be at the expense of bandwidth when compared with the corresponding magnetic coupling shown in Fig. 4. In the electric field coupler (Fig. 3) a transverse wire feed from the coaxial input is located at approximately a quarter of the signal wavelength from a short-circuit termination formed by connecting together the screen and the outer screen. In Fig. 4 the magnetic field coupling is shown for the case of a TEM field excited by a winding of the dipole mode cable and extending a short distance from the short-circuited end. A three-section matching unit is used to transform the impedance of the coaxial input down to the very low impedance of the loop. Table I shows the loss and bandwidth achieved in practice with these two different types of launcher.

Cable attenuation

Particular interest in dipole mode cables centres on the fact that their attenuation has been shown to be considerably lower than that of an equivalent, conventional coaxial cable, furthermore the dipole-mode cable has no cut-off frequency and, consequently, can be used satisfactorily at quite low frequencies.

WIRELESS WORLD JULY 1981

WIRELESS WORLD JULY 1981

Fig. 1. Cross-sectional view of basic form of dipole-mode cable.

Fig. 2. Two different forms of dipole-mode cable.

Fig. 3. TEM-to-dipole-mode transducer, using transverse-electric field coupling.

Fig. 4. Cross-section of dipole-mode launcher using magnetic coupling.

Fig. 5. Measured losses of multi-conductor cable in dipole-mode and TEM-mode transmission.

Table 1. Comparison of available bandwidth and losses for dipole-mode launchers shown in Figs. 3 and 4.

Launch type

Bandwidth (1/3dB points)

Nominal loss (TEM to dipole-mode) dB

Magnetic coupling

350

500

Electric coupling

3 dB

500

2.5

500

0.26
The 6809 is a recent 8-bit microprocessor in which a 16-bit architecture to considerably improve the performance available from an 8-bit device. Because the number of conventional 16-bit processors is accelerating, many designers think that the 6809 represents a practical limit for an 8-bit device. Unfortunately, few potential users have been able to evaluate this processor because there is very little hardware available at present and the information is still scarce. This design is based on the well-tested and tried Nanocomp (Jan. 81) and provides a useful low-cost evaluation system for the 6809.

The 6809 in the most recent addition to the M6800 family of microprocessors and provides a much more advanced architecture than the 6802. Internally the device is a 16-bit processor, which can perform 16-bit operations, with several extra registers and other improvements. However, because the device retains an 8-bit external data bus, the hardware is very similar to the 6802 and can therefore be used with a slightly modified Nanocomp.

The improved performance of the 6809 is attributable to various features besides the potential of 16-bit operations. An important advantage is the addition of extra and more powerful addressing modes which enable the processor to recognize 1446 different variations of instructions and addressing modes from a basic instruction set of 59. Despite this large number of instructions, the instruction set description makes the device easier to program.

To preserve software compatibility with earlier machines, the 6809 is compatible at source-code level with the 6800 so all but a small number of existing machine language programs can be transported to the 6809. Exceptions such as INX have been excluded to maintain as rigidly as possible the regularity of the architecture. Extra addressing modes have been provided for the existing instructions and new instructions, unique to the 6809, have been added. Therefore, source programs written for the 6800 can be re-used without modification, and most (not all are the same as the 6800) and existing software can be transferred without ammendments except from the 6809 can be performed by new instructions. Although it may seem pointless to transfer existing software to a more powerful processor, it allows users to upgrade their systems without memory map has been revised and is now shown in Table 1. The monitor workspace, which is now positioned at the top of the 1K memory and therefore about 40 bytes are free for user programs. All other aspects of the circuit and testing are as described for the 6802 version.

Operation

The 6809 operates more or less the same as the 6802 version. As the monitor software list now includes cassette-tape handling routines, the 61K allocated to the monitor program, 7700-77FF, is now used. These routines use the L and P keys and are described later. The main alteration to the monitor is the register display command which is at address 0130 which is normally used to display the contents of the increased number of c.p.u. registers. This command is automatically entered after a SW1, but may be re-entered by the user depending on the register being displayed, as shown below.


class-condition register

- acc = A
- b = B
- direct page register = X register (index)
- F register
- H register
- P register
- program counter
- S register
- hardware stack pointer

The key will increment through the various registers, and their contents will be shown on the left of the four-digit display, 5 the unit automatically returns to the monitor start. The two new software interrupt instructions, SW13 and SW14, are not used by the monitor but, with the hardware interrupts, the program can jump to and continue from a specified address in certain memory locations. These are listed in Table 2. When an interrupt occurs, the continuation address is fetched, which is usually a different routine, and processing continues from that address.

The following sections describe the various routines and their functions.

Interrupt

Table 2. Interrupt jump locations

<table>
<thead>
<tr>
<th>Interrupt</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW13</td>
<td>13E5</td>
</tr>
<tr>
<td>SW12</td>
<td>13D9</td>
</tr>
<tr>
<td>RI0</td>
<td>13E4</td>
</tr>
<tr>
<td>SW14</td>
<td>13D8</td>
</tr>
</tbody>
</table>

Table 1. Revised memory map

<table>
<thead>
<tr>
<th>Operation</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>pomonitor</td>
<td>7700</td>
</tr>
<tr>
<td>user</td>
<td>7800</td>
</tr>
<tr>
<td>eprom</td>
<td>7400</td>
</tr>
<tr>
<td>user</td>
<td>7500</td>
</tr>
<tr>
<td>monitor workspace</td>
<td>13FF</td>
</tr>
<tr>
<td>monitor workspace</td>
<td>13A0</td>
</tr>
<tr>
<td>user stack</td>
<td>1300</td>
</tr>
<tr>
<td>user stack</td>
<td>1310</td>
</tr>
<tr>
<td>program ram</td>
<td>1000</td>
</tr>
</tbody>
</table>

WIRELESS WORLD JULY 1981

uprated Nanocomp and cassette interface by R. Coates

Table 2. Comparison of diode-mode and TEM losses for five different types of ceramic insulators.

<table>
<thead>
<tr>
<th>Insulator</th>
<th>Mode</th>
<th>Loss at 2.22 mm diameter outer screen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diode</td>
<td>TEM</td>
</tr>
<tr>
<td>B4</td>
<td>0.15</td>
<td>0.25</td>
</tr>
<tr>
<td>B2</td>
<td>0.10</td>
<td>0.80</td>
</tr>
<tr>
<td>B1</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>B3</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>E</td>
<td>0.20</td>
<td>0.20</td>
</tr>
</tbody>
</table>

measurements in mm
singing continues from that point. The NMI input, however, is used for the short key and its jump address is set automatically when a reset occurs, but it may be modified for other purposes by a user program. The monitor has been written to ensure that the useful monitor subroutines, listed in Table 2 of the original article, function identically and have the same entry address points. There are two points to the monitor from a user program 71979, which also applies to the 6802 version.

The four original programs can be modified if a 2 or 4K e.p.r.o.m. is used. The start address for hex-decimal/decimal-hex converter is 700, decadeshift - 7900, branch calculator - 7400 and main/min - 7300. For decadeshift, the speed is set at location 1000 and 1 because there is no memory at 0000 in the 6809 version. Two's complement offsets used by the branch instructions of the 6802 are limited to 8 bits but the 6809 also uses 16-bit offsets, with the PC relative addressing mode, therefore the branch calculator program now caters for these. In addition to requesting the start and destination addresses, the program requests the number of bytes in the instruction, $b$, in the right-hand display, which must be entered. If an instruction has only two bytes, it must be a 16-bit offset so an 8-bit value is given or two dashes if it is out of range.

An instruction which requires a 16-bit offset must be three bytes or more, so a 16-bit answer is displayed if a byte value of three or greater is given.

Programming

Because programming information for the 6809 is not readily available yet, a brief description of the architecture is given together with the instruction set and programming details. However, for serious programming, Motorola's MC6809 Preliminary Programming Manual is essential.

A programming model of the 6809 is shown in Table 3, and details of the register are given below.

Accumulators (A, B, D)
The A and B registers are general purpose 8-bit accumulators for arithmetic calculations and data manipulation. Some instructions link the registers to form a single 16-bit accumulator (D) with A as the most significant byte.

Direct page register
The direct addressing mode in the 6809 allows for a shorter form of instruction to be used for accessing the bottom 256 bytes of memory. This facility has been enhanced in the 6809 so that the 8-bit direct page register is used as the most significant byte for direct addressing. This allows the direct mode to be used under program control at any place in memory.

Index registers (X, Y)
These are the same as the single 6800 register. The 16-bit address in the register takes part in the calculation of effective addresses and can be used to point to data directly. The address can also be modified by an optional constant or register offset.

The 8-bit constant offsets are supplemented with 5 and 16-bit offsets. All four pointer registers (X, Y, U, S) can be used as index registers.

Stack pointers (U, S)
The hardware stack pointer, S, is used by the processor during subroutine calls and interrupts, and points to the top of the stack instead of the next free location as in the 6800.

The user stack pointer, U, allows arguments to be passed to and from subroutines. Both stack pointers can also be used as index registers, and have additional Push and Pull instructions which can operate on any or all of the registers (except themselves).

Program counter
Uses the processor to point to the address of the next instruction to be executed.

Condition code register
This register, also known as the flag register, defines the state of the processor at any time. The register comprises:

- C (bit 7) CARRY. Indicates a carry occurred on the last ALU operation, or a borrow from subtraction instructions.
- V (bit 6) OVERFLOW. Set by an operation which causes a two's complement arithmetic overflow.
- Z (bit 5) ZERO. Set if the result of the previous operation was zero.
- N (bit 3) NEGATIVE. Contains the m.s.b. from the result of the preceding operation. Therefore, a negative two's complement will leave N set.

Immediate. In this mode the opcode contains all necessary address information (single byte instruction).

Extended. The data to be used by the instruction immediately follows the opcode in memory. Can be an 8-bit or 16-bit value depending on the instruction.

Index.

The main improvement offered by the 6809 is the proliferation of addressing modes which are summarised below.

Immediate. The data to be used by the instruction immediately follows the opcode in memory. Can be an 8-bit or 16-bit value depending on the instruction.

Extended.

The contents of the two bytes following the opcode specify the 16-bit effective address used by the instruction.

Index. A special case of indexed addressing where one level of indirect addressing is added to extended addressing, i.e., the two bytes following the basebyte of an indexed instruction contain the address of the data addressed.

Direct. Similar to extended but only the lower 8 bits of the effective address are specified in the byte following the opcode. The upper 8 bits of the effective address are supplied by the direct page register.

Indexed. Programs using this mode rather than extended will use less memory.

Indexed Indexed.

The most complex addressing mode. In all indexed addressing, one of the pointer registers (X, Y, U, S and sometimes PC) is used in a calculation of the instruction. The postbyte of an indexed instruction specifies the basic type and variation of addressing mode, and the pointer register to be used. Table 4 gives the details necessary for calculating the postbyte for all forms of indexed addressing. The five basic types of indexing are

- Zero Offset. The selected pointer register contains the effective address of the data to be used by the instruction.
- Constant Offset. A two’s complement offset and the contents of one of the pointer registers are added to produce the effective address of the operand. The pointer register’s initial content is unchanged by the addition.
- Three sizes of offset are available, ± 4-bit (−16 to +15), ± 7-bit (−128 to +127) and ± 15-bit (−32768 to +32767). The 5-bit offset is included in the postbyte whereas 8-bit and 16-bit offsets require 1
or 2 bytes respectively after the postbyte for the offset.

Accumulator Offset. Similar to constant offset except that the value's complement value in one of the accumulators (A, B or D) is used and there is no postbyte corresponding to the postbyte specified which, neither register is altered by the operation. Auto Increment/Decrement. Similar to zero offset, but with auto increment. After the pointer register is used it is incremented by 1 or 2 and then used as an index. Indexed Offset. All indexing modes, except auto increment/decrement/one and five offset, can have an additional level of indexing. This means that the effective address is calculated by the location specified by the content of the index register plus any offset.

RELATIVE. Branch instructions use the relative addressing mode, i.e. the byte(s) following the branch opcode is a signed offset which is added to the address pointed to by the program counter. If the branch condition is true, the calculated address (PC + signed offset) is loaded into the program counter. Execution then continues from the new address. Short branches require 1 byte offset and long branches require 2 bytes.

PROGRAM COUNTER RELATIVE. Another type of indexed addressing where the program counter is used as the pointer, which can be 8 or 16-bit offset. This is very useful for pointing to blocks of data in a program which must be relocatable, i.e. runs anywhere in memory. The Load Effective Address instruction makes use of this mode. For example, to point the X register to a block of data by specifying an offset, relative to the current PC position, where the block resides. This offset will remain constant wherever the program is run, whereas with a LDX instruction the absolute address must be specified. An additional level of indirect is available with this mode.

New instructions

PSE/PUL. These instructions allow any combination of the pair to be popped or pushed onto the stack. Which registers are pushed or popped is defined by an immediate byte transferred are specified in an immediate byte. A code contained in the most significant four bytes specifies the first register and the least significant four bytes specify the second.

<table>
<thead>
<tr>
<th>Type</th>
<th>Non Indirect</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assembler form</td>
<td>Postbyte op-code</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>R</td>
</tr>
</tbody>
</table>

Table 4. Indexed addressing modes

MUL. Multiplies the unsigned binary numbers in the A and B accumulators and places the unsigned result into the 16-bit D accumulator.

Although this short account of the 6809 is by no means complete, it should enable the constructor to start programming this very powerful processor.

Cassette tape interface

One feature which is more or less essential with any computer system is a means of storing programs. The cheapest convenient means of storage of a cassette tape and, as most users will have access to a cassette recorder, all that is required is the appropriate interface and software. This simple interface can be used with either version of the Nanocomp and will load the 1K memory in about 1.5s. An important part of the tape storage system is a set of routines, so required using the original monitor which will need to reprogram their

e.p.r.o.m.

Data to be stored is transmitted to the recorder from a p.i.a. output line in the usual asynchronous serial format of a start

bit, eight data bits and two stop bits for each data byte. Data bytes are transmitted in blocks of up to 16 bytes and each block starts with a 2-byte code, which identifies the start of a block on playback, followed by 2 bytes which give the start address of the block. The data bytes are then sent, followed by a checksum byte which is calculated by adding all the bytes in the block. The occurrence of a recorder is specified by an end-of-file code. Each is encoded onto the tape as one cycle of a square wave, and the period of 50us or 2ms determines whether it is a 1 or 0 respectively. When loading a program, the period of each cycle is measured by checking whether it is greater or less than the average period, which makes the system reasonably tolerant of tape speed changes between different machines.

The interface plugs into the p.i.a. connector and is powered by the Nanocomp. Spare lines P16 and P17 are used for data transmission and reception so the interface can be permanently connected. The data to be recorded is transmitted from P16 and reduced in amplitude by the potential divider R13, R1 in Fig. 2. On playback, the output from the divider is limited and squared for driving the logic input of the p.i.a. A CA316 is used to generate a simple 5V supply. The cassette interface can be assembled on a small p.c.b. as shown in Fig. 3. Four connections are required to the Nanocomp and these are numbers are

+5V 12V

+12V

If a ribbon cable is not available, ordinary stranded wire can be used and soldered onto the connector.

Operation

The L and P keys are used to load and dump data respectively. To save a program, key P and the display will request the start address of the memory block to be saved, followed by the finish address F. Transmission will start immediately after the key is released, so the recorder should be started before then. When the recording is finished, F will appear in the left of the display which indicates that the recorder can be stopped. Abort or Reset will return the monitor prompt.

To load a program, key L and the recorder just before the beginning of the program. To provide a form of feedback, the top and bottom segments of the lefthand display are turned on as data is received. When a 1 is received, the top segment is on and when a 0 a received, the bottom segment is on. If the program is loaded correctly, when the end-of-file code is displayed F is displayed. Abort or Reset returns the prompt. If a checksum error is encountered in one of the data blocks, F is displayed and loading is stopped. If this occurs the tape must be rewound and reset.

Although some experimentation the record and playback levels can be optimised although, with a reasonable recorder, they are not critical. It should be noted that the requirements for recording data on a tape are different: 1/10000th of 1K tape is high quality audio cassettes or, preferably, certified data tape should be used. Also, a better quality recorder does not give an acceptable performance with speech or music is unlikely to produce reliable data recordings. Auto record-level machines may also cause problems because their signals are designed to be used with a low mean-to-peak ratio square wave.

Although the Nanocomp was originally intended as a microprocessor trainer, many constructors may want to upgrade the unit as shown, and interface the circuit to other systems. We intend to support this development with further article describing extra peripheral devices such as a-tod and d-to-a converters and a simple e.p.r.o.m. programmer.

The original monitor/util program has been revised to remove a potential bug in the original version, and to improve the performance if poor quality cassettes are used. A hex list of the new monitor, which also contains the cassette interface software, can be obtained from the editorial office by sending a large a.s.n.c. clearly marked 6809 or 6809.

A set of e.p.r.o.m.s for the 6809 Nanocomp (power supply and logic board) will be available for £9.00 and a cassette interface board, inclusive of a-tod and d-to-a postage, from M. R. Sagin, 23 Kays Road, London N.W.2.

Technoclin Ltd. 17 Burely Road, London N.W.10, 79-452 1500, and Magnetics Electronics Ltd. 136 Hunter Street Burton on Trent Staffs, 0283-96435, will be offering a kit of components. Both companies will also reprogram e.p.r.o.m.s for both versions of the Nanocomp.

![Table 4. Indexed addressing modes](image)

<table>
<thead>
<tr>
<th>Type</th>
<th>Non Indirect</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assembler form</td>
<td>Postbyte op-code</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>R</td>
</tr>
</tbody>
</table>

![Fig. 2. Cassette interface. This circuit is powered from the Nanocomp via the p.i.a. connector.](image)
Leap seconds
Story of the transfer from astronomical to atomic time

by L. Essen, D.Sc., F.R.S.

Most people now know that all time measurements and time signals throughout the world are based on atomic time. The system used to adjust them by one second at the end of the year is not well understood. It follows from this fact that it is not possible to give precise uniform intervals of time between the events of daily life (e.g., the time of day which is determined by the non-uniform rotation of the earth). The transfer from astronomical time to atomic time and the co-ordination of the two systems was an important step in the advance of science and it is surprising that the story has not been told. The requirements of radio engineers were always prominent in the discussions.

The time of day is not required very accurately for civil purposes – it is changed by an hour, twice a year – but for navigation at sea it should be fairly close to the time scale based on the position of the stars, known as UT1. Time intervals, on the other hand, are required to be as precise and uniform as possible, particularly for air navigation and the control of frequency of radio transmitters. For these applications the actual time or epoch of the signal is irrelevant.

These two requirements are so different that it might be asked why two separate technical signals, giving astronomical time for navigation and civil time for time intervals, are needed. This was indeed suggested by Dr. G. M. Clemente of the US Naval Observatory, I was able to attend this meeting to describe the clock and the initial results. One of the main topics of discussion at the meeting was a proposal to redefine the unit of time, making it in effect a fraction of the time of revolution of the earth round the sun instead of a fraction of the time of rotation on its axis. It was believed that this unit, the second of ephemeris time (ET), would be more constant than the second of universal time (UT1). It is difficult to measure it and the value being recommended was in effect the average value of the second of UT1 over a period of 200 years. Such a unit might be useful for astronomical work but it is not the right one for the use to physicist and radio engineer. I suggested that it might be wise to abandon any decision until agreement was obtained on the definition of an atomic unit which would certainly be required in the future.

However, the proposal to change to ET was adopted and was confirmed at the General Conference on Weights and Measures in 1956. It was a strange decision and it meant that from 1956 until 1967, when an atomic unit was defined, the definitive unit of time existed only on paper. The unit used in practice was the second of UT1; and at the NPL this was defined in terms of the provisional atomic unit, which was made available throughout the world by our standard frequency transmissions and their 1 Hz tuning pulses derived from the standard. These were used in the International Bureau de l'Heure to smooth out the irregularities of the astronomical signal.

Although the atomic clock had a lukewarm reception at the Dublin meeting an immediate demand was made on the advocacy of Dr. W. Markowitz. It was agreed that the relationship between the atomic frequency and the second of ET had been established the atomic clock

The next leap second will be on 30th June 1981 in the last minute of that month. This will result in an extra 1 second before midnight will contain 61 seconds instead of 60 seconds.
The second of atomic time was therefore the time occupied by 9192631770 cycles of the caesium line, the limits of error being omitted since they were due almost entirely to the astronomical measurements. This value was used at the NPL in place of the provisional value, from 1958, in accordance with the Dublin resolutions.

There was still strong opposition from astronomers to the formal adoption of the atomic unit. They regarded the atomic clock as a kind of superior quartz clock which could be used to smooth astronomical time, and ignored the fundamental difference between them. The quartz clock is simply a stable oscillator which can be adjusted to have any frequency by altering its dimensions, whereas the atomic clock has a frequency with great precision by natural constants. It is reproducible anywhere in the world and provides a unit of time which is immediately and readily available. It is ideally suited to be a definitive unit of time, and although this was not a serious contender as a time standard it led to the development of the master clock and the atomic time.

The advantages of the caesium clock precluded and in 1967 it was accepted for defining the unit of time, with the almanac given above.

The co-ordination of the times carried standard frequency transmissions with astronomical time signals presented several technical problems. The problem was taken when they were made to coincide on 1 January 1958. It was realized that they would diverge because of the variations in the rate of rotation of the earth, and the question to be raised was how much of the difference could be tolerated. The first figure suggested was 0.15s and to keep within this tolerance the actual frequency of the caesium clock was offset from its nominal value by a stated amount each year, and in addition occasional adjustments were made to the timing pulses. A further move towards co-ordination was made in 1960 when it was agreed with the RGO that the caesium time signals transmitted from the UK could have the same epoch.

It was of course rather illogical to offset the constant unit in order to accommodate the co-ordination of astronomical units, but strong efforts were made to end this situation particularly through the International Scientific Radio Union. A satisfactory solution became possible when astronomers agreed that the signals could diverge by as much as 0.7s from astronomical time UT1. The frequency offset was eliminated, standard frequency transmissions operating on their true nominal values and the timing pulses on gave true atomic time in terms of the Coordinated Universal Time (UTC) of 1958. The master caused the pulses to be offset to a period of 1.7s by 30 June or 31 December. This enabled the pulses to continue undisturbed but the master clock, distinguishing the 1-minute pulse was moved along by 1s. The use of these leap seconds enables the time signals to be made within 0.7s of UT1, and for those who need it, the difference from UT1 is made even more accurately by a code or Morse announcement. The only inconvenience caused to those measuring time involved in radio astronomy is that when the pulse is made to a period the time signal is divided by the velocity of light, and this is the period used by the velocity of light.

The second atomic time was therefore the time occupied by 9192631770 cycles of the caesium line, and this is the standard as was often pointed out, that unlike the earth, it does sometimes stop and start at a point of no practical significance. When one clock stops it can be reset by reference to another, and this has been used to determine how much of the difference could be tolerated.
WIRELESS WORLD JULY 1981

FAST TRAVERS MODIFICATION

The servo motor now has to overcome the magnetic drag of the second motor during normal operation, if this second motor is a permanent magnet type. This is avoided by applying a small bias current to the second motor of a value that will overcome the drag but not make the motor revolve. This can be done by a suitable resistor via the switching network. Alternatively, a motor with a field coil can be used, avoiding this requirement altogether. But whichever type of motor is used, it needs to be sufficiently powerful to overcome the slipping clutch and drive the lead screws, without the advantage of the reduction gearbox that the servo motor employs. There is no requirement for it to be vibration-free or quiet running like the servo motor, so a relatively robust and inexpensive motor can be used.

The new arm is of the same aluminium alloy as the Mk 1, HT307, which is a hard alloy fully heat-treated and cannot be manipulated (eg drawn, bent or compressed) in the usual way without cracking. The diameter of the 9.5mm tube was chosen to give an increase in overall stiffness over the Mk 1 arm. Wall screw direct and simply slipping the drive band from the servo motor — not good practice because of the stretching and general increased wear of the drive band. It also puts an unfair strain on the miniature gears in the worm gear transmission. A much more acceptable method is to drive the lead screw indirectly as on page 43.

By using a double-groove pulley wheel with a slipping clutch on the output shaft of the servo gearbox, the drive bands are operated within their limits, and the slipping clutch relieves the gears inside the gearbox of excessive strain. Such a slipping clutch is easy to construct from a couple of way-up spring washers and set collars, as shown on page 43.

The servo motor arm has been considerably modified from the original parallel track arrangement. It is also very easy to cut to shape.

Drive cords. A superior material has been found in the form of round-section expanded neoprene cord. This is a soft, resilient cord which has excellent vibration absorbing properties, and which is designed to be joined with cyanocrylate "super-glue" to form a fitted drive band.

Acoustic isolation of the servo motor and gearbox was neatly solved by the introduction of Sorbothane. This is a remarkable visco-elastic compound (modestly described by the manufacturer as "a significant advance in polymer technology") which can recover from deformations of more than 500% and which is very kossy to any mechanical excitation, typically 90% absorption. The texture is somewhere between that of plasticine and soft rubber. Used as mounting pads for the servo assembly in place of the rubber grommets first specified, it gives superior results. It is also an excellent material for decoupling the counterweight.

Gimbals. On the original model, if the horizontal position of the gimbals was knocked off the support pillars, there was nothing to stop them from going completely adrift. The design of the support pillars has therefore been modified to incorporate lead pins in a U-shaped recess so that this cannot happen. The improved design is shown on page 43.

Fast traverse. The criticism most often voiced concerned the two-minute return time, which was found by many to be inconveniently long, even for transcription purposes. This simple modification has been developed for a traverse time of just a few seconds. It can be retrofitted to existing machines.

The modification consists of a second motor which drives the lead screws at speed without the assistance of the servo motor. Several constructors appear to have tried this method already, by driving the lead Modifications and improvements shown on page 43 include simplified side supports and pivots, new tracking arm, and fast traverse action and slipping clutches, as well as a substantially alternative parallel track (bottom). The track, which uses two steel rods instead of a long slot in a strip of aluminium alloy, is easier to make if you have a drilling stand for an electric drill. Accurate lengths of assembled track depends on the straightness of the steel rods and not so much on the accuracy of drilling (drill both plates together); this simplifies the construction of producing a well-tried track.

Precision-ground steel rod of 4mm diameter is readily available from engineers merchants and is not expensive. The rods are fixed into the end plates with Loctite, which is allowed to set with the assembly resting on a flat surface such as a piece of plate glass.

Lead-out wiring. Litz wire can be used to greater effect than first realised. Because individual strands of litz wire are insulated it is possible to conduct most of the signals in just a couple of wires. The soldering technique for such fine wire is more demanding, but the unwanted forces introduced by the lead-out wires at the point where they exit from the tracking arm are reduced, considerably.

Tracking arm. The diameter of the duralumin tube used for the tracking arm has been increased to 9.5mm. The original smaller-diameter tubing performed well with most types of cartridge, but with the increased use of moving-coil cartridges I felt that a much stiffer tube was needed. A comparison of the new arm with a conventional arm is given at the end of this article.

Slider (part 19). The material now recommended for this part is Nylon 66, which is a high-tenacity grade of nylon and has far superior low-friction and low-wear properties compared with the original brass/stainless.
Comparison of new arm with conventional arm

In the arm design, the inertia of the arm about the pivot and the arm length has been kept constant in all arm types, to ensure that the masses remain the same. However, the arm length has been increased in the new arm design, to accommodate the increased size of the pickup arm and cartridge combination. A comparison of the inertias of the old and new arms, with the same mass and length, is shown in Figure 1.

One way of achieving faster traversal is to use a second, inactive, rotatory slip clutch.

One of the difficulties with digital speech storage and analysis is that new signal-processing techniques have to be applied to the analog signals. Since these only appear at the beginning, and are rather mathematical, they have not been used very often. Concepts like the z-transform, the discrete Fourier transform, and digital filters are quite unfamiliar to many practicing electronic engineers. Although there are several textbooks on the subject, nearly all of them treat it in a frighteningly abstract and academic way. The aim of this article is to introduce some of these ideas in a down-to-earth and practical way.

Computer-generated speech is still rather esoteric subject, despite the explosive growth in practical applications that we are witnessing. Texas Instruments' Speak 'n Spell toy — now about three years old — is probably the best example of a consumer device that uses speech output. There are others. Cheap speech synthesizers intended for hobby use have been on the market for several years now, and a television manufacturer has even announced a video game in which the player's score is affected by how well he or she understands what the machine is saying.

Carbon fibre, neoprene rubber, Nylon 66, and other components are available from J. Isaac Ltd, 110 Southall Road, Southall, West Middlesex UB2 8BN.

Inertia of arm without cartridge

The inertia of the arm from pivot to stylus position can be assessed as that of a uniform circular cylinder 18 cm in diameter and 2 cm thick, with an end correction difference in mass between cartridge holder and tube. This is:

\[ I_{cm} = \frac{M \rho}{3} \left( \frac{R^4 - r^4}{R^2 - r^2} \right) \]

where \( \rho \) is the density of the material, \( R \) the radius of the outer cylinder, \( r \) the radius of the inner cylinder, and \( M \) is the mass of the arm. The substitution of the values 30g for \( M \), 18cm for \( R \), and 2cm for \( r \) gives a value of 185g cm^2 for the overall inertia of the arm about the pivot.

Now, \( I_{cm} = \frac{M \rho}{3} \left( \frac{R^4 - r^4}{R^2 - r^2} \right) \)

where \( I_{cm} \) is the total inertia of the arm about the pivot and \( M \) is the mass. The substitution of the values 1265gm cm for \( M \), 23cm for \( R \), and 2cm for \( r \) then gives a value of 185g cm^2 for the overall inertia of the arm about the pivot.

Now, with the cartridge attached to the arm, the total inertia of the arm about the pivot is 185g cm^2 and 10gm for the cartridge.

Thus the total mass, and inertia, of the arm is 185g cm^2 and 10gm for the cartridge.

For example, if a cartridge weighs 5gm, the total mass of the arm about the pivot is 185g cm^2 and 5gm. The substitution of the values 1265gm cm for \( M \), 23cm for \( R \), and 2cm for \( r \) then gives a value of 185g cm^2 for the overall inertia of the arm about the pivot.

For even revolution the record surface has to be pressed against the stylus tip by its own weight and by the force of the pressure. As the record is played, the stylus tip moves in the air. Remember, this is a very small tip and it is moving through the air. The tip is made of a soft material, so it is very soft and flexible.

One of the advantages of digital storage is its ability to store very long words by allowing overflow on to subsequent sample words. For example, if the IBM 7770 Audio Response Unit, employs drum memory to store a sample of 300 ms words, it can be accessed randomly, within half a second at most. Although one can arrange to store longer words by allowing overflow on to adjacent tracks at the end of the record period, the facts that the drum words are provided by the system make it virtually impossible for it to be used to store uttered speech. The only way to get the right words is to find something that sounds appropriate words for the story.

The Cognitronics Speechmaker has a similar structure, but with the analogue speech waveform recorded on photographic film. Storing audio waveforms optically is not an unusual technique, for this is how soundtracks are recorded on ordinary film. The original version of the "speaking clock" of the British Post Office used a disk containing master glass disk. This was developed in the mid 1930s, and synchronization of utterances was achieved by an intriguing manner. A 4 Hz signal from a pendulum clock was used to supply current to an electric motor, which drove a shaft equipped with cams and gears that rotated the glass disc containing utterances for seconds, minutes and hours at appropriate speeds.

One second was used for avoiding analogue storage is price. It is difficult to see how a random-access tape recorder could be incorporated into a talking pocket calculator or a child's toy without considerably inflating the price. In any case, the use of real electronic is much cheaper than mechanics.

The best reason that is, in many applications of speech storage and analysis, to form utterances by linking together separately recorded parts. It was played by linking individual words which were recorded in isolation, or in a different context, to create new utterances.

For example, in an experiment performed in 1960, the words were recorded on acoustic tape, which was spliced with its words in the different order to make sentences. The experiment was to link up the effects of the subject, who were scored on the number of key words which they identified correctly. The conclusion was that the use of different words in different contexts is painful.

The above-mentioned information is not something that can be used without a certain amount of understanding. For example, the phonetic symbol for the word "speech" is [spi]. This symbol is not the same as the English symbol for speech, which is [sp]. This symbol is used in the International Phonetic Alphabet (IPA). The IPA is a set of symbols that represents the sounds of speech.

Sampling

Digital storage and analysis of speech

by Ian H. Witten, M.A., M.Sc., Ph.D., M.I.E.E. University of Calgary
Figure 3 shows how the linear frequency axis for continuous systems maps on to a circular axis for sampled systems. For present purposes it is easier to imagine the bottom half of the circle as being reflected into the top half, so that traversing the upper semicircle in the anticlockwise direction corresponds to frequencies increasing from 0 to 1/2T (half the sample frequency), and returning along the lower semicircle is actually the same as coming back along the upper one, and corresponds to frequencies from 1/2T to T. Thus, being mapped into the range 1/2T to 0.

As far as speech is concerned, we must ensure that before sampling a signal no significant components at greater than half the sample frequency are present. Furthermore, the sampled signal will only contain information about frequency components less than this, so the sampled frequency must be chosen as twice the highest frequency of interest. The telephone network aims to transmit only frequencies lower than 3.4 kHz. This region will contain the information-bearing formats, and some — but not all — of the facitative and aspiration energy. Transmitting speech through the telephone system degrades its quality very significantly, probably more than you realize since everyone accustomed to telephone speech — the dial-a-disc service and compare it with high-quality music for a striking example of the kind of degradation suffered.

Since speech contains significant amounts of energy above 3.5 kHz, it should be filtered before sampling to remove this. Otherwise, the resulting components would be mapped back into the baseband and distort the low-frequency information. Because it is desirable to use filters that cut off very sharply, the sampling frequency is chosen to be rather greater than twice the highest frequency of interest; for example, the digital telephone network samples at 8 kHz. The pre-sampling filter should have a cutoff frequency of 4 kHz; aim for negligible distortion below 3.4 kHz; and transmit negligible components above 4.6 kHz — for these are reflected back into the band of interest, namely 0 to 3.4 kHz. Figure 4 shows a block diagram for the input hardware.

Quantization
Before considering specifications for the pre-sampling filter, let us turn from sampling time to amplitude conversion, which is the subject of our concern. This is performed by an a-to-d converter *“The Charterhouse,” Wireless World 84 and 85 (December 1978 and January 1979), for a simple explanation of formats, friction, and aspiration.

*“The Charterhouse,” Wireless World 84 and 85 (December 1978 and January 1979), for a simple explanation of formats, friction, and aspiration.

is to avoid, the maximum amplitude level of the a-to-d converter must be set at a value which makes the power of the speech signal as small as possible, or as a result of the minimum-sine-wave sine wave. Furthermore, different people speak at very different volumes, and the overall level fluctuates constantly with just one speaker. Experience shows that while 4- to 8-bit converters may provide sufficient signal-to-noise ratio to preserve telephone-quality speech for the speaker level, lower levels are usually controlled, about 11 bits are generally required to provide high-quality reconstruction of speech with a uniform quantization. With 11 bits, a sine wave whose

where x is the original signal and y is the value which is to be quantized, gives a signal-to-noise ratio which is independent of the input signal level and therefore cannot be realized physically, for it is undefined when the signal is negative and diverges when it is zero. However, realizable approximations to it can be made which retain the advantages of constant signal-to-noise ratio within a useful range of signal amplitudes, one widely used approach being that of so-called “companding,” a contraction of “compressing-expanding.” The original signal can be retrieved from the A-law by an antilog expansion.

Figure 6 shows one common 8-bit coding scheme which is a piecewise linear approximation to the A-law. This provides an 8-bit code, and gives the equivalent of a 12-bit linear quantization for small signal levels. It approximates the A-law in 16 linear segments, 8 for positive and 8 for negative inputs. Consider the positive part of the curve. The first two segments, which are actually colinear, correspond exactly to 12-bit linear conversion. Thus the output codes 0 to 31 correspond to inputs from 0 to 31/2048, in equal steps. (Remember that both positive and negative inputs are linearly converted, so a 10-bit linear converter will allocate 2048 levels for positive signals and 2048 for negative ones.) The next segment provides an approximate 12-bit linear quantization, output codes 32 to 47 corresponding to inputs from 16/2048 to 31/2048. Similarly, the next segment corresponds to 10-bit quantization, covering inputs from 31/2048 to 63/2048. As an example of the last section giving 6-bit quantization of inputs from 163/2048 to 31/2048, the full-scale positive output is converted similarly. For signal levels of

where y is the value which is to be quantized, gives a signal-to-noise ratio which is independent of the input signal level and therefore cannot be realized physically, for it is undefined when the signal is negative and diverges when it is zero. However, realizable approximations to it can be made which retain the advantages of constant signal-to-noise ratio within a useful range of signal amplitudes, one widely used approach being that of so-called “companding,” a contraction of “compressing-expanding.” The original signal can be retrieved from the A-law by an antilog expansion.

Figure 6 shows one common 8-bit coding scheme which is a piecewise linear approximation to the A-law. This provides an 8-bit code, and gives the equivalent of a 12-bit linear quantization for small signal levels. It approximates the A-law in 16 linear segments, 8 for positive and 8 for negative inputs. Consider the positive part of the curve. The first two segments, which are actually colinear, correspond exactly to 12-bit linear conversion. Thus the output codes 0 to 31 correspond to inputs from 0 to 31/2048, in equal steps. (Remember that both positive and negative inputs are linearly converted, so a 10-bit linear converter will allocate 2048 levels for positive signals and 2048 for negative ones.) The next segment provides an approximate 12-bit linear quantization, output codes 32 to 47 corresponding to inputs from 16/2048 to 31/2048. Similarly, the next segment corresponds to 10-bit quantization, covering inputs from 31/2048 to 63/2048. As an example of the last section giving 6-bit quantization of inputs from 163/2048 to 31/2048, the full-scale positive output is converted similarly. For signal levels of
The pre-sampling filter

Now we have some indication as to what the accuracy requirements for quantization, let us discuss quantitative specifications for the pre-sampling filter. Figure 7 sketches the characteristics of this filter. Assume a sampling frequency of 8 kHz and a relaxation time of 0.3 ms. Although all components are at frequencies above 4 kHz, the bandwidth will be reduced to the 4 kHz baseband, below 4 kHz. This effect is caused by the relaxation of the components at frequencies above 4 kHz. In the harmonic distortion caused by aliasing to the same level as the quantization noise in 11-bit linear conversion, the standard deviation of the signal to noise ratio must be reduced to 0.7 dB. The upper 8-bit code is not of such a critical, for two reasons. Whilst the presence of a few components alleviates that situation has been lost about the quantization components within the range of interest, the number of comparisons of the bit level needs to be reduced. It could be possible to avoid this economic where a multichannel digitizing capability is required, as in local telephone exchanges where the subscriber connection is an analogue one, they unlikely to prove cost-effective for a single channel.

In these occasional articles, the authors will introduce readers to the hobby of long-distance television reception, or DX as it is often called. More experienced operators as dedicated amateurs. This first part discusses how TV signals are affected by the atmospheric conditions, basic set requirements, simple aerials and signal identification.

There are many factors, such as transmitter powers and terrain, which will influence the signal over which a television signal can be reliably received, but in general, the strength of the signal becomes weaker as the distance increases. As the signal is transmitted, the power is reduced by the distance. In this way, a signal that is weak at the transmitter may be weak at the receiver.

In some cases, a distant signal can be received on a set with a tiny aerial, but in other cases, a set with a larger aerial may be needed. In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.

In some cases, it may be possible to improve the signal by using a larger aerial.
Aerials
In the minds of most people, the very reception of television signals from other countries conjures up an elaborate array of aerials atop an ornamental lattice. This need not be the case. Sparkling enhancements in signal strength, especially during an intense opening, and consequently the simplest of aerials will suffice. It should be noted that for serious DX work and the reception of weak signals, an outdoor multi-element system should be considered. It can be made of the directional properties of the aerial if some method of polarization is chosen. An Alden of Continental transmission is isotropically polarized, the receiving aerial should, thus, be mounted in the same plane, i.e., with its elements horizontal.

A simple aerial system for the beginner consists of a quarter-wave dipole, as shown in Fig. 1, mounted outside on a 6-foot pole. The aerial is made of copper tubing, the rods being connected at the base by a radius of 11.5 feet. Since the aerial is designed for DX reception, it should be mounted in a stable area, to be connected to the rest of the system which will be obtained if the aerial can be rotated.

Signal identification
After a distant signal has been received, one will automatically want to identify its source. This can be difficult if the source happens to be a programme, but if a test pattern is received the chances of identifying the transmitter are greatly enhanced. Until fairly recently there were many different test patterns in use throughout the world and depending on the model of television receiver, the decode would either be printed on the screen or it would simply be displayed with no signal at all. Today it is much easier to identify the source of a test pattern and the decode is very useful in identifying a signal.

Literture received
Application note 757-4, from Altech, describes the use of the Altech 577-57 GFIP Interface Unit in conjunction with their 757 spectrum analyser. Copies are available from Eton Ltd, EIL, Sherwood House, High Street, Cresswell, Buxton, Derbyshire, DE4 0GR.

Reference guide to IBM strain gauges, which lists hundreds of types and present information on measuring adhesives and accessories, can be had for £100, from Caradec (UK) Ltd, Stowfield Way, Randal, Midsomar HA6 1JT. WW409

A great many hortens and accessories from the UK and overseas, together with tools, instruments and small components are described in the New West Hyde catalogue, which is obtainable from West Hyde Developments Ltd, Unit 9, Park Street Industrial Estate, Burslem, Staffordshire HP2 1ET.

Readers wishing to respond to the authors' questions should turn to them in the WW editorial.
culation of six and six ratios, for broadband directional coupling, and for the horizontal and vertical signal levels due to "off cut" and cable/equipment temperature mismatch.

4. At avoided under "Licences", full use should therefore be made of the RHC's 3D, formatting, and other features, that show the great deal of difficult task of omitting the remaining unsecured 0.3% population not captured in this way. The elimination of this coverage plan which is projected to 1986.

Many of these points were made by Mr. Osbourne's article and successful endeavours. In the...
gineers should be redoubling their efforts to make maximum use of their limited budgets.

Jack Anderson

Trinity Hall

I do hope that the proportion of letters in favor of your editorial "Microchips and megadrums" in the November 1981 issue is typical of your postbag and of engineers in general. I am sorry to recall that, for too many of us after leaving university, I was too wedded in "defence" projects for a leading electronics manufacturer. However, engineers and computer scientists are fortunate in having a wide range of job opportunities available. I would encourage anyone who is employed in "defence" work (especially projects for other countries which help to fuel wars in which Britain has no interest) to look for more useful employment. When one leaves defence projects it is a great joy to be able to talk freely about one's work, and to contemplate its use without envisaging war.

Could Wired World take matters further by publishing one or more detailed articles listing the firms students should avoid when looking for employment? The Campaign Against Arms Trade (5 Caldonian Road, Kings Cross, London N1 DX, tel: 01-278 1976) would be only too happy to supply information to any other interested readers.

David Bailey
Manchester 16

OPTO-ELECTRONIC CONTACT BREAKER
Your article on opto-electronic contact breakers (April issue) suggests that they can be fitted to any make of distributor. My own Hillman Hunter uses a distributor in which vacuum advance moves one of the contacts of the contact breaker, and as you can see from the enclosed pages of the November 1980 issue, all vacuum advance would be lost if the contact breaker were changed as the author suggests.

M. D. Saman
University of Salford

The author replies:

Mr Saman is, of course, correct in saying that the opto-electronic contact breaker is not suitable for sliding contact type distributors. This type of contact breaker is designed to extend contact life by spreading the area of contact erosion, but must be regarded as a palliative rather than a cure for the well known problems of conventional ignition systems. It is particularly unfortunate that no proprietary devices are available to replace such a contact breaker, for the same reasons which rule out my own device.

On re-reading the article as published I could not, however, see where it was suggested that any make of distributor was suitable for conversi-

DIVIDING BY FRACIONS

Referring to the article by Gilbert Pearson in your April 1981 issue, which described a method for dividing by fractions, I would like to suggest a simpler way to accomplish this. By using the dual pulse synchronizer (NSN74S274) signalled by Knowles (May issue), you can easily "remove" a single period of the 4.6MHz signal 21 times per second. After counting down by 1.185 you have a frequency of 2006.25Hz with very low jitter. Using a simple phase locked loop, either a

ETHICS IN ACTION

There is no escaping the moral responsibility which is placed upon all of us to examine our role and function in society (June letter). We should see whether our actions are contributing directly or indirectly to the design and manufacture of armaments, or other socially unacceptable products, and then reconcile this role with our conscience, ethics, religious beliefs, or whatever standards we hold by, and then act upon the case.

All my life I have refused to work on anything whatsoever to do with armaments or warfare, and any price I may have paid has been trifling in comparison to the degree of sympathy and respect I have encountered, often from the most unexpected quarters.

Western civilization and technology cannot continue much longer without facing the facts and realizing that there will be consequences arising directly from its actions -- mostly, I fear, very unpleasant ones -- but fixed they must be, and your courageous editors will do much to start electronic engineers thinking.

Robin H. Mansfield
C.E.G.B.

Hammers

PICKPACK SPARKS

Regarding Mr A.R. Churchie's remarks in April letter, it may be of interest to refer to the paper in the Journal of the Institution of Electrical Engineers, vol. 95, part IIa, no. 5, 1946, "The development of triggered spark gaps for high power modulators" by J.D. Craggs, M.E. Halen and J.M. Medc. This paper describes the development of triggered spark gaps, during the war years, for use in short pulse modulators for magnetrons for radar applications.

The pulses generated by the discharge of anheated transmission lines were used to microsecond in duration and up to a few megawatts power. Repetition frequencies up to 2,500Hz were achieved. Early work was on short electrode sparks in air. Later this was extended to similar gaps sealed in glass vessels containing a pressure of up to three atmospheres of a mixture of argon with a 6% oxygen, and latter to suppress the long lived metastable state in argon which inhibited ionization. The ratio of the trigger pulse energy to that of the main pulse was 30:1 to 1.

The transmission lines were charged from a d.c. source through a choke. As first was done at the resonant frequency of the choke and the transmission line capacitance, so that line charged twice the direct voltage. To achieve a variable frequency system a series diode allowed the line to change twice the direct voltage and then again the voltage of the trigger pulse. However, it was later found that, without the choke, the frequency could be increased to any value above the resonant frequency and still give the doubling of voltage. The charging waveform then tends to a linear form.

It may be interest that patents were applied for and granted only for the sealed systems. The open air gaps system was rejected by the Patent Office because of a similar system patented in the last century for a lightning arrester.

M.R. Hatton
West Haddon, Heref

The SS6520 to 520MHz synthesized signal generator is flexible enough to meet your need

REMOTE PROGRAMMING

This option simplifies remote control of all major functions

IEEE488 INTERFACE

Add-on module for low cost microcomputer controlled A.T.E. Switching module and other IEEE488 accessories available

TRANSMITTER TESTING

Compatible with TTS520 transmitter test set for component testing of base stations, mobile or fixed radars up to 100 watts rating, pocketphones, pages, etc.

Send for our comprehensive folder of rf test equipment

WIRELESS WORLD JULY 1981
**Units Available from 100VA - 12KVA.**

**Two Units May Be Connected to Provide Up to 4kW,**

**Power Response DC — 45kHz ± 1dB.**

**D.C. Output 20 Amps at 100 Volts or 2kVA.**

**Harmonic Distortion Less than 0.05% DC-20kHz at 1kW into 6 OHMS.**

**Plug-In Modules: Constant Voltage/Current; Precision Oscillators**

**Unipolar and Bipolar Digital Interfaces, Function Generators, and Many Others.**

**Output Matching Transformers Available to Match Virtually Any Load.**

**Full Open and Short Circuit Protection Guaranteed Stable Into Any Load.**

**Two Units May Be Connected to Provide Up to 4kW.**

**Interlock Capability for Up To Eight Units.**

**3 Year Parts and Labour Warranty.**

**Units Available from 100VA-12KVA.**

For full details on Amcron Products write or phone Chris Flack

---

**Wafer-scale integration**

Reducing costs by using i.c. chips on the wafer

by Ivor Catt

Microprocessor Applications Project, Waford College

Much of the cost of manufacturing electronic equipment with integrated circuits lies in making connections to the chips and interconnecting them. Considerable reduction in this cost is claimed for the method proposed here in which memory chips are used while they are still on the semiconductor wafer, the whole of which is permanently built into equipment. On the wafer, a chain of good chips is formed under external control to produce a long serial memory. Any bad chips are automatically bypassed without requiring programming of the metallization that interconnects them or advance knowledge of the distribution of the bad chips on the wafer.

The traditional method of manufacture of a “silicon chip” microcircuit is as follows. A wafer of pure silicon material several inches in diameter is sent through a series of furnaces where hot gases are diffused into selected areas of the surface, creating some 500 identical two-dimensional microcircuits (“chips”) on the surface, half of them perfect and half of them faulty. At this stage, a minute fraction, perhaps 1%, of the total manufacturing cost of a complete computer system has been spent.

The microcircuits are tested using a wafer probe and marked to distinguish the good from the bad. The wafer is then cut up into individual microcircuits measuring perhaps one tenth of an inch square and each good one individually packaged in a one inch long black box with about fourteen contacts. The black boxes are tested and assembled into printed circuit boards. Then the boards are tested and assembled into systems which are also tested (see Fig. 1).

What is being called “the microelectronics revolution” is the successful attempt to reduce the cost of all these stages by squeezing more and more circuitry into each microcircuit (or black box) so that a complete deliverable system can be made with fewer of them. However, more circuitry on a chip means that each chip must be larger and more likely to be useless as a result of its including a faulty spot on the wafer. This leads to lower yield and increased cost, and the practical limit to the size of a chip is in the region of one or two tenths of an inch square. Also, as the complexity of a microcircuit increases, the cost of testing escalates in geometric proportion, so that even today’s conventional, relatively simple microprocessors and RAMs are expensive because of appalling testing problems.

Wafer scale integration is an alternative approach to the above. Although nominally divided up into “chips”, the wafer is never dissected, and there are built-in interconnections between chips. The full wafer, including faulty chips, is installed in the final electronic system. All the only conventional manufacturing stages — testing the wafer, dicing, packaging, testing, interconnection, testing — are omitted.

The wafer is conventional except that metallization overlaps between chips to give the inter-chip connections mentioned above. Grids of metallization lines across the wafer distribute voltage supplies and clocks. Crossovers between grids are achieved by two layer metallization. An array of fuzzy links on the grids localizes the effect of any shorts between voltage supplies. Each chip contains bonding pads for voltage supplies and clock inputs, but only a small number of these pads are connected to the outside.

There are four classes of w.s.i. as shown in the chart in Fig. 2. Of these, two were tried and abandoned or found wanting. One is a possible dream for the future. That leaves the fourth, “fault tolerant w.s.i.” Now that everyone realizes that the more complex microcircuits already on the market are unstable, it is coming to the fore as the main contender for further advancement in microelectronic technology.

The “fault tolerant” interconnection approach is based on the fact that today’s “chip” contains a massive quantity of circuitry — more than 5,000 transistors — the same amount of logic as was contained in a control general purpose computer in the 1960s. The process of getting rid of bad chips and linking up good chips into a perfect machine is delayed until after the wafer has been installed in a working machine, and even after the machine has been switched on for use in the morning. Further, the interconnections between good chips are “broken” when the machine is switched off, so that every time it is switched back on the machine is rebuilt from virgin circuitry during the first five minutes of operation. A very small proportion (some 5%) of the circuitry in each chip is devoted to this reconstruction process after switch on. The reconstruction is under the control of a control board containing logic of conventional design (100 packages which could of course be integrated into a single microcircuit). This control board is called “chip 0.” The rest of this article describes the author’s approach to fault tolerant w.s.i.

The aim is to build up on the wafer a
spiral of interconnected good chips which avoids the bad chips. This is achieved by a gradual growth process, shown in Fig. 3, where additional chips (or mezzanine layers) are added to the growing spiral, one by one. The latest chip being tested and discarded if found to be faulty. Chip Z communicates with the good chips ABCDE already in the spiral.

We end up with one or more spirals of perfect tested chips (Fig. 4), which for architectural purposes might as well be a straight line.

In the simplest machine, of which the preceding model has been built under Russell C. Aubusson at the Middlesex Polytechnic, the wafer accommodates one (or more) shift registers which can naturally replace computer disc memory and get rid of the inconvenience of rotating tapes.

The next machine in the family has the addition of a fast (or control) line to the periphery (or data) line, as shown schematically in Fig. 5. Serial commands travel rapidly down the spiral along the fast line, checking the address field in each chip as they pass and completing a read or write with the appropriate word. The addition of this fast line speeds up memory access by 20 milliseconds to about 5 microseconds, a speed approaching that of conventional random access memory. Although somewhat slower than r.r.m.s. of conventional design it is attractive because of its extremely low cost, between 10 and 100 times cheaper than conventional design. Because wafer fabrication can achieve, and also because it is less expensive. If a fault is detected, it is only necessary to switch off the machine and the memory will be repaired with switch-on, the newly failed chips being avoided when the new wafer is formed. Because of cost reduction and reliability improvement, computers could be expected to operate at very much lower rates using w.a.r. as a matter of course when the memory size is 256,000 words or more.

The rest of this article outlines the opportunities open to us via w.a.r., once we break out of the stranglehold of the Von Neumann computer architecture, an archaic design more than a third of a century old which has set the pattern for all computers, microprocessors and microcomputers up to the present time (see Editorial, February 1981, p. 31). For the rest of us, the idea has become entrenched that electronic computers are "information processing" devices, a phrase which implies sequential processing in the same way as a doctor sees his patients sequentially, forgetting about all one patient when he turns to the next. To develop the analogy further, it has become accepted that the doctor has no recollection of what the patient's third finger looked like when he examines the fourth, and so on. If a doctor, examining his fourth finger, notes down in the record the state of the third finger, and then moves on... it is remarkable, and in my opinion unfortunate, that the conventional Von Neumann computer is regarded as able to make reasonable showing at performing quite complex tasks in spite of its being virtually unprepared.

86

WIRELESS WORLD JULY 1981

Fig. 2. Chart showing variants of wafer-scale integration and the condition of the chips resulting from these methods.

Discontinuous wiring

Drilled holes

Faulty lines (10%)

Fault

100%

Fault tolerant

Fig. 3. Process of building up a spiral (or spirals) of chips on a wafer by adding contiguous good chips and avoiding faulty chips. This is done by external control via the external chip Z.

Fig. 4. Schematic of a spiral built up on a wafer.

complexly split down the middle, between memory and processing. However, my book "Computer Worship" lists a number of applications in which such a machine will not perform satisfactorily. There are several applications in which it is required to operate on data according to its content rather than merely according to its location. Wafer scale, fault tolerant hardware units, the possibility of the very cheap, reliable machines of a different kind, it is clear that more sophisticated operations need to be added to the "read" and "write" of the wafer so that it can be performed in a processing mode. For instance, the data field on the fast line in Fig. 5 would be added to the data field on the slow line rather than merely replace it. That is, we could have an "add" command instead of the "write" command. This is a first step towards operating on more than one word in the store at the same time — that is, towards distributed processing (a much misused phrase). A number coming down the fast line can be added to more than one word in memory at the same time. A major break with tradition should be noted. Whereas a word in memory has commonly been used as a fixed size memory word (accessed) by its physical location, words in this kind of memory are addressed by one word only. The word that is, each word carries its address with it. We actually have a content addressable memory — a "associative memory" masquerading as a r.r.m.s. We can consider moving forward towards even more powerful, more complex machines. Basic principles are sketched in Fig. 7. It is possible to send a "loop" command down the fast line, with the result that all words get trapped in tiny loops rather than continuing in a "follow my leader", barreling mode. Further, a "mixed mode", or "process" command can be sent down the fast line, causing words of one class to loop while words not of that class barrel. The "mixed mode" makes it possible for any word in memory to have rapid access to all other words in the memory. For example, in the case of a machine used to monitor aircraft circling above an airport, one word, containing the co-ordinates of an aircraft, could be caused to barrel past the records of all other aircraft stacked up waiting to land, so that those co-ordinates could be both be compared and a collision risk by that aircraft foreseen.

The next step in sophistication comes when we realize that when a bit word passes by a looping word, the situation is similar to a word on the fast line put on the slow line. It is possible to cause barrelling words to act as commands and operate on looping data words so that the overhead on the fast line is reduced. Machines could have been worked out whereby segments of the slow line behave as autonomously subroutines, the relevant words looping past each other like a lot of children, and tagging when a computational task is completed. We can get an extreme of the "mixed mode" by applying it to many processes at the same time although the hardware is very cheap and self repairing.

The first project based on the principles described here proved the feasibility of the microelectronics aspects of the subject. With E.A. Newman as its technical head, ACTP (Advanced Computer Technology Project, a section of the Department of Industry), financed the project in the Microelectronics Centre at the Middlesex Polytechnic, where it was led by Dr R.C. Aubusson. ACTP then fund provided to develop a computer architecture. These were at Brunel University under R.M. Lee, and at Prestwick Castle Ltd.

The Royal Signals and Radar Establishment, Dunstable, has, for the funded two projects on the airborne digital signal processing implications of the computer architecture. This work, at Prestwick Castle Ltd, is led by Ken Wood. Burrhoughs Corporation, Cumbernauld and San Diego, is now investing in the development of both the microelectronics and of the computer architecture. This work is led by Malcolm Wilkinson.

Wafers designed at Cumbernauld, processed in San Diego and then used at Cumbernauld have successfully generated spirals of more than 200 chips on an imprint of 0.5 inches. This lays the foundation for technical doubts about the overall feasibility of the invention.

References


Digital storage and analysis of speech

continued from page 48

Reconstructing the analog waveforms

Having digitized and stored a signal, it needs to be passed through a d-to-a converter (digital-to-analog) and low-pass filters (see Fig. 4) to be processed. These filters are cheaper than a to-d, and the characteristics of the low-pass filters for output can be the same as those for input. However, the decimation operation introduces an additional distortion, which has an effect on the output signal at the frequency of

\[
sin(\alpha f_0) / f_0
\]

where \(f_0\) is the sampling frequency. An "aperture correction" filter is needed to compensate for this, although many systems simply do without it. Such a filter is sometimes incorporated into the codec chip.

For telephonic-quality speech, existing codec chips, coupled if necessary with integrated pre-filtering, can be used, at a remarkably low cost. For higher-quality speech storage the analog interface can become quite complex. Comprehensive studies of the problems as they relate to digitization of audio, which demands much greater fidelity than speech, have identified the following sources of error:

- slew-rate distortion in the pre-filtering filter for signals at the upper end of the audio band;
- insufficient filtering of high-frequency input signals;
- noise generated by the sample-and-hold amplifier or pre-filtering filter;
- acquisition errors because of the finite settling time of the sample-and-hold circuit;
- insufficient settling time in the a-to-d conversion;
- errors in the quantization levels of the a-to-d converter;
- noise in the converters;
- jitter on the clock used for timing input or output samples;
- aperture distortion in the output samples;
- noise in the output filter as a result of limited dynamic range of the integrated circuitry;
- power-supply noise injection or ground coupling;
- charging in characteristics as a result of temperature change.

Care must be taken with the analog interface to ensure that the precision implied by the resolution of the a-to-d and d-to-a converters is not degraded by inad- equate analog circuitry. It is especially important to eliminate high-frequency noise caused by fast edges on nearby computer buses.

To be continued.
An experimental approach to additive synthesis employing digital techniques is described. The system enables an infinite number of waveforms to be generated by a basic fixed oscillator. It is shown that feeding a set of digitally programmed attenuators into a frequency analysis of known waveforms the system may be used as a source of sound for music synthesis, provided that a voltage-controlled oscillator and filter are added to the basic system. Using additional hardware, time-dependent spectrum changes are possible.

A sound may be represented by a series of sinusoidal components whose frequencies, amplitudes, and phases are specified. The frequency range and the number of required harmonics are determined by the properties of the sound involved. In the particular case of music synthesis, the primary task is to synthesize the complex vibration modes of a simple sound source, such as a piano key or a violin bow. The sound source is divided into a series of partials, or harmonics, which are then synthesized using a bank of voltage-controlled oscillators. The output of each oscillator is modulated by a filter, which determines the shape of the envelope of the sound. The resulting signal is then summed to produce the desired waveform.

A second important point which must not be missed is that the system is not only an analysis of the waveform but also a synthesis of the sound. The system is designed to be able to both analyze and synthesize the waveform, enabling it to be used in both music composition and performance.

The Walsh function series is a set of functions that are used in digital signal processing and information theory. They are defined as the Walsh functions of order n, which are a set of orthogonal functions that form a complete basis for the space of all square-integrable functions. The Walsh functions are a special case of the Haar functions, which are used in wavelet analysis.

The properties of the Walsh functions make them useful in various applications, including digital signal processing, data compression, and cryptography. They are also used in the design of digital filters and in the analysis of digital communication systems.

In summary, the Walsh function series is a powerful tool for the analysis and synthesis of complex waveforms, and its properties make it a valuable tool in a wide range of applications.
feeds the Walsh function generator also feeds a divide-by-2 counter. In this manner the period over which the coefficient of the particular Walsh function is varied is controllable. Once again, the counter cycle is made programmable.

The output of each d.p.a. is then summed in a traditional variald earth summing amplifier, the output of which is fed to a voltage-controlled filter (v.c.f.), this being controlled by the same control voltage which controls the v.c.o. Thus, the v.c.o. and v.c.f. track together. The total system results in a waveform being synthesized in which the spectrum may be altered in a programmable manner, both in terms of type and rate of spectrum change. In practice the sequence is initiated by the keyboard controller.

Polyphonic waveform synthesis

By the application of appropriate Walsh Fourier series both triangular and sawtooth waveforms may be synthesized in a manner compatible with existing organ divider techniques. The principle by which polyphonic operation is achieved in electronic organs is well known. Briefly, pitches raised in accordance with the scale of equal temperament are generated for the highest octave; either 12 independent oscillators are employed or a single master oscillator working in conjunction with a digital function generator. Lower octaves of each scale member may then be generated by the use of binary dividers, as tones spaced at octave intervals have a 2:1 frequency ratio. By this method, any number of pitches may be generated polyphonically, while the number of oscillators required need not exceed 12. Being of digital form the method has the disadvantage that only one waveform is directly available at the divider outputs, namely a squarewave. For reasonable additive sound synthesis a minimum of two additional waveforms should also be simultaneously available: triangular and sawtooth waves.

If the organ dividers are arranged to be of the form shown in Fig. 3, the signals present at the various outputs become not only octave-related but also take the form of useful Walsh functions and may be employed in direct Walsh/Fourier synthesis, enabling a practical circuit for the simultaneous generation of square, triangular and sawtooth waveforms to be constructed.

Referring to Fig. 3, given that the index \( n = 5 \), five Walsh functions are directly available from the divider chain \( \text{Wal}_1 \),...,

By applying the functions to the appropriate inputs of two d-to-a converters, accurate summation of the functions may be realized. Although of higher cost, d-to-a converters have two distinct advantages over operational amplifier summators. Firstly, as the output of a converter is in binary-weighted proportion to a single reference voltage or current, the accuracy of summation becomes independent of any variations in the logical 1 or 0 levels present at the outputs of the dividers or exclusive-or gates. Secondly, high accuracy summation resistors need not be fabricated.

Fig. 3. Binary divider chain providing \( \text{Wal}_2 \), \( \text{Wal}_3 \), \( \text{Wal}_4 \), \( \text{Wal}_5 \) and \( \text{Wal}_6 \) at consecutive outputs.

Fig. 4. By adding inverters and four exclusive- or gates triangle and sawtooth waveforms can be synthesized.

WIRELESS WORLD JULY 1981

wall5, wall7, wall11 and wall15 at consecutive outputs of the divider. The Walsh/Fourier series of a sawtooth waveform, limited to the 0:4:2 functions applicable when \( n = 5 \) is as follows:

\[
-\text{Wal}_1, -0.5\text{Wal}_3, -0.25\text{Wal}_7, 0.125\text{Wal}_15, 0.0625\text{Wal}_31.
\]

The negative signs in the series are interpreted as function inversion for practical purposes. All the necessary functions for sawtooth waveform synthesis are directly available from the divider outputs, provided function inversion is taken into account.

Now consider the Walsh/Fourier series of a triangular waveform:

\[
0.5\text{Wal}_2 + 0.25\text{Wal}_6, + 0.125\text{Wal}_14, + 0.0625\text{Wal}_{30}.
\]

None of these four functions are directly available at the divider outputs. But the table shows that these four functions may be derived by the use of only four exclusive- or gates. The complete arrangement for deriving all the necessary function for synthesis of both triangular and sawtooth waveforms is detailed in Fig. 4.

To sum these functions accurately in the relevant proportions they are rewritten in more familiar binary-weighted form:

\[
+2\text{Wal}_2 + 2\text{Wal}_6 + 2\text{Wal}_{14}, + 2\text{Wal}_{30}.
\]

and for the sawtooth wave:

\[
-2\text{Wal}_1, -2\text{Wal}_3, -2\text{Wal}_7, -2\text{Wal}_{15}, -2\text{Wal}_{31}.
\]

By applying the functions to the appropriate inputs of two d-to-a converters, accurate summation of the functions may be realized. Although of higher cost, d-to-a converters have two distinct advantages over operational amplifier summators. Firstly, as the output of a converter is in binary-weighted proportion to a single reference voltage or current, the accuracy of summation becomes independent of any variations in the logical 1 or 0 levels present at the outputs of the dividers or exclusive-or gates. Secondly, high accuracy summation resistors need not be fabricated.

Fig. 5 shows a practical circuit developed for evaluation of the system using readily available integrated circuits. For economy, the facility for simultaneous waveform generation has been dropped during evaluation; only a single d-to-a converter is employed together with some additional data selection logic.

Digital-to-analogue conversion

The d-to-a converter is the six-bit Motorola MC1406L, whose digital inputs are compatible but inverting which must be taken into account when selecting appropriate outputs from the dividers. The device requires an external reference for its operation and, as the output is in the form of a current waveform, current-to-voltage conversion is also necessary in this particular application. The reference for the MC1406L device, \( V_{\text{ref}} \), consists of the temperature-compensated zener diode with a current of 7.5mA supplied through \( R_6 \), with \( C_3 \) providing a c.c. decoupling. Because the negative reference input (pin 13) of IC3 is the high impedance node of the internal reference amplifier, buffering is not necessary. The device requires its reference in the form of a current, determined by resistors to pin 12 and the reference voltage. With the potentiometer set to mid-position, the values are selected to produce a reference current of \(-2\text{mA}\). The value of \( R_3 \) is selected so that both reference input points have the same source impedance, to reduce reference current error and temperature drift. The internal reference amplifier also requires compensation to maintain stability; with the values selected for the input resistances, the compensation capacitor \( C_2 \) must have a minimum value of 180pF to maintain an acceptable phase margin.

The output of IC3 (pin 4) provides a current which is a linear product of a six-bit digital word and an analogue reference voltage. The output current is negative and is derived from the equation:

\[
I_{\text{out}} = I_{\text{ref}} \left( \frac{A_5}{2} \right)
\]

where \( I_{\text{ref}} \) is the reference current and \( A_5 \) through \( A_3 \) are the digital inputs, m.s.b. through l.s.b. respectively. \( A_0 = 0 \) if the input is at logical 1, and \( A_0 = 1 \) if the input is at logical 0. As the voltage at the
output must not rise above ±0.4 V for accurate conversion, simple resistive current-to-voltage conversion is not practical and an opamp converter IC is used. The virtual-earth effect of the amplifier maintains the voltage at pin 4 of IC within the permitted value, while the voltage drop (∆V_R) may be set to any reasonable value by the suitable selection of R4. With R4 set at 2.7 kΩ, the output voltage may be set to a peak value of +5 V by adjustment of the reference current. Capacitor C2 provides low-pass filtering of the output waveform; the operational amplifier is a 741 general-purpose device.

Digital filter generation and selection logic

Although the MC1404L device is a short-time dual-channel multiplier, the conversion is required in this application. To maintain maximum accuracy during conversion, the input corresponding to the least-significant bit is dropped and disabled by connecting to +5 V. The remaining most-significant bits are supplied through data selection gates. The four most-significant bits are supplied with the SN74157P, 2×2 to 1 line data selector, IC6. Hence, either of two functions may be present during the main conversion, simple resistive input voltages of the data selectors are allowed to their respective d-to-a conversion points, the B-inputs of the data selectors are assumed to be 2.7 kΩ, the output voltage may be set to a peak voltage of +5 V by adjustment of the reference current. Capacitor C2 provides low-pass filtering of the output waveform; the operational amplifier is a 741 general-purpose device.

Practical extension for full polyphonics

By applying available output voltages to separate summators any number of different waveforms may be synthesized simultaneously at a given frequency. For full polyphonics, simultaneous multi-frequency generation of these waveforms must also be arranged. As an aid to locating functions which form a useful geometrical progression in sequence, an analogy may be made with the sine and cosine notation again useful. Designating the odd and even indexed functions and cal respectively, one obtains

\[
s_k(a) = s_{cal}(2a)
\]

where the cal function of index a has twice the sequence of the sal function of index a, and

\[
cal(2a) = cal(2a)
\]

where the cal function of index a has twice the sequence of the sal function of index a.

From this it may be deduced that the functions at consecutive outputs of the divider are octaves related and form a geometrical progression in sequence. For multi octave generation of the functions -wal1, -wal5, -wal7, -wal8 and -wal9, necessary to select the correct extended-divider outputs, -wal1, -wal5, and -wal7, for synthesis purposes at pin A8 (8080 Hz) for example, is the identical function -wal, for synthesis purposes at pin A8 (8080 Hz) and A9 (4040 Hz), and so forth.

To extend the generator scheme for multi-octave generation of the functions -wal1, -wal5, -wal7, -wal8 and -wal9 however requires separate groups of exclusive-or gates. For convenience, -wal at pin A8 (8080 Hz) for example should be formed by modulus-two addition of the functions -wal1, -wal5, -wal7, -wal8 and -wal9 giving frequencies of 8800 Hz and 17600 Hz for wal1 and wall respectively.

Thus extension of the basic generator scheme to full polyphonic capability, while requiring a formidable amount of hardware in m.s. form. It is found that the reference current of the operational amplifier is set at 2.7 kΩ. Then C1 = 1/2·C2·R1. This gives a value of 4.7 kΩ.

![Clock generator](image)

**Fig. 6** Clock generator frequency is set to 2 kHz for testing dynamic operation of Fig. 5.

**Table 1. Current proposals of h.f. broadcast services**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.900 to 4.000</td>
<td>BAND 1</td>
<td>BAND 2</td>
</tr>
<tr>
<td>4.750 to 4.880</td>
<td>BAND 3</td>
<td>BAND 4</td>
</tr>
<tr>
<td>5.000 to 5.125</td>
<td>BAND 5</td>
<td>BAND 6</td>
</tr>
<tr>
<td>5.750 to 5.890</td>
<td>BAND 7</td>
<td>BAND 8</td>
</tr>
<tr>
<td>7.000 to 7.125</td>
<td>BAND 9</td>
<td>BAND 10</td>
</tr>
<tr>
<td>9.000 to 9.125</td>
<td>BAND 11</td>
<td>BAND 12</td>
</tr>
<tr>
<td>11.000 to 11.125</td>
<td>BAND 13</td>
<td></td>
</tr>
<tr>
<td>13.600 to 13.800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.500 to 17.750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.400 to 21.650</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.000 to 25.250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.750 to 29.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 2. Present and proposed h.f. broadcast frequency spectrum**

<table>
<thead>
<tr>
<th>CURRENT BANDS</th>
<th>WAR C.</th>
<th>PROPOSAL (AFTER 1982)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.900 to 4.000</td>
<td>BAND 1</td>
<td>BAND 2</td>
</tr>
<tr>
<td>4.750 to 4.880</td>
<td>BAND 3</td>
<td>BAND 4</td>
</tr>
<tr>
<td>5.000 to 5.125</td>
<td>BAND 5</td>
<td>BAND 6</td>
</tr>
<tr>
<td>5.750 to 5.890</td>
<td>BAND 7</td>
<td>BAND 8</td>
</tr>
<tr>
<td>7.000 to 7.125</td>
<td>BAND 9</td>
<td>BAND 10</td>
</tr>
<tr>
<td>9.000 to 9.125</td>
<td>BAND 11</td>
<td>BAND 12</td>
</tr>
<tr>
<td>11.000 to 11.125</td>
<td>BAND 13</td>
<td></td>
</tr>
<tr>
<td>13.600 to 13.800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.500 to 17.750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.400 to 21.650</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.000 to 25.250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.750 to 29.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WIRELESS WORLD JULY 1981**

**Which way h.f. broadcast receivers?**

Proposals for the development of s.w. sets

by Y.-C. Heng and R. C. V. Macario, University of College Swansea

With a vast number of shortwave receivers around the world, estimated as being over 10 million, the proposal of new selective bands in regular use, and with a majority of listeners with little or no technical knowledge, there are still a large number of these sets in a wide variety of environments, it is worth taking a look at methods for improving the design of these sets. The use of digital tuning techniques and the incorporation of microprocessors are discussed.

According to conventional estimation, there exist in the world today between 200 and 300 million radio sets capable of shortwave broadcast reception. A regular audience approaching 100 million is also estimated. The idea underlying these concerns shortwave broadcasters, but also indicates how important is the function of shortwave broadcasting. It is estimated that there are one million amateur radio enthusiasts (class A) around the world, but as this is only 1% of the suggested audience clearly the majority of shortwave broadcast listeners have relatively little technical interest or perhaps background and accept comparatively inexpensive receivers. In a few sets, listeners operate their sets either in an environment of a high level of man-made noise or have a very inefficient aerial. On the other hand, they are usually hampered by disaster, radio-quiet environment and the undefined signal reception, and poor receiver stability, yet form the majority of shortwave broadcast listeners. In order to turn out to discuss which way a shortwave broadcast receiver designer may go with regard to alternative design approaches and the discussion is supported by practical demonstration. The capability of applying microprocessors in popular shortwave broadcast receiver design must also be considered, depending on this approach are also included.

**What is required?**

In this section, difficulties of both manufacturers and users of shortwave broadcast receivers are outlined but at the same time requirements of users and recommendations of broadcast unions are evident. In order to bring out the difficulties facing the shortwave listener, it is essential to realize that the requirements of broadcast frequencies in the radio spectrum. It seems that the arrangement of radio spectrum has never been able to totally satisfy any holder of the spectrum. "It is to be hoped that the radio spectrum for each different service will always be a difficult technical and political exercise. Moreover, the results of the discussion in particular is briefly considered here.

In the past twenty years, the total shortwave broadcasting service (excluding in-and-out-of-band) has grown up from 11,000 to 27,000 different broadcasting services, and the problem of congestion is well understood. Re-allocation and expansion suggestions of the broadcast bands on shortwave from the Asian Broadcasting Union (ABU), the European Broadcasting Union (EBU) and the United Kingdom before the 1979 World Administration Radio Conference (WARC) are set out in Table 1. At WARC 1979, the frequency allocations in Table 2 were agreed and these are available for allocation from January 1982. Table 2 also lists the present band planning. A glance at Table 2 and Table 3 shows that most broadcast bands are scattered between 3 and 27 MHz, with no simple arithmetic relation among them.

**Design difficulties**

Despite the general difficulties faced by radio broadcast designers, there are some distinct problems for a popular low-cost shortwave receiver.

In 1959, there were only a few transmitters with transmitting powers of over 200 kW, but during the last 20 years, the number has increased to about 400. They generate tens, in some cases hundreds, of millions of watts at the antenna terminals when received. The trouble caused in the receiver is that strong signals generate large number of intermodulation products, strong enough to give the appearance of liveliness, yet masking weak wanted signals. How to distinguish the weak wanted signal from massive strong unwanted signals is always a major technical task.

![License](image)

[License Information](image)
A free-running local oscillator in a superhet receiver is always troublesome, especially when the first intermediate frequency is set to a high frequency to improve image rejection ratio. Even with the most sophisticated mechanical tuning to design a resolution of 10Hz at 30MHz can really never be achieved. One can therefore imagine the outcome of the accuracy of a normal popular shortwave broadcast receiver.

Good shaping of the selectivity curves of the r.f. and i.f. stages offers a direct way of rejecting unwanted signals, but cost is a factor when seeking good selectivity curves.

Due to skywave transmission, a fading phenomenon is inherent with shortwave broadcast reception; a way to conquer this problem should always be considered.

User's difficulties and requirements

No need to say, as often as got the designer's difficulties mentioned above are overcome in a popular-model shortwave broadcast receiver design by being transferred to user operation and reception difficulties.

Fig. 1. First approach for a functional system.

Fig. 2. Second approach for a functional system.

A free-running local oscillator in a superhet receiver is always troublesome, especially when the first intermediate frequency is set to a high frequency to improve image rejection ratio. Even with the most sophisticated mechanical tuning to design a resolution of 10Hz at 30MHz can really never be achieved. One can therefore imagine the outcome of the accuracy of a normal popular shortwave broadcast receiver. Good shaping of the selectivity curves of the r.f. and i.f. stages offers a direct way of rejecting unwanted signals, but cost is a factor when seeking good selectivity curves.

Due to skywave transmission, a fading phenomenon is inherent with shortwave broadcast reception; a way to conquer this problem should always be considered.

User’s difficulties and requirements

No need to say, as often as got the designer’s difficulties mentioned above are overcome in a popular-model shortwave broadcast receiver design by being transferred to user operation and reception difficulties.

Difficulties to tune to a desired station, and maintain that listening station from drifting, unavoidable interference and spurious signals due to poor linearity and selectivity, audio output variations due to fading effects, are among the major difficulties facing users. What do the users want? The users simply want easy operation, good performance and low cost receivers, requirements of course, in almost direct conflict with manufacturers.

After a joint meeting between representatives of national receiver and transmitter manufacturers associations and an EBU study group concerned with h.f. broadcasting, a brief and peremptory description was suggested for a popular shortwave broadcast receiver design; it should be reasonably-priced, stable with product de-
mnodulator and easy-tuned. Following this suggestion, the design philosophy is divided into four sections: ease of operation, high stability, low cost and good performance.

One way and better way to relieve the difficult task of mechanical tuning is to apply a digital tuning technique. Digital tuning can make it possible to tune quickly and accurately over a large number of shortwave broadcast stations. Incorporation by means of frequency synthesizer circuits is discussed below.

Tuning a station can be achieved by keying in frequency information, wave-length information, or a pre-assigned code. Before the idea of programme labelling/1,2 can be widely implemented, listeners will need to look up from a handbook or simply memorise the identity information of a station. It is tiresome to find out station identity information from a handbook each time, but it is also impractical to memorise such information. For example, the Philips LN 123 and Plessey NJ 8811 synthesizers are used in two different designs.

To keep receiver cost down is almost mandatory. In general, manufacturing cost can be subdivided into material cost, testing cost and assembly cost. By using cheaper components, such as integrated circuits, ceramic filters, etc., not only the material cost, but also the testing and assembly costs can be reduced. A suggested frequency allocation proposal which can reduce the price of the receiver system design is given in design approach 2.

Good performance and low cost are not easy to reach at the same time by a designer, sometimes the two requirements are in direct conflict, but this does not mean a low cost receiver need not have good performance. To some extent, the art is how to distribute the expense over the design. Nevertheless, some specifications which should be considered as a "must be good" are listed here: (1) Linearity (2) Sensitivity (3) Selectivity (4) Image rejection ratio (5) Frequency stability

H.F. Receiver Design Approaches

Having just specified the design requirements, we now describe two designs which achieve the requirements, which are based on quite different approaches.

Fig. 1 shows a system block diagram. In this first system design approach, frequency allocation is based on the WARC 1979 new agreement, listed in Table 2. The whole frequency spectrum is arranged to have 12 frequency bands and a channel spacing of 5kHz is assumed. Under this scheme, a broadcast station with a transmitting frequency at 9,645MHz would now have an identity code: Band 6, Channel 30. To tune to this station, the operator presses the key 'B' first, opening the gate to the band memory unit and at the same time closing the gate to channel memory unit. The number '6' is then pressed and the memory display unit then shows this band number. The user then presses key 'C' reversing the above gate switch functions and then the number '30'. The channel display unit should then show this channel number. The actual digits stored in the band and channel memory units are b.c.d. coded. These b.c.d. numbers are then used as address codes to fetch the corresponding set of words from the eprom to program the programmable divider. The vco (voltage-controlled oscillator) output, via a buffer and prescaler stages, is divided down in the programmable divider and then sent to the phase comparator unit to compare with the reference frequency signal. If a different frequency or phase exists, an error voltage is generated through the loop filter to correct v.c.o. frequency or phase in the usual way. With the corrected v.c.o. frequency, the receiver is tuned to the wanted station frequency.

The antenna r.f. signal is selectable by converting to the i.f. frequency. An up-conversion superhet system with a first i.f. of 455Hz and second i.f. of 455Hz has been adopted so as to ensure a high image rejection ratio. Diversity spectrum is arranged to have two conversion stages to improve various interference characteristics such as broadcast modulation, spurious noise, etc. New low-voltage high-level balanced modulators, with which the manufacturers claim a third-order intermodulation of -60dB and a 1dB compression point of 15dBm, are currently available.

Although at the forthcoming WARC HF conference in 1983, any possible planning of the shortwave broadcasting bands will be based on a double-side band (a.b.b.) sound broadcasting system, the introduction of single-side band (s.s.b.) transmissions has to be taken into account. A carrier reduction in excess of 40dB, with respect to peak envelope power, is also likely. A residual carrier is necessary for the operation of automatic-gain-control circuits in the receiver and for frequency-locking or carrier acquisition purposes. On the other hand, a 12dB reduction makes for a sensible reduction of transmitter power consumption and running cost.

The upper-side band (u.s.b.) transmitting mode is likely to be used in the future shortwave broadcast s.s.b. transmission, therefore only u.s.b. detection is considered in the s.s.b. designer's test. As indicated a registered carrier signal from the carrier acquisition circuit mixes with the received carrier signal in the product demodulator stage. The audio information is then amplified after a low-pass filter to the required level through audio amplifiers. The nature of possible carrier acquisition circuits is not discussed here for two reasons. Firstly, such circuits are not easy to devise and secondly they deserve a long separate discussion.
THE W.W. DISK OFFER
RE-OPENS AT LAST

We have obtained a limited stock of European single sided drives so please get orders in soon.
Circle the enquiry number for data.

Total U.K. price including VAT at 15% and carriage, CWO.

ONLY £155 EACH INCLUSIVE
(Drive £132, P and P £2.78, VAT £20.22)

Please make cheques and P.O.S payable to W.W. Disk Offer and send to:

W.W. DISK OFFER
49 Milford Hill
Bathford
Herts

Please call 0582-429122 to check on availability before ordering.

Allow 21 days for delivery. This offer applies to U.K. only and is subject to availability. For non U.K. orders send SAE for quotation.

FLOPPY DISK DRIVES
NOW EVEN LOWER PRICES BUT TRUE UNBEATABLE ON!

Note these specifications:
- TRACK READ SENSING
- AUTO-FORMAT FUNCTION
- AUTOMATIC STOP AT DISK END IN CASE OF ERROR
- AUTO STOP AT CURRENT SWITCHING AT TRACK 43

Please call or write.

STRAINS LTD.

A quiet word from Siemens

Siemens produces a range of electronic teleprinters and printer terminals which are quiet, rugged and require little maintenance thanks to a plug in fault diagnosis and modular design and construction.

TELEPRINTERS are available in various configurations with or without paper tape facilities or keyboard, or with magnetic tape attachments that will take the place of a tape reader and punch and provide a convenient method of storing messages.

The Model 1000 Teleprinter uses a logical type wheel for high print quality whereas the PT80 I is a version of the PT80 but using the ITA (No 2) telegraphy code can be supplied with either needle or ink-jet matrix printing. Multiple-orientation versions of the Model 1000 Teleprinter (1000V) are available for specialized applications along with the Teleprinter 1000 CA crypto teleprinter and ancillary equipment covering error correction and modulation and demodulation.

For complete details contact:
Siemens Ltd, Siemens House, Wharncliffe Road, Surfandy-on-Thames, Middlesex, TW15 7TB
Tel: Surfandy-on-Thames (0932) 65656
Telex: 809107

Siemens—printer terminals are our business
Within this range nine 6 MHz bands have been released by Racal for frequency hopping. Within a chosen 6 MHz "hop band" the frequency hops among 256 channels, each hop taking 7 microseconds. The method used to achieve the necessary synchronization between transmitter and receiver, notably better than any earlier known, is described in an earlier report on the prototype (December 1979 issue, p.83). The hopping rate is controlled by the maker or "medium", which means somewhere between 50 and 500 hops per second. Some idea of the spread-spectrum effect on transmission can be gained from the spectrum monitor display here. Frequency hopping systems are discussed in the document and their likely cost. For instance, a new model of 6 MHz spread-spectrum equipment using ESA's European Communications Satellite would cost about £1.25 per channel per year over a ten-year period. A five-channel system broadcast via the L-Sat, ESA's large satellite, would cost about £5.50 per channel. Cost would be reduced by starting with a pre-operational system with a spare satellite held for launching, though there were a breakdowns in the operational satellite.

**Component supplies**

It is annoying to need a particular component and not be able to find a supplier. We have mentioned how inquiries from new suppliers and any new source is always welcome. Amiga Component Supply would almost certainly quote for small sets of parts in the UK, especially if the application is a new one. However, a catalogue describes in its 110 pages resistors, capacitors, semiconductors, microprocessors, integrated circuits, electronic components, tools, test equipment and large sets of parts. The catalogue is in English, French and German. L-Bah, 21-72, London, sells all types of parts. The catalogue list to be ordered and sent to the supplier or by telephone. The catalogue is in Japanese, and it is export to the world.

**We should buy Dutch radar?**

Although the value of the defence industry may be questioned in its ability to actually defend our country against potential enemies, one thing is in favour of it that provides work for the manufacturers of defence equipment. Although none have been revealed, it is possible that the French company Grumman, which has been decided to buy the Dutch company NICO in order to give the Dutch a better defence against potential enemies. Marconi Radar Systems are, understandably, upset about this, since the Seabees has been in use with the Royal Navy and in full-scale production. Over the past 25 years they have built up an expertise in systems design and have been improving the performance of the radar against low velocity targets. Marconi have proposed a series of modifications to make the Seabees lighter while ensuring that the performance improvements at a comparable price. They point out that such equipment would also have considerable export potential, but as the Navy's decision goes against them there would follow the destruction of the design and loss of employment in various factories.
Technologists detained in USSR

Two professional workers in the field of electronics have been arrested in the USSR after unsuccessful attempts to obtain visas to enable them to emigrate to the country. Both are Jews, Kim Feldman, an electronics engineer, and creationist student, and David Estrin, a systems engineer, who was a student at the Institute of Electronic Control Machines, Moscow.

Both men appear to have run foul of the current hysteria against holding cultural and scientific seminars in their homes, in spite of the fact that these meetings were conducted on strictly religious grounds, and created no practical or ethical objection for "Refusenik." To hold such seminars, men are continually threatened with expulsion and have their professional knowledge up to date. Such is the charge against Estrin in "isuch." The arrest appears to be a precautionary measure against those who have been arrested and dismissed from their work, and live in fear of arrest and ramped-up charges resulting in imprisonment.

New satellite earth station

British Telecom are to build a new satellite communication earth station at Braintree, Essex, which it is proposed to be used for telephone services. The station will be in Braintree, and will be located on the site of a disused airfield. The station will be completed in 1982, and will be used to provide services to the North of England and to the North West of Scotland.

The station will be equipped with a satellite dish, which will be used to transmit and receive signals. The dish will be located on a mountain top, and will be large enough to allow the satellite to communicate with the station. The station will also be able to communicate with other earth stations, and will be able to transmit and receive signals to and from satellites in orbit.

I am grateful for the opportunity to reply to various letters that have been sent to the Editor in response to Professor Herbert Dingle's article. I shall start with Tom Wilkie's letter [June issue], which has been written in a spirit of inquiry and analysis and I shall reply to it. I am glad to see that Tom Wilkie feels that he has been given a chance to express his views, and that he has been given the opportunity to express his views in a fair and balanced manner.

I am not sure that I can completely agree with Tom Wilkie's views, but I would like to make some comments about the letters which may say something to others who may view the same thing as being still open.

To reply to Tom Wilkie's comment that "most aca
demic journals have for some years vigorously warned the public of the mistakes that have crept into the reasoning of some of the more discussion of it as one of a few papers", and his final plea to "get it right," I am afraid that I must say that I think he was the one who was the imputed "The Two Theorems of Prasie" named in 1977, which led directly to the writing of Dingle's paper.

One of the interesting features of the responses to Herbert Dingle's criticisms of special relativity, is his question of what Dingle's answer is to the question of the relative rates of time and space. I think it is clear from the following that neither one of the scientists (or both) misunderstood either the theory or the experiment (or both). It is more than that there is a contradiction in the theory.

I am not sure that the events of the latter part of 1981 are not a solution to the problem of the contradiction, but to the question of the problem of the contradiction, the events of the latter part of 1981 are not a solution to the problem of the contradiction.

A description requires observers, apparatus and measurement procedures before it can be observed. They are not left unchanged by a change in the reference coordinate system. For example, the parcel of measurements that has to have the same name as the other measurement in the same way, is a true measurement. The measurement of the speed of light requires the use of a clock to be used in a real slowing, not merely to compare different speeds. The par
delays in the measurement of the slowing of the clock, which was intended to be a real slowing, not merely to compare different speeds, but which we do not know how to construct.

To reply to Wilkie's paragraph about all the scientists who did not choose to seek fame by destroying Einstein's theory, I am afraid that I cannot agree with him. The scientists who sought fame by destroying Einstein's theory were not scientists who did not choose to seek fame by destroying Einstein's theory. The scientists who sought fame by destroying Einstein's theory were scientists who did not choose to seek fame by destroying Einstein's theory.

The situation according to Special Relativity is as follows (for instance, see Introduction to Relativity by L. D. Landau and E. M. Lifshitz, Pergamon Press, 1968).

According to Dingle the outward and return journey of a beam of light according to Peter they take 15 years each. Thus Peter receives the beam by the factor 19x365 = 3650.

According to Paul, Peter's clock is moving relative to Paul's clock, and therefore the outward journey Paul says that 355 seconds have passed. Peter's clock is on his own clock. Peter claps his own clock.

Paul's clock is on his own clock. Paul says that Peter's clock is moving relative to the beam. Peter, on the other hand, claps his own clock.

The situation according to Special Relativity is as follows (for instance, see Introduction to Relativity by L. D. Landau and E. M. Lifshitz, Pergamon Press, 1968).

According to Dingle the outward and return journey of a beam of light according to Peter they take 15 years each. Thus Peter receives the beam by the factor 19x365 = 3650.

According to Paul, Peter's clock is moving relative to Paul's clock, and therefore the outward journey Paul says that 355 seconds have passed. Peter's clock is on his own clock. Peter claps his own clock.

Paul's clock is on his own clock. Paul says that Peter's clock is moving relative to the beam. Peter, on the other hand, claps his own clock.

The situation according to Special Relativity is as follows (for instance, see Introduction to Relativity by L. D. Landau and E. M. Lifshitz, Pergamon Press, 1968).

According to Dingle the outward and return journey of a beam of light according to Peter they take 15 years each. Thus Peter receives the beam by the factor 19x365 = 3650.
cause he is moving relative to Peter, Peter says that this additional clock is not synchronous with Peter's own clock but is running slow by 15 years minus 35 seconds; this is an example of the relativity of simultaneity. As soon as Paul reverses direction he judges that Peter's clock now leads the local clock (which reads 15 years) by 15 years minus 35 seconds. Paul measures 115 days on his own clock for the return journey after a total of 3 days whilst he judges that only a further 35 seconds elapse on Peter's clock (making a total of 3 days). According to Paul, Peter's clock therefore races forward by 30 years minus 35 seconds during the reversal; as discussed by Einstein this can be explained using General Relativity. (Alternatively, since Paul changes inertial frames it cannot be stated in McCausland's special relativity is stated in term frames of reference. Relativity to a change in his definition of simultaneity.) Special Relativity does not therefore preclude the possibility that Paul is retained at the beginning of the return journey, and Dingole's criticism of the theory on this basis is not valid. It seems to me that his is not a satisfactory answer to Dingole's article. It should be recalled that Dingole was discussing Einstein's own resolu- tion of the twin paradox, and that this resolution required the use of general relativity. "Einstein's article" takes the form of a discussion between a relativist and a critic; the discussion of the paradox starts from special relativity, and the critic asks for a resolution that satisfied the general theory, and is as near as resolution that Dingole discussed in his article."

This seems to me to suggest that Dingole's argument must be seen in terms of the general theory, not the special theory. The other point to be noted is Einstein's resolution that he that it is perfectly valid to accelerate a whole course of events, provided that the appro- priate fields of force are involved. This means that the fields of force are not that Einstein can synchronize with his own at the point where Paul reverses direction will still say that this clock reads 15 years at the end of the outward journey. Paul will, however, have assigned a duration of 15 years to the outward journey. (In case it may be argued that the fields of force in question are those of Peter and Paul might suggest the synchronization is that of clocks in space-time. Paul are moving uniformly relative to one another, and the fields of force at the different points of the fields of force are needed at the central point.)

W.J. states that "Dingle gives a wholly spurious symmetry to the problem by assuming that the Universe is empty but for the clocks in his analysis (although in the statement of the problem he refers to the earth.) I cannot find any such assumption made in Dingle's article. Dingle talks about the earth and a distant planet, whereas Einstein's statement of the same problem defines it wholly in terms of reference frames. Einstein's article does not name any objects except the travelling twins to resolve the paradox, except that later in his paper, when his supposed critic suggests that the gravitational fields are fictitious, he states that "all the stars in the firmament can be conceived as appearing in the creation of the gravitational fields." I do not think that this is true once we have objected to this statement, and faut that Dingle did not happen to mention the stars in the firmament. I do not think that this can scarcely be taken as an equiva- lence on his part that the universe is empty except for the two clocks."

W.J. also states: "The clock paradox of special relativity is stated in Macculloch's article if there are two clocks in uniform relative motion the special theory of relativity requires each clock to run faster than the other. Each clock, of course, does not even mention the clock paradox, much less refer to it in his paper. Yet I think that Dingle makes such an assumption as much more than Einstein did. Dingle states quite clearly, in the passage Dingle quotes, that retardation of a clock during such phase of the experiment was over-compensated by faster working during the other phase, and Dingle works faster if located at a point of greater graviti- onal potential. I think that Dingle's following Einstein's argument to its inevitable conclusion."

"E. Burtt (May letters) asks "Am I the only reader of Wireless World with an interest in phys- ics who finds the long series of articles on special relativity somewhat boring?" After mak- ing some interesting comments about the modern physics, he ends his letter by writing: "When a new more inclusive theory which will embrace quantum mechanics and general relativity, I suspect that few "anti-rela- tivists" will take the result."

I do not know the grounds on which Burtt bases his suspicion that few anti-relativists would like such a result. There seem to be no obvious objections that come to mind.

J.C. to me as a question that those who criticise the like of Luddinglinger is for a recent in pre-Einstein physics, whereas in modern physics it is clear that there is nothing time for the scientific world. Dingle, in the possibility of relativism in post-Einstein physics.

Some correspondents, such as, W.J., J.M. of the Rice, R.V. Harvey, and A.B. Stand- field, present alternative mechanisms, or partial resolutions, of the clock paradox. For the reasons given in my earlier comment, I believe that some of Dingle's arguments can cause them to identify a fault in his reasoning. M.M. Althaus (February letters) suggests a new experiment to test the validity of relativity by an inspection of the constancy of light; using time intervals four orders of magnitude lower than those in the Michelson-Morley experiment. A.H. Winford states that Dingle is wrong in believing that the ma- thematics of special relativity is impotent; states that the mathematics of the theory is wrong, and refers to his recently-published book "Einstein's Error!". Other correspondents, such as, C.L. Thomas, W.T. Mossberg, Peter Allen, and J.A. MacIiwa, contrib- uted interesting comments and suggestions, and V. Hallah made a discussion contributed by Dr. Eisen's article in Wireless World dated Octo- ber 1978.

There is another letter which I think I require comments, namely a letter by J.H. of which appeared in New Scientist last year. Some of the comments below were made in a letter to me that I sent to the editor of New Scientist October 1980, but to the best of my knowledge my letter has not been published.

Professor Fleming stated that he would "like very much to refute the suggestion that oppo- nents of the theory of relativity find it difficult to get a proper hearing." He might like to make the suggestion, but his letter certainly does not do so. I only evidence he presents in support of his "refutation" is about things that were published, whereas the suggestion that he claims to refute is related to the fact that papers have been denied publication. There is no contradiction between the fact that some papers were refused publication, and that they were have been denied. Unfortunately Professor Fleming, except those who have direct ex- perience, are aware of the difficulty of having any paper published. Any one in criticism of relativity of the problem is that almost all the evidence about papers that have been rejected is hidden in the footnotes of the papers."

To take a specific example, Professor Dingol- le, states that by similar analogy, the high- frequency response is 1 dB at 50kHz without the 3x3 output capac- itor. The output capacities of 53b and below, 150mV, distortion is caused solely by the push-pull input stage. Capabilities with high impedances will give lower distortion. High quality components must be used to eliminate this problem which should be next with no long connections. The circuit shown has been optimised for an OFetron moving-coil cartridge, but other types should also be suitable.

Performance
Voltage gain 35dB Input impedance 20k

Output harmonic distortion (mainly 3rd) R

400mV 0.12% 150mV 0.05%

100mV 0.1% 50mV 0.05%

Noise (unweighted) 10.75Hz to referred to input (includes hum).

c.o. 74V 2 74V2 transistors only

Frehen Response
-1dB at 15kHz

-5dB at 50kHz (see test)

R. Lee Bradford

Avoiding tone breaks between adjacent notes

When an electronic organ keyboard is divided into sections using each of the two filters to...
Plotting oscilloscope waveforms

This system enables a display to be plotted from an oscilloscope which has a delayed sweep facility. The oscilloscope is set in the A—intensified-B mode so an unknown signal is displayed with a bright portion showing the extent of the delayed sweep. The delayed sweep gate, a pulse which corresponds to the intensified portion of the waveform, is used to operate a sample and hold circuit whose output voltage is equal to the waveform voltage at the end of the delayed sweep interval. The output is measured by a digital voltmeter and fed to the Y axis of an X-Y recorder. An X drive for the plotter is derived from the wiper of the delay-time multiplier potentiometer in the oscilloscope. To plot a waveform, the potentiometer is rotated through its full range, which drives the pen horizontally while the sample and hold circuit drives the pen vertically. The sample and hold circuit can be fed from the oscilloscope Ch1 output terminal, which provides the plotter with vertical deflection features such as adjustable scale factor, ac/dc coupling, and variable positioning.

To calibrate the plotter, ground the scope input, position the trace vertically at an appropriate reference point and scan horizontally using the delay-time timing, i.e. one inch for one c.r.t. horizontal track. The plotter is then adjusted for full deflection—e.g. one inch for one c.r.t. horizontal division. With any sampling system, the waveform must be repetitive, and trigger jitter on the oscilloscope will blur the plotter waveform.

This arrangement can form the basis of a powerful computer controlled waveform acquisition system. In this case, the position of the B gate pulse is set by a control voltage from the computer. As the waveform samples are digitized by the computer, the control voltage is increased and the sampling position is scanned across the waveform. Although this is a slow data acquisition system, the accuracy of digitization is highly desirable.

Variable output regulator

A small modification to the normal three terminal regulator circuit will provide a number of output voltages and retain the short-circuit protection of the regulator. Most designs have been published which increase the output voltage by returning the common terminal to a positive pedestal but, if the common terminal is returned to a negative pedestal, the output is reduced by the voltage of the pedestal. This circuit uses Zener diodes to provide switched outputs below 15V, however, the diodes could be replaced by an adjustable low power regulator. An IN4002 protects the regulator from reverse voltage if the output is shorted. Dual supplies can be provided by adding the op-amp and transistor shown, but the negative rail is not protected.

J. McDonald
Pembridge Hants.

Procedures for the step-by-step design and implementation of interfaces in interrupt-driven microprocessor-based systems are described in this article. The authors show that the interface hardware is the same for both vectored and non-vectored interrupts. Procedures that are almost independent of the microprocessor chip used. Fully worked-out examples, using the Intel 8089 and the Motorola 6800 chips are used to demonstrate these statements.

As explained in the first article on this subject (June issue), interrupt-driven circuits are used when sensitivity to the environment is needed. This would be the case with equipment and/or processes which, when they malfunction, require fast corrective action to avoid catastrophes that may result in damaging equipment, shutting down systems and so on.

The concepts we used to develop such systems are straightforward, involving basically the equipment or the process signaling the microprocessor when it wishes to communicate with it, and waiting for the microprocessor to respond. This resulted in the development of an uncomplicated interrupt configuration, whose block diagram is given in Fig. 7 in the June article. For ease of reference this diagram is reproduced here as Fig. 1.

Similarly, the function of the interrupt controller in Fig. 1 is to generate the interrupt request signal, IRQ, when one or more flags are present, and to provide the microprocessor, when it responds to the interrupt request, with some meaningful information which allows it to vector to the appropriate service routine. The meaningful information is denoted variable 1. The design and implementation of interrupt controllers and a review of support chips implementing their function will be considered in a later article.

Interface hardware

Although at first sight the design and implementation of the interface hardware might appear complex (particularly when the unintended, in practice it turns out to be a straightforward process, as we shall demonstrate next. Our starting point is Fig. 1, which clearly indicates that the interrupt hardware is a logic circuit whose function is to monitor the status signals of the peripheral (which may be either equipment or a process) and generate flag #i when the status signals indicate to the peripheral wishes to communicate with the microprocessor. The interface then simply waits for the microprocessor to respond electronically.

The use of this flag implies that all interrupts are non vectored. However, because the microprocessor responds to specific set of signals, whose output do not vary greatly from microprocessor to microprocessor, the interface hardware is almost identical for all types of microprocessors.

Interrupt interfaces, in common with all other interfaces, are designed and implemented using well-established procedures that always work. We shall demonstrate the simplicity of the design procedures and the fact that complexity is not a necessary condition of the implementation, by means of a design problem, after we describe the nature of the interrupt software.

Interrupt software

As in the case of the interface hardware, the interrupt software is relatively uncomplicated and should present no difficulty to the reader who possesses some knowledge of programming. In the author's experience, the primary cause of misoperation in practice is lack of proper initialization procedures, which results in unwanted signal spikes (glitches) that are generated on interrupt lines during hardware and/or software initialization of interrupt interfaces.
We mentioned earlier that during a program interruption, the re-entry point, consisting of
1. The return address;
2. The condition flags, and;
3. The working registers; must be preserved during program interrup tion. In practice this information is stored in stack, which is a block of consecutive locations in r.a.m. that can be accessed from one end on a last-in-first-out (lifo) basis. A stack is established in r.a.m. by loading a base address into the stack pointer. Every time a new item is put on stack the stack pointer is 'advanced' (incremented) and everytime an item is removed the stack pointer is 'reduced' (incremented). This means that the base address points to the highest location in stack.

Push, pop and return instructions, explained earlier, refer to explicit operations in which information is transferred between the microprocessor chip and locations in stack specified by the stack pointer.

In summary, for the purpose of writing the interface software the only system feature that one has to know, is the vectoring address associated with each of the interrupt flags one is generating.

We shall now give an example to demonstrate the steps used to design and implement interrupt-driven microprocessor systems.

Design example — an event counter
Pulses representing events arrive randomly on line q in Fig. 5. Our program is to design an interrupt-driven system that would allow a print-out of the event-count to be produced each time switch m is activated. Activation of the switch, which can be assumed to be infrequent, resets the count.

We will implement the design using an action/status printer, and either the Intel 8080 or the Motorola 6800.

Solution
Step 1: aim of the design. To demonstrate the steps used in designing and implementing interrupt interfaces.

Step 2: resources. A microprocessor-based system and an action/status character printer.

Step 3: our solution. Our solution consists of evoking a COUNT routine when an event is detected, and a PRINT routine each time switch m is activated, as shown in Fig. 4. The COUNT routine will be given a higher priority than the PRINT routine should signals q and m be both present before the program is interrupted. The block diagram of our solution is shown in Fig. 5.

8080 implementation
Step 4: hardware design. Reference to Fig. 5 shows that the basic functions of the interface hardware is to generate interrupt flag f5 when switch m is activated and signal f7 when a pulse is received on terminal q, and allow them to be cleared under program control. The most straightforward method of implementing these two functions is to use two JK flip-flops, as shown in Fig. 6.
Which way h.f. broadcast receivers

continued from page 67

The prescaler and prom devices used in the second system approach were quite expensive at present. A direct entry waveform calculation method could be used to replace the prescaler, but the cost reduction would be balanced out by adding a different crystal frequency due to the fact that simple arithmetic relation exists among the channel traverse broadcast channels. An alternative approach is, however, to ask whether a rearranged frequency allocation plan could end up with a cheaper system design. Fig. 2 shows the system functional block diagram. The suggested frequency allocation allows for the data to be listed in Table 3. The amount of spectrum allocated is the same; but the band edge standardization of frequencies are different from the current and proposed WARC frequencies.

TABLE 3. Suggested proposal

<table>
<thead>
<tr>
<th>MHz</th>
<th>(c/n)</th>
<th>offset (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.900</td>
<td>3.900</td>
<td>4.900</td>
</tr>
<tr>
<td>4.900</td>
<td>4.900</td>
<td>5.900</td>
</tr>
<tr>
<td>5.900</td>
<td>5.900</td>
<td>6.900</td>
</tr>
<tr>
<td>6.900</td>
<td>6.900</td>
<td>7.900</td>
</tr>
</tbody>
</table>

The final function of the interface is to activate the printer. We can either use a separate OUT instruction for this purpose or simply connect an output gate to the action terminal of the printer. This causes execution of OUT 63 both to clear the printer, and to activate the interface. This, in addition to saving an extra gate, also avoids using an extra OUT instruction. A separate OUT 63 software design and PRINT routines are shown in Table 1.

6800 implementation

Step 4: hardware design. We use the same procedures to derive the interface hardware of the Motorola 6800. The read-out attention is directed to the fact that the two interfaces are almost identical.

Step 5: software design. The PRINT and OUTPUT instruction is not required.

Well-defined steps for the design and the implementation of this interface have been demonstrated. Specifically, it has been shown that the interface hardware is the same for both vector and non-vector interrupts and that it is almost independent of the microprocessor core.

References


The next article in the series will deal with interrupt controllers.

Correction note

Data store by reading average, May 1981, contained three incorrect hex bytes in the machine code as indicated. The correct values are underlined. We apologise for these errors.

Address

OE4E B5 28
OE6D B0 10
OE6G B0 26

Electrical and mechanical units are they the same

by D. A. Bell, F.Inst.P., F.I.E.E.

In order to obtain a quantity which describes the magnetic field on the surrounding medium, (3a) is transposed into the form

$$e_\phi = e + i d$$

The new quantity $D$ was originally called the flux density. It is a useful property that the integral of $D$ over any closed surface is equal to the charge enclosed (Gauss's theorem in relativistic units); this is obvious in (3b) if the charge is imagined to be surrounded by a sphere of radius $r$ and therefore surface $\pi r^2$. $D$ is measured in coulombs per square metre in SI units. Notice that $e_\phi$ as well as $e$ and $D$ have been transferred to the left-hand side of (3b), and $e_\phi$ which we originally introduced as a transient serving to give the right size of unit, is commonly called "the permeability of free space", which is when the controversy begins. Some physicists argue that permeability is a property of matter, and therefore free space cannot have a permeativity. Accordingly, they claim that the e.g.s. of systems is inherently equal to putting $e_\phi = 1$. This cause in free space must then be the same as putting $e_\phi = 1$. However, this is not so. The argument that $D$ is a causal property of charge, which can be observed directly, cannot be modified by the interposition of a material medium having the property described by the constant $e_\phi$ and that is necessarily a pure number but is the constant factor relating $e$ to cause. The field $F$ is therefore independent of $E$, though in practice it may be difficult to obtain a field which is the one and which is the other. It is now clear that magnetic phenomena are essentially of two types and can usually be classified with directions as well as magnitude; and the directions therefore have to be specified. Most of them, however, can be obtained from the analogous

$$I = e_\phi + e + d$$

Perhaps one should qualify this as "old-fashioned engineering", since there is now talk of "software engineering".
The equation for B has been altered as analogous to the one for E, a consequence of replacing \( v / a \) by \( v \). But it seemed a plausibility conjecture that the electrostatic effect might involve all four components. It is possible that there is an electrical phenomenon which appears equally in \( v / a \) and \( v \) and therefore cancels out in the product. It is equally plausible, however, the electrical phenomena must involve both \( v / a \). The detail of the task is that the difference between the M’s and SI systems in this postulate that \( a / v \) is the electrical ‘dimension’, in contrast to both the c.g.s. and MksA systems, through the MksA system (A for \( v \)) has half way there. Both fundamentally, \( a / v \) and \( a / v \) have the same dimensions which is contrary to the c.g.s. assumption that \( a / v \) and \( a / v \) are different in space. I wonder how long the matter will be allowed to rest there.

Literature received

Burr East, Industrial Estate, Adnall, Midhills TWIS 1AX.

Catalogue of components and instruments is available from HRS Company, Ltd., Redhouse Passage, Bury St Edmunds, Bury St Edmunds.

Short catalogue describing a range of motion film equipment and a range 100mph to 25mph can be obtained from Ahlbrandt electronics Ltd., 28 Somerset Road, Carshalton.

Leaflet at the 3M Videodisc communication system installation in Building 4K.

This is nothing to do with a video disc system, but it is connected with the use of a monochrome television instead of multiple types of video vision and data transmission, without a build-up of static, which allows the collection of any equipment relatively cheaply. Copies from Mike Green, The Interactive Systems Group, 3M (UK) Ltd., London, House P.O Box 1 Bracknell, Berkshire RG12 1IL.

References


Sound synthesis using Walsh functions

continued from page 64

L.C.R bridge

Coordination of capacitance, inductance, resistance and Q are the L.C.R Databook 400's three mutually essential function ranges. On the LC range the bridge bridges between inductors and capacitors and gives the value and the appropriate range of inductables or capacitables, which have irreversible auto-ranging through right diagonals. Measurement of the frequency of 100kHz and 18kHz are selected. The relative autocalibration of the bridge is given when the component under test can be measured more accurately using the frequency not selected. A similar indication is given in the series and parallel measurement modes when the best mode for a given component is selected. Range limits are limited to 100kHz, 0.1 milliamp, 0.1 milliamp and 0.1 to 999Q for Q measurements, all with a basic accuracy of 0.25%, ± 1 digit. Six push-buttons are the only controls and the readings, obtained within the second of insertion of the component, is given on a 4-digit LED display. The unit of measurement is indicated by one of nine i.e., a, b, r in the case of L range when all range i.e., d are extinguished. Input protection, automatic polarizing voltage for electrolytics and a socket for external probes are also provided. Internally, a 320 microprocessor carries out the control functions. An option is available with digital outputs for use with limits comparators, and the standard version costs £450. AMD Cambridge Ltd, Burro Rd, Indest, Est. St Ives, Huntingdon, Cambridges PE17 1LF.

A.m./f.m. signal generator

A full programmable microprocessor-controlled signal generator covering the range of 0.5 to 1024MHz has been introduced to the market by Marcon Instruments Ltd. The manufacturers claim that this feature is prime from non-harmful spurious additions from 0 to 1024MHz, ± 1dB level accuracy, 40kHz output across the complete frequency range and a bandwidth noise figure better than –16dB at 4kHz offset in the range 2kHz to 5kHz. The slow-sweep facility produces an approximate swell in between any two frequencies on one of nine carrier ranges so that spurious responses within a receiver can easily be found. The carrier frequency can be stepped up or down in steps of any size and the step size is indicated by one of nine digits giving a total of a, b, c, d e digits. The carrier frequency can be set to within 0.1% using a, b, c, d, e digits. This feature is prime for any application of a.f.m. signals and is particularly suitable for RF and Intermediate frequency and test signals.

Video editing interface

Trigger Happy is designed to help organisations who have a U-matic edit pak of video recorders be able to want to use material shot on low- and intermediate orbit format. Built to a Factory specification, it 'bridged the gap between consumer and U-matic formats', allowing film to move between U-matic decks (VHS, Beta, Sony 3600, National 3610) direct into a U-matic edit deck and the normal edit controller.

Trigger Happy obeyed the task for a transfer first on U-matic with a revised loss of quality, of course. It contains two counter displays, one which counts control player functions of the tape to a meter and a separate number to the time the control editor is being used. A start causes the U-matic edit deck to roll down to the edit point at precisely the right time.

According to its designer, Richard Moonhouse of Controltron, Trigger Happy is easy to use and data and kits are provided (tape feed deck and a field controller). The editors are being needed except for editing socks. Price is £440 from sale distributors Factory Video Ltd and is registered charity company with 42 Thoroughs Road, London WC1N 8BN.

High-temperature thermistors

The range of thermistors available from Electromed has been expanded by the inclusion of the Mid- range series for temperatures from 200 to 600°C. These resistors are used as temperature sensing elements in temperature controllers, soldering and photo-coupler fuses. Manufacturers are The Electrical Research and Engineering Co, Queens Rd, Maidstone, Kent ME14 2BG.

WW305

WW304
World Edition W July 1981

WIRELESS WORLD JULY 1981

Microcontroller
Both a microcomputer for business and personal use and applications software are available from LSI Computers Ltd. The standard system consists of a computer, manufactured in Great Britain, based on the 8085 Microprocessor with 64K, 128K or 256K memory, disc drives and keyboard, with 109 keys, four of which are programmable. Versions with the 8085/1s/4K disc pack are replaced with the 8085/2s/128K disc packs and Centronics matrix printers for use with the system can also be supplied. A CP/M operating system is included as standard. The basic system costs under £300, excluding VAT. LSI Computers Ltd, Cape Rd, St Johns, Woking, Surrey GU21 1UX.

IEEE data bus connectors
Up to fifteen programmable measurement instruments or instrumentation devices can be interconnected using the Amphenol's terminated cable assemblies to IEEE 488 interface standards. Each assembly comprises a 24-core screened cable and two rack and panel type connectors, i.e., connectors which can be mounted in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and socket', which can be mounted upon each other in a 'plug and sock
INSIST ON
VERSEATOWER

BY PROFESSIONALS—FOR PROFESSIONALS

The VERSATOWER range of telescopic and tilt-over towers cover a range of 25ft to 120ft (7.5M to 36M).

Designed for Wind Speeds from 85mph to 117mph conforming with CP3 Chapter V, part 11.

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

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

VERSATOWER
THE PROFESSIONALS' CHOICE

PORTLAND HOUSE, COPPICE SIDE BROWNHILLS, WREXHAM LL11 4TV TEL: (04943) 6211 TELEX: 332455 SEL
WW-067 FOR FURTHER DETAILS

FOTOLAK

POSITIVE LIGHT SENSITIVE AEROSOL, LACQUER

Enable YISI to produce perfect printed circuits in monochrome. Baking time should be adjusted to suit. A full range of required colours on new sensitised surface. Exposure to daylight, develop and print. Any number of exact copies can of course be made from one master. Widely used in industry for prototype work.

FOTOLAK
Deko-300
Table Dance 300

Pam Copperplate Fibreglass

Pre-coated 300 FIBRES-GRADE BOARD

Aluminium 2.1mm thick, 2500mm x 1200mm

Approx. cleaning: 2 1/2mm thick, 2500mm x 1200mm

App. 1650mm x 1200mm

Oak Acrylic Sheet for making master: 2000mm x 2000mm

HAMBURG

Áusserer Ailingер Straßе 14
11 Mäntwiel 5

10 OUT OF 10.—IT’S ELEKTRIK!

- Whose amplifiers sound audibly superior?
- Who supplies the BBC, IRA, top loudspeaker manufacturers international recording studios etc?
- Which power amplifier modules feature high speed, electronic protection, virtually zero TM, negligible THD, 110dB S/N ratio, and a range of power outputs from 60-300 WRM?
- Which amplifiers are guaranteed unconditionally stable thermally, electrically and mechanically?
- Whose reputation for back up, service and friendly advice is second to none?
- Who makes amplifiers OEM capable of driving motors, magnets, vibrators etc?
- Who offers a complete hi-fi kit amplifier at half the cost of any comparable ones?
- Who also specialises in active amplification?
- Who offers a complementary range of ancillary equipment such as heat sinks, bridge drivers and toroidal power supplies etc?
- Who is the leading name in innovative and proven amplification?

ARASHI ELEKTRIK

If you would like further details on our complete range send a 7" x 10" box and 50p cheque or PO for our comprehensive users/application manual to:

ARASHI ELEKTRIK, 59, CLAYMILL ROAD, LEICESTER LE6 7JU Telephone D353-761920 Telefax 34694 CRIMLEK

SALE BY AUCTION

Due to a shift in concentration and production, the machines, assembly lines and also the entire plant and business equipment of a works are available. On behalf of the management of the firms GTE/Sylvania and Schwerswalder Electronik Werk I am selling by auction the plant of the firm.

SABA—WERK III

Aussere Ailinger Strasse 14
7905 Friedrichshafen, West Germany

Tuesday, 7th July, 1981, 10 a.m.
Wednesday, 8th July, 1981, 9.30 a.m.

For a catalogue.
Flow soldering plant with immersion bath, armament lines, casing corning conveyor, spray paint stations, dry heating kiln, ultrasonic degreasing plant, assembly lines, modern electropainting equipment, control panel, spot welding presses, bending and cutting automatic machines, testing compartments, transformers, hydraulic and pneumatically, punching presses, ultrasonic spot welding machines, rotary heel kiln, upset proofing plant, from degreasing plant, rover, Wolfram welding equipment, continuous heating kiln, hydrogen and argon eight and ten head lock and seal machines for 90° and 110° colour tubes as well as shelves, canning equipment, machine tools, fork lift truck and over 1,000 items measuring and testing equipment for many more items.

Viewing: Monday, 6th July, 1981, from 10.00 to 17.00 hours; Tuesday, 7th July, 1981, from 8.00 to 9.45 hours; Wednesday, 8th July, 1981, from 8.00 to 9.15 hours. Preview can be arranged by telephone call. Catalogue with over 3,000 items on request.

www.americanaohistory.com
The range grows...bigger...better...

New Profile Amplifiers - Two New Series

MOSFET

CHOOSE AN I.L.P. MOSFET POWER AMP WHEN IT'S DIRECT-OUTPUT TECHNOLOGY CAN SELL YOUR NEW TOTAL SYSTEM AT FASTER THAN ANYTHING ELSE! THIS NEW MOSFET POWER AMP IS DESIGNED TO PERFORM THE MOST DEMANDING OF ALL THE TYPICAL AMPLIFIER USES AND TO PROVIDE SUPERBURSTING POWER AT AN EXCELLENT PRICE.

<table>
<thead>
<tr>
<th>Model</th>
<th>Output Power</th>
<th>Distortion Total @ 1kHz</th>
<th>Dynamic Range</th>
<th>Signal/Noise Ratio</th>
<th>Price &amp; VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY120</td>
<td>500W</td>
<td>0.006%</td>
<td>90dB</td>
<td>95dB</td>
<td>£168.84</td>
</tr>
<tr>
<td>HY60</td>
<td>100W</td>
<td>0.008%</td>
<td>87dB</td>
<td>90dB</td>
<td>£33.46</td>
</tr>
</tbody>
</table>

(Bipolar)

CHOOSE AN I.L.P. BIPOLAR POWER AMP WHEN IT'S DIRECT-OUTPUT TECHNOLOGY CAN SELL YOUR NEW TOTAL SYSTEM AT FASTER THAN ANYTHING ELSE! THIS BIPOLAR POWER AMP IS DESIGNED TO PERFORM THE MOST DEMANDING OF ALL THE TYPICAL AMPLIFIER USES AND TO PROVIDE SUPERBURSTING POWER AT AN EXCELLENT PRICE.

<table>
<thead>
<tr>
<th>Model</th>
<th>Output Power</th>
<th>Distortion Total @ 1kHz</th>
<th>Dynamic Range</th>
<th>Signal/Noise Ratio</th>
<th>Price &amp; VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY66</td>
<td>15W</td>
<td>0.01%</td>
<td>90dB</td>
<td>95dB</td>
<td>£12.19</td>
</tr>
</tbody>
</table>

NEW PRE-AMPS

HY6 (mono) and HY60 (stereo) are new to I.L.P.'s range of advanced audio modules. These improved transformers and styling ensure that they are compatible with all I.L.P. power amp, both MOSFET and BIPOLAR, giving you the chance to get the best possible reproduction from your equipment. HY6 and HY60 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Module mounting boards are available as below:

- HY6 - 40 x 10 x 40 mm
- HY60 - 40 x 20 x 40 mm

We want to know

We have always maintained good working relations with our customers, and therefore (and for the sake of the company's success and growth) now that we are running our most exciting program yet, we would like to have your comments. If you feel that we can improve our service, please let us know, but we do not want to hear about our competitors. When sending your order (with your user name, etc.) you will be sent a C.O.D. payment envelope, please add 11% TOTAL VAT to the total price.

The new pre-amp modules

- HY6 - £12.19
- HY60 - £21.46

New Power Supply Units

Of the range of power supply units which make up our current range, none more uniformly mechanical in performance than the New I.L.P. Power supply units. Each unit is housed in a moulded case, and the supply units are protected against short circuit and wrong polarity. The New I.L.P. power supply unit is designed to provide a high output of power for the amplifier, and the supply units are protected against short circuit and wrong polarity. The New I.L.P. power supply unit is designed to provide a high output of power for the amplifier, and the supply units are protected against short circuit and wrong polarity.

- HY66 Mounting Board for one HY66 - £12.19
- HY6 Mounting Board for one HY6 - £21.46

No Quibble 5 Year Guarantee

7 Day Dispatch on All Orders

British Design and Manufacture

Free Post Service

* See also our ad. on page 101
THE COMPLETE SOLUTION TO STRAIN GAUGE AMPLIFICATION

- COMPLETE WITH BRIDGE SUPPLY
- COMPLETE WITH ALL ADJUSTMENTS (SPAN ZERO BRAKE VOLTAGE)
- COMPLETE (NO EXTERNAL COMPONENTS NEEDED)

The series SGA 700 provides the complete solution to Strain Gauge Amplification. Simply connect the bridge, connect the power supplies and the SGA 700 does the rest. It also offers high stability. Minimize size, good input rejection — in fact a specification as good as many instruments many times the price and size.

CIL Electronics Ltd
16 Bybrook Road,
Wotton-under-Edge,
Glos.
Tel: 01453 881188
Telex: 885950 CIL E

TELETYPE ASR33 1/0 TERMINALS
ICL TERMINPNT 300 BAUD TERMINALS
SCOOP PURCHASE 12" VIDEO MONITORS

EQUIPMENT CASES

GIVE ME YOUR M.P.U. A HOME WITHIN A DAY

YOU CAN HAVE IT FOR £25 + VAT

THE PRINTER SCOOP OF THE YEAR
THE LOGARAX 180L MATRIX PRINTER

A new line of full page matrix printers - the best of its kind. A complete range of printers with space savings up to 80% from traditional printers, and a wide choice of character sizes and font styles. The Logarax 180L is the perfect choice for medium to large office use.

SEASIDE CUFFS

EASILY FITTED - 60p

MAJOR HARD DISK DRIVES

HURRY WHILE STOCKS LAST

STEPS TO THE 80's WITH TOMORROW'S WORLD TECHNOLOGY TODAY
THE TAYLOR PRECISION-VIEWDATA ADAPTOR

Only £94.99 + VAT

D C Comics Coil World

OFFERED TUESDAY - SUNDAY

ASAID CODED KEYBOARDS

ONLY £15.99

TV TUBE REBUILDING

Faircrest Engineering Ltd manufactures a comprehensive range of equipment for Servicing all types of television, colour and mono. Standard or custom built units for establishments or home service men. We offer a wide range of replacement parts and an excellent service backed by a strong technical team.

Full training courses are individually tailored to customers requirements.

For full details of our service contact Neil Jupp.

FAIRCREST ENGINEERING LTD.
Willis Road, Crendon. I.CRO2XX.
01628 1422/01684 0244

WIRELESS WORLD JULY 1981
New KONTAKT Sprays
for the Electronics & Electrical Industries

KALITRON 601
A new cleaner for Magnetic Recording Units. Kalitron 601.
has an extremely fine surface action enabling the
cleaning of magnetic sound heads leaving no deposit or
other trace.
It is chemically pure (99.8%) - non-conductive -
non-deforming.
Its use is also recommended for cleaned electronic equipment
and electronic equipment; e.g., videotapes, tape recorders,
data processing systems etc.

Also NEW

PRINT 66
Spray cleaner for type wheel printers, matrix printers and chain printers. Can
also be used for cleaning normal typewriters.

SCREEN 99
Specialised for the cleaning of all types of screen, including data terminals and
T.V. Screens.

VASELINE SPRAY 701
For use in communications engineering and construction of antennas.
Provided as a non-corrosive inhibitor for cable clamps, connecting screw
nuts etc. Application from spray can will carry out the job in clean and simple.
Distibuted by

Special Products Distributors Ltd.
81 Pond Street, London, W.1 UK
Tel: 01-626 9556. Cables: Speccord, Lon'ton, W.1
Telex: 255290 jennewenlack RACEn.

DIGI-TEL ELECTRONICS
20 Trenches Road
Crawley, Sussex
Tel: Crawley 5068

---

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

AUDI'O FREQUENCY
TRANSFORMERS OF EVERY TYPE

YOU NAME IT! WE MAKE IT!

OUR RANGE INCLUDES:

Microphone transformers (all types), Microphone
Splitter/Combiner transformers, Input and Output
transformers, Direct Injection transformers for Con-
verters, Multi-Secondary output transformers, Bridge
transformers, Line transformers, Line transformers to•
GP.O. Auditing Test Specification, Tapped impedance
matching transformers, Gramophone Pickup trans-
formers, Aetin, Mixing Desk transformers (all types),
Miniature transformers, Micro Miniature transformers
for PCB mounting, Experimental transformers, Ultra-
low frequency transformers, Ultra linear and other
transformers for Transistor and Valve Amplifiers up to
500 watts, inductive Loop Transformers. Smoothing
Chokes. Filter, Inductors, Amplifier to 100 volt line
transformers (from a few watts up to 1,000 watts) 100
volt line transformers to speakers, Speaker matching
transformers (all powers), Column Loudspeaker trans-
formers up to 200 watts each.

We can design for RECORDING QUALITY, STUDY
QUALITY, HI FI QUALITY OR P.A. QUALITY.
Our PRICES ARE HIGHLY COMPETITIVE and WE SUPPLY
LARGE OR SMALL QUANTITIES AND EVEN SINGLE
TRANSFORMERS.

Many standard types are in stock and normal deliveries are made in short and
several weeks.

OUR CLIENTS COVER A LARGE NUMBER OF BROADCASTING
AUTHORITIES: MOVING DISK MANUFACT
MURERS, RECORDING STUDIOS, HI FI ENTHU
SIASTS, BAND GROUPS AND PUBLIC ADDRESS
FRMS. Expertise is a specialty and we have overseas
clients in the COMMONWEALTH ECC, USA, MIDDLE
EAST etc. Sowter Transformers which; when
completed, enables us to post quotations by return.

E. A. Sowter Ltd.
Manufacturers and Designers

The Boat Yard, Cullingham Road, Ipswich IP1 2EZ, Suffolk, P.O. Box 36, Ipswich IP1 2EL, England
Phone: 0473 52794 & 0473 115290
**FLYLYDE**

**TRANSUDER AND RECORDER AMPLIFIERS AND SYSTEMS**

Reliable high performance systems, individually adjusted for practical controls. Superbly covered modules, mains or dc option single cases and up to 17 modules in standard 19" chassis small size low weight—realistic prices.

**FLYLYDE**

Electronic Laboratories Limited.

49/51 Fyde Road Preston PR1 2QX

Telephone 0772 57560

**LOW COST, AUTOMATIC, MULTI-FUNCTION COUNTER**

MODEL 1900A

- Averaging peak hold switch, plus range selectivity, automatic zero adjustment and display range indication
- Frequency measurement, time measurement, electric and magnetic fields
- Optimum direct-current (true rms) measurement from 100 mV to 100 V
- Selection of built-in square-wave (100 kHz), triangular-wave (100 kHz) and white-noise (100 kHz) signals
- Optional internal memory with 10 memory channels
- Battery operation

Price £215

(1900A)

**Switch 3Vt**

**ROTARY STUD SWITCH**

A rotary stud switch system for use with a variety of stud diameters and stud mounting positions.

Price £35

**BERKSHIRE MAGNETIC CLUTCH**

A magnetic clutch for use in medical equipment, research laboratories and industrial applications.

Price £25

**Bench and portable digital multimeters**

- **MODEL D.**
  - Small size—low standard 19" crate individually sealed.
  - Small size—low standard 19" crated.
  - Small size—low standard 19" crate individually sealed.

**FLYLYDE**

Electronic Laboratories Limited.

49/51 Fyde Road Preston PR1 2QX

Telephone 0772 57560
BULK EPM RP PROGRAMME
FABRO PRODUCTION EPM RP PROGRAMME

This unit provides simple, reliable programming of up to 8 EPROMs simultaneously. It has been designed for ease of operation -- a single "program" key turns the program switch - very sequence.

Features
- High voltage instrumentation
- Programmable power supply
- Programmable output current limit
- Low bias current
- Test equipment

Price £50.00. VAT Post paid

BULK EPM RP ERASING

Send for full product listings of Alexander Micro-erase's exciting product range

Pascal Electronics Limited
Head Office: 29 High Street
Gillingham, Kent ME6 6TX
Telephone: 0761-242163
Telex: 864450

W W - 965 FOR FURTHER DETAILS

radio component specialists

3D WHITEHORSE ROAD, CROYDON

Large stock of components

Tel. 01 681 8300/8476

GP INDUSTRIAL ELECTRONICS LTD

Unit 6, Burs Road, Tondern Industrial Estate, Tondern, Devon
Telephone: Tondern (068) 800000, 843300 technical

DISTRIBUTORS REQUIRED - EXPORT ENQUIRIES WELCOME

W W - 399 FOR FURTHER DETAILS

USING POST RENDER MODEL

撰写的英文文本内容包含了一系列的广告和产品信息，涵盖各种电子产品和音响设备的详细规格与价格。例如，有一个名为“MODERN O V140 EPROM ERASER”的产品，它提供简单、可靠的程序写入，适用于最多8个EPROM芯片。另一个产品是“TWIN CONE speaker”，适用于10或11英寸的记录，配有刷镀铝制臂和立体声卡座。还有一款名为“Baker 150 Watt METER/POTENTIOMETER”的产品，主要用于汽车音响系统，其体积为118 x 73 x 3.1英寸，重达14磅8盎司。

除了这些产品信息，文本还包含了一些关于如何订购和获取详细信息的指示。例如，文本中提到可以用英国的邮批服务退货，也可以全球出口服务。此外，文本中还提到了一些特定的产品尺寸和重量。

总的来说，这份文档是一份详细的电子、音响设备产品目录，包含了各种产品的规格、价格和订购信息，适合电子爱好者和音响设备专业人士参考。
**PRINTED CIRCUITS**

FOR WIRELESS WORLD PROJECTS

£5.00
£4.25
Fm. tuner (advanced). April 1976. 1 s.d.
£5.00
Cassette recorder—May 1976 1 s.d.
£6.25
Audio company—July 1976. 1 s.d.
£6.25
Time clock class—Aug 1976. 1 s.d.
£8.50
Sat. align. b.i.t. switch—June 1977. 1 s.d.
£8.50
Audio preamplifier—November 1977. 1 s.d.
£4.00
Starkrider—April 1976. 1 s.d.
£4.00
Money keyboard and paddles—May 1976. 1 s.d.
£14.00
Rgta board (10'x, 5') keyboard and menu (12x, 15x).—May 1976.
£14.00
Low distortion audio oscillator—September 1977. 1 s.d.
£3.50
Synthetic flanger. January 1977. 2 s.d.
£4.25
Modulator. June 1978. 1 s.d.
£3.70
£2.00
Regulate for car Alignment—August 1978. 1 s.d.
£2.00
Wideband noise reducer—November 1977. 1 s.d.
£2.50
Variable noise generator—January 1979. 1 s.d.
£5.00
200MHz Frequency Synthesizer—January 1979. 1 s.d.
£5.00
High performance preamplifier—February 1979. 1 s.d.
£5.50
Disruption noise and oscillator. August 1978. 1 s.d.
£3.50
Modulator. August 1978. 1 s.d.
£2.10
Audio monitor. August 1978. 1 s.d.
£2.60
Audio monitor. August 1978. 1 s.d.
£2.60
Digital frequency meter—April 1980. 2 s.d.
£1.70
Colour graphics system—July 1980. 5 s.d.
£8.50
Audio spectrum analyser. May 1980—2 s.d.
£10.50
Measuring instrument—March 1981. 1 s.d.
£0.90
Flaring bridge power amp. Oct. 1980. 1 s.d. (12V or 40V)
£4.00
£3.50
£8.00
Modular Frequency meter. March 1981. 1 s.d.
£2.00
ctx electronic panel breaker. Dec 1981. 2 s.d.
£4.00

**Send/Phone for extensive special offer**

**LISTS**

74LS4, 8000, 8200, 8600

**LOW COST DELIVERY**

49 BARTHOLOMEW, NEWURY, BERKS. TEL: 01-666 3760. PLEASE ADD VAT, P & P. 6%. BARCLAYCARD, ACCESS & OFFICIAL ORDERS WELCOME.

**SUPERIOR QUALITY PRECISION MACHINERY**

NEW POWER RHEOSTATS

40 WATT, 100 WATT, 220 WATT & 320 WATT

**PRINTED CIRCUITS**

FOR WIRELESS WORLD PROJECTS

£5.00
£4.25
Fm. tuner (advanced). April 1976. 1 s.d.
£5.00
Cassette recorder—May 1976 1 s.d.
£6.25
Audio company—July 1976. 1 s.d.
£6.25
Time clock class—Aug 1976. 1 s.d.
£8.50
Sat. align. b.i.t. switch—June 1977. 1 s.d.
£8.50
Audio preamplifier—November 1977. 1 s.d.
£4.00
Starkrider—April 1976. 1 s.d.
£4.00
Money keyboard and paddles—May 1976. 1 s.d.
£14.00
Rgta board (10'x, 5') keyboard and menu (12x, 15x).—May 1976.
£14.00
Low distortion audio oscillator—September 1977. 1 s.d.
£3.50
Synthetic flanger. January 1977. 2 s.d.
£4.25
Modulator. June 1978. 1 s.d.
£3.70
Modulator detector. July 1978. 1 s.d.
£2.00
Regulate for car Alignment—August 1978. 1 s.d.
£2.00
Wideband noise reducer—November 1977. 1 s.d.
£2.50
Variable noise generator—January 1979. 1 s.d.
£5.00
200MHz Frequency Synthesizer—January 1979. 1 s.d.
£5.00
High performance preamplifier—February 1979. 1 s.d.
£5.50
Disruption noise and oscillator. August 1978. 1 s.d.
£3.50
Modulator. August 1978. 1 s.d.
£2.10
Audio monitor. August 1978. 1 s.d.
£2.60
Audio monitor. August 1978. 1 s.d.
£2.60
Digital frequency meter—April 1980. 2 s.d.
£1.70
Colour graphics system—July 1980. 5 s.d.
£8.50
Audio spectrum analyser. May 1980—2 s.d.
£10.50
Measuring instrument—March 1981. 1 s.d.
£0.90
Flaring bridge power amp. Oct. 1980. 1 s.d. (12V or 40V)
£4.00
£3.50
£8.00
Modular Frequency meter. March 1981. 1 s.d.
£2.00
ctx electronic panel breaker. Dec 1981. 2 s.d.
£4.00

**Send/Phone for extensive special offer**

**LISTS**

74LS4, 8000, 8200, 8600

**LOW COST DELIVERY**

49 BARTHOLOMEW, NEWURY, BERKS. TEL: 01-666 3760. PLEASE ADD VAT, P & P. 6%. BARCLAYCARD, ACCESS & OFFICIAL ORDERS WELCOME.

**SUPERIOR QUALITY PRECISION MACHINERY**

NEW POWER RHEOSTATS

40 WATT, 100 WATT, 220 WATT & 320 WATT

www.americanhistory.com
Children know more about computers than their parents. True or False?

Well, true enough for Practical Computing to propose a twinning scheme for schools and businesses, bringing pupil brainpower to bear on business problems. Read all about it in the July issue.

Also in this issue of Practical Computing:
Reviews of Explorer 85, a modular system which can be built up from a single board to a full disc configuration. And Gemini — a large capacity business system.
Prolet — a package of subroutines to ease data entry on the Pet.

All this plus the usual Apple, Tandy, Pet and Z800 advice pages in the July issue of Practical Computing. Price 80p. At your newsagent or complete the coupon.

To Marketing Department, IPC Electrical/ Electronic Press, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Please send me Practical Computing for one year. I enclose cheque/F.D.O. for £10 (U.K.)/£16 (overseas) made payable to IPC Business Press Ltd.

Name
Address
years of research... "on components and accessories for dictating machines, tele-communications, hearing aids and electroacoustic equipment etc."

Please add 50 pence for carriage. All prices EXCLUDE VAT. Please send s.a.e. for price list.

STRUTT LTD.
ELECTRONIC COMPONENT DISTRIBUTORS
3c BARLEY MARKET STREET, TAVISTOCK
DEVON, ENGLAND PL19 0JF
Tel. Tavistock (0822) 5439/5548. Telex: 45263

Switch to Amplivox and receive the best

The advanced design of the 410 Headset has placed the product far ahead in the world of radio communications. Its light weight, low ear pressure and trim design make the headset ideal wherever long periods of continuous use are required. A pliable, sliding headband reduces head pressure to an absolute minimum and as the earpads are constructed of non-hardening, tear-resistant material they give an excellent low pressure and as well as providing optimum comfort whilst in use. The headband is constructed of nylon covered stainless steel spring wire and will prevent any form of wire straining and also carries the receiver signal. Twist wiring has been incorporated to give extended electrical life under high vibration movements.

Model 410
Specifications
- Receive IMP 400 OHMS
- Microphone Imp 200 OHMS
- Max Sensitivity at 8200uV

Please send one sample of the Amplivox 410 Headset.
Anglia is a franchised distributor with a wide product range. Our catalogue is available to all professional users.

If your need falls between 10MHz and 30MHz then we can measure up to it, including narrow operated models. Every scope in the range is designed to meet our basic design philosophy of building in extra benefit. The 3337 is a complete 30MHz instrument with signal delay, plus a 10KV CRT for a bright display normally reserved for much wider bandwidth scopes.

**MEASURE UP TO YOUR NEEDS WITH CROTECH**

**TYPE 3337**

DC-30MHz Bandwidth

11.7ns Rise time

50V/div sensitivity

100mA/div 0.2s/div timebase

Triggers to 50MHz

Full X-Y operation

Composed trigger mode

C.R.T. 10KV PDA £355*

For your copy of the Crotech catalogue just telephone Reading (0734) 869694

---

**OVERSEAS SUBSCRIPTION AGENENTS**

Australia: Gordon &

Smith Distribution Agency,

3840 Lidcombe Road,

Melbourne 3050, Victoria

Belgium: Universal-

Intercontinental B.A.C.,

1046 Bruxelles, Brussels

Canada: Data Circulation

Agency, 123-2nd Ave.

Montreal North, Toronto 185

D.R.I.

Cyprus: General Press

Agency Ltd, 20 P.O.

Box 608, Nicosia

Denmark: Danish

Advertising Agency,

P.O. Box 4028, Copenhagen

Egypt: British

Agency 26, Al—Kasr El—Aini,

11039, Cairo

Finland: Reklaamilait

Liitto Oy, Ainola 12,

02150 Espoo

France: Dernon—France

S.A., 8 A. F. 51211,

Paris 11

Germany: W. E. Speck

Zollern, 65420, Ludwigshafen

Greece: Hellinik

Archon, P.O. Box 915, 10681,

Athens

Greenland: Greenland

Agency, P.O. Box 2, Nuuk

Italy: O. S. A.

Nuova Contras, 19,

Amatrice 139

India: International Book

House, 135—Farokh Daruvala,

Mumbai 400032

Canada: Slady, 1291

Cote Road, Berwick

Iran: A.D.A., 151 Karshen

Street, Tehran

Israel: Crotech Agency Ltd &

P.O. Box 928, Tel-Aviv

Italy: Interpressim

Via C. Beltrissi 6,

16049 Genova

Japan: Crotech Co., Ltd,

15, New Endo 3-Chome,

Tokyo 110

Kenya: National Distributors

Agency, P.O. Box 11028,

Nairobi

Kenya: Crotech Agency Ltd,

P.O. Box 11028, Nairobi

Malaysia: Times,

28 Nagore Rd, Penang.

Mali: A. O. K.,

55, Boulevard, 23002,

Dakar

Morocco: Crotech Agency Ltd,

24, Avenue de la Plage,

Casablanca

Netherlands: Intercontinental

Dutch Agency, 1024 AD,

Amsterdam

New Zealand: Intercontinental

Australian Agency, 1024 AD,

Auckland

Nigeria: Daily Times of

Nigeria, P.O. Box 132,

Lagos

Norway: A.O. Williams

Intercontinental B.A.C.,

Blommeveien 2, 0214,

Oslo

Portugal: Luiz 

Bertoucha, Rua da Apoio 37, Amadora

South Africa: Central

agency, P.O. Box 11902,

Johannesburg

Spain: Continental

Agency, C. A. S. A. 2,

1534 Barcelona 10

Sweden: Worlde

Svensk AB, W. G. 2375,

25 Stockholm

Switzerland: Intercontinental

Swiss Agency Ltd,

Cl Mat, Rue Lauber 6,

1213 Geneva 16

UK: Crotech Co. Ltd,

10/24 AD, London

U.S.A.: John Basil,

C. P. 981 Bolling Postoffice,

215 East 29th Street,

New York, N. Y. 10016

---

**Wireless World: Subscription Order Form**

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

**Subscription Manager**, 
IPC Business Press, 
Oakfield House, 
Perrymount Road, Haywards Heath, Sussex RH16 3DH, England
Enquiry Service for Professional Readers ONLY.

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

Name:

Position in Company:

Name of Company:

Address:

Telephone Number:

Nature of Company/Business:

No. of employees at this establishment:

VALID FOR SIX MONTHS ONLY

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

BUSINESS REPL. SERVICE
Licence No 12045

Wireless World
Reader Enquiry Service
429 Brighton Road
South Croydon
Surrey CR2 9PS

Please enter my subscription to Wireless World for 1 year

Made payable to

IPC BUSINESS PRESS Ltd.

Farnell International
Farnell International Instruments Ltd.,
Sandbeck Way, Wetherby
West Yorkshire LS22 4DH
Tel 0937 63541 Telex 557294 Farist G

Wireless World
Subscription Order Form

Wireless World, July 1981

UK subscription rates
1 year: £10.00
Overseas 1 year: £13.00

USA & Canada subscription rates
1 year: $33.80

Please enter my subscription to Wireless World for 1 year

I enclose remittance value

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

Valid for six months only

PUT A SMILE BACK ON YOUR OLD AVOMETER!

Send it now for estimate, repair or recalibration

Quick turn round on estimates/repairs

Large stocks of new AVOMETERS

AVO Sales and Service

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

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

At a price of £240.00 + VAT.

Ensures British leadership in the low cost high performance oscilloscope market.

Distributors required in certain countries

COPEX

Plumtree Avenue, Letchworth,
Herts SG6 1JL Tel: (04626) 72771

I wish to pay by Barclaycard/Trust Card. Please charge to my account

My Barclaycard/Trust Card No. is

Name:

Company:

Address:

Tel:

Please send me full details of the 14D10.

WIRELESS WORLD JULY 1981

14D-10

An Independent British Company

The New Scopex

10cm x 8cm display.

2mV sensitivity on both channels.

Add and invert facility.

Probe compensation.

Push button X-Y.

Trace locate.

10MHz (1–3dB) over full display.

Complete with probes.
When an accident involves severe electric shock, people on the spot may be suffering from a kind of shock themselves. The realisation that one has literally only seconds to save a life can itself be momentarily paralysing. That’s why Electrical Review has completely re-styled its Electrical Shock Chart. The new chart, prepared in consultation with St. John’s Ambulance Brigade, highlights the main points in red, and explains and illustrates the actions to be taken so clearly that you can be grasped instantaneously even in a crisis. It also includes vital instruction on what to do if the casualty does not respond to artificial respiration—with a section on external heart compression.

Action this second could save a life. Post this coupon NOW.

VIVID RED AND BLACK. PLASTIC CARD OR PAPER.
SIZE 19 in × 13 in (474mm × 346mm)

ELECTRIC SHOCK
ACT AT ONCE - DELAY IS FATAL

1. Take a deep breath and check the power switch is off.
2. Remove the plug and take off all metal items near the casualty. Look for possible hazards. Fix any faults, and ensure the power is off.

Make sure it is safe to approach.

If the casualty is not breathing, the first step is to make sure it is safe to approach.

The casualty is NOT breathing. Take deep breaths and look for a steady rise and fall in the chest, then feel for a pulse respiration-speed is essential.
When an accident occurs electric shock, people often suffer a kind of shock realization that one has the ∧ to save a life can itself be an Electric, that's why it re-styled its Electrical chart, prepared in a Ambulance Brigade.

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

Published again in November, this 1981 edition in larger magazine size means more comprehensive coverage of the whole range of home entertainment equipment, from aural to headphones, to microphones to video recorders and from radios to electronic organs. Backed by authoritative articles on developments in the world of Hi-Fi, plus details of stockists, Hi-Fi Yearbook and Home Entertainment 1981 is essential reading for enthusiasts and buffs.

ORDER FORM

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

Please send me: [Copy of the Hi-Fi Yearbook and Home Entertainment 1981 @ £3.50 including postage and packing. Cheque/postal order should be made payable to IPC Business Press Ltd.

Registered in England No: 677836.

Altron, Tavistock Wril - 01975 4349 · Tel: 46256

W W - 003 FOR FURTHER DETAILS.
**READ ALL ABOUT IT — all the latest on home entertainment equipment and ideas in...**

**HI FI YEARBOOK AND HOME ENTERTAINMENT 1981**

Published again in November, this new 1981 edition in larger magazine size means more comprehensive coverage of the whole range of home entertainment products, from aerials to headphones, from microphones to video recorders and from radios to electronic organs.

Backed by authoritative articles on developments in the world of Hi Fi, together with details of stockists, Hi Fi Yearbook and Home Entertainment 1981 is essential reading for enthusiasts and buffs.

Available from leading newspapers from 1st November 1980. Price £3.00.

If you do not have a copy of your direct order from the

**ORDER FORM**

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

Please send me copies of the *Hi Fi Yearbook and Home Entertainment* 1981 @ £3.50 including postage and packing. Cheque/postal order should be made payable to IPC Business Ltd.
Guide to Broadcasting Stations

18th Edition

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

£3.25 inc. postage.

Advertisements accepted up to 12 noon Monday, June 29, for August issue, subject to space being available.

ALWAYS AHEAD WITH THE BEST!
£5,000-£15,000
POP 11: NOVA; ECLIPSE: 280; 8800; 6800; BIT-SLICE: TTL; ECL: RADAR; SONAR; SATCOM; Phototypesetters; Wordprocessors; Flight Simulators; ATE: Electro-Medical: Teletext: Data-Comms; Automation: Microwave?

Where does your skill and interest lie?
- Design? Test? Service? Software? Consultancy or perhaps Research?
  - Our clients are drawn from all sectors of industry:
  - There are opportunities for Managers, Project Managers, Engineers and Technicians.
  - Most UK locations and some Overseas
  - Make your first call count - Contact MIKE GERNAT on 076 384 676/7 (usually until 8 p.m.)

ELECTRONIC COMPUTER AND MANAGEMENT APPOINTMENTS LIMITED
148-150 High St, Banbury, Oxfordshire, OX10 8EG

Electronic Engineers - What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £12000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you. All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL PERSONNEL SERVICES,
13 Mount Ephraim, Tunbridge Wells, Kent. TN4 8AS.

Please send me a TJB Appointments Registration form.

Name:

Address:

TJB ELECTROTECHNICAL PERSONNEL SERVICES,
13 Mount Ephraim, Tunbridge Wells, Kent. TN4 8AS.

Tel: 0892 39588
Techincians in Communications

GOHQ We are the Government Communications Headquarters, based at Cheltenham. Our interest is R&D in all types of modern radio communications - HF to satellite - and their security.

The Job All aspects of technician support to an unparalleled range of communications equipment, much of it at the forefront of current technology.

Location Sites at Cheltenham in the very attractive Cotswold area, the heartland of British communications research and development, opportunities for service abroad.

Pay Competitive rates, reviewed regularly. Relevant experience may count towards increased starting pay. Promotion prospects.

Training We encourage you to acquire new skills and experience.

Qualifications You should have a TEC Certificate or Telecommunications or acceptable equivalent, plus practical experience.

How to Apply For full details on this and information on our special scheme for those lacking practical experience, write now to

Robby Robinson, Recruitment Office
GOHQ, Oakley, Priors Road, Cheltenham
Glos. GL5 2AJ.
Telephone: 0242 21491
Ext 2208

Electronics

R&D

£7,999

Join us in the forefront of technology

Take your pick

HF-VHF-UHF

Microwave Optics & Acoustics
A challenging and full career in Government Service

Candidates, normally aged under 30, should have a good honours degree or equivalent in a relevant subject, but any candidates about to graduate may be considered.

Appointments as Higher Scientific Officer (£6,075-£7,999) or Scientific Officer (£4,905-£6,490) according to qualifications and experience. Promotion prospects.

Please apply for an application form to the Recruitment Officer (Dept I.E.1.), H M Government Communications Centre, Harolds Park, Milton Keynes MK19 7BH.
A p p o i n t m e n t s

**SALES SUPPORT ENGINEER - VISION MIXERS**

We need an electronics engineer with a background in TV studio engineering to work on the commissioning, acceptance, demonstration and after-sales activities of broadcast standard vision mixers. Direct experience of mixers, whilst not essential, would be a definite advantage. Ideally you should have worked on video switching systems and be familiar with the performance requirements of modern computer-based TV presentation and switching.

Considerable involvement with customers will be necessary and the position would require occasional travel within the U.K. Minimum age: 25.

Applicants should have at least 3 years experience of vision mixing equipment.

**DESIGN AND DEVELOPMENT ENGINEER - VIDEO**

We are looking for designers, minimum age 25, who are qualified to degree level and who have at least four years' experience of electronic technology. A knowledge of microprocessor techniques and video engineering would be an advantage.

Salary offered are extremely competitive and are backed by free life and health insurance plus a contributory pension scheme. Generous financial assistance with relocation will be given where appropriate to help successful candidates move to this pleasant rural part of Hampshire which offers easy access to London and major towns in the South of England.

Please phone Jacqui Comal at Andover (0264) 61546 and ask her to send you an application form or, alternatively, let us have full details of your background and experience.

*Walter W. Estate, Andover, Hampshire, England*  
Telephone: Andover (0264) 61346

**DEVELOPMENT OPPORTUNITIES**

**COMMUNICATIONS WEST SUSSEX**

Our Research & Development Laboratories in Crawley, West Sussex, are actively involved in developing the Communications technology and equipment of the Telecommunications Division.

To meet the demands of our expanding programme, we are currently seeking additional R & D personnel with proven expertise in any of the following areas:

- High frequency antennas and linear
- Wideband Amplifiers
- VHF/Mobile Radio Systems
- Switching/Processing & Control
- Communications Hardware/Software

All positions are at Senior/Principal Engineer level and offer highly competitive salaries together with attractive benefits.

Development opportunity, make this your next move.

For further details and application forms, please telephone or write to:

David Bird, Personnel Department, Rediffusion Radio Systems Limited, Broomhill Road, London, SW18 4QG.

Telephone: 01-874 7281

---

**Air Traffic Engineers**

The Civil Aviation Authority has vacancies for men and women as Air Traffic Engineers Grade 2 in its Telecommunications Division offering a very wide range of electronic systems and experience requirements.

Air Traffic Engineers Grade 2 are involved in the installation and maintenance of radar, radio navigation and landing aids, and data processing systems. Staff are employed at some Civil Airports, Air Traffic Control Centres and Radar Stations and at other locations throughout the UK but at present most of the vacancies are likely to be in the South of England with a few vacancies elsewhere in the UK.

**Qualifications and Experience**

You should be at least 20 years of age and have obtained either the O.E.C.G. (E) with a minimum grade 5 or an Additional Certificate in Telecommunications Technician T3 Certificates or other similar technical qualification.

Skilled working experience in radar, data processing is essential.

**Salary**

Salaries are on an incremental scale £5,683 - £8,783. Posts in the London area attract an additional allowance (Inner London £1,082 - Outer London £462). Grade 1 posts (maximum salary £5,109) are normally filled by promotion from Grade 2.

**APPLICATIONS**

For full details and an application form complete and send to the Civil Aviation Authority, 70 Broadwick Street, London W1, within the next few weeks.

---

**REDDIFFUSION**

**Radio Systems**

...great to communicate with

**Gresham Executive Appointments**

**D.E.C. EXPERIENCE?**

Real Time Mini/Micro Applications  
Industrial Computer Systems

Experience and your personality create progression in the following areas:

**SALES ENGINEER SENIOR SOFTWARE ENGINEER APPLICATIONS ENGINEER DEVELOPMENT ENGINEER**

Contact Keith Dippet on 0273 653 5271
GRESHAM EXECUTIVE APPOINTMENTS  
9th Floor, New Broad Street  
67a New Street, Birmingham

---

**TOP JOBS IN ELECTRONICS**

In posts at Computers, Medical, Controls, etc. O.C.H. to P.H. or Free service.

Phone: 01-906 0281

---

**Appointments**

**WIRELESS WORLD JULY 1981**

**SITUATIONS VACANT**

---

**WIRELESS WORLD JULY 1981**
IMPORTANT 4-DAY SALE BY AUCTION OF TELEVISION MANUFACTURER’S EXCELLENT MODERN MACHINERY & EQUIPMENT & KITCHEN EQUIPMENT

**DAY ONE**
**TUESDAY, 30 JUNE 1981**
WIREWORK & WIRE COMPONENTS

MANUFACTURING PLANT

- **AUPPA W30 12-STEM SEQUENTIAL WINDERS**
- **WINDHAM 12-STEM SEQUENTIAL WINDERS**
- **ROSWATER WINDERS**
- **Bench & Pillar Drills**
- **BEAVR VBR P TURRETT MILL**
- **BEAST MILL**
- **CARS**
- **ROVER 3.5 & JAGUAR 3.4 AUTOMATIC SALOON CARS**
- **BTH 330 KVA DIESEL GENERATOR, BROOM WADDE V500 AIR COMPRESSION**
- **GENERAL ENGINEERS VACUUM IMPELLER PLANTS**
- **BARLOW WHITNEY ELECTRIC CURING OVENS & WAX CASTING**
- **1980 ZEVTRON TL3 DIP SOLIDER MACHINE, FLOW SOLDER MACHINES**
- **SABRE TOOTH TURBO VENTILATION UNITS**
- **ADCOCK & SHIPLEY ELECTRIC COOK Ovens & WAX IMPELLER PLANTS**
- **WEIDMANN BIR TURNTABLES, INTERWOUND OR, ROUTER WINDERS SDM II**
- **PEARL PERFORMER PRINTING & NOCKING MACHINES**
- **30 TL & MANUMULKO ML PLASTICS INJECTION MACHINES**
- **SHELBY 4422 VACUUM FORMING MACHINE**
- **EDWARDS TRENDE & POWER GUMMITY FLINDEX, PRESS FLINDEX, BOX & PANEL DRYERS**
- **BALLARD DEGNESIANT PLANT, AEW STOVING OVEN**
- **MACMILLAN MACHINE, SURFACE PLATEN, ANGLE PLATE, ROTARY TABLE, PLANT, WAX, ELECTROMECHANICAL**
- **HINERIGI PLC DRYER, LABORATORY BENCH, DEXED CBD PADDY PALLET MAILING**

**DAY THREE**
**THURSDAY, 2 JULY 1981**
MACHINE TOOLS, PLASTICS & SHEET METALWORKING MACHINERY

- **VITAL, UNIVERSAL & TURRET MILLS by Adcock & Shipley, Shires, Vickers, VSY**
- **BIR TURNTABLE, SURFACE GRINDER, CLARKSON & G C REEDER, BCA ML III VERTICAL**
- **ALEXANDRA 3A DESGINING MACHINES, MANGON CUTTER BENCH & PILLAR DRILLS, BENCH SAW, STARTER 316 VERTICAL**
- **WEIDMANN BIR TURNTABLES, INTERWOUND OR, ROUTER WINDERS SDM II**
- **SABRE TOOTH TURBO VENTILATION UNITS**
- **IMAR BS 35A DIESEL GENERATOR, INTERWOUND OR, ROUTER WINDERS SDM II**
- **SHEPHERD MILL**
- **MACHINES & ACCESSORIES TO SELL**
- **5 ABE PLANT**
- **SHELBY 4422 VACUUM FORMING MACHINE**
- **EDWARDS TRENDE & POWER GUMMITY FLINDEX, PRESS FLINDEX, BOX & PANEL DRYERS**
- **BALLARD DEGNESIANT PLANT, AEW STOVING OVEN**
- **MACMILLAN MACHINE, SURFACE PLATEN, ANGLE PLATE, ROTARY TABLE, PLANT, WAX, ELECTROMECHANICAL**
- **HINERIGI PLC DRYER, LABORATORY BENCH, DEXED CBD PADDY PALLET MAILING**

**DAY FOUR**
**FRIDAY, 3 JULY 1981**
MODERN OFFICE FURNITURE & EQUIPMENT

- **EXTENSIVE RANGE OF EXECUTIVE & SECRETAIRY DESKS & CHAIRS**
- **PUNCH & DECORATORS TABLES & CHAIRS**
- **FABRIC CABINETS, LIBRARY SHELVING, CUPBOARDS, OFFICE FURNITURE**
- **PERMANENT, ALARMS & LOCKS BACK**
- **CAST BLOOM**
- **SILVER GILDING COVERS & FOLDED EDGE COVERS**
- **SEYMOUR 2000B VERTICAL PLASTICS INJECTION MACHINES**
- **AET ELECTRIC MUFFLE FURNACES, SPRAY BOOTH, AET VAPOR DRY AIR MACHINES**
- **KHALCO PIVOT MACHINES, FABRIC CABINETS, LIBRARY SHELVING, CUPBOARDS**
- **ADLER ELECTRIC TYPEWRITERS, OLEVITI ADD-LISTERS**
- **RLO A50 AND OTHERS 1 STEP TO 5 FLAME PRINTERS RANK XEROX 3195, 3195 VI, FLAPIPHOTOCOPIERS**
- **SEAMAN ADDITION DEVICES, VARIOUS**

**DAY THREE**
**THURSDAY, 2 JULY 1981**
RADIO & TV ELECTRONIC INSTRUMENTATION

- **HSCHROEDER 1043 ELECTRONICS, PHILIPS**
- **KONING, MITCHELL, ROTHSTEIN & SCHWARZ, TELTON, TELEVISION**
- **ADMITEC VIVAIR, ARMWORTH, CURTIS, DAVIS, GROO, HEITRON, HINERIGI, IGE**
- **KHALCO, FABRIC CABINETS, LIBRARY SHELVING, CUPBOARDS, OFFICE FURNITURE**
- **DIAMONDS & JEWELLERY 14.0 AUTOMATIC SALOON CARS**
- **GRANADA 2.6L AND CITROEN CX20G & GLO PALLAS SALOON CARS**
- **FORD 1817 ARTIC UNITS, D131 RIGID AND TRANSIT COMMERCIAL CARS**
- **FORD 1817 ARTIC UNITS, D131 RIGID AND TRANSIT COMMERCIAL CARS**
- **AND JRUGAR 14.0 AUTOMATIC SALOON CARS**

**ON VIEW**
- **Monday 22 to Friday 26 June, 1981**
- **Catalogues, when ready, from the Agents:**

---

**Weatherall Green & Smith**
Chartered Surveyors

Auctioneers and Values of Industrial Property, Plant and Machinery

Londoncausey Park, Newcastle upon Tyne

---

**21st Lane, R Finchley, London, N12. 5 min. from Tally to C&H**
INDEX TO ADVERTISERS JULY

Appointments Vacant Advertisements appear on page 119-127
The TL99 and TL100 are designed for the Professional Electronics, TV or Instrument Technician who needs to carry a large number of specialist tools. Constructed from hard wearing ABS with strong aluminium frames, twin handles and toggle locks. They offer a moulded tray in the base, a comprehensive 2 sided tool pallet that’s reversible with space for up to 40 tools. – The TL100 will take quite a few more. There’s space for documents and a heat sink for a hot soldering iron to prevent any damage being caused.

TLW4 Toolwallet measures 11” x 14” x 2½” when closed. Made from reinforced PVC with a heavy duty industrial zip. The TLW4 Toolwallet is a compact alternative when only tools are needed to be carried.