Design competition - 5th month

Full-duplex modem
New radio services
The new microprocessor controlled EP8000 Emulator Programmer will program and emulate all EPROMs up to 8k x 8 sizes, and can be extended to program other devices such as 16k x 8 EPROMs, Bipolar PROMs, single chip microprocessors with external modules. Personality cards and hardware changes are not required as the machine configures itself for the different devices. The EP4000 with 4k x 8 static RAM is still available with EPROM programming and emulation capacity up to 4k x 8 sizes.

- EP8000 8k x 8 Emulator Programmer - £695 + £12 delivery  
- BSC4 Buffered emulation cable - £49  
- SA27128 Programming adaptor - £69  
- SA25128 Programming adaptor - £69  
- EP4000 4k x 8 Emulator Programmer - £545 + £12 delivery  
- BSC4 Buffered emulation cable - £39  
- BP4 (TEXAS) Bipolar PROM Module - £190  
- Prinz video monitor - £99  
- UV141 EPROM Eraser with timer - £78  
- GP100A 80 column printer - £225  
- GR1 Centronics interface - £65

VAT should be added to all prices

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WW - 028 FOR FURTHER DETAILS
Rather than try to show how electronics could help disabled people this month's cover by Geoff Harrold depicts the things you might choose to surround yourself with in entering our design competition.

NEXT MONTH

Compact electronic typewriter can be equipped with an RS232 interface to enable it to be used as a printer for computer output at a total cost for both typewriter and interface of just over half that of the lowest price commercial alternatives.

Loudspeaker measurement techniques designed to avoid the vagaries of personal prejudice and room acoustics normally require a calibrated microphone. But using the principle of reciprocity Peter Dobbins shows how three transducers can be calibrated with no specialized equipment.

Simple ultrasonic transmitters and receivers with appropriate control by 6502 or Z80 can give a robot distance-measuring capability, even in a noisy environment.

Current issue price 80p, back issues (if available) £1.00, order and payments to EEP General Sales Dept., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS Tel: 01-661 8660. Editorial & Advertising offices: Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Telephones: Editorial 01-661 3614. Advertising 01-661 3130. See leader page.

Telex: 820284 BIPSRS G.

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prompt despatch to all parts of the Country. Electronic Brokers offer full technical support and expert advice on all aspects of electronic test and measuring. Visitors are welcome to our showrooms where all products are on display and demonstration. For customers wishing to order by phone, we offer a 24 hour answering service.

<table>
<thead>
<tr>
<th>HAMEG Oscilloscopes</th>
<th>ICE Analogue Handheld Multimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hameg HM705 70MHz Oscilloscope</td>
<td>I.C.E. 680G Analogue Multimeter</td>
</tr>
<tr>
<td>General purpose scope with a multitude of operating modes and triggering facilities. Extremely bright and well defined display, with 6 x 10cm screen and internal illuminated gratuile. TV triggering, Z modulation, X-Y display facilities and sweep delay mode. Dual trace. £588</td>
<td>Wide range of measurement capabilities with high sensitivity (200kHz/V) and high accuracy (DC1 1% d. d.) Mirror scale protected meter movement and fully screened against magnetic fields. Large range of accessories. £25.00</td>
</tr>
<tr>
<td>Hameg HM204 20MHz Oscilloscope</td>
<td>Microtest 80</td>
</tr>
<tr>
<td>High performance scope with peak value triggering up to 50MHz. Versatile triggering facilities and variable hold off control. Dual trace, delay/swap mode. Z modulation, X-Y operation, internal illuminated gratuile and component tester. Complete the attractive specification £365</td>
<td>40 ranges, accuracy DC 2%, 20kV/V £19.00</td>
</tr>
<tr>
<td>Hameg HM203-4 20MHz Oscilloscope</td>
<td>Supergetter 680R</td>
</tr>
<tr>
<td>Designed for general purpose applications in industry and education. Versatile triggering performance to at least 40MHz-z. Dual traces, X-Y operation, TV triggering, add and invert mode and component tester make the price-performance ratio of this scope most attractive £264</td>
<td>80 ranges, accuracy DC 1.5%, 20kV/V £32.00</td>
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<table>
<thead>
<tr>
<th>FLUKE Handheld and Bench/Portable DMM's</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluke 8050A Bench/ portable DMM</td>
</tr>
<tr>
<td>Unique functions and fine performance from this 4½ digit LCD microprocessor based DMM. Nine functions include iB, conductance, true RMS and relative reference mode. Selectable impedance references, Comprehensive accessories and NiCad battery option. £315</td>
</tr>
<tr>
<td>Fluke 8026B Handheld DMM</td>
</tr>
<tr>
<td>The new addition to the Fluke range. A 4½ digit LCD meter with true RMS capability. Eight functions including conductance and high speed audible continuity. 2 year warranty applies to this rugged general purpose meter. £180</td>
</tr>
<tr>
<td>Fluke 8020A DMM</td>
</tr>
<tr>
<td>with enhanced functions</td>
</tr>
<tr>
<td>Fluke 8020B 3½ digit handheld DMM</td>
</tr>
<tr>
<td>with conductance ranges</td>
</tr>
<tr>
<td>£99</td>
</tr>
<tr>
<td>£120</td>
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<td>£150</td>
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</table>

Electronic Brokers Ltd., 61/65 Kings Cross Road, London WC1X 9LN. Tel: 01-833 1166 Telex 298694
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**ANALYSERS**

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Price</th>
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<tr>
<td>DVM's</td>
<td>608-3 Line Oscilloscope Monitor</td>
<td>£2800.00</td>
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<tr>
<td>Hewlett Packard</td>
<td>141T/BX/6805A 10MHz 18GHz</td>
<td>£8300.00</td>
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<td>500A Signature Analyzer</td>
<td>£830.00</td>
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<tr>
<td>520A Digital Signal Analyzer</td>
<td>£1,000.00</td>
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<tr>
<td>840A 1/10 15MHz 4 Channel Analyzer</td>
<td>£800.00</td>
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<tr>
<td>Marconi</td>
<td>952003 Mod Meter</td>
<td>£460.00</td>
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<tr>
<td>97516P Oscilloscope</td>
<td>£350.00</td>
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<tr>
<td>Tektronix</td>
<td>AD01 50MHz 10Hz to 100kHz</td>
<td>£700.00</td>
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<td>TF2008 1MHz 10Hz to 100kHz</td>
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<tr>
<td>TF2008 2MHz 10Hz to 100kHz</td>
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<td>TF2120 10MHz 10Hz to 100kHz</td>
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**OSCILLOSCOPES**

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<tr>
<td>Hewlett Packard</td>
<td>5230 High Quality CRT Display</td>
<td>£1500.00</td>
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<tr>
<td>1720A Dual Trace 25MHz with 1000V Channel</td>
<td>£500.00</td>
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<tr>
<td>1803A 100MHz 4 Channel Plug-In</td>
<td>£2000.00</td>
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<td>1812A Timebase Plug-In</td>
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<td>Philips</td>
<td>PM5000 Dual Beam 1MHz</td>
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<tr>
<td>PM1024 True Dual Beam Storage Oscilloscope 10MHz New CRT</td>
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<tr>
<td>Tektronix</td>
<td>510M Portable battery scope/DMM, 0.1%</td>
<td>£750.00</td>
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<tr>
<td>TF2110A Scope 35MHz, Dual Trace 35MHz, 0.1%</td>
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<td>TF2112A Scope 35MHz, Dual Trace 35MHz, 0.1%</td>
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**BRIDGES**

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<tr>
<td>Boonton</td>
<td>100MHz Bridge 100MHz Bridge</td>
<td>£2800.00</td>
</tr>
<tr>
<td>Marconi</td>
<td>971/131A 0.1% LCR Bridge</td>
<td>£775.00</td>
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<tr>
<td>TR112520 Set of Inductors</td>
<td>£350.00</td>
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<tr>
<td>Wayne Kerr</td>
<td>BK9522 10%</td>
<td>£795.00</td>
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<tr>
<td>SR-218 Source &amp; Detector</td>
<td>£875.00</td>
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**DVM's AND DMM's**

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Price</th>
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<tr>
<td>Fluke</td>
<td>8020A 3.9 digits 0.02%</td>
<td>£75.00</td>
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<tr>
<td>Fluke</td>
<td>8020A 3.9 digits 0.02%</td>
<td>£75.00</td>
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<td>DVM's and DMM's</td>
<td>90 day warranty</td>
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**MICE CAMELEON**

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<th>Product</th>
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<tbody>
<tr>
<td>Bruel &amp; Kjaer</td>
<td>2208 Sound Level Meter</td>
<td>£850.00</td>
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<tr>
<td>Dantec</td>
<td>8001 2 Transducer Recorder</td>
<td>£750.00</td>
</tr>
<tr>
<td>Dantec</td>
<td>8002 2 Transducer Recorder</td>
<td>£750.00</td>
</tr>
<tr>
<td>Ferrerograph</td>
<td>RTI1 Test Set</td>
<td>£285.00</td>
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<tr>
<td>Fluke</td>
<td>515A Portable Calibrator DC and AC</td>
<td>£1500.00</td>
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<tr>
<td>Hewlett Packard</td>
<td>5430A Counter 10Hz-1MHz</td>
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<td>HP</td>
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</tr>
<tr>
<td>HP</td>
<td>5430A Counter 10Hz-1MHz</td>
<td>£1500.00</td>
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**TEKTRONIX TV TEST EQUIPMENT**

<table>
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<tr>
<th>Product</th>
<th>Description</th>
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<tbody>
<tr>
<td>14B8 Pal Insertion Test Generator</td>
<td>£1800.00</td>
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<tr>
<td>15B1 ScopeWave Generator</td>
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<tr>
<td>15B2 ScopeWave Generator</td>
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<tr>
<td>15B2 ScopeWave Generator</td>
<td>£1850.00</td>
<td></td>
</tr>
</tbody>
</table>

Please note: Prices shown do not include VAT or carriage.
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With over 10 years experience in audio amplifier technology ILP are recognized as world leaders.

---

**BIPOLAR MODULES**

<table>
<thead>
<tr>
<th>Module Number</th>
<th>Module</th>
<th>Output Power (Watts)</th>
<th>Load Impedance (Ω)</th>
<th>DC Voltage (V)</th>
<th>Current (mA)</th>
<th>Price inc. VAT (£)</th>
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<tr>
<td>17/18</td>
<td>MPA-7</td>
<td>15</td>
<td>8</td>
<td>75</td>
<td>100</td>
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<td>17/19</td>
<td>MPA-12</td>
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<td>8</td>
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**MOSFET MODULES**

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<th>Current (mA)</th>
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<tr>
<td>MOS 128</td>
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<td>MOS 216</td>
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<td>MOS 364</td>
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**PREF A MP SYSTEMS**

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<th>Module Number</th>
<th>Module</th>
<th>Functions</th>
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<tr>
<td>17/18</td>
<td>MPA-7</td>
<td>MPA-7</td>
<td>100mA</td>
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<td>17/20</td>
<td>MPA-20</td>
<td>MPA-20</td>
<td>100mA</td>
<td>18.00</td>
</tr>
<tr>
<td>17/21</td>
<td>MPA-30</td>
<td>MPA-30</td>
<td>100mA</td>
<td>20.00</td>
</tr>
</tbody>
</table>

Most pre-amplifier modules can be driven by the PSU or using the main power, and a separate PSU 20 is available purely for pre-amplifier modules of required for £34.50 inc. VAT. Pre-amp and mixing modules are 18 different in appearance. Please send for details.

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For ease of construction we recommend the BR modules HVY-12 £1.05 inc. VAT and the BRN for modules HVY-8 £1.20 inc. VAT.

**POWER SUPPLY UNITS**

(incorporating our own toroidal transformers)

<table>
<thead>
<tr>
<th>Module Number</th>
<th>For Use With</th>
<th>Price inc. VAT (£)</th>
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<tr>
<td>PSU 21X</td>
<td>1 x W2720</td>
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<td>PSU 21X</td>
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<td>PSU 22X</td>
<td>1 x HV128</td>
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<td>PSU 24X</td>
<td>1 x HV128</td>
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Please note: X x position indicates resistors value. Please insert "G" in these of X for 110V. X for 220V or 3 x fuse of X for 240V.

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<tr>
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<tr>
<td>HiFi Separates</td>
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<tr>
<td>UC1 Preamp</td>
<td>£29.95</td>
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<tr>
<td>UP1X 30W/30W/80W Bipolar Stereo HiFi</td>
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<td>UP3X 60W/40W Bipolar Mono HiFi</td>
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<td>UP4X 120W/60W Bipolar Mono HiFi</td>
<td>£74.95</td>
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<td>UP5X 120W/60W Bipolar Mono HiFi</td>
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<tr>
<td>UP6X 60W/8W MOS Mono HiFi</td>
<td>£64.95</td>
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<tr>
<td>UP7X 120W/4W MOS Mono HiFi</td>
<td>£84.95</td>
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Please note X in part number denotes mains voltage. Please insert 'O' in place of X for 115V-11, 'U' in place of X for 220V (Europe), and 'Z' in place of X for 240V (U.K.). All units except UC1 incorporate our own toroidal transformers.

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Design competition

Although it is too early yet to know whether the outcome of our design competition will be successful, it is at least possible to say that the number of entries and variety of devices under development give grounds for encouragement.

From boxes intended to identify the contents of tins of food to quite exotic equipment concerned with cars, a great deal of imagination is being demonstrated by those who have registered their intention of entering the competition; there are more examples on page 67. It is possible, of course, that some of the ideas will remain exactly that - ideas. But the spur of a rather large money prize and the somewhat more intangible satisfaction of making people’s lives more convenient and pleasurable will, without doubt, convert a significant number of nebulous notions into hardware.

It is not going to be easy. One of the hardest parts of a wide-open competition of this kind is to decide exactly what to design. Many needs can be better satisfied by a simple mechanical device than by a complicated piece of electronics: good judgement in this decision can be the most telling aspect of an entry. The next hurdle comes when it is discovered that the realization of an idea is not as straightforward as it was at first imagined, and the temptation to change one’s mind appears. There is nothing wrong with that, if there is still time before October to complete the work, but it is often the case that this approach leaves one with two half-baked projects instead of one well-done one. It is surprising how a little gentle research in the literature can straighten one out, when to all intents and purposes stuck fast.

The last date for registration is June 30. You do not have to present entries at that time: simply register your intention to do so before October. A panel of judges experienced in both engineering and use aspects of devices to assist handicapped people will take some time to arrive at their decisions, during which some entrants will be asked to come to London to discuss their designs and perhaps take part in a prize-giving ceremony, which may well be televised.

There are six prizes, but we expect to describe many more entries than the winning six during the subsequent year, so that even one of the designs not chosen as a winner could attract attention and may be adopted as a commercial proposition.

This is an interesting, socially valuable and possibly profitable competition. A large number of readers have already entered; there is still time for a great many more. You have a couple of weeks left to make up your mind.
Spectrum battles

Although the US Congress agreed late last year to the ratification of the WARC 1979 "Radio Regulations", many influential American groups continue to express disenchantment with the whole process of international frequency allocation and ITU procedures. Among the critics have been members of FCC who were most unhappy at the proceedings at the ITU Plenipotentiary Conference at Nairobi in Autumn 1982, and the "needless politicization" of the decision making. Although it is being suggested that the US should remain in the ITU it is being urged that, if "politicization" continues, the US should have available "a fully developed and workable alternative organization". However Kalmann Schafer, international affairs adviser to the FCC, believes that few important US interests have been surrendered and that "the day will come when the Third World realizes that disruption of ITU conferences will be against their own best interests".

The sort of problems that face the forthcoming ITU Conference on DBS planning for Region 2 is shown by the fact that both the UK and Argentina have listed the Falkland Islands — with 1800 residents and a lot of sheep — as an area they intend to serve by DBS. One suspects it might be less costly to provide every home with a v.h.f. and a large number of cassettes, or cable every habitation! Meanwhile the mere idea of having two different international spectrum regulatory bodies would seem the sure path to chaos.

World television?

That chaos is already close on h.f. was emphasised recently by Douglas Muggridge, m.d. of BBC External Services who sees that disruption of ITU conferences will be against their own best interests.

By 1986 the question of "world television" whereby direct broadcast satellites will send pictures across frontiers will be of practical concern: and despite what is sometimes suggested deliberate jamming of DBS transmissions is possible and would affect viewers in the whole of the coverage area. For years, international organizations have been discussing questions of "cultural or economic imperialism" and the potential cultural damage and loss of the "unique identity of a population after exposure to outside ideas and lifestyles".

On the other hand Article 10 of the European Convention states: "Everyone has the right to freedom to hold opinions and to receive and impart ideas without interference by public authority and regardless of frontiers". But what is a right to free speech to some, is malevolent propaganda to others!

In reality, of course, international regulation of the radio spectrum and the use of the airwaves to broadcast to other than your own people have been inconclusively debated for over 50 years. Did the old International Broadcasting Union in May 1933 — on the initiative of a BBC plagued by Radio Luxembourg and Captain L. F. Plugge's Radio Normandie — resolve that the systematic diffusion of programmes or messages specifically intended for listeners in another country should be considered an "inadmissible act" — though such a resolution must have seemed a poor breakwater against the rising flood of transmissions from Zeesen, Radio Roma and Radio Moscow. It was not long before the UK was plunging into foreign-language broadcasting. Even today some countries argue that there should be no transmissions of "politically subversive or culturally disruptive material" across frontiers "without the prior consent of the receiving State", and defend their right to jam transmissions they find offensive while themselves engaging in massive external broadcasting. The USSR has ground-wave jammers in all Soviet cities of more than 200,000 people and rather less effective skywave jamming in rural areas. The Western Nations, it would seem, are attempting to counter jamming by engaging in the power race and multiple-frequency techniques that in themselves contribute to the destruction of orderly spectrum planning. The BBC, for example, is currently seeking permission to install at the former Post Office receiving station at Bealrey, Warwickshire six 300kW h.f. transmitters primarily for serving Eastern Europe. Today few people distinguish between h.f. and/or m.f. broadcasting in your own language (e.g. BBC World Service), surely a laudable service, and the one-time "inadmissible" practice of foreign-language broadcasting!

Black broadcasting

Governments are not always content even with straight-forward external broadcasting, as witness the take-over of one of the 250kW transmitters on Ascension Island last year and similar action during the Suez affair in 1956. A detailed study of radio signals of Western Nations recently been published by Ellic Howe, an eminent typographer whose special skills were used in World War 2 to forge leaflets and other printed material on behalf of the Political Warfare Executive. His book "The Black Game" (Michael Joseph, 1982) provides much new information on P.W.E.'s many "black" radio services and the building in 1942 of the 600kW "Aspidistra" m.f. transmitter at Crowborough, a transmitter that was finally retired last year. Much of the technical detail has been provided by Harold Robin who for many years was chief engineer of the Diplomatic Wireless Service but who previously worked for Sir Richard Gambier-Parry's wartime "Special Communications".

E.m.p. bomb?

In the December 1981 issue of WW Kenneth Cook of the M-O Valve Co. Ltd drew attention to his company's gas-filled protection devices that operate in less than one nanosecond. Such devices he claimed "will protect solid-state receivers and telephone equipment in a simulated e.m.p. ...making it impossible to ascertain that an e.m.p. is the massive pulse that follows the explosion of a nuclear device high above ground.

Despite this assurance that effective protection against e.m.p. is available, there can be little doubt that the potential threat to radio communications, computer installations and telecommunications posed by...
high-altitude (40 to 400km) nuclear explosions is still being taken very seriously in many parts of the world. Even if military installations can be effectively "hardened" there remains the problem of the enormous number of civilian installations.

Now, according to recent press reports from Washington, the US Government is investigating the possibility of developing an atomic weapon designed specifically to provide "defensive" systems that would "hurt the enemy without necessarily hurting his people". E.m.p.-bombs could be launched to black-out enemy communications; the Americans are also reported to be currently providing additional shielding against e.m.p. on their B-52 long-range bombers. Similarly scientists at the University of Minnesota are reported to be working on techniques that would not only counter the effects of e.m.p. but could also reduce the effects of solar flares, which can cause radio blackouts, auroral propagation etc. particularly in northern latitudes.

**New callsigns**

Before long the Home Office expect to be issuing callsigns in the G0, GM0 etc sequences for Class A, and G1, GM1 etc sequences for Class B. The figures 01 are the only remaining unused digits since G7, G9 are used for commercial "test and development" licences. The present G6 class B sequence is already up to "W" and G4 class A to "I". When the 0 and 1 sequences are used up it would be possible for the Home Office to issue British amateurs calls with an M-prefix. Both GAA to GZZ and MAA to MZZ are internationally allocated to the UK.

One internationally-recognized radio amateur, Ray Cracknell, Z22JV of Zimbabwew (formerly G2AHU) would welcome either a G or an M callsign when he returns soon to the UK. Ray Cracknell has been, over several decades, one of the most successful pioneers of transatorial propagation. It has been responsible for uncovering, with the help of his equipment and a series of "beacons" which he has built, a wealth of information about the tropical ionosphere, much of it previously unknown and unsuspected by both professional and amateur researchers. Yet recently when he sought to renew his British licence it was indicated, presumably as the result of a dispute over reciprocal licensing with Zimbabwe, that he would be required to sit an RAE and take a Morse test. One can think of few people deserving of an unhindered re-issue of a licence than Ray Cracknell. Let us hope by the time these notes appear the Home Office will have graciously rescinded such an apparently bureaucratic ruling.

**I onospheric focusing**

Although it is now generally accepted that many low-power h.f. transmissions travel long-distances without intermediate ground-reflection by what is termed chordal hop propagation, amateur operators have paid less attention to antipodal-type mechanisms that result in enhanced signals at a point precisely on the opposite side of the globe. Signals travelling along great circle paths all converge on the antipodal point. Amateurs in the UK have no exact antipodal point with which to exchange signals, since this point is in the Pacific Ocean, although UK amateurs have long recognised the consistency of the long-distance paths to Australia and New Zealand, the nearest land-mass to the antipodal point.

Brian Austin, Z66BKW, writing from the University of the Witwatersrand, Johannesburg notes that South Africans are more fortunate in that they have Hawaii as the antipodal point. He comments: "Over many years I have listened, on and off, to WWVH mainly on 15 MHz. What has struck me lately is that the Fort Collins, Colorado station, WWV, runs the same power (10kW) and I assume uses similar antennas. Yet WWVH is by far the stronger signal of the two in this country. Could it be because of antipodal focusing or would the fact that Hawaii is a relatively small land mass, and hence the signals may be launched more effectively over the sea "groundplane" be the reason? He feels there is still much to be finally discovered about h.f. ionospheric propagation.

**Code-free in USA?**

Although in late 1982, the president of ARRL, Vic Clark, W4KFC, asked FCC to defer for at least 18 months any action that might lead to a class of amateur licence not requiring a test in the international Morse code, the FCC has subsequently issued a "notice of proposed rule making" for two forms of code-free licence. The first would eliminate the 5wpm test for existing "Technician" licences (above 50 MHz). The second would be an "Experimenter" licence rather akin to the Canadian "Digital Amateur Class Certificate" but conveying all normal operating privileges on frequencies above 144 MHz. There are no proposals for any form of code-free h.f. licence. Comments on the FCC proposals were due by April 29.

**In brief**

Harold Ling, G4CCH has made several e.m.e. ("moonbounce") contacts on 1.3GHz using only an 8ft aerial dish and 100 watts of transmitter output. . . . In CQ-TV, R. Platts, G8ZP comments on the "anti-social and selfish" behaviour of some amateur television enthusiasts who make broadband transmissions on 430MHz "in excess of two hours duration". He feels such operation should last more than 15-20 minutes. . . . John Wood, G3YQC of Rugby, in association with G8YBC, has succeeded in exchanging pictures on 1255MHz with F1EDM at Le Havre, a distance of about 200 miles. . . . The paid-up membership of AMSAT-UK increased from about 1300 to 1700 during 1982 . . . Launching of the Phase IIIIB Oscar amateur satellite, set for June 3, has been delayed. . . . Amateurs in north-west England have been experiencing considerable interference on 432 MHz from Syledis. . . . Forthcoming mobile rallies: June 26 Longleat Park, Warminster; July 10 Droitwich High School, Ombourne Road, Droitwich; July 17 RAIBC Picnic at The Fairground, Broadlands Estate, Romsey, Hants, and Camborne Technical College, Camborne, Cornwall; July 24 Anglian rally, Stanway School, Colchester, Essex and McMichael rally, Bells Hill, Stoke Poges, near Slough; July 31 Rolls-Royce Sports & Social Club, Barnoldswick; August 7 RSGB National rally at Woburn.

PAT HAWKER, G3VA

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**Wireless World** July 1983

**Amateur Radio**

**DX-disaster**

For several decades, there have been an increasing number of "DX-peditions" mounted by radio amateurs in remote and out-of-the-way places. The object has been to permit a well-equipped team of operators to activate one of the rare country callsigns and then make thousands of brief contacts with amateurs all over the world. Funds for such expeditions are often donated by amateurs eager to increase their "countries worked" totals, although there has always been opposition to the technique of making a charge for QSL cards.

Since there is "resident" amateur radio operation in most countries of the world, DX-peditions have increasingly been directed towards smaller, more remote islands some of which are little more than reefs.

In mid-April a German DX-expedition to Spratly Islands, a group of small islands in the China Sea between West Malaysia (Borneo) and Vietnam, ran into problems that caused the death of at least two members of the party. The islands are territories politically in dispute by several countries and appear to be under military occupation by more than one country. As the German vessel approached the islands it was fired on with fatal consequences, and sank, although some survivors were later picked up about 100 miles away in a small boat by a Panamanian ship.

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www.americanradiohistory.com
Planning for plenty

Objections to the introduction of new “community” radio services have included claims that such stations will place excessive demands on frequency space. Norman McLeod — one of the few engineers involved in the campaign for new stations outside the BBC and IBA — puts forward suggestions for accommodating new services, with an account of current technical thinking on the subject.

by Norman McLeod

It is three years since I last looked at some of the technical questions surrounding community radio in this journal. Since then, the idea that radio broadcasting in this country offers an incomplete service — which could usefully and practically be extended by new and different stations — has gained wide acceptance.

Indeed the Home Office has received to date over a hundred applications from various organizations requesting licences to operate broadcast services. And as a scan across broadcast wavebands in many cities will show, many enthusiasts are prepared to offer new services to the public without bothering with the paperwork to HQ. It is not hard to see why pirate stations do not wait for the formalities: the Home Secretary recently announced that there would be no further progress on the question of licencing community radio until 1985. And there is no guarantee of licences being forthcoming even then.

There have been attempts by what one observer has called “an uneasy hotch-potch of pragmatists, careerists, reformists, radicals, commercial interests and radio enthusiasts” to form campaigns to press the case for more stations and to promote community radio ideas and ideals. But there is still no effective central organisation, no public relations budget, no full-time workers striving to bring people and ideas together. Such progress as has been made has come not from marching forward in unison, but from various small independent initiatives — not least from the hundred organisations who have been applying to the Home Office.

One such initiative came just before Christmas last year, when the Greater London Council commissioned a report from Wireless Workshop — a small firm in Brighton in which I am a partner — to examine the question of frequency resources for community radio in London. This provided a welcome promise of funds to sit down and work through proposals for new radio services in more detail than had previously been possible. But we were left with the problem of deciding just what sort of services we were supposed to be finding frequencies for. There were two general ideas circulating in community radio circles: one was “neighbourhood radio” and the other “community of interest” services.

Briefly, neighbourhood radio would be intended to provide a more localised service than is available at present. In the case of London, each so-called “local” radio service, provided by the BBC or the IBA, broadcasts to a potential audience of over 10 million people. There is clearly some scope for splitting this vast audience up to provide services more local and distinctive in character — Radio Brixton may be expected to sound quite different from Radio Hampstead, for example.

The other idea was that across the whole of London there are various subdivisions of the public who would be interested in listening to a service directed specifically at their interests and aspirations. These minority audiences — ethnic groups, fans of particular types of music, students, the elderly, media radicals etc. — are not necessarily concentrated in any particular part of London and therefore require a transmission system which will reach a city-wide audience. It has been suggested that these are the sort of programmes BBC Radio London should be doing instead of tagging along behind Capital Radio with the likes of the Tony Blackburn show but this is not a question we can dwell on here.

Armed with these basic ideas, we proceeded to take a look at some of the possibilities for broadcasting to London.

Transmission systems and technology

With the prospect of wideband cable services looming ever closer, we examined briefly whether new technology might have any relevance for the development of community radio services. But the only advantages we could see arising from the new cable technology were that it might provide — eventually — a lower cost method of networking various small transmitters across the city, by establishing point-to-point links more cheaply and flexibly than the present British Telecom landlines.

The advantages of using existing broadcasting bands and receivers were overwhelming: compared to any high-technology systems, sending radio programmes out from conventional transmitters to conventional receivers represents the cheapest, easiest and most flexible way of establishing new services. In discussions held between the GLC and various interest groups and consultants, it was suggested that the “pay-as-you-listen” programme scrambling techniques might be applied to broadcast radio. We did not think there was any mileage in this idea: a radio service costing more than a few pounds per listener per year would be very expensive indeed, and the hardware involved in coding and decoding the signals would cost far more than the revenue it would generate. In any case, using the public broadcast band for “privatized” signals like these would set a dubious precedent.

Previous plans

In November 1979, a report entitled “The Technical Feasibility of Community Radio in London” was produced by a team of consultants headed by former IBA engineer Fred Wise for the Community Communications Group. It addressed itself to some possibilities for new radio services operating in the v.h.f. band — m.f. channels were not explored.

Wise envisaged three categories of community station: category A, with a service radius of three to four kilometer, was the smallest. Category B described medium-sized stations covering a sector of the city, and category C covered larger stations aimed at specialist interests and covering the whole city.

In the spectrum below 97.6 MHz, Wise concluded: “... presently available channels could be used to provide about a dozen category A stations and one category B station, or, alternatively, about fourteen category A stations.”

He also said that none of the channels which he discovered were suitable for the high power needed for an all-London station. Looking at the upper section of the band (above 97.6 MHz), Wise said that: "... if it could be agreed that community services could operate on the basis of provisionally assigned frequencies, which may subsequently need to be changed, then a number of additional community stations could be authorised at an early date..."

But Wise warned that the number of additional stations likely to be possible in this part of the band was very much dependent on BBC and IBA plans. At the time these were not known, but the Home Secretary’s statement sheds some light on the matter: “... frequencies for (two) national net-
works should be used to provide an independent national radio service. The Government finds this proposal attractive. I propose to allocate the other new network to the BBC so that there can be separate v.h.f. networks for Radios 1 & 2.

So the frequencies between 97.6 and 102MHz — which the Home Office has promised to clear by 1990 — will be used by two new national networks. This leaves 102.1 to 104MHz as a new local radio sub-band. Frequencies in this sub-band are going to be employed for some of the new BBC and commercial local radio services around the periphery of London, but at present there are no official plans from the BBC or the IBA to establish more radio services in London itself. Our own proposals do not include this sub-band because at the time it was not clear what the future of the spectrum above 97.6MHz was likely to be.

Official comment

The Third Report of the Home Office Local Radio Working Party (HOLRWP) was published at the end of 1980 and remains the last official report which took note of community radio aspirations. The working party itself was set up by the Labour Home Secretary Merlyn Rees, and was retained by William Whitelaw to prepare proposals for the long-term expansion of local radio. It has twelve members, four from the BBC, four from the IBA, and four from the Home Office. The secretary of the Working Party is a Home Office civil servant.

Although no community radio groups were themselves represented on the working party, a substantial section of the report addressed itself to the question of community radio. This section began by stating that there were no commonly accepted guidelines as to what constitutes a community radio station, although the authors did recognise the distinction between “neighbourhood” radio and “community of interest” services, which I outlined earlier.

On the question of frequency planning the working party was far from enthusiastic:

“. . . it would be wrong . . . to allocate frequencies to small community stations at the expense of the expansion of BBC and independent local radio . . . there may be some scope for additional very low power stations at both v.h.f. and m.f., but there are a number of important reservations . . . the number of stations which could be accommodated in this way would be small and is likely to prove least in areas such as London where the demand is likely to be greatest . . .”

The Working Party also cast doubt on whether the higher-power “community of interest” stations would be technically possible at all, and they also suggested that a more flexible approach to planning standards would almost certainly be necessary.

Fred Wise — author of the earlier plan for community radio services on v.h.f. — prepared some comments in response to this report. He did not share the pessimistic attitude of the HOLRWP towards fitting new low-power services within the existing spectrum. He said that this seemed to at least provide a realistic approach for an experiment.

HOLRWP had suggested that the sharing of frequency bands between the BBC and the IBA on the one hand and other, community broadcasters on the other would require strict control of technical standards. Wise dismissed this, saying:

“. . . it does not seem obvious . . . why this sharing of the band with the present broadcast services should pose great difficulties in the control of technical standards. The principle seems already to have been established in the television bands where authorised privately-operated self-help transmitters may be used . . .”

A further objection to new radio services was raised by HOLRWP. They claimed that a very small station could represent a major constraint on frequency planning, because of the need to protect it from interference from other services, thereby preventing the re-use of the same or closely adjacent frequencies for high-powered stations nearby. They missed the point that the order of planning is all-important. As Wise put it:

“. . . the practical reality is that, in accordance with established practice, the larger stations would be planned first and the very small stations fitted in later. In this way the very small stations would not impose constraints on the larger stations . . .”

The latest report

Our own report dealt with only two of the three segments of radio spectrum available for broadcasting to ordinary receivers — the m.f. (medium-wave) band and the lower part of Band II (88 to 97.6MHz). On v.h.f., our proposals differ from the earlier Wise stations in that the stations envisaged on v.h.f. are much smaller — only 2km service radius instead of 3-4km, but a much greater number of them were considered to be practicable — up to 160 instead of a dozen or so (Fig. 1).

Each transmitter would cover between 25,000 and 100,000 people, depending on the population density surrounding the transmitting site. If this is thought to be too small, we suggest that stations use more than one transmitter linked by landline or re-broadcast links to the studio. Since transmitters are likely to be much cheaper than studios this would appear to be an attractive proposition financially.

We suggested that transmitters should be sited in such a way that their “impact area” — where signal strength is not strong enough to provide useful reception but still strong enough to cause interference to other services — is minimised. This would seem to suggest that conventional techniques of v.h.f. transmitter siting should be turned on their head. Rather than siting the transmitting aerial on a tall mast, or on top of a block of flats, such that the optical horizon may be twenty or thirty miles away, we suggested that aerials should be located near the lowest part of

Fig. 1. Planning lattice for v.h.f. “neighbourhood” stations. Each frequency used is represented by a number in a circle chosen so as to be at least 600kHz away from existing services and from each other and also free from strong “out of area” transmissions. Adjacent transmitters are 3.6km apart and stations using the same frequency are 10km apart. The approximate service radius of each station is 2km, though this will vary with the effect of geographical factors as will the siting of the transmitters.
the target area, and that their maximum height should be restricted to no more than, say, 15 metres above ground level. In this way, geographical screening outside the service area will be maximised, while the service within the designated area should be adequate in most locations.

We considered that with careful siting of transmitting aerials along these lines, it should be possible to re-use any frequency successfully at a distance of just five times the service radius — i.e. 10km should separate adjacent neighbourhood stations on the same frequency. This is backed up by two very simple but useful experiments which we carried out into practical levels of co-channel interference.

Co-channel protection ratios

The first experiment involves hooking the output of an f.m. signal generator via a crocodile clip to the telescopic aerial of a portable v.h.f. receiver (Fig. 2). The receiver should then be tuned to a local programme, and the generator tuned to the same frequency, and modulated with an alternative programme (or tone). With the radio operating in mono, adjust the level of signal emitted from the generator while listening to the output from the radio. The object of the experiment is to determine the degree of co-channel protection needed to obtain subjectively satisfactory suppression of the weaker signal.

One assumption may be made about the programme content: it may be taken that the modulation is compressed or otherwise kept reasonably constant in depth (such as the signals from Radio 2 or commercial radio). Under these circumstances, we consider that acceptable levels of unwanted interference can be obtained with a co-channel protection ratio of as little as 20dB. The total range covered on the generator's attenuator, between virtual inaudibility and almost complete 'capture' of the frequency, is never much more than 40dB, in our experience.

A development of this experiment is shown in Fig. 2. Here, instead of having the generator connected directly to the receiver, it is connected instead to a dipole aerial of appropriate length (about 1.5m). The attenuator of the signal generator should be set for maximum output, and the receiver moved away from the dipole aerial until a point is reached where the signals from the local generator and the more distant broadcast transmitter are competing — in space — for its attention.

You should find that very minor movements of the receiver and/or its aerial will produce nearly complete elimination of one signal or the other, as far as the audible output from the receiver is concerned.

The conclusions which we draw from these two experiments are: (a) that 20dB co-channel protection ratio is just adequate for mono reception; (b) that where two or more signals are present, moving the receiver and/or its aerial very slightly has a marked effect on the relative signal strengths picked up from the melange.

In the case of our idealised lattice (Fig. 1), free-space attenuation alone will provide a 12dB ratio between a transmitter 2km distant and one 8km away. We then have geographical screening and receiver positioning available as factors to ensure that at least a further 8dB difference is introduced between the wanted and the total unwanted signals. On the face of it, this does not seem too implausible, though practical tests would be interesting to carry out.

We suggest that the total power radiated by each transmitter should be of the order of 2 to 10W c.r.p. — the idea being to ensure that 2km distant the service is limited more by co-channel interference than by failing signal strength. The unattenuated field 2km away at this level of power is several millivolts per metre, but we are assuming that we ought to be receiving portable receivers in less-than-advantageous domestic locations.

Medium wave

We also looked at medium-wave, and carried out a number of exploratory calculations to see what would happen when the medium-wave transmitters of various powers were operated. The first step towards performing these calculations is to draw up a mean propagation curve from published data. This curve is shown in Fig. 3, and is compiled from the average of two CCIR recommendations for signals at 1500kHz — one for a ground conductivity of 3mS/m, and the other for a ground conductivity of 10mS/m. This curve may be taken to be valid, within a few dB either way, for frequencies between 1251 and 1602 kHz and for the range of ground conductivities present in and around London.

We restricted our calculations to the high-frequency end of the m.f. band because it seemed that this was the most fruitful place to search for relatively quiet channels — in daytime at least — and also because fairly efficient aerials can be constructed on these frequencies without the need for great height.

If the signal strength 1km from the

<table>
<thead>
<tr>
<th>TX power</th>
<th>70dB</th>
<th>area</th>
<th>Population '000s</th>
<th>40dB</th>
<th>sky wave 100-400km</th>
</tr>
</thead>
<tbody>
<tr>
<td>1W</td>
<td>2.5km</td>
<td>20km²</td>
<td>155</td>
<td>70</td>
<td>20km</td>
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<tr>
<td>2W</td>
<td>3.5km</td>
<td>30km²</td>
<td>260</td>
<td>114</td>
<td>23km</td>
</tr>
<tr>
<td>4W</td>
<td>4.5km</td>
<td>50km²</td>
<td>400</td>
<td>170</td>
<td>28km</td>
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<td>260</td>
<td>33km</td>
</tr>
<tr>
<td>16W</td>
<td>6.5km</td>
<td>112km²</td>
<td>970</td>
<td>375</td>
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</tr>
<tr>
<td>32W</td>
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<td>1260</td>
<td>542</td>
<td>44km</td>
</tr>
<tr>
<td>64W</td>
<td>9.0km</td>
<td>254km²</td>
<td>1970</td>
<td>850</td>
<td>50km</td>
</tr>
<tr>
<td>128W</td>
<td>11.0km</td>
<td>380km²</td>
<td>2960</td>
<td>1270</td>
<td>61km</td>
</tr>
</tbody>
</table>

The conclusion is that the predetermined level is achieved.
transmitter is known (and this can be inferred from the effective monopole radiated power) then the predicted signal strength at any distance up to 60km from the transmitter can simply be read off the graph. The vertical axis of Figure 3 is scaled in decibels relative to the signal strength at 1km.

Figure 3 shows how this curve is used to predict the 'service' (70dBu) radii of transmitters using various amounts of power. Also shown on this curve is the 'impact' radius — defined by the 40dBu contour, and representing the minimum radius, at which the occupied frequency could be reused.

The IBA transmitter on 1548kHz is also shown on the diagram to provide a sense of perspective. All three London 'local' radio stations use high-power channels — channels which could (and in the view of the author should) be used for network levels of power and coverage. Our proposals cannot run to the tens of kilowatts used by the BBC and the IBA because international clearance for such powers would not be forthcoming. Indeed, after contemplating 'impact' radii and sky-wave propagation estimates (Table 1), we decided that we could keep effective monopole radiated power down to a few hundred watts on any frequency, while providing London-wide coverage on a pair of channels.

We take the view that new community radio services should take the lead in applying an approach to broadcast engineering which seeks to maximise the efficiency with which every watt or radiated power is used. It is clear from the data which we have generated from our exploratory calculations that using a large number of smaller transmitters is much more effective than using one large one with the same total power. For instance, eight two-watt transmitters will cover an area of 272km² with a field strength of 70dBu or more; one sixteen-watt transmitter covers just 112km² to the same effect. Clearly, there are economic imperatives which ultimately point us in the other direction. But maximising the number of listeners per watt is probably the most important task facing broadcast engineers in the all-too-crowded spectrum.

The hypothetical m.f. transmitters which we have analysed may either be used independently, or as part of a network of fully-synchronous transmitters using two frequencies per service — in much the same way as Radio 1 and Radio 2 already cover the country. We suggested that between eight to ten transmitters, each with an effective monopole radiated power of about 50 to 80W, should be assigned to the two frequencies in such a way that good reception on one channel coincided with poor reception (due to multiple signals) on the other. The problem of cyclic fading, due to imperfect synchronisation between carriers, and of modulation distortion due to unequal time-delays in the distribution network are both easier to solve on this smaller scale. Cyclic fading can be tackled by locking each transmitter to a common frequency source (such as one of the Brookman’s Park m.f. transmitters), while the time delays in any distribution circuit are sufficiently small for correction circuits to be easy and practical.

We did suggest (perhaps rather optimistically) that frequencies at v.h.f. or u.h.f. (possibly old broadcasting frequencies released by the Merriman Spectrum Review Committee) should be made available for point-to-point links across the city, thus saving the expense and bother associated with land-lines.

Conclusions

For the moment, all this can be dismissed as just an amusing piece of speculation. Continued on page 44
Mixed logic

First came nand and nor, their functions being a product of the technology of the time. Circuit synthesis procedures evolved which regarded these devices as actually performing nand/nor logic functions. We now inherit a system which automatically generates obscurely-intentioned circuit schematics. But all is not lost . . .

A circuit diagram is a medium of communication and is one of the most important items of documentation linking the designer with the user.

The circuit diagram of a digital system should convey the original logic intentions of the designer of the circuit. It should do this directly, with no requirement for elaborate transformations.

− Circuit symbols should represent combinational logic directly in and-or-not terms.
− Correspondence between logic value (true and false) and physical voltage counterpart (high and low) should be evident at any point in the circuit.
− Notation should clearly indicate type of physical device used at any point in diagram.

The reality

A manufacturer produces a device with the following response to applied input voltage signals

![Fig. 1](image)

Using positive logic convention, the manufacturer suggests a logic truth table for this device

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
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<td>H</td>
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</tbody>
</table>

![Fig. 2](image)

And assigns a symbol to the device . . .

Now make a full analysis with the aid of Fig. 5.

"Duality. — Given a physical device characterised by a table of combinations, the logic function performed by the device is determined by the specific choices of the 1-state at its inputs and outputs . . ."

Highlighted sector of Fig. 2 is the only region that most customers consider. As a result, a whole tradition of logic synthesis has evolved which concerns itself with forcing reduced expressions into a fixed format (network of nand gates) by tortuous manipulation, De Morgan’s rule being constantly invoked.

Examination of Fig. 2 however reveals that it conceals another logic identity . . .

![Fig. 4](image)

Mike Butler, M.S.E.R.T., joined Marconi International Marine Co. as a Radio Officer in 1961. After 6½ years he went ashore to head office in Chelmsford as a test engineer. Work in the engineering division led to his current position as a radar development engineer in the company’s laboratories.

![Mike Butler](image)

By M. B. Butler

Fig. 5

WIRELESS WORLD JULY 1983
Definition extracted from BS3939, section 21. In Fig. 5, left, we may recognize two pairs of 'duals', i.e. (b) i & ii and (c) i & ii. Examine another physical device:

It is evident from Figs 5 and 6 that one physical device may have its logic function interpreted in four ways, i.e. two pairs of logic duals.

We must regard an example to reinforce our wildermenter.

Fig. 7 above illustrates a standard schematic representation of a logic function. Without the transformation shown, it is not possible to directly interpret its function. Re-draw the circuit, using the logic dual concept (intentional logic):

From Fig. 8
- the 'negation indicator' (circle at input/output) may be regarded as a De-Morgan operator
- two negation indicators at each end of a connective line, cancel the effect of each other
- use of the logic dual clarifies interpretation of a schematic representation.

negative logic representation Fig. 6 (c)? And are the two gates in the example, physical nor gates using positive logic representation Fig. 5 (b)?

We are left with the problem of identifying the physical implementation of the above circuit, with no clues to conjure with!

**Summary so far**
- Classical logic synthesis procedures tend to generate unreadable circuit schematics.
- A logic function may be synthesized directly in and-or terms using logic duals (intentional logic).
- The 'not' function may be implemented easily by manipulation of the negation indicator on connectives.
- Logic diagrams below do not directly relate logic state to voltage level at each node in the circuit, a factor which can be of extreme significance in field servicing.

**Back to basics**
The functions 'and' and 'or' are represented by the customary symbols BS3939.

Following conventions are stated
Logic validity defined as true symbolized by 1 or false symbolized by 0
Voltage level is described as high symbolised by H or low symbolised by L

A new symbol is introduced to indicate application of a convention: the 'flag' or polarity indicator.

This is applied as shown below.

**Fig. 11**

For example

**Fig. 12**

Presence or absence of polarity indicator serves only to define which voltage convention in force at interconnection input or output interface of basic logic symbol, and does not indicate reversal of logic state.

To reinforce this concept, study the following examples. Note that they include two truth tables to emphasize the crucial distinction between logic and voltage.

From Fig. 13 over,
Logic truth table remains same for each basic identity, whether flagged or unflagged.
Relevant section of voltage truth table modified where flag is applied.

The voltage truth tables above can be taken to describe the action of a physical device which would be used to implement
the function. The voltage truth table of (ii) describes a t.t.l. 7400 nand gate, while the voltage truth table of (iv) describes a t.t.l. 7402 nor gate. Two more examples are shown in Fig. 14.

**Logic duality**

If you now compare the voltage truth tables in Fig. 14 with the voltage truth tables of the previous four examples in Fig. 13, you should come to a startling conclusion, Fig. 15, right.

The same physical gate may perform an 'or' or an 'and' logic function under certain conditions, a physical nand gate may perform a logic 'or' function, and a physical nor gate may perform a logic 'and' function. This is the law of Logic Duality.

We now introduce the non-equivalence and equivalence logic functions. Figure 16 shows the gate symbols and truth tables for these two functions.

You are now left to prove the Fig. 17 duals, using the procedure outlined earlier.

Figure 18 summarizes logic duals.

**Voltage level changing**

Given the following problem, what do we do?

![Not flagged](Flagged) [1 = H]

![Required](A B) [1 = L]

![Logic Voltage](A B) [L H]

Fig. 19

To validate the voltage truth table in physical terms, we require of course a physical device called a voltage inverter, symbolized below.

![1](OR) 1

Fig. 20

Our solution to the above problem is therefore

![X](A B) [M]

Fig. 21

Note carefully that no logic change has occurred; the same logic signal is present on both sides of the voltage inverter. Sole function of the voltage inverter is to change voltage representations for logic truth.

As further example for emphasis, consider implementation of equation M = A + B, where

input A is flagged ('1' = L)
input B is un-flagged ('1' = H)
output M is flagged ('1' = L).

![A B] M

Fig. 22
We obviously require a voltage inverter at the A input.

Fig. 23

The same logic signal is present on both sides of voltage inverter on A line. The voltage inverter may be implemented in a variety of other ways.

Fig. 24

All of these variants will be encountered in practical circuits.

Logic inversion
What is the physical implementation of logic 'not'? Consider the circuits of Fig. 25.

Logic variables A and B are being physically implemented by the same voltage on wire. The logic tables above are derived
from voltage on line (H or L), logic states depending on the presence or absence of flags at A and B. In cases (a) and (b) no inversion occurs. However, in cases (c) and (d) the logic truth table indicates logic inversion (logical not).

To summarize: logical not operation occurs over a piece of wire on which voltage convention is 'switched'.

To guard against any tendency to wonder about an error in the circuit diagram, an oblique 'slash' . . .

is placed across any line over which logical not operation has occurred.

The logical not operation is thus clearly identified on the diagram, and shows that voltage convention has been switched:

The presence or absence of a 'polarity indicator' also serves to define voltage convention in force at a 'labelled' input or output to combinational logic network, and is associated with validity of 'label' at these points, Fig. 27.

**Last words**

Adoption of the system presented means total reversal of an outlook drilled into a generation of students by basic classic textbooks, and I confess to performing many mental gymnastics in the process of re-conditioning my thinking. During this procedure however, many nasty rule-of-thumb habits were discarded.

With regard to design of combinational logic circuits, the technique is very powerful and results in economical design. Greatest advantage lies in the fact that the designer works in pure logic and only reverts to the physical world when choosing devices to implement the design; at which point a few voltage inverters transform the circuit into the real world.

Use of duals in circuit diagrams appears to upset users who encounter this representation for the first time, and the response is very typical: "This is all very nice and academic of course, but how will the p.c.b. layout draughtsman and service technician be able to identify the physical type of, say, IC30 and IC31?"

The answer lies of course in the fact that manufactured devices are always in 'and', 'or' nand or nor form, i.e. they don't have flagged inputs. Therefore on encountering a gate with flagged inputs a mental dual transformation is all that is necessary, Fig. 28.

---

**INPUTS**

- Write/read
- Read/write

**OUTPUTS**

- Vector
- Vector

![Fig. 26](image)

![Fig. 27](image)

![Fig. 28](image)
300baud full-duplex modem

Most designs featured in magazine articles have been acoustically coupled and have not met any previously adopted standard for frequencies. This design directly couples to the telephone line, giving better security and lower error rates, and uses standard data channel frequencies.

The unit has been designed to meet British Telecom specifications but as these include the standard of construction and layout it cannot therefore be said to be BT approved. But if all the layout instructions are followed the unit should meet with BT approval. This can be done locally through the Telecom Efficiency Officer or by submitting an application to

Telecom HQ
Marketing Executive
R.C.S.D.
Tenter House
45 Moorfields
London EC2Y 9TH

The modem offers the facility to originate or answer the call manually, or by using the auto answer unit it can be used as an auto-answer modem. The unit is designed to be compatible with the BT Datel 200 service to give data rates of up to 300 b/s.

Duplex transmission over two wire circuits is achieved by using frequency-division techniques, as shown in the table. Two channels are used with the following frequencies:

| Channel 1 | 980Hz—binary 1 |
| Channel 2 | 1650Hz—binary 1 |

A protocol must be established so that one channel is used in one direction of transmission and vice versa, by creating call and answer modes of operation.

<table>
<thead>
<tr>
<th>Call mode</th>
<th>Frequency</th>
<th>Answer mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmit</td>
<td>Channel 1</td>
<td>Receive 160Hz—binary 0</td>
</tr>
<tr>
<td>Receive</td>
<td>Channel 2</td>
<td>Transmit 1850Hz—binary 0</td>
</tr>
</tbody>
</table>

Using this convention the contention of two modems trying to transmit to one another on the same frequencies will not arise provided that each modem is in the complementary mode.

To enable duplex transmission over a two-wire circuit the transmit and receive signals must be separated by the use of a hybrid transformer and transmit and receive filters. The hybrid transformer also provides a d.c. loop on the telephone circuit to hold the call. This is required on both the originating call and the answering call to indicate to the exchange equipment that the line is in use. The transformer must be able to carry a primary direct current of up to 120mA and not saturate, thus enabling a.c. signals to be sent and received through the transformer without attenuation. Both the transmit and receive signals are buffered by zero-gain amplifiers to give a stable impedance of 600 ohms to the hybrid and they also provide a degree of protection to the filter against high voltage transients which could be induced into the transformer from the telephone circuit.

The filter consists of a single integrated circuit specifically designed for modem use. It is the Reticon RS631, a monolithic i.c. containing two 10-pole switched-capacitor band-pass filters fabricated in n-mos technology with a 16 pin dual in-line package (see below for pin connections).

Included in the chip is a receiver gain-control stage which is externally variable from 0 to 20dB, a separate limiter for use with the receive output, a clock oscillator and t.t.l.-compatible switch inputs for self-test and mode selection, Fig. 3. The self-test mode gives the ability to loop the modulator and demodulator together via the filter and thereby enable local testing to be carried out.

The mode select and self-test gives the following combination of filters.

**Modulator**

The modulator is built using the XR2207 f.s.k. modulator i.c. which gives phase continuous output, the frequency of which is determined by C7 and the resistors R7-R4 selected by the logic combinations on pins 8 and 9.

The XR2207 provides two outputs, one a square wave on pin 13 and the one used in this application is a triangular waveform on pin 14. Use of the channel-select input on pin 8 gives the ability to change channel when the modem is switched between the
To auto answer unit

To set the frequencies of the modulator follow this procedure. Apply a logic 1 to the data input and select channel one by applying a logic 0 to pin 8, this can be done by switching to originate mode. Adjust R\textsubscript{V1} to give an output frequency of 980Hz. Then apply a logic 0 to the data input and adjust R\textsubscript{V2} to give 1180Hz at the output. The adjustments must be done in this order as R\textsubscript{V1} affects both the low and the high frequency whereas R\textsubscript{V2} only affects the high frequency.

The same procedure applies to set channel 2 frequencies. This is done by selecting the answer mode and applying logic 1 to the data input. Resistor R\textsubscript{V3} is then adjusted to give a frequency of 1650Hz. The data input is then set to logic 0 and R\textsubscript{V4} adjusted to give an output frequency of 1850Hz. The output level is adjusted to give -10dB into 600ohms at the two-wire line side of the hybrid transformer. This completes the alignment procedure for the modulator.

This switched capacitor filter chip is Reticon 5631. Adjustable resistors around 2207 circuit (top) are R\textsubscript{V1} to R\textsubscript{V4} in text.
Since he qualified in communications in 1972, Des Richards has been an engineer on a local radio station. He also runs a small business designing and supplying specialist equipment, and finds time to build model steam engines and fly light aircraft.

Demodulator

The demodulator is built using another Exar circuit, the XR2211 which is a monolithic phase-locked loop device. It consists of a basic phase-locked loop for tracking a signal within the passband, a quadrature phase detector that provides carrier detection, and an f.s.k. voltage comparator circuit that provides f.s.k. demodulation. It will detect a signal between 2mV and 3V and has a built-in a.c.g. preamplifier. The centre frequency, bandwidth and output delay are set by external components, centre frequency being determined by $C_f$ and $R_c$. Adjustment of $R_t$ is as follows.

Open $R_t$ and monitor pin 13 or 14 with a high impedance probe. Don't try to adjust the centre frequency by monitoring $C_f$ with everything connected and no input signal applied.

The two centre frequencies are adjusted in the same way. Select call mode and adjust the frequency to 1750Hz and then select the answer mode and adjust the frequency to 1080Hz. This completes the alignment of the demodulator.

The carrier detect output drives the hold relay on the auto-answer board, and also gives a status indication of carrier being present on the circuit. The complementary output to this is connected to the data output circuit to hold the output to a logic 1 (-12V) when no carrier is present. This prevents spurious data from appearing on the output when no carrier is present. The output of the demodulator is unipolar and is converted to RS232 by an op-amp buffer to give ±12 volts.

To be continued

Continued from page 32

With regard to servicing, one is only concerned with reading the logic action and checking voltage levels at specifically numbered pins on labelled i.c. packages (assuming a silk-screened p.c.b., and suitable documentation). It is only when replacing a defective package that one must identify its physical type, and this information should be present in the documentation.

Example

With (a), (b) and (c) representing spare gates, which two of three shown can be connected to fulfill the function of the network illustrated?

How will the network be represented in mixed logic notation? (For maximum clarity of operation.)

Fig. 29
More micros for minors

Eight million pounds of Government money is to go toward new computing equipment and up-grading existing computers in schools and colleges of further education.

The extension to the Micros in Schools Scheme consists of 50% funding to allow RM380Z and BBC Model A computers to be converted. The Research Machines computer will be provided with 56K of memory (formerly 32K) and the graphics board with software, while the BBC design in its Model B form is to have disc drives and an Econet interface. Both computers can be supplied with a Microvitec colour monitor and a Walters printer. As an extra to the computers, the Government will also assist schools to buy a Buggy, which is a three-wheeled robotic device by Economics, controlled by the computer, which will adaptively follow set paths, detect and delineate objects, operate a pen and find its way towards a given point. There is also Vela, which is effectively a multipurpose measuring instrument for voltage, frequency, waveform generation, transient capture and data analysis, being a central-hardware, programmable-function device.

A further scheme — CNC Machine Tools in Further Education — has as its aim the equipping of colleges with computer numerically controlled tools of various types, again on a 50% basis. Announcing the CNC programme, Kenneth Baker MP, Minister for Information Technology, said “This scheme follows the enormously successful micros for school schemes, as a result of which the UK has achieved the greatest progress of any country in technological education for young people.” More than 6500 secondary schools have already received microcomputers under the scheme.

934MHz changed to meet European plans ...

UK 934 MHz citizens’ band is to be moved downward by 12½kHz following a Home Office decision to fall in line with a recent international channelling agreement for Europe reached by the Conference of European Posts and Telecommunications Authority, CEPT. Other technical requirements for 934MHz remain unchanged and existing sets may be used for the present. Dates by which existing sets must be modified and sets being manufactured must conform to the new channel requirements have yet to be fixed. Amendments to Home Office performance specification MPT1321 are being made to reflect the new channel plan.

... for whom?

Currently only one UK manufacturer, Reftec, makes sets for 934MHz and according to the company’s main distributor, 934 Communications, some 500 transceivers have been sold since Reftec first started manufacturing some 15 months ago. But a second company, Bee-ware of Harrogate, is about to break the monopoly by selling a 934MHz transverter that can be used with existing 27MHz sets. Bee-ware expects to sell around 1800 transverters in the first 12-18 months, a figure representing 2½% of the existing 75 000 official and unofficial c.b. operators.

Prices of a basic Reftec transceiver and a Bee-ware transverter with a 27MHz set are almost the same, working out at around £250, but the second option is more attractive to those who already have 27MHz sets and to those who want to operate on both bands. But according to Don Lane, a spokesman for 934 Communications, “Bee-ware cannot be serious. Japanese companies need an order of 10 000 before they will manufacture anything and there just isn’t the market for that number of sets.” Technical Director of Bee-ware, Bill Dewhurst replied “Of course we are serious. We have carried out a feasibility study, spent money and liaised with the Home Office on the specifications — had it not been for the recent changes, our product would be on the market now.” Sanwa make the company’s 27MHz set but Mr Dewhurst could not tell us who was manufacturing the Grandstand transverter expected to be available by the end of July.

Sets conforming to a European standard can potentially be exported. When approached on this subject, Dewhurst said “the snag is that the Japanese like to do things their own way. Exporting Japanese sets from the UK would not be easy but we have plans to manufacture in the UK, in which case we would be looking into exports. We have a design for a complete 934MHz transceiver and are looking into other fields of communications like marine and land-mobile radio and satellite tv.”

Lasers and radiation safety

Rapid increase in the use of lasers in both industrial and commercial has led to a complete revision of the BSI standard on laser radiation safety which has been in effect since 1972. Radiation safety of laser products and systems, BS 4083, has been published in advance of an international standard, which is an infrequent occurrence, and it could be that ISO in Geneva will base their standard on its content.

BSI says “It is impossible to regard laser products and systems as a single group since hazards vary according to factors such as wavelength, power and energy of the beam and duration of the emission. Eyes are the organs most at risk because the incoming visible or near infrared beam may be focussed on the retina to a 10 to 200μm spot which raises energy density by
up to half a million times. High irradiance, either direct or reflected, may cause skin damage. Other potentially dangerous sources are power supplies and cooling agents sometimes used. The standard is in three parts, one covering determination of maximum permissible exposure levels in a summary of biological considerations, one specifying manufacturing requirements, and a user's guide covering safety operation, maintenance and servicing of lasers.

NRPB, who are more concerned with biological effects of lasers rather than with mechanical construction which is BSI's main concern, plan to publish a review of maximum permissible limits for exposure to laser radiation in about six months at the request of the Health and Safety Executive. This information is used by BSI as a basis for its standard. A further consultative document on laser radiation hazards from NRPB is due in about a year.

Finalization of the consultative document concerning non-ionizing radiation limits summarized in Wireless World, April 1983 has been delayed 'slightly' due to an unexpected influx of comments and questions at the NRPB, particularly concerning e.l.f. radiation.

In brief

An agreement to support European Computer Manufacturers' Association work towards proposed CCITT electronic mail standards was signed on 29 April by seven companies - ICL, Rank Xerox, Ferranti, CII Honeywell Bull, Olivetti, ITL and Logica.

City & Guilds Radio Amateur course 765 starts at Oak Farm centre, Chaucer Road, Farnborough, Hants on 22 September. For further details teleph one 0252 540084.

Incorporated Practitioners in Radio and Electronics, IPRE, is born under the wing of the Society of Electronic and Radio Technicians. Providing professional services to engineers involved in domestic and industrial electronics servicing, IPRE bases its entry levels on City and Guilds courses and is the only institution open to the many service technicians whose study is not normally recognized because of its practical nature.

Infrared astronomical satellite IRAS spotted a comet approaching us at 28km/s on 11 April and estimated that it would miss Earth by 4.5 million kilometres on 11 May, appearing faint but several times the size of the moon.

Racal gets 25 years in cells

Racal Millicom has received a 25-year licence to run a mobile telephone service based on cellular-radio technology but according to the DoI, the competing licence to be held by the BT/Securcor consortium 'is still to be issued.' The licence requires that the service must start no later than 31 March 1985 - unless the holder has a good excuse - and that 95% of the population must be served by 1989.

When asked why BT hadn't got its licence yet, a spokesman said: 'We are working toward providing a cellular radio service in early 1985 - the licence is incidental, and there's no need to have it immediately.' On the other hand, Racal could not tell us anything more than what is in the licence and how much it costs (£1,000 initially then £1,000 p.a.). When asked when production of equipment might start - or indeed when anything concerned with cellular radio might start - Racal replied 'we'll let you know.' But as we write, the election looms and one can say that it is likely to be more embarrassing for a Government to retract a licence than it would to refuse to issue one in the first place.

Digital v.c.r. with metal powder tape

Using recently developed metal-powder coated tape and a modified domestic video cassette recorder, researchers at NHK laboratories have demonstrated that high-density digital recording can give better results than conventional analogue v.c.r.s. The researchers say that given some improvement in head sensitivity and tracking accuracy, the digital v.c.r. will consume less power than its analogue counterpart and produce good picture quality.

Digital circuits used are the same as those developed for NHK's 1979 digital v.t.r. experiments but using trial samples of Fuji's metal powder tape has allowed recording density to be more than doubled, to 3kbit/mm. With the same tape consumption as a conventional recorder, digital rates of 216Mb/s were achieved. This experiment is outlined in NHK Laboratories Note No 218.

<table>
<thead>
<tr>
<th>Tape</th>
<th>Head</th>
<th>Recorder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe metal-powder coated (trial product)</td>
<td>Sendust metal head</td>
<td>Domestic VHS cassette video recorder</td>
</tr>
<tr>
<td>Tape-to-head relative speed</td>
<td>Bit interval</td>
<td>Density</td>
</tr>
<tr>
<td>11.6m/s</td>
<td>0.33µm</td>
<td>3kbit/mm</td>
</tr>
<tr>
<td>45µm</td>
<td>58µm</td>
<td>2 channel</td>
</tr>
<tr>
<td>3x1f&lt;sub&gt;ref&lt;/sub&gt; 6bit/sample</td>
<td>35dB</td>
<td>Reproduced signal s/n ratio</td>
</tr>
<tr>
<td>2.5x10&lt;sup&gt;-4&lt;/sup&gt;</td>
<td>Block error rate</td>
<td>Block error rate</td>
</tr>
<tr>
<td>2x10&lt;sup&gt;-3&lt;/sup&gt;</td>
<td>35dB</td>
<td>Remaining errors</td>
</tr>
</tbody>
</table>

Calculated results of recording density for metal powder vs conventional tape. With good head sensitivity and tracking accuracy, recording density for metal tape is 5.5µm<sup>2</sup>/bit.

General specifications for NHK's experiments in high-density digital recording for video signals. Digital circuits for both experiments are the same but using metal powder tape has double recording capacity. Characteristics of reproduced digital video signal are also given. 'There were many dropouts because a trial production metal-powder tape was used, but error rate could be reduced to one tenth of this value by using a mass-production coater in the tape manufacturing process.'
MOS power device with thyristor on resistance

A mos gate-controlled power switch with an on resistance comparable to that of a thyristor has been developed by RCA. On resistance of v-mos power devices rises with increasing drain-source voltage capability, limiting their high-voltage applications, but the newly structured device exhibits an on resistance ten times lower than standard state-of-the-art mosfets with the same size and voltage rating. RCA scientists have manufactured several hundred of the devices, called Comfets (conductivity-modulated fet), some 1.5mm² and some 3mm², and nearly all of the larger chips had on resistances of less than 0.1Ω at 20A.

Typical experimental Comfets with 8A anode current took 1us to turn on but between five and 20µs to turn off, which is relatively slow. The n-p-n-p structure of the device is similar to that of a thyristor and it can be made to latch using high drive currents. In the larger devices latching occurred at between 10 and 30A, depending as one would expect on temperature and anode voltage. But an interesting feature of the device is that latching current is also strongly influenced by gate turn-off time. Slow gate turn off times of around 10µs permit anode currents up to 30A without latching but a rapid gate turn off of less than 1µs leads to latching at much lower anode-current levels in the region of 10A. The Comfet is detailed by J. P. Russel, A. M. Goodman, L. A. Goodman and J. M. Nielson in IEEE Electron Device Letters, vol. EDL4, no 3, March 1983.

4Mbyte micro-floppy

Using a different approach to perpendicular magnetic recording, Sony claims to have produced the highest density magnetic recording ever, with a linear density of 2.58kbit/mm. This represents an improvement of 31 times that of a 514in floppy disc or eight times that of a high-density microfloppy. Toward the end of last year Toshiba claimed a 27-fold improvement over conventional floppy discs for their p.m.r. technique (February News) and although this figure is lower than the latest claim, Toshiba indicated their disc and drive was ready for manufacture whereas Sony's development is still in the experimental stage.

Effects of magnetic properties and thickness of single-layer cobalt-chromium media on perpendicular recording with a ring-shaped head are discussed in IEEE Transactions on Magnetics, vol. Mag-18, no 6, November 1982. In this experiment Sony researchers achieved a recording density of 4.5kbit/mm using a ring-shaped head but the disc drive more recently described uses a w-shaped head to give a recording density of 2.58kbit/mm. Toshiba uses a ring-shaped head in its drive.

Obituary

Lawrence Henry Hewes Cooper, 'Dick' Cooper to his many friends and associates, died in hospital last February following an operation.

Born in 1912 and educated at Dulwich College, he spent a lifetime in electronic engineering. In his early career he worked with P.G.H. Voight at the Edison Bell Company, where he was involved in sound recording and reproduction. In 1933 he joined British Acoustic Films and worked on the design and installation of recording equipment at the Gaumont British Studios in Shepherds Bush. By 1935 he was working independently on the design of battery charging equipment using wet tantalum rectifiers, work which, coupled with other developments, led to the formation of Correx Communications and Correx Amplifiers. During this period he took out a patent for a modified form of push-pull drive circuit using a double-wound choke in place of the resistance or transformer feed circuit then in current use.

In June 1948, Transformer Equipment Ltd was founded and was soon serving many of the best known names in the electrical engineering industry. In addition to a wide range of other transformers, from 1958 the company made well known and widely used ultra-linear output transformer designed by J. Somerset-Murray.

Corrections

High-impedance electronics. In the first paragraph of this article, which appeared in the April issue, a line was dropped. The relevant section, nine lines into the paragraph, should read "... it saturates at 500 to 600mV as the junction becomes forward biased (Fig. 2). If the diode is connected between 'real' earth and the virtual earth ...".

Domestic alarm system. Several errors occurred in this article, published in the March issue. In Fig. 1, V+ should go to the right of the fuse, and C2 (unlabelled) is connected to pin 4 of gate A. The Disarm line should continue to the disarm switch, bypassing pin 5 of IC2, and the 1µF capacitor across IC2 should still go to pin 5. Diodes across the relays are 1N4001, and the resistor on pin 4 of IC3(a) is 680k not 220kΩ. The caption to Fig. 2 shows a 25s delay, not 20s.

In Fig. 3, the capacitor on pin 4 of IC3(a) is 47µF, 16V and IC10 is a 7555. The switches should be S3 and S4, not S1 and S2, which are fire and disarm in Fig. 1. Capacitor C2 is on pin 2 of IC7(a). Lines 14 and 15 of the first paragraph of page 30 should refer to FIRE, not FIRE, and line 2 of this paragraph should say "IC2 input". The third line of paragraph two of the section headed 'Control unit' should refer to a 30s delay.

Lawrence Cooper's phase-splitting circuit was the subject of an article in the 22 October 1937 issue of Wireless World. At that time, centre-tapped inter-valve transformers had been widely used for driving push-pull output stages but the demand for high-fidelity reproduction had led to resistive phase splitting circuits being introduced which became inefficient with low h.t. supplies. Mr Cooper's solution was to use a double-wound choke in place of the phase-splitting resistors to give a greater anode voltage with a lower potential difference between heater and cathode at low h.t. supplies.
Organ interface for microcomputer

The software is described in four sections, see panel. The first enables the microcomputer to repeat a performance made on the organ, with variation of speed, whilst the second provides the edit functions. The third section allows music to be typed into the microcomputer, and the fourth (in Forth) provides simple polyphonic extemporization.

The first section comprises only about 150 instructions. Only the first two sections were conceived when the interface was originally designed but to date the software has obstinately refused to stop growing.

Read and play routines
The system now has 24 register pairs. Two groups of 24 bytes of ram are designated console fields 1 and 2. When the read and play modes are entered, the console fields are set to represent the console switches with all keys off (status 0) and all stops cancelled (status 1). The PIO is then set up to mode 01 (input) and the interrupts are enabled, as described by the source listings given in List 1. It is worth commenting that four levels of interrupt have to be set: c.p.u. interrupt mode 2, PIO port B interrupt, c.p.u. enable interrupt, and pending interrupt disable. The last of these was particularly vexing: even Mostek did not seem to know about it when they wrote the provisional data sheet on the MK3881 PIO. It was finally laid to rest on page 109 of the Mostek 1979 Microcomputer Components Data Book. The address of the routine which services the interrupt is kept at the vector address.

Once the PIO and c.p.u. are ready to accept an interrupt, the microcomputer enters a wait loop which includes a scan of its own keyboard for the read-mode direct commands. On the Nascom 2 with NAS-SYS 3 this is accomplished very simply with the routine "in" (DF62H) which transfers the ASCII code for any character typed to the A register. When the interrupt arrives from the interface hardware, operation moves to the interrupt service routine (List 1) and the first byte is read in through port A to console field 2. The remaining 23 bytes follow at about 20µs intervals. Operation relies on the hardware working slightly faster than the software (which necessitates a short wait loop if the c.p.u. is running at 4MHz) but the hardware and software are re-synchronized after each byte because the hardware has to wait for the c.p.u. to raise the ready line.

Thus the status of each register is read into the appropriate place in console field 2 once per frame. Before operation returns to the wait loop for the next frame (i.e. as part of the interrupt service routine), the new console field is compared byte by byte with the previous one. If there has been no change, the null frame counter (n.f.c., a two-byte variable) is incremented. If something has changed, the contents of the n.f.c. and the number and revised status of the register or registers which have changed are read to the data field (which normally starts at 1340H) and the data field packed data pointer is incremented accordingly to the start of the next frame. Thus a frame comprises 3+2n bytes including the frame byte when n is the number of registers whose status has changed. The packed data and other pointers are sometimes parked in a scratchpad area of ram but where speed is important they are kept in register pairs of the Z80 or where necessary on the stack. Both sets of registers are used to provide sufficient pointers for comparing console fields 1 and 2, which is probably faster than using the index registers would be. The source code for this part of the interrupt service routine is given in List 2. Once the information has been extracted from console field 2 it is transferred to the console field 1 position so that console field 2 becomes free for the next frame.

Operation in play mode is simpler than in read mode because comparisons are not required. As before, a console field is initiated and the PIO and interrupts are enabled in the same way, except that different vector and interrupt service routine addresses are used and that the PIO is set to mode 00 (output) via port B. The wait loop is then entered and includes the checks for the play mode direct commands. When the interrupt arrives, the console field is trundled out through port B into the 4094 latches and the n.f.c. is decremented.

Operation then returns to the wait loop, which includes a check of the n.f.c. When it reaches zero, control passes to the update console field routine, which takes less than one frame period. This routine inspects the next byte in the date field. If it is a frame byte, the next value of n.f.c. is taken and the process continues, but if it is a register number the revised status of that register (the following byte) is read to the appropriate position in the console field and so on until the frame byte is reached (software coupings can be introduced at this stage). Operation then returns to the wait loop so that when the next interrupt arrives the revised console field is read to the console latches.

Console field 2 (read mode) or the console latches (play mode) are reset for every frame whether or not anything has changed. Should an error occur due to triggering of the interface hardware by a noise spike (a rare event) it will quickly be corrected, normally within one or two frames. Similarly, the synchronization of hardware and software is achieved one or two frames after the execution of the play mode and read mode routines.

Edit routines
The principal edit routines are effected by the play mode direct commands J (join) and E (edit) once the edit points have been

Software breaks down into . . .

1. The read and play mode routines for transferring the data between the microcomputer and the organ, interrupt-driven via the PIO, and for converting this to and from data format.
2. The edit routines, based on a scan of the microcomputer keyboard in play mode and block transfers of sections of data in data format.
3. The translate mode routines for translating music typed into the microcomputer from entry format into data format, mainly by means of look-up tables.
4. A vocabulary of some 60 words in Forth (about 4K of compiled Forth code) which operates on both the duration and event components of themes in data format to produce some simple polyphonic extemporizations, including some basic harmonization rules, which could quite easily be extended.

By R. D. Easson

Principles used for each section of the software for the Nascom 2 organ interface and music editor, described in the June Issue, with source code listings for the critical elements.
selected. The principle is directly analogous to splicing tape recordings in that the 250 block transfer routines (LDIR and LDIR) are used to move sections of a recording in data format from one part of the ram to another, with frame bytes overlaid. The lowest and highest source and destination addresses, as appropriate, are kept in a scratchpad area of ram for loading to the HL, DE and BC registers when everything is ready. Join throws away the intervening section (unless it has been kept by K) whilst edit inserts a new section as stored by keep. The edit routine needs to check whether the new section is longer, shorter, or the same length as the old one using the length of the block from the highest edit point to an arbitrary upper limit, normally set to C000H. The lowest address for K is D000H; it can therefore store about five minutes of music (below F000H), whilst edit can accept an extra two minutes or so without interfering with what has been stored by K. Clearly the limits can be changed if this is not adequate.

Most of the remaining play mode direct commands either are simple conditional branches or cause modifications to fragments of code. For example, P (pause) in read mode merely removes the enable interrupt in the wait loop. Short cuts of this kind may not be good practice, but they are very convenient for a relatively simple control program written in machine code rather than assembler, whilst being fast and compact. The two things to remember are firstly to keep a note in the source or reference of what was changed and of everything that changes it and secondly to remember to restore the program eventually. Entry points should also be clearly marked as a precaution against later changes to the code being entered, and one needs to be mindful of the branching protocol.

Early during the development of this system, the p.d.p. was parked in video ram between active frames to provide an indication of operation. It was soon found convenient when editing to decode the resulting hieroglyphics into a four-character address in hexadecimal.

Translate mode
The principles of operation are:

that the note values ( durat ions) are translated directly into values of the null frame counter, incremented or decremented for each following + or − respectively;

the stop key codes are first translated into the appropriate register number and status by means of the jump table.

The register status is then added or subtracted from the current status in the console field.

In each code group, the first character is one of the eight directory characters H, R, P, S, T, L, ; and . For H, R, P and T the next two characters are converted to look-up table addresses. For S, there is a further directory of three characters (H, R and P) which enable the same two-character stop codes which follow it to be used on each division of the organ.

Some care was needed over the construction of the look-up table. There is a trade-off between the complexity of the conversion process and the size of the table, which ended up with 384 bytes spread over 2.5K of memory (F600H to FFFCH). The interstices are not wasted: they gradually filled with various subroutines and other scraps of program.

The first step in constructing the look-up table was to provide a complete set of addresses for the notes C1 to C5 (or C6) including "black" notes. Then two more such sets for the other two divisions are required, plus three further sets for stops and one for pistons.

To make it easier to avoid clashes, the table was divided exclusively by the second least significant half-byte of the 16 digit code, as follows:

Hauptwerk stops
Natural keys and pedals
"Black" keys and pedals
Pedal stops
Rugpositiv stops
Thumbpistons

A, B and C
D and E

List 1. PIO and interrupts are enabled for read mode. First part of the interrupt service routine reads in one frame from the console registers.

List 2. Second part of the read mode interrupt service routine compares two successive console fields and transfers information on differences to the frame data field.
Furthermore, the key codes for the three divisions were divided exclusively by the least significant half-byte. From then on, things fell into place quite easily. For example, the address of the first byte in the table for any of the 49 Hauptwerk keys is found by adding B800H. Thus the register number for C3 (433H in ASCII) is stored at FB53H, whilst its status is stored at FB55H. The Z (for #) adds a further 10H to give the corresponding table addresses for HC3#: FB43H and FB63H. At a later stage, extra routines were added to convert flats (indicated by j) to the corresponding sharps. The same conversion process works for all notes except A for which an extra test is required, as shown in List 3. Again to keep the table reasonably compact the stop codes (e.g. P8 for Prinzipal 8) are divided into two groups: the first group having initial character P, Q, R, S, T, U, V, or W with all others in the second group.

The thumbpistons on the instrument in question are divided into five groups designated A1 to E3, plus four “disables”. These codes are converted in a similar manner. The complete table of conversion factors (apart from those for the thumbpistons which are specific to that instrument) is shown at the foot of this column.

Some rearrangement might be required for different stop lists. The stop names and codes used on the instrument to which the interface is connected are shown in Table 2.

The directory character L (lift) causes a search through the 16 bytes of the console field which represent keys and pedals. If the status of any of these is non-zero, their register numbers are read to the data field with status zero. The console field is also reset to zero. Later keying entries in the same frame might cause a further change of status, but the final status is left in the console field when the data field is unpacked by operation in play mode.

When the translate routine is operated, up to eleven lines of 48 characters in video ram are scanned directly, one or two characters at a time, by the video ram pointer according to the video ram line and column count (VRLC and VRCC). Scanning ceases at “.”. Spaces are ignored, except for the ones which define the ends of Duration definitions. Following any space, any character apart from the eight directory characters is treated as an error.

The knottiest part of this section is the part which sorts out the natural, sharp and flat notes and the keyings from releases. One way of doing this is shown in list 3, in which the two-character key codes as typed are designated VRNC (video ram note code) whilst the contents of the look-up table (LUT) are designated ORN and ORS (organ register number and organ register status).

Additional characters could be added to the main directory. For example, “,” instead of “.”, indicating a bar line before the next duration, using a different frame byte; would enable the microcomputer to vary rhythm and tempo. “X” might be used for expression (swell pedal) followed by a number which range say 0 to 1FH to indicate degree of opening. This information could also probably be stored in the frame byte.

Usually it is not necessary to type everything. Most music contains sequences (phrases repeated at a different pitch) and echo passages. When this occurs the first phrase can be edited for the second or subsequent phrases.

Polyphonic extemporization

By this time, the original 150 instructions had grown to some 5K bytes of code, documented in about 60 pages of minute manuscript, some of which had been rewritten several times. Things were getting unwieldy and an alternative approach to programming seemed to be required. Fortich came to the rescue. Using ‘character fetch' and ‘character store', together with four machine-code Fortich words mainly extracted from the earlier programs, communication was soon established between the console field, the data field and the Fortich stack. New console fields expanded, each one having an address defined by a Fortich constant, with
Digital filter design procedure

These examples of the design of a simple digital filter (June issue) and that of a fourth-order Butterworth filter show how laborious maths may be simplified and the recurrence formula written without having to solve a fourth-order equation.

by J. T. R. Sylvester Bradley

Bilinear transformation. The analogue Butterworth filter has a transfer function with a flat characteristic at low frequencies, rolls off sharply at the cut-off frequency and falls to zero at an infinite frequency. The digital version must follow the analogue characteristic as closely as possible, with a flat characteristic in the pass band, roll-off sharply at cut-off, and then fall to zero at $f_{max}$ (not infinity, as for an analogue filter; $f_{max}$ is half the sampling frequency and is the maximum frequency that can be processed by the digital filter). We have to make the frequencies on the z-plane correspond with those on the s-plane of the analogue equivalent. One way to make the frequencies correspond is use the mapping

$$s = \frac{2(z-1)}{z+1}.$$  

It follows that the frequencies on the z-plane are represented by angles ($\omega T$) so

$$\omega T = 2\tan^{-1}\omega/2.$$  

$T$ is the sampling period. Thus the z-plane maximum frequency is $\omega_{max}$ corresponds to an analogue frequency given by

$$\tan^{-1}\frac{\omega_{max}}{T} = \tan 90 = \infty.$$  

So having chosen the cut-off frequency $\omega_c$ as $3\%$ sampling frequency on the z-plane the equivalent analogue cut-off frequency $\Omega_c$ is

$$\Omega_c = 2\tan^{-1}\omega_{c}T/2.$$  

In general, for a nth-order filter $H(s) = \frac{\Omega_n^a}{(s+\sum_{i=1}^n\pm j\Omega_i)(s+\sum_{j=1}^n2\pm j\Omega_j)}$, . . . $(s+\sum_{n=2}^a\pm j\Omega_{n_2})$.

*See page 207 of Digital Signal Processing by Oppenheim and Schafer.

There are poles on the s-plane where $s+\sum_{i=1}^n\pm j\Omega_i = 0$ (i = 1 to n/2). Using the transformation given, the poles on the z-plane are where

$$\frac{2(z-1)}{z+1} + \sum_{i=1}^n\pm j\Omega_i = 0.$$  

For +j$\Omega_1$, $2-2z = \sum_{i=1}^n\pm j\Omega_iz + \sum_{i=1}^n\pm j\Omega_i$.

For pole 1, $z_1 = \frac{2-\sum_{i=1}^n\pm j\Omega_i}{2+\sum_{i=1}^n\pm j\Omega_i}$.

Design method

- Filter data: $f_c$ 3kHz, $f_s$ 8kHz, $f_{max}$ = 4kHz and

$$\omega_cT = \frac{2\times 3000}{8000} = 2.356.$$  

- Pre-warp the cut-off frequency to obtain the equivalent analogue cut-off frequency

$$\Omega_c = 2\tan^{-1}\omega_{c}T/2 = 2\tan 1.178 = 4.828.$$  

- Draw the s-plane diagram for the equivalent analogue Butterworth filter. This has poles distributed equally round the left-hand side of a circle (the Butterworth circle) of radius $\Omega_c$, Fig. 9. The positions of the poles are given in terms of $\sum+\Omega\Omega_j$ as

$$p_1 = \Omega_1\sin 22.5 = 1.848.$$  

$$\Omega_1 = \Omega_1\cos 22.5 = 4.460.$$  

$$p_2 = \Omega_2\sin 22.5 = 1.848.$$  

Similarly for $p_3$ and $p_4$ in conjugate positions.

- Find the positions of the corresponding poles on the z-plane.

For $p_1$, $Z_1 = \frac{2-\sum_{i=1}^n\pm j\Omega_i}{2+\sum_{i=1}^n\pm j\Omega_i}$

$$= \frac{2-1.848-4.460}{2+1.848+4.460} = 0.758 \angle -137.2°.$$
Fig. 10. Z-plane diagram and $|H(jw)|$ frequency spectrum of the fourth-order digital Butterworth filter showing a typical flat response up to the cut-off frequency.

The denominator multiplied out and with like terms collected is

\[
(16A+8B+4C+2D+E)z^4 + (-64A-16B+4D+4E)z^3 + (96A-8C+6E)z^2 + (-64A+16B-4D+4E)z + (16A-8B+4C-2D+E)
\]

Now obtain the coefficients of $z$ in the $H(z)$ transfer function equation by evaluating $A$, $B$, $C$, $D$ and $E$ from the values for $\Sigma_1$, $\Omega_1$, $\Omega_2$, $\Sigma_2$ given earlier ($\Sigma_1=\Omega_2=1.848$, $\Sigma_2=\Omega_1=4.46$). Then

\[
A=1
\]
\[
B=2\Sigma_1+2\Sigma_2=12.616
\]
\[
C=\Sigma_1^2+\Omega_1^2+\Omega_2^2+2\Omega_1\Sigma_2+4\Sigma_1\Sigma_2=79.58
\]
\[
D=2(\Sigma_1^2\Sigma_2^2+\Omega_1^2\Sigma_2^2+\Omega_2^2\Sigma_2^2+\Omega_2^2\Sigma_2^2)=294.04
\]
\[
E=\Sigma_1^2\Sigma_2^2+\Omega_1^2\Sigma_2^2+\Omega_2^2\Sigma_2^2+\Omega_2^2\Sigma_2^2=543.2
\]

The parameters of $z$ in the denominator are conveniently evaluated using the tabular form shown on the next page (top). Totals are normalized to $a_0$. This only affects $G$, which can be made any convenient value in a digital filter, so dividing both numerator and denominator of the general $H(z)$ by $a_0$ yields

\[
a_0=1
\]
\[
a_1=1.968
\]
\[
a_2=1.734
\]
\[
a_3=0.7242
\]
\[
a_4=0.1203
\]

and substituting these values in $H(z)$ gives the transfer function $H(z)=\frac{G(z+1)^4}{z^4+1.968z^3+1.734z^2+0.7242z+0.1203}$

The coefficients of $y$ and $x$ in the recurrence formula can be read directly from the transfer function in this form

\[
y(z) = a_0 y(n-4) + a_1 y(n-3) + a_2 y(n-2) + a_3 y(n-1) + a_4 y(n) + x(n)
\]

The $b$ coefficients in the recurrence formula are simply the fourth-order binomial coefficients. Cross multiplying gives

\[
Y(z).z^4+1.968Y(z).z^3+1.734Y(z).z^2+0.7242Y(z).z+0.1203Y(z)
\]

Fig. 11. Realization diagram for the fourth-order digital Butterworth filter.
Fig. 12. Fourth-order Butterworth filter in action, showing impulse response with the filter "ringing" at 3/4 of the sampling frequency, as expected.

Fig. 13. Filter processing a series of four-sample pulses.

Dividing by $z^4$ gives

$$y(n) = -1.968y(n-1) - 1.734y(n-2) - 0.742y(n-3) - 0.1203y(n-4) + x(n) + 4x(n-1) + 6x(n-2) + 4x(n-3) + x(n-4)$$

written directly into a computer to realize the filter. Impulse response is shown at Fig. 12, from which it can be seen that the filter rings at 3/4 of the sampling frequency $f_s$, as expected.

Planning for plenty

The Government shows no sign of being on the brink of licencing new radio services, perhaps because so far attempts to press it to do so have been ill-organised and incoherent. But it is important that engineers - without whom no radio services can ever be possible - become involved in the discussion about future directions for our radio services. Perhaps they can bring to it some clarity, cohesion - and common sense!

Further reading

Partridge, S. "Not the BBC/IBA: The Case For Community Radio" Comedia Publishing Group ISBN 0 906890 18 7 (9 Poland Street, London WIV 3DG)

"Relay - the other magazine of the airwaves" available quarterly from Box 12, 2A St Paul's Road, London N1 - annual subscription £2 for individuals

References


2. "Comments written answers no.59 and no.60 29 March 1983. Speaking specifically about community radio, Mr Whitelaw said: " . . . given the resource demands of other developments in the broadcasting field, and since the spectrum available in the longer term is not yet known, I have concluded that it would not be right to take matters further at present. However, in the preparation of UK proposals for the v.h.f. Band II Broadcasting Planning Conference next year, account will be taken of the possible needs of community radio with the aim of reducing the spectrum constraints which could otherwise apply in the future; and further consideration will be given to the possible development of community radio when the outcome of the Conference is known."


8. CCIR recommendation 368-2, XIIIth Plenary Assembly, Geneva, 1974

WIRELESS WORLD JULY 1983
Checking op-amps

Checking first-order integrity of op-amps with a transistor curve-tracer needs only simple interpretation, lending itself to "goods inward" testing.

by B. L. Hart

In analogue circuit development work involving the popular 741 operational amplifier it is useful to have available a simple, independent method of checking what might be termed the first-order integrity of the device, i.e. its capability of behaving as a direct-coupled differential gain block. There is certainly little point in making more detailed tests on parameters such as input offset voltage and common-mode rejection ratio until this has been established. This article describes the basis of a simple check that is applicable if a transistor curve tracer is available. The method has two major merits - first, no auxiliary power supplies are required, and second, no detailed interpretation of the display is necessary so the check can be performed by unskilled personnel, e.g. at a "goods-in" test stage.

Terminals C,B,E are collector, base, emitter terminals of the transistor curve tracer the relevant parts of which are shown in block form inside the box. The positive collector voltage sweep of the curve tracer is applied, via the dissipation-limiting resistor RD to the positive rail supply of the amplifier under test: the negative rail supply is earthed. The amplifier is connected for 100% d.c. negative feedback and an attenuated version of the collector sweep is applied to its non-inverting input terminal.

The controls of the curve tracer are set for display of base voltage vB collector voltage. The base step voltage generator cannot normally be switched off - a desirable condition for the check being performed - but its effect can be reduced by arranging for the display of the fewest small amplitude positive-going steps (e.g. four steps with step amplitude 10 mV) and using the maximum value of base drive resistor RB.

Circuit operation can be understood by reference to the signature of a good 741, sketched below. The characteristic has three parts: (i) vB=0 initially because vC=0 and RB is effectively connected to earth, but when vC starts to increase vB rises to the lower saturation level of the amplifier; (ii) vB remains almost constant at its saturation value as vC increases because vC is insufficient for all the bipolar devices comprising the amplifier to operate in the forward-active mode; (iii) vB increases linearly with vC. In this operating condition all the transistors of the amplifier operate in the forward-active mode and the feedback is operative. The circuit behaves as a unity-gain voltage-follower. As there is insignificant potential difference between the inverting and non-inverting terminals, vB= -vC/2, so that the characteristic has a slope of +0.5 and when extrapolated back appears to pass through the origin of coordinates.

The precise location of (i) and (ii) of the characteristic might depend slightly on the particular amplifier but the location of (iii) should be independent of the specific parameters. It is this feature that forms the basis of the check of amplifier integrity. In (iii) there are large changes in the open-loop voltage gain AV of the amplifier because AV is a function of the rail supply. However, there is no significant effect on the slope of the characteristic as this is dependent on the expression AV (1+AV) and AV >1 throughout region (iii). For practical convenience the curve tracer controls can be set so that the horizontal scale (V/cm) is twice that of the vertical scale. Then (iii) has an easily-recognized slope of unity.

The sweep test technique can obviously be adapted for use with an oscilloscope providing it has a time-base sweep voltage output socket and an x-y display facility.

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Characteristic of op-amp chosen from 75 amplifiers by several manufacturers (left) with circuit waveforms (centre). Double-exposure photo (right) shows coincident characteristics from two randomly chosen op-amps. Scales: 1V/cm horiz., 0.5V/cm vertical except for centre traces which are 5 ms/cm horiz., 5V/cm for Vc(top), 2V/cm for Vb (bottom). Curve tracer: Tektronix 575 (RD=2k, RB=22k, R=10k).
Obtaining quick and accurate measurements of resistance has long been a problem for designers and equipment users alike. There are two problems: one is the wide range of magnitudes required (10⁻⁷ or 10⁻³ to one) and the other is the fact that any moving-coil meter is current-driven and so the resistance-to-current relationship is reciprocal. The scale calibration of the meter will therefore not be linear.

In the average moving-coil test meter, even with a low current meter movement, we are restricted to two or at the best three highly non-linear resistance scales. In addition it is usually necessary to provide two power sources if the higher scales are to be useful.

A more accurate method but one far more tedious to operate is the Wheatstone bridge. This requires a galvanometer delicate enough to detect a fine balance yet robust enough to withstand the full out-of-balance current. The basic unit can be expensive and even more so if a two or three-coil galvanometer is employed.

In more recent times the advent of the semiconductor and in particular the highly predictable operational amplifier has allowed the exploitation of two methods of resistance measurement long known but little used.

The first is the ratiometric method. In this case a current is passed through a known resistance and the unknown resistance in series. The voltage across each resistance is measured simultaneously and the value of the unknown resistance is then calculated as the value of the known resistor multiplied by the voltage ratio.

This method can be easily implemented by using the 7106/7107 type of digital voltmeter i.e. Reliable measurement can be made from tenths of an ohm (limited by lead and circuit resistance) to megohms (limited by resistor and circuit noise). The difficulty comes when the behaviour of a changing resistance is important; for instance, when moving a cable form looking for an intermittent short-circuit or earth connection an operator would not find it easy to cope with a continually changing set of numbers.

This article therefore concentrates on the second approach. In this method a specific current is passed through the unknown resistance and the voltage across the resistance is measured. If the current is constant then the voltage to resistance relationship is linear, resulting in linear scales (although one scale per decade is then required). However, if low voltage supplies are chosen, then very low currents with high stability will be required when high values of resistance are to be measured; and if a constant current circuit is used then when there is no load the voltage across the measuring terminals will rise very close to the supply. The following

---

**Figure 1.** In this complete circuit of the unit, ICL7650 is a chopper-stabilized operational amplifier - ordinary op-amps are not suitable. R14 and R15 may be assembled from standard-value resistors in series, as shown.
voltmeter will then get a nasty surprise every time the resistance terminals become open circuit!

The constant current source can be provided using a purpose-made integrated circuit, but protection for the meter is more of a problem. All the i.c.s used in the voltmeter described last month are capable of withstanding the full supply voltage at their input terminals; but there is still the meter movement to worry about because there is insufficient voltage headroom to incorporate current limiting in series with it.

The sensible answer is to place the limitation in the resistance measuring unit such that whatever the condition of its input terminals its output cannot exceed a value just in excess of full scale deflection of the voltmeter on its lowest range. The voltmeter could then be left switched to this range (or be directly connected) and the resistance scale switching effected from the resistance unit.

Circuit description

The circuit is shown in Fig. 1. IC1 is a small transistor-sized i.c. designed to allow a constant current to flow in any circuit with which it is connected in series. The value of the current is determined by a resistor Rm, connected between the R terminal and the negative terminal of the device. The i.c. is tolerant of a fairly wide voltage range across its terminals, but its output is temperature-dependent. Compensation is provided by the addition of D1 and Rcomp (R5, 6).

Without compensation the value of the current is calculated as \( I mA = 67.7 Rm \). Addition of the compensating components approximately doubles this value, and so the formula to use in this case is \( I mA = 67.7 \times 2 \times Rm \). Rcomp should be about ten times Rm. The term approximately is used because, strictly, the value of Rcomp should be found by trial and error for each particular device; but the values indicated here will be found satisfactory.

IC1 and D1 drop about 1.6 volts. To leave some leeway, the voltage across the unknown resistor was calculated not to rise above 1V during measurement. With no resistance being measured (that is, the input terminals open circuit) the terminal voltage would rise almost to the supply rail. To prevent this, IC2 (protected by R7) amplifies the voltage across the input terminals in such a way that when this voltage just exceeds the maximum value permitted for the range in use, the output limits. The gain of the amplifier is changed by R7-R9 to ensure that this is achieved. Taps are taken from the feedback network so that whichever range is selected, the output of the voltmeter provides a full scale deflection of 10mA. This obviates the need to switch the voltmeter.

Since there is no ready means of checking the current out of IC1, test resistors (one for each current range) can be optionally included.

The ability to measure resistances over 1 megohm is not often required in radio work and its implementation is not practical using this circuit. This is because of the low voltage available and the limitation on the voltage applied to IC2 (±8V). Dedicated equipment is more suitable for measurement of high resistance and insulation resistance.

For the odd occasion when high values need to be measured a fair indication can be obtained by connecting the unknown resistance in parallel with a high value known resistor, measuring the pair, then calculating the value of the unknown using Ohm’s Law.

Construction

A suggested p.c.b. is shown in Fig. 2, with a component overlay in Fig. 3. The layout can stand alone or it can be printed on the same board as the voltmeter. Position 7 of the voltmeter switch can be used for the add-on unit if the resistors which only use the switch as a tag-board are moved round.

There is no need to have the voltmeter input divider present at all since the resistance unit output is 10mV. If the input and output leads are kept separate then the wires between the switch and board can be laced together.

Calibration

If the resistance unit is carefully set up there is no need for panel-mounted adjustments because the accuracy is independent of the supply voltage. There are two variables in the circuit: the test current and the gain of IC2. It is unlikely that the average constructor will have the equipment to measure a current of one microamp with any degree of confidence except by indirect methods, so we must look for another reference point in the circuit. We have one if IC2 is driven to its output limiting condition, provided that the supply voltages remain constant. However, as with the voltmeter itself, the internal current-limiting feature of the 7650 should not be used in this circuit (i.e. pin 9 of IC2 must not be connected to pin 4).

Before starting to set up the unit, give the construction a final check, then put a pencil mark on the meter scale about two divisions (4%) past the end of the normal f.s.d. scale position. Leave the input terminals open circuit and set all resistance trimmers to half way except R1 which should be set to maximum.

Power up the circuit and, if a battery model is being calibrated, set the supply voltage to 8V (equivalent to a low battery). Adjust R8 on the 1Ω range, R9 on the 100Ω range and R10 on the 100kΩ range so that the meter needle just rests over the mark previously made on the scale.

Now, a non-inverting amplifier under dynamic conditions has three points of equal potential: the two input terminals and the tap on the feedback divider. In this circuit the lower part of the feedback divider is fixed, therefore the voltage across this portion is equal to the input voltage. Those last three adjustments effectively set the gain of the amplifier so that with a 4% overload at the input we have a 4% overload at the output. At the same time we are defining the point at which the amplifier limits, thereby setting the maximum output to the following voltmeter when the resistance unit terminals are open circuit.
Having set the gain of IC₂ now set the test currents by switching the standard resistors to the input terminals and adjusting R₁ with 111, R₂ with 100Ω and R₃ with 100kΩ to obtain full-scale deflection on the appropriate scales. The adjustments should be carefully carried out at each stage since the test currents and amplifier gains do not go in pairs: one test current serves three gain settings and so each adjustment should be as near perfect as possible.

In battery-operated models with a fresh battery fitted the limiting voltage of IC₁ is higher, so that under input open-circuit conditions the meter needle will hit the forward stop. Accuracy will not suffer, but IC₁ will not limit until an overload of more than 4% has been applied. The half-supply difference between a new battery at 9V and an old one at 8V is 12%. In the new-battery condition therefore the meter tries to read 112.5%, so it is in no great danger.

The table (left) indicates the status of the various parts of the circuit on different ranges; this may also be useful in interpreting the connections of the range switch.

For testing capacitors, the 1MΩ range can be used. The meter needle will move downwards indicating a low resistance until the capacitor becomes charged. Semiconductor diodes can be tested on the 1kΩ range, and the forward voltage drop of the diode deduced from the table. Obviously the test current cannot be forced through a reverse-biased diode.

**Components**

For the four sections of S₁, four one-pole 12-way miniature switch wafers may be used. The diodes and integrated circuits are obtainable from RS Components or from Technomatic Ltd. Cermet trimmers are recommended for the variable resistors. The fixed resistors should be 1% tolerance or better; a suitable range is available from Ambit International.

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**BOOKS**

TV for Amateurs, by John L. Wood, G3YQC. Paperback, 522p. Available from BATC Publications, 14 Lilac Avenue, Leicester LE5 1FN, for £1.75 including inland postage.

It is said that around one-sixth of British households now have a video recorder. No doubt amongst all those householders there must be quite a few who would like to use their video equipment on the air; and for them, this book provides an excellent practical guide. It does not attempt to replace the more comprehensive Amateur TV Handbooks also published by the BATC, but provides enough circuit designs and background information to enable the average radio amateur to set up a basic television station. There is a useful section on operating practices and, for the more faint-hearted, a list of sources of some of the commercially-made transmitting equipment now becoming available to the t.v. amateur.


After the less-than-rapturous reception accorded by the British public to the latest newcomers to the television airwaves, some may wonder how many more channels the viewer really wants. For satellite television enthusiasts, such considerations of programme content do not apply. In the United States, and increasingly in Europe, commercially-available satellite receiving terminals for the home are making it possible even for non-technical people to eavesdrop on the multitude of programmes from the skies. This book is aimed at the installers and owners of such equipment, and it offers a satellite-by-satellite guide to the sort of transmissions to expect and where to look for them. As well as broadcasts for direct reception, these include distribution links for terrestrial t.v. services and international exchanges such as the daily news feeds.

The author is one of the leading British authorities on satellite t.v. reception, and he provides a great deal of practical information which is otherwise difficult to obtain – for example, technical details and operational information about some of the many Soviet communications satellites, much of which has been compiled from his own detailed observations. It must be hoped that the engineers at the Dubna ground-station are not already behind bars as a result of Mr Birkill's revelations: on Friday nights, apparently, they keep their Gorizont satellite channel open with such un-Soviet material as Bugs Bunny cartoons and old editions of the BBC-tv's 'Top of the Pops'.

The book contains no constructive information, though it does offer a few technical suggestions for improving reception. Among these are hints at ways of getting round the video and audio scrambling on which some of the more unsporiting telecommunications authorities insist. The text is extensively illustrated with off-screen photographs, mostly taken at the author's home in the North of England, and the many diagrams include visibility charts and band plans for a wide range of satellite-borne services. It is a pity that the book is so expensive.
 KNOW HOW RESOURCE OR PROPERTY

Your editorial (April, 1983) poses a fundamental question: to whom should the resources of the planet (including the airwaves) and technology (including the entire means of production, distribution and communication) belong? The Left appear to have opposite answers, but in reality their social objectives are more similar than they are different. Both Right and Left stand for a minority possession of the earth’s resources— even though the state capitalism of the Left is presented as ‘public ownership’. Both Right and Left accept the market as the economic arbiter of need— with the Left indulging in Keynesian fantasies about regulating the market so as to make profit compatible with the public interest.

The alternative to a system of minority ownership and control, where goods and services are produced for sale on the market with a view to profit, is a social order based upon common ownership and democratic control of the earth by all of its inhabitants. In such a system of society production will be solely for use, with no buying and selling, but free access to the available resources. The aim of creating a genuine socialist society defies the imaginations of both the Right and the Left, of which which confine themselves to the sterile debate between private and state capitalism. Yet in a world which modern communication technology has turned into a global village, are not those of us who aim to end property and the market and simply produce for use attempting no more than to harmonise productive forces— which are the pillar of a social science—what are the product of centuries past?

Stephen Coleman
Clapham
London

PROGRESS?

By now your readers must all have a wide selection of electronic equipment around the house and in the interest of progress it is time to take a look at the most old-fashioned and inefficient of these, the telephone. To do so may assist anyone contemplating working for British Telecom.

In ten years in central London my phone has gone wrong dozens of times and has taken up to three weeks to repair. Lately research on these goings-on has uncovered an internal message system instituted since the split with the Post Office and rather slower, which is doubtless a good deal more costly as well on account of the much smaller traffic. Another discovery is that the microphone insert is liable to failure every few years which leads to inadequate current for dialling, but they can often be ameliorated by banging. However at best they only yield faint speech at the other end due to their inherent weakness and the long runs of thin underground wiring met in calls across London; this lack of decisiveness cannot be cured as it does not officially exist.

However what we have here is a century-old instrument that has retained a tariff keeping its use to a fraction of the public (when modern technology would have started by considering every household a market and worked from there) and causing severe worry to commercial firms, with many exchanges still based on principles developed by an undertaker, Strowger, bent on preventing cavedropping by operators who approached it. This is a source of deaths, thus emphasising the lack of privacy carefully maintained by British Telecom today with massive bugging installations which Duncan Campbell of the New Statesman has pointed out beam to American homes by microwave the entire cross-channel telephone traffic for some reason— a wild allegation which a Parliamentary reply carefully avoided denying. (There are said to be rocks ahead over enabling BT as a private firm to continue this task.)

A friend who worked at the BT HQ complained that he was kept re-hashing stuff from 6 years before but in the matter of telephone exchanges their deficiencies are more serious. After taking 10 years to perceive that the gas-tube driven one at Highgate Wood did not actually work, they embroiled British manufacturers in the TXE4 which was an early Sixties design still being produced.

About that time they wrote to my mother explaining they were about to install the latest electronic equipment and I observed they wouldn’t even recognise the latest electronic equipment. In fact I was right. Well, the right thing to run telephone exchanges is a computer, but ITT, according to Anthony Sampson’s book “ITT— the Corporate State”, used to keep a man in New York specially to stop engineers developing computers, since they might have involved some sort of collision with IBM. So there they were messin around with r.f.l. in the TXE4, and System X was born, another failure the last I heard.

When I consider the robust telephones we had before the war which often had to be held away from the ear to reduce volume, much the same as the instruments people were using on 300 mile runs of robust overhead wires before 1900, I remark that since then we have been robbed of telephone numbers by the introduction of STD, whereby the dialling code is a function of two variables, caller’s exchange and exchange radius. We have been given coin boxes which do not take 20p pieces followed by coin boxes which do not take 5p pieces, and the latter have no provision for directories.

None of this is funny at a time when electronics everywhere is getting cheaper in leaps and bounds. Obviously the private telephone is a cost problem since many people only make 2 calls a week. The obvious answer these days is simply to incorporate elaborate micro-circuits to do something fairly appropriate; I suspect this would first involve bunching phones in fifties on a sort of ring main rather like the first transatlantic cable speech amplifiers, supplying +50V and —50V and allowing each phone a 1.5V drop as its supply; speech and instructions would be digitized and sent by packet-switching techniques, but later I would expect telephones to be powered from subscriber’s mains so they could be called up by electronic device in view of techniques of optical isolation available for decades now at speech frequencies, I would expect subscribers to be able to have such isolation if they wished and These have been given to be allowed to connect anything they pleased provided it would receive and transmit calls while avoiding the frequencies used by BT for dialling via trunk lines.

Bernard Jones
London W1

AERIALS AT SEA

Perhaps we are tiring of the subject of ‘Aerials at sea’. However, I have a suggestion relevant to liferaft aerials.

A useful aerial would be a vertical loop. This works well at low height, and as it is low-impedance, would not be too upset by salt spray. The main problem with a loop is to obtain a sufficiently low r.f. resistance. This is achieved by using a sufficiently large gauge of conductor, which may be hollow, because of skin effect. I imagine a loop in the form of an inflated torus, similar to a large bicycle inner tube, metalized on the enclosed surface, made part of the structure of an inflatable liferaft.

As a starting point for a design, a land-based rigid loop, as used by the US Army, is described in “Amateur Radio Techniques” by Pat Hawker (G3VA) (p 234, 5th edition).

D. Parnell
Pickering
N. Yorkshire

RADIO AMATEURS EXAMINATION

The periodic review of the syllabus for the Radio Amateurs Examination is now due and the City and Guilds R.A.E Subject Committee has established a working party for this purpose.

The principal objective of the examination is to ascertain the candidate’s ability to operate an amateur station within the terms of the licence and not necessarily to test expertise in particular aspects of the Amateur Service. Suggestions for alterations or amendments to the existing syllabus would be welcome and should be sent to Mr S. D. Allison, City and Guilds of London Institute, 46 Britannia Street, London WC1X 9RG.

S. D. Allison
City and Guilds of London Institute

CITIZENS BAND

Having followed, within the pages of JW, the running battle about CB in your country for some time, I am finally moved to make the profound comment, “history repeats itself.”

To read these letters bemoaning the advent of CB by some amateurs, and the such lucid arguments for its introduction by those in favour, is to pick up dusty back issues of many local (Australiian) magazines of nearly a decade ago.

Now it’s legal, and still the battle continues. With the benefit of my 20-20 hindsight, may I make a few observations, as it is possible to interpolate between the British scene and that which convulsed Australia and led to so many changes.

Many amateurs believed that CB would lead to the demise of amateur radio as a hobby. This has as yet not happened in this country; in fact the opposite has taken place. The number of amateur licences has increased rapidly. The many “new friends” have come up through the ranks of the CB operators.

At first there was a large amount of piracy outside the legal allocations, but apart from the few ‘hard core’, who have always been with us, this seems to have lost its fascination. There was a time when nearly all the repeaters had their trouble makers, it took some time to educate some of the normal users of these devices not to
react, as this surely gave 'them' the encourage-
ment to continue. The worst of these offenders were caught and dealt with by the authorities, in due course.

It was a two way learning process, the staff of 'Telecom' had a lot of lessons to learn, not in the least hindered by the archaic wireless telegraphy act, that has yet to be brought up to date with changes since the two world wars. But now it seems to be working. The rationalization of the processes of obtaining a CB licence and the availability of cheap, mass produced equipment for the 'legal' channels, has provided the majority with what they want, personal two way radio.

The initial CB hysteria has died to quiet obscurity, in fact many amateurs at times use radio. The availability of licences and many more have expensive CB equipment sitting in the cupboard unused for years. The once crowded bands are at times totally quiet; u.h.f. users have the required facilities once pioneered by the edited in-

In fact many amateurs have CB licences; you see the wife is not interested in A.R. but it's very useful to be able to contact her via CB.

Robert Wilkins V3AUR
Tallangatta
Victoria

DESIGN

COMPETITION

I was interested to see that one reader has come up with the idea of informing blind persons the contents of cans and packages without opening them. No further information was given.

I should like to suggest (if this is not the method used) that it would be a simple matter to 'read' the bar codes that are appearing in-

creasingly on modern packaging by means of a light reader; decoding the information and re-

moving extraneous information normally used in stock control; and presenting the edited in-
formation to the blind person by means of a voice synthesizer through a private earpiece.

Being completely without technological training I would nevertheless suggest that in this day and age this chip is not be beyond the realms of possibility to produce a fairly light-
weight pack which could be worn like a handbag over the shoulder and weigh about the same.

Once the technique had been perfected there is no reason why bar-code labels could not be used in other circumstances to aid the blind to read. We already see these codes on the edges of supermarket shelves and on packaging. Why not make complete sentences and print books in the same manner. Naturally a monotonous Da-

lek 'voice' would never replace the enjoyment of silent reading that Braille offers but this would be ideal for official pamphlets for the blind, direc-
tion signs and other informative instruc-
tions.

J. Devereaux
West Midlands

Some weeks ago you or one of your colleagues was interviewed on the BBC Radio London programme for the Blind "Guideline". I should like to put forward some suggestions for suitable projects that may be of interest to your readers.

Firstly, let me give you some background detail as to the reason for these suggestions. I am a member of the British Computer Associa-
tion of the Blind, which is affiliated to the British Computer Society. The aims of the B.C.A.B. are to promote the employment and training of blind and visually handicapped people within the field of computing. Due to my specialist knowledge, I have a degree in electronics, I provide technical liaison for the association, particularly in relation to computer-
terminals for the blind and communications problems.

At the present time there are some 90 blind people in the UK, and the figure is growing every month, who use "paperless Braille machines". These are essentially microproces-
sor-based devices which have a "soft copy" electro-mechanical Braille display. They are used by blind people as computer terminals or word processors or simply to provide an electronic filing system. One of the major prob-
lems facing the blind, particularly the profes-

ional, is that of finding information, i.e., for example, a particular reference book is available on tape or in Braille. At the moment this in-
formation is held somewhat haphazardly in dif-
ferent locations and in different catalogues, with numerous supplements.

As a result of the increased availability of these machines the association has now begun to discuss the viability of setting up a data base for the visually disabled. Such a data base would provide information on Braille books, tapes and even aids available.

We would like ideally to use Prestel or a similar system. However, this poses a few tech-
nical problems which might be solved by one of your readers.

I should like to also make some general points of guidance to your readers. There is little point in re-inventing the wheel; talking terminals are already available from a number of sources. There is little chance that an individual will have the necessary resources to produce a better one. Simplicity is the best approach.

If a device is to be widely used, its cost must be low and it should be easy to use, remember that many blind are elderly.

Finally I would like to make contact to me if you would like any assistance or advice on the suitability of aids for the blind. The association is always pleased to support ventures which can benefit the blind and the field of electronics offers many as yet unexplored possibilities. My office telephone number is 0242 431344, ext. 6003.

Gary M. Robinson
St. Leonards-on-Sea
East Sussex

List of projects

Project 1.

Current Viewdata systems, Prestel etc use an asymmetrical duplex system for the transmis-
sion and reception of the data between the users termi-

nals and the data base. Unfortunately most of the paperless Braille machines used by blind people are designed to run under a more conventional symmetric duplex system.

A line speed converter is therefore required to convert the 1200 baud line speed signal used by the modem to a 1200/1200 symmetric duplex signal from the Braille machine. The converters for the conversion from 1200 to 75 baud is only required for the backward channel, and this data is coming from a keyboard any buffering problem will be minimal. Though commercial line speed converters are available their cost is prohibitive and their capabili-
ties are excessive for this simple task.

Such a device would enable a paperless Braille machine to be used in conjunction with one of the cheap "Prestel" type modems that are appearing on the scene and through it gain access to a data base.

Project 2.

A mains on/off timer.

This device which would control any mains de-
vice would plug into the standard 13 amp mains socket and the device to be controlled into it. The mains switch would be that the setting would be electronic and would have a spoken numeric readout. There are a number of simple numeric speech chips available so that speech in this simple case would not be difficult.

A more sophisticated version of this could be perhaps extended to give multiple settings both for on and off so as to allow the blind to have a timer control facility on things like tape recorders etc. Existing ones rely on the blind user being able to read Braille or have a good sense of touch and since they are tactile they can be somewhat inaccurate when trying to set a precise time.

Over the years there have been several methods for the disabled to signal help when they are in difficulties - cords, bells, lights, whirlies etc. and, of course, the telephone. They are all so limited that they are virtually useless for the very people for whom they are most needed - the very severely disabled, including the frail elderly. When they fall to the floor, or in similar difficulty, they are helpless; they cannot reach any of the communication aids presently sug-

ggested.

What is needed is a portable fail-safe alarm, a device that can be worn round the wrist or neck which the person can immediately operate, ac-
tivating automatically the telephone or similar means of communication to an outside source of help. I have to say that there are one or two such devices on the market, but they, too, are limited and, I think, expensive.

If something really suitable could be pro-
duced it would be a tremendous boon for the increasing numbers of disabled people. There would be an enormous market amongst them, and Social Services departments, especially with the increasing emphasis on community care.

I hope this will be taken up.

E. M. Cohen
Southend-on-Sea

STEPPER MOTOR

DRIVE

Unfortunately, I do not seem to have got my main point over to B. S. Beddoes (May Letters), despite the headline description "simple, cost-
effective."

My circuit is no more complex than the resis-
tance limited drive it is intended to replace (just one extra small transistor T7 per phase) and yet offers greatly improved efficiency, and hence savings in the cost of power supply components.

His circuit is nothing more than a 'chopper drive' (did he try positive feedback around the comparator?) and so is very much more complex then mine. He offers voltage control of current, better temperature independence and, of course, has an input. The price of these features in terms of component count, p.c. area and reduction of mean time between failures must be carefully evaluated.

Incidentally nowhere in my article do I claim originality. I put the circuit in the category of "one of those obvious things that needs saying." A. D. Bailey
Loughborough
Leicestershire

WIRELESS WORLD J ULY 1983
GATE SYMBOLS

May I ask for guidance through your columns as to what logic symbol is appropriate to indicate the function of the following circuit?

This gives an output only when one of the inputs is in the opposite logic state to the other two, and should thus, I presume, be called a Disparity Gate. The truth table is as shown:

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>All 0</td>
<td>0</td>
</tr>
<tr>
<td>One as</td>
<td>0</td>
</tr>
<tr>
<td>Two as</td>
<td>1</td>
</tr>
<tr>
<td>All 1</td>
<td>0</td>
</tr>
</tbody>
</table>

When the new logic symbol pundits have worked out that there is an elaboration of this circuit that can convert it into a Two out of Three Quorum Gate* which has the additional property of being exclusive.

Power supply? Anyone who has not been ordered to design circuitry without any power supply specified doesn't know what it feels like to be an electronic engineer!

J. C. Rudge
Harlington, Middlesex


HERETIC'S GUIDE TO MODERN PHYSICS

In his May article, Dr Scott Murray is yet again guilty of the inexcusable — misquoting facts out of context. This was blatantly manifested when he used Dirac's postulation of the positron as a pretext to an attack on the tunnel effect, despite the fact that there is no connection between the two.

Dirac's calculations had a square root in the result for the charge of electrons. This allowed them to have either negative charge-electrons, or positive charge-positrons. Dirac never suggested that positrons had negative mass. He did not have to 'explain' the positron; his mathematics predicted it and physics later confirmed its existence. Dr Murray appears to have confused the positron with its negative mass 'counter', the hole. The holes are gaps in a free electron continuum, and in that context only can you have positively charged particles with negative mass.

In conclusion, Dirac's antimatter concept may appear in some science fiction, but it is very much science fact. Dr Murray's use of this, misquoted out of context and in any case totally irrelevant, is a very poor attempt to mislead gullible readers.

M. J. Niman
Manchester

In the May issue a number of letters critical of Dr Scott-Murray's long-running saga 'A Heretic's guide to modern physics' appeared. In commenting on mine Dr Murray wisely sidestepped the first two paragraphs and concentrated on the third. A number of ideas which were current half a century ago have not stood the test of time, and the notion of duality is certainly one of them. In fact, in publishing my first letter I emphasized that 'quantum objects' such as photons and electrons were neither waves nor particles, exactly the point made by Mr Gleave in the May letters. Nevertheless Dr Murray in his first comment on my letter chose to flagrantly misrepresent me by stating that I had written as if 'light is both (particle and wave) simultaneously'.

In this context a feature not brought out by Mr Gleave is the fact that quantum mechanics provides a single mathematical description of photon behaviour which covers not only the quasi-particle and quasi-wave aspects, but in addition the in-between world typified by the remarkable kinds of behaviour shown in such types of Mössbauer experiments. Originally Planck and Einstein attributed properties to photons in an essentially ad hoc fashion, but for some decades now theoretical accounts of behaviour have been available (see Heitler's 'Quantum Theory of Radiation') which show that they must be regarded as behaving in a way far removed from the billiard-ball-like objects of Dr Murray's imaginary physics.

In the unpublished letter I also pointed out that the spectra of gamma rays from radioactive sources obtained using Ge(Li) detectors regularly showed features indicating that over a microsecond or so any bunching was less by some orders of magnitude than the millions which Dr Murray in his October article said he would settle for, yet that these gamma rays still showed interference effects, in that their energies (or wavelengths) could be determined by passing them through a quartz crystal acting as a diffracting grating. These facts too he felt entitled to ignore.

Turning to his second comment, I must first admit some order of magnitude difficulties of my own: a photon of visible light has a wavelength, not of some tens, but of some thousands of interatomic spacings. He asked in connection with the optical photo-electric effect why is it that only one of these (millions) of electrons is ejected by the photon's impact?*. The answer is simple — on the purely classical basis of the image force between a charged conductor it will take a finite amount of energy to remove even a conduction electron from a metal. Photons of visible light simply do not have enough energy to remove more than one conduction electron from alkali metals such as sodium and potassium.

He went on to ask 'what physical mechanism determines which electron is ejected, and how wide is a photon, please?' Now Doppler shift measurements show that the conduction electrons in metals have speeds of about 0.1% of the speed of light, some ten times the value to be expected from classical theory, but fully in agreement with the predictions of wave mechanics. If one assumes that the delay between a photon hitting the surface of a metal and any subsequent emission of a photoelectron is of the order of 1 ps, a typical conduction electron will in that time have travelled some thousands of times the average distance between neighbouring atoms, so that willingly the photon will have interacted with electrons over an area comparable with the square of its wavelength. These same conduction electrons have De Broglie wavelengths of several interatomic distances, and according to wave mechanics this is the feature which allows them to move freely about in metals. Dr Murray really should try his hand at using his ideas to account for, say, the temperature dependence of the resistance of metals at liquid helium temperatures. Although no-one would realize the fact from reading his articles, it was the success of wave mechanics in interpreting this dependence and many other puzzling aspects of the behaviour of solid materials that first persuaded many physicists to consider the new theories seriously.

C. F. Coleman
Grove
Oxfordshire

Abstract Law is just as unbreakable in Copenhagen as anywhere else!

I have already touched briefly upon the law of pressure, resistance and flow: another is the law of decay from interaction.

The further interaction is reduced, the less decay there is. Insulators attempt to stop interaction, and they succeed more or less. There is not, nor can there ever be a perfect insulator, and any perfectly insulated device would be an absolute singularity having nothing to interact with. Needless to say, there is one, and only one, and you are in it up to the eyes and beyond!

For these reasons, no potential barrier can be absolute, and I could not really care a tinker's cuss how electrons manage to get past it, though I am happy to hazard a guess (based upon the same deductive logic which says that energy exists) that there is a massive carrier in apparently empty space through which energetic interaction occurs.

Thus, while I positively adore Dr Scott Murray, it seems to me that his subjective arguments are so shallow and superficial that they merely invite argument from the specialists of this world: the drops in the ocean may be seen as particles in motion, and it takes one particle an impossible amount of work to make a wave.

What is all the fuss about? Rubbing the nose of a mess-maker in his mess merely makes him argue. Let them stew in it: make the prognosis, and let time prove it.

Dirac and Bohr must come to accept that space is not empty: it just appears that way because you can't catch a basic building block! There is nothing smaller with which an adequate mesh can be made, so that it inevitably slips through the holes.

It is a simple matter of inter-disciplinary analysis of which the single discipline specialist is mentally incapable. Farm the blighters!

James A. MacHarg
Wooler
Northumberland

WIRELESS WORLD JULY 1983

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In Wireless World of April 1983, p.48, Jones gives an impressive list of oversights and omissions which were present in the interpretation of the Michelson and Morley experiment. However, I missed one important problem I have always felt when dealing with this problem.

In this experiment it is always taken for granted that the velocity of light does not change at reflection. However, how can one be sure about that? Apart from Romero and similar determinations of the velocity of light I do not know of any other way of determining the velocity of light, thus without mirrors and lenses. On the contrary, from the point of view of light a stream of photons it is at least just as likely that light might change its velocity at reflection: if a photon excites an electron which on its turn produces another photon there is no reason why the velocity of light of the original photon should be the same as the newly created one. But if the velocity of light may change at reflection, already for this reason the experiments of Michelson and Morley cannot produce a difference in the velocity of light (after reflection).

Dr. M. O'anga
Haarlem
Netherlands

I was very interested to read M. G. Wellard’s letter (January), including his comments on N. Rudakov’s book “Fiction Stranger than Truth”, which I have also read with considerable interest.

Wellard states that Rudakov has collected “more than enough evidence to show that the physics Establishment is in the hands of ideological extremists”. It is a little unfortunate that he then goes on to mention, as a sample of that evidence, a somewhat exaggerated statement of Rudakov’s. Wellard refers to Rudakov’s citation of a review of one of Harold Aspden’s books, and repeats Rudakov’s assertion that the review says that Aspden is a crank! Although the review is somewhat pejorative, it is an exaggeration to say that it calls Aspden a crank!

On the same page of his book (p.9), Rudakov writes that “Lyttleton is of the opinion that the truth of relativity seems so self-evident as to be beyond need of discussion by any sane people.” Although he does not give the source, he is fairly obviously referring to a letter to The Times, which is reproduced on pages 10-11 of Herbert Dingle’s book “Science at the Crossroads”. A careful reading of the letter shows that what Lyttleton wrote is completely different from what Rudakov attributes to him.

As Rudakov rightly says, (p.7), “Silence is the main weapon of the relativists.” There is also ample evidence that members of the scientific community view scientific heretics with scorn and refuse to take their arguments seriously, and I was glad to see Wellard’s reference to the scornful heading of an article in New Scientist. After perusing the relevant correspondence and seeing the heading “Einstein 6, Cranks 1”, the reader may possibly conjure up a picture of Einstein playing golf. Whatever game the writer of the heading had in mind, it certainly was not cricket!

Ian McCausland
University of Toronto
Canada

The principle of indeterminacy is not a topic which I have studied to any great extent, but I would like to put a question to Dr. Murray. He argues in your March issue that it is possible to determine what the velocity of an electron is “to any accuracy we please”. But all electrons look alike. How then can we know whether the electron on which the second observation of position was made is the same as that on which the first observation was made?

K. S. Hall
City University
London

FORTH COMPUTER

In his article on a FORTH computer Brian Woodroffe takes the dangerous step of comparing microprocessors c.p.u. by preparing a number of examples of small isolated sections of code. Whilst I do not wish to take a standpoint in favour of any particular device I would like to point out that this sort of comparison is, at best, worthless and can be misleading. To quote one counter example, the 8088 +4 operation could be carried out via the instructions

POP AX
MOV BX, SP
ADD [BX], AX

equal to the 6809 in terms of instructions, or, BP has a fixed relation to SP, as is the case in most executing programs,

POP AX
ADD [BP + a] AX

where X is an assembly time constant. I hasten to point out that I am not trying to challenge his choice of processor but simply to point out that his reasoning is flawed. I have no doubt that any software engineer (sorry Mr Catt) familiar with the other c.p.u. mentioned could improve upon the quoted examples.

J. O’Connor
Crewe

ELECTROMAGNETIC DOPPLER

In the May issue Mr S. Hobson offers his explanation of c. m. Doppler. His assertion that the mechanism is ‘v’ is not helpful, ‘v’ is the cause, a change in frequency is the effect; the mechanism sought is that which links the two. The description he gives for ‘wave crests’ is equally valid if applied to a string of bullets fired at B by A and in this case the velocity of the bullets as seen by B would be the equivalent of (c-v).

What S. H. does is to divorce the fact that the light travels from A to B from the fact that A and B are moving apart, carefully avoiding describing the resultant composite motion. His final suggestion that v is not velocity but rate of change of distance is playing with words. The light must leave A and must arrive at B and at each must have an observed velocity, frequency and wavelength which together conform to the equation:

\[ v = \beta \]

The light leaves A at velocity c. If at B one assumed that it still travels at a relative to A then its velocity relative to B will be c-v. We can write

\[ a_A = f_A \]
\[ a_B = f_B \]

\[ f_A = c - v \]
\[ f_B = c + v \]

This then is a common-sense description of events which very elegantly produces the right answer but is of course heresy.

If it was not possible by observing the light from a source to tell whether or not the source is moving, one could logically deduce that the motion of light is unaffected by the velocity of the source. As it is possible to tell if a source is moving, then clearly something is affected by movement. If the frequency of a periodic function is lower, then either it is going past more slowly or the ‘wave crests’ are further apart. If one is not a heretic, light cannot be going slower, therefore the wavelength must have increased. What causes the wavelength to change? Where does the change take place?

Suppose at the moment of measurement B passes a third observer D stationary with respect to B. If the change in frequency observed by B is attributed to a yet unexplained change in wavelength which has occurred at a yet unspecified point between A and B how is it that D does not also observe this change in wavelength. He is at the same point of time and space as B, is observing the same wave as B observes, passing him at the same velocity as it passes B.

Heresy is so much simpler.

J. Kennaugh
Cornwall

Like your correspondent Kennaugh in Wireless World, May, 1983 I have been looking at the Doppler theory.

If one considers a particle stream where there is velocity, frequency and separation instead of velocity, frequency and wavelength then the Doppler effects can still be expected.

In calculating the relative velocities of the source and the particles with respect to the observer one can invoke the presence of an ‘ether’ against which the velocities are measured. These can then be summed to get the relative velocities and to remove the ‘ether’. This may at first sight appear to be a pointless exercise but if it is done for an Einsteinian system then it is obvious that for every value of a relative velocity (of the source with respect to the observer) there is an infinite set of pairs of velocities (of each with respect to the ‘ether’) that produce the same Doppler effect. With a non-Einsteinian system there is only one set of velocities that produces the effect.

The reason for this is that in a non-Einsteinian system the movement of the source produces a change in the velocity and the separation of the particles but not the frequency whereas a movement of the observer produces a change in the velocity and the frequency of the particles but not the separations. Thus the movements of the source and the observer do not cause the same change in the Doppler effect whereas in an einsteinian system they do.

An interesting consequence of this is that in a non-Einsteinian system the universe has built into it a means of identifying which object, source or observer has changed its motion. The contributions of each body to the total relative velocity can thus be calculated. It would appear, therefore, that some velocities are relative and some absolutely so.

James L. Smith
St. Albans
Hertfordshire
variables for a rash of new pointers. Two further machine-code words provided nine-bit multiply and divide by two which greatly speeded up the process of transposition, made faster still by an alternative word to transpose by eight notes at a time. This is particularly useful for transposing between divisions of the organ – fortunately, care had been taken when the hardware was installed to wire the 128 keying register lines in a logical sequence.

To date, the extemporizations available are largely based on canon in two or three parts, with independent time and pitch offsets (mostly defined by variables) for each part. Each part has its own p.d.p. in the input data field (representing the theme) and its own input and output (i.e. transposed) console fields. The Firth program then combines the two or three parts into a new output data field, which can then be auditioned using play mode in the usual way. Up to now, therefore, the machine does not perform true extemporization, that is to say in real time, but the speed of operation suggests that this is feasible if the correct interrupt priorities can be established.

For a three-part canon, a seven-branch decision tree is needed to determine from the durations whether all three, which two or which one of the parts are (or is) the next to move. A decorated line, which can be combined with a two-part accompaniment, is provided by using the two-part canon routine but allowing only the latest part to move to appear in the output console field. With the appropriate time offset, this can provide a highly synchronized variation on the original theme, plus curious 'hocket-like' effects when the original notes depart slightly from strict time or strict legato.

The next thing to do was to provide some harmonization rules. By temporarily transposing the console field for one part and comparing it with another, any interval can be detected and changed into any other interval. To date, this has been used only to turn adjacent notes into minor thirds, but even this simple rule can produce charming suspensions and cadences (charming at least in relation to their somewhat austere surroundings).

The structure of the Firth words seems to clarify by an interactive process (by the programmer, not the computer) as the work proceeds. For example, the harmonization rule mentioned above boils down to the word 'augment minor seconds', abbreviated to AMS. To use this, it is simply inserted at the beginning of the definition of 'transfer and/or console fields' which prepares the combined console field for output to the data field. Needless to say, if the machine were "performing" in real time, the output data field would not be necessary.

Perhaps the most charitable thing which could be said about the results from the extemporization routines after six weeks of spare time work is that they offer plenty of scope for further development. Probably the next fruitful step would be some rules for motion of the separate parts.

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Table 2. Stop-list codes used in translate mode, Copeman Hart Chamber Organ, London, 1974/1982

<table>
<thead>
<tr>
<th>Manual I</th>
<th>Manual II</th>
<th>Pedal</th>
</tr>
</thead>
<tbody>
<tr>
<td>16' QD</td>
<td>8' G8</td>
<td>Prinzipalbass 32' FD</td>
</tr>
<tr>
<td>8' PB</td>
<td>4' P4</td>
<td>Untersatz 16' UB</td>
</tr>
<tr>
<td>8' VB</td>
<td>4' F4</td>
<td>Prinzipal 8' P8</td>
</tr>
<tr>
<td>8' R8</td>
<td>Nasat 2½' N3</td>
<td>Gedeckt 8' G8</td>
</tr>
<tr>
<td>4' O4</td>
<td>Gemshorn 2' G2</td>
<td>Oktav 4' O4</td>
</tr>
<tr>
<td>4' S4</td>
<td>Terz 1½' T2</td>
<td>Nachthorn 2' N2</td>
</tr>
<tr>
<td>2' W2</td>
<td>Sifflo 1' S1</td>
<td>Muxtur Il-1 MR</td>
</tr>
<tr>
<td>1½' Q1</td>
<td>Zirbel II MR</td>
<td>Kontraposaune 32' KP</td>
</tr>
<tr>
<td>8' K8</td>
<td>Krummhorn 4' S4</td>
<td>Posaune 16' PB</td>
</tr>
<tr>
<td>4' SK</td>
<td>Schlamei 4' S4</td>
<td>Trompete 8' T8</td>
</tr>
<tr>
<td>16' RD</td>
<td>Tremulant TR</td>
<td></td>
</tr>
<tr>
<td>8' T8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** As is usual, D indicates Double

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**EVENTS**

June 14-17
Tectronica 83; International exhibition for test, measurement and control and for the laboratory. Earls Court, London. Industrial and Trade Fairs Ltd. Tel: 021-705 6707.

June 21-22
World Electronics: Europe – the way ahead. Financial Times conference to be held in London. Details from Financial Times. Tel: 01-248 8000 ext 4123.

June 21-23
Compec North 83; Business computer show. Belle Vue, Manchester. Reed Exhibitions. Tel: 01-613 8040.

June 22-24

June 27-July 1
Digital signal processing; course organised by the George Washington University (18 St George Street, London W1R 9DE), at Imperial College, London. Tel: 0626 83 3012.

June 27-29
Videotex '83; Conference and exhibition at the New York Hilton, NY, USA. Organised by London Online Inc. Details in UK from Online. Tel: 09274 28211.

June 27-July 1
Laser 83 Opto-electronik. Sixth International Congress and trade fair. Trade Fair Centre, Munich. AMEG, Messegelande, Postfach 12 10 09, D-8000 München 12.

June 28-29
Comex 83; Conference and exhibition of mobile radio communications and paging systems. De Vere Hotel, Coventry. Federation of Communications Services. Tel: 01-635 2657.

June 30-July 1
An applications-oriented approach to artificial intelligence. Course organised by the George Washington University at Imperial College, London. For details tel: 0626 83 3012.

July 3-8
Semi-custom ic design and vlsi; IEE vacation school at Edinburgh University. IEE. Tel: 01-240 1871 ext 330.

July 3-8
Interfacing techniques for microprocessor instrumentation. IEE vacation school at University College of North Wales. IEE. Tel: 01-240 1871 ext 330.

July 3-15
Microwave solid state components and subsystem design. IEE vacation school at Leeds University. IEE, tel: 01-240 1871 ext 308.

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**WIRELESS WORLD** JULY 1983
Aspects of audio amplifier design

Given sufficiently high linearity of certain silicon bipolar transistors with initially linear regions of their input characteristic, it seems expedient to use them in audio amplifiers — especially those feeding horn loudspeakers — without overall feedback.

The perfection of audio amplifiers involves not only the perfection of electric circuits but the perfection of amplifying elements — transistors — as well. Efficiency in audio amplifiers may sometimes be considered a secondary technical requirement because of the existence of compact effective and relatively cheap power supplies with the mains to convert the 50-60Hz frequency at the power supply input to a higher one. This article illustrates, through the example of single-ended amplifier design for horn loudspeakers without overall feedback, some aspects that might become significant in the future, as well as in the present time. High stability and (as a rule) better dependence of non-linear distortion on output voltage can be achieved by simple methods and without sacrificing other parameters. In push-pull amplifiers, some compensation of the second harmonic exists but with an increase of third harmonic that is more considerable than the decrease of the second. Another essential feature of single-ended amplifiers is the equalising of the amplifier load of the loudspeaker by the small resistance in the emitter of the Darlington output stage.

Modern horn radiators have an output exceeding 114-117dB (1m/1W) when using cobalt, samarium and other highly efficient magnets for normal polar response. The output of low-frequency loudspeakers without horns is limited by the flat amplitude response at low frequencies, this output usually being no more than 94-97dB. Bearing in mind that the maximum power of low frequency loudspeakers is limited by voice coil heat dissipation and by the nature of the moving system as a whole, and taking into account large intermodulation distortion in i.f. loudspeakers at .P_out>5 to 25W (the ear becomes more sensitive to a.m./f.m. as sound pressure level increases), the maximum power of low-frequency loudspeakers cannot exceed 25-200W. And this has been borne out in practice. In addition, horn radiators possess specific (non-smooth) distortions because of the change from a sinusoidal wave to a shock wave and a non-linear elasticity of air in the plenum chamber for large throat amplitudes. These distortions occur when the acoustic power divided by the input horn area is greater than about 0.25W/cm². If the throat area is 6cm² and the efficiency around 50%, then the rated amplifier power will be about 3W. Thus the power output of medium and high-frequency channels of power amplifiers should equal 0.25 to 2W, and taking account of the spectra of musical signals, we come to a value for power output of 1 to 4W.

Such amplifiers can be designed on the basis of a single-ended circuit, below, and can meet the most stringent up-to-date requirements provided that all of their components — capacitors, resistors, transistors — also meet up-to-date requirements.

Realisation of such an amplifier with either valves or field-effect transistors gives no advantage from the point of efficiency, output resistance and even linearity. The output resistance of valve and field-effect transistor amplifiers cannot be reduced sufficiently without overall negative feedback, or special complicated circuits if followers are used. Then the output resistance is

\[
R_{out} = \frac{R_1}{1 + \mu} \geq 20\text{ohm.}
\]

From equation 1 (appendix) the output resistance of followers using bipolar transistors, particularly a Darlington transistor, reduces to

\[
R_{out} = r_{f3} + \frac{(R_1|R_2||R_3}{Z_{in}} \times Z_{in}
\]

In this case \( R_{out} \leq 0.4 \) to 0.2ohm, with \( R_3=1.5k\Omega, Z_{in}=3x10^3 \). This value of output resistance is enough even for a low frequency channel.

In general, the output resistance is a complex value \( Z_{out} \), the modulus of which increases with increase in frequency due to weakening of local negative feedback \( (b_{212}) \). The input resistance of Darlington transistor is limited by resistance \( r_{f3} \), from equation 2 (appendix). In general, the input resistance of a follower is also a complex value and approaches \( R_{f3} \) with increase in frequency. Moreover, \( f_{upper} \) (\( f_c \) is pole frequency in \( Z_{in} \), see appendix).

As a first approximation, one may ig-
WIRELESS WORLD JULY 1983

Born in Moscow in 1947, Yuri Miloslavsky graduated from the department of physics of the Saratov State University in 1971. Assigned to a military plant in Saratov, he worked in the fields of microwave technology and digital telephone systems. Later he joined the scientific research institute of television and broadcasting in Moscow where he worked on problems of electroacoustics, architectural acoustics, subjective aspects of sound reproduction. Since 1978 he has been in the laboratory of architectural acoustics in the Moscow institute of the physics of construction. Last year he emigrated to the USA.

more variations in non-linear resistances \( r_b \) and \( r_e \) as well as weak variations in \( C_c \) and \( C_r \) as a function of signal level, and adopt their average values relating to the d.c. operating points \( \{ \text{Idc}, V_{CE}\text{dce} \} \) and rated \( P_o \) of 0.25 to 0.5 \( P_{r\text{max}} \). (We ignore in our case internal voltage feedback due to base thickness modulation; \( \mu = \frac{dV_e}{dV_c} \text{IEconst} \approx -\frac{q\tau}{kT} \text{const}/V^2 \).)

When supplying short pulses with small rise time to the follower the output cable capacitance may influence the form and amplitude of the pulses. The transition time of the follower should be smaller than the transition time of the signal.

In the calculation of the transient response (as, for example, using the integral of Duamel) it is not necessary to take into account the isolating capacitors used as crossover networks which cause the appearance of additional multipliers \((1+\text{p}r_b)\) in the numerator of the transfer function, as there are complementary transient responses in the mid and low-frequency channels and their corresponding radiators. But the problem of transient response still remains. In general, given the resistor in the emitter network and without taking isolating capacitors into account for the cascade of a common emitter and common collector (emitter follower) the transient function is usually written as follows (basing it on an equivalent circuit under certain assumptions):}

\[
K(p) = \frac{K_0(1+\alpha p)}{1+mp+np}
\]

Such a function points to possible oscillatory character of the transient process or a possible overshoot. With the calculated capacitor \( C_L = C_p + p^2 \) connected in parallel with the resistor mentioned above, the transient function becomes ideal (ref. 8) under certain conditions:

\[
K(p) = \frac{K_0}{1+np},
\]

where

\[
m = \alpha + \frac{n}{\alpha}
\]

\[
f_{\text{pole2}} = f_{\text{zero}2},
\]

\[
f_{\text{pole2}} > f_{\text{pole1}}
\]

and

\[
C_L = n^2 \neq C_1, f_{\text{upper}} \text{ max.}
\]

In the case of an emitter follower signal frequencies must be properly limited, since the abrupt displacement of the operating point into the region of small \( h_{21} \) is possible, and the transient process is defined by time constant \((Z_{C_L} || R_K) \times (C_{C_L} + C_r) \) with \( R_{\text{out}} = R_{\text{out}}(t) \).

Because the output and input resistances are complex values and their module are accordingly dependent on frequency, there is a tendency to raise \( f_{\text{upper}} \) to 1 to 10MHz so that non-linear distortions, output resistance and frequency dependence of amplitude and phase responses deteriorate as little as possible in the operational frequency band of around 200kHz. This bandwidth is necessary for more faithful reproduction of transient processes, for decreasing the level of difference tones for frequencies higher than 20kHz, and for decreasing amplitude and phase distortion of the whole system. The correct reproduction of transients becomes a decisive factor in many cases. Piano sound is the most characteristic case, with its abrupt attack and lack of stationary sound4, which corresponds to conclusions given in reference5. Some of the basic parameters of amplifiers are upper frequency limit, coefficients \( a_2 \) to \( a_n \) in the power series transfer characteristic

\[
V_{\text{out}} = kV_{\text{in}} + a_2V_{\text{in}}^2 + a_3V_{\text{in}}^3 + a_4V_{\text{in}}^4 + \ldots + a_nV_{\text{in}}^n
\]

the nature of dependence \( a_0 = a_m (\beta, \omega, T) \), signal-to-noise ratio, output resistance, reliability, life time, constructional design, and overall cost. Let us analyse some of the specified parameters in detail. The value 0.5 to 2MHz of \( f_{\text{upper}} \) can easily be achieved using proper high-frequency bipolar transistors and using small-signal source resistances \( R_S \) for each stage. We assume that this bandwidth is sufficient in the present situation.

Amplifier design without overall negative feedback is preferable according to Nyquist's "regeneration theory" and the theory of electrical networks, in particular t.i.m. But it is necessary to meet the most stringent and rational requirements to reduce non-linearity. The characteristics \( I_C = I_C(V_{CE}, V_{BE}, \text{const}) \) and \( I_C = I_C(V_{CE}, V_{BE}, \text{const}) \), especially in n-p-n transistors, are of the same order as the corresponding characteristics in valve pentodes \( I_A = I_A(V_{CE}, V_{BE}, \text{const}) \), and in some cases are even better. The input characteristics \( I_k = I_k(V_{BE}, V_{CE}) \) of transistors are non-linear, except in some special cases. By these and other factors, one can explain lower non-linearity (i.e. sufficiently fast approach of transfer characteristic coefficients \( a_2 \) to \( a_n \), especially \( a_4 \) to \( a_0 \), to zero) in circuits with valve pentodes and triodes. We should also take into account that in the presence of large overall negative feedback, and for a large non-linearity in a system without overall feedback, the law of feedback changes in an unfavourable direction6. In semiconductor circuits the signal often passes through an excessive number of p-n and n-p junctions, which in addition operate impulsively at high temperatures (for horn radiators one stage is more than enough for voltage amplification). Strong dependence of the junction temperature on signal level is also undesirable. Sometimes high junction temperatures cause undulation of output characteristics. As to push-pull stages with semiconductor components, a large asymmetry of arms additionally occurs as a rule through the overall

Undesirable non-linear distortion, e.g. in the second harmonic, can reach several per cent in a single-ended cascade in a small-signal regime7. Amplitude and phase distortion above 10kHz can be several orders more than corresponding internal distortions due to \( C_e \) and \( C_r \) in h.f. transistors8. Reference 7 gives possible methods of compensation for these distortions.

Elegant amplifier construction is easily attached to the loudspeaker and provides shielding for the circuit as well as heat dissipation for Tr3.
operational range of voltage and current, often of very complicated nature. All these factors make reduction of non-linearity in semiconductor amplifiers more difficult (though a sum of certain factors may partly compensate for some $\alpha_k$).

For amplifier stages the class A operating mode is always preferable because the ear becomes more sensitive to harmonic and sum and difference tone distortion as sound pressure level decreases, based on specific features of hearing thresholds under masking\(^1\), because of smaller $\delta_2 - \delta_3$ dependence on $\omega \beta$ and because of weak dependence of junctions temperature from signal level. If operational areas of input and output characteristics of amplification elements are correctly selected class A distortions decrease or increase as a function of output voltage of the load linearity or strictly monotonically.

What can be expected from such an amplifier in practice? In this circuit I have used the following transistors: KT630B(b) as $T_1$ and $T_2$; KT912 as $T_3$ (see catalogue of Mashpriborintorg, USSR). The most essential known parameters are

**KT630**
- $P_{\text{Cmax}} = 0.8W$ (T = 25°C); $V_{\text{CEmax}} \geq 120V$;
- $I_{\text{Cmax}} = 1A$; $h_{\beta 1E} = 40$ to 240; $T_1(1-2A) \geq 50 MHz$; $C_{\text{C}}=15PF(V_{\text{CE}}=10V)$; $C_{e}<65PF$.

**KT912**
- $P_{\text{Cmax}} = 30W$ (T = 85°C); $V_{\text{CEmax}} = 70V$;
- $I_{\text{Cmax}} = 20A$; $R_{\text{b},(\beta E)} = 1.66\Omega/W$; $h_{\beta 1E}(c-2A) = 20$ to 100; $f_{\text{fmax}} = 90MHz$.

Transistor KT912 must be thoroughly selected on the basis of initial current $I_C = I_{C}(\text{of } V_{\text{CE}}; \beta = 0)$, and stability of $h_{\beta 1E}$ in the operational range of collector current and voltage. The collector, usefully, is electrically isolated from its package.

It should be specially mentioned that initial operational areas of the input characteristic $I_B = I_B(\text{of } V_{\text{BE}})$ in the KT630 and KT912 - up to 0.3 and 0.6V respectively - are linear and do not practically change with variation in $V_{\text{CE}}$. Output characteristics $I_C = I_C(V_{\text{CE}}, I_{b,\text{const}})$ and $I_C = I_C(V_{\text{CCKONST}})$ of these transistors in operational areas are also satisfactory.

Non-linearity attenuation, as measured with Brüel & Kjaer frequency analyser 2010 by the harmonic distortion method with rated power of 0.25 to 0.75W corre-

The output resistance of power supply including resistance of wires between power supply and amplifier should be low enough to prevent distortion of and transient responses. On the other hand, the requirements for the stability of the power supply voltage are very mild and the following version of power supply is likely to be optimum, see diagram, for which

$$ R_{\text{out}} = \frac{r_{\text{ZD}} + r_{\text{T1}}} {h_{\text{IET1}} + h_{\text{IET2}}} \frac{r_{\text{T2}} + r_{\text{T3}}} {h_{\text{IET3}}} \frac{r_{\text{ED}} + r_{\text{T4}}} {h_{\text{IET4}}} $$

The existence of the additional parametric stabilizer (with additional winding of the transformer) for the supply of the zener diode $D$ increases dramatically the ripple suppression coefficient (stabilization factor $K$), by approximately one hundred times. As a rule the frequency and transient properties of this stabilizer are better than in multistage stabilizers.

This power amplifier circuit can be designed on the basis of maximum possible efficiency (a push-pull version is also possible\(^6\)), or on the basis of the smallest power dissipation by transistors $T_2$ and $T_3$. In general the maximum possible efficiency approaches 8.6%, or 25% with a dynamic current source as $R_o$.

### Further reading


Appendix 1

Output resistance $R_{out}$ is approximately

$$r_x + \frac{R_x + R_{out}}{\pi} + \frac{R_{in} + R_{out}}{\pi} + \frac{r_{in} + r_{out}}{\pi} = \frac{R_x + R_{out}}{\pi}$$

$$R_{out} = R_x + R_{in} + r_{in} + r_{out}$$

where $r_{in}$ function of many variables for the given type transistor and approximately equal to 2 to 4 x 10$^{-5}$ I L ohm, and $r_{out}$~0.0265 L ohm.

$f_{3,6}$ of $R_{out}$ for $3$ and $4$ ohm.

$$R_{out} = R_x + R_{in} + r_{in} + r_{out}$$

Omitting $r_{in}$ and $r_{out}$ in our case

$$R_{out} = R_x + R_{in} + r_{in} + r_{out}$$

Value $r_{in} = r_{out} (r_{in} + (S + G))$ depending on the signal current imposes a principle restriction on the attainable nonlinear distortion level, depending on $R_x/R_{out}$. Moreover, it is obvious that the value $r_{in}$ is itself a source of nonlinearity.

Appendix 2

Based upon Jacobi’s simplified equivalent network for a bipolar transistor (Tr). If $R_x = 0$,

$$Z_m = \frac{f_{CT} + f_{CT} + f_{CT} + f_{CT} + f_{CT} + f_{CT}}{f_{CT} + f_{CT} + f_{CT} + f_{CT} + f_{CT} + f_{CT}}$$

where $r_{in} = r_{out} + r_{in} + r_{out}$ and $C_o = C_o (V_{ce})$

Formulas for prototype may be hand-wired rapidly may be re-wired easily if the Quick-connectors have been used, according to an eight-page brochure from AstraluxDynamics Ltd, Red Barn Road, Brightlingsea, Colchester, Essex CO7 0SW.

WW410

Measuring instruments for temperature, air flow velocity, humidity, velocity and the presence of gases are shown in a shortform catalogue from Testoterm Ltd, Old Flour Mill, Queen Street, Emsworth, Hants PO10 7BT.

WW411

Signal processing circuits. Formulae, definitions and application notes are included in a Designers Guide and Handbook produced by Analogic. Guide covers a-to-d and d-to-a converters, sample and hold circuits, analogue multiplexers, filters, isolation circuits, power supplies and various subsystems. Available free from Analogic Ltd, 68 High Street, Weybridge, Surrey.

WW412

Soldering irons from miniature to 500W sizes, temperature controlled or uncontrolled are listed in a catalogue from S & R Brewster Ltd, 86 Union Street, Plymouth PL1 3HG.

WW413

Nickel cadmium, sealed lead-acid batteries and a variety of battery chargers and battery holders are listed and priced in a leaflet from Sandwell Plant Ltd, 2 Union Drive, Boldmere, Sutton Coldfield, West Midlands B73 5TE.

WW414

Multi-user computer system of British design based around the 16-bit 68000 processor, uses the Idris operating system and incorporates full C and Pascal compilers with disc drives which can read and write Unix, CP/M and RT-11 file systems, is fully described in brochure from Integrated Micro Products Ltd, Number One Industrial Estate, Medomsley Road, Consett, Co Durham DH8 6SY.

WW415

LITERATURE RECEIVED

VisiCalc users can get ‘hotline’ answers to any problems they may have with the system from Gunther Computer Consultum, who also publish a newsletter each month and run seminars on the use of VisiCalc. Gunther Computer Consultum, Lake Drive, Southampton, NY 19868, USA.

WW400

Microprocessor and memory i.e. from Fujitsu, monochrome and colour v.d.u.s from Panasonic, and Ethernet transmitter and control products are listed in shortform stocklist and price guide from Ambar Components Ltd, Gatehouse Road, Aylesbury, Bucks HP19 3ED.

WW401

Wide range of computer printers and interfaces, mostly in the 16 to 40 column range are listed in a 22-page product guide and price list. Introduction contains useful information on the advantages of the various types of printer. DED, 47 Station Road, Lydd, Kent TN29 9ED.

WW402

Uninterruptable power supply unit from 1 to 6kVA are designed to protect sensitive equipment such as computers, data loggers, controllers, communication networks and alarm systems, is described in leaflet. Avel-Lindberg Ltd, South Ockendon, Essex RM15 5TD.

WW403

Half-wave antenna for use with c.e.b. radio has been manufactured by a British company who have also produced a data sheet about it. Claimed to be manufactured to a high specification, the firm has previously made mobile antennas for civil and military use. Bantax Ltd, Abbey Road, Park Royal, London NW10 7SJ.

WW404

Hand tools and tool kits for the electrical and electronic engineer are described in a 40-page catalogue. Sections of the catalogue are devoted to wire and cable strippers, crimping tools, pliers, nut and screwdrivers, ancillary equipment and tool kits. AB Engineering Co, Timber Lane, Woburn, Milton Keynes MK17 9PL.

WW405

Two Plessey handbooks, one on Linear integrated circuits (PS1973) includes details of op-amps, linear r.f. amplifiers, phase locked-loop circuits, limiting wideband amplifiers and other radio communication and power control circuits. The other on high-speed data processing (PS1989) covers crystal oscillators, ECL III, data conversion circuits, fast gates, comparators, flip-flops and a-to-d-a-to-d-a circuits. Both from United Components Ltd, Unit 5, Wye Estate, London Road, High Wycombe, Bucks HP11 1LH.

WW406

Clamps and clips, board supports and all sorts of plastics fasteners and components are illustrated in a 52-page catalogue from Richco International Company, West Street, Erith, Kent.

WW407

A Guide to Personal Computing, produced by Digital should be more accurately titled the Guide to Digital Personal Computing as that company’s products are featured prominently. Nonetheless, it contains useful information on computers and their operation and is free from Digital Equipment Co Ltd, Customer Information Centre, Basingstoke, Hants.

WW408

Aids for the production of p.c.b. artwork, circuit diagrams consist of self-adhesive symbols and shapes which may be accurately positioned using a registration system and stuck down by finger pressure. Fully illustrated in a catalogue from Circuitape Ltd, New Street, Aylesbury, Bucks HP20 2LN.

WW409

References

Forth computer

Interface circuits and software for disc-drive control are main subjects of Brian Woodroffe’s third article describing his 6809-based microcomputer. First, operation of the video controller is concluded and i/o software discussed.

by Brian Woodroffe

since it is cheaper than using s.s.i./m.s.i.

Character-code and row information for the video-controller i.c. is supplied as an address to a character rom. Character information for each row is fed to an LS165 shift register and serial output from this register is combined with synchronization signals in an analogue gate to give a standard 1V p-p composite-video signal which is subsequently fed to a u.h.f. modulator.

The dot clock, consisting of a Schmitt-trigger relaxation oscillator, should be adjusted to the minimum frequency to minimize the luminance bandwidth required in the monitor consistent with all text displayed on the screen. Character values 10 to 1F hexadecimal are programmed into the character rom to give coarse graphics. Two 2114rams hold enough information for one 1024-character Forth screen to be displayed.

Two further video rams store text normally lost at the top of the screen. A switch allows a page of lost text to be displayed.

Terminal and i/o software

The Forth reset routine checks to see if there is an M6850 present and if not automatically redirects terminal i/o routines from the RS232 interface to the p.i.a. for parallel i/o. Forth words giving access to user ports are included in this operating system. These words, P(@) and P(!) act in the same way as Forth words @ and ! except that they allow access to user i/o ports.

The software-driven output word, P!, makes data available on the p.i.a. B lines then activates the address coded on the A lines. On-input, P@, reads data while the port address is made. Output ports ideally connect to LS273 latches and input ports to LS244 buffers. Port-strobe lines are decoded from the p.i.a. A lines using LS138 three-to-eight-line decoders. Eight read and eight write ports can be connected to this hardware and if more ports are needed then a further 6821 p.i.a. could be connected and mapped into the USER variable-address area. Cursor control codes, i.e. decimal codes for EMIT, are as follows.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>left (backspace)</td>
</tr>
<tr>
<td>9</td>
<td>right (tab)</td>
</tr>
<tr>
<td>10</td>
<td>down (line feed)</td>
</tr>
<tr>
<td>11</td>
<td>up</td>
</tr>
<tr>
<td>12</td>
<td>home and erase</td>
</tr>
<tr>
<td>13</td>
<td>carriage return</td>
</tr>
<tr>
<td>14</td>
<td>home</td>
</tr>
<tr>
<td>15</td>
<td>carriage return and line erase</td>
</tr>
</tbody>
</table>

Disc interface hardware

Interfacing to the floppy disc is done using the most readily available controller since it is cheaper than using s.s.i./m.s.i.

Table 1. Code showing how the M6809 SYNC instruction is used for floppy-disc drive data transfer.

<table>
<thead>
<tr>
<th>BRED2</th>
<th>STB FDC</th>
<th>SYNC</th>
<th>LDB FDC</th>
<th>BIT #2</th>
<th>BEG BRR</th>
<th>LDA FDC+3</th>
<th>STA 0,Y+</th>
<th>LEAX =1,X</th>
<th>BNE BRED2</th>
<th>BRR</th>
<th>RTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F7C000</td>
<td>13</td>
<td>F6C000</td>
<td>C502</td>
<td>2710</td>
<td>B8C003</td>
<td>A7A0</td>
<td>301F</td>
<td>26EF</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>send command byte to f.d.c.</td>
<td>wait for f.d.c. response</td>
<td>get status</td>
<td>test byte-in</td>
<td>no, then error</td>
<td>get byte</td>
<td>store, advance pointer</td>
<td>reduce count</td>
<td>loop back</td>
<td>wait till</td>
<td>f.d.c. finishes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 cycles at 1.5MHz = 22us</td>
<td>Upon entry</td>
<td>B=command code</td>
<td>Y=pointer to data destination</td>
<td>X=byte counter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The author is with Hewlett Packard in research and development.
Problems with phasing are most noticeable when double-density recording is used, so a means of preventing bunching of the bits is used. Precamppensation prevents bunching by moving the written data bits slightly relative to the nominal position in a bit cell so that when the data is read back the bits appear to be in their correct positions. The matter of precamppensation depends on the drive used. For those drives that do not require precammpensation, including the TEAC FD50A used in the original design, the precammpensation circuit is omitted.

The disc should be set to respond to its address and head-load on drive select and not to the motor-on signal, i.e. the TEAC FD50 disc drive should be set as follows (for further drives, follow the same pattern).

**DRIVE 0**  
HS = set, MX = set, DSO = set, DSI, DS2, DS3 = unset, HM = disconnected.

**DRIVE 1** (if fitted)  
HS = set, MX = set, DS1 = set, DSO, DS2, DS3 = unset, HM = disconnected.

**Disc-interface software**

Under command of the c.p.u., the floppy-disc controller takes care of head positioning, sector positioning, data serialization and cyclic-redundancy checking. As soft sectoring is used, sector positioning is determined by the address record read from the formatted disc. The controller may be programmed to format the disc. So long as certain inter-record gap and record sizes are adhered to, the formatted disc capacity may be increased, Table 2.

Different systems use different sector formats, numbers and sizes of sectors and sector numbering systems. In this system, all variables associated with disc formatting are defined by the user which means that most disc formats may be read. The sector size is written into the address record of each sector so it is possible for the system to adjust its buffer size to that of the disc. Forth word /DISC is included to read the current disc and set parameters termed DENSITY, /BUF and SEC/TRK to those associated with the disc. Only formats mentioned in Table 3 apply to the disc format program and /DISC.

When formatting a disc, it can be advantageous to interleave the sectors on a track. With this in mind a dummy word SKEW was included which is currently defined as no operation, but it may be redefined to perform an interleaving algorithm during formatting. Table 3. Defining Forth word FORTH FOR format for disc formatting is shown in Table 4.

Forth treats all disc memory systems in the same way, i.e. as a contiguous set of 1024 byte screens, hence the choice of a v.d.u. Main Forth words used to gain access to screens on a disc are R/W, which moves data between a disc and memory, and BLOCK. As disc sector size depends on format, words BLOCK and constants /BUF, bytes-per-sector, SEC/TRK, sectors-per-track, TRK/SIDE, tracks-per-side and SIDE/DISC provide a means for Forth to work out which sectors make up a screen. The size of virtual memory buffers in Forth should be the same size as a sector.

Time taken for the head to position itself over the relevant track is a major constraint when using disc drives. Other time factors for a 5¼in floppy-disc drive are motor start-up time, head-load time and rotational latency. To speed up access time for double-sided discs it is usual to physically combine two tracks on opposite sides of the disc into one logical track. This minimizes head seek time for it is likely that the sector required will be on the same bigger logical track and the time taken to gain access to the other side of the disc is governed by the time taken for an electrical switch to act rather than by the delay of a mechanical head seek. But since Forth treats all discs in the same way, including this feature would have meant that one could not mix single and double-sided discs.

When using the Teac FD50A disc drive, access time is dominated by the start-up time of 1s. If faster disc drives are used, time constants may be changed (discussed in a following article). Start-up time and head-stepping rate constants are moved into ram from eeprom by the Forth start-up word (COLD and may be modified to suit faster drives. Forth constants normally hold the values of constants in the parameter-field address (p.f.a.) but as this system is rom based, modification of the constants would not be possible so they are coded with a new routine which stores the value in ram. This list shows how the constant DENSITY is altered from single to double density and gives other constants and their meanings.

| DENSITY = 1 (double density), 0 for single density |
| B/BUF = 512 (number of bytes per disc sector) |
| SEC/TRK = 16 (number of sectors per disc track) |
| TRK/SIDE = (number of tracks on disc, normally 35-40 for a mini-floppy) |

**SIDE/DISC = 1 (for double-sided) |
| SEC-OPST = 1 (for numbering sectors 1 to n, 0 for numbering 0 to n-1) |

1! (value to store, returned after execution of DENSITY)  
1 (find DENSITY p.f.a. address)  
@ (p.f.a. in this special constant points to constant position)  
! (store 1 there)

**Power supply**

Only one 15V secondary winding is required on the transformer to provide a low-current ~5V supply for biasing the dynamic rams, +12V for the rams and floppy-disc drive and +5V for all logic circuits. A minimum value for the unregulated supply is determined by the 12V rail; unregulated input should be 20V to ensure adequate regulation with low mains supplies. Heaviest current demands are on the 5V supply and using a linear regulator to provide this rail would have resulted in excessive heat generation with a loss of efficiency so a switching regulator was designed.

**Table 2. Capacity of a formatted disc may be increased provided that certain record sizes and gaps are not exceeded.**

<table>
<thead>
<tr>
<th>Density</th>
<th>Single</th>
<th>Double</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bytes/sector</td>
<td>128</td>
<td>256</td>
</tr>
<tr>
<td>Sectors/track</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Bytes/track</td>
<td>2048</td>
<td>2560</td>
</tr>
<tr>
<td>Bytes/disc</td>
<td>82K</td>
<td>102K</td>
</tr>
<tr>
<td>Relative</td>
<td>100%</td>
<td>125%</td>
</tr>
</tbody>
</table>

**Table 4. Routine for defining Forth word FORMAT for disc formatting.**

<table>
<thead>
<tr>
<th>FORMAT</th>
<th>0</th>
<th>DR-SEL</th>
<th>100MS</th>
<th>RATE</th>
<th>CMND</th>
</tr>
</thead>
<tbody>
<tr>
<td>#SIDEx</td>
<td>DO</td>
<td>TRK/DISC</td>
<td>0</td>
<td>DO</td>
<td>DP @</td>
</tr>
<tr>
<td>1</td>
<td>J</td>
<td>BLD-TRK</td>
<td>WR-TRK</td>
<td>&quot;track/side/status = &quot;</td>
<td>J</td>
</tr>
<tr>
<td>1</td>
<td>STEP</td>
<td>DP</td>
<td>LOOP</td>
<td>RATECMND</td>
<td>LOOP</td>
</tr>
<tr>
<td>DE-SEL</td>
<td>FORMAT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FORMAT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>DR-SEL</td>
</tr>
<tr>
<td>100MS</td>
<td>RATE</td>
</tr>
<tr>
<td>CMND</td>
<td></td>
</tr>
<tr>
<td>#SIDEx</td>
<td>DO</td>
</tr>
<tr>
<td>TRK/DISC</td>
<td>0</td>
</tr>
<tr>
<td>DO</td>
<td>DP @</td>
</tr>
<tr>
<td>1</td>
<td>J</td>
</tr>
<tr>
<td>BLD-TRK</td>
<td>WR-TRK</td>
</tr>
<tr>
<td>&quot;track/side/status = &quot;</td>
<td>J</td>
</tr>
<tr>
<td>1</td>
<td>STEP</td>
</tr>
<tr>
<td>DP</td>
<td>LOOP</td>
</tr>
<tr>
<td>RATECMND</td>
<td>LOOP</td>
</tr>
<tr>
<td>DE-SEL</td>
<td>FORMAT</td>
</tr>
</tbody>
</table>

1 start compiling the word format)  
2 (turn disc drive on, seek track 0)  
3 (do for both sides)  
4 (for all tracks)  
5 (save pointer to scratch area)  
6 (build up image of track, write it out)  
7 (inform user, 0=good status)  
8 (step in for next track)  
9 (recover scratch area)  
10 (for other side)  
11 (turn drive off, finish compilation)  
12 (carry out format)
After bridge rectification and capacitive filtering, the 15V r.m.s. transformer output gives approximately 20V. Dynamic rams are sensitive to the sequence in which power is applied to them so the supply had to be designed so that –5V appears first, followed by +5V then +12V.

Heart of the switch-mode power supply is a relaxation oscillator, the squarewave output of which feeds a charge pump to produce about –20V peak. This is regulated by a zener diode to produce –5V. Reference for the +5V supply is a 10V zener diode connected in a feedback loop to maintain constant current even when the 20V unregulated supply varies. An error signal derived from the +10V reference and +5V supply, and the relaxation oscillator triangle wave are fed to a comparator. A portion of the triangle wave depending on the magnitude of the error signal is fed to the switching transistor. This pulse-width modulated base drive is disabled when the –5V supply is not present.

The free-wheel diode, inductor and smoothing capacitor are fed by the switching transistor and are chosen with the operating frequency in mind. Around 17kHz is used since it is the best compromise between high-frequency losses and component size. At low frequencies the smoothing capacitor and choke become too large and at high frequencies the switching transition time takes up a large portion of the cycle time and efficiency is reduced.

Unregulated supply passes to the 12V monolithic regulator under control of a transistor switched by the +5V supply. To prevent overvoltage problems, an s.c.r. is included which switches on and blows the secondary winding fuse if either the +5 or +12 rails rise too high.

To be continued with construction tips, parts list and vocabulary.

References
A-to-d realises non-linear functions

An analogue-to-digital converter and differential multiplexer can replace diode function generators to realise arbitrary transfer functions with flexibility and excellent drift characteristics. The circuit shown is for an eight-segment function using the three most significant bits of an inexpensive a-to-d converter to generate eight segments.

The converter is connected in continuous-conversion mode and controls the multiplexer. Depending on the converter output, the appropriate slope-select resistor and intercept voltage are switched in to realise the transfer function. The number of segments may be increased and the circuit extended for positive and negative slopes as shown. These circuits can realise continuous or non-continuous transfer functions.

K. Neelakantan
Reactor Research Centre
Kalpakkam
India

Simplified backup for cmos rams

The prime consideration when setting cmos ram in low-current standby mode is that the chip-enable voltage must be $\geq V_{cc} - 0.2$. Usually one would use back-to-back diodes with a charging resistor in the positive supply rail but anything connected to the chip-enable input must allow the voltage to drop to zero when the main supply is removed so a switch and pull-up resistor are usual. Current through the measuring link should drop from a few mA to a few µA when the main supply is removed.

V. R. Halsall
Bushey
Watford

Three-phase sequence detector

Phase-sequence detection in three-phase systems can be accomplished by generating signals that contain the relative phase difference between two successive phases and comparing them with an arbitrary reference.

Two exclusive-NOR gates form phase comparators to produce signals representing the difference between phases A and B (A $\oplus$ B) and C and A ($C \oplus A$). Since the voltages applied to A, B and C have phases of $E \leq 0^\circ$, $E \leq +120^\circ$ and $E \leq -120^\circ$ respectively and exclusive NOR operation
produces signals that contains the ±120° phase difference. Appropriate outputs are compared with a reference clock to give sequence detection; outputs A/B and C/B are compared with the reference phase A using two D-type flip-flops. The flip-flop output is low or switches at 30Hz with a 1/6 duty cycle depending on whether the sequence is normal or reversed. Two remaining NOR gates form inverters to drive the indicators through current-limiting resistors. A complementary output from the flip-flops may be used to activate reverse-sequence alarms, relay drivers, direction indicators for motors and gyrocompass synchro-repeaters or for inhibiting three-phase s.c.r.-controlled battery chargers to avoid misfiring which leads to line-to-line faults.

Three 230/12V isolating transformers are star-connected to allow a larger input-voltage swing and limit the upper input voltage to 440V. When the input voltage falls to 190V the regulator is affected. Input capacitors filter line harmonics and r.f. For lower line voltages opto-isolators may be used instead of transformers but a separate power supply is needed; batteries make the unit portable.

A. L. Eguizabal
Vancouver
Canada

**Z80 16bit output**

Normally one would use two output ports of the Z80 to give a 16bit word but if both bytes are to be strobed or latched at the same time, additional hardware is needed to synchronise the two output executions and complications arise. But during an OUT(C),r instruction the Z80 places data and the port address on data lines and the lower byte of the address bus respectively and places B-register contents on the upper eight address lines so only one output-port instruction and one output port are necessary.

The circuit was used to control eight multiplexed seven-segment leds for a small controller. I/O port-select was not decoded – As was used instead. If one of address lines 0 to 7 is used it must be low to select.
Data to control the active segment is loaded into the accumulator, the active digit mask is loaded into register B and the port address is loaded into register C. An OUT(C),A instruction is then executed. Common-anode or common-cathode LEDs may be used. Active digit outputs should be buffered by transistors. It is also possible to perform an eight-bit input and an eight-bit input with only one input instruction with a different circuit.

Javier Cazot
Horndean
Hants

Positive feedback without hysteresis
This circuit overcomes the problem of conventional d.c. hysteresis degrading precision low-level detection for comparators driven from poor voltage sources. To obtain reliable switching from low-level voltages (<100mV) exhibiting slow rates of change and non-zero output resistance it is usually necessary to provide positive feedback around the comparator. Direct current positive feedback can generate significant hysteresis, substantially shifting the switching levels, resulting in an asymmetrical output. The method operates by a.c. coupling positive feedback through $C_f$ resulting in zero-d.c. hysteresis. The value of $R_f$ is chosen to give the desired amount of feedback in conjunction with the source resistance $R_s$. Typical values for $C_f$ are between 10-100pF. To operate correctly at high repetition rates that the time constant $C_fR_f$ is less than the time constant of the input waveform to ensure that $C_f$ has time to recharge between transitions. For best results, comparator supply lines should be decoupled to ground by 0.01µF disc ceramic capacitors close to the i.c. For example, using a 311 comparator a 50mV 1kΩ triangular waveform can be reliably switched with no hysteresis up to 1MHz with $C_f = 10pF$ and $R_f = 100kΩ$.

B. Wilson
Nottingham University

Single-frequency shortwave receiver
I designed this shortwave receiver for one frequency only; it has the advantage that the local oscillator can be crystal controlled. Our radio news in Denmark is rather bad so the receiver is designed to receive BBC World Service on 9.41MHz. An S042P (Siemens) forms the local oscillator and mixer, the output feeding a 455kHz LC filter followed by a 455kHz ceramic i.f. filter. I.f. amplification and a.m. detection are performed by a ZN414 (Ferranti). This i.c. has its own a.g.c. but it is not sufficient to handle large amplitude variations on the shortwave band. To improve this the 414 output is amplified by about ten times after low-pass filtering. Output from this amplifier is connected to gate two of the mosfet h.f. stage to control gain and improve reception. Finally the i.f. signal is amplified by an LM386 (National Semiconductor) which gives about 0.2W into 8Ω with a 6V supply.

Per Hojielv
Copenhagen
Denmark

World Service frequency information can be obtained from BBC External Services Publicity, Bush House, PO Box 76, Strand, London WC2B 4PH.

COIL WINDING
$L_1, L_2$: 30 turns of 0.2mm copper wire
$L_3$: 5 " " " "

Wireless World July 1983
The Thévenin-Norton transient theorem

The Thévenin-Norton theorem is restricted to the manipulation of independent sources only. This new theorem manipulates all sources, but still produces equivalent generators, similar to those contributed by Thévenin and Norton. Finding the generator immittance is now greatly simplified.

A theorem can be formulated that produces the two equivalent generators of a transient network, either entirely in the time domain, or in the s-domain. It extends to the case of dependent sources ki(t) or kv(t) being included in the network. Theorem:

A step-excited linear network with an accessible port has two equivalent generators, the series-form generator having the generator impedance in series with the open-port voltage due to all sources, the parallel-form generator having the generator impedance in parallel with the close-port current due to all sources, the generator impedance in time or s-domain form being the port looking-in impedance when all sources are removed.

In the theorem formulation, "all sources" means the driving sources together with all initial-value sources. Other kinds of driving sources may be substituted in accordance with the rules well-known in the art. The proof of the theorem is provided by an application of the basic Source Transformation Theorem. As an example, consider the simple time-domain network in Fig. 1, where ki(t) is the unknown. We wish to replace the network to the left of port 0,0 by a parallel-form generator, and shall do this without leaving the time domain, making use of the D-operator. The desired network is shown in Fig. 2(a). Employing the delta function,

\[ i(t) = \frac{e(t)}{Z'(t)} - \frac{L}{Z'(t)} i(t) - \frac{V_o}{Z'(t)} \]  

The equation read-off from the Fig. 2(a) network is

\[ i^*(t) - \frac{R}{Z^*(t)} i(t) = 0 \]

and it is the same one that we would have obtained from the original network, proving our construction correct.

A common form of equivalent generator is shown in Fig. 2(b). To obtain this one, we pair the second term in equation 1 with the time-impedance z(t) in Fig. 2(a) and the make use of the source transformation theorem to change the combination into the series-form generator, shown as a shunt branch in Fig. 2(b). Here i^*(t) is the first term in equation 1.

The above is readily turned into an s-domain derivation by the observation of proper s-variables and the replacement of D by s. Many of the equivalent-network derivations are carried out much faster if we refrain from the use of the heat Laplace transform with its dependence on proper tables and instead stay in the time domain all the time. The required time-immittance is made available by the versatile D-operator. However, when the answer has to be given as an operator-free time expression, Laplace's method usually provides the quickest route to the answer, except for periodic steady-state portions, where Steinmetz' method yields a still faster solution.

Application example

An interesting case is at hand when the theorem is applied to a segment of a larger network, the segment containing dependent sources only. Then the Thévenin-Norton theorem does not apply, while the new theorem allows us to construct an equivalent generator that replaces the segmented network. For a simple example see Fig. 3, where the network segment to be replaced is shown to the left of port AB, while the series-form generator that takes its place is shown in broken line to the right of port AB. Assume that the total network does not extend beyond the points marked x.

If the driving voltage e(s) is a step voltage, we may use Laplace's method, but if it is a sinusoidal e.m.f. we would probably use Steinmetz' technique. Consider the unknown quantity to be i(s). The theorem yields directly

\[ e^*(s) = arZ(s)i(s)/[Z(s) + R_1] \]

\[ Z^*(s) = R_3 + Z(s)R_1/[Z(s) + R_1] \]

We readily find for the total network

\[ i(s) = [e(s) - e^*(s)]/Z^*(s) + r]. \]

In this simple example, a conventional solution using Kirchhoff's laws is almost as quick, but for more complicated cases the theorem saves time. This is particularly true when the segmented network contains a mixture of dependent and independent sources, and when initial conditions must be taken into account.

by Harry E. Stockman


WIRELESS WORLD JULY 1983

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www.americanradiohistory.com
Craft and technology

Should modern technology be combined with the craftmanship associated with the past?
Dr Ken Smith discusses the role of the industrial designer.

By K. L. Smith

In answer to my question, the designer/craftsman, Mr R. Marchant, said, "Contemporary artists and craftsmen must use modern materials and mould them to give a message of what we are doing now".

My sympathy with this philosophy led me to muse about the function of industri-

Resonance applied to timekeeping

Up to about 1650, the escapement of mechanical clocks was aperiodic with a bang-bang type motion. These foliot escapements had virtually no Q and their period was dependent on the driving force. The discovery of the gravity pendulum in the early 1600's, although imperfectly understood initially as a resonant system, soon resulted in continuing improvements that have only been realised in recent times, as the graph indicates. Clock-makers soon realised that the maintaining force should be tiny, for the best timekeeping. A whole epoch of fine clock-making gradually developed - with much work on escapements and long heavy pendulums. The long case and bracket clocks of England reached a peak of fine craft.

On the theoretical side, logarithmic decrement, δ, became the standard quality measure of mechanical vibrations; this is the natural logarithm of the ratio of any two successive amplitudes. A pendulum will swing freely for some 2000 to 20000 times before reaching half initial amplitude. Now Q = πδ therefore Q = πn/log₂, and because n is the number of oscillations to reach half amplitude, this indicates that a good pendulum has a Q ranging between 10,000 and 100,000.

The piezoelectric effect was discovered by Jacques and Pierre Curie in 1880.1 By 1917, A. M. Nicolson2 had used a piezoelectric crystal to control the frequency of an oscillator, while P. Langevin3 used large resonant blocks of quartz from 1918 onwards in his experiments on submarine depth sounding and signalling. In 1925, K. Van Dyke4 described the electrical equivalent circuit of a quartz plate, thus establishing the criteria for designing and calculating the Q of a quartz resonator.

Much later (1947) Van Dusen, with co-worker Maynard Waltz5 measured the decrement of a precision zero coefficient ring crystal made for high precision timing. They found that vibrating freely in a vacuum it would vibrate over a million times before the initial amplitude was halved. This indicates the Q was some 4.5 million.

The first person to propose the use of quartz crystals in clocks was Warren A. Maritime. His notebook for November 1924 clearly outlined a high frequency quartz controlled oscillator and frequency translation system for driving a clock motor. By 1927 with J. W. Horton6 he described and demonstrated a working quartz clock with temperature controlled crystal at a meeting of the International Union of Scientific Radio Telegraphy. Marriott's 1930 paper "The Crystal Clock"7 proposed the use of this clock as a world standard time source. It was developed and adopted and remained pre-eminent in this role until displaced only recently by the even higher precision atomic clock.

As indicated, the best crystal clocks8 reached an accuracy of a few parts in 10⁻¹⁰, some 100 times more precise than the fluctuations and variations that go on continually in the motions of the earth.

Continuous improvements in the various methods of timekeeping is well illustrated by plotting the date of the attainment of results against the precision obtained. (Three parts in 10² amounts to about one second per year).

In the past? Bạn có thể kết hợp công nghệ hiện đại với kỹ năng thủ công truyền thống? Dr Ken Smith thảo luận về vai trò của thiết kế công nghiệp.

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Continuous improvements in the various methods of timekeeping is well illustrated by plotting the date of the attainment of results against the precision obtained. (Three parts in 10² amounts to about one second per year).
rial design. Such artefacts as a well-structured p.c.b. with all the components colour-coded and laid out for strictly functional use, can be aesthetically (though unintentionally) very pleasing, and may be subjects of study by future art historians, much as we now collect and discuss vernacular objects from the past. Many mass-produced goods disguise themselves in poor design, however good the technology incorporated in them.

What relevance has all this in an electronics journal like Wireless World? The answer is that the clock I have mentioned, although it originated in a cottage industry established by a craftsman, uses a very up-to-date quartz drive.

Many clockmakers denigrate the advance of the quartz clock; they think of it as damaging and vulgarising their craft. It is true that microelectronics with tiny precision quartz resonators, has completely swept the clock and watch market. Millions of digital and analogue devices have appeared and digital watches seem to cost little more than the cells that drive them.

Yet with high craftsmanship and deliberate exploitation of the medium, M. Marchant's clock bridges the void between fine individually made objects and the anonymous mass-produced (although highly technological) goods.

The success of this design encourages me. It has a message that individualism in small scale industry is very much alive. There are artists and craftsmen on the fringe of capitalism who can use its media and materials to express themselves, and make an income. They do not need to go through the paraphernalia of 'management studies', 'rationalisation', factory development, growth and so on. In this age of depression, listlessness, unemployment, technocracy, with electronics engineers working as mercenaries on machines of death, this could be an important message, and much in keeping with some recent editorial comments in Wireless World.

References

Last chance to enter

Our cover reflects the theme of the competition announced in the March issue in which we invited readers to design an electronic device to help the disabled. We asked intending competitors to return their entry forms by the end of June, and so there is still an opportunity for you to take part if you have received this issue in good time.

An encouragingly substantial heap of entries is already with us. They come from participants of every description, including academic groups, professional designers working on their own or in teams and individual hobbyists. Some have already told us about the projects they are working on, and they range from small gadgets to complex computer-based devices. Complexity, however, will not win prizes if it means unreliability and a high cost to the user; and so the lone entrant with limited resources is not necessarily at a disadvantage. Our judges will be looking for devices which provide a practical solution to the problems of the type of person, they are aimed at and which are affordable as well.

More information about the compe-
Single-chip printer controller

Until recently the preserve of the high-volume manufacturer, the single-chip microcomputer is now becoming available to a wider market. Here is an original application for an Intel 8048 microcomputer, as the controller for a small dot-matrix printer.

by S. J. Pardoe

Although the microprocessor has become an accepted electronic component rather than a curiosity, most engineers and users are familiar only with the general purpose 8 or 16 bit devices exemplified by the 8085, 6502 and 6800. These microprocessors are always accompanied by random access or read/write memory (ram), read-only memory (rom) and input/output (i/o) devices to make them into something useful in a multichip system. In fact, these devices represent only the tip of the microprocessor iceberg.

By far the majority of applications are too cost-sensitive to use a multichip system, and the semiconductor device manufacturers have responded by designing a wide range of simple, cheap computers in which the c.p.u., ram, rom and i/o are integrated into a single silicon chip. These find applications from toys to business machines, and are sold in tens of millions. Many have special architectures optimized for control rather than computation, though a few are derived from general-purpose processors, such as the 6502 or 6800.

The single-chip controller used as the basis of this article is the Intel 8048, an eight-bit microcomputer with c.p.u., 1K of ram, 64 bytes of ram, and 27 slines in a 40-pin package. Such devices are mask-programmed; that is, the program is built into the chip during manufacture, and cannot be changed. An eprom equivalent, the 6848, can be used for development or small-volume manufacture.

The Epson M150/M160 series of miniature dot-matrix printers is unique in several ways. Exceptionally compact, yet printing on plain paper with a 5V supply and very inexpensive, they open up a whole new range of printer applications. It is now feasible to incorporate a printer into low-cost equipment; the M160 is the printer chosen for the new Epson HX20 handheld computer. As it makes little sense to swamp such a small and inexpensive printer with a costly multichip interface, a single-chip controller was programmed to handle data input mechanism control and character generation.

The M150/M160 differ from most matrix printers in having only four printing solenoids, arranged horizontally in a shuttle which moves from side to side, building up characters as a raster of dot rows. A d.c. motor, gears and cams move the shuttle and feed the paper on synchronism; an a.c. tacho and reed switch time...
the dot pulses and indicate the start of each dot line. A dynamic brake is required to stop the motor quickly between dot rows.

The M150 prints 16 characters across the 44mm paper, four to each solenoid, the M160 prints 24 across 57mm, six to each. Interface hardware is identical, but the software is slightly different to accommodate the character format. From now on, the two will be referred to as the M150. The full electrical specification would occupy half his magazine, but briefly it is

Solenoids (4): 4.0V d.c. 1.5A 2.5A pk

Motor (drive): 4.5V d.c. 0.17A 0.8A pk  (brake): 4.5V d.c. 0.3A

Tacho output: 3V pk-pk

These requirements can be met by very simple circuits, as shown. The solenoid drives are paired as each 8048 output can sink only 1.6mA, whereas 3.2mA $I_s$ is needed to produce a 2.5A $I_s$ from a BD676 device. No flyback diodes are needed, as these rugged Darlington can easily absorb the turn-off spike, and the high instantaneous reverse voltage helps to collapse the solenoid field and makes for crisper printing. The brake circuit effectively shorts out the d.c. motor, which is rapidly brought to rest. Experience has shown that the tacho signal easily drives the 8048 $I_s$ input if suitably biased: some trimming of the divider may be needed to equalize print density between solenoids.

Data interfaces are provided that are parallel, rather like Centronics practice and designed for connection to the host via a PIA port and serial, following RS232 protocol at 110, 300, 1200 and 2400 baud, though at 5V levels. The rate is selected on data 5 & 6, and serial mode selected by taking S/PS high. Four i/o pins are left for local control functions: paper feed, self-test, selection of reversed printing (for use in panel mounting applications), and selection of mechanism (150 or 160).

The FP150 chip accepts ASCII seven-bit data. Control codes select various print formats, including double width and height, and inverted print. It will also print graphics patterns by accepting binary-coded ‘characters’, again with special control codes. It is then possible to print any dot pattern that can be accommodated in a 96-wide field (144 in the M160).

The 8048 program memory area of 1024 bytes is divided into four pages of 256 bytes. The 64-character ASCII set is coded up as 320 bytes, or five per character, in hexadecimal, to give a 5 by 8 character set (the eighth bit is used for underlining and descenders on punctuation marks). The character generator software ‘looks up’ these data bytes, and shifts them into the appropriate pattern to form the dot matrix as the print solenoids move across the paper.

Character generation is complicated by the requirement to print in both normal and reversed modes, in single or double width and/or height, and to accept graphics input. In all, 16 printing modes are provided, so all through the character generator conditional jumps hop and skip through the listing to select the functions required. This has led to nearly half the available 1K program being devoted to character formation.

The other major software area is in the data interface. Here the parallel input is straightforward, consisting only of a bus read instruction and testing of the strobe input once that mode is established. The serial input routine is much more complicated: the strobe pin is sampled at intervals determined by the data rate chosen, to build up a replica of the transmitted char-
Frequency control of turntable motors

Many high-quality turntables use a small synchronous motor to drive a heavy turntable platter through a flexible belt. Where mains frequency fluctuates, the speed of the turntable alters. This circuit overcomes the problem by providing a reference frequency independent of the supply.

Synchronous motors achieve their constant speed by locking on to the mains frequency. However there are two main disadvantages: Firstly the wow and flutter performance depends on a constant supply frequency. This is not always met, particularly in my country, New Zealand, where periodic fluctuations, outside the stated limits are evident, presumably due to faults with generator regulation and where frequency is reduced when the grid is under heavy load, compounded by a subsequent speed-up to regulate the time on synchronous clocks. Then secondly, synchronous motors do not allow any convenient method of speed regulation, unlike many direct-drive or d.c. controlled turntables.

Synchronous motors use very little power and can lock on to the supply frequency over a wide range of voltages. Thus it is relatively simple to construct an oscillator that will produce the required frequency signal and then boost the output voltage to the level of the mains by the use of a power amplifier, which can be small and cost little, and an output transformer.

The motor needed a waveform close to a sinusoidal, or it could find difficulty locking on to the frequency and could even run backwards. Waveforms with excessive harmonic content could cause sound to be radiated through the motor and the belt. A Wien bridge oscillator with its inherent sinusoidal output would seem to be ideal, but it needed two resistors to be varied simultaneously to adjust low frequencies. During tests it was found that any mismatch in the tracking caused settling delays which could make the turntable stop and start and run in reverse. Another disadvantage was the ability to find a suitable thermistor to act as a gain control element.

Voltage-controlled oscillators (v.c.os) are an appropriate choice which give a constant amplitude of the output wave independent of the output frequency. Unfortunately v.c.os give triangular or square waves and these need to be shaped. The circuit shown in Fig. 1 has been devised to do this. IC2, a 566, is a very stable v.c.o. whose frequency of oscillation is given by: \( f_0 = \frac{2(V_c - V_i)}{R_1 C_1 V_i} \), where \( V_c \) is the control voltage at pin 5, \( V_i \) is the supply voltage and \( R_1, C_1 \) are as indicated in Fig. 1. If \( V_c \) is derived from a resistive divider, the ratio \( V_c \) to \( V_i \) is constant so the frequency should be independent of the supply voltage. The only likely source of drift in the frequency is the temperature coefficient of \( IC2 \) (300 p.p.m/°C), the divider chain, \( R_1 \) and \( C_1 \). The use of metal oxide resistors and a high quality potentiometer should help to minimise this. The motor was unable to lock on to high or low extremes of frequency so the resistor chain was selected to restrict the range. The potentiometer I used was a ten-turn Beckman Helitrim. A high quality wire-wound potentiometer was also used.
with a changeover switch to select a preset turntable speed.

The 741 has a diode resistor matrix in the feedback loop to convert the triangle wave output of the 566 into an acceptable approach to a sine wave. R3 and R4 both control the shape of the output waveform and are most easily set by using an oscilloscope on the output. R5 controls the shape of the peaks while R4 controls the positive and negative symmetry. R6 is set to give the required voltage output to the motor.

Alternative v.c.os, like the Intersil ICL8038, can produce a sinusoidal output directly, but one was not readily available to me. However, by the time that the necessary external components are added, for controlling the symmetry, minimising the distortion etc. is unlikely that the component count would be much below that for the circuit given.

Power amplifier choice was dictated more by the contents of my junk box than by any particular suitability for the application. However it does work satisfactorily even on the rather low supply voltage (the junk box again!). The output transformer is a small power transformer used backwards. It takes a few watts of power to provide the magnetising current or the core allowing for this, the power consumption of the motor with a little headroom must be considered when choosing a suitable amplifier. In addition falling impedance with frequency causes excessive power consumption, though this may be offset by a capacitor-coupled amplifier since the capacitor impedance increases with falling frequency.

The effects of the series capacitor at low frequencies and of the transformer inductance at higher frequencies mean that output voltage will decrease at higher frequency. The d.c. resistance of the transformer produces some reduction in the output voltage under load. However there is no need for output voltage regulation as the synchronous motor is very tolerant to variations in voltage. The neon across the output provides a simple indicator while the capacitors across the input prevent transients from getting into the mains and hence into the hi-fi system.

Satisfactory performance over several months has been achieved on my Thorens TD-160 turntable. It is suitable for a number of high quality turntables driven by synchronous motors including Linn Sondek, Transcriptors and other Thorens models. One difficulty has been finding a suitable way of measuring the correct turntable speed in order to regulate the output frequency. I used a stroboscopic disc under the mains lighting, but this is far from ideal as the whole point of the circuit is that the mains frequency is not constant. I leave it to the reader to devise the most satisfactory means of setting the speed.

\[ Continued from page 69 \]

\[ character in the 8048 accumulator by shifting the carry bit into it. \]

Once the parallel or serial character is received, the busy line is set high to tell the host not to send more data, and the processor then tests the received character to determine what should be done with it. Control codes are compared with a look-up table, a suitable response being made if a match is found; lower-case codes are arithmetically converted to upper case, and illegal codes discarded. Valid printing characters are stored in a designated area of the 8048 ram. When the ram is full or a line terminating character is received, the printing cycle starts.

The data input and sorting routines occupy about a quarter of the rom; the remaining quarter is taken up by a self-test routine, and various initialisation, timing and housekeeping subroutines. The entire 1K byte of program were written directly in machine code, leading to a very compact program with no wasted space.

Similar design techniques have since been applied to interface controllers for other dot matrix printers, I.C.D. interfaces, and an MSF Rugby clock decoder/display driver, recently featured in WW (New Products, February issue page 83) and the subject of a future article.

\[ Peter Stockwell holds an honours degree in Biochemistry and is currently involved in the development of computer programs to analyse DNA sequence data at the Biochemistry Department of Otago University. 31 years old, his interests include electronics particularly as applied to high fidelity, music (he plays a pipe organ), and photography. \]

\[ WW offer \]

For readers wishing to try the printer for themselves, Able Systems can supply the following items from stock:

- **M150 16-column printer mechanism** £29.45
- **M160 24-column printer mechanism** £27.80
- Kit of p.c.b. FP150 controller chip, mechanism, connector cable, 8MHz crystal and application data £22.10

Paper rolls cost £12 per pack of 20, and spare ribbons £1.80 (M160) and £1.90 (M160). Carriage, packing and insurance costs £5, and vat is at 15%. Able accept payment by Access card or personal cheque at Unit 3, Kingfisher Court, Northwich, Cheshire CW9 7TU. Tel: 0606 49669.

Wireless World July 1983

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www.americanradiohistory.com
NEW PRODUCTS

COMPUTER GRAPHICS SLIDES

Developed to meet a demand for electronic production of high-quality slides for use in audio-visual presentations, the Dicomed system is both fast and flexible. A wide range of support and commands are at hand, together with an extensive library of images including lines, circles and polygons as well as existing artwork, maps, logos, etc. Composition and balance from a choice of 64 colours can be altered and every element of the design can be moved, enlarged or reduced, replicated or rotated to any angle. Freehand drawing may be entered using a digitizing tablet. Animation is possible with start and end images; the computer can interpose in-between steps.

Designs are stored in digital form on a floppy disc and some 133 designs may be stored on one disc. The designs can be posted on a floppy disc or transmitted by telephone line to be reproduced on the company's slide production equipment. The images are photographed using a high resolution c.r.t. with 4000 lines. Also available is a software package for use with an Apple II microcomputer to allow creation of graphs, pie charts and histograms.

Eidographics Ltd, 47 Marylebone Lane, London W1M 5FN. WW301

BALL CONTROL

Tracker balls seem to be in competition with mice as computer input devices to plot x-y positions accurately on a v.d.u. Marconi have two controllers to translate the motion of a tracker ball into precise positional control. They can be used to position markers on a display, including radar and are claimed to be fatigue-free when used with interactive graphics displays in the engineering design field.

The protruding ball is in slip-free contact with two shafts positioned at right angles. Slotted discs attached to each shaft offer optically detectable motion which is translated by the electronic circuitry. The two basic versions are a rugged 2in diameter ball or a 3in ball. Marconi Electronic Devices Ltd, Dodington Road, Lincoln LN6 0LF. WW302

RELAYS WITHOUT TRANSIENTS

Photo-s.c.r. coupling provides transient-free switching as well as 2,500V input-output isolation in the Teledyne SerenDIP, d.i.l. packaged solid-state relays. The maximum measured generated noise is claimed to be less than 15μV at all test frequencies from 0.45 to 30MHz, which makes the relays suitable for computer applications while the high voltage isolation is useful in industrial controls. There are three versions with output voltage ratings of 140, 250 (with 400V peak) and 250 with 600V peak. The 645 range is available from STC Electronic Services, Edinburgh Way, Harlow, Essex. WW303

COMPUTING OSCILLOSCOPE

A digital storage oscilloscope waveform analyser, transient signal analyser, spectrum analyser and a data acquisition system are all combined into one instrument, the Analogic Data 6000. Built around a 16-bit microprocessor with an 8MHz internal clock, it has 48K-bytes of rom and 8K-bytes of ram. The scope has been designed for the analysis of transient signals which may occur as digital glitches, or may arise during analysis of transient responses in networks. Other applications are in medical monitoring, wind tunnel, shock and destructive testing equipment. Data can be recorded for up to 5,000 hours. Analogic Ltd, The Centre, 68 High Street, Weybridge, Surrey. WW304

DUAL LOW-PASS FILTER

Suitable for continuously variable-slope detection or speech synthesis, the MC145414 is a dual, tunable, low-pass filter using switched capacitor techniques. It consists of two fifth-order elliptical filters and includes two extra op-amps for gain adjustment or extra filtering. Capacitor circuitry ensures low power consumption from a supply between 10 and 16V. Clock frequency may be varied between 15 and 400kHz to provide cut-off frequencies of 1.25 to 10kHz. Motorola Ltd, Semiconductor Products Division, York House, Empire Way, Wembley, Middlesex HA9 0PR. WW305

14-BIT A TO D

Claimed to be the first c-mos monolithic analogue-to-digital converter, the Interis ICL7115 uses thin-film resistors together with an on-chip rom calibration table to give 14-bit linearity without the need for expensive laser trimming. Internally it works with 7 bits with an exponential (1.88) base. It can measure accurately signals up to 118% of full scale. The rom incorporates an error-correction code and therefore does not rely on the accuracy of the resistor ladder in its successive approximation algorithm. The rom is programmed after manufacture to take into account any measured variations. The circuit may be easily interfaced with microprocessor systems. Reference voltage inputs and signals have separate sense controls so that the device can accept positive signals relative to a positive reference and negative signals with a negative reference level. It operates from ±5V with a power consumption of 60mW. Conversion time is 40μs. Interis Datel UK Ltd, Belgrave House, Basing View, Basingstoke, Hants. WW306

MICRO-TURTLE

A two-wheeled mobile robot which can be controlled by any microcomputer has been developed by Colne Robotics. Movements are controlled through an umbilical cable. The robot has touch sensors and the accompanying software 'teaches' it how to find another route. A retractable pen is attached to the underside and allows the machine to draw Logo graphics. The Zeaker Micro-turtle comes complete with interface, power supply, operating manual and software all for £69.50 assembled, or £52.00 in kit form (v.a.t. extra). Colne Robotics Co. Ltd, Beaufort Road, off Richmond Road, Twickenham, Middlesex TW1 2PH. WW307

AID FOR THE COLOURBLIND

Component identification by the use of colour codes can lead to hazardous situations if the constructor is colourblind. Difficulty with the difference between red and green is the commonest form of colourblindness and a simple viewer incorporating selected red and green filters can assist in distinguishing between these colours. The makers of Viewbouy claim that, with practice, the severely handicapped can also identify most other colours. J. Holter, 10 Lancot Avenue, Dunstable, Beds LU6 2AW. WW308
SPACE-SAVING PCB SWITCHES
By turning the dual-in-line switch on its side, Erg claim to save 30% of the p.c.b. area taken up by conventional switches. SDOS-10-023 contains ten on/off switches which may be edge-mounted to offer front-panel switching with no additional hardware. Two to 18-way switches, colour-coded and numbered, will be included in the range. Erg Components, Luton Road, Dunstable, Beds LU5 4LJ. WW309

WIRELESS JOYSTICKS
A single-chip radio transmitter has been incorporated into a tv games joystick to allow the user to zap the space invaders from the comfort of an armchair, without the encumbrance of wires. A receiver is placed next to the games unit (and could be incorporated into it). It decodes the signals sent by the joystick into the same signals that would have been received if the joystick were connected directly, and feeds these through the normal joystick ports into the games computer. The 'serious' application of the joystick control is menu-driven computer programs. The product is the first of a series planned to be expanded to include a wireless computer keyboard. The Wireless Joystick is manufactured in New York by Conex and marketed in the UK by Dynavest Ltd, 8 Waterloo Place, London SW1Y 4BE. WW310

LOW-COST AVO METER
Despite the digital explosion of multimeters, Avo still have faith in analogue meters and have produced a series of test instruments called the 'analogue toolbag range'. The Avometer 1001 can measure direct and alternating voltages up to 1kV, direct current up to 1A and resistance up to 2MΩ. Sensitivity is 10kΩ/V on d.c. ranges. A continuity buzzer is included. The a.b.s. plastics case features an integral carrying handle which has a slot in it to allow for quick and easy lead stowage. The meter costs £28.50 (trade price) with a heavy duty version with a tougher case for £37.30.

Announced at the same time is a series of Megger insulation testers which no longer have the generator handle on the side as they are battery driven, powered by a 9V (PP3) battery. Different models offer test voltages of 500 or 250V with continuity ranges on all models of 0 to 200Ω and 0 to 21Ω, the last-mentioned being used to suit the methods laid down by the IEE wiring regulations. One model has an additional voltage range while others provide intermediate resistance ranges of 1MΩ and 500kΩ. All the meters come complete with test leads, probes and clips which fit into moulded channels on the back of the case. Thorn EMI Instruments Ltd, Archcliffe Road, Dover, Kent CT17 9EN. WW311

PORTABLE RECORDING STUDIO
A four-track cassette recorder combined with a mixer needs only microphones and monitor headphones to make multi-track recording almost anywhere. The Fostex X-15 Multitracker is battery powered and is little larger than an average cassette deck, yet incorporates many features found normally only in a recording studio. It has equalizer, gain and pan controls for each of the channels which may be used in overdub or mixdown. Punch-in may be remotely controlled and there is ±15% pitch control for tuning or for special effects. Dolby-B noise reduction is incorporated. Manufacturers claim that professional musicians can use the recorder as a 'sketch pad' to prepare a session, much as a Polaroid camera may be used to compose a shot in a photographic studio. The X-15 retails at £299, inclusive. Bandive Ltd, Brent View Road, London NW9 9EL. WW312

ELECTRONIC OFFICE FROM BT
Word processors and computers with an accent on telecommunications are now being marketed by British Telecom. The Merlin range of business systems starts with the M1100 communicating v.d.u. terminal which may be used to access Prestel or data banks and can be used for electronic mail with automatic dialling.

The M2226 business computer has 256K memory internally with a 5Mbyte Winchester disc and 800Kbytes on floppy disc. It can operate with CP/M and therefore has access to a wide range of software; BT have added their own MerlinMaster software interface to make the whole system easy to use.

In addition there is the M3300 word processor which has two floppy-disc drives and a daisy-wheel printer. Both the computers can have auto-dial modems, can be linked to teletypewriters and have full access to teletex and telex services. There is a range of peripherals and software launched at the same time. British Telecom Merlin, Room 2028 Howland Street, London W1P 6HQ. WW313
INFORMATION THEORY

There are many ways of gathering information. We all know the trials of formal study to pass exams or for more immediate and practical reasons. But, in general life, we gather most of our knowledge by piecing together fragments picked up in random conversations. Sometimes it is the experts talking but more often its just ordinary folk.

Moreover, the breadth of experience revealed in the most casual conversation is often quite surprising. There was that painter, for example, in the next office boasting to his mate about the marvellous television reception in Croydon — “. . . and all we had was one of those two-pronged indoor aerials that stand on the set like a Martian’s helmet”.

Then our cleaning lady was telling me about her young son, who came in wearing blue sun glasses. As he is only about four feet high and has red hair, she told me, those glasses made him look just like a Martian.

Weeks later, on a very wet morning our dedicated cyclist, Jimmy, arrived dripping with rain, clad in waterproof leggings and a pale blue plastic cape. Kathy, our office girl, gasped with astonishment “. . . in those yellow trousers and blue top, I thought you were a Martian!”

*A show by any other name*

I see they are holding IFSEC at Olympia as usual this year; and then there is HEVAC at the Barbican Centre a week or so later.

Of course, they are names of exhibitions. The first is the International Fire, Security and Safety Exhibition and Conference — not surprising that it is abbreviated to initials — and the second is the Heating, Ventilating and Air Conditioning Show. But only a cypher expert would find it easy to work out what is going on at these exhibitions from the title alone.

Some almost seem to be deliberately misleading. How about CONTEXT? Something to do with printing you may think, or some other form of self-expression. No, its the co-ordinated Furnishing Exhibition at Earls Court. Then there is TECTRONICA — not an exhibition of oscilloscopes but an international show for the life and physical sciences. POWTECH has nothing to do with turbo-generators or enormous high-fi amplifiers — it is all about powder and bulk solids.

Of course there are many exhibitions where the title is fully appropriate, so that one can guess what the show is all about immediately. There is ELECTRONICA in Munich, SHOPEX in London, TESTMEX and TEST at Wembley; but, familiar though it may be, I have never worked out the meaning of INTERNEP-CON and, judging by the variety of types of exhibit, I doubt if anyone else has either.

However, for the most appropriate exhibition name the prize must go the Farmers’ Waste Management Exhibition at Stoneleigh. They call it MUCK — a show by any other name would smell as sweet.

*Words and Music Maestro*

I have just been watching that programme on television about the British Leyland Maestro, and the way in which the more sophisticated versions feature an audio readout of certain dashboard information. Do we call this a speakout? It is quite a status feature, and rather upstages such refine-
ments as electric windows or remotely controlled door mirrors.

The only demonstration of the speakout was the rather bossy synthesized feminine voice telling the driver to fasten his seat belt. But I understood from the report that the thing is programmed to blurt out information when an alarm situation occurs; e.g., “we’re nearly out of petrol!” I suppose it also draws attention to the engine overheating, very low oil pressure or lack of brake fluid. I wonder if it mentions tyre pressure — that is the one we usually forget.

In the report that I heard, the only microcomputer mentioned was the one that controls the engine, but you may be sure that the speakout system depends on at least one of these devices. No modern electronic system amounts to much without one. So we are naturally led to speculate on the conversational ability of the car of the future as more-and-more data processing power is compressed into smaller-and-smaller devices.

I read quite recently about a Japanese heavy-goods vehicle with solid-state television cameras mounted at “blind” locations on the truck body, with a c.r.t. in the cab to augment the conventional rear-view mirrors. There are already computer programmes for interpretation of signals and tv cameras into exact information for machine-tool control, etc., so who knows what the future may bring.

With the general trend towards the use of high technology for totally frivolous purposes, it is possible that the techniques mentioned will one day be combined to enable the car to utter those helpful comments currently made by one’s passengers; e.g., “all clear left . . . if you’re quick”, or “that’s a police car you’re overtaking”.

Such technical developments could ultimately do away with the need for passengers altogether; we could have quite chatty cars to keep us company on long journeys; and there may even be the optional electronic “hitch-hikers” which gives an authentic account of all the lifts he’s ever thumbed while you are trying to listen to the test match commentary on Radio 3.

MORE TALKING MOTOR CARS

It seems that BL have started a trend with the talking Maestro. I have just read a report in the Financial Times about a new experimental car by the Japanese Nissan Company, which not only talks to the driver but also responds to spoken commands.

It has a voice dialogue system which enables the driver to ask for such things as lights to be switched on and wing mirrors adjusted. Have you ever tried to adjust a wing mirror for a friend in response to his spoken instructions? “. . . up a bit — no, not too far — now a bit to the left — etc.” It’s very difficult and always leads to bad feeling. Now imagine trying to instruct a stupid computer — in Japanese.

And that’s only the beginning. This car also has a drowsiness monitor, which measures brainwave patterns and can tell if the driver is becoming tired. If he begins to fall asleep a flashing light and a buzzer operate, and the computer will eventually ask him to rest. With all these distractions it may, of course, be already too late; he may be resting permanently.

But he will not have driven into the back of the vehicle ahead, because this car is fitted with a radar which measures the distance to the vehicle in front, and if the gap becomes too small for any given speed the car is slowed until a safety distance is restored. Very useful in fog, but if it fails does it fail-safe? . . . and does fail-safe mean fail with the brakes on?

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The finalists will be invited to London to talk over their entries with the judges and be awarded their prizes. The prizes are:

1st prize £2,500
2nd prize £1,500

and the 4 runners up will be awarded prizes each of £1,000

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---

**Design an Electronic Device to help the Disabled**

**LIST OF RULES**

1. The competition is open to all UK residents only.
2. Entries can be individual or groups.
3. All entrants must register their interest in entering the competition on the form provided which must be returned to the Wireless World Editorial Department by the 30th June 1983.
4. All entrants agree to give Wireless World full editorial publication rights to an article describing the entry.
5. All entrants indemnify Wireless World against liability in respect of injury to people or damage to property arising from the use of the design.
6. All submitted designs must be the original work of the entrant or entrants and must not infringe the right of third parties in any way.
7. All submissions should consist of:
   a. A statement of design objectives
   b. An overall description of the device
   c. Detailed circuit descriptions and diagrams
   d. A model of the device or a unique aspect of the design sufficient to demonstrate its feasibility.
8. The design will be judged on:
   a. Originality and benefit to the handicapped
   b. Potential for production
   c. Elegance of engineering design
   d. Electronics content
   e. Design reliability
   f. Simplicity of operation
   g. Freedom from excessive maintenance
   h. Safety
9. Submissions not meeting the above requirements will be rejected.
10. The judges' decision is final.
11. All details must be submitted to the Wireless World Editor by 1st October 1983.
12. Shortlisted entrants must be prepared to travel to London to demonstrate their design. All costs will be paid by the journal.
13. Entrants agree to the hands-over date not allowed to enter other competitions.

---

**COMPETITION ENTRY FORM**

"Design an electronic device to help the disabled"

**Name of competitor**

**Address**

**Telephone (home):**

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I intend to enter the competition and to abide by the rules as laid down in the July 1983 issue of Wireless World.

I understand that, in order to qualify, my entry must be in the hands of the judges by 1st October, 1983.

**Signature:**

**Signature:**

**Date:**

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<table>
<thead>
<tr>
<th>MODEL</th>
<th>POWER RANGE (Continuous RMS)</th>
<th>TYPICAL LOADS</th>
<th>PRICES (one off)</th>
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<tr>
<td>PFA 100</td>
<td>50W-150W</td>
<td>451, 861</td>
<td>£20.85</td>
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<td>PFA 125</td>
<td>100W-250W</td>
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<td>£23.75</td>
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<td>PFA 250</td>
<td>250W-500W</td>
<td>211, 413, 861</td>
<td>£42.90</td>
</tr>
<tr>
<td>PFA HV</td>
<td>200W-300W</td>
<td>451, 861, 1612</td>
<td>£36.04</td>
</tr>
</tbody>
</table>

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CR1

TUBE DATA

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<table>
<thead>
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<th>Wirewound Resistors</th>
<th>BASES ETC.</th>
<th>Zener Diodes</th>
<th>Thermistors</th>
<th>BATTERIES</th>
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**Wirewound Resistors**
- **4 Watt**
  - 10K, 0.24
  - 100K, 0.18
  - 1M, 0.12
  - 10M, 0.06
  - 100M, 0.04
  - 1K, 0.24
  - 10K, 0.24
  - 100K, 0.24

**Bases ETC.**
- **10K**
  - 100K, 0.18
  - 1M, 0.12
  - 10M, 0.06
  - 100M, 0.04
  - 1K, 0.24

**Zener Diodes**
- **1N5GT**
  - 1N5617, 0.23
  - 1N5618, 0.28
  - 1N5619, 0.37
  - 1N5620, 0.45
  - 1N5621, 0.55
  - 1N5622, 0.65
  - 1N5623, 0.75
  - 1N5624, 0.85
  - 1N5625, 0.95

**Thermistors**
- **VA104**
  - 0.23
  - 0.28

**Batteries**
- **VA105**
  - 0.23
  - 0.28

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<thead>
<tr>
<th>Type</th>
<th>Series</th>
<th>Secondary</th>
<th>RMS</th>
<th>Current</th>
<th>Price</th>
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(amount in ABS plastic)

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**Toroidals**

The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognize the advantages toroidals offer in size, weight, lower radiated field and, thanks to ILP, PRICE.

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 7 days together with a short lead time on quantity orders which can be programmed to your requirements with no price penalty.

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**Design**

The benefits of ILP toroidal transformers:

- ILP toroidal transformers are only rated by the weight and height of their laminated equivalents, and are available with 110V. 230V or 240V primaries coded as follows:
  - For 110V primary (Europe) 1 in place of X in type number
  - For 220V primary (USA) 2 in place of X in type number
  - For 240V primary (UK) 3 in place of X in type number

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**For mail order please make your crossed cheques or postal orders payable to ILP Electronics Ltd. Barclaycard/Access welcome. Trade orders standard terms.**

Pay by ILP Electronics Ltd. Graham MK House, Rector Close, Canterbury CT2 8N Kent, England

Telephone (0227) 54778, Telex 955768 (division of ILP Electronics Ltd.)

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Pye Europa M5FSM high-band sets, complete but less
mike and cradle, £30 each plus £2 p.p. plus VAT.

Pye W294 high-band FM sets, complete but less
mike and speaker, £100 each plus £2 p.p. plus VAT.

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and like new, £200 each plus VAT.

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Pye Westminister W15 AM mid-band crystals and
tuned to 129.9 MHz, 130.1 MHz, 130.4 MHz. Very
good condition, £120 each plus £2 p.p. plus VAT.

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craddles. £70 each plus £2 p.p. plus VAT.

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MHz and 400-500 MHz.

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WIRELESS WORLD JUNE 1983

89
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Illustrated
10kHz-32MHz, AM/FM, £750
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100 pcs: 100R, 1K, 10K, 100K, 1M, 50 pcs of each. 1K, 10K, 100K, 1M, 50 pcs of each. 1K, 10K, 100K, 1M. Total 1000 pcs £28.50.

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5 AMP MAINS FILTERS

- Cure those unwieldy hang ups and data glitches caused by mains interference. MatchPatch - 8 or 10 pin, £55.00. File reconditioned. EX1 X flyer.
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5 AMP MAINS FILTERS

- Cure those unwieldy hang ups and data glitches caused by mains interference. MatchPatch - 8 or 10 pin, £55.00. File reconditioned. EX1 X flyer.
- Suppression Devices SODA 53.55
These latest designs from the drawing board of John Linsley Hood are engineered to the very highest standard. They represent the very best that is available on the market today. The delicacy and transparency of the tone quality enable these amplifiers to outperform on a side-by-side comparison, the bulk of amplifiers in the commercial market place and even exceed the high standard set by his earlier 70 watt designs.

Three versions are offered: a 30 watt with Darlington output transistors, both with Muter output devices. All are of identical outside appearance which is designed to match and stack with our Linsley Hood cassette recorder 2.

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We have done two kits to this design, one using the Linsley Hood kit and the other a kit similar in size and design from a different supplier.

A hard copy of our more recent designs. We would not therefore recommend repurposing of the original three articles.

We will therefore therefore recommend the following.

1. Sendust Alloy Super 01.

This is a hard copy of the original three articles.

Please consult our list for technical details on these and other special purchase kits.

Please consult our list for technical details on these and other special purchase kits.

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A hard copy of our more recent designs. We would not therefore recommend repurposing of the original three articles.

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1. Sendust Alloy Super 01.
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Application form and job description from:
District Personnel Department
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Bow Road
London E3 4LL
Tel. 01-980 4899, ext. 7

Closing date: July 13th, 1983

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Applications in writing, full cv, personal snapshot and salary requirements to:

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THE JOB. RF service engineer based in London to provide RF service and technical support throughout UK, Europe and Scandinavia. The candidate should be a self starter, willing and able to work on his own, and be able to trouble-shoot and solve problems in the field.

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Applications and cvs should be addressed to:
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PLASMA THERM LTD.
Kangley Bridge Road, Sydenham
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94 WIRELESS WORLD JULY 1983
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Salaries are currently under review and are in the range £7,314 to £7,892 in London and £6,384 to £6,962 outside London, depending upon experience. These are anticipated to rise to a basic of £7,750 in London and £6,720 outside London. Shift allowances are in addition to the above basic salaries.

The Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA

Name:
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Tel no:
Age:
My qualifications are:
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Wireless World July 1983
Satellite Communications

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Qualifications required are Degree/HND/HNC in a relevant discipline, plus experience. Excellent salaries and comprehensive range of benefits are offered, together with relocation assistance if required.

Please complete the coupon below and send it to Jack Burnie, Marconi Space and Defence Systems, Browns Lane, The Airport, Portsmouth, Hants. Tel. Portsmouth 674019.

(All posts are open to both male and female applicants)

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Premier international electronics companies — very secure and expanding in London and the south of England — require professional senior staff (including departmental heads). Relocation allowance up to £3,000.

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Engineers required with experience of circuit or component design or development for microwave equipment or digital logic or computer peripherals or electronic packaging or film technology or telecommunications. Also above for updating in modern techniques. Salaries up to £15,000.

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Engineers or mathematicians required for development of commissioning and design proving programmes from assistant to team leader level. Salaries up to £12,000 p.a.

Please contact by telephone, or letter, to discuss companies and possibilities. Watford 49456 anytime.

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   Installation and maintenance of studio and TV equipment UK and abroad.
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   We have many clients interested in employing ex-service fitters and technicians at sites throughout the UK. Phone for details.
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CHARING CROSS HOSPITAL

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INCLUSIVE SALARY SCALE:
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Applications are invited for the above post which carries responsibility for the day-to-day administration of the technician staff in the Medical Electronics Section of the Medical Physics Department.

The main duties are associated with equipment management which includes maintenance, electrical safety testing and evaluation of new equipment. Extensive use is made of a micro-computer for record keeping and work scheduling.

Applicants should have considerable experience of electronic equipment and should currently be in charge of an equipment maintenance section. The successful applicant will probably have a degree, HNC or HND in Electronic Engineering and will be appointed on the Medical Physics Technician scale.

For further information please telephone Mr. C. G. Carter, Senior Electronics Engineer, on 01784 2040, Ext 2588.

For an application form and job description please contact the District Personnel Department, Bradenham House, 116 Fulham Palace Road, London, W.6. Tel: 01-784 2040, Ext 2902.

Closing date June 24, 1983 (1146)
Systems Engineer

Sony Broadcast, one of the world’s leaders in professional broadcast television equipment and systems, are undergoing a planned programme of expansion. As a result of continued growth and success, we are now looking for experienced engineers to join our Systems Department. The successful applicants will join a young and enthusiastic team involved in the design, manufacture and commissioning of complex static and mobile television systems. This is a challenging and responsible position and candidates should have direct experience of sound and television principles, gained in operational television or its allied manufacturing industry.

If you like the thought of enjoying the success of one of the world’s leaders in Broadcast technology, together with an attractive salary and benefits package, then write with details of career and current salary to Mike Jones, Senior Personnel Officer, Sony Broadcast Limited, City Wall House, Basing View, Basingstoke, Hampshire RG21 2LA. Telephone (0256) 55011

Sony Broadcast Ltd.
City Wall House
Basing View, Basingstoke
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United Kingdom
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Attractively situated in a semi-rural area in one of the Home Counties, our client is engaged in the research, development and manufacture of a wide range of advanced systems for guided weapons, satellites and electronic warfare. The company is one of Britain’s most successful and prestigious companies who have recently acquired major new contracts which necessitate the recruitment of people to work on state-of-the-art projects in the following disciplines:

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For interesting work in the design and development of digital circuits, or analogue circuits, or D to A and A to D converters. Or VLS, to discrete circuits or logic circuits; also for packaging and thermal design of components and assemblies.

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For software design associated with INTEL 8086 and 8086 microprocessor based real time systems or computer modelling and simulation, or data analysis.

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To deal with the definition of engineering and performance requirements, algorithm development, simulation and modelling, trials co-ordination and data analysis associated with complex, high-technology systems.

You would join a young, informal, enthusiastic team, working in a pleasant environment, producing state-of-the-art designs at the forefront of technology using the very latest techniques and equipment to solve the most challenging problems. The rapid rate of change within the industry would ensure you will be constantly aware of new challenges and will be able to expand on the expertise you have already acquired.

Executive Recruitment Services

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WIRELESS WORLD JULY 1983

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TELECOMMUNICATIONS:
careers with extensive scope at Cheltenham

Join the Government Communications Headquarters, one of the world's foremost centres for R & D and production in voice/data communications ranging from HF to satellite – and their security. Some of GCHQ's facilities are unique and there is substantial emphasis on creative solutions for solving complex communications problems using state-of-the-art techniques including computer/microprocessor applications. Current opportunities are for:

Telecommunication Technical Officers
Two levels of entry providing two salary scales: £5980-£8180 and £8065-£9085

Minimum qualifications are TEC/SCOTEC in Electronics/Telecommunications or a similar discipline or C & G Part II Telecommunications Technicians Certificate or Part plus Maths B, Telecommunications Principles B and either Radio Line Transmission B or Computer or equivalent ONC in Electrical, Electronics or Telecommunications Engineering or a CIE Part I Pass, or formal approved Service technical training. Additionally, at least four years' (lower level) or seven years' (higher level) appropriate experience is essential in either radio communications or radar, data, computer or similar electronic systems. At the lower entry level first line technical/ supervisory control of technicians involves "hands-on" participation and may involve individual work of a highly technical nature. The higher level involves application of technical knowledge and experience to work planning including implementation of medium to large scale projects.

Radio Technicians
£5232-£7450

To provide all aspects of technical support. Promotion prospects are good and linked with active encouragement to acquire further skills and experience. Minimum qualifications are a TEC Certificate in Telecommunications or equivalent plus two or more years' practical experience. Cheltenham, a handsome Regency town, is finely-endoed with cultural, sports and other facilities which are equally available in nearby Gloucester. Close to some of Britain's most magnificent countryside, the area also offers reasonably-priced housing. Relocation assistance may be available.

For further information and your application form, please write to
Recruitment Office
GCHQ Oakley, Priors Road
Cheltenham, Gloucestershire GL52 5AJ
or phone 0242 21491, Ext. 2269.

Solid State Logic Limited manufactures a world-beating range of computer-assisted sound mixing consoles for the record and broadcast industries. Due to continuing expansion, we are looking for experienced engineers to work on design and development of new products.

Senior Test Engineer
We are looking for an engineer with experience of professional audio equipment and microprocessor-based digital and analogue systems to assist with extending our test facilities.

Applications must be accompanied by a recent CV and we look forward to hearing from you.

For an application form, please write to:
Senior Test Engineer
Solid State Logic Limited
The Poplars, Manor Road
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To: £12K

TO: £12K

Responsible for establishing complete on-site design programmes through to the manufacturing stage for high performance C.R.T. monitors used in new project/product introduction.

Applicants should have experience in monitor design or support.

You should hold an HND/BSc together with 2/5 years relevant industrial experience.

Opportunities for development into either technical, management or support functions are excellent.

Please write enclosing career details, or telephone Malcolm Lakin, Personnel Department
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COLNEY STREET,
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TEL. RADLETT 4722

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SALES ENGINEER

CEL urgently require a field sales engineer to assist with the sales and support of a widening range of digital video products. Based at Saffron Walden, the post will involve work both at our factory and throughout the UK and Europe.

The successful applicant will have extensive knowledge of video equipment in general (ideally both broadcast and non-broadcast) and be able and willing to work alongside a wide variety of operational situations.

An excellent remuneration package is on offer to the right person.

Applications in confidence to:

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Sales & Marketing Director
CEL Electronics Limited
Chroma House
Shire Hill
Saffron Walden
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To work as a technical adviser with a Latin American organisation for education by radio, with 40 affiliated radio stations in 17 countries.

The engineer will initially be based in Quito, Ecuador and will later travel to radio stations in other countries. The job consists of planning and running training courses for local technicians in maintenance of mainly small, short and medium wave transmitters, aerials and studios.

Applicants should have radio engineering experience, gained in a broadcasting environment: the post will demand skills in training people with non-technical backgrounds and in planning and improving equipment. Spanish speakers especially welcome, but language training can be provided.

The post is initially for three years on a basic salary. Because of extensive travel, it is unlikely to suit applicants with families. CIR will provide orientation and language training, insurance, air-fares and various allowances.

For a job description and application form, please send a brief cv to CIR Overseas Programme, 22 Coleman Fields, London N1 7AF, quoting ref WW/2.
Telecommunications Technicians
Up to £9,830

The posts available are varied, but broadly they fall into two groups at three different locations.

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for installation, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment; teleprinters, telephone subscribers' apparatus, PMBXs, PAXs, PABXs and ancillary equipment including that using analogue and digital techniques and voice frequency telegraph.

CROWBOROUGH, SUSSEX
for maintenance and operation of high power, medium and short wave broadcasting transmitters and associated equipment.

Applicants should normally have four years' relevant experience, and must hold one or more of the following:

★ ONC in Engineering (with pass in Electrical Engineering 'A')
★ ONC in Applied Physics
★ TEC/SCOTEC Certificate
★ City & Guilds Telecommunications Technicians Certificate Part II (Course No 271) or Part 1 plus Maths 'B', Telecommunications Principles 'B' and one other subject.
★ a pass in the Council of Engineering Institutions Part I examination
★ an equivalent or higher relevant qualification

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

Salary: £6,262-£8,580, London £1,250 more, starting salary may be above minimum for those with additional relevant experience. Promotion prospects are good. Relocation assistance may be available.


Foreign & Commonwealth Office

SERVICE MANAGER
SERVICE ENGINEER
MEDICAL LABORATORY EQUIPMENT

Due to continuing expansion of the medical division within the UK, Greiner have vacancies for the above positions.

Either position would suit applicants already working as service engineers on electro-mechanical instruments, or persons employed in medical/biochemical laboratories and familiar with automatic analysers.

Applicants should have mechanical aptitude and a good working knowledge of digital electronics. Ability to work with the minimum of supervision and a willingness to travel, for short periods, within the UK, will be expected.

In addition those applying for the Service Manager position should also be capable of organisation and control of a service department and have a proven ability to obtain immediate response.

Competitive salaries will be offered, together with a company car. Full product training will be given in the UK and Switzerland. Please write, giving details of experience, qualifications and past career, to:

GREINER ELECTRONICS (GB) LTD.
185 Angel Place
London N18 2UD
Tel: 01-803 8432

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Specialist for PC and stepping motors, fans, blowers, AC capacitors, relays, microswitches, linear and switched mode power supplies, VDUs, keyboards, test equip, electric and geared motors.

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ENCAPSULATING EQUIPMENT FOR coils, transformers, components, degasing silicone rubber, resin, epoxy. Lost wax casting for brass, bronze, silver, etc. Impregnating oils, transformer, motors, components, Vacuum equipment, low cost, used and new. Also for CRT regunning metallising. Research & Development Ltd, Barrymill, Mayo Road, Croydon CR9 2QF. 01-684 9917. (1975)

HALF INCH VCR ENGINEER

VCL Communications Ltd have a vacancy for a Half Inch VCR Engineer at their duplication facility in Central London.

Requirements:
Applicants should be experienced, preferably manufacturer or facility trained and be able to work with minimum supervision.

Salary: Negotiable, depending on ability and experience.

Other Benefits:
Bupa, Social Club, etc.

Phone or write to Dave Smith, VCL Communications, VCL House, 9a Dallington Street, London EC1. Tel: 01-251 6131.

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BROADCAST

"Scattered or sown over the General Surface"

Broadcasting these days tends to refer to those people scattering information rather than barley, but then much has changed! If you could be interested in changing then here is a small sample of the positions we have within our Communications division.

RF Components Designer to £14,500 Rural Southern England
To design very sophisticated components used by the communication industry. Ref: 046/1

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RF/Telecomms/TV (Cable & National) Audio + Speech Synthesis Engineers Required throughout UK. Many for smaller and unusual companies.

Telephone Paul Hequet on Lewes (07916) 71271 or write to him to broadcast your own potential.

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East Sussex BN7 2LU
Tel: Lewes (07916) 71271

TECHNICAL TRAINING FOR TELEVISION

Thames Television will be running its Technical Training Scheme beginning October 1983. The course will be 9 months duration and posts will be available in the following areas.

1. Technical operations covering VTR, Telecine, Vision Control and maintenance.
2. Studio Sound Operations.
3. Film Editing.

The course will consist of 5 months broad based training and 4 months specialist training and will take place at the Training Centre, Teddington, with additional experience gained on attachment at each of the Company's sites.

Salary during training will be 1-3 months £5,500 per annum, 4-9 months £6,300 per annum.

Successful Trainees will then be absorbed into operational departments at one of the Company's sites and go on to a salary structure applicable to the grade.

Candidates should preferably be 20-30 years of age and have academic qualifications, specialist training or experience relevant to their chosen area.

Thames is an equal opportunity employer and these vacancies are open to all male and female candidates regardless of national/ethnic origin and marital status.

For an application form and further details please send a large stamped addressed envelope to:-

Mike Allen,
Personnel Department,
Thames Television Limited,
Broom Road,
Teddington Lock,
Middlesex.
CABLE TELEVISION

CABLETIME is a newly formed company involved in the manufacture and installation of cable television systems, based in pleasant offices in central Newbury, Berkshire.

To assist in this new venture Cabletime are looking for the following staff:

SENIOR PROGRAMMER

A Senior Programmer is needed to join the Cabletime team of highly qualified engineers, to design and develop new high and low level software, and support and extend existing software packages. A suitable candidate for this position would be qualified to degree level or equivalent, have at least 2 years’ experience in the design and implementation of real-time systems (biased towards communications), using DEC hardware and software. Also experience of developing microprocessor software for Intel microprocessors, and fault-finding of microprocessor based systems would be useful.

DEVELOPMENT ENGINEER

A Development Engineer with experience in the field of television engineering is needed to design and develop electronic circuitry for the cable television industry. Experience of VHF/UHF techniques, and/or data communications would be a distinct advantage. A suitable candidate is likely to be a graduate, but this should not preclude anyone with a proven track record from applying.

If you are interested in an exciting career with this new venture then please write or telephone for an application form to:

The Personnel Officer, Cabletime Ltd., 17 West Mills, Newbury, Berkshire. Tel: Newbury (0635) 48222.

A member of the UEI/Micro Consultants Group.

Barcud is an independent television facilities company supplying outside broadcast and editing facilities and staff to television companies and producers from its base in Caernarfon. Because of recent and forthcoming expansion in its work and facilities, we now have a vacancy for an experienced

VISION AND VTR ENGINEER

The successful applicant will have experience of operating 1” VTR machines and familiarity with the Sony 5000 editing system would be an advantage. There will be opportunities to work on the company’s single and multi-camera outside broadcast units and in the new editing suite.

Salary, according to experience and qualifications, based on a scale in excess of ACTT rates. The company offers a pension and a bonus scheme.

Please send cv and names of two referees to: The Managing Director, Barcud Cyf, Cibyn, Caernarfon, Gwynedd by June 25th. Tel: (0286) 3459.

(1514)
Senior RF Engineer

The modern communications complex of Marconi Space and Defence Systems at Portsmouth requires an experienced professional Senior Engineer to develop new VHF/UHF receivers and micro processor based communications systems. This involves directing the technical work of engineers in a project team who will be working on the design, development and evaluation of RF circuits.

Marconi Space & Defence Systems

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HEWLETT PACKARD computer HP 9826A, in excellent condition, 135-6160, 36 bi GPIB controller, BASIC 2.0, disc drive, full documentation, 4c, disc, including a C.to.C scanner, 4c, disc. 963-5000. HP 7225A, digital vector plotter. GPIBM, fully equipped £1,000. 61-76 2869.

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The Cube Systems

All CUBE systems are delivered to the customer configured to his exact requirements, and tested in that arrangement. An appropriate text editor, machine code assembler and high level language are included with each system, as our experience has shown that most applications demand these tools, and the CUBE systems offer just about the most cost effective development station available.

The Software Products

Each of the three processor options 6502, 6809 and 68000 have associated machine operating systems, disk operating systems, and machine code assemblers.

On 6502, the user has a choice of a 12k version of ROM or disk BASIC with built-in screen graphics commands, or a 12k version called ICOL which provides real time control of ingress, output and timers.

On 6809, the disk operating system offered is FLEX, under which a wide variety of languages may be used, such as Pascal, BASIC, and PL/8. The advantage of PL/8 is that while it is similar to BASIC in ease of use and quickness of implementation, the final program is compiled, and therefore is much faster in operation than interpretive BASIC, and does not require the purchase of an interpreter for each implementation. A 12k version of this BASIC on ROM is also available.

BASIC is available on 68000.

The Hardware Products

EUROCUBE. The complete system on one small card. Available with either 6502 or 6809, and supplied complete with two channels of serial I/O, 30 channels of digital I/O, four memory sockets, each of which can take up to 32KB of ROM, EPROM or RAM, and a battery back-up circuit which provides non-volatility for CMOS RAM.

FORCE PROF II. 68000 single board computer with 128kb of DRAM, 2 serial and 2 digital ports, and 2 user EPROM sockets.

CU-MEM. Universal Memory Carrier board for ROM, EPROM and RAM up to 8KB per device, with 2 banks of four 16 pin memory sockets and battery back-up circuit for CMOS RAM.

CUBRAM. 64kb of DRAM Plus 16kb ROM/EPROM socket.

CU-KEY. Standard QWERTY layout keyboard, or non-staggered arrangement of 5×8 or 5×12 keys.

CU-GRAPH. High resolution VDU card for programmable text layout of up to 80 columns × 25 rows, mated with graphics of 112 × 256 pixels. Uses independent memory from microprocessor, and colour extension allows eight logical colours with no loss of resolution.

CU-MOT. 6802 single board computer for study purposes, without machine or disk operating systems, or languages support.

CU-PROM. EPROM programming unit for EPROMs up to 32KB (eg 32768)

CU-CLOCK. Real time calendar clock, with battery back-up and watchdog circuit.

CUPS. Range of power supplies for CUBE system.

CU-STOR. Single and double density floppy disk controller.

INDIO. Industrial heavy duty input/output system.

RACKPRINT. Panel mounted impact printer.

VIEWLINE. Single line display module.

CU-BUS. Analog interface with choice of 8 bit or 12 bit conversion.

ROMULATOR. Development tool for simulating ROM based programs in target systems.

SERIO. 2 or 4 channel serial interface.

BEEBEX. Allows use of BBC computer with CUBE peripherals.

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