Radio and electronics into the 'eighties
Take a high performance dual beam storage mainframe, add any two of five vertical plug-ins and you have a specification range which embraces a whole spectrum of applications. With variable persistence, up to four input channels, 15MHz bandwidth and the option to operate in X-Y and differential modes — that's the Telequipment DM63. All the superb basic features are available in a non-storage model, the D63.

Four-trace versatility with or without storage

Tektronix UK Ltd., PO Box 66, Coldharbour Lane, Harpenden, Herts. AL5 4UP.
Tel. Harpenden 85141.
37 Into the 'eighties

38 RADIO AND ELECTRONICS INTO THE 'EIGHTIES

Land mobile radio by W. M. Pannell
Broadcasting by D. P. Leggatt
Consumer electronics by St John C. Jackson
Radio navigation and radar by D. W. G. Byatt
Audio by Adrian Hope
H.f. radio communication by R. F. E. Winn
Electronic measuring instruments by John L. Minck

61 News of the month
More v.h.f. broadcasting Engineers want registration
Japanese make Prestel terminals

64 World of amateur radio

67 Practical parallel-tracking pickup arm — 2
by R. Cooper

73 Circuit ideas
Simple waveform generator Amplitude modulator
Long duration timer

77 Letters to the editor
Sidebands as phasors Digital filters
The Poynting vector

81 More on the scientific computer
by J. H. Adams

87 S.s.b. and f.m. tranceiver — 4
by G. R. B. Thornley

92 Novatexts: astables — logic gate circuits
by P. Williams

95 New products
Hameg the name for quality, performance and value in OSCILLOSCOPES. Advanced design optimising the use of both integrated circuits and discrete components ensures reliability.

Just a glance at the specification chart will make you want to know more.

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Specifications</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>HM 307</td>
<td>Single Trace DC-10 MHz, 5 mV/cm</td>
<td>Plus built in Component Tester</td>
<td>£149</td>
</tr>
<tr>
<td>HM 312</td>
<td>Dual Trace DC-20 MHz, 5 mV/cm</td>
<td>Sweep Speeds 40 ns - 0.2s/cm 8 x 10 cm</td>
<td>£250</td>
</tr>
<tr>
<td>HM 412</td>
<td>Dual Trace DC-20 MHz, 2mV/cm</td>
<td>Sweep Speeds 40 ns - 2 s/cm and Sweep Delay</td>
<td>£350</td>
</tr>
<tr>
<td>HM 512</td>
<td>Dual Trace DC-50 MHz, 5 mV/cm</td>
<td>Sweep Speeds 20 ns - 5 s/cm plus Sweep Delay</td>
<td>£580</td>
</tr>
<tr>
<td>HM 812</td>
<td>Dual Trace DC - 50 MHz, 5 mV/cm</td>
<td>20 ns - 5 s/cm, Sweep Delay and Storage</td>
<td>£1325</td>
</tr>
</tbody>
</table>

We may be a new name to you, but each instrument is backed by over 21 years experience in oscilloscopes.

For FULL Details please contact

HAMEG Limited
74 - 78 Collingdon St.,
Luton, Beds. LU1 1RX.
Tel: (0582) 413174
UK Subsidiary of Hameg K Hartmann KG

All prices UK list exc. VAT.
## DON'T GAMBLE
### WITH PERFORMANCE
#### BUY
### LEVELL OSCILLATORS

**TGF200**
- **FREQUENCY**: 1Hz to 1MHz in 12 ranges
- **ACURACY**: 0 to 1% fine control on TGF200D
- **SINE OUTPUT**: 7V r.m.s. down to <200μV with Rs = 60kΩ
- **DISTORTION**: <0.05% from 50Hz to 15kHz,
  <0.1% from 10kHz to 50kHz, <0.2% from 50kHz to 150kHz, <1% at 1Hz and 1MHz
- **SQUARE OUTPUT**: TG200D, DM & DMP only, 7V peak down to <200μV, rise time <150ns
- **SYNC OUTPUT**: TGF200D, DM & DMP only, 0V/2V & -10V/+10dB on TGF200DM,
  0V/2V & -14/+6dB on TG152DM
- **SIZE & WEIGHT**: 260 × 130 × 180mm. 4.3kg with batteries.

**TGF200D**
- **FREQUENCY**: 3Hz to 300kHz in 5 decade ranges
- **ACURACY**: ±2% ±0.1Hz to 100kHz increasing to ±3% at 300kHz
- **SINE OUTPUT**: 2.5V r.m.s. down to <200μV
- **DISTORTION**: <0.2% from 50Hz to 50kHz, <1% from 100kHz to 200kHz
- **SQUARE OUTPUT**: TG200M, DM & DMP only, 0V/2V & -10V,+10dB on TG152DM
- **SYNC OUTPUT**: 2.5V r.m.s. sine
- **METER SCALES**: TG200D, DM & DMP only, 0/2V & -14/+6dB on TG152DM
- **SIZE & WEIGHT**: 260 × 130 × 180mm. 3.4kg with batteries.

**TGF200MP**
- **FREQUENCY**: 3Hz to 300kH in 5 decade ranges
- **ACURACY**: ±2% ±0.1Hz to 100kHz increasing to ±3% at 300kHz
- **SINE OUTPUT**: 2.5V r.m.s. down to <200μV
- **DISTORTION**: <0.2% from 50Hz to 50kHz, <1% from 100kHz to 200kHz
- **SQUARE OUTPUT**: TG200M, DM & DMP only, 0V/2V & -10V,+10dB on TG152DM
- **SYNC OUTPUT**: 2.5V r.m.s. sine
- **METER SCALES**: TG200D, DM & DMP only, 0/2V & -14/+6dB on TG152DM
- **SIZE & WEIGHT**: 260 × 130 × 180mm. 3.4kg with batteries.

**TG152D**
- **FREQUENCY**: 0.2Hz to 1.22MHz on four decade controls
- **ACURACY**: ±0.02Hz below 6Hz, ±0.3% from 6Hz to 100kHz, ±1% from 100kHz to 300kHz, ±3% above 300kHz
- **SINE OUTPUT**: 5V r.m.s. down to 30μV with Rs = 600Ω
- **DISTORTION**: <0.15% from 15Hz to 1kHz, <0.5% at 1.5kHz and 150kHz
- **METER SCALES**: 2 Expanded voltage and −2/+4dBm
- **SIZE & WEIGHT**: 260 × 180 × 180mm. 5.4kg.

**TG152DM**
- **FREQUENCY**: 0.2Hz to 1.22MHz on four decade controls
- **ACURACY**: ±0.02Hz below 6Hz, ±0.3% from 6Hz to 100kHz, ±1% from 100kHz to 300kHz, ±3% above 300kHz
- **SINE OUTPUT**: 5V r.m.s. down to 30μV with Rs = 600Ω
- **DISTORTION**: <0.15% from 15Hz to 1kHz, <0.5% at 1.5kHz and 150kHz
- **METER SCALES**: 2 Expanded voltage and −2/+4dBm
- **SIZE & WEIGHT**: 260 × 180 × 180mm. 5.4kg.

**TG66B**
- **Battery model**: £245
- **Mains & battery model**: £260

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

**LEVELL ELECTRONICS LTD.**

MOXON STREET, BARNET, HERTS., EN5 5SD.
TEL: 01-449 5028/440 8686
The Quantum Electronics
THE LATEST AND BEST SOURCE OF SUPERFI AUDIO EQUIPMENT

Whether we may be a new name to you, our products use refinements of circuitry which
has been well proven over the years. Our philosophy is to design and build an
exacting product which will provide most performance and looks at a price
shone in and all power ratings are RMS watts, unlike the phoney
corresponding to what we consider the

**'STATE OF THE ART' PRE-AMP**

Unquestionably the best pre-amp on the market, it
is supplied ready-built, with a kit, and eases
P1. Mono 1 x 55W/80, 80W/40 £67.86
P2. Mono 2 x 45W/80, 65W/40 £59.32
P3. Mono 1 x 120W/80 £43.24
P4. Stereo 2x15W/80 £32.48
P5. Mono 1 x 150W/80, 250W/80
£36.23 £83.32
P6. Mono 1 x 250W/80 £112.35
Also available ready-built POA

**DOMESTIC' POWER AMP KITS**

Stylish and finished to match the CI, they are supplied with ready-built and tested kits and
require only simple assembly and point-to-

P1. Mono 1 x 55W/80, 80W/40 £67.86
P2. Stereo 2 x 45W/80, 65W/40 £59.32
P3. Mono 1 x 120W/80 £43.24
P4. Stereo 2x15W/80 £32.48
P5. Mono 1 x 150W/80, 250W/80
£36.23 £83.32
P6. Mono 1 x 250W/80 £112.35
Also available ready-built POA

**'SLAVE TRAY' & RACK MOUNTING KITS**

These kits are designed to cope with sustained
ing level use, for which the domestic kits are
not suitable. The same high performance
circuitry is used with the power.
transistors mounted on substantial
heat sinks. The 'slave tray' is the bare bones of a power
amp and comprises a simple plan finished
chassis, tested amp petty and transistors,
heatinks and power supply. No specific
connectors are supplied to allow flexibility
of application. You can mount the slave tray in
your cabinet, and fit or blank or leave
it as a match with our preamp. The slave
tray forms the basis for the rack mounting kits
which add a black lid and heavy gauge ¾ ins
black from. Low field toroidal transformers are
used and there is spare room for extra circuitry
if required. We stock a range of connectors for
your convenience.

**MODULES: UP TO 250W r.m.s.**

These modules are available in a variety of powers and
forms (including 1 bracket mounting) and are designed
for users only. They can be mounted and tested
and use the same power circuitry as the other amps in
the range and set an unprecended standard of performance
and reliability. We also have power supplies for use with
these. Please contact us for price and complete details.

**EXTRACTS**

If you have to learn Fortran (and no one actually wants
to anymore) buy this book. Forget the
others — this one is so good it will even help you understand
the standard, dense, boring, unintelligible texts. "New Scientist

THE ALGORITHM WRITER'S GUIDE £3.75

FLOW CHARTS & ALGORITHMS help you present safety
procedures, government legislation, office procedures, teaching
materials and computer programs by means of YES and NO
answers to questions.

The Algorithm Writer's Guide explains how to do this, including:
the best order and draw the flow chart, with numerous examples shown. All that
students require is an aptitude for logical thought. Size: A5, 130
pages. This book is a MUST for those with things to say.
Understand Digital Electronics

In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your vehicle speed and fuel consumption; you could be ‘phoning people without posting delays; they bring your name into a telephone which would automatically look up their number and dial it for you.

These courses were written by experts in electronics and learning systems so that you could teach yourself the theory and application of digital logic. Learning by self-instruction has the advantages of being faster and more thorough than classroom learning. You work at your own pace and must respond by answering questions on each new piece of information before proceeding.

After completing these courses you will have broadened your career prospects and extended your fundamental understanding of the rapidly changing technological world around you.

DIGITAL COMPUTER LOGIC AND ELECTRONICS £7.00

Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes - each A4 size - and serves as an introduction to the subject of digital electronics. Everyone can learn from it - designer, executive, scientist, student, engineer.

- Book 1 Binary, octal and decimal number systems; conversion between number systems.
- Book 2 AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables.
- Book 3 Positive ECL, De Morgan’s Laws; designing logic circuits using NOR gates.
- Book 4 R-S and J-K flip flops; binary counters, shift registers and half adders.

DESIGN OF DIGITAL SYSTEMS £11.50

Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes - each A4 size - are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers. Contents include:

- Book 1 OIctal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.
- Book 2 OR and AND functions; logic gates; NOT, exclusive-OR NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgan’s Laws; canonical forms; logic conversion; Karnaugh mapping; three-state and wired logic.
- Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic units (ALU’s); multiplication and division systems.
- Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAM) and read only memories (ROM).
- Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
- Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computer; executive programs; operating systems and time sharing.

O-LEVEL ENGLISH LANGUAGE £7.00

More and more jobs require a C-GRADE PASS, and over 250,000 people fail to get this every year. Will one of them be in your family? This new course, written by experts in a style that’s serious yet fun to read, shows you how to mark your own work and compare it with the work of other people in their exam year. Set your own pace and assess your results immediately with no postal delays; watch your speed and standards improve. In Book 1 learn how you will be marked on COMPREHENSION, Book 2 covers SUMMARY, PUNCTUATION & SPELLING, and Book 3 teaches you in the principles of COMPOSITION. Size: 3 A4 volumes totalling 250 pages.
In future, recording the present will be a thing of the past.

What’s past is past. And said to be best forgotten. But it’s fundamental to the very existence of communications recording to be able to replay a selected portion of tape to find out what was said by who, to whom . . . and when. And ‘when’ can be vital.

Equally vital, particularly in emergencies when every second counts, is the ability to obtain such replay access rapidly, precisely, automatically. With absolute certainty—and without time-consuming multiple knob-twiddling aided by guesswork.

Racal Recorders has recognized this need and produced TIMESearch—designed specifically for its ICR range of multi-channel communications recorders—and providing just these facilities.

TIMESearch can generate a coded time reference signal of crystal accuracy and index it onto the tape. It can read and display that signal. It can search a tape at high speed for a pre-selected time signal and automatically initiate replay at that time.

In communications recording, the future becomes the present; the present becomes the past. And when you need to recall the past with precision, you need TIMESearch.

And for providing precise time signals every 10 seconds for recording onto magnetic tape: the International Timing Unit.

Racal Recorders always on the right track


WWW — 822 FOR FURTHER DETAILS
The CINTEC Sinusoidal Frequency and Voltage Stabilizer

Applications

* Sound Recording
* Video Recording
* Medical
* Marine
* Computers
* Navigational Systems

The CINTEC Frequency & Voltage Stabilizer provides the answer to both these problems.

When the supply frequency is fluctuating wildly, between 45Hz and 65Hz and the voltage by more than 10% the output from the Stabilizer will not vary more than .01% from 50Hz or 1% in voltage, even when different loads are imposed.

Used by Government establishments, oil rigs, hospitals, police, video and electronic industry, shipbuilders etc., for a wide range of applications including video systems, medical, frequency conversion, navigational aids and sound recording systems.

In many countries and even in the United Kingdom during periods of heavy demand, the variation in the frequency and voltage is sufficient to introduce errors and the malfunction of such items as Recording equipment etc. Likewise, in certain areas, the only source of supply is from a Generator, the output of which can vary considerably when different loads are imposed. This has precluded the use of a wide range of equipment in many countries. Voltage Stabilizers are readily available but these do not stabilize the frequency of the supply which, in many instances, is essential.

Applications for the use of CINTEC FREQUENCY & VOLTAGE STABILIZER are more numerous than can be listed. Therefore, if you have a supply problem, contact CINTEC LIMITED whose engineers will be only too pleased to assist.

**SPECIFICATION**

<table>
<thead>
<tr>
<th>INPUT</th>
<th>100-125 volts or 200-250 volts at 45.65Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTPUT</td>
<td>115 volts or 230 volts</td>
</tr>
<tr>
<td>RATING</td>
<td>500VA or 250VA</td>
</tr>
<tr>
<td>STABILITY</td>
<td>Voltage Frequency</td>
</tr>
<tr>
<td></td>
<td>±1% No load to full load—</td>
</tr>
<tr>
<td></td>
<td>±0.01% No load to full load</td>
</tr>
<tr>
<td>FREQUENCY</td>
<td>50Hz or 60Hz Single or dual versions</td>
</tr>
<tr>
<td>WAVEFORM</td>
<td>SINUSOIDAL</td>
</tr>
<tr>
<td>DISTORTION</td>
<td>2%</td>
</tr>
<tr>
<td>AMB TEMP</td>
<td>−20°C to +40°C</td>
</tr>
<tr>
<td>COOLING</td>
<td>Fan Cooled</td>
</tr>
<tr>
<td>DUTY</td>
<td>Continuous</td>
</tr>
<tr>
<td>DIMENSIONS</td>
<td>432 (W) x 196 (H) x 508 (D) (17&quot; x 7.7&quot; x 20&quot;)</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>45 or 30Kg unpacked</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td>Cabinet or rack mounting</td>
</tr>
<tr>
<td>TERMINATION</td>
<td>Cannon Connectors at rear of case</td>
</tr>
<tr>
<td>NATO CODIFIED</td>
<td></td>
</tr>
<tr>
<td>24V DC Inverter</td>
<td></td>
</tr>
</tbody>
</table>

In addition to the A.C. operated models, a 24v D.C. INVERTER Stabilizer is available which operates from a heavy duty 24 volt battery and has output ratings similar to the A.C. models. This type of Stabilizer is particularly suitable for mobile operation.

CINTEC LTD

Detailed Specification and Brochure - Available Post Coupon or Telephone/Telex

Name  
Position 
Company  
Address  
WW5

WW-819 FOR FURTHER DETAILS
Sonic Sound, the premier home entertainment store have now added yet another big name in the field of sound equipment to further enhance their prestige in London’s centre of the audio/visual and Hi-Fi field in Tottenham Court Road.

Eddystone, at the top of the tree since short wave began, have now appointed Sonic Sound Audio as sole retail distributors in the United Kingdom. Anyone even contemplating purchasing short wave equipment, be they looking for the best possible available for their Embassy, press department or home use, should visit or contact Sonic where they will be able to view and listen to the most comprehensive range of the latest short wave equipment on the market today.

Listen and choose in comfort at Britain’s most up-to-date air conditioned sound demonstration studios. Full ranges of Hi-Fi, Video equipment, In-car and portables, etc., from all leading manufacturers; B & O, Sanyo, Sony, Hitachi, Pioneer, JVC.

*End user, quantity one, cash with order price.*
within your reach!

The M80-MC 80 column printer from Mannesmann Tally

Higher reliability, longer life, faster operation... that's the M80-MC.

It may cost just a little more than some "personal computer" printers, but it offers a whole lot better value.

When other cheaper printers come to a halt in the middle of a heavy work load, the Mannesmann Tally M80-MC carries on. It's a proven, 200 c.p.s. bi-directional printer which is based on microprocessor electronics—hence the low price.

* 80 column, 200 c.p.s., bi-directional, 7 x 7 matrix (64 character U.K. set).
* Industry standard parallel interface—compatible with all popular microcomputers.
* Simple DIY installation.
* Only £995 + VAT (includes Securicor delivery).
* 12 month comprehensive Warranty (return to factory); fixed price repair service thereafter.

Field service agreements available from our own nationwide maintenance organisation.

Options include:- 16.5 c.p.i. condensed print, 9 x 9 matrix, 96 c. set, serial interface, etc.

Applications assistance is only a 'phone call away.

MANNESMANN TALLY

Send coupon for more details.
Tally Limited, Tally House,
7 Cremyll Road,
Reading,
Berks. RG18NQ.

Make positive contact

IEA-ELECTREX

International Electrical Electronic and Instrument Exhibition

The third International Electrical, Electronic and Instrument Exhibition will once again prove to be a unique point of contact for specifiers, buyers, and indeed anyone interested in the future of the industry.

Over 1,000 different exhibiting companies covering just about everything electrical and electronic. From heavy power production equipment, coil-winding machinery, insulation and lighting... to electronic test, control and measurement instruments, general and sophisticated Electric vehicles and allied equipment... to scientific and laboratory instruments. Transformers... to a host of electronic devices. Electrical and electronic components of all kinds.

To help you locate specific items, the highly successful computer enquiry service will once again be operating; providing an instant readout of exhibitor and product information, as well as the specific location, based on the visitor's particular enquiry.

As an additional bonus, too, visitors will be able to transfer free of charge, to IPLEX '80—The International Pneumatics and Hydraulics Exhibition.

Naturally enough, IEA ELECTREX '80, the only internationally recognised event for the electrical and electronic industries in the UK, will have an internationally recognised venue—Birmingham's National Exhibition Centre.

Here, in the heart of the country, facilities for visitors are unrivalled. Excellent communications, accommodation and entertainment make a fitting location for this shop window for the British and international electrical and electronic industries.

Make sure you're there. And make some positive contacts at IEA ELECTREX '80. IEA ELECTREX '80. Together, they mean business.

National Exhibition Centre Birmingham,
England 29-29 February 1980
Opening hours: 09.30-18.00 hrs. daily.

Please send me further information on IEA Electrex '80

Name

Address

Send to: Print Services Department, IEA Electrex '80, Industrial & Trade Fairs Ltd., Rodcliffe House, Blenheim Court, Solihull, W. Midlands B91 2BG. Tel: 021-705 6707. Ref: 337073
This ruggedized version of the famous Eddystone 958 Series of high-grade professional receivers is fitted with anti-vibration mounts and drip-proof cowling. It covers 10kHz to 30MHz, with 1Hz digital readout and 4Hz stability under rigorous conditions of service. This receiver is ideal for general communication use, network monitoring, surveillance, military, mobile and shipboard installations. It is also available in standard form for bench or rack mounting.

Eddystone Radio Limited
Member of Marconi Communication Systems Limited
Alvechurch Road, Birmingham B31 3PP, England
Telephone: 021-475 2231 Telex: 337081
A GEC-Marconi Electronics Company

TOTAL AMPLIFICATION FROM CRIMSON ELEKTRIK
WE NOW OFFER THE WIDEST RANGE OF SOUND PRODUCTS —

POWER AMPLIFIER KIT. The kit includes all metalwork, hardware and necessary components, and its quality is consistent with that of our other products. Comprehensive instructions and full back-up services enable a novice to build it with confidence in a few hours.

PRE-AMP KIT
This includes all metalwork, pots, knobs, etc. to make a complete pre-amp with the CPR1(S) module and the MC1(S) module if required.

POWER AMPLIFIER KIT
- £39.03
- CPR1(S) £33.97
- CPR2(S) £25.98
- CPR3 £23.02
- CPR4 £19.52
- CPR5 £18.58
- CPR6 £17.12
- CPR1 £16.00
- CPR2 £15.15
- CPR3 £14.04
- CPR4 £13.67
- CPR5 £12.56
- CPR6 £11.56
- CPR1(S) £10.94
- CPR2(S) £9.59
- CPR3 £8.93
- CPR4 £8.40
- CPR5 £7.84
- CPR6 £7.28
- CPR1 £6.95
- CPR2 £6.53
- CPR3 £6.23
- CPR4 £5.96
- CPR5 £5.79
- CPR6 £5.62

CRIMSON ELEKTRIK
1A STAMFORD STREET, LEICESTER LE1 6NL Tel: (0533) 535508
U.K. — Please allow up to 21 days for delivery.

All prices shown are U.K. only and include VAT and post. COD & Bacs only. 14-day limit. Errors or omissions, please write for specific prices. Send stamp SAE in an international reply coupon for detailed information.

DISTRIBUTORS: Down H' s & Radio Centre, 66 Allens Street, Bangor, N. Ireland, Badger Sound Services Ltd., 45 Wood Street, Lymn, G. Arrows, Lancashire PR1 14G.
Avo produce an impressive range of servicing instruments for on-site and work-bench use.

1. There is the tried and tested Avmeter 8, with overload protection and a robust centre-pole movement resisting all the knocks of on-site work. It is just one of a complete range of portable multimeters.

2. Then there is the Avoscope A101, a portable, mains operated dual channel 10 MHz oscilloscope - a low cost instrument offering an accuracy of ±5% that is simple to use.

3. Also, Avo offer a choice of AM or AM/FM Signal Generators with variable outputs, providing accurate repeatable attenuation.

Avo quality is built on many years of experience. If you'd like more detailed information about the range, contact your nearest Avo Appointed Distributor, or ask Avo.

Avo Limited,
Archcliffe Road, Dover,
Kent CT17 9EN.
Tel: 0304 202620 Telex: 96283

You'll never meet a better meter

WW — 055 FOR FURTHER DETAILS
The invention of the silicon chip by Texas Instruments, turned science fiction into science fact overnight. That was in 1965, but only now is the full potential of the ‘chip’ being realised.

Texas Instruments offer you 14 years of extensive research and development in the form of data and reference books that will enable you to get the very best from their micro-miracle.

Whether it’s your business or hobby, anyone interested in micro-technology will find these books invaluable.

Get the real facts from the inventors of the ‘chip’.

Texas Instruments

Texas Instruments Ltd, Supply Division,
MS21, Manton Lane, Bedford
Tel: 0234 67466

Slough: 186 High Street, Slough, Berks. Tel: 0753 70531

Manchester: Knightsbridge Mall, Arndale Centre,
Market Street, Manchester. Tel: 061-832 6238

Please send me the books ticked. I enclose £_________ plus £1.15 P&P

DATA BOOKS
☐ T.I. Data £5.00  ☐ Linear Control Data £2.50
☐ Interface Circuits Data £3.50  ☐ Optoelectronics Data £3.50
☐ Power Semiconductor Data £3.20
☐ Transistor and Diode Vol. I £3.50

OTHER T.I. BOOKS
☐ Optoelectronics Theory and Practice £7.50
☐ Semiconductor Circuit Design Vols. I to IV £6.50 each
☐ Understanding Solid State Electronics £1.20
☐ Understanding Digital Electronics £3.50
☐ Software Design for Microprocessors £2.00
☐ 9900 Assembly Language Guide £4.00
☐ 9900 Family Systems Design £8.00
☐ Calculating Better Decisions (SRI-II) £5.00
☐ Calculator Decision Making Source Book (TI-51 III) £5.00
☐ Calculator Analysis for Business and Finance (TI-42 MBA) £7.00
☐ Sourcebook for Programmable Calculators (TI-58/58C/59) £11.45

TI-59 PAKETTES
Each pakette contains complete listings of programmes suitable for use with the TI Programmable 59 calculator £5.95 each
☐ Electronic Engineering ☐ Oil/Gas/Energy
☐ Black Body Radiation ☐ Printer Utility
☐ Astrology ☐ Programming Aids
☐ Marketing/Sales ☐ Fluid Dynamics
☐ Mathematics ☐ 3D Graphics
☐ Production Planning ☐ Lab Chemistry
☐ TI-59 Fun (Games Pakette)

NAME________________________________________
ADDRESS_____________________________________

To: Lascar Electronics, Unit 1, Thomasin Road, Basildon, Essex.

Please send me Data
☐ LMM-100 £82.17  ☐ LMM-200 £11.34  ☐ LMM-2001 £52.84  ☐ TEST LEADS £2.53

Name________________________________________
Address_________________________________________________________________________________

Tel No. __________________________________________________________________________________

I enclose cheque/PO value

Lascar Electronics Ltd, Unit 1, Thomasin Road, Basildon, Essex.
Telephone No: Basildon (0285) 723793.

WW - 610 FOR FURTHER DETAILS

PORTABLE PRECISION

A range of 3½ digit LCD multimeters offering high precision and extended battery life. All feature 0.5" LCD read-out with ‘battery low’ warning, inputs protected against overloads and transients, Auto- polarity, Auto-zero, rugged ABS cases and a full 1-year warranty.

The LMM-200 is a compact handheld multimeter with 0.5% basic accuracy and 15 different ranges. It measures voltage from 0.1mV to 500V, current from 0.1µA to 2 Amps, and resistance from 0.1Ω to 2MΩ.

The LMM-2001 is an identical instrument but with 0.1% basic accuracy.

The LMM-100 has an adjustable handle, a 2,000 hour battery life and is ideally suited to field or bench use. It measures voltage from 0.1mV to 1kV, current from 0.1µA to 2 Amps, and resistance from 0.1Ω to 20MΩ. 0.1% basic accuracy.

Lascar Electronics Ltd, Unit 1, Thomasin Road, Basildon, Essex.
Telephone No: Basildon (0285) 723793.

WW - 651 FOR FURTHER DETAILS
4-DIGIT DDD'S FOR LCD'S. SMARTER. CHEAPER. MONOLITHIC. FROM INTERSIL. NATURALLY.

LOW POWER CMOS DDD'S.

Today, Intersil offers a complete family of counters, timers and display drivers in low-power MAXCMOS™. Monolithic circuits that reduce your component count, power requirements and design time. At a cost that helps you think CMOS.

COMPARE PRICE AND PERFORMANCE.

<table>
<thead>
<tr>
<th>ORDER PART NUMBER</th>
<th>OUTPUT CODE</th>
<th>INPUT CONFIGURATIONS</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCD</td>
<td>ICM7211/7212</td>
<td>HEXADECIMAL CODE B</td>
<td></td>
</tr>
<tr>
<td>DISPLAY</td>
<td>ICM7211A/7212</td>
<td>MULITPLEXED 4-BIT</td>
<td>£3.55</td>
</tr>
<tr>
<td>ICM7211/7212</td>
<td>ICM7211A/7212</td>
<td>CODE B</td>
<td></td>
</tr>
<tr>
<td>LED</td>
<td>ICM7212/7212</td>
<td>HEXADECIMAL CODE B</td>
<td></td>
</tr>
<tr>
<td>DISPLAY</td>
<td>ICM7212A/7212</td>
<td>MULITPLEXED 4-BIT</td>
<td>£2.57</td>
</tr>
<tr>
<td></td>
<td>ICM7212A/7212</td>
<td>CODE B</td>
<td></td>
</tr>
</tbody>
</table>

COUNT ON US.

Whatever your display or counting problem, there's probably a better, simpler solution available from Intersil. For complete information on the ICM7211/7212, call your Intersil Sales Office, Franchised Distributor, or return the coupon below.

U.K. SALES OFFICE
Intersil, Snaprogetti House, Basing View Basingstoke RG21 2EE, Hants.

U.K. DISTRIBUTORS
Macro Marketing Ltd. 396 Bath Road, Slough, Berks.
Tel: Burnham 63011
Trancient Electronics (U.K.) Ltd. 61-63 London Road, Redhill, Surrey. Telephone: Redhill 69217 Telex: 8953230 TRELEC C
Rapid Recall Ltd. 46-50 Beam Street, Nantwich, Cheshire CW5 5LJ.
Tel: Crewe 626061 Telex: 36329
Rapid Recall Ltd. Soho Mills Industrial Park, Wooburn Green, Bucks.
Tel: Bourne End 24961 Telex: 849439
Andis Components Ltd. Ewall Street, Derby. Tel: Derby 363296

INTERSIL
Intersil, Snaprogetti House, Basing View Basingstoke RG21 2EE, Hants.
Send me everything I'll need to know about the ICM7211/7212 DDD's.
— Send me literature on your family of display driver/counter/timer circuits.

Name __________________________
Company ________________________
Address __________________________
Tel.: ____________________________

WW — 024 FOR FURTHER DETAILS
If QUAD amplifiers are so perfect, why does it still sound better in the concert hall?

In real life, the sounds from all the instruments and sometimes parts thereof are independently radiated and so are not ‘phase locked’ together nor are they subjected to common eigentones. These mutually incoherent wavefronts are subjected to tiny but important reflections at the pinna and finally end up as just two channels representing the pressure at the two ear drums. It is not possible to achieve this transfer accurately by means of loud-speakers or headphones however good these components may be. Nevertheless with good amplifiers and loudspeakers (and on those occasions when the people at the recording and transmitting end get it right) a musical experience can be achieved which is extremely satisfying and one of the greatest pleasures of our time.

For further details on the full range of QUAD products write to: The Acoustical Manufacturing Co. Ltd., Huntingdon, Cambs. PE18 7DB. Tel: (0480) 52561.

QUAD
for the closest approach to the original sound

QUAD is a registered Trade Mark

WW—027 FOR FURTHER DETAILS
MINIATURE TRANSFORMERS
- Solid-state mains transformers to BS4232
  - 95% type transformers, 0.4% to 50,000V
  - Order as WTM99. Price £2.19
  - By type transformers: 0.4% to 50,000V, 0.8% to 500,000V.
  - Order as WTM11W Price £3.50
  - 170 type transformers: 1.0% to 500,000V, 1.5% to 750,000V.
  - Order as WTM11T Price £2.19
  - 164 type transformers: 1.0% to 750,000V, 1.5% to 1,000,000V.
  - Order as WTM11B Price £2.19.

AMP KITS
- Complete kits of parts with full instructions to make 8 amplifiers with enclosures.
  - EW amp kit: Order as LW95P Price £13.37
  - SUN amp kit: Order as LW52P Price £14.49

PIEZO HORN TWEETER
- Very simply assembled to any speaker system up to 100W.
  - Minimum required sensitivity: 15%, Order as LW89K Price £9.37

COLD ROLLED COIL METER
- Ranges:
  - Oboe: Order as X416 Price £125
  - Single-play rim-drive turntable with stereo ceramic cartridge:
    - Order as YB93SC Price £123.31
  - Single-play rim-drive turntable "S" shaped tone arm:
    - Order as X82SC Price £60.29
  - Single-drive rim-drive turntable "S" shaped tone arm:
    - Order as X82SC Price £68.12

SOLEDER
- A high quality standard grade by Emco. Moulds ideal for miniature components - 25gms, 90gms, about 152 metres.
  - Order as YF720M Price £7.17

SLR50NS
- A small, low distorting speaker operating on 10V, 60W.
  - Order as YB25SC Price £11.31

MIC Stand
- Quality microphone stand extends to 150cm, arm for long microphones.
  - Stand: Order as X849F Price £17.71
  - Boom: Order as X846A Price £11.25

PCOCHER RING & KITS
- Active CX, 100mW:
  - Order as FY122 Price £4.85
  - Order as FY726 Price £4.85

REEL REGENERATION SYSTEM
- The "syston" having sold in your home Tapes.
  - Driver module:
    - Order as FY89K Price £20.41

KS10 HARDWARE KITS
- Complete with stand, microphone, battery and instructions:
  - Order as CL500 Price £7.95

LASER TUNER
- A return for 3,800 foot turn under full details on page 201 in our catalogue.
  - Order as X811M Price £19.36

ADJUSTABLE LAMP
- Adaptable to suit bright lights or miniature components. We offer bracket for clamping or holding to bench or wall. Shade and position fully adjustable and made from white plastic.
  - Order as YF726 Price £4.05

FOR FULL CATALOGUE DETAILS SEE BACK COVER

www.amplon.com
Everyone who works with electricity needs to know at some time or other what's going on inside the cable he's handling. What voltage. What current. What resistance. Not knowing the answers, or worse still having inaccurate answers, can make life difficult, even terminal.

Eagle Test Equipment gives the right answers

The range covers general multimeters, high voltage probes, clamp meters, insulation testers. Here are just four. Send the coupon for details of all the rest.

**KEW 7 Multimeter**
1000 OPV. DC volts up to 1000, DC amps up to 100 mA, AC volts up to 1000. Resistance up to 150 Kohms. Pocket size. "Off" damping. Complete with leads & battery. R.R.P. £6.95 ex. VAT.

**EM 1200 Multimeter**
100,000 OPV. Taut band movement. Overload protection. Reversible DC polarity. AC amps: 15, AC volts to 1500. DC amps up to 15, DC volts to 1500. Resistance up to 200 megohms. R.R.P. £49.95 ex. VAT.

**K1400 Multimeter**
20,000 OPV. DC and AC volts up to 5000, DC and AC amps up to 10. Resistance up to 20 megohms. "Off" damping. Overload protection. R.R.P. £79.35 ex. VAT.

**EM 10, 20 & 30 Multimeters**
10, 20 & 30,000 OPV. All with antiparallax mirror scale. DC volts to 1000 (1200 for EM30), DC amps to 250 mA (600 for EM30). AC volts to 1000 (1200 for EM30). Resistance up to 6.5 and 60 megohms respectively. R.R.P. EM10 £13.50, EM20 £17.25, EM30 £20.75 ex. VAT.

---

Test Equipment: EAGLE

Please send me details of your complete range of Test Equipment.

Name __________________ Company __________________

Address ________________________________

EAGLE INTERNATIONAL Precision Centre, Heather Park Drive, Wembley, Middlesex HA0 1SU.

WW — 077 FOR FURTHER DETAILS
CROPICO - A CERTAIN MEASURE OF PERFECTION

Cropico, established as one of Britain's leading manufacturers of precision electrical measuring equipment, offers a wide range of instruments which have been proved for accuracy and performance throughout the world.

- Resistance Boxes
- D.C. Null Detectors
- Resistance Bridges
- Digital Temperature Indicators
- Resistance Standards
- Electronic Standard Cell
- D.C. Potentiometers
- Multimeters, Digital or Analogue

Thermocouple
- Reference Junc.
- Termocouple Switches
- Earth Resistance Meters
- Pt 100 Switches
- Pt 100 Simulators
- Fluxmeters

Cropico - Britain's leading manufacturer, exporter and importer of precision electrical measuring equipment.

Request full details — Visitors Welcome

CROPICO LTD: Hampton Road, Craydon CR9 2RU
Telephone: 01-684 4025 and 4094
Cables: CROPICO-CROYDON
Telex: 945632 CROPICO G

CROPICO

WW — 075 FOR FURTHER DETAILS

POWER UNITS
Now available with
3 OUTPUTS

Type 250VRU/30/25

OUTPUT 1: 0-30v, 25A DC
OUTPUT 2: 0-70v, 10A AC
OUTPUT 3: 0-250v, 4A AC

ALL Continuously Variable

FOR Sake BOB! WHY
DIDN'T YOU TELL ME ABOUT THE
LR71 MONTHS AGO!

for all demagnetising problems

LEEVERS - RICH
have the answer

LR70 for tapes
up to 8\(\frac{1}{4}\) Dia and 1" wide

LR71 for tapes
up to 11\(\frac{1}{2}\) Dia and 1" wide

LR72 Han-d-mag for
demagnetising heads and
tape path components

LEEVERS - RICH EQUIPMENT LTD
319 Trinity Road, Wandsworth, London
SW18 3SL Tel: 01-874 9054 Telex: 92355

WW — 01 FOR FURTHER DETAILS
Pil are pleased to announce the official opening of their new 1500 sq. ft. showroom to the public. Offering a range of some 350 electrical measuring instruments manufactured by around 60 manufacturers, both British and international. Pil can cater for practically every electrical/measurement problem for any user on an ex-stock/short delivery basis.

The showroom facilities and its technical back-up are available to everyone from export houses and overseas users, buyers, engineers, to do-it-yourself enthusiasts and hobbyists.

Instruments Electrical the service and calibration division can provide full guarantee facilities as well as offering their normal repair and calibration service. For an immediate solution to your instrument problems, contact the Instrument Group at Instrument House.

Factory/Repairs 01-639 0155
North London Showroom 01-965 2352

Showroom/Sales/Export 01-639 4461
Open Mon. to Fri. (ring for Sat. opening times)

INSTRUMENT HOUSE, 727 OLD KENT ROAD, LONDON SE15
TELEPHONE: 01-639 4461 TELEX: 8811854 (INSTEL)

WW-064 FOR FURTHER DETAILS
Top value test equipment from TANDY

**LCD DIGITAL MULTIMETER.**
Low-cost hand held digital multimeter with a full 3½ digit LCD display. 0.5% basic accuracy, auto polarity operation. 10 Mohm DC input impedance. Reading to ± 1999.

**AC/DC 8 MHz OSCILLOSCOPE**
A new approved 8MHz version of last years winner! The advance design features of this oscilloscope make it an absolute essential for industrial uses on production lines, in laboratories and schools. Ideal for radio and TV servicing, audio testing, etc.

**LOW-COST LCD MULTIMETER**
A portable, compact sized multimeter with a full 3½ digit LCD display. Auto polarity operation, low battery indicator. 10 Mohm input impedance.

**COMPONENTS AND PARTS**

<table>
<thead>
<tr>
<th>CAT. No.</th>
<th>DESCRIPTION</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>276-032</td>
<td>LED</td>
<td>4 for</td>
</tr>
<tr>
<td>276-033</td>
<td>LED</td>
<td>2 for</td>
</tr>
<tr>
<td>276-034</td>
<td>LED</td>
<td>2 for</td>
</tr>
<tr>
<td>276-142</td>
<td>IR LED Emitter Detector Pair</td>
<td>£1.37</td>
</tr>
<tr>
<td>277-1003</td>
<td>12V DC Alternative to Tandy LED Module</td>
<td>£17.52</td>
</tr>
<tr>
<td>276-9110</td>
<td>6 pin edge connector</td>
<td>40p</td>
</tr>
<tr>
<td>276-1373</td>
<td>Power Terminal Mounting Hardware</td>
<td>50p</td>
</tr>
<tr>
<td>276-1363</td>
<td>10 220 Heat Sink</td>
<td>60p</td>
</tr>
<tr>
<td>276-1364</td>
<td>10 1 Heat Sink</td>
<td>81p</td>
</tr>
</tbody>
</table>

**AC/DC 8 MHz OSCILLOSCOPE**
Scales:
- DC voltage: 2 - 200 - 2000 300V
- AC voltage: 200 - 500V
- DC current: 2 - 200 - 200MA
- Resistance: 200 - 200K
- Power source: 9V battery or AC adapter
Size: 275 x 130 x 83 mm

**PRICE**

- 53.99

**PRICE**

- 39.93

**PRICE**

- 137.36

**TANDY DEALER**
Most items also available at Tandy Dealers. Look for this sign in your area.

The largest electronics retailer in the world.
Offers subject to availability. Instant credit available in most cases.
OVER 170 STORES AND DEALERSHIPS NATIONWIDE.

WWW - 060 FOR FURTHER DETAILS
Low Profile Sockets

**INTERSIL CHIPS ARE DOWN**

Due to bulk purchase, we are able to offer unbeatable prices on Intersil chips. Compare our prices and see how much you save. Contact us for details.

**LINEAR ICs**

- NE5534B I.C. 18p
- NE5564 14 Dual Timer 10p
- UA723ON Voltage Regulator 35p

**VOLTAGE REGS**

<table>
<thead>
<tr>
<th>7805</th>
<th>7812</th>
<th>7905</th>
<th>7912</th>
</tr>
</thead>
<tbody>
<tr>
<td>20p</td>
<td>25p</td>
<td>50p</td>
<td>75p</td>
</tr>
</tbody>
</table>

**POWER CONVERTER**

MT56WS

Now you can operate 115/120 Volts American equipment from 240 Volts. This converter has outputs for American type 2 or 3 pin plugs, fitted 20VA. Only £19.99

**LED BAR GRAPH AND ANALOG METER DRIVER**

New from National LM3194. Drives 10 LED directly for making bar graphs, audio power meters, analog meters, LED oscilloscopes, etc. Units can be stacked for more LEDs. A superb versatile and truly remarkable IC. Just out! Special price: Only £1.99.

**FAIRCHILD RED LED LAMPS**

FLV057 Medium Size Clear Case RED EMITTING. These are not restocked off spec. units as sold by some of our competitors. These are factory prime, first quality new units.

**MICROCOMPUTER SEMEL-ABACUS IN KIT FORM**

- Supplied with 16X of RAM
- Use the powerful 2.80 Microprocessor
- Space for up to 32X RAM on board
- 8K Full Basic
- VDU Memory Mapped
- 64 Characters by 16 Lines
- Tape Interface
- Single Board Construction
- RS 232 Printer Interface
- Puts into a standard TV set
- Full alphanumeric Characters plus 64 User Defined Graphics
- Stabilised power supply

**OPTIONAL**

- Colour Graphics
- Expansion board to full 64K Memory
- Analogue Interface

£376.50 + VAT

**ORDERING INFORMATION:**

For orders under £30 add 50p p & p. Add 15% VAT to total. All items are subject to prior sale and therefore subject to availability. Prices are subject to change without notice.

**Quantity discounts are available for OEMs and dealers. Send SAE for details.**

**THE ULTIMATE IN PERFORMANCE - MEASURES RESISTANCE TO 0.01 OHMS, VOLTAGE TO 100 MICROVOLTS, CURRENT TO 1 MICROAMPS AT LOWEST EVER PRICE!**

**FEATURES**

- 3½ digits 0.56" high LED for easy reading
- 100µV, 1µA, 0.01Ω resolution
- High input impedance 10 Megohm
- High accuracy achieved with precision resistors, not unstable trimpots
- Input overload protected to 1000V (except 200mV scale to 600V)
- Auto zeroing, autopolarity
- Mains (with adaptors not supplied) or battery operation
- Built-in charging circuitry for NiCads
- Overrange protection
- Hi Low power ohms, Lo for resistors in circuit

**SPECIFICATIONS:**

- DC Volts
  - Range 200mV, 2V, 20V, 200V, 1000V
  - Accuracy 1% ± 2 digits, Resolution 1mV
- DC Volts
  - Range 200mV, 2V, 20V, 200V, 1000V
  - Accuracy 1.5% ± 2 digits, Resolution 1mV
- DC Current
  - Range 2mA, 20mA, 200mA, 2 amp
  - Overload protection 1000V max, 200mV scale 600V
  - Accuracy 1% ± 2 digits, Resolution 0.1 ohms
  - Environmental Temp coefficient 0 to 30°C ± 0.25% C
  - Mains adapter: 6 - 9 Volts @ 200mA (not supplied)

**Price:**

<table>
<thead>
<tr>
<th>DC Volts</th>
<th>200mV</th>
<th>2V</th>
<th>20V</th>
<th>200V</th>
<th>1000V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>± 2 digits</td>
<td>± 1 digit</td>
<td>± 1 digit</td>
<td>± 1 digit</td>
<td>± 1 digit</td>
</tr>
<tr>
<td>Resolution</td>
<td>1mV</td>
<td>1mV</td>
<td>1mV</td>
<td>1mV</td>
<td>1mV</td>
</tr>
<tr>
<td>Overload protection</td>
<td>200mV scale 600V</td>
<td>1000V max</td>
<td>200mV scale 600V</td>
<td>1000V max</td>
<td>200mV scale 600V</td>
</tr>
</tbody>
</table>

**Dimensions:**

- Height 65mm
- Width 160mm
- Depth 150mm

**Weight:**

- 2.5 kg

**Guarantee:**

- 1 year

**Shipping:**

- UK £60
- Overseas £60

**Contact:**

To: Maclin-Zand Electronics Ltd
1st Floor, Unit 10, East Block
38 Mount Pleasant, London WC1X 0AP

**Please send me**

- @ £66.70 inc. p&p + VAT (overseas £60)
- £60 inc. p&p + VAT (UK sales only)
- £55 inc. p&p + VAT (overseas sales only)

**Name**

**Address**

**BLANK LETTERS PLEASE!!**

**Also available from:**

- Audio Electronics, 301 Edgeware Road
- London, W2
- Telephone: 01-724 3564
- SN Zand

**Me**

Maclin-Zand Electronics Ltd
38 Mount Pleasant, London WC1X0AP
Tel: 01-837 1165
Telex: 8953084 MACLING

**WW-069 FOR FURTHER DETAILS**
NewBear Books

WE HAVE 397 TITLES IN STOCK, SEND FOR COMPLETE LIST.

GAMES
Chess & Computer         D. Levy  £ 7.16
Chess Skill in Man and Machine P. Frey £11.84
52 Basic Programs for the Pet D. Spencer £9.95
Game Playing with Computers D. Spencer £10.20
Basic Computer Games D. Ahl  £ 5.50
Star Ship Simulation      £ 5.10
Game Playing with Basic   £ 4.10
Sargon                     Spracklen £ 9.50

MISCELLANEOUS
Intro. to TRS 80 Graphics Zaks  £ 5.75
Microprocessors C291      £ 7.50
Scleri Byte Primer        £ 2.95
Business Data Systems     £ 5.75
The Systems Analyst       £ 6.60
Your Home Computer        £ 4.95
Programming a Micro 6502  £ 7.95
5502 Applications Handbook Zaks £ 8.95

BASIC
Learning Basic Fast       £ 6.30
Basic Basic               J. S. Coan £ 5.00
Advanced Basic            £ 5.50
Illustrated Basic          £ 2.25
Basic with Business Applications £ 8.40
Introduction to Basic     £ 6.50
The Basic Handbook        £11.00

COBOL
COBOL Programming         £ 6.95
Learning COBOL Fast       £ 6.20
COBOL with Style          £ 4.20
Reducing COBOL Complexity Mc Clue £11.30

PASCAL
Pascal: User Manual and Report Springer-Verlag £ 5.52
Problem Solving Using Pascal Springer-Verlag £ 7.84
Programming in Pascal     £ 7.50
A Practical Intro. to Pascal A. Addyman £ 3.50
An Introduction to Programming and Problem Solving with Pascal Schneider £ 9.50
Introduction to Pascal    J. Welsh & J. Elder £ 6.95

FORTRAN
Elementary Computer
Programming in Fortran IV  Boguslausky £ 6.30

PROGRAMMING
Chemistry with a Computer  £ 7.96
Seminarical Algorithms     £17.85
Fundamental Algorithms     £17.85
Assembly Level Programming for Small Computers  £12.50
Sorting & Searching        £17.85
Top-Down Structured
Programming Techniques McGowan £12.50
The Design of Well Structured and Correct Programs Alagic & Arbib £10.00
Computer Mathematics      £ 8.58
Basic Principles of Data Processing Saxton/Steyer £ 7.75
Fundamentals of Computer Algorithms Horowitz/Sahni £15.00
Computer Approach to Introductory College Mathematics Scalzo £11.30
Computer Input Design      £ 8.85
Computer Output Design     £ 9.70
How to Program Micro's     £ 6.55

CREDIT SALES (Minimum £10), Access and Barclaycard
Welcome. "BY RETURN ORDER SERVICE"

CALLERS AND MAIL ORDER: 40 Bartholomew Street, Newbury, Berks. Tel: 0635 30505
CALLERS ONLY: 220-222 Stockport Road, Cheadle Heath, Stockport. Tel: 061 491 2290

WE - 008 FOR FURTHER DETAILS

METER PROBLEMS?

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

Full Information from:
HARRIS ELECTRONICS (London)
138 GRAYS INN ROAD, W.C.1 Phone: 01/837/7937

WE - 026 FOR FURTHER DETAILS

FYLDE

TRANDUCER and RECORDER
AMPLIFIERS and SYSTEMS

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

Fylde Electronic Laboratories Limited.
49/51 Fylde Road Preston PR1 2XQ
Telephone 0772 57560

WE - 040 FOR FURTHER DETAILS
NEW UNBEATABLE 1980 PRICES NOW!

EXPLORER/85

FEATURES INTEL 8085 CPU
WITH ON BOARD S-100 EXPANSION

FLEXIBILITY: Real flexibility at LAST. The EXPLORER/85 features the Intel 8085 cpu 100% compatible with all 8080A and 8085 software. Runs at 3MHz. Mother Board (Level A) with 2, S-100 pads expandable to 6 (Level C).

MEMORY
2K Monitor ROM
4K WORKSPACE / USER RAM
1K Video RAM
8K Microsoft BASIC in ROM or Cassette.

INTERFACES
STANDALONE FULL ASC11 Keyboard Terminal, 32/64 characters per 16 lines
Cassette interface (with motor control and cassette-File structure)
RS-232/20MA Loop, 4, 8bit: 1, 6 bit I/O ports, programmable 1bit binary counter/timer.
Direct interface for any S-100 Board
FULL Buffering decoding for S-100n Bus pads, wait state generator for slow memory.
Each stage has separate 5v. 1A regulator for improved isolation and freedom from cross talk.
P.S.U. requirements: 8v. 6.3v AC.
Runs with North Star controller and Floppies/CPM.
EXPLORER/85 is expandable to your own requirements with easy to obtain S-100 peripherals.
EXPLORER/85 can be purchased in individual levels, kit form or wired and tested. OR as a package deal as above.

£275 + VAT
Microsoft BASIC on Cassette

£295 + VAT
Microsoft BASIC in ROM

AVAILABLE NOW!

WE ARE KILLING INFLATION WITH

ELF II

THE TRIED AND TESTED
MICROCOMPUTER
SYSTEM
THAT EXPANDS
TO MEET
YOUR NEEDS

STARTS AT
£59.95
+ VAT

ELF II
BOARD WITH VIDEO OUTPUT
FEATURING THE RCA COSMAC 1802 cpu

STOP reading about computers and get your "hands on" an ELF II and Tom Pitman's short course. ELF II demonstrates all the 91 commands which an RCA 1802 can execute, and the short course quickly instructs you how to use them.

ELF II's VIDEO OUTPUT makes it unique among computers selling at such a moderate price. The expanded ELF II is perfect for engineers, business, industry, scientific and educational purposes.

NEWTRONICS KEYBOARD TERMINAL AT £114.20 + VAT

The Newtronics Keyboard Terminal is a low cost stand alone Video Terminal that operates quietly and maintenance free. It will allow you to display on a monitor 16 lines of 64 characters or 16 lines of 32 characters on a modified TV (RF Modulator required). The characters can be any of the 86 ASC II alphanumerics and any of the 32 special characters, in addition to upper/lower case capability, it has scroll-up features and full X-Y cursor control. All that is required from your microcomputer is 300 baud RS232-C or 20ma loop serial data plus a power source of 8v DC and 6.3v AC. The steel cabinet is finished in IBM Blue-Black. And if that is not enough the price is only £114.20 + VAT as a kit, or £144.20 + VAT assembled and tested. Plus £2 P&P (Monitor not included).

RACAL AP12, C12 TAPES: 10 for £4.50+VAT

NOW AVAILABLE 8K FULL BASIC FOR ELF II

NEWSOFT GAMES FOR ELF II: 4 for £5+VAT

SEND SAE FOR COMPREHENSIVE BROCHURE

Please add VAT to all prices (except manuals). P&P £2. Please make cheques and postal orders payable to NEWTRONICS or phone your order quoting BARCLAYCARD, ACCESS number.

NEW ADDRESS:
H. L. AUDIO LTD.
Bigger Premises
255 ARCHWAY ROAD
LONDON N6 5BS

New Phone No. 01-348 3325

We are now open for demonstrations and Sales, Monday-Saturday, 9.30 a.m.-6.30 p.m. Near Highgate Underground, on main A1 into London.

DEPT. WW
Carston Electronics

specialists in second user test and measuring instruments

Oscilloscopes

TEKTRONIX 465
DC-100MHz Dual Trace 5mV-5V/Div
0.05µs-0.5s/Div Delayed T/B XY DC 4MHz
£1200

TEKTRONIX 475A
DC-250MHz Dual Trace 5mV-5V/Div
0.01µs-0.5s/Div Delayed T/B XY DC 3MHz
£1950

These instruments sold with one year full guarantee

Other New Additions to our Stock —

Amplifiers
- MICRO MOVEMENTS
  M129 AC Amplifier and Strain Gauge Conditioning Unit... 60
  M128 DC Amplifier 15V/190V... 50
  2 and 10 channel rack systems available

Counter Timers
- HEWLETT PACKARD
  5260A-5260B DC-50MHz 6 Digit... 210
  RADAL
  B65 DC-15MHz 6 Digit Time interval /Period/ Rasio... 110

Distortion Systems
- RADFORD
  DM2 10kHz 100kHz meter... 160
  LD02 10kHz 100kHz Oscillator... 160

Modulation Meters
- MARCONI
  TF200A AM/FM 1000MHz... 495

Oscilloscopes
- DYNAMOCO
  7210 DC-10MHz Dual Trace... 230
  PHILIPS
  PM3210 DC-25MHz Dual Trace... 325
  TEKTRONIX
  547 1A DC 50MHz Dual Trace DTB... 525
  1A4 DC 50MHz Four Trace DTB... 625
  Plug ins for 550 Series
    1A1 Dual Trace Plug-In DC 50MHz... 225
    1A2 Dual Trace Plug-In DC 50MHz... 180
    1A4 Four Trace Plug-In DC 50MHz... 375
    1A5 Differential Plug-In... 175
    2 Differential Plug-In... 140
    BI Adapter Plug-In 1A Series to 580 Series... 75

TELEUGPMENT
- D34 DC 15MHz Dual Trace
  Bait Mains Portable... 450

Power Meters
- MARCONI SAUNDERS
  6966 100kHz 40GHz (Depending on Head).... 300
  6420 10MHz 12.4GHz 10mw... 75
  6421 10MHz 12.4GHz 100mw... 75
  6422 10MHz 12.4GHz 1mw... 50
  6428 5.4GHz 10mw... 50

Pulse Generators
- EH
  1200 100Hz-10MHz 20v 500 RT 1ns... 100
  122 1kHz-20MHz 5V 500 RT 12ns... 220
  1322 1MHz-20MHz 20v 500 RT 1ns... 130
  1330 10kHz 50MHz 5V 500 RT 6ns... 175
  1221 Timing Unit 6 Channel
    0-1MHz 7V 500 RT 8ns... 50

Recorders
- HEWLETT PACKARD
  260M/5 inch Single Pen
    3mV 120V/1 P 200cm min 2.5cm/Hr... 295
  SOUTHERN INSTRUMENTS
    100' Channel U/V 5.1000mm sec... 250
    M100 100Channel U/V 5.2000mm sec... 325
  Selection of Galvanometers available at £15.00 each
  YOKOGAWA
    1076 10 inch Chart Single Pen
    0.5mV 100V / P 2.60cm min 2.5cm/Hr... 350
    3030 2 Pen Version of 1076... 425

Voltmeters Digital
- FARNELL
  DM1131 1999 FSD AC DC OHMS Current Temp. 110
  SOLARTRON
  LM1420 3 2300 FSD DC Only 0.05%... 99
  LM1420 2BA 2300 FSD AC True RMS DC... 110

WW-070 FOR FURTHER DETAILS
Wireless World, January 1980

More second
user bargains

Acoustic
BRUEL & KJAER
2204 Precision sound level meter
2704 Precision sound level meter
1613 Octave filter set couples directly to 2203 & 2204
0.1 µF - 1 mF
0.1 if step
T F 2333 Transmission Test Set
Cable Test Equipment
TF2333 Transmission Test Set
STC
74216A Noise Generator CCITT
74216A Noise Generator CCITT
Counter Timers
HEWLETT PACKARD
5393A Time Interval plug-in
MARCONI
TF2434A DC 40 MHz 7 digits
RACAL
9024 10 Hz 600 MHz 7 + 1 digits
9835 DC 15 MHz 6 digits
9837 DC 80 MHz 6 digits
Logic Analyzers
HEWLETT PACKARD
1601 Logic state analyzer 12 channel display
Mains Monitors
AMPROBE
LAVJ3 Main’s voltage recorder
RUSTRAK
268 - CT Clamp on AC recording ammeter
Modulation Meters
AIRMEC
210.1 -300 MHz AM/FM
409.3 -1500 MHz AM/FM

Pressure & Displacement
Transducers
ELECTRO MECHANICS
LVD0 DC input variable 0.5 to 50 ns/sec.
Pulse Generators
E H RESEARCH
G1765 V/50 Mhz 20 Hz 50 MHz RT
124AL 50 V/500 MHz 3 MHz RT 12 Hz
Recorders & Signal Conditioning Equipment
BRUNO WOELK
MF102B Wav and Rutter meter
MF102C Wav and Rutter meter
Signal Sources & Generators
ADVANCE
H1.15 Hz 50 KHz
Dawe
410C 1 Hz 10 KHz
HEWLETT PACKARD
2002 5 Hz 600 Hz D 10 V RMS
5693 100 3 8 3 GHz 5 mW
608E 10 480 MHz AM
6108C 8 7 6 GHz FM
MARCONI
TF1717 FM Devaluer Meter 1024 MHz
TF5680 12 MHz 50 kHz square
TF599A -215 270 MHz AM FM
TF599B -160 3 220 MHz AM FM
TF2006 Two tone 20 Hz 20 KHz
ROHDE & SCHWARZ
10021B 6 1200 MHz 5012
WAYNE KERR
5121 10 Hz 120 KHz
02210 Hz 10 MHz

Temperature & Humidity
LEE-DICKENS
HP Humidity probe
HUMIDUN Temp/Humidity probe
RAYTEK
T1000 infra-red thermoprobe
Vibration
DAWE
1461 C(2) Portable Vibration Analyzer Kit
Voltmeters - Analogue
BRADLEY
C417C AC/DC/Digital
Linscheid
M28 DC/A 10 Hz 500 kHz
MARCONI
TF2601 AC voltmeter to 1 5 GHz
Voltmeters - Digital
SOLARTRON
A30 19999 FSO DC Only
A30 19999 FSO AC/DC/D
7045 19999 Auto AC/DC/D/HMS
7050 19899 Auto AC/DC/D/HMS
WAVE Analysers
GENERAL RADIO
1123A Tuned amplifier and null detector 20 Hz 20 KHz
HEWLETT PACKARD
302A 20 Hz 50 kHz 75 db range
WAYNE KERR
1221 C 20 Hz 100 kHz

Carston Electronics Limited
Shirley House, 27 Camden Road, London NW1 8NR. Telex 23820
Contact David Kennedy 01-267 5311/2

Redundant Test Equipment
Why not turn your under-utilized test equipment into cash? Ring us and we’ll make you an offer.

VAT charged at Standard Rate

(Wire history.com)
MODEL 756
FULL ASCII KEYBOARD

£39.50 + VAT 15%

Also available:
- Numeric keypad — interfaces with 756
  £7.50
- DC to DC converter to give — 12V
  (Mounts direct on 756 P.C.)
  £5.00
- Plastic enclosure type 701
  £10.75
- Gold plated edge connector type 756/com
  £1.95
- Generous Quantity Discounts Available

Carter Associates
P.O. Box 11262 VLAEBERG
South Africa postal code 8018

EMC/R.F.I.
INSTRUMENTATION

6-8 WEEKS DELIVERY/
FULL AFTER-SALES SERVICE

- ELECTRO-METRICS Interference Analysers
  (20Hz-40GHz) CISPR/VDE/ANSI/MIL-STD
  461/2.
- HIRE: A wide range of equipment available.
- FISCHER CUSTOM COMMUNICATIONS
  Current Probes — Spikeguard Suppressors
  (12 weeks delivery)
- AERITALIA Electric and Magnetic field sensor
  system
- CONTACT:
  Electro-Metrics Services Ltd.
  'Coach House', 84 Tilehouse St.
  Hitchin, Herts.

Electro-Metrics Services LTD.

Telex: 825115 ELMEC
Tel: Hitchin (0462) 59698

A new edition of a Newnes-Butterworths classic

Radio and Electronic Laboratory Handbook

Ninth Edition
M. G. Scroggie
assisted by G. G. Johnstone

- First published in 1938, and now recognised
  as a standard work in its field
- Covers every aspect of modern electronic
  laboratory practice
- Many new techniques are included for the
  first time and the subject of filters has been
  expanded
- Includes chapters on the general principles of
  measurement and laboratory practice including
  interpretation of results, methods of measure-
  ment and a comprehensive reference section
- Describes the use of integrated circuits and
  digital instruments

1980 666 pages £17.95 (US $40.50)

Newnes-Butterworths

Borough Green, Sevenoaks, Kent TN15 8PH
Tel: (0732) 884567

Butterworths has companies in Australia, Canada, New
Zealand, South Africa and the USA, where local prices
apply.
SEED SYSTEM ONE
prices from £1500-£2500
NEW-FORTRAN £80

SEED SYSTEM 12
prices from £4500-£12000

Suppliers of equipment to: Leading Universities, H.M. Government, Hospitals, Schools, Colleges and Small Business

SEED - STRUMECH - PORTLAND HSE. - COPPICE SIDE - BROWNHILLS - WALSALL

WW — 076 FOR FURTHER DETAILS

The King of Valves

Genuine Gold Lion valves — hand built, utilising advanced pumping techniques and individually tested to a tight specification — are your answer to the high quality sound demands made by musicians and listeners alike.

Gold Lion KT77's and KT88's covering 30-200 watts, are now available from M-OV along with data and distribution details. Find out all about the King of Quality — from M-OV.

Trade Mark of M-OV Audio Valves.

M-OV
A MEMBER OF THE GEC GROUP

THE M-O VALVE CO. LTD., HAMMERSMITH, LONDON, ENGLAND. W6 7PE. TELEPHONE: 01-603 3431. TELEX: 23433. GRAMS: THERMIONIC LONDON.

WW — 067 FOR FURTHER DETAILS
The new Toolrange catalogue

still the only catalogue of its kind

The New Toolrange Catalogue is still the only comprehensive single source of electronic tools and production aids.

The product range has almost doubled since last year and now over 2,000 tools, toolkits and service aids are illustrated in full colour.

Products from over 100 top manufacturers are available from stock.

Over 60,000 catalogues are now in circulation. If you don’t have one simply write, telephone or telex Toolrange for your free copy.

The 935

from Data Precision

HANDY · VERSATILE · TOUGH · PRECISE

HANDY—easy to hold, to carry, to use, to read. Always at hand to make difficult measurements easy.

VERSATILE—all the functions and ranges you need. 20 in all: volts and amps: s.c. and d.c., switchable H and L ohms.

TOUGH—built to take the rough and tumble of hard service and survive total malfunctions. The 935 will stay in cal.

PRECISE—basic 0.1% d.c. accuracy — better than many bench models!

VISUAL—big, clear, high contrast 3½ digit LCD display, readable anywhere, from characters.

EXPANDABLE—accessories extend measure-ments to 1000A 40kV r.f. at 700MHz or temperatures from 60 to 150°C.

INEXPENSIVE—the 935 has the lowest price tag of any high performance hand-held DMW at £55. UK, mainland delivered excl VAT. It uses a low cost PPS battery which can give up to 200 hours use.

Get the leaflet now and see why your next multimeter should be a Data Precision 935!

Contact: Farnell International

WW — 068 FOR FURTHER DETAILS
- the Mark III ASCII encoded touch keyboard

This professional quality touch sensitive keyboard has the full ASCII code set of characters available from the main keyboard, plus a separate 12 key pad to allow fast numeric entry. The MK III has a ‘bleep’ facility with volume control and power ‘on’ light plus a polyester sealed wipe clean surface making the unit particularly suitable for use in hostile environments. The MK III is supplied complete with mating gold plated edge connector in a low profile matt grey plastic case with non-slip feet.

Optional extras (all options are incorporated in the unit)
A  Serial output compatible to RS232/V24 £6.00
A1 Internal baud rate generator. For use with Option A or C. Please state Baud rate required ...£5.00
A2 Internal generation of ±12 Volts for use with Option A £8.00
C 20 mA Current loop output. Passive ...£6.00
D On board – 5 Volt regulator. Requires unregulated D.C. input of 7-12 V £4.00
E Earphone socket and plug in personal earphone £2.00
F Switch selectable TTY compatibility £10.00

With Option ‘A’ or ‘C’ the Baud rate may be supplied externally by the user
With Option ‘A’ the — 12 Volt may be externally supplied

Additional features
• 7 bit parallel ASCII encoded output with positive and negative strobes
• Odd and even parity check bits (bit 8)
• Two user definable pads - switch closures (24V 50mA max)
• Repeat pad
• Illuminating, electronically latched shift lock pad
• Electronic hysteresis
• Industry standard key spacing (¾ in)
• Operating life greater than 5,000,000 operations per pad
• Available ex stock (manufactured in U.K.)

Custom keyboard design and manufacturing capability

Please send me details of your range of keypads. Price £48.50 plus VAT

Postage and packing
U.K. £1.00 'Europe £2.00 'Outside Europe £3.00
(This includes Air Mail delivery)

Payment should be made in sterling drawn on a U.K. bank or I.M.O.
Cheques made payable to Star Devices Ltd.
P.O. Box 21. Unit 1, Mill Lane. Newbury, Berkshire.
Telephone 0635 40405

Access/Eurocard/Mastercharge
Name .....................................................................................................................
Address ..................................................................................................................
Card Number .................................................................................................

BLOCK CAPITALS

WW — 072 FOR FURTHER DETAILS
A major exhibition of computers, peripherals, terminals and services, held each spring in the most highly industrialised area of Western Europe.

**COMPEC EUROPE’80**

Centre International Rogier, Brussels, May 6, 7 & 8, 1980

The ever-growing international attendance gives Compec Europe exceptional status as a sales platform for providers of hardware, software and services from every country. Ensure participation in its benefits by posting the coupon below.

**COMPEC EUROPE’80 STAND RESERVATION FORM**

To: The Exhibition Manager, Compec Europe, Room 821, Dorset House, Stamford Street, London, SE1 9LU, England.

Please provisionally reserve for us stand space at Compec Europe 80 and send the undersigned more information.

Name ________________________________ Company ________________________________
<table>
<thead>
<tr>
<th></th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HI-FI DRIVE UNITS</strong></td>
<td></td>
</tr>
<tr>
<td>Audax HD 12 9025</td>
<td>£7.65</td>
</tr>
<tr>
<td>Audax HD 13034H</td>
<td>£12.75</td>
</tr>
<tr>
<td>Audax HP11256B</td>
<td>£6.65</td>
</tr>
<tr>
<td>Audax PX11325</td>
<td>£13.25</td>
</tr>
<tr>
<td>Audax HD24545C</td>
<td>£20.50</td>
</tr>
<tr>
<td>Baker Superb</td>
<td>£9.45</td>
</tr>
<tr>
<td>Castle Super 8RS/DD</td>
<td>£12.65</td>
</tr>
<tr>
<td>Chartwell CE205 8&quot;</td>
<td>£18.00</td>
</tr>
<tr>
<td>Ciles 4001</td>
<td>£7.65</td>
</tr>
<tr>
<td>Ciles 3000</td>
<td>£7.65</td>
</tr>
<tr>
<td>Celestion 1300 II</td>
<td>£10.25</td>
</tr>
<tr>
<td>Celestion HC 2000</td>
<td>£10.25</td>
</tr>
<tr>
<td>Daleford DT 10 tweeter</td>
<td>£8.45</td>
</tr>
<tr>
<td>Daleford D30/110 811</td>
<td>£11.25</td>
</tr>
<tr>
<td>Daleford D50/153 81/4</td>
<td>£12.25</td>
</tr>
<tr>
<td>Daleford D50/200 81/4</td>
<td>£12.25</td>
</tr>
<tr>
<td>Daleford D70/200 10/10</td>
<td>£22.25</td>
</tr>
<tr>
<td>Daleford AB 10k</td>
<td>£10.25</td>
</tr>
<tr>
<td>Daleford D100/310 12/8</td>
<td>£36.75</td>
</tr>
<tr>
<td>Deca London horn</td>
<td>£57.25</td>
</tr>
<tr>
<td>Deca HK 30 horn</td>
<td>£43.75</td>
</tr>
<tr>
<td>Deca CO 1000/8</td>
<td>£10.25</td>
</tr>
<tr>
<td>EMI 16A 1770 14x 9in</td>
<td>£19.50</td>
</tr>
<tr>
<td>EMI Bin x 5 din/c.</td>
<td>£6.95</td>
</tr>
<tr>
<td>EMI Type 350 4 ohm</td>
<td>£9.45</td>
</tr>
<tr>
<td>Isophon KX9/8</td>
<td>£8.15</td>
</tr>
<tr>
<td>Isophon KX10/8</td>
<td>£8.45</td>
</tr>
<tr>
<td>Jordan Watts Module</td>
<td>£20.40</td>
</tr>
<tr>
<td>Jordan Watts HF kit</td>
<td>£9.15</td>
</tr>
<tr>
<td>Jordan 60Kem unit</td>
<td>£23.00</td>
</tr>
<tr>
<td>Jordan CB crossover (pair)</td>
<td>£23.00</td>
</tr>
<tr>
<td>Jordan Mono crossover (pair)</td>
<td>£23.00</td>
</tr>
<tr>
<td>Kel 12 Richard</td>
<td>£9.45</td>
</tr>
<tr>
<td>Kel 1110</td>
<td>£12.00</td>
</tr>
<tr>
<td>Kel 2000</td>
<td>£13.25</td>
</tr>
<tr>
<td>Kel 3139</td>
<td>£27.00</td>
</tr>
<tr>
<td>Kel DN 13</td>
<td>£5.40</td>
</tr>
<tr>
<td>Kel 12</td>
<td>£6.85</td>
</tr>
<tr>
<td>Kel DN 22 (pair)</td>
<td>£40.85</td>
</tr>
<tr>
<td>Lowther PM6</td>
<td>£51.00</td>
</tr>
<tr>
<td>Lowther PM7</td>
<td>£88.45</td>
</tr>
<tr>
<td>Peerless K10DT</td>
<td>£10.50</td>
</tr>
<tr>
<td>Peerless DT10FC</td>
<td>£10.50</td>
</tr>
<tr>
<td>Peerless K040MRF</td>
<td>£12.25</td>
</tr>
<tr>
<td>Radford DB25 I</td>
<td>T.B.A.</td>
</tr>
<tr>
<td>Radford MD29</td>
<td>T.B.A.</td>
</tr>
<tr>
<td>Radford MD6</td>
<td>T.B.A.</td>
</tr>
<tr>
<td>Radford FB8/FN831</td>
<td>T.B.A.</td>
</tr>
<tr>
<td>Radford DB25 II</td>
<td>T.B.A.</td>
</tr>
<tr>
<td>Rienard 3170</td>
<td>£6.35</td>
</tr>
<tr>
<td>Richard Allan CDEM</td>
<td>£11.25</td>
</tr>
<tr>
<td>Richard Allan CDEM7</td>
<td>£11.25</td>
</tr>
<tr>
<td>Richard Allan CGT12 Super</td>
<td>£25.30</td>
</tr>
<tr>
<td>Richard Allan LP8B</td>
<td>£11.75</td>
</tr>
<tr>
<td>Richard Allan LP8B</td>
<td>£17.60</td>
</tr>
<tr>
<td>Richard Allan HP18</td>
<td>£28.95</td>
</tr>
<tr>
<td>Seas H107</td>
<td>£17.80</td>
</tr>
<tr>
<td>Shackman Electrostatic</td>
<td>£18.00</td>
</tr>
<tr>
<td>Shlachman Electrostatic</td>
<td>£18.00</td>
</tr>
<tr>
<td><strong>PA GROUP &amp; DISCO UNITS</strong></td>
<td></td>
</tr>
<tr>
<td>Baker Group 35</td>
<td>£15.45</td>
</tr>
<tr>
<td>Baker Group 50/12</td>
<td>£23.45</td>
</tr>
<tr>
<td>Baker Group 50/15</td>
<td>£35.15</td>
</tr>
<tr>
<td>Celestion Powercell 12/150</td>
<td>£66.90</td>
</tr>
<tr>
<td>Celestion Powercell 15/250</td>
<td>£69.25</td>
</tr>
<tr>
<td>Celestion G12/60 Twin cone</td>
<td>£15.95</td>
</tr>
<tr>
<td>Celestion G12/80 Cambric edge</td>
<td>£20.25</td>
</tr>
<tr>
<td>Celestion G12/80 Twin cone</td>
<td>£19.75</td>
</tr>
<tr>
<td>Celestion G12/75 Cambric edge</td>
<td>£35.10</td>
</tr>
<tr>
<td>Celestion G15/100 Cambric edge</td>
<td>£31.95</td>
</tr>
<tr>
<td>Celestion G15/100 Twin cone</td>
<td>£32.25</td>
</tr>
<tr>
<td>Fane G18/1/200</td>
<td>£25.25</td>
</tr>
<tr>
<td>Fane DM1000</td>
<td>£15.95</td>
</tr>
<tr>
<td>Fane Pop 40</td>
<td>£12.50</td>
</tr>
<tr>
<td>Fane Pop 50H0</td>
<td>£13.80</td>
</tr>
<tr>
<td>Fane Pop 75</td>
<td>£19.70</td>
</tr>
<tr>
<td>Fane Pop 65</td>
<td>£21.25</td>
</tr>
<tr>
<td>Fane Pop 80</td>
<td>£28.80</td>
</tr>
<tr>
<td>Fane Pop 100</td>
<td>£41.80</td>
</tr>
<tr>
<td>Fane Guitar B8C</td>
<td>£26.10</td>
</tr>
<tr>
<td>Fane Guitar B8C</td>
<td>£27.15</td>
</tr>
<tr>
<td>Fane Disco 80</td>
<td>£27.15</td>
</tr>
<tr>
<td>Fane PARO</td>
<td>£26.10</td>
</tr>
<tr>
<td>Fane Bass 85</td>
<td>£34.00</td>
</tr>
<tr>
<td>Fane Crescendo 12E</td>
<td>£57.50</td>
</tr>
<tr>
<td>Fane Crescendo 15E</td>
<td>£74.90</td>
</tr>
<tr>
<td>Fane Crescendo 18E</td>
<td>£84.75</td>
</tr>
<tr>
<td>Fane J44</td>
<td>£6.90</td>
</tr>
<tr>
<td>Fane J73</td>
<td>£9.75</td>
</tr>
<tr>
<td>Fane JPTX / HPX/2</td>
<td>£3.85</td>
</tr>
<tr>
<td>Fane HPX3A</td>
<td>£5.60</td>
</tr>
<tr>
<td>Fane HPX3B</td>
<td>£4.55</td>
</tr>
<tr>
<td>Fane HPX4</td>
<td>£5.85</td>
</tr>
<tr>
<td>Fane HPX5</td>
<td>£5.60</td>
</tr>
<tr>
<td>Goodman 8PA</td>
<td>£5.85</td>
</tr>
<tr>
<td>Goodman 12P</td>
<td>£21.00</td>
</tr>
<tr>
<td>Goodman 13PD</td>
<td>£23.95</td>
</tr>
<tr>
<td>Goodman 12P</td>
<td>£23.95</td>
</tr>
<tr>
<td>Goodman 18P</td>
<td>£24.45</td>
</tr>
<tr>
<td>Goodman FJax 50X</td>
<td>£21.85</td>
</tr>
<tr>
<td>Motorola Porta horn 3/16&quot;</td>
<td>£8.50</td>
</tr>
<tr>
<td>Motorola Porta horn 2x16&quot;</td>
<td>£12.25</td>
</tr>
<tr>
<td>Richard Allan HD10T</td>
<td>£24.45</td>
</tr>
<tr>
<td>Richard Allan HD15</td>
<td>£43.40</td>
</tr>
<tr>
<td>Richard Allan Attsa 18&quot;</td>
<td>£85.15</td>
</tr>
<tr>
<td>Richard Allan Attsa 18&quot;</td>
<td>£110.75</td>
</tr>
<tr>
<td><strong>WILMSLOW AUDIO</strong></td>
<td></td>
</tr>
<tr>
<td>KITS FOR MAGAZINE DESIGNS etc.</td>
<td></td>
</tr>
<tr>
<td>Kits include drive units, crossovers, BAF/long fibre wool, etc, for a pair of speakers</td>
<td>£33.75</td>
</tr>
<tr>
<td>Practical Hi-Fi and Audio PROP.TI (Rogers) Felt panels for PROP.TL £77 plus £1.00 carriage</td>
<td>£138</td>
</tr>
<tr>
<td>Hi-Fi Answers Monitor (Rogers)</td>
<td>£146</td>
</tr>
<tr>
<td>Hi Fi News State of the Art (Atkinson)</td>
<td>£182</td>
</tr>
<tr>
<td>Hi Fi News Miniliner (Atkinson)</td>
<td>£48</td>
</tr>
<tr>
<td>(carragge £2.66)</td>
<td></td>
</tr>
<tr>
<td>Hi Fi, for Pleasure Compact Monitor (Colloms)</td>
<td>£115</td>
</tr>
<tr>
<td>(carragge £5.25)</td>
<td></td>
</tr>
<tr>
<td>Popular Hi-Fi Mini Monitor</td>
<td>£74</td>
</tr>
<tr>
<td>Popular Hi-Fi Round Sound (Stephens) including complete cabinet kit</td>
<td>£71</td>
</tr>
<tr>
<td>Popular Hi-Fi, plus (carragge £2.66)</td>
<td></td>
</tr>
<tr>
<td>Practical Hi-Fi &amp; Audio BSC3 (Rogers)</td>
<td>£69</td>
</tr>
<tr>
<td>Practical Hi-Fi &amp; Audio Monitor (Giles)</td>
<td>£155</td>
</tr>
<tr>
<td>Practical Hi-Fi + Audio Triangle (Giles)</td>
<td>£99</td>
</tr>
<tr>
<td>Practical Hi-Fi &amp; Audio Mini Triangle (Giles)</td>
<td>£108</td>
</tr>
<tr>
<td>Wireless World Transmission Line (Bailey) KEF</td>
<td>£122</td>
</tr>
<tr>
<td>Wireless World Transmission Line (Radyford) RAYFORD</td>
<td>£184</td>
</tr>
<tr>
<td>Hi-Fi News Tabor (Jones) with 4 bass units</td>
<td>£60</td>
</tr>
<tr>
<td>Hi-Fi, News Tabor (Jones) with 6 bass units</td>
<td>£66</td>
</tr>
<tr>
<td>Smart badges free with all above kits (to give professional touch to your DIY speakers); Send 50p for up to 6 emprints/construction details of above designs.</td>
<td></td>
</tr>
<tr>
<td><strong>CARRIAGE &amp; INSURANCE</strong></td>
<td></td>
</tr>
<tr>
<td>Tweeters &amp; Crossovers 80p each</td>
<td></td>
</tr>
<tr>
<td>Speakers 4&quot;, 6½&quot;, 80p each</td>
<td></td>
</tr>
<tr>
<td>Speakers 10&quot;, 12&quot;, 80p each</td>
<td></td>
</tr>
<tr>
<td>Speakers 1&quot; ,13&quot;, 1&quot; ,8&quot;&quot;&quot;, 14&quot; ,X&quot;, 80p each</td>
<td></td>
</tr>
<tr>
<td>£1.75 each</td>
<td></td>
</tr>
<tr>
<td>£2.76 each</td>
<td></td>
</tr>
<tr>
<td>£4.00 each</td>
<td></td>
</tr>
<tr>
<td>£4.00 each</td>
<td></td>
</tr>
<tr>
<td>£6.00 each</td>
<td></td>
</tr>
<tr>
<td>£1.75 each</td>
<td></td>
</tr>
<tr>
<td>Mag. design kits</td>
<td>£3.95</td>
</tr>
</tbody>
</table>

**P R I C E S  C O R R E C T  A T  1 8 . 6 . 7 9**

**ALL PRICES INCLUDE VAT @ 15%**

Send 30p stamp for free 38 page catalogue ‘Choosing a Speaker’

Telephone Speakers, Mail Order and Export

Hi-Fi: (Swift of Wilmslow) 0625 529599

Lightning service on telephoned credit card orders!
New:

220 with aircraft, direct programming without calculating

A range of digital scanners with microprocessor, so without crystals...
Extremely accurate and reliable. Each Bearcat-scanner searches its frequencies itself, which you can read out immediately at the display. Lock-out, delay and search are some of the many functions of the Bearcat. Each type is delivered in the European frequency.

Bearcat 210 10 channels
72 - 90 MHz. 146 - 174 MHz. 416 - 512 MHz.
sensitivity through all bands 0,6 µV/20 dB

Bearcat 250 50 channels
72 - 90 MHz. sensitivity 0,3 µV/12dB
146 - 174 MHz. sensitivity 0,3 µV/12dB
420 - 512 MHz. sensitivity 0,6 µV/12dB

Selectable speed control for both scan and search, as well as priority.

Bearcat 220
Police, Marine and Aircraft band, 20 channels
66 - 88 MHz. sensitivity better than 0,3 µV/12dB
144 - 174 MHz. sensitivity better than 0,3 µV/12dB
118 - 136 MHz. sensitivity better than 0,8 µV/10dB
420 - 512 MHz. sensitivity better than 0,6 µV/12dB

The Bearcat 220 has an extremely good selectivity, a selectable speed control for both scan and search, as well as priority.

Instead of 72-90 MHz. (BC 220-66-88 MHz.) the Bearcats can also be delivered in 30-50 MHz.

Please send us your leaflets and pricelist of the Bearcats.

Name
Address


Wolfsen Electronics is the exclusive import dealer for many European countries.

THE MODERN WAY TO MEASURE TEMPERATURE

A Thermometer designed to operate, as an Electronic Test Meter. Will measure temperature of Air, Metals, Liquids, Machinery, etc., etc. Just plug-in the Probe and read the temperature on the large open scale meter. Supplied with carrying case, Probe and internal 1½ volt standard size battery.

Model “Mini-Z 1” measures from --40° C to + 70° C. Price £30.00
Model “Mini-Z 2” measures from --5° C to +105° C Price £30.00
Model “Mini-Z Hi” measures from + 100° C to 500° C £33.00

(VAT 15% EXTRA)

Write for further details to
HARRIS ELECTRONICS (LONDON)
138 GRAY’S INN ROAD, LONDON, WC1X 8AX
(Phone 01-837 7937)

QUARTZ CRYSTALS
made to your spec.
MOD & CAA APPROVED

AEL CRYSTALS LTD
GAYWICK HOUSE, HONLEY SURRY, ENGLAND - S.1Y
G8/04445/1055/155232352 / Telex 871153 Aerogram M/F
CABLES AEROCON TELEX

W W — 030 FOR FURTHER DETAILS

carbon film RESISTORS
PRICES REDUCED. SEND FOR DETAILS NOW

AERO SERVICES LTD.
42-44A-48 Westbourne Grove
London W2 5SF
Tel. 01-727 5641 Telex 261306

W W — 047 FOR FURTHER DETAILS
PORTABLE MAINS DISTRIBUTION

New!
Slim Jim
Dim. 1 3/4" x 2 1/2" x 18 1/4"
£12.15. P&P 85p + VAT

New! 10 sockets switched in sloping box

Type 13A/10SW £27.50. P&P £1.85 + VAT
COMPLETE WITH 6FT CABLE AND 13-AMP FUSED PLUG.

INSTANT TRUNKING SYSTEM FOR WALL OR BENCH MOUNTING

EPROM ERASER
Low cost ultra violet eprom erasing lamp will erase up to 12 chips at one time.
PRICE £95.00 + VAT

TR6 — 6 sockets switched £21.50
TR9 — 9 sockets switched £25.50
Plus P&P £2 + VAT

MAINS ISOLATING UNIT
The Olson mains isolating unit is an essential bench item for safety when testing and repairing mains operated equipment. The isolating transformer has an earthed screen and is rated 250VA.
£38 + P&P £2 + VAT

AEL
Suppliers of
Electronic Tubes Semiconductors
For use in Professional Equipment

Exceptionally wide range of spares for most equipment in use

Write for catalogues or just state your requirement to

AEL
AERO ELECTRONICS (AEL) LIMITED
GATWICK HOUSE, HORLEY, SURREY, ENGLAND RH6 9SU
Telephone: Horley (0293) 5353
"Telex: 87116 (Aero G Horley)
Cables: Aero G Telex Horley

747 UNIVERSAL COUNTER TIMER
£175 + £3.50 p&p

DC-150MHz
8 DIGITS
8 FUNCTIONS
3 CHANNELS

Also available — Counter Timers, Frequency Meters, Filter Oscillators, Function Generators, Off-air Standards, Lab/Bench Power Supplies, Panel Meters & Bar Indicators.

OMB ELECTRONICS
Riverside, Eynsford, Kent DA4 0AE
Tel: Farningham (0322) 863587
Prices, which are CWO & ex-VAT, are correct at time of going to press and are subject to change without notice.
3 4

**Predictable in use and performance**

- High tolerance on insert procedure
- High conversion rate on ageing
- Long service life

- Neck glass, tube bases, equipment and accessories also supplied

For full details contact:

**EDICRON LTD.**

Redan House, 1 Redan Place, London W2 4SA.
Tel: 01-221 4717  Telex: 265531 Edicrn G

---

**LOWE ELECTRONICS LTD.**

119 CAVENDISH ROAD, MALTOCK, DERBYSHIRE
TEL. 0629 2430 OR 2817. TELEX 377482 LOWLEC G

---

### CS1352 DUAL TRACE 15 MHz/2mV PORTABLE

The CS1352 oscilloscope offers you not only dual trace, 15MHz bandwidth operation at sensitivities down to 2mV/cm but also use from 100-240 Vac mains and portable operation using the optional rechargeable battery pack. Automatic triggering is carried out when the CS1352 is plugged into a mains supply. Now you can have top performance both on the bench and out in the field — and at an affordable price.

**£350 + VAT**

---

### CS1575 DUAL TRACE 4 FUNCTION

The CS1575 is a unique tool for the audio engineer. It features the normal facility of dual trace display with sensitivity to 1mV/cm but not only can it display the input signals on two channels, it can simultaneously display the phase angle between them and measure the phase angle referenced to a zero phase calibration display. In addition to these unique features, you also have independent triggering from each channel to give stable displays even with widely differing input frequencies.

 Absolutely indispensable to the professional audio engineer, the CS1575 is now in use all over the world. See it in action or send for complete details.

**£278 + VAT**

---

**TRIO OSCILLOSCOPES**

The Trio range of oscilloscopes offer top quality at moderate cost. The brief specifications show the performance features which have made these oscilloscopes firm favourites in all parts of the world, with bandwidths to 30 MHz and sensitivities down to 1mV/cm on 130 mm screens. Prices are very realistic and we try to ensure that delivery is ex-stock at all times — quite a change these days.

For full details on these and other models, contact the sole agents, LOWE ELECTRONICS.

**WW — 014 FOR FURTHER DETAILS**

---

**MOUNTING HARDWARE - THE NO.1 SOURCE**

Wide range of brackets and bases to mount from 2m up, along single or dual high-LCD - components in spaces. Also electronic modules with flange base or plugs, to suit your own layout. Frames or complete solutions to meet your needs.

- In stock, from complete to partial availability.
- Attractive one piece bored with low price. * £ 10 / pair.

---

**LCD DIGITAL PANEL METERS ULTRA-Low COST**

DPMs 1 and 2 are extremely compact, significantly saving panel space while full scale values 0-40 199.9V or 0-19.9.9mV are variable by means of a multi-turn potentiometer. Plastic bezel is screen, user selection of decimal point, auto polarity, to zero. Accuracy of ±0.1% and character heights of 0.7” 0.5”. Combine to offer probably the most attractive DPM on the market.

---

**WW — 016 FOR FURTHER DETAILS**

**WW — 017 FOR FURTHER DETAILS**

---

**PCL**

Perdix Components Ltd
98 Crofton Park Road, London S E 4. Tel: 01 650 1914 Telex 87863
Whatever it is, the H||H 'S' range of power amplifiers will handle it

The H||H 'S' range is designed to handle heavy industrial usage in the fields of vibrator driving, variable frequency power supplies and servo motor systems.

**S 500D**
- Dual Channel
- 19" rack mount 3½" high
- 500w r.m.s. into 2.5 ohms per channel
- 900w r.m.s. in bridge mode
- DC–20 KHZ at full power
- 0.005% harmonic distortion (typical) at 300w r.m.s. into 4 ohms at 1 KHZ
- 3KW dissipation from in-built force cooled dissipators

**S 250D**
- Single Channel
- 19" rack mount 3½" high
- 500w r.m.s. into 2.5 ohms
- Retro-convertible to dual channel
- DC–20 KHZ at full power
- Full short and open circuit protection
- Drives totally reactive loads with no adverse effects

A complete range of matching transformers and peripheral equipment for closed loop, constant current and voltage use are available.

Alternative input and output termination to order. Rack case for bench use built to specifications. For complete data write or call.

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

FRANCHISED COMMERCIAL AND INDUSTRIAL AGENTS FOR H||H ELECTRONICS
fact:
you can choose your microphone to enhance your sound system.

Shure makes microphones for every imaginable use. Like musical instruments, each different type of Shure microphone has a distinctive "sound," or physical characteristic that optimizes it for particular applications, voices, or effects.

Take, for example, the Shure SM58 and SM59 microphones:

**SM59**
Mellow, smooth, silent...

The SM59 is a relatively new, dynamic cardioid microphone. Yet it is already widely accepted for critical studio productions. In fact, you'll see it most often where accurate, natural sound quality is a major consideration. This revolutionary cardioid microphone has an exceptionally flat frequency response and neutral sound that reproduces exactly what it hears. It's designed to give good bass response when miking at a distance. Remarkably rugged—it's built to shrug off rough handling. And, it is superb in rejecting mechanical stand noise such as floor and desk vibrations because of a unique, patented built-in shock mount. It also features a special hum-bucking coil for superior noise reduction!

**SM58**
Crisp, bright "abuse proof"

Probably the most widely used on-stage, hand-held cardioid dynamic microphone. The SM58 dynamic microphone is preferred for its punch in live vocal applications...especially where close-up miking is important. It is THE world-standard professional stage microphone with the distinctive Shure upper mid-range presence peak for an intelligible, lively sound. World-renowned for its ability to withstand the kind of abuse that would destroy many other microphones. Designed to minimize the boombiness you'd expect from close miking. Rugged, efficient spherical windscreens eliminate pops. The first choice among rock, pop, R & B, country, gospel, and jazz vocalists.

---

professional microphones...by

Shure Electronics Limited, Eccleston Road, Maidstone ME 15 6AU—Telephone: Maidstone (0622) 59881

WW—071 FOR FURTHER DETAILS
Our front cover this month, introducing the articles "Radio and electronics into the 'eighties", symbolizes man's increasing involvement with his technology. This is a two-way process. The more devices and systems he produces the more he changes his environment and this reflects back on him by modifying his customs, institutions and general way of life. And it may go deeper than this. According to the early sociologist Durkheim, a person's knowledge of himself — his self-image — is created by the society in which he lives. Not only does he exist in society but society exists in him. So in modifying the material basis of society and hence social relations by technology, he continually changes his concept of himself as an individual and all the imagined needs or wants that arise out of this concept. No wonder that modern man in industrialized society seems such a restless, anxious and dissatisfied creature.

This two-way process is very intense when the technology is electronics, for here we are concerned with transmitting and transforming information, and ultimately, if not directly, this information causes human beings to think, feel and act. What seems to emerge from the developments described in the following articles is that the 1980s will see a further intensification of the links between the human being and his electronic systems. The systems will become even more closely matched to the input and output capabilities of the biological organism and will make even greater demands on it. It's not simply a case of more communication channels conveying more information in a given time, but a continuing increase in the refinement and variety of the information put in by and presented to the human beings.

Higher quality sound and visual images, and higher performance in radar systems and laboratory instruments, for example, all demand greater attention and discrimination. In broadcasting the addition of colour and text to television and stereophony to sound have already given us more to perceive and cognize, and electronic tricks in sound and vision synthesis are stretching these abilities to the edge of confusion. In radiocommunication, voice messages are being supplemented by digital data transmission, often on the same circuits, to make possible greater detail and accuracy. And now the general public can retrieve useful facts from data banks over the ordinary telephone lines.

Telecommunications are, of course, essential to organizations — especially large, far-flung organizations like multinational companies, airlines and political/military alliances — to enable them to respond quickly and appropriately to events in any part of their structure. Any message demands a decision, if only to ignore it, but with messages arriving quicker, and in even greater quantity and detail, the mounting pressure on responsible people to be continually making decisions and deciding priorities is reaching inhuman proportions. Some individuals have found it too much and have left for a quieter life.

On the 50th anniversary of Bell Laboratories, the president, W. O. Baker, said of communications: "I see it also as a mission of importance involving great responsibility. Improving communications, more efficient and satisfying handling of information — these I deeply feel are essential to help solve economic and social problems and aid efforts to civilise the future". These are noble sentiments but it is already evident that we cannot solve such problems by technology alone. As humans we are limited in our powers to assimilate information and in our good will to act on it properly. Perhaps what we really need is less information and more wisdom.
Radio and electronics into the ‘eighties

Intelsat V (above) the latest communications satellite, which will be launched at the turn of the year, marks dramatically the entry of radio and electronic technology into the 1980s, for it has double the communications capacity of its predecessor, Intelsat IVA. Equally important advances are being made in terrestrial radio and its related fields, and in the following pages we present articles by seven specialists who first look back at what has happened over the past decade and then project their thoughts and expectations into the ‘eighties.

Land mobile radio

by W. M. Pannell, M.I.E.R.E. Pye Telecommunications Ltd

Technical progress in the electronics industry over the past decade has taken vast strides, with the land mobile radio sector certainly not lagging behind. The inevitable questions arise: What effect have all the changes in technique had on the mobile radio industry and its users? Which changes have made the biggest impact? And, what can we expect over the next decade?

Although the changes to the mobile and portable units, the fixed equipments and the peripherals have shown considerable innovation over the past ten years, many of the changes in technique have been brought about by the increasing complexity of overall system requirements.

One change that made a major impact on mobile radio in the UK, over a decade ago, was the decision to split the channel bandwidth at v.h.f. from 25 to 12½ kHz. This resulted in some immediate relief in the search for extra spectrum and a marked reduction in co-channel interference. The change improved the utilization of channels for many types of user.

During the 1970s we also saw the increasing use of personal portables in all types of system. This is, of course, a logical progression in view of communication being needed between people rather than vehicles in most cases — the main exceptions being where interrogation of vehicle status is desired or where vehicles are the essential tool, for example fire engines.

It was at this point that the move towards miniaturization became an essential requirement in all types of equipment, not so much because of the need for smaller equipments, although in portable design this was naturally a fundamental requirement, but more to enable equipments of increased complexity and versatility to be designed for the more sophisticated systems without increasing the total volume of individual units. So an upsurge in the use of integrated circuits took place: the ubiquitous light bulb was replaced by light emitting diodes: l.e.d. followed by l.c.d. displays became a recognised means of presenting information; while conventional components became steadily smaller to keep up with the new techniques. At the same time, higher stability frequency sources and better i.f. filters became necessary in fixed, mobile and portable equipments as the need for higher performance developed.

Meanwhile, in the systems control field, processors began to take over many of the functions which had previously involved complicated manual operations. More facilities and information became available to the system controller, while, in the mobile, actions
of the microprocessor. While the full advantages of such systems in frequency spectrum economy have yet to be seen, undoubtedly first indications are favourable. The use of trunking, however, can raise an operational problem concerning the ownership of the base complex, and this may limit its use to definite types of system where single ownership or the radio common carrier type of operation prevails.

Quasi-synchronization. System techniques evolved during the 1970s included the use of a quasi-sync — a method whereby a number of transmitters carrying the same intelligent radiate simultaneously without interference in a number of overlapping areas. Although as early as 1946 J. R. Brinkley proposed the use of staggered carrier techniques, this method ultimately became unworkable as the channel bandwidth was reduced down to 12kHz. At these narrow bandwidths much closer staggering, of the order of a few hertz, is required, so that a need arose for high stability, low noise oscillator sources. The technique of quasi-sync is generally applicable to a.m. and f.m. at frequencies up to 500MHz although at v.h.f. the use of f.m. quasi-sync is subject to some reservations.

Frequency sources. The development of frequency synthesisers for mobile radio also shows signs of increasing in tempo as the need for greater frequency agility grows. Several designs have been announced using various custom built chips. It is just a matter of time before the cost of such devices is comparable with conventional crystals, even for one channel. Meanwhile frequency control has improved considerably by the use of a phase lock loop system and this is often standard on present day fixed receivers in the land mobile bands.

Modulation methods. Overshadowing many of the developments during the past few years has been the obvious rapidly diminishing spectrum space available for each new land mobile radio system. Much has been written on the.
subject and at the recent World Administrative Radio Conference in Geneva much was undoubtedly discussed.

Even if, as a result of all the decisions made, extra spectrum is handed to mobile radio, the rate of growth is such that economies must be made. To this end techniques are already being investigated to achieve spectrum savings and further bandwidth splitting by the use of s.s.b. is but one method currently under review. Others include spread spectrum methods, stored speech and the virtual elimination of speech by the total use of data in those applications where standard forms of message predominate. The latter methods are still in the early stages of investigation, but the development of s.s.b. is quite advanced and shows considerable promise.

Cellular systems. Much has also been written on the use of small cell techniques in urban area radio systems. In the United States, where a lot of work has originated, several systems are being put into operation at 900MHz using this principle. Although the cells involved initially in these systems cannot really be described as 'small cell', the possibility of sub-division exists and will undoubtedly be the subject of further investigation. Small cell systems are necessarily oriented towards processor control if all the functions proposed are to be implemented. Cellular systems and trunking have a great deal in common in many design aspects.

Energy sources. In spite of the huge variety of systems which have been devised over the past decade, one common denominator remains — that of the energy source required to drive the equipment. Vehicle units are generally no problem, there being a ready source of d.c. in the vehicle. Portables are a different matter insofar as, although a battery of a suitable type is included in the assembly, this must be either replaced or recharged after a period of work. There has been no outstanding design change during the past ten years which has increased the portable battery capacity appreciably or reduced its size, so this is one aspect where changes are required.

In fixed equipment the tendency has been to use secondary batteries charged from sources of energy ranging from the public power supply through diesel generating sets, wind and water driven generators, thermal generators to solar cells. All methods have their place in providing power to radio equipment. With the present energy crisis, further work is indicated, not only to find means of providing power in relatively inaccessible places but to do so using the minimum resources at present in great demand.

The next ten years

In view of the vast changes which have taken place over the past decade one is tempted to forecast the future almost in terms of science fiction. It is not my intention to examine such possibilities but rather to consider the more down-to-earth developments of existing techniques.

Data will undoubtedly appear as one of the mainters for optimising usage of the frequency spectrum. While speech will be with us for some considerable time, particularly in the simpler systems, the efforts being made in the data field must be recognised. For example although there is a lack of economically viable vocoders suitable for digital speech at the moment, they will undoubtedly appear. Alternatively, stored speech controlled by a digital bit stream could well be a relatively inexpensive method of spectrum conservation. Speech synthesisers driven directly by computers are also likely. Good speech quality at real time digital speeds of 2 or 3 kbit/s now appears probable in the next decade. Bubble memory techniques permitting occupancy time reduction are, even now, a possibility, with available bubble memories capable of $10^6$ bits/chip, one square centimetre in size, already available.

At present the rate of growth of data by digital methods is in excess of 20% per annum and is expected to maintain or even exceed this during the next ten years.

Obviously the use of digital techniques, spread spectrum for example, provides a high degree of privacy and at the same time enables a high degree of large scale integration to be employed — all leading to smaller equipments and, one hopes, greater power economy.

The use of data processing methods to impart "intelligence" to a system is of course one of the most important aspects. Already microprocessors play a major role in the more sophisticated systems, as indeed they are beginning to do in many other areas of present day activity. The future holds an almost unlimited range of possibilities. Dynamic channel allocation, automatic transmitter power level adjustment to suit the propagation conditions and local interference levels, automatic call routing, and many others are already in the pipeline, and every day sees a new requirement.

In spite of the digital revolution we must not forget the more conventional forms of mobile communications — forms which will undoubtedly remain in use for a long time, particularly in the simple system and in many of the overseas areas where sophistication is not necessarily needed at present. Here single sideband transmission at level 500 MHz could well provide all the channels needed until the end of the present century even in areas of international congestion — where, for economic reasons, several countries merge into a single overall area. It should also be emphasised that s.s.b. can also carry the simpler forms of data on equal terms with the more conventional a.m. and f.m. systems.

Portables will tend to become the more normal form of unit, although generally adaptable also for mobile use. Here again the use of data may modify the portable as we see it. For example, display methods may be incorporated to minimize standard speech messages. Key pads to send alpha-numeric messages will be of greater convenience than speech, in many cases, for example, in crowded environments where privacy is required. Similarly key pads will be used for routing the call.

The low efficiency of the portable antenna is another area for further development. However, it could well be that, rather than improving the ranges possible with portables, cell type systems will predominate and most fixed networks will consist of many low power stations closely spaced. Typically, if operation into the telephone is envisaged, the existing telephone call box could be used to locate individual fixed stations, the present physical spacing being close enough to permit very low power to be used, available power and easy connection into the telephone system favours such an approach.

All these innovations will inevitably increase the complexity of the portable, requiring more compact packaging if only to maintain the same size. Work must be undertaken on battery design if sizes are to remain as at present or preferably reduced in volume, while the extra consumption of the ancillary equipments means that increased battery efficiency is a 'must'.
With the ever increasing use of integrated circuits it is not impossible that the design of much of the radio circuitry will become largely discrete components to both hybrid and monolithic types. With this approach the basic radio equipment will tend to become stero-typic in design and specification, with only the overall packaging being different. The ancillaries, which will be determined by the system, will then be the part of the package which will highlight the individual units.

It is for these reasons that, although there is a desire to harmonize specifications in as many aspects as possible, future advances may be inhibited by too great a degree of commonality as integration becomes more involved. The use of common designs, however, show up some advantages. Already we are at the point where 'throw-away' modules are often more economical if and when a fault develops. This practice could even extend to the complete unit, especially where the simpler type is in use. Even now for example, it is cheaper to buy another medium wave pocket broadcast radio than to repair it. It is only a short step to the more complicated mobile/portable transmitter/receiver unit.

In the realm of power supplies, one hopes that there will soon be some breakthrough in the overall efficiency of batteries relative to size. Ultimately the size of portable units — in spite of increasing electronic complexity — must be reduced to a point where they can be 'worn' in an inconspicuous manner by the average person. Nevertheless, very small units are not really practicable at this moment for a number of technical and functional reasons.

Possibly a packet of 'king' size cigarettes is about optimum, although the present day 'credit card' calculator seems to be popular, and this format could well be considered in future personal radio designs. The 'king' size package has already been achieved in many types of pager, but of course the battery requirement here is quite different as there is no heavy transmitter drain.

Methods of charging batteries, whether the batteries are small in size and number, or are the larger types feeding a fixed station, are important aspects requiring further attention. In many parts of the world solar energy is the obvious immediate answer for powers up to a maximum of 500 watts. If efficiency could be improved, many other types of station could benefit, quite often saving expendable fuel.

In suitable areas the wind is already utilized as a source of electrical power and work on optimizing the energy conversion has produced good results. The energy in water movement, whether wave motion, tidal changes or just flow, also offer large scope for investigation.

Without any doubt, the future of mobile radio looks exciting. We must however, keep a firm grip on future developments to ensure that they do not fall into 'nice to have' category, but perform a real service to the world.

Improved communication, saving of energy and all the other advantages likely to accompany the microchip era will undoubtedly gain momentum as we move through the years towards the next century. It is up to the engineer to ensure that the steps taken follow an ordered path.

Broadcasting
by D. P. Leggatt B.Sc., F.I.E.E.
Engineering Information Department, BBC

One of the most striking features of the last decade has been the public appetite for high-quality audio. The 'hi-fi' was becoming a must in any modern household in the early 'seventies and by the end of the decade this had developed into the 'stereo.' While this movement has been led by the gramophone record, it represents a gratifying conversion to the gospel preached by the broadcasters since the introduction of v.h.f./f.m. broadcasting in the 'fifties, with the addition of stereo in the 'sixties. Public acceptance was slow to develop but at last there is wide appreciation of high-quality reproduction. Much recent development in radio broadcasting has been spurred by this public expectation: in the studios, stereo origination is becoming standard; on the distribution networks, high-quality digital p.c.m. systems are spreading stereo broadcast-

Radio and electronics
into the eighties

possibly a packet of 'king' size cigarettes is about optimum, although the present day 'credit card' calculator seems to be popular, and this format could well be considered in future personal radio designs. The 'king' size package has already been achieved in many types of pager, but of course the battery requirement here is quite different as there is no heavy transmitter drain.

Methods of charging batteries, whether the batteries are small in size and number, or are the larger types feeding a fixed station, are important aspects requiring further attention. In many parts of the world solar energy is the obvious immediate answer for powers up to a maximum of 500 watts. If efficiency could be improved, many other types of station could benefit, quite often saving expendable fuel.

In suitable areas the wind is already utilized as a source of electrical power and work on optimizing the energy conversion has produced good results. The energy in water movement, whether wave motion, tidal changes or just flow, also offer large scope for investigation.

Without any doubt, the future of mobile radio looks exciting. We must however, keep a firm grip on future developments to ensure that they do not fall into 'nice to have' category, but perform a real service to the world.

Improved communication, saving of energy and all the other advantages likely to accompany the microchip era will undoubtedly gain momentum as we move through the years towards the next century. It is up to the engineer to ensure that the steps taken follow an ordered path.

Possible a packet of 'king' size cigarettes is about optimum, although the present day 'credit card' calculator seems to be popular, and this format could well be considered in future personal radio designs. The 'king' size package has already been achieved in many types of pager, but of course the battery requirement here is quite different as there is no heavy transmitter drain.

Methods of charging batteries, whether the batteries are small in size and number, or are the larger types feeding a fixed station, are important aspects requiring further attention. In many parts of the world solar energy is the obvious immediate answer for powers up to a maximum of 500 watts. If efficiency could be improved, many other types of station could benefit, quite often saving expendable fuel.

In suitable areas the wind is already utilized as a source of electrical power and work on optimizing the energy conversion has produced good results. The energy in water movement, whether wave motion, tidal changes or just flow, also offer large scope for investigation.

Without any doubt, the future of mobile radio looks exciting. We must however, keep a firm grip on future developments to ensure that they do not fall into 'nice to have' category, but perform a real service to the world.

Improved communication, saving of energy and all the other advantages likely to accompany the microchip era will undoubtedly gain momentum as we move through the years towards the next century. It is up to the engineer to ensure that the steps taken follow an ordered path.

Possible a packet of 'king' size cigarettes is about optimum, although the present day 'credit card' calculator seems to be popular, and this format could well be considered in future personal radio designs. The 'king' size package has already been achieved in many types of pager, but of course the battery requirement here is quite different as there is no heavy transmitter drain.

Methods of charging batteries, whether the batteries are small in size and number, or are the larger types feeding a fixed station, are important aspects requiring further attention. In many parts of the world solar energy is the obvious immediate answer for powers up to a maximum of 500 watts. If efficiency could be improved, many other types of station could benefit, quite often saving expendable fuel.

In suitable areas the wind is already utilized as a source of electrical power and work on optimizing the energy conversion has produced good results. The energy in water movement, whether wave motion, tidal changes or just flow, also offer large scope for investigation.

Without any doubt, the future of mobile radio looks exciting. We must however, keep a firm grip on future developments to ensure that they do not fall into 'nice to have' category, but perform a real service to the world.

Improved communication, saving of energy and all the other advantages likely to accompany the microchip era will undoubtedly gain momentum as we move through the years towards the next century. It is up to the engineer to ensure that the steps taken follow an ordered path.

Possible a packet of 'king' size cigarettes is about optimum, although the present day 'credit card' calculator seems to be popular, and this format could well be considered in future personal radio designs. The 'king' size package has already been achieved in many types of pager, but of course the battery requirement here is quite different as there is no heavy transmitter drain.

Methods of charging batteries, whether the batteries are small in size and number, or are the larger types feeding a fixed station, are important aspects requiring further attention. In many parts of the world solar energy is the obvious immediate answer for powers up to a maximum of 500 watts. If efficiency could be improved, many other types of station could benefit, quite often saving expendable fuel.

In suitable areas the wind is already utilized as a source of electrical power and work on optimizing the energy conversion has produced good results. The energy in water movement, whether wave motion, tidal changes or just flow, also offer large scope for investigation.

Without any doubt, the future of mobile radio looks exciting. We must however, keep a firm grip on future developments to ensure that they do not fall into 'nice to have' category, but perform a real service to the world.

Improved communication, saving of energy and all the other advantages likely to accompany the microchip era will undoubtedly gain momentum as we move through the years towards the next century. It is up to the engineer to ensure that the steps taken follow an ordered path.
transistors, large-scale integration and computer techniques, technical solutions can be devised for most problems. Increasingly, as time goes on, it will be economic, political and social factors which determine the course and pace of development. The questions for the future will more often be “how much do we want and what can we afford?” rather than “is it technically feasible?”

The next ten years
You want '100 Best Tunes' in the kitchen, so you pull out the telescopic aerial in your v.h.f. portable. For good results you need the aerial horizontal and angled for best reception; and in doing so you sweep three cups onto the floor! Then you find Radio 1 is taking its turn on the v.h.f. channel so you switch to medium wave. You find three or four stations transmitting serious music, so which is Radio 2? Eventually you hear Alan Keith's voice, but with an excitable Frenchman in the background plus crackles from your neighbour's electric drill. So there's nothing for it but down to the pub again!

This points the way to some main tasks for the 'eighties. We need more radio channels, signals which can be more easily received, and something to help us find the programme we want. It is to be expected, following the World Administrative Radio Conference in Geneva, that more broadcasting channels will become available in the v.h.f. Band II. This will enable us to re-engineer the existing v.h.f. transmitting networks to avoid the necessity for sharing between BBC Radio 1 and Radio 2; to reduce the need for displacement of some Radio 3 and Radio 4 programmes by educational material; to cater for significant extensions of local radio services, ILR and BBC; and to increase the number and power of transmitters so that adequate signal strengths for reception on portables and in cars become available throughout most parts of the country. Further expansion of the p.c.m. signal distribution system will be a necessary ancillary to this transmitter development.

Towards the end of the 'eighties we may see the start of some direct transmission and reception of sound programmes in digital form. Although this may become the norm in the long-term future, current investment in conventional analogue systems is such that change to digital methods is not likely to be rapid.

Choosing a programme from the published schedules, selecting the right channel at the right time and tuning the receiver for optimum reception are becoming increasingly difficult for the average listener. Ideas are now developing for radio transmissions to carry coded identification signals inaudible to the listener but detectable by a suitable receiver. Given such codes, a receiver could be pre-programmed at the listener’s choice to search for any desired programme — or type of programmes such as news, light music — and switch on at the appropriate time without the need for any manipulation or control by the listener. Such coded signals could also be used for automatic control of cassette recorders and to carry time information for electronic clocks.

New radio services we can expect in the 'eighties may include whatever form of surround-sound is finally agreed; and a dedicated channel of motorising information such as the BBC's Carfax development.

At the programme origination end, digital sound recorders will fairly soon be with us and will offer quality good enough for multi-generation work with little need for the careful alignment and maintenance which analogue recorders demand. Digital sound mixing desks will also appear, together with computer control of complex mixdowns from multitrack recordings which is already a facility in some recording studios and television sound dubbing areas.

Television. Although the solution to many technical problems can be foreseen, there are in television one or two areas where we need to tell our inventors "go away and make a breakthrough!"

The limited sensitivity of colour cameras is a case in point. Existing sensors are already approaching the region where photon noise — arising from the quantum nature of light — becomes the limiting factor. No new sensor, however revolutionary, can cross this fundamental barrier. We can foresee optical devices of manageable size which would gather in many more of the limited number of photons emitted by an ill-lit scene. The apparently much greater sensitivity of the human eye/brain combination is achieved by physical and subjective integration processes and it is down this road that useful investigation may proceed: the current development of integrating noise reduction equipment perhaps points the way.

In another area, colour camera sensors and receiver display devices employ rather cumbersome three-colour superimposition techniques with attendant disadvantages in terms of size, complexity and cost. A single colour pick-up device is wanted with outputs directly related to hue and luminance and no need for optical colour separation filtering; correspondingly a large area, flat display device is needed, responding to hue and luminance signals rather than relying on superimposition of three separate colour images. We must hope that the 'eighties will see a breakthrough in this area.

Turning to more foreseeable developments, work will continue through
the decade to extend relay station coverage to yet smaller population groups in the UK, with community aerials and local wired distribution systems playing an important part. The fourth television channel will be with us and there may be increasing pressure for local television services. More channels will be needed and the u.h.f. bands may be extended to accommodate this; 485-line services on v.h.f. Bands I and III will be closed down and Band III at least is likely to be re-developed for extended, or new, television networks. Band I is not ideal for television and could be used for mobile services displaced from Band II and perhaps for the start of direct digital radio broadcasts. Television broadcasting via satellites — for direct reception at home or with local distribution from a number of ground stations — is being actively planned for some European countries, but seems less needed in the UK where conventional transmitter coverage is fairly comprehensive.

An alternative source of television programmes is the video cassette recorder. Already well launched in the 'seventies, its use for replay of pre-recorded material will become a significant factor in programme distribution in the 'eighties.

In the studios, programme makers will be looking for increased flexibility and reliability. These qualities are offered by digital techniques, by which signals may be stored, manipulated and passed between areas with little degradation or need for manual intervention. Already we have digital systems for special effects and graphics, standards conversion, noise reduction, source synchronisation, sound distribution, teletext services and numerous routing control functions. We can soon expect to see digital video recorders and editing systems, digital vision mixers and digital camera processing chains. Digital PAL coding will reduce very significantly the cross-colour effect which is perhaps the most obvious shortcoming of present-day colour television. For outside broadcasts we can look forward to compact cameras using highly integrated digital circuitry (and a single colour sensor?) with digital transmission via transportable satellite links into the network control centre.

The islands of digital operation now appearing in the chain will steadily be
Consumer electronics

by St John C. Jackson, Thorn Consumer Electronics Ltd.

The last decade has been one of rapid development in the different design areas of consumer electronics products making use of advances in electrical component availability and electrical engineering to entertain or make life easier for the majority of people, whose interest lies mainly in what such products will do rather than how they work.

There is perhaps one feature which, on looking back, makes consumer electronic products unique when compared with any other manufactured product. It is the fact that, despite the very real improvements and the ravages of inflation at the end of the 'seventies, on a like-for-like basis, products were cheaper at the end of the decade than they were at the start—in many cases in cash terms but without doubt in real money terms. A comparison of consumer electronics products shows that a 12in mains/battery monochrome portable tv cost around £55 (or 2 weeks average earnings) in 1970 and nowadays even with V.A.T. at 15%, the same two weeks' average earnings will almost buy a 14in portable colour tv. Similarly, the first electronic calculators retailed at over £200—now for less than £10, a pocket calculator is commonplace and includes all or more of the functions of the earlier £200 machine. But the electrical engineer could point to the benefits of quad, the same engineer forgot that the user didn't have four ears or, perhaps more to the point, his girl friend, mistress or wife was not prepared to accept four separate loudspeakers in the living room.

There was also a more fundamental point; the competing quadraphonic systems each required their own pre-recorded software and because more time and effort was spent on selling the advantages of one system against the others, confusion reigned. For the future, it is important that product development is based on agreed international and common standards, but let's look at specific pocket areas and how they developed in the 'seventies.


With tv receivers now in 97% of UK homes (70% colour) it's right and proper to consider television first. In the early 'seventies, the transition was being made from hybrid chassis with a mixture of valves and transistors to all solid-state. With moves in this direction, styling improvements were made possible to reduce the overall size of the average television cabinet and chassis engineering moved towards modular construction.

Ultrasonic remote controls made their appearance, and were quickly accepted only to be gradually replaced by quicker-acting infra-red control systems. Whilst ultrasonic controls were more than adequate for the typical viewer of the late 'seventies who wanted to send simple commands to his receiver, the introduction of infra-red microprocessor-controlled systems is particularly relevant to the customer requirements of the 'eighties when...
Teletext and Prestel are likely to be in widespread use.

However, both of these great British developments with their data display capabilities are still in their infancy and the lack of average consumer awareness about their existence and what the services offer is an indication that it is not enough for the engineers to apply their minds and develop such powerful means of communication. Marketing people must do more to promote their benefits.

Probably the product area of the 'seventies which will have the greatest impact in the 'eighties is domestic video, both cassette recorder and disc. The late 'seventies saw the introduction of domestic video cassette recorders not much larger than conventional audio cassette recorders and almost as easy to install and use. The early recorders (of any format) relied heavily on mechanical control functions but already we are beginning to see mechanical operations replaced by electronics and especially microprocessor controls, but more of this later. The audio scene saw one overriding development — the growth in importance of the conventional audio cassette, aided by the world-wide acceptance of a common standard. Ten years ago, the available cassette hardware and software was still regarded as something of a novelty and not a serious contender to the established position of the quality record player and audio disc or open reel recorder. Developments such as noise reduction systems, improved drive systems and record/replay heads, software developments improving overall performance standards (with first of all CrO₂ tape and more recently the introduction of metallic tapes) have elevated the performance of cassette equipment and cassettes of ten years ago to a replay medium generally accepted even in serious hi-fi circles. Certainly the public have also accepted the cassette. At the close of the 'seventies, UK homes owned more cassette playing equipment than disc playing.

The development of low price, good quality cassette mechanisms made the music centre a practical proposition and without doubt this particular item was the audio home entertainment product of the 'seventies. The audio cassette is also the common denominator amongst those other products that during the period had greatest appeal for the public. Cassette and radio cassette recorders now sell at an annual rate of more than 2 million units per annum in the UK. The biggest growth area in the late 'seventies was quality stereo radio cassettes with automatic programming facilities and even Dolby Noise Reduction.

Cassette-based products have been so successful because they have two overwhelming advantages over their disc counterparts; the cassette can be re-recorded and the machine is easily portable, satisfying today's demand for music on the move. In-car entertainment products have also adapted to the higher ownership levels of home based cassette equipment so that today it is possible to have better quality audio sound in a car than was possible in most homes ten years ago.

But enough of the past; it seems that the 'eighties will see most of the colour televisions acquired during the 'seventies replaced by receivers which, on the outside, may look similar (apart from the reduced number of function controls) but on the inside will bear very little likeness. The modular chassis of the 'seventies will increasingly be replaced by single board chassis designed to optimize the availability of large scale integrated circuits (l.s.i.) and the application of microprocessors, remote control teletext and viewdata displays. The introduction of single board chassis will revolutionise not only product reliability but also the approach to servicing so that the service department of the 'eighties will look vastly different to that of the 'seventies. Today's cathode ray tube technology means that the television viewers of tomorrow will see demonstrably better pictures and data displays than have been seen to date.

Increasingly, tv receiver design will have to accommodate the requirements of home computers, video games etc. which are rapidly changing the nature of television from a passive piece of equipment capable of only showing programme material being broadcast by the BBC or IBA to a two-way, interactive display medium at the centre of a communications network. By the mid 'eighties, satellite broadcasting could become a reality, allowing the viewer a much wider choice of programme material. It is also reasonable to predict that voice-activated controls will begin to make their appearance, freeing the
viewer from the arduous task of having to press the control buttons of a hand-held remote unit!

But, as previously mentioned, the 'eighties will more than anything else be the decade of the widespread introduction of domestic video products. The VHS (Video Home System) format has quickly established itself as the best-selling video system in the world in all the major developed markets - the UK, Europe, USA and Japan - but despite this, other video formats are likely to be around for many years to come. The conventional format of the early video recorders is likely to change with the accent being on the portability of a recorder unit linked to a separate programmable TV tuner/timer which could be indispensable when satellite broadcasting is a reality. Indeed the situation could well arise that despite the increased leisure time available, video owners will be so busy recording programmes they will never have the time to replay them!

Already the introduction of the vidicon tube has made low-cost, good quality colour video cameras a reality. No one can doubt that the already high performance standards of today's products will be improved, real money prices will fall and the cameras themselves will weigh less and diminish in size. No wonder that with the arrival of electronic photography manufacturers around the world are getting out of the conventional cine 8 camera business as quickly as possible - they have seen the writing on the wall.

It is forecast that the ownership of domestic video cassette recorders will parallel the early growth of colour TV in the UK. By 1984 at least 7% of UK homes are expected to have acquired one. They will be used mainly for time-shift recording and the replay of home-made video movies at around £5 per hour, compared with £100 per hour plus for cine, the difference adding greatly to consumer appeal. The additional appeal of pre-recorded video cassette software will pale into insignificance when video disc players with their lost cost software become a reality. One thing is certain; the incompatibility of the various video disc standards that are likely to appear will be a much more serious factor than with the present ones surrounding video cassette recorders. The availability of disc software will be a critical factor on three counts:

a. without the appropriate software the disc player itself is useless.

b. questions related to the low cost production of video discs still have to be resolved.

c. material for reproduction on video disc is likely to be surrounded by a minefield of copyright issues which have still to be resolved.

However, the video disc player is likely to lead to the further demise of the conventional audio record player because despite the name "video disc," all video disc players give the capability of very much improved audio-only replay, making possible a signal-to-noise ratio in excess of 90dB through the use of p.c.m. recording techniques. So looking ahead, any audio disc system that does not include a video replay mode is likely to find the going a bit tough.

So far no reference has been made to monochrome television receivers which, as the years pass, are likely to become increasingly less attractive as potential purchasers accept colour TV viewing as the norm. On the other hand it is not unreasonable to suggest that the youth of tomorrow will look at television in the same way that today they look at radio and the cassette. That is, they will want to take it with them wherever they go. Therefore (and with continuing miniaturization) today's combination TV products either with radio, or radio and cassette, are likely to become more and more popular. Audio products either mains-only, portable or "in-car" will become increasingly cassette-based as the youngsters of today become the purchasers of tomorrow. This is a generation to whom the cassette is not something new and the majority look upon their parents collection of 78, 33⅓ and 45 r.p.m. discs with the same degree of interest that Arthur Negus looks at 17th century
Beyond the 'eighites?

Quite recently Ferguson had an experimental look at the home entertainment centre of the early 1990s. The result was a concept called "Total Television" which included in a domestic console unit, a VHS electronic cassette recorder, floppy disc machine, electronic audio cassette, Prestel/home computer keyboard and videophone with remote control of all viewing functions. The conventional c.r.t. was replaced by a wall-mounted flat screen including four monitor screens to take account of the multiple screen viewing that might be a requirement of the future. A dream? Well apart from the sorting out of problems related to the flat screen the other features of the unit are either with us today or at least a large scale manufacturing possibility.

Only time will tell how close to reality the ideas of the late 'seventies will be at the end of the 'eighties.

Radio navigation and radar


The fields of radio navigation and radar cover a broad range of constantly changing techniques, and are influenced by advances in computers and military systems.

With both these topics, we are interested either in where we are, or where someone else is. The system may rely on transmitting or receiving signals at a known location or vehicle in question (ship or aircraft). Almost every permutation and combination of these alternatives has been investigated over the past fifty years or so.

In moving a vessel from A to B some basic form of dead reckoning and position plotting should be maintained and in ships in particular, traditional methods using the sextant, chronometer and compass are fundamental to good navigation. In the air, long-haul aircraft frequently rely on inertial navigation, again based upon the gyro, and indeed ships also use this type of navigational aid. However, we are here primarily concerned with radio aids and radar, and in very many ships, in aircraft and at airfields, the ubiquitous direction finder (d.f.) is used, and is sometimes the only form of aid. In fact, both radar and radio navigation can trace their ancestry back to the simple d.f.

The adoption of new equipment in civil aircraft and ships is inevitably limited by financial constraints; every piece of new hardware proposed for a ship or aircraft must be justified in terms of cost effectiveness. This means that adequate, well-proven techniques and systems tend to have a very long operational life. Nevertheless, if rapid, accurate position-fixing can shorten journeys and minimize delays, then in a period of increasing fuel costs, new equipment capable of providing this must become more readily acceptable.

Safety at sea and in the air is, of course, vitally important. At sea, minimum safety requirements are recommended by the International Maritime Consultative Organization (IMCO) primarily for vessels above 300 tons, although the country in which the ship is registered legislates for this - in the UK, it is the responsibility of the Department of Trade. In the air, the equivalent authority is the International Civil Aviation Organization (ICAO).

Direction finding

Before dealing with some of the more recent developments in navigation aids, the current state of d.f. is worth examining. There are three major areas of common commercial usage, air-to-ground, ship-to-shore and ground-to-air. There are other military applications, but for general navigation the major advances have been in improving the equipment. A typical marine automatic direction finder, in common use, covers the m.f. beacons in the band 250-550 kHz and also operates on the international distress frequency of 2182 kHz. This equipment is as simple to use as a domestic receiver, gives automatic ambiguity resolution, the bearing of the station being read directly from a compass-type scale, typically to within ±1°. Because of the relatively short range of reliable bearings, ship navigation by d.f. is mainly confined to coastal waters; in the consumer field, many thousands of simple direction finders are in use in modest sailing boats and motor cruisers. The situation with airborne d.f. is similar to that for ships: most aircraft carry one and the accent is...
on automatic operation. The frequency band is typically 190 to 1800 kHz. The size of the antenna loops have been reduced and contained in stream-lined bumps to reduce air drag. In many parts of the world a.d.f. is still the primary source of navigation information, which in areas with good reception can provide a bearing of ±1°.

Ground-based direction finders require only the minimum of a communication set in the aircraft to provide a position line, so that if all else fails, navigation assistance can still be provided. These direction finders mostly operate on v.h.f/uh.f. and in order to minimize the bearing errors from all causes, antenna arrays are multi-element, frequently wide aperture and automatic in operation, with direct-reading bearing presentation. Most locations can provide ±1° accuracy on signals of reasonable strength.

A short-range navigational aid closely allied to d.f. is the v.h.f. omni-range (VOR) which, when associated with a distance-measuring equipment (DME), gives aircraft a precise location. The range limitations caused by operating at v.h.f./uh.f. (108-118 MHz for VOR and 960-1215 MHz for DME) make this system unattractive for ships.

### Hyperbolic systems

Measuring distances from known ground radio stations is a well-established navigational aid. Hyperbolic systems are so-called because the position lines they provide from such measurements are hyperbolic curves. Referring to Fig. 2, if T₁, a transmitting station, emits a short pulse, and transmitter T₂ simultaneously emits a second pulse, then any receiver on line A-B will receive these pulses together. Positions at which one pulse is delayed by a given time with respect to the other lie on one of the hyperbolae. The association of a third transmitter would provide two position lines and therefore a fix.

One of the best known pulse systems is Loran ‘C’ which operates on a frequency of about 2 MHz and covers large areas of the Pacific, Atlantic and Europe. During the last war, a similar British system known as GEE operated at v.h.f. With a good ground-wave pulse, position accuracies of better than one mile in 100 miles are possible but, as with many long-range navigational aids, ionospheric sky-wave propagation can produce errors an order of magnitude larger, and considerable skill is needed to interpret results in adverse conditions. The Deca system, operating at around 100 kHz, also became established during the second world war. This uses c.w. signals and phase measurement to provide position lines and fixes. Very many ships and aircraft carry Deca, which has been considerably refined over the years to overcome propagation and ambiguity problems, so that automatic plotting on route maps is now generally in use, giving accuracies of fractions of a mile.

A system of increasing importance, which is designed to minimize range and propagation problems, is Omega. This operates on very low frequencies (v.l.f.)—typically 10-14 kHz—with inter-station baselines of around 5,000 miles. The very low frequency provides long range, stable and predictable propagation characteristics and the large separation between stations means that position lines are almost parallel over very large areas. Omega is a c.w. phase-comparison system and is virtually the only radio navigation system that can be used by completely submerged submarines.

A typical marine Omega receiver incorporates four channels for continuous monitoring of four transmitters, each channel measuring the phase of the signal relative to an internal high stability reference oscillator. Phase difference can be measured to one-hundredth of a cycle, defined as centi-lanes. In use, the receiver is run continuously from leaving port, automatically logging the lanes. It takes about half an hour to cross one lane, and modern equipment provides direct
read-out of position. World cover is achieved with eight Omega stations.

For aircraft use, initial problems arose with antenna design for such low frequencies: a further difficulty was the high speed of lane crossing. However, advances over the last few years have led to an increase in the use of Omega for aircraft, current equipments providing automatic operation with 95 per cent errors less than 3 nautical miles.

**Terrain-reference navigation**

The Doppler navigator provides an aircraft with means for measuring the frequency shift of a radio signal reflected from the ground. With no drift and for a radio beam transmitted at a forward angle $\theta$ to the aircraft horizontal axis, the Doppler frequency shift $=\left(2V/\lambda\right)\cos\theta$ Hz. Thus, the Doppler shift can provide an accurate measure of the aircraft ground speed, $V$.

If two beams are radiated downwards at an angle to the forward direction then it is possible to measure the sideways motion or drift of the aircraft. Note that the Doppler shift is also proportional to the cosine of the vertical angle of the beam, hence antenna systems must be horizontally stabilized or a further pair of beams arranged to point aft to provide a differential signal, independent of attitude.

The Doppler itself gives ground speed and drift angle: to determine location, accurate heading information must be provided to the navigation computer. Most Doppler systems operate at microwave frequencies around X-Band (3 cm) and are sufficiently refined to drive an automatic map reader, or feed an integrated navigation system. Overall accuracies of one or two per cent of distance flown can be expected.

Sonar Doppler operating on similar principles is increasingly used by larger ships, and mariners also use depth sounding to augment their position fixing, particularly near harbour.

Airborne radar systems giving very high azimuth resolution and known as synthetic aperture radar (s.a.r.) can be used for navigation by map reading the high quality returns. The high resolution is obtained by simulating the radiation as from a wide aperture antenna by storing and recombing the individual signal elements from a small antenna as the aircraft carrying this small antenna moves along its track.

Similarly, by storing the height of the terrain along or adjacent to your own desired flight path, and comparing actual height from a radio altimeter, positional information may be obtained using correlation techniques.

**Satellite navigation**

NAVSTAR or Global Positioning System (G.P.S.) is designed to give very accurate position and velocity information anywhere in the world. The full system is intended to include 24 satellites in three orbits, giving visibility of 6 to 11 satellites at 5° or more above the horizon from any location on the earth's surface.

The basic method of position fixing by means of satellites is similar to celestial navigation except that distance, rather than angle provides the basic data. Fig. 4 shows the essential components of NAVSTAR. The height of the satellite is accurately determined, the earth's radius is known and the range is measured by timing radio signals from the satellite. In three dimensions, the range line traces a circle upon the earth's surface giving an observer position line. Two such lines give a location fix, and three are needed...
for an aircraft to include its height.

Signals are transmitted on two L-band frequencies, 1227 MHz and 1575 MHz, containing identification and the navigation data for the user to compute his position. This includes information on the status of the satellite, orbit details to enable the user to calculate the position of each satellite at the time of transmission, time corrections and propagation delay corrections.

High accuracy can only be achieved by precise synchronization of the satellite clocks with each other and the user clock error must be known or corrected; each space vehicle carries an atomic frequency standard which is corrected at least daily with a caesium clock at the master control ground station. In terms of accuracy one nanosecond of time error is equivalent to 0.3nm range error.

The concept of navigation by satellite is simple. In practice however, for a worldwide system, a number of space vehicles must be maintained in accurate orbit, constantly updated for time and position. The user equipment includes a microwave antenna and receiver, together with a comprehensive navigation computer. Nevertheless, advances in microwave and microprocessor devices have made possible a range of receivers for ships, aircraft and missiles, and even a 10kg manpack, which will locate position to within about 10m. At present, GPS is in the validation phase I - about six satellites are in operation. Phase II is the period of development for military use, primarily in the USA, and this phase will end in 1982. True production of an operational system will take place between 1984 and 1987. Thus, one can expect that it will be the latter part of the 80s before NAVSTAR can be considered a truly universal worldwide navigational aid.

Radar systems
There is an enormous variety of radar equipment and techniques, ranging from small boat sets, to large ground military complexes.

Radar is frequently used for navigation, especially by ships, but here I would like to discuss a few recent innovations affecting the big system design philosophies.

A simple, basic, airfield-based surveillance radar locates an aircraft by rotating a continuous train of pulses in a transmitted radio beam, narrow in azimuth, and measuring the time of flight of the pulses reflected from the aircraft. The aircraft position is usually displayed on a cathode ray tube or plan position indicator (p.p.i.) in the form of range and bearing from the radar antenna.

There have been considerable developments in radar techniques since the last war to help controllers cope with increased air traffic. Early improvements integrated computers and alpha/numeric labelling systems to automatically track and identify target returns. Extensive signal processing and moving target indication circuitry

Fig. 5. Automatic vehicle location, base station v.d.u.
state of development and undergo continuing refinement towards these objectives.

One must, however, differentiate between military and civil use. Cooperation-dependent systems, such as those based upon satellites or global transmitters, could well be vulnerable in times of national conflict. Probably the self-contained navaid is least open to this sort of criticism if high accuracy at reasonable cost can be sustained.

One can fairly safely predict that semiconductor microcircuit advances will continue to affect radar and radio navigation developments in a very significant manner. Digital processing and storage are already leading to new concepts in system organization and complex error corrections not previously feasible.

Miniaturization of the newer solid-state, microwave power sources and other components leads to new applications. One example is for location and control of road vehicles, increasingly important for large, commercial fleets or public utilities in these times of energy problems and rising fuel costs. The display shown in Fig. 5 is of part of the area of a map of London, where the characteristics of each road junction are stored in a computer in the boot of a car for automatic position fixing.

A further example is in radar developments which are making feasible static antenna arrays where each element of the array is effectively a miniature transmitter/receiver and the beam is electronically rotated or selected. One such system, known as bi-static, can use a separate transmitter as an illuminator, with several spaced receiving systems using multi-beam static arrays. Such a system could provide enhanced protection against noise, interference and signal fluctuation.

The US Air Force hopes to deploy a 600 ft diameter radar in earth orbit by 1985, using the space shuttle. This could be used for tracking ships, aircraft, cruise missiles, inter-continental ballistic missiles and even armoured vehicles on the ground.

The author thanks the technical director, GEC-Marconi, for permission to publish this article.

Further Reading

Audio
by Adrian Hope

BACK IN the early winter of 1969 the Olympia Exhibition Hall played host to the International Audio and Photo-Cine fairs. Ten years ago, although burgeoning trade and public interest in sound reproduction had made it impractical to continue the post-war tradition of exhibiting equipment in the Russell, Washington and Waldorf hotels in London, there was still insufficient support to justify an audio-only show at Olympia. It soon changed of course as hi-fi became an essential domestic luxury. Now, ten years later, we have seen the rise to dizzy heights and fall into disfavour of Olympia as a hi-fi exhibition site. Indeed in many respects Olympia has been a barometer of hi-fi trade. After 1969 the Audio and Photo-Cine Fair became the Audio Festival and Fair and then the Home Entertainment Show. It was cancelled at the eleventh hour in 1976 and in 1977 drew only very disappointing crowds. Since then there hasn’t been an Olympia audio exhibition.

The face of audio retailing has changed at least as much as the Olympia Exhibition. At the beginning of the 1970s most of the electronic shops in London’s Tottenham Court and Charing Cross roads sold electronic components, along with construction kits and a smattering of ready-built audio equipment. Almost all had one characteristic in common: undisguised impatience with the average customer. It was, I suppose, understandable. There is little profit to be had from testing a valve or advising an amateur constructor on why a resistor has burned out. Soon the names of the shops started to change, for a while almost exclusively, to Lasky. Profits increase because the shops started to concentrate on selling hi-fi equipment, to the exclusion of components. By the mid-seventies any one asking for a fuse, a resistor or a spare part could expect to be treated like a mad leper in all but a very few shops. Gradually the public became reconciled to the idea of buying equipment in a cardboard box from a shop assistant who might just as well have been selling washing powder or potatoes. The main culprit, some observers argued, was the end of resale price maintenance and the consequent declaration of a competitive price war. Shops selling at cut-to-the-bone prices could not hope to offer anything in the way of before and after sales service or advice. Some dealers stuck to higher prices but offered service into the bar-

Radio and electronics into the eighties

gain. Inevitably some customers took free advice from the high price dealer and then bought the recommended product at cut price in a cardboard box from a warehouse dealer. Between these extremes some dealers, both in London’s golden mile and elsewhere in the UK where the golden mile image had spread, offered intelligent advice and reasonable service at a low price. Others offered neither service nor advice but at high price.

It was inevitable that the bubble would eventually burst. There comes a time, especially when money is short, when a householder with an adequate sound system will no longer go out once a year and buy a replacement. There comes a time too when the public, working hard for their money, start to resent the need to junk relatively new equipment for the want of a single spare part that proves unobtainable, or at least an expensive nightmare to procure. It is no secret that now, at the end of the decade, the audio trade is in bad trouble. Spare cash now, and there is clearly less of it around, goes toward a video recorder or a second colour TV, not a new stereo amplifier, record turntable or cassette recorder to replace a perfectly adequate system which is still giving faithful service.

The Olympia barometer of hi-fi is not however to be taken as gospel. Although Olympia is no longer the site of an annual audio exhibition in London, other shows flourish. The sad truth is that Olympia now has a bad name in the audio world. Exhibitor firms have suffered once too often from what they euphemistically refer to as "union problems," but which in less euphemistic terms means spending many tens of thousands of pounds to exhibit and finding the stand unfinished on opening day. It’s also a bane of a place, in many respects the unideal venue for audio demonstrations. But smaller shows in hotels in and around London have always left some exhibitors or visitors dissatisfied. One year in the mid-seventies there were two rival shows at two Heathrow hotels running in parallel. An autumn 1979 show in London was cancelled at the last minute through lack of trade support. Currently, perhaps rather curiously, the major UK show is the annual exhibition held at Harrogate in Yorkshire. The fact that so many of the trade, press and public are prepared to venture so far

51
north into the provinces as to make Harrogate an annual success, while declining to give sufficient support to make a London show viable, is surely the audio phenomenon of the decade.

Another phenomenon of the decade has been the rise, and occasional fall, of so many audio and hi-fi publications. At the beginning of the decade there were just a handful of specialist hi-fi magazines. Both had a fairly staid outlook. Then the first of the breakaway "glossies" appeared followed by a string of several more. After various changes of ownership, a few bankruptcies, and several changes of title and direction the market now appears stable.

One theory is that the current misfortunes of the trade are partly due to the boom in hi-fi journalism. The argument is that enthusiasts, with limited money, are now content to read about new developments and leave buying them to someone else. Whereas magazines like Playboy and Penthouse work on the assumption that readers are interested mainly in vicarious thrills, the hi-fi industry has so far assumed that a stimulating article on audio will stimulate sales of the product described. As a result they have continued to keep the magazines in business by using them as an advertising vehicle. (It is easy for the lay reader to forget that although reputable magazines try hard to ensure that editorial content is not influenced by advertisers, every magazine relies on advertisements for commercial viability). Although the hi-fi magazine market now seems to have stabilized, with all those publications currently on sale likely to remain so, it is highly unlikely that any new hi-fi magazines will now appear.

Perhaps the most notable overall trend of the last decade has been the massive influx of Japanese electronics equipment, moving towards almost a total market domination in some areas. At the 1969 Audio and Photo-Cine Fair there was a substantial number of Japanese exhibitors, notably ADC, Shure and Koss. From Europe (excluding Britain) there were 15 exhibitors, including Agfa, Arena, B & O, BASF, Dual, Grundig, Luxor, MB, Mikrofonbau, Ortofon and Peerless. From the UK (excluding the BBC, and several magazine and book publishers) there were over 40 companies of which only a very few were importers. Among the British names showing were Brenell, Bush, Colton, Decca, EMF, Ferguson, Ferrograph, Ferranti, Garrard, Hacker, HMV, Leak (then still of Brunel Road, London, W3), Lowther, Lustrophone, Mullard, Dansette, Philips and Sinclair. These were in addition to currently-famous names such as Armstrong, B & W, Celestion, Connoisseur, Goldring, Goodmans, KEF and Quad who were all already well established. From Japan, and often with very low profile, came just 14 exhibitors. Of the Japanese firms, Yamaha was showing just loudspeakers and cabinets but Trio offered a full range of amplifiers and tuners and Toshiba, Sony and Sanyo offered tuners, amplifiers and turntables. Teac offered just tape recorders. It is sobering to compare this list with the catalogue for the 1979 Harrogate Audio Exhibition. For the European electronics industry ten years has been a very long time.

The last decade has seen any number of new developments and offered, often foisted on the buying public. But a few have stood out head and shoulders from the rest either as a result of value which has been subsequently proven or because the passage of time has underlined their lack of consequence. But some ideas of consequence have failed, at least first time round. And some ideas of no consequence have succeeded, at least temporarily.

From a considered and selective recap on the technology seen in the 'seventies, likely trends for the 'eighties become clear.

The 'seventies must surely go down in history as the decade in which surround sound didn't happen. In the late 'sixties engineers in the USA started to show interest in improving the reproduction of music in a relatively small domestic room by adding reverberation to simulate the sound of concert hall or large room. Early workers soon recognised that it was not sufficient merely to remove all sound absorbtion furnishing and furniture from a small room, with short reverberation paths. An artificial long path reverberation signal had to be generated and reproduced from loud-speakers behind or around the listener. The 'sixties experiments sought to record and reproduce natural hall ambience, rather than simulate it at the reproduction stage.

The then-new breed of multitrack studio recorders provided the ideal tool to record ambience along with the main, front, sound stage. An eight-track tape cartridge or four-track tape-recorder provided the ideal medium for selling the resultant multichannel surround sound to the public. The record companies, forseeing a drastic drop in two-channel stereo disc sales, panicked. At the turn of the decade numerous engineers around the world beavered away to produce a multichannel surround sound disc that would also offer good stereo and mono.

Not to be outdone, the broadcasters addressed themselves to the same problem. At first there was excitement that the apparently impossible had been achieved; a quartet of loudspeakers around the room could be fed with four sets of signals derived from a two-channel stereo source. But as the inevitable trade-offs and compromises became better understood, thinking engineers became disillusioned. So did the public not so much because of the various system deficiencies, but because of the lack of standardisation between so many competitive systems.

With the benefit of hindsight we now know that lack of standardisation on any one system was probably the best thing that ever happened to domestic audio. If any one early 'seventies system had become a world standard we would now be stuck with it — and all its inherent inadequacies. But early in the 'seventies surround sound reproduction (or quadraphonics as it became known when four loudspeakers in the four corners of a room became tradition) looked to the marketing men like potential big business. The 1972 Consumer Electronics Show in Chicago saw private discontent flaire into public squabbles. While the manufacturers tried to produce reproduction equipment capable of playing any or all of the competitive systems then available or announced, the record companies hedged over which system to adopt. "They ought to be locked in a room and kept on bread and water until they come out with an agreement" said one frustrated manufacturer.

When broadcasters finally agree a surround format we might get multi-channel surround sound records from the industry again.
At around this time a compromise offered by American engineer David Hafer started to find favour. This was the now familiar “Hafer circuit” which feeds a rear pair of loudspeakers with the difference information available across the outputs of a conventional stereo amplifier.

This simple connection provides signals for the rear, from almost any programme material. Readers of hi-fi magazines, puzzled over which quadraphonic system to buy, were repeatedly advised to compromise with a Hafer system temporarily until a standard was agreed. Even now, long after the quadraphonic bubble has burst, many enthusiasts retain a Hafer connection to feed rear loudspeakers because, especially with programme material recorded with a simple crossed pair of microphones, the results can be highly acceptable. There is now little doubt that every quadraphonic system marketed during the last decade is dead in its present form.

But the last years of the decade has seen the progressive acceptance of Ambisonics surround sound technology. This of course stems from the work of Michael Gerzon and Professor Peter Feligge.

It is also embraced, albeit to a fluctuating extent, by the BBC and IBA. The recent patent pool agreement between Ambisonics-NRDC, Nippon Columbia and Duane Cooper (joint holders of most of the crucial patents covering a hierarchical approach to Ambisonics surround-sound technology) will almost certainly prove a significant influence in the next decade. In the USA the Federal Communications Commission is currently debating, yet again, the future of surround-sound broadcasting. The signs are that the final FCC choice will be between Ambisonics and the CBS SQ system, or modern variants thereof. Until recently there has been a fairly unified approach from the Ambisonics faction. But now the IBA has raised a question mark over the validity of the hierarchical approach. Essentially the IBA argues that the best compromise is a three channel system, which offers good surround sound to listeners with a three-channel decoder, and good stereo and mono with existing equipment. This conflicts with the Ambisonics-NRDC approach which seeks to offer the surround-sound listener the choice of using either two or three channel (the third with or without limited bandwidth) reproduction equipment in hierarchical fashion. The IBA now describes the two approaches as “irreconcilable” so it is clear that if surround sound is to progress in the eighties past the laboratory stage the IBA-NRDC-Ambisonics-NRDC-Radio and electronics into the eighties
that the future of one is dependent on the other. It was in 1972 that Philips first announced a video cassette recorder capable of recording colour TV pictures and sound on a cassette of half-inch tape. Although the original N1500 machine was intended for the industrial and educational market, by 1974 it was launched for — albeit limited — open sale to the general public. This started not only the domestic video revolution but also the inexorable move toward digital sound. Any recording system capable of handling the four or 5MHz necessary for colour video is more than capable of handling the bit stream necessary for stereo or multichannel sound in digital form. Moreover a decade of work into video reproduction from discs, which culminated in the USA test marketing launch of a practical video disc system by Philips-Magnavox in 1979, brings the digital audio disc a step closer. Philips has of course already shown the compact disc, or digital audio version of the Philips VLF video disc, and toward the end of 1979 announced a patents liaison with Sony. Sony had independently developed a laser-optical disc system similar to that proposed by Philips. With the union of Philips and Sony standardization of a laser-read optical video disc comes a step closer. Almost certainly the Philips-Sony union will bring agreement on a digital Compact Audio Disc smaller than the 36cm proposal made by Sony and larger than the 11.5cm diameter chosen by Philips for the compact disc. Very probably a digital "compact audio disc" of around 15cm will emerge from the union. But this will almost certainly not herald world standardization. JVC still sticks hard with its different, and quite incompatible, capacitance-read grooveless disc and RCA argues in favour of a grooved capacitance disc. Matsushita has proposed a grooved disc which is read by a mechanical pressure-sensitive stylus similar to that developed by Telefunken and Decca early in the decade and briefly marketed at the Teldec TeD video disc. It is now known that Teldec has a miniature digital audio disc version of TeD. This Teldec Mini Disc is ready to launch in Europe if and when the time is adjudged commercially right. Without doubt there are many bitter battles ahead before there can be world standardization on the digital audio disc. These battles will delay standardization and give impetus to the short term stop gaps such as metal tape. There is also a move toward 45sp/min long-playing analogue discs. It is argued that their higher rotational speed, coupled with the long playing time per side offered by computer-assisted cutting techniques, offer the analogue album a shot in the arm.

Casual observers talk vaguely of some wholly new, yet undreamed of, storage medium to replace the tape or disc. Without doubt it would be possible to encode programme material in holographic form. But the idea of a chip or memory, storing an hour of programme in solid state, must surely remain a dream for at least the next decade. Although high density memories with fast access time are available, a few moments calculation is sufficient to show that solid-state memories have a long way to go before they can offer the equivalent of an LP record in real time. Prophecies, especially in such fast-moving times, are always dangerous, but it seems a safe bet that for the next ten years sound and vision in the home will be stored on, and reproduced from, a moving strip of magnetic, capacitive or optical material or a rotating disc of similar characteristics.

The speed with which a new storage medium becomes a commercial success and gains acceptance as a household norm, will depend entirely on the behaviour of the companies involved in the development and promotion of such a new medium. Rapid agreement on digital encoding standards and storage techniques could bring a new record medium into the home within a couple of years. But behind the scenes squabbling, similar to that which killed off the quadrophonic systems could delay even the start of a transition from analogue reproduction until at least the mid-eighties. But as we learned from the quadrophonics fiasco this may not necessarily be a bad thing. Currently the signs are that the strong US and Japanese influences may impose on us world coding and sampling standards for digital sound reproduction which are tied to local TV standards. These could well prohibit or make expensively difficult, the exchange of recorded audio material between continents. Certainly it would be an appallingly regressive step. Moreover in their enthusiasm for a new generation of recording and reproduction techniques, engineers at laboratory level appear to have overlooked, or at least brushed to one side, the very real problems of mass producing high-density storage programme material in reliable quality as well as quantity. After one hundred years of analogue disc recording, there are still all too few record pressing plants capable of producing a respectable audio disc pressing. With track spacing between 50 and 100 times tighter in digital or video programme storage the importance of producing blemish-free pressings becomes paramount. The video and digital audio systems that succeed in the long run may well be the system for which it proves easiest to mass produce programme material.

Cassette recorders for the eighties will have bias and equalization for metal-particle tape but will the public pay the extra price?

H.f. radio communication

by R. F. E. Winn B.Sc.(Eng.), F.I.E.E. Racial Communications Ltd

Advances in component technology and new design concepts during the past decade, together with projected future developments, ensure that h.f. radio communications will retain importance well into the twenty-first century. In particular this is true of the maritime mobile service where satellite communication is still in its embryonic stage, in developing countries where the economics of h.f. point-to-point working with low traffic density are attractive, in defence (as a back-up if not always primary system), and in emergency use where air-transportable containerised stations can be rapidly deployed. As well as advances in technology in recent years there has been a better understanding of the vagaries of propagation. This has resulted in greater precision in predicting maximum usable frequencies over various paths during the 24-hour day at different seasons and during sun-spot cycles.

For medium and long-haul communication h.f. radio today is still an economic, efficient and reliable solution.

Receivers of the 1970s. The most significant technical changes have been in receiver design in which a number of ideas, coupled with newly available
components, converged to provide by the early 1970s a completely new order of excellence in terms of overall performance and ease of operation. Before discussing the “breakthrough” of the 1970s it is helpful to look briefly at two previous generations of receivers.

In the immediate post-war years the most exciting development was the drift-cancelling technique known as the Wadley Loop. Although a tricky concept, demanding skilled mechanical as well as electrical design, it was successfully implemented in the now classic RA 17 receiver, made by my company, of which some thousands are still in daily use throughout the world. For the first time it had become possible to tune to a given frequency and leave the receiver unattended with reasonable confidence in its frequency stability over extended periods.

The next big challenge came in the 1960s with the change from thermonic valves to solid state devices. Early examples were heavily influenced by the previous valved designs, and although greater ingenuity was sometimes achieved they were little more than an exercise in re-engineering using transistors in place of valves. The advantages were reductions in weight, size and power consumption and an increase, at least in theory, in reliability. Overall performance, however, was disappointing and, in general, the best of the first generation of solid state receivers were inferior to the best of the valved sets. There was not even an advantage in price.

A parallel development in the 1960s was the frequency synthesizer, which generated a wide range of frequencies each with a stability equal to that of a single master crystal oscillator. This was seen as an elegant substitute for the often troublesome free-running local oscillator in superhet receivers and as a simpler solution to drift than the Wadley Loop. Unhappily the early synthesizers brought their own problems in the shape of unwanted intermodulation products generated by the internal mixers, adders and dividers. The advent of the digital synthesizer provided a cleaner output and today’s units are capable of excellent spectral purity. The early synthesizers also suffered from the operational disadvantage in that frequency was selected through decade switches. Excellent if the exact frequency of a wanted signal was known, but hopeless for “searching”. This problem was overcome later.

With so much new technology becoming available, engineers in this field came to the conclusion that a radical re-think on receiver design was overdue. Not only on how newly available technology and components could be implemented to advantage but also all aspects of performance and operation in modern conditions. The starting point was a statistical analysis of their occupancy of the h.f. frequency spectrum in terms of density and types of signals, their distribution and relative strengths, which would give a clearer indication of how a receiver needed to perform in order to use efficiently the 9,000 or so 3kHz channels available. An analysis was made by a computer in my company and, independently, a similar exercise was carried out by B. M. Sosin of Marconi Communications Systems.

It had been realised that the most significant limiting factor in receiver performance was linearity. Selectivity was as important as ever but the emphasis on front end sensitivity which had been a paramount feature of design for the past 50 years had come to the end of its usefulness and no further gains were necessary or indeed possible in this area.

It was found from the analysis and measurement that high powered broadcast and commercial stations were generating tens, in some cases hundreds, of millivolts at the antenna terminals when received on large collecting systems. The strong signals were generating a large number of intermodulation products strong enough to give the appearance of liveliness in the receiver yet masking weak wanted signals. What was required was a big increase in dynamic range together with extreme linearity, and the key to the problem of intermodulation products was to work out the linearity of previous receivers and to discover where the products were formed and at what level.

The first range of solid state receivers to incorporate the new principles in the 1970s was the RA 1770 series, of which the RA 1772 general purpose receiver will be discussed. The block diagram of this receiver (Fig. 1) shows it to be a straightforward double conversion superhet but with a number of novel features which provided a performance with respect to dynamic range, intermodulation products, reciprocal mixing, cross modulation, blocking and spurious response far superior to any other receiver then in production. This
was achieved through using a single linear broadband r.f. amplifier, a double-balanced hard-driven fast-switching m.o.s.f.e.t. first mixer, only moderate gain at the first i.f. of 35.4MHz with the main gain in the second i.f. amplifier operating at 1.4MHz.

The new order of performance at first caused some confusion. First comments on the development models, later echoed by the first customer, were apparent lack of sensitivity because there were far fewer signals. Repeated tests with a signal generator were necessary to convince ourselves that the design sensitivity had indeed been achieved and that the "emptiness" of the h.f. band was due to the elimination of spurious signals and not lack of band activity or insensitivity.

Apart from the redistribution of gain throughout the receiver the most notable advance in achieving the new performance was the use of a high first i.f. of 35.4MHz. This became possible through using a high stability digital synthesizer which also provided additional advantages. It was now no longer necessary to employ the traditional tuned r.f. preselector amplifier ahead of the first mixer to eliminate image signals. There were no tracking problems associated with a linear broadband amplifier so the front end was greatly simplified and this, in turn, helped open the way to remote control.

As a general purpose receiver, the set needed a free-tune facility and this was achieved by using an optical shaft encoder on the tuning knob which provided electrical pulses and directional information to step the synthesizer in 100Hz (fast) or 10Hz (slow) intervals up or down giving the operator all the "feel" of the familiar v.f.o. but with synthesizer stability. The tuning knob could be disengaged electrically to hold the receiver on any particular frequency. The digital frequency read-out, derived from the local oscillator, although at first disliked by operators accustomed to dial and pointer indicators, was necessary if the accuracy of the synthesizer was to be exploited operationally. No traditional mechanical analogue dial could achieve a resolution of 10Hz at 30MHz and even the most conservative of the old-time operators now see its advantages.

Another innovation was to provide a complete receiving terminal in a single case instead of extending facilities with add-on adaptor units, which, in the past, had frequently resulted in a 6ft high rack of equipment. Provision was made for six internal filters, which could be fitted at the customer's choice. The filters were selected through transistor switching controlled by d.c. only from the front panel. This not only eliminated the potentially troublesome mechanical switching of r.f. circuits from the front panel but also simplified remote control.

Although an earlier receiver had been developed using plug-in modules it was decided in the interests of economy to use conventional construction in the RA 1770 series but the physical configuration allows all circuits and components to be tested by test gear for fault diagnosis while the receivers are in an operating condition. By the mid-1970s the series had been extended to include programmable and remote control receivers. The programmable set, in addition to continuous tuning at three selectable rates (10Hz, 20Hz or 1kHz), had twelve programmable channels selected from a front panel switch.

The receiver for extended or full remote control is in two units, the receiver itself with a blanked-off front panel except for local test facility, and an associated remote control unit with all the front panel controls. The receiver is triple conversion with the third i.f. at 10kHz. Apart from a spin-wheel tuner and rotary controls for b.f.o. setting and i.f. and a.f. gain, all other functions on the remote control unit are controlled by push-buttons. Control is exercised by a time-sharing data-multiplexing system which converts parallel control information into serial form for transmission over single wire lines. For extended control of all receiver functions three cable pairs are required. For full remote control over virtually any distance standard data modems are used on an ordinary unconditioned four-wire telephone circuit.

The system enables complete receiving systems to be built in which a single operator with one remote control unit commands several remote receivers.

Transmitters of the 1970s. Transmitter development in the past decade has not been as spectacular as in receivers. The digital synthesizer came into more general use for frequency control in drive units and remote control systems provided flexible extended and fully remote control. The most dramatic development was a solid-state power amplifier delivering up to 1kW of power (Fig. 2). This presented a great technical challenge, the problem as with solid state receivers being the inherent non-linearity of bipolar devices which demanded careful balance at every stage. No single device could produce significant output and my company's approach was to employ eight modules, each of 125W output with combiners summing through hybrid units to 250W, 500W and finally 1kW. The system had to survive a module failure which necessitated some complexity in design to provide protection over a large frequency range.

The advantages of the solid state design were mainly in reliability and ease of servicing. The 30V supply rail was non-lethal (although it is still possible to receive a serious r.f. burn from the antenna terminal). In terms of reliability there was adequate redundancy, failure of a module merely reducing total power output and any of the eight modules could be replaced or worked on without interruption of service. A 500W version on the same principle but with only four 125W modules was also produced.

For higher powers the valve remains supreme in terms of economy and efficiency. One 10kW transmitter of the 1970s period, still in production, was solid state in the drive stages with air-cooled ceramic electrodes in the power stages. Automatic tuning, servo-driven, gave a typical tuning time of 8 seconds with a maximum movement over the band of frequencies of 20 seconds. Automatic level control was provided and the power supply had automatic overload protection with automatic re-set which would not finally lock out the supply in...
the case of a transient fault until four unsuccessful attempts at reconnection had been made.

The next ten years
Both technical and economic gains are anticipated in the decade ahead and in fact are already being realised. The market is highly competitive and it is clear that design trends will be towards better specification and more facilities per unit cost.

A positive example is an m.f./h.f. receiver which made its public debut in London in October 1979. It is a joint Anglo-American development and substantial orders have already been received from the US Air Force. The receiver (Fig. 3) has the overall performance of its predecessors at a far lower price, achieved largely by more functions per integrated circuit and therefore a smaller number of components. It is a double conversion superhet with the first i.f. at 40.455 MHz and the second i.f. at 455kHz. Frequency and receiver status displays are liquid crystal and all functions are push-button selected, control being through a microprocessor.

The important innovative advance is the synthesizer. In the RA 1772, described earlier, there were five circuit loops constructed on four printed circuit boards. In the new receiver a single loop synthesizer occupies only one board and as well as generating the local oscillator frequencies at intervals of 1Hz (previously 10Hz resolution) it also generates the b.f.o. output in 10Hz steps. Because of the single loop design the new synthesizer has even greater spectral purity because all mixing has been eliminated and thus fewer frequencies are being generated. The unit is based on an i.s.i. m.o.s. chip developed by Racial Microelectronics Ltd which achieved 1Hz resolution by synthesizing phase as well as frequency.

The UK version has a 100-channel frequency store and an interface for a remote control system. The US version has IEEE 488 input/output interfaces as standard, but both versions can be adapted for other interfaces by software changes.

Fig. 3. Anglo-American m.f./h.f. receiver. This recently introduced model uses a microprocessor for control and a new synthesizer.
The synthesizer mentioned above is also employed in a military wide-band receiver where it is used to cover the h.f./v.h.f. spectrum continuously from 2MHz to 512MHz.

On the transmitter front the advances that one will see in the 1980s are less spectacular but none-the-less worthwhile. A second-generation 1kW solid state amplifier uses four 300W modules which, allowing for losses in the combiners, delivers a full 1kW to the radiating system. Linearity has been further improved so that for the first time the CCIR recommendations for intermodulation products have been met over the whole of the h.f. range.

Looking further ahead there are two great hopes. One is v-m.o.s. devices which could provide much greater linearity than current bipolar devices, and of greater efficiency. The second is the feed-forward or polar loop concept on which research is being conducted at Bath University. If successful, there is a promise of solid-state transmitters comparable in efficiency and linearity with current class AB vacuum tube amplifiers.

On a more immediate note the world demand for low-cost channelised transmitters continues unabated, and it is now becoming apparent that the conventional channelised drive unit may well be displaced by a programmable synthesizer on economic grounds. With modern technology a synthesizer is already comparable in cost with a 10-channel crystal drive unit.

Receiver performance has now reached a new plateau but the application of the microprocessor will provide considerable refinement, resulting in more “intelligent” units in both systems management through remote control and in the receiver itself. For example, there is the self-adaptive receiver already realisable which senses the type of signal it is receiving and automatically adjusts itself by minor frequency shift and selection of appropriate filters and demodulators to the transmission mode it is receiving without operator intervention. If on c.w. it would probably select the narrowest filter and adjust the h.f. frequency for a pleasant tone, and audio gain to a convenient level, for recording or operator convenience. If s.s.b. is detected then the appropriate upper or lower sideband filter, and so on. The microprocessor will also be used for routine self-checking of sensitivity and other parameters.

The newer techniques pioneered on h.f. are already producing a spin-off at higher frequencies, particularly the concept of a high first i.f. which opens the door to broad band pre-mixer amplification. High stability v.h.f. synthesizers will also allow s.s.b. on v.h.f. and u.h.f., thus enabling more efficient use of the spectrum as has happened on h.f.

We may also expect new forms of modulation which will help overcome the inherent limitations of ionospheric propagation. There could be re-births such as the Piccolo system, where the advent of solid state circuitry has made the system economic enough to attract much wider application.

Work is currently being conducted on topics such as time encoded digital speech at 2.4 kilobit/s and, though presenting considerable technical difficulties, few professionals doubt that such developments will eventually prove successful and further enhance communications at h.f.

Although for purposes of illustration the practical examples quoted are all from the author's own company, he gladly acknowledges parallel work in other countries which, through professional cross-fertilisation, will continue to advance the art and science of h.f. radio.

**Electronic measuring instruments**

by John L. Minck Hewlett-Packard Company

Progress in instrumentation is a result of at least three driving forces: the on-rush of new system requirements such as fibre-optic communications and satellite technology; 'breakthroughs' in component technology, such as microprocessors or microwave, hybrid microcircuits; extensions and combinations of present instrumentation, such as the remarkably successful IEEE-488 interface bus for programmable systems.

Very often, progress is really an intricate combination of all of the above. In so many cases successful instruments don't involve technology 'breakthroughs', but merely embody the right combination of customer requirements. With few exceptions, most of the component technologies were already in place at the beginning of the decade. Digital, analogue, and microwave integrated circuit techniques advanced substantially, but the primary technology was already there.

The 1970s

Dramatic progress did take place during the 'seventies. Probably the most important new developments were of logic analysers and logic design instruments. The earliest of these, typified by the HP 1601L introduced in 1973, was nothing more than a standard oscilloscope display with columns of 0s and 1s. An early serial data analyser, the HP 5000A, permitted diagnostics on long streams of data captured and displayed on rows of I. of. ds.

In the six years since, the progress in logic analysers and microprocessor design instruments has been nothing less than breathtaking. And none too soon either, because relentless marketing pressure is pushing microprocessors well beyond the obvious applications in calculators and communications into appliances, toys, electric organs and motor cars. Design, qualification, production test, maintenance and service all need these measurement tools to work with microprocessors and digital circuitry.

One common theme of the 'seventies for most classes of instrument was that requirements moved two ways at once. Thus, the market called for smaller, more portable and less expensive models at the same time that other models went as far as technology would allow, with highly complex and powerful instruments and remarkably high price tags. An example of the former is the low-priced, digital voltmeter, while the high-priced example is the HP 3455A, a high-precision, system d.v.m.

Oscilloscopes handled higher frequencies and became both smaller and more portable, while others became much more powerful and complex, using microprocessors to measure digital time delay or rise times. Waveform, pulse and function generators tended to go in only one direction—towards smaller and cheaper designs, but with remarkably strong specifications. It's amazing how much waveform performance can be packed in a small package these days. The more complex pulse-generator products usually were the word and coded-pulse instruments.

![Fig. 1. Modern logic analysers can show timing waveforms, logic states, and some provide logic “maps” which help engineers diagnose malfunctioning processors.](image-url)
required by new digital communications technology and fibre-optics.

**R.f. and microwave.** R.f. and microwave instruments entered the seventies with great promise. In 1970, hybrid microcircuit technology and the design processes using scattering parameters were in place, ready to supply the building blocks; G.a.s.f.e.t. devices were coming. The results were truly astounding. The microprocessor has made the difference—about half the circuits in many microwave instruments are now digital and it comes as no surprise that about half of our microwave design teams are digital and software designers.

A typical result is a newly-introduced synthesized signal generator. The 10kHz-1280MHz signal spectral purity of this generator rivals the best cavity-type generator of previous years, but it is also fully programmable and frequency agile (500μs switching time). The real contribution of this very expensive generator is in the design of the front panel controls. The mostly digital keyboard communicates only to the microprocessor, which does all the circuit and signal control, making things extremely easy for the operator. For example, he can set up ten completely different front-panel signal conditions, store each, and recall them at the push of a button.

Another example of this “smart” type of microwave instrument is a recent 1500MHz spectrum analyser. Starting from power switch-on, the machine runs through 30 self-tests and draws its own group titles and titles, and provides powerful measurement routines which are far beyond usual manual testing. Self-tuning routines bring identified signals to the centre of the screen and read out frequency and amplitude digitally. Sweep speed, bandwidth and resolution are automatically selected in program to prevent errors and ease the job. Peak detecting and hold and store functions capture information digitally to show historical peaks. Six sets of user-defined front panel set-up conditions can be stored and recalled. Powerful diagnostic routines and displays aid maintenance people. This new measurement capability can’t be appreciated by reading about it. One must sit down in front of such a machine for about an hour to grasp its significance. For example, if the spectrum analyser is connected to a receiving antenna, all background spectrum accumulated for a given period can be used to cancel a given signal environment and the display will then show only new signals which show up later.

R.f. network analysis finishes the seventies with a typical instrument, covering 500kHz to 1.3GHz, which measures, calculates and displays complex impedance transfer functions, group delay, deviations from linear phase, etc. It’s about all the design power an r.f. design engineer needs.

In instrumentation, the seventies brought one development which probably overshadows all other advances in instrument techniques—the IEEE-488 bus. Interestingly, the IEEE bus was not a technological breakthrough; it was really more of an organisational and political advance. A simple data party line allowing automatic control of instruments and resulting data computations has revolutionised measurements already: over 700 instruments and controllers from over 160 manufacturers throughout the world now operate on the bus. Engineers now think in terms of automatic measurements for labs and production and maintenance uses.

**Servicing.** Finally, in the late 1970s, a more coherent strategy for dealing with service and repair of digital circuits was emerging. Early attempts at field diagnosis and repair of ‘digital’ boards placed the emphasis on changing the board. When the total number of instruments in service was small and widely scattered, the organisation to make this feasible was difficult.

One solution gaining rapid acceptance now is a design strategy based on signature analysis of digital circuitry. Instruments with a high content of digital components are designed with a certain portion of the microprocessor set aside to be used in fault diagnosis. In that test mode, the instrument circuitry is forced through a switching procedure which causes each digital circuit node or pin on a digital logic pack to produce a sequential stream of 0s and 1s. That repetitive pattern is unique to that pin of a good instrument. Thus a signature analyser like the HP 5004 takes a bit stream as long as 2^16 bits and compresses it into a 4-digit alphanumeric display. Instruction manuals and test procedures are written to measure and assign a unique 4-digit signature number to every digital circuit pin. Technicians can quickly troubleshoot right down to a component level, picking out faulty i.c. packs with little trouble and alleviating the serious problem of stocking complete p.c. boards.

The future Forecasting the future is always risky, but the clues to the next five years of instrumentation are already apparent from the most recent offerings.
Alternative digital methods will continue to invade analogue and r.f. techniques. For example, instead of a super-accurate, flat-frequency-response r.f. attenuator for use in signal generators, a signal generator will use a moderately-accurate but highly stable one: a highly-precise calibration table stored in memory then corrects the output signal. This is effective and inexpensive so long as there is already a microprocessor available.

It seems quite clear that analogue and radio-frequency circuit techniques will be further eroded by digital methods. As faster analogue-to-digital converter components come along, instruments will sample and convert signals to digital form further forward in the measurement process. Output signals may be more commonly generated by digital waveform synthesizers. For example, oscilloscope sweeps would be much more accurate if generated digitally by a clock whose frequency was referred to a crystal standard.

**Systems**. Systems engineering will call for new initiatives in measurement which will create new instrument concepts. Communications systems are moving rapidly to digital modulations. Signal simulators will be needed for generating phase-shift-keyed modulations for satellite work as well as frequency agile signals for the new military communications and the cellular mobile telephone technology.

Fibre optics technology's on-rush into communications, in spite of its highly optimistic projections, has been underestimated: few people really see its impact clearly. The bandwidths of communication power to be unleashed by fibre optics will revolutionise not only the system business but will change instrumentation. Fibre optic data links can already link IEEE-488 bus instruments. Computer and terminal links as well as medical data transmission with no ground loops are just the beginning. These technologies will call for design and test equipment not yet envisaged. More importantly, they will call for new concepts in measurement.

The computer system technology will have memory and processors in every corner. Instrumentation will more than adapt: there is very heavy interaction between logic design instrumentation and the semiconductor revolution itself.

**Fig. 4.** Each pin of a digital i.c. pack has a unique 4-digit signature displayed and referenced in the repair manual, allowing diagnostics down to a component level.

Certainly, computer-aided design for assistance in lab. projects becomes crucial. Engineering productivity is the key in the 'seventies, automatic test equipment found willing ears for production test and for lowering costs — it was easier to justify.

The 1980s must attack the design side of things. Technology moves so fast that any lab. project which lasts longer than three years is going to produce a product with old or obsolete technology. As a result, there will be a steady proliferation of IEEE-488 bus mini-systems in laboratories. New instruments will appear with more operator-interactive controls and displays which interact, compute, correct and translate into your terms.

Complicated measurement procedures will be captured in software so the same tests can be re-run two weeks later. Suppose you run a particular test as you complete your circuit board. Two weeks later, after modifications, you would like to recall the same procedure, set up all front panel settings as they were, run the test and compare the data to the previous test. This may sound a little like the HAL computer from the movie 2001, but it isn't: the technology to do that is here now on IEEE-488 bus systems. Now just contemplate individual instruments doing much of the same.

How will we maintain all this equipment? One computer maker recently proposed throwaway p.c. boards as a repair strategy; that might happen. Super-integration and high-reliability test programs could well give a substantial advance in reliability. But the usual reaction to that is to pack even more complexity into the instrument functions, putting instrument reliability back where it started. Smaller, lower cost, highly digital instruments will get more reliable. Larger, more complex, high priced instruments will hold their own on reliability. The most likely course will be a combination. With maintenance labour rates bound to increase, there may be some trends towards the throw-away-type repair on very low-priced instruments. In higher-priced equipment the instrument will contain more self-test and diagnostic capability, under control of its own microprocessor: that trend is already apparent. Then when the self-test has isolated problems to a given module or p.c. board, the digital signal analysers will take over.

Instruments in ten years will still consist of printed-circuit mother boards and plug-in modules. But p.c. board testing which has focused mostly on production functions may gravitate to maintenance depots where repair quantities can justify the cost. The new super-flexible automatic board-test systems are becoming attractive because of their remarkably low prices.

So, get ready for some technically exciting times. The surface has barely been scratched.
"Make way for engineers"—IERE president

The normal fabric of British life will have to be substantially changed, claims Professor William Gosling of the University of Bath, if we are to create an engineering profession adequate to the needs of our society. Giving his inaugural address as new president of the IERE, he said that we urgently need "an elite corps of engineers, particularly electronic engineers, who will be as able, perhaps able, than any others in the world. To induce the most talented people to seek such a life, society will need to use the only inducements which have ever been known to work, namely honour, prestige and wealth. They will also need a good 'second division' of supporting engineers, of technician engineers and technicians. At each level of employment the appropriate rewards—tangible and intangible—to secure the quality and numbers to meet our social needs must be forthcoming. Such things are not achieved cheaply, but only by the diversion of resources in the appropriate direction. Since the wealth of society cannot immediately increase, even with the most favourable industrial policies, we are faced with a stark logic. If we need better engineers, more able to facilitate creation of wealth by industry, we must make that career more attractive to the ablest of our children. To do that the rewards must be markedly improved. But if the very best engineers grow richer, everybody else, including all the other engineers, the trade union members and the arts graduates, must for a time see their prosperity grow less rapidly than would otherwise have been the case. This is a high hurdle for us all to get over, particularly in a society largely run by a collusion of arts graduates and trade unions, which has developed a marked predilection for living on its seed corn."

In a reference to the Finntston inquiry into the engineering profession, Professor Gosling said that nothing that could conceivably come out of this will change overnight the whole status and remuneration of engineers. "Maybe if engineers could be organised into a tight and monolithic union, and if they exploited their power ruthlessly and without regard for others, a change of that magnitude could be achieved. So far, engineers have for the most part not shown that willingness to unionize themselves, nor yet to their credit the extreme degree of ruthlessness and militancy. We may be sure that what they have not been prepared to organize themselves for, and force from society, they will not be given unasked, from some kind of altruistic recognition of merit. We do not live in that kind of world."

Japanese see opportunity in Prestel

Only a month after Prestel, the Post Office's viewdata system, started as a full public service (December 1979 issue, p55), the Japanese firm Sony displayed in London some equipment it has specially developed and manufactured for this information retrieval service. Shown by Sony (UK) Ltd at the Professional Viewdata Exhibition in November, it consists of two 14-inch colour television terminals using the familiar Trinitron tube (December 1979 issue, p597), one with a simple keypad and the other with a full alpha-numeric keyboard. Editing will be possible on these terminals. The equipment was developed at Tokyo and at the Sony (UK) market research centre at Bridgend, Wales, and is assembled at Bridgend.

Speaking of his company's involvement in Prestel, Mr Kazuo Imac, of the Commercial and Industrial Division, said: "As well as being the first Japanese company to develop Prestel equipment, we have considerable investment in viewdata technology and this Prestel equipment is only the first of many developments to come." It will be remarked that this Japanese company seems to show considerably more enthusiasm for the system than the television set manufacturers in the country where Prestel was born. The British set makers have been well behind schedule in supplying viewdata receivers ordered for the test service started in September 1978.

- Four companies, Mullard Ltd, General Instruments, Texas Instruments and VG Electronics, demonstrated the British teletext/viewdata system in Tokyo on December 10 and 11. The object of the presentation was to show the advantages of the system's components and sub-assemblies to Japanese setmakers who undertake, or plan to undertake, the manufacture of suitably-adapted tv receivers in the UK or Europe. The presentations were organised by the British Overseas Trade Board. The Sony terminals mentioned above in fact use Mullard viewdata integrated circuits.

Arts competition

The Royal Society of Arts is including an audio-visual presentation in its 1979/80 Design Bursaries Competition, which this time will offer awards to the value of £50,000. In the audio-visual presentation section, students and young designers are given the opportunity to develop their technical skills and to apply their visual imagination to animating a sequence of ideas by means of lasers, holograms or any other audio-visual method.

Further information may be obtained from the Royal Society of Arts, John Adam Street, Adelphi, London WC2N 6EZ.
A new microprocessor-controlled radio paging system, recently installed by Mulitone Electric Company Ltd at Frenchay Hospital near Bristol, includes synthesized speech. Mulitone's ACCESS 1800 paging terminal has enabled the hospital to organise several group alert sections of staff and considerably speed up the connection of one member of staff to another by telephone without using the switchboard staff.

ACCESS 1800 enables simultaneous calls to be made to as many as 12 team members in up to ten teams including the cardiac arrest team, a mobile resuscitation unit, and major accidents and fire teams. A member of staff can locate any receiver holder by simply dialling an access digit on any telephone, followed by the receiver number and the caller's extension number. He may then hang up the phone. A "beep" will be heard by the receiver holder who, upon pressing a button, will then hear a synthesized speech message giving the caller's extension number. The switchboard is not involved in this at all. The cardiac arrest team can be alerted and muster within seconds to a particular ward by a verbal message over their receivers. Similarly, the mobile resuscitation unit can usually be mobile in about 30 seconds from the origination of a call from the switchboard.

Thirty calls may be stacked in the computer's memory and automatically processed in sequence, even when temporarily interrupted by a priority call. Any temporary change of receiver number, for staff on call, can be programmed into the memory, which will automatically call the alternative number when the original, unobtainable number is dialled. If one doctor is unobtainable, a second on-call doctor can be summoned automatically in his place. This call transfer system eliminates the need to inform all staff of the change of number when any receiver is exchanged.

## Pseudodirect satellite speculation

Mr Pat Hawker of the IBA, speaking as a 'devil's advocate' – his own words – at a meeting of the Society of Cable Television Engineers on October 16, posed the question "What would happen if a commercial company in Luxembourg were to use a lower-power satellite positioned at 19°W (the orbital position allocated to Luxembourg, France, West Germany etc.) on the appropriate television channels and carrying a stream of bought-in programmes in the English language?" Speculating, he said, "Such transmissions would be picked up in the UK."

A small number of enthusiasts, according to Mr Hawker, would undoubtedly be capable of making their own equipment to receive these transmissions, either directly or for community distribution. For good quality reception, he said, they would need efficient satellite receive-only terminals with – for 12GHz – possibly 1.5, 2 or at most 3 metre dish aerials and theese, while requiring greater profile accuracy, would not necessarily be any more expensive than the 4.5 metre dishes used in the USA. According to a recent press report, he said, enthusiasts in North America had managed to receive TV from Westar and Satcom Systems, mainly to mining and timber camps. The report said that Canadian government officials had estimated that 50 unlicenced stations were involved, but their operators were not shut down because the government had difficulty in locating them and there was a genuine danger, according to an official, that the lumberjacks and miners would resist with force.

Reminding his audience that Radio Luxembourg had been carried on cable, Mr Hawker posed a second question, "Would British cable networks be permitted to distribute programmes from France, West Germany or Luxembourg?"

"It would need Home Office approval," he said, "but as Erik Jurgensen, chairman of the Netherlands Broadcasting Corporation has pointed out, there is Article 10 of the European Convention. This states: Everyone has the right to freedom of expression. This right shall include freedom to hold opinions and to receive and impart information and ideas without interference by public authority and regardless of frontiers. This Article shall not prevent States from requiring the licensing of broadcasting, television or cinema enterprises." Mr. Hawker suggested that such an Article posed legal questions which only experts could answer, and that it was possible that no two experts would agree on how this might be held to effect the distribution of programmes from other members of the EEC and where no copyright protection was sought. If cable operators could distribute programmes in such a manner, it would open the way for programmes and advertisements which did not conform to BBC or IBA conventions, guidelines and regulations – de-regulation of broadcasting.

Pat Hawker made it clear that the views expressed were entirely his own and not those of the IBA.

## CA for CB

The Consumers' Association have come out in favour of introducing a citizens' band radio service in the UK. In a one-page summary of the arguments for and against in the November issue of their magazine Which? they conclude: "Citizens Band radio in this country may not save many lives, nor may it be the best way of relaying traffic information. But it could provide an easy-to-use, relatively cheap method of communication that many people would find useful to have on occasions. We'd like to see it available here, if the problems of interference can be overcome."

The Association maintains in fact that the possibility of interference with other electronic equipment is the only serious argument against the introduction of c.b.: "The system of transmission used in most other countries would certainly cause interference, and shouldn't be used in the UK. There are other systems (e.g. v.h.f./f.m.) that would be much less troublesome – but the problem of interference is undoubtedly important, and more research is needed to ensure that any chosen system would be satisfactory."

## SERT move

German press considers higher frequencies for c.b.

Conditions on the 27MHz citizen's band are giving users cause for concern and every day there are new calls for better operating conditions. The German electronics journal, Funkchau, therefore carried out tests and compared some alternative bands to get acquainted with the advantages and disadvantages of each one as far as c.b. was concerned. Their findings showed that shifting c.b. into the v.h.f. or u.h.f. region could produce considerable advantages. It would cause much less interference to home-entertainment equipment, and the substantial increase in the channels which could be used would put an end to the present overcrowding.

Because special permission is required in West Germany to use frequencies around 900MHz, this band could not be included in the tests. Instead the 23cm amateur band (1295MHz), which has similar propagation characteristics, was considered, together with the 76cm (435MHz) band and the current 11cm (27MHz) band. On the 11cm band they found that there was always some interference from stations in countries further south and from industrial generators, while on v.h.f. and u.h.f. only noise could be heard. The tests were carried out using omnidirectional antennas with no gain and powers of less than 1W.

For propagation comparisons the different types of terrain were considered. Munich was chosen as a heavily built-up municipality, the Upper-Bavarian lakes were used for propagation over areas of water, and the hilly country in the north of Munich enabled trials to be done over undulating terrain. As expected, the poorest ranges were observed in Munich, the Upper-Bavarian lakes, and the hilly country in the north of Munich enabled trials to be done over undulating terrain. As expected, the poorest ranges were observed in Munich, the Upper-Bavarian lakes, and the hilly country in the north of Munich enabled trials to be done over undulating terrain. The larger the purchase, the more time the people were willing to invest to ensure the best possible pre-sale inspection of a particular product. Price did not seem to be a critical factor as long as the service was available.

The consulting firm compared the owners of systems costing $1400 or more with owners of systems costing less than $800, and found that 72.7% of the owners of high-priced systems spent at least a month selecting component brands, but only 37.2% of low-priced owners spent as much time. Two factors accounted for this, according to the firm. Firstly, the larger the purchase, the more time the people were willing to invest to ensure the best possible pre-sale inspection of a particular product. Price did not seem to be a critical factor as long as the service was available.

The consulting firm compared the owners of systems costing $1400 or more with owners of systems costing less than $800, and found that 72.7% of the owners of high-priced systems spent at least a month selecting component brands, but only 37.2% of low-priced systems owners spent as much time. Two factors accounted for this, according to the firm. Firstly, the larger the purchase, the more time the people were willing to spend on pre-sale inspection of a particular product. Price did not seem to be a critical factor as long as the service was available.

The v.h.f. sound broadcasting band in Region 1, at present 87.5 MHz to 100 MHz, will almost certainly be extended upward to 104 MHz as a result of a decision at WARC 79, we understand. In Britain, for example, this will allow an extension of BBC and IBA local radio services, will avoid the necessity for sharing between BBC Radio 1 and Radio 2, and will reduce the need for some Radio 3 and Radio 4 programs to be displaced by educational broadcasts (see article by D. P. Leggatt in this issue). To permit this extension of broadcasting, the police radio communications at present occupying 106-108 MHz will have to be moved elsewhere but it is not yet known what frequencies are likely to be used.

Apart from this loss, mobile radio in Region 1 has benefited overall from the decisions at WARC 79, where the time of going to press we understand from unofficial sources that this service will be allocated sections of the spectrum which it has not had the use of before.

In Britain one of these sections could well be part of Band I (47-68 MHz) which is at present used for 405-line television broadcasting by both the BBC and IBA, but what happens here will in fact be an internal UK decision made by the Home Office. The BBC hint that the remainder of Band 1 could perhaps be used for the new direct digital radio broadcasts.

It seems there has been something of a conflict at WARC 79 between the USA and Canada over the allocations for services in the u.h.f. bands in Region 2. Because the heavily populated areas of Canada are close to the US border it is obviously necessary that the two countries use these bands in the same manner in an interference protocol. Canada wants to use the u.h.f. bands exclusively for television broadcasting (the present exclusive allocation for this service being 470-890 MHz), partly because it has a large number of language groups to cater for both native peoples and immigrants, while the USA wants a more flexible arrangement in which they are shared with mobile radio. For example, the land mobile radio community in the USA recommended a co-equal mobile and broadcasting allocation between 470 and 806 MHz to provide flexibility in the international table of allocations and leave the domestic u.h.f. television allocation intact to the degree that is necessary. At the time of going to press we understand that the Canadian case is getting strong support from other delegations, but the issue is not yet settled.

Impulse buying by hi-fi customers

A consulting firm, Venture Development Corporation, from Massachusetts, claims that there is a link between the time spent by a customer selecting a hi-fi product and the amount of money spent by the manufacturer. The Corporation says that hi-fi buyers sometimes have a lot in common with new car buyers in that they need a lot of information, they often price shop, and they frequently require substantial psychological support. At other times, it says, the hi-fi buyers behave like chewing-gum buyers, needing very little time to make a brand selection and being completely pre-sold on a particular product. Price did not seem to be a critical factor as long as the merchandise was available.

The consulting firm compared the owners of systems costing $1400 or more with owners of systems costing less than $800, and found that 72.7% of the owners of high-priced systems spent at least a month selecting component brands, but only 37.2% of low-priced owners spent as much time. Two factors accounted for this, according to the firm. Firstly, the larger the purchase, the more time the people were willing to invest to ensure the best possible pre-sale inspection of a particular product. Price did not seem to be a critical factor as long as the service was available.

The consulting firm compared the owners of systems costing $1400 or more with owners of systems costing less than $800, and found that 72.7% of the owners of high-priced systems spent at least a month selecting component brands, but only 37.2% of low-priced owners spent as much time. Two factors accounted for this, according to the firm. Firstly, the larger the purchase, the more time the people were willing to invest to ensure the best possible pre-sale inspection of a particular product. Price did not seem to be a critical factor as long as the service was available.

V.o.r. computer

Walter Freter, who is a member of the Munich gliding club and the Siemens (Munich) amateur electronics group, has developed an automatic v.h.f. omni-range (v.o.r.) receiver, using a microprocessor to calculate and display the required compass bearing. Normally, the pilot of an aircraft is required to look up the frequency of the selected v.o.r. beacon, tune his navigation receiver and set the omni-bearing selector, observing the left/right indications of the display and adjusting the heading to keep the needle centered.

Freter's design avoids all this by virtue of its programmed table of all European frequencies, and the power of its microprocessor to tune the navigation receiver to the beacon transmission. The processor will calculate the required compass course to fly, using the left/right information which would normally be displayed, and will show the continuously up-dated compass course on a numerical display on the control panel.

Siemens say that several manufacturers (not Siemens?) have shown interest in the equipment.
Past the peak?
By the time these words are published it appears that the peak of Solar Cycle 21 may have passed — although this will not be known for certainty until mid-1980. Long-distance paths on frequencies up to and above 50MHz reappeared in mid-October with many cross-bands (50MHz/28MHz) amateur contacts between Europe and North America. The season appears to have opened on October 18 when American 50MHz signals were received in West Germany. The amateur station, G3SSO, operated by personnel at GCHO, Cheltenham is thought to have been the first British station to make such a contact this autumn, working Canadian VE1AVX on October 19. RSGB advises that 28.875 — 28.895MHz has become established as the frequencies for cross-band s.s.b. operation with 50MHz North American stations.

The sunspot peak has been reached sooner than expected, although if the cycle follows the usual pattern, the decline will be considerably slower and several more seasons of 28MHz (and possibly 50MHz) long-distance "openings" appear likely. The past decade has shown once again the difficulties experienced by radio physicists in accurately predicting, except in the short-term, the dates of maxima and minima and the level of maximum sunspot activity. Perhaps the most interesting new theories to emerge recently are those of Professor R. H. Dicke of Princeton University who believes that the cycles are accurately timed deep inside the sun by a form of magneto-fluid oscillator but take varying times for the magnetic fields to reach the surface; he also espouses the theory that the true solar cycle last 22 years with a reversal of magnetic field polarity at 11-year intervals.

The amateur radio market
Throughout the 1970s, the amateur radio equipment market has been increasingly dominated by Japanese firms whose products are now used by the majority of amateurs in most parts of the world (including many of the Eastern European countries although not in the USSR where much of the equipment continues to be described as "home made"). Although during the decade the total amateur market for equipment has risen sharply, few of the old-established British or American firms have come through unscathed from the torrent of equipment from Yaesu, Trto, Kenwood, Icom (Inoue), FDK etc. Some firms have adopted the policy of continuing to manufacture established designs but without introducing new equipment involving heavy development costs; others have attempted to keep ahead of the Japanese designs, although this is proving an increasingly difficult and hazardous policy and there are unconfirmed rumours that one of the more innovative American firms may soon be a further casualty of the trade war.

In brief
The USSR is planning to launch an RS3 amateur radio satellite during spring or summer 1980. . . . King Hussein of Jordan (JY1 and G5ATM) recently met 45 members of the Radio Society of Harrow at a reception given by the Mayor, Richard Thurlow, G3WW has become the third amateur in the world to obtain a CQDX award for working 100 different countries on slow-scan television (No. 1 was W8YEH, No. 2 G3JAD) . . . Japan is now issuing amateur call-ins in the JM prefix series . . . The IFF Committee of the RSGB has recommended 145.650MHz as a "calling frequency" for amplitude-modulated transmissions.

PAT HAWKER G3VA

Foxhunting
One of the aspects of amateur radio that continue to attract a small but faithful and enthusiastic following is the art of locating hidden stations by the use of direction-finding receivers. For many years the RSGB has organized a series of "qualifying events" leading to a "national final" based on transmissions in the 1.8MHz amateur band. For the qualifying events, competitors are expected to locate two different hidden transmitters within about a ten-mile radius of the starting point, but for the national final it is a question of finding three stations in a matter of a few hours. The 1979 winner, Eric Mollart of the Mid-Thames Club, took just over two hours to do this, in spite of the many ingenious difficulties that tend to get built into the course as a result of past experience. For example, a technique which has been used at several events is to have an extremely long aerial which even when located may apparently lead nowhere. At Wolverhampton, in one of the 1979 qualifying events, for instance, one transmitter had several hundred yards of fine wire suspended in the trees as aerial, but with a final length tacked under the horizontal rails of a fence, eventually leading to gorse bushes in which the operator and his transmitter were concealed. The d/t bearings thus led the competitors only to a wooden fence with no sign of the concealed station.

A rather different form of 'foxhunting' using the 144MHz band, is also organized, for example, by the UK FM Group (London), though one gains the impression that care is taken to ensure that it can be combined with the objectives of the Campaign for Real Ale!
NOBODY CAN DO IT LIKE SABTRONICS CAN. NOBODY!

We pioneered the first benchtop professional quality Digital Multimeter at lowest price anywhere. We sold tens of thousands of units around the world and are still selling. Nobody has been able to beat our price/performance ratio.

Now we are making the impossible again. A 3½ Digit LCD handheld professional quality multimeter at an absolute low price of only £59.95*. But don’t get sold yet, wait till you have read further.

QUALITY, PERFORMANCE AND ACCURACY

The model 2035A offers you long term accuracy with a laser trimmed resistor network, a stable bandgap reference element, and single chip LSI circuitry. Expert circuit design and board layout have reduced component count to the optimum minimum. With 32 ranges** and 6 functions, you can measure AC or DC volts from 100 µV to 1000 V; AC and DC current from 0.1 µA to 2 A; resistance from 0.1 Ω to 20 MΩ. Typical DCV accuracy of 0.1% ± 1 digit.

OVERLOAD PROTECTION FOR GREATER SAFETY

Input overload is protected to 1000 V (DC + AC peak). Ohm and current ranges are fuse protected. These features, plus a high immunity to voltage transients, protect the 2035A against uncertain input conditions. Input and battery eliminator jacks are recessed to ad to operational safety.

Wait don’t order it until you have read further.

OTHER FEATURES FOR GREATER CONVENIENCE AND FLEXIBILITY

Automatic zero: Automatic polarity (+ implied, – shown); Large ½” LCD readout with automatic decimal and low battery indicator; uses inexpensive 9 V transistor battery; 200 hours battery life; push button switches for easy operation; light weight (only 11 oz); fits easily into a jacket pocket; specially designed injection moulded rugged plastic case in beautiful grey beach colour with matching switch buttons; only 2 calibration controls. Whether you are professional or amateur, you should check out the Model 2035A for yourself.

BRIEF SPECIFICATIONS MODEL 2035A & 2037A

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Volts</td>
<td>5 ranges 100 µV to 1000 V</td>
</tr>
<tr>
<td>AC Volts</td>
<td>5 ranges 100 µV to 1000 V</td>
</tr>
<tr>
<td>DC Current</td>
<td>5 ranges 0.1 µA to 2000A</td>
</tr>
<tr>
<td>AC Current</td>
<td>5 ranges 0.1 µA to 2000A</td>
</tr>
<tr>
<td>High Ohms</td>
<td>6 ranges 0.1 Ω to 20 MΩ</td>
</tr>
<tr>
<td>Low Ohms</td>
<td>6 ranges 0.1 Ω to 20 MΩ</td>
</tr>
<tr>
<td>Temperature**</td>
<td>2 ranges -40°C to +100°C</td>
</tr>
<tr>
<td>Input impedance</td>
<td>10 MΩ – DCV and '0 MΩ/10pf – ACV</td>
</tr>
<tr>
<td>Burden voltage</td>
<td>100 mV at 1000 display</td>
</tr>
<tr>
<td>Over voltage protection</td>
<td>1000 (DC + AC peak)</td>
</tr>
<tr>
<td>Over current protection</td>
<td>2x250 V fuse</td>
</tr>
<tr>
<td>Ohm overload protection</td>
<td>250V DC or AC peak</td>
</tr>
<tr>
<td>AC Frequency response</td>
<td>40 Hz to 5 kHz</td>
</tr>
<tr>
<td>Battery life (hrs)</td>
<td>200 Hours typical with alkaline battery</td>
</tr>
<tr>
<td>Weight</td>
<td>11.6 oz (319 gms) without battery</td>
</tr>
<tr>
<td>Accessories supplied</td>
<td>Test leads</td>
</tr>
<tr>
<td>Temperature Co-eff.</td>
<td>0.1 x °C</td>
</tr>
<tr>
<td>Display</td>
<td>½” (13 mm) Character, 3½ Digit Liquid Crystal display with low battery indicator and +/– sign</td>
</tr>
<tr>
<td>Case colour</td>
<td>Light grey with matching buttons</td>
</tr>
<tr>
<td>Case Material</td>
<td>ABS Rugged plastic with texture</td>
</tr>
<tr>
<td>Optional</td>
<td>Touch and hold probes for hard to reach measuring areas</td>
</tr>
</tbody>
</table>

ORDER YOURS NOW!

* Model 2035A as shown.
** Model 2037A with temperature measuring circuitry £69.95.

Send your orders with payment to:

TIMWOOD LTD.
14 Albert Street, Cowes Island of Wight, England: Telex 86892

Please send me by parcel post:
- Model 2035A
- Model 2037A
- Model THP 20

Touch and Hold probe at £ 9.95

Plus VAT at 15% and p.p. £ 3.50 each

Total enclosed herewith:

Name:
Address:
City: Postal Code:

Making Performance Affordable

sabtronics INTERNATIONAL INC.

WW — 018 FOR FURTHER DETAILS
**Micro-soldering!**

**ANTEX TCSU 1 & CTC**

...its the perfect kit

<table>
<thead>
<tr>
<th>Model TCSU1</th>
<th>Micro-Soldering Station</th>
<th>Model CX 17 watts - 230 volts</th>
<th>Model X25 25 watts - 230 volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate pin point temperature control between 65° and 400°C. Heating element and sensor built in tip of the iron for fast response. Interchangeable slide-on bits from 4.7 mm (3/16&quot;) down to 0.5 mm. Zero voltage switching, no spikes. No magnetic field, no leakage. Supplied with miniature CTC (35-40 watt) iron or XTC (50 watt). TCSU1 soldering station with XTC or CTC iron £36 (6.44). Nett to industry.</td>
<td>A miniature iron with the element enclosed first in a ceramic shaft, then in stainless steel. Virtually leak-free. Only 7¹/₂&quot; long. Fitted with a 3/32&quot; bit. £4.20 (36) Range of 5 other bits available from 3⁄₃₂&quot; down to 3⁄₆₄&quot;. Also available for 24 volts.</td>
<td>A general purpose iron also with a ceramic and steel shaft to give you toughness combined with near-perfect insulation. Fitted with 1/8&quot; bit and priced at £4.20 (56) Range of 4 other bits available. Also available in 24 volts.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model SK3 Kit</th>
<th>Model SK4 Kit</th>
<th>Model SK1</th>
<th>Model MLX 12 volts</th>
<th>ST3 Stand.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contains both the model CX230 soldering iron and the stand ST3. Priced at £6.70 (1.49). It makes an excellent present for the radio amateur or hobbyist.</td>
<td>With the model X25/240 general purpose iron and the ST3 stand, this kit is a must for every toolkit in the home. Priced at £6.70 (1.49).</td>
<td>This kit contains a 15-watt miniature soldering iron, complete with 2 spare bits, a coil of solder, a heat sink and a booklet. How to Solder: Priced at £5.95 (1.53).</td>
<td>The soldering iron in this kit can be operated from any ordinary car battery. It is fitted with 10 feet flexible cable and battery clips. Packed in a strong plastic envelope it can be left in a car, a boat or a caravan ready for soldering in the field. Price £4.95 (1.14).</td>
<td>A strong chromium plated steel spring screwed into a plastic base of high grade insulating material provides a safe and handy receptacle for all ANTEX models soldering irons. Priced at £1.50 (51).</td>
</tr>
</tbody>
</table>

* VAT + P&P as shown in brackets ( )

[ANTEX](#)

Stocked by many wholesalers and retailers or direct from us if you are desperate.

Please send me the Antex colour brochure. ☐ I enclose cheque/P.O./Giro No. 256 1000 ☐

Name: ____________________________

Address: ____________________________

Antex Ltd. Freepost, Plymouth PL 1 18R Tel. 0752 67377

WWW — 957 FOR FURTHER DETAILS
Despite the many advantages of the parallel-tracking record deck, the high cost of owning one deters all but the well-heeled few. This prompted the design and construction of a pick-up arm and control system with simplicity of construction specifically in mind. By avoiding complex engineering it is possible to construct the design with non-specialized tools in about 40 hours and for a fraction of the cost of a commercial item.

WHilst access to a lathe makes construction quicker and easier, it is quite feasible to make all the parts with tools normally found in a small workshop. An electric drill and stand, some BA taps and dies and a selection of metal cutting files and saws are however essential.

Both the tracking arm and reference arms are made of thin-wall Duralumin tube, readily available from aeromodel shops. One end of the tracking arm is plugged with a tight fitting brass rod and glued into place with Araldite. This serves to strengthen the fragile tube where the vertical pivot goes through, and provides some degree of counterbalance.

Constructors will notice that the positions of horizontal and vertical pivots have been transposed, compared with the conventional arrangement. Having the vertical pivot on the tracking arm is not good practice on a conventional arm of course, but is permissible here because the tracking arm on a parallel-tracking machine does not swing on the pivot more than half a degree, whereas the conventional must swing through a wide angle. The change enables an unusual design of horizontal pivot to be used — one that allows the tracking arm assembly to be easily taken off for transport or adjustment, without having to dismantle anything, and allows replacement without having to re-align it with the reference arm. There are other advantages to this design, namely: it is much easier to make than the usual spindle type, it is virtually friction-free, needs no lubrication, has no play due to bearing clearances and does not introduce play due to wear.

Avoiding play is important because the control system cannot distinguish between play and tracking error. It is for this reason too that the sliding platform is spring loaded, so that any running clearance in the track is taken up. Diagram 3 shows the horizontal pivot design. Two adjustable screwed pivot points rest on top of two support pillars, one in a slot and the other in a conical cup on the opposite side of the gimbal ring. The arrangement is quite stable, provided the two pivots are far enough apart.

The vertical pivot is straightforward. Adjustment for inclination is by means of the brass plate which forms the upper bearing, and which can be moved around on the flat top of the gimbal ring to the correct position.

The track in Fig. 4 can be cut with a small hacksaw and then filed to the exact dimensions. It is worth spending some time ensuring the track is straight, as the whole concept depends on the reference arm maintaining a constant angle to the tracked radius of the record. Also, it is essential that the carriage slides without any hard spots. It is not necessary to produce a perfect fit, as a small amount of slack will be taken up by the spring-loading.

To reduce wear, a few drops of clock oil (which has good non-gumming properties) can be applied to the vertical pivot, the lead screw and the running surfaces parallel track. Don't use mineral oil sold as general-purpose or light machine oil because it thickens to a gum after a while.

The hinge pivot holder part 14 is soldered in position to the lower plate, part 11. The best way of doing this is to pre-solder both plate and holder; with a length of 6BA rod through both holders, position them the correct distance apart and place them on the plate, and gently heat the plate from below. It is then quite easy to move the two holders into the exact position while the solder is molten; excess solder will cause holders to float out of place, so use the bare minimum.

For the sake of simplicity, the counterweight on the prototype was made from a piece of 1in diameter brass bar drilled through the centre and decoupled with a foam rubber insert. However, the comments by Randhawa on counterweights (WW April 1978 pages 63-8) should be noted by constructors as a better design is probably possible. The main requirement for the counterweight is that it should give neutral equilibrium with the chosen cartridge when the tracking arm is positioned about half way up the vertical pivot.

The photocell holder was fixed from a piece of solid engineering-grade p.v.c. which is particularly easy to use, but
other reinforced or filled plastics such as Tufnol would probably be suitable. The two photodiodes were cemented to the holder with Araldite. An aluminium shim separated the diodes, this being necessary to prevent light from one diode reaching the other by reflections via the transparent sides of the BPW34. The size of the shim is not critical but for good light cut-off between the diodes it should project ¼ in or so all round.

A shroud was made from the same shim material to clip onto the holder. It is best if this is eventually fixed in place with Araldite when the system has been proved to work satisfactorily. Beer and soft drink cans are a good source of strong, thin aluminium. It is important that the weight of the holder and shroud is kept as low as possible to preserve the low inertia of the tracking arm.

Regarding the finish and appearance of the self-made metal parts, both polished brass and aluminium can be protected from tarnish by Letraset aerosol spray No. 101. This provides quite a tough, abrasion-resistant transparent film which is almost undetectable.

Fig. 3. Improved design of upper assembly differs from author's original as shown in photographs. Note that spigot on part 22 in Fig. 4 has projecting part filed to fit loosely in slider, part 19.

Fig. 4. Lower assembly comprised lead screw arrangements as shown, together with drive mechanism pictured in December issue.
Wiring to the cartridge, opto-switch and filament bulb is made with 3x45swg Litz wire. There seems to be no readily available alternative to Litz wire which is flexible enough for the job. The cartridge and opto-switch wiring is carried inside the tubular tracking arm, exits near the vertical pivot and is firmly clipped to the back of the upper platform. From here the cartridge wiring is kept apart and carried in p.v.c. sleeving to a 16 pin dual in-line plug and socket on the plinth. The opto-switch wiring is combined with the wiring from the bulb and carried in separate p.v.c. sleeving to the socket. This arrangement gives a neat and symmetrical layout and helps prevent the lead-out wires from fouling the gimbals.

The T1¼ filament bulb is rated at 24V 35mA and is run directly from the 20V supply. When under-run like this it has a very long life but does not emit much white light. This hardly matters, as the response of the BPW34 diode lies mainly in the infra-red and matches the bulb’s output quite well. An infrared-emitting diode could probably be used instead. The efficiency of the reference arm tube can be improved by polishing the inside surface — bright aluminium has a high reflectivity in the infra-red register.

The T1¼ bulb is the only commonly available bulb which will insert into the standard ¼in diameter tube. It should not be free to move when in place, and wrapping a small piece of adhesive tape round the plastic body of the bulb will make it a firm push fit. Insert so that the filament is vertical.

The cassette motor used in the prototype drew 60 mA on normal play, rising only a few milliamps when running on full rated voltage, but drawing 500 mA when stalled. The output transistors need to be mounted on heat dissipators to avoid overheating when the motor is stalled; though stalling should never take place in theory, it is not unlikely during testing and setting up. Similarly, the short-circuit protection resistor in the BD135 collector circuit should be generously rated.

The relay used was a sensitive reed-switch type with a coil wound specifically for this circuit, but a standard 12V relay could be used in conjunction with a series ballast resistor. The 47kΩ adjustment potentiometer should be set so that in normal ambient light conditions and with the light slit off the face of the photodiodes, the relay will close. High ambient light conditions may swamp the diodes despite the shroud, and prevent the relay from closing. However this is never likely to occur if the unit is used sensibly, for example away from bright sunlight. A heavily-tinted or even light-tight cover on the record player is recommended.

The power supply for the turntable, servo motor and electronics is a 20V stabilized unit capable of giving 1A (my turntable required 350mA peak). As the design of the power supply is by no
means critical it is left to the discretion of the constructor. On the prototype, which had the mains transformer bolted to the plinth, it was found that mechanical vibration was finding its way to the tracking arm to give 50Hz hum. Mounting the transformer on rubber grommets cured the problem, but it is perhaps a better solution to have a power supply unit which is separate from the plinth. At least one commercial unit has adopted this approach.

Setting up

With the tracking arm fully assembled with cartridge and counterweight, raise or lower the vertical pivot to produce neutral equilibrium. The horizontal pivots can also be adjusted to help produce equilibrium, and then set in place with Locite thread-locking compound. With the cartridge resting on a discarded record, the level of the opto-switch is now adjusted to be in line with the light beam, by means of the spacing washer (Fig. 1, part 1), which may have to be filed down or added to in order to achieve this.

A template to check the accuracy of tracking is essential. A sheet of thin aluminium is cut to suit Fig. 6, the corners being checked against an engineer's set-square. Find distance d, which will depend on cartridge position, with the template resting firmly against the front edge of the parallel track. Scribe a radius line at distance d parallel to the front edge of the template, left to right, and then using the set-square scribe several lines for reference purposes at right angles to this radius. Adjust the reference arm by means of the screws securing it to the upper platform so that it is parallel to one of the reference lines on the template. Track the arm fast forward and check that the reference arm remains parallel to the various other reference lines. If there is a discrepancy, the parallel track is not straight, and should be re-filed; fortunately the eye has very good perception of parallelism. When this is satisfactory, and with the opto-switch disconnected, play a record, setting the voltage to the servo motor so that the tracking arm keeps pace with the record, very approximately. Note this voltage.

Now connect the opto-switch and with the record stationary and the sliding platform disconnected from the lead screw, bring the tracking arm parallel to the reference arm. The meter reading should now correspond to that obtained with the opto-switch disconnected. If it is not then either the reference arm must be moved sideways to correct this (and then re-aligned of course) or the opto-switch must be moved in relation to the tracking arm.

As a final check, observe the tracking arm from above as it plays a record properly, and note the changes in meter reading as the servo-system corrects tracking errors. Now is the time to adjust the sensitivity by means of R4 and the maximum voltage to the motor (if necessary), by changing the 13V limiting Zener diode for a higher or lower value as required. The prototype was set to correct an error of 0.2 degrees in about 0.5 seconds, which I found to be adequate. The time taken depends not only on the sensitivity but on how hard one is prepared to drive the servo motor.

The amount of noise and vibration generated is naturally small in motors designed for cassette decks, but in the prototype, which used a 6V motor, 5.5V was the optimum voltage, before noise from this motor overtook noise from the turntable motor.

S. G. Brown, F.R.S.

At the time of his death shortly after the end of the second world war Sidney George Brown F.R.S. had more than 1000 patents for inventions. These included the gyrocompass used by the Admiralty during the first world war, when they wanted to avoid adopting the American Sperry equipment; the tuned-reed headphones, which were so sensitive to weak signals that they were a standard issue for wireless operators; and a loudspeaker. Brown was the son of a family which had already won fame in the USA for proposing methods of preventing a repetition of the fire which destroyed much of Chicago in the eighteenth century.

Mr. F. P. Thomson, biographer of A. D. Blumlein, is now preparing a biography of Brown. He would like to hear from people who knew the Brown family in the USA or worked for S. G. Brown or his company in Britain and who could give or lend papers, notes, photographs, etc. Mr. Thomson's address is 39 Church Road, Watford, Herts WD1 3PY.

Editorial writer for Wireless World

Wireless World needs a new person on its editorial staff. Technical experience in electronics and / or communications and an ability to write are essential. The work is varied and includes writing technical news reports and other material, attending meetings, exhibitions, press conferences and other events, some abroad, and editing contributed technical articles. A good deal of freedom will be given to a person who shows ability and responsibility. Preferred age range 25 to 35. Write to: The Editor, Wireless World, Dorset House, Stamford Street, London SE1 8LU.
C.m.o.s. compatible piezo sounder

Piezo electric sounders are efficient and reliable devices which contain a ceramic transducer and a switching transistor. Although the average current drain is 50mA, the sounder functions as a class C blocking oscillator where the current is pulsed with a peak of 800mA.

It is difficult to switch such a current directly with C.m.o.s. or t.t.l. and a switching transistor would need a wasteful 50mA of base current to ensure saturation. Although v.m.o.s. transistors need no drive current they are relatively expensive and have a significant saturation voltage. The simplest solution is a small thyristor which requires a maximum gate current of only 0.2mA. Because the anode current falls to zero between each pulse, the thyristor will turn off unless gate current is present. No gate to cathode resistor is required because a logic low output clamps the gate off.

C. Stephens
Woodbridge
Suffolk

Variable current-limiting supply

This simple power supply offers variable current limiting from 10mA to 3A by using the pass transistor to offset the \( V_b \) of the protection transistor. Resistor \( R_1 \) can have any reasonable value and omitting \( R_2 \) allows unlimited maximum current. In the alternative circuit, \( R_3 \) and \( D_1 \) must be chosen for the maximum current required.

D. Rawson-Harris
Stockport
Cheshire

Thermistor replacement for oscillators

The R53 thermistor is often used in oscillator circuits to stabilize the output and reduce distortion. Unfortunately the device is reasonably expensive and intolerant of accidental power surges. This circuit provides a more stable output than the bridge driven rectifier previously published in Wireless World.

In the bipolar version the transistor and diodes can be any general purpose silicon types. The output level can be raised by connecting a Zener diode in series with the emitter. As the output of the oscillator is stabilized to 2.5V ± 5% it should be at least 3.5V r.m.s. before limiting.

If low distortion is important, a similar circuit with a f.e.t. can be used as shown. This does, however, require an oscillator output which at least equals \( V_{pe} \), i.e. 8V r.m.s. for a 2N3820.

K. Dynan
London

Continued on page 94
Improved transistor tester

This transistor tester is based on a circuit by N. E. Thomas in the March 1977 issue of Wireless World. Any unknown bipolar transistor can be placed in the test socket and the transistor leads can be in any order. The ring of three oscillators produces a three-phase waveform which switches either two green and one red LED, or two red and one green for a p-n-p type. Other displays indicate a faulty device. By switching S1 to the appropriate position, the base can be biased via the correct test socket switch. When this has been identified, increasing the base current by reducing the variable resistance turns the collector LED on first so all three leads are identified. Noting the position of the wiper and the brightness of the LED gives an indication of the transistors' gain.

M. Odyniec
Podlaska
Poland

12W class A power amplifier

Almost all of the published audio power amplifier designs have had outputs in excess of 30W. However, there are still many applications where a high quality amplifier with less output is needed.

This circuit uses a class A output stage with feedback control of the quiescent current. Two independent amplifiers throughout simplify the circuit and provide a 3 dB improvement in the signal to noise ratio. The necessary trimming of resistors R1 to R4 can be achieved by temporarily connecting them in a bridge arrangement. Specification of the prototype is shown below.

- Power output into 8Ω: 12.5W
- Frequency response: 5Hz to 225kHz (~3dB)
- Output slew rate: 10V/μs
- Distortion: <0.02%
- (5Hz to 20kHz, 0 to 10W)
- Hum (rel. full power): -85dB
- Noise excluding hum: -103dB
- Component: Unconditional
- Output offset without nailing network: 19mV

N. Pollock
Victoria
Australia

CIRCUIT IDEAS
Now, the complete MK 14 micro-computer system from Science of Cambridge

VDU MODULE. £33.75 (£26.85 without character generator) inc. p & p.
Display up to 1K memory (32 lines x 16 chars. with character generator; or 4096 spot positions in graphics mode) on UHF domestic TV. Eurocard-sized module includes UHF modulator, runs on single 5V supply. Complete ascii upper-case character set can be mixed with graphics.

Delivers 8V at 600 mA from 220/240 V mains - sufficient to drive all modules shown here simultaneously. Sealed plastic case, BS-approved.

Widely-reviewed microcomputer kit with hexadecimal keyboard, display, 8 x 512-byte PROM, 256-byte RAM, and optional 16-lines I/O plus further 128 bytes of RAM. Supplied with free manual to cover operations of all types - from games to basic maths to electronics design. Manual contains programs plus instructions for creating valuable personal programs. Also a superb education and training aid - an ideal introduction to computer technology. Designed for fast, easy assembly; supplied with step-by-step instructions.

Science of Cambridge Ltd
6 Kings Parade, Cambridge, CAMBS, CB2 1SN.
Tel: 0223 311458.

CASSETTE INTERFACE MODULE. £7.25, inc. p & p.
Store and retrieve programs on any cassette recorder. Use for serial transmission down single line at up to 110 baud (teletype speed), e.g. over telephone line, and to communicate between two or more MK 14s.

PROM PROGRAMMER.
Use to transfer your own program developed and debugged on the MK 14 RAM to PROM (74S571) to replace SC10S monitor for special applications, e.g. model railway control. Software allows editing and verifying.

To order, complete coupon and post to Science of Cambridge
Return as received within 14 days for full money refund if not completely satisfied.

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.

Please send me:

☑ MK 14 standard kit @ £46.55.
☑ Extra RAM @ £4.14 per pair.
☑ RAM I/O device @ £8.97.
☑ VDU module including character generator @ £33.75.
☑ VDU module without character generator @ £26.85.

I enclose cheque/MO/PO for £ (total).

Name:
Address (please print):

(All prices include p+p and VAT.)
FROM HERE...

TO HERE...

NEED NO LONGER TAKE AN ETERNITY OR COST A FORTUNE

Time is money and with conventional custom designs, the process from the detailed logic design through to layout of the chip can take 6 to 9 months of total engineer involvement.

The following stages of mask making, prototypes, and test programmes still have to take place. In this age of rapidly changing technology, two years to production is an eternity in both commercial and economical sense. This is why GEC Semiconductors have developed the Cellinos system, which allows customers to benefit from special LSI designs with a much lower starting fee and in a much shorter time.

Once we have approved logic diagrams, our computer will process the design through a series of programmes, which will layout the circuit onto the chip. The whole sequence will not take more than a few hours of computer and engineering time. The turn round time from the approved logic to samples is within 12 weeks. Hardly an eternity...

If you feel the Cellinos system can help with your problem, please write or phone our sales office for further details or even a demonstration.

GECS Semiconductors Limited
East Lane, Wembley
Middlesex HA9 7PP
Tel: 01-904 9303 Telex 28817.

WW — 051 FOR FURTHER DETAILS
HURRAH FOR TELETEXT

May I, as a television dealer, air my views concerning teletext, which seems to have dominated Letters to the Editor in recent issues?

I feel the first point I must make concerns the letter from Mr Williams in the October 1979 issue. He complains on the one hand that there are not enough pages, and then goes on to add that if there were, he would not have time to read them all. Spelling and punctuation errors, he says, occur frequently but in my opinion they do not occur as often as in some newspapers.

Regarding access time, it takes on average 12 seconds for a page to appear, a little longer on Oracle — not bad for a system that has to ride piggyback on a few borrowed lines.

Teletext is not fading away as some people would have you believe. We dealers must take a lot of the blame for its slow start. My teletext customers are extremely pleased with their sets, which could be due to the fact that we spend over an hour demonstrating the full teletext facilities to them.

I keep wondering why some people wish to change the format of teletext. As far as I am concerned, it offers a very good and comprehensive service the way it is. Teletext sales are on the increase and I feel there is a healthy market developing for the future. So hands off our teletext service, it is the best thing in television for years!

R. J. Timms
Swadlincote
Burringham-Trent

SIDE BANDS AS PHASORS

The opening remarks of J. M. Osborne’s excellent article “Sidebands as Phasors” (September 1979) suggest that Bessel functions are necessary to show that the sidebands of a frequency modulated wave extend to infinity. This is not strictly true for their use is merely a mathematical convenience. The same result can be achieved using mainly traditional trigonometrical methods.

A general expression for a frequency modulated wave (see Terman’s “Electronic and Radio Engineering”, page 586) is:

\[ e = A \sin (\omega_1 t + m \sin \omega_2 t) \]

where \( \omega_1 \) and \( \omega_2 \) are 2\( \pi \) and the carrier and \( 2\pi \times x \) the modulation frequency respectively and \( m \) is the modulation index. This expression can be expanded using the well known “sine—sum” formula to

\[ e = A \left[ \sin \omega_1 t \cos (m \sin \omega_2 t) + \cos \omega_1 t \sin (m \sin \omega_2 t) \right] \]

Thus the problem now turns on finding a simplification for the terms \( \cos (m \sin \omega_2 t) \) and \( \sin (m \sin \omega_2 t) \) and here we must depart into the realm of simple differentiation. Since \( \sin \) and \( \cos \) each can be expanded in series form (see, for example, Saxelby “A Course in Practical Mathematics”, page 221) so that:

\[ \sin x = -x^3 / 3! + x^5 / 5! - \ldots \]

and \( \cos x = 1 - x^2 / 2! + x^4 / 4! - \ldots \)

Substituting \( m \sin \omega_2 t \) for \( x \) in these two series we arrive at two other series, one with odd powers of \( \sin \omega_2 t \), and the other with a zero frequency component and even powers of \( \sin \omega_2 t \). Each has related coefficients in powers of \( m \).

The individual terms of each series can be further expanded into fundamental and harmonic components of \( \omega_2 \). The even indices will produce cosine terms of even harmonics and the odd indices harmonic sine terms, the highest harmonic in a particular term being equal to the order of the index.

For example:

\[ \sin \omega_2 t = \frac{2}{3} (\sin \omega_2 t - \sin 3 \omega_2 t) \]

and \( \sin \omega_2 t = \frac{1}{4} (3 \cos 3 \omega_2 t + \cos 4 \omega_2 t) \)

It is now necessary to collect together terms of similar frequencies and to consolidate their coefficients. We have to substitute these terms back into the original expansion where the cosine terms will be multiplied by \( \sin \omega_2 t \) and the sine terms by \( \cos \omega_2 t \). We are now on familiar ground where each term will resemble that of an a.m. wave.

The terms will have the form:

\( (\cos \omega_2 t) \), \( \sin \omega_2 t \) and \( \sin \omega_2 t \), \( \cos \omega_2 t \)

where \( p \) is an odd integer and \( n \) is an even one.

The expansion of these two expressions results in:

\[ \frac{1}{3} \sin (\omega_2 t - \omega_2 t) \sin (\omega_2 t - \omega_2 t) \]

and \( \frac{1}{2} \sin (\omega_2 t + \omega_2 t) t + \sin (\omega_2 t - \omega_2 t) t \)

respectively.

These are, of course, the infinite sidebands of the frequency modulated wave. The carrier term will result from the zero frequency component arising from the expansion of the even powers of \( \sin \omega_2 t \) and it should be noted that it will have an amplitude depending on a complex function of \( m \).

The method is laborious and it does not have the elegance of the more accepted method. However, it may appeal to students who have not progressed far with their mathematics — if they have the time and patience to pursue the complicated calculations. There may also be advantages when the modulating wave is not a simple sine or cosine function as, for instance, in frequency shift telegraphy, although the mind boggles at the intricacy of the ensuing manipulations.

A similar expansion can also be used for showing the infinite extent of the sidebands when phase modulation is employed.

S. F. Brown
Post Office Telecommunications
Rugby Radio Station
Warwickshire

CORRECTIONS

In the second part of J. M. Osborne’s article “Sidebands as Phasors” in the October issue, several errors occurred on page 68. In Appendices 1 and 2, for which we apologize to readers. In Appendix I the expression in the side band (for p.m. of carrier) should read:

\[ a \sin (\omega_1 t - \sin \omega_2 t) \]

The second expression (seventh line) should read:

\[ a \sin (2\pi f + \sin 2\pi ft) \]

In Appendix 2 the first expression (for f.m. of carrier) should read:

\[ a \sin (\omega_2 t - \sin \omega_2 t) \]

and the second expression (seventh line) should read:

\[ a \sin (2\pi f + \sin 2\pi ft) \]

Also in Appendix 2 the expression in the middle column of p. 68 for the maximum rate of swing in terms of frequency (11 lines from top of column) should read:

\[ 2\Delta f = 12 \pi ft \]

Editor.

WHAT IS AN ELECTRON?

Neither Dr Theocharis nor Professor Jennison appears to understand the aim of modern physics (Letters, October). This is to discover and systematise useful descriptions of the natural universe as we observe it in experiment. Those descriptions are invariably mathematical and some of them are carefully bounded. Professor Jennison has proposed a model and time alone will show whether or not it is useful. Particle-wave duality must be one of the classic paradoxes and it remains unresolved. Dr Theocharis thinks that most physicists actually believe in a real Jekyll and Hyde electron. Professor Jennison actually appears to do so — and that is his prerogative. Most modern scientists will be happy to leave these two to fight it out. Paradoxes arise through the inadequacy or incompleteness of mathematical descriptions but that does not itself invalidate those descriptions. One must simply be careful in making use of them.

D. A. Rose
Poynton
Cheshire

CITIZENS’ BAND AND THE LAW

In November a correspondent criticised you for "supporting" the illegal use of c.b. radio, and his criticism was based on the belief that law-breaking is automatically wrong in any circumstances. Is law-breaking automatically wrong? Let us hear some eminent views.

J. J. Rousseau, 1762: "The inflexibility of the laws, which prevents them from bending to circumstances, may in certain cases make them injurious, and bring about in a time of crisis the ruin of the state."

Edmund Burke MP: "It is not what a lawyer tells me I may do, but what humanity, reason, and justice tell me I ought to do."

J. S. Mill, 1861: "There is no ethical creed which does not temper the rigidity of its laws by giving a certain latitude ... for accommodation to peculiarities of circumstances ... it seems to be universally admitted that there may be unjust laws, and that law..."
consequently, is not the ultimate criterion of justice."

"There are different degrees of obedience and it is not every degree that is commendable. Only an unmitigated despotism demands that an individual citizen shall obey unconsciously every mandate of persons in authority."

Bertrand Russell: "Individuals who opposed received opinions have been the source of all progress. . . . Without rebellion mankind would stagnate and injustice would be irremediable."

C.B. is not illegal because it's wrong but only because the constitution has virtually ground to a halt under the strain of modern life. Within government it is mainly the unelected bureaucrats who are against c.b. and neither the Home Secretary nor the Commons has had time to examine the issue closely because of more pressing matters. So the bureaucrats rule by default. In respect of this and most other matters we are ruled by what J. S. Mill called "the obstructive spirit of trained mediocrity." This is not democracy, it is not even elective dictatorship; it is pure tea-cup dictatorship; and in a tyranny it is morally right to break the law because of the absence of democratic procedures for changing the law.

My pleasure says that he is opposed to modification of law by blatant disregard for it, but he fails to understand that the only reason the law is being modified in this way is because there is, in practice, no other way.

C.B. is only one of a number of issues which are clamouring for the attention of an overburdened parliament. (For an example of another issue see the remarks of Dr. Budworth, News, August 1979, p. 41.) The threat to the rule of law does not come from Wireless World but from the lack of parliamentary time to deal with these matters. This problem does not exist in federal countries like Australia and Switzerland, nor need exist here. The more support that respected journals give to the fight against the tyranny of centralism the sooner that tyranny will be ended and the sooner respect for the law will be restored.

Carry on Wireless World!
S. Frost
Dansyre Lanarkshire

COMMENT IS POLITICAL

I have read Wireless World for more than 25 years and paid for it out of my own pocket as, unlike many readers, I do not have the subscription paid for by my company. During this period it has served me well and I shall be forever grateful for the technical help and guidance it has provided me with. There have also been delightful moments of humour which have helped to demonstrate that technical people can be human.

However, recently I have noticed a tendency to knock the establishment - whatever flavour it might be. I consider the inclusion of political rhetoric out of place in a journal of the calibre of Wireless World: your November editorial was particularly distasteful to me. I like Wireless World for many reasons but they do not include being subjected to the political bias of the editorial staff, both in editorials and general content.

Please, Mr Editor, can we return to an apolitical World - crusades I can accept but political bias no.
J. Greenwood
Chelmsford
Essex

DIGITAL FILTERS

It is with great interest that I have been following the Wireless World articles on digital filters ever since the original article by Rees1. Having programmed the RC low-pass filter on my H-P calculator, I would like to draw attention to a problem that seems to have been overlooked concerning the testing of these algorithms.

As the algorithm is basically derived from the impulse response via the Laplace transform method, the user is tempted to test it by applying a unit step, and feel satisfied when the desired exponential response is obtained. However, the filter cannot operate meaningfully on any frequency above the Nyquist frequency, while any impulsive type of test signal contains a large proportion of its energy in its high frequencies. Thus the only acceptable test signal must be one containing no harmonics beyond a certain frequency.

When a sine wave was used to test the RC filter it was found to be phase advanced by an amount corresponding to half of one time increment. The amplitude error was 0.16% when there were 10 samples per cycle and the period was equal to RC. To correct the time error a sliding mean was applied. Each sample was weighted with the previous sample before being used (see Fig. 1). The sliding mean can be considered as another filter with a rectangular impulse response whose first frequency null falls upon the sampling frequency (see Fig. 2). The equivalent geometrical procedure is to interpolate the samples as shown in Fig. 1. Even so the procedure is not entirely satisfactory as odd multiples of the Nyquist frequency are only attenuated, not removed. The interpolated sine wave had negligible phase error but the amplitude error had increased to 3.5%.

The process is equivalent to using an almost ideal filter on the interpolated waveform and then sampling the output at the original sample rate. Presumably a more sophisticated pre-processor such as for example a filter with a Gaussian impulse response would reduce errors due to residual harmonics.

In conclusion, and as Ham2 points out, altering the input signal is to be avoided if at all possible. Thus, at least for instrumental data there is no entirely satisfactory substitute for an analogue anti-aliasing filter to be applied before any digital processing. For synthetic test data, some digital pre-processing is needed to reduce unwanted harmonics. It seems that digital filters are not necessarily as simple as has been implied in your articles.

W. Gray
Farnborough

Hants

References

PROGRAMMABLE NOTES FOR MUSICAL INSTRUMENTS

Your correspondent M. Robins (November letters) does not seem to be aware that the scale of tuning proposed in his letter was in fact discarded some 250 years ago. Until this time 'just' temperament was the standard, but, as M. Robins says, the problem is that a piece of music sounds very different when played in different keys, some keys being unusable. Bach was a great promotor of 'equal' temperament tuning and composed his 48 Preludes and Fugues as proof that all keys could be used with this tuning method. He even called these pieces "The Well-tempered Clavier". Incidentally, even in 'equal' temperament tuning certain keys sound 'brighter' than others. This is a well known fact amongst musicians who would also consider going back to 'just' temperament very much a retrograde step.

Richard Waters
Leighton Buzzard
 Beds

POYNTING VECTOR

Apparently many people find the concept of displacement current useful and some find it distressing. Not being a member of either group I would normally be prepared to continue as a passive spectator of the fascinating correspondence which has been stimulated by your recent articles on the subject; after all, no-one is suggesting that 2D/ct should be struck out from Maxwell's equations, and presumably no-one is insisting that everyone must believe that there is any physical reality in a current which is said to flow in empty space where there is nothing to carry it (and nothing to be displaced). I would even leave it to others to point out that in Fig. 4 of "The history of displacement current" in your March issue the current i will vary continuously between B and B', as is the way

---

Fig. 1. Replacement of v(t) with \( \frac{1}{2}(t+\Delta t) \).

Fig. 2. (a) Spectrum of sampled sine-wave frequency \( \omega_s \). (b) Frequency response of sliding-mean pre-processor.
with transmission lines, so if you want a component that has a constant displacement current, not localised at B, but distributed along the length of the transmission line.

However, the excellent iconoclasts, Davidsson and Walton, have spurred me to action by their uncharacteristically unquantum use of a concept/mathematical construct which is far less harmless than displacement current, namely the Poynting vector or "energy current". A single, example will show what I mean. Suppose I take a battery and connect it to a lamp by a pair of good thick metal wires. Since the electric field is negligible inside the wires the Poynting vector is zero, but one would not be allowing oneself to be blinded by one's own mathematics to deduce from the fact that the Poynting vector is partially zero in the wires and is at a maximum between the wires that the energy flows mainly between the wires and not to any appreciable extent through them.

In case anyone does believe that even in this case the Poynting vector represents a physical energy flow I propose the following experiment. Place a metal screen between the battery and the lamp, insulated from the wires themselves, but fitting as closely as possible, so as not to leave more than the tiniest space for the Poynting vector to escape through. Note the effect (if any) on the amount of energy which gets to the lamp. Now take away the screen and make a break (just a little one, mind) in one of the wires. Again, note the effect on the amount of energy (if any) which gets through. A similar experiment could be carried out on telegraph lines, at some inconvenience to the public. If the Poynting vector really represents a physical energy flow the screen should have more effect than the break. After all, what do we mean when we say (if we do) that the energy flows between the wires rather than through them, other than that if we cut the break the flow of energy we would do better, to a first approximation at least, to insert a barrier where the energy flows than where it does not flow.

Perhaps it is time someone did a hatchet job on the Poynting vector along similar lines to that of Catt, Davidson and Walton on displacement current, with the hoped-for result being that it is cut back to its proper size, not that it is necessarily cut out completely. It may be less entertaining (surely not if the same team could be persuaded to take on the job) but the usefulness in actual practice would arguably be greater.

C. M. K. Watts
West Elec Company Ltd
Woodgreen
Essex

The authors reply:
The last sentence of Mr Watts's first paragraph shows that he does not understand the mechanism for a TEM signal travelling undisturbed between two perfect uniform conductors.

We should however applaud, not con-
demn, those who come out in the open and discuss electromagnetic theory even though their grasp of the fundamentals is weak. CAM Consultants have found that those professors and text book writers who are hiding from the present dialogue, although they are not hiding and admit them otherwise, are more ignorant than Mr Watts and the other brave men who are rushing in to the vacuum. CAM Consultants challenge professors of physics and electronics to come out of the undergrowth and start earning their salaries by discussing the fundamentals of electromagnetic theory.

Returning to par. 2, if Mr Watts bares his chest to the sun, does he believe that the electromagnetic field is burning his skin? How energy is travelling from the sun to him down conducting wires, or through a dielectric?

Paragraph 3 is very instructive. (Why must he leave the 'tiniest space'? Why leave a space at all if the conductor is what it is all about?) Our book Electromagnetic Theory Vol. 2 discusses such situations thoroughly, on pages 465 and 319 and elsewhere. Referring again to his second sentence, conventional transmission line theory tells us that energy current rapidly builds up to a high flow rate through a small gap as a result of repeated reflections. The argument somewhat resembles that in the appendix to our article in the December 1978 issue. If in his second sentence, the screen hedges the conductors for a long length (say one mile), creating a long section with very low characteristic impedance, transmission line theory tells us that energy current rapidly builds up to a high flow rate through a small gap as a result of repeated reflections.

I. Catt, M. F. Davidson, D. S. Walton

'_TRIVIAL'_ AMPLIFIER DESIGNS.

I find it quite incredible that Wireless World should see fit to publish yet another article describing amplification equipment for domestic sound reproduction, in which purely academic distortion levels are pursued virtually for their own sake. The author states that he designed the amplifier with a view to its being "competitive with current commercial designs." Can this really be an altruistic aim? In my experience the second and third harmonic distortion audiibility threshold (even where skilled sound engineers and producers are concerned) is in the region of 0.1%. Given that this is so, then an amplifier with second and third harmonic distortion not in excess of 0.1% over its entire bandwidth should sound as good as one with 0.0002% second harmonic distortion, all other factors being equal - entrance sleeve limitations, overload effects, audiibility threshold of high harmonics, et al.

A multitude of exotic schemes of thought currently abound to extol the 'sound' of polypropylene capacitor, special loud speaker cables, discrete circuitry, valves, f.e.t.s, 'real time' amplification, 180V/μs slew rates, passive equalisation, minimal overall feedback, etc. I challenge Wireless World to seek out the truth, even that of the author, rather than to present conventional designs adnusiaem. I wish to state that I in no way whatsoever wish to deprecate per se the designs presented by Douglas Self and B. J. Codd, but rather to suggest that whilst these engineering approaches are interesting, they are really grossly trivial in a world where the allowable second harmonic distortion a studio tape machine is of the order of 3%, where 70% of record pressings defy the above, and electromechanical transducers from the cutting head to the loudspeaker are as yet imperfect.

To exemplify: I have recently built Douglas Self's Mk 1 advanced preamplifier design using TDA 1034N op-amps. Using horn loaded loudspeakers and Crimson Electrik amplifiers in a tri-amplified configuration, I perceive no difference. I am still waiting for my friends to say that 'it sounds different.' The chances are high that your recently acquired records were mixed in the studio on decks stuffed with 'nasty' op-amps and transformers. Need I say more?

B. R. Duncan
Tattershall
Lincoln
THERMIONIC DEVICES

I know of nothing more likely to start an argument between historians than that of the thermionic into the ring a seemingly innocuous statement such as "... no doubt that Fleming's diode ushered in the thermionic 'valve era'..." (November 1979, p.94).

Dare I suggest that Edison's patent of 1884 (nothing to do with wireless of course) covered a most practical application of thermionics to the control of a generator? For all I know this may also have been the first thermionic closed-loop servo-mechanism to be described. But Edison was very busy inventing hundreds of other things, and can perhaps be excused for not applying his "so-called" effect to wireless, the phonograph, moving pictures etc. as well.

What is most puzzling is that Fleming was apparently so slow off the mark - a whole 20 years before the penny dropped! Of course he had been fairly busy around 1900 combining the more recent ideas of Tesla, Thomson and Marconi into the Poldhu transmitter, a very substantial engineering task; and this may have diverted his mind from developments in Germany, such as Wehnelt's lime-coated thermionic filament also published in 1904 which was incorporated into the Braun-Webhelt cathode of 1905. (The same Braun, of course, who later shared a Nobel prize with Marconi.)

In the event it must have been a little humiliating for Fleming that there was not more interest in his thermionic diode (though it may have stimulated the invention of the crystal detector). The reasons were that the carborundum detector was simpler and more rugged and the Marconi magnetic detector needed no battery. Thermionics really took off in a more obvious fashion about a decade later, with the advent of better vacua and other technical improvements. In fact, it became important enough for Litigation over rights; and though neither side seemed to emerge with much of value, the ruling did confirm Fleming's legal title to his (rather gassy) diode valve.

Desmond Thackeray
University of Surrey
Guildford

MICROPROCESSOR PERIPHERALS

A problem exists in the design of circuits using the latest microprocessor peripheral Ics. I would like to suggest a solution which, although using one more pin of the package, would require little complication of the ic.

The problem is evident when several such peripherals interface to the same data bus, and this bus includes one or more sets of bi-directional bus buffers. In order to ensure that these buffers are always driving in the correct direction, the logic designer finds himself duplicating circuitry that must already exist inside the ic. Some peripheral chips put data on the bus for up to one of these buffers, reversing the direction of the relevant bus buffer, all these states must be decoded, and ORed together, along with similar lines from other peripheral chips on that section of the bus.

My suggestion is that a 'drivers active' function be brought out to a pin of each bus-interfacing device. Relevant bus buffers could be turned around by a simple OR of these few signals. Even greater simplicity could be achieved if the 'drivers active' lines were open-collector types, a wired-OR then being possible.

I feel sure that this line would also be useful in the debugging phase of microprocessor support circuitry where problems of bus conflicts and floating buses may have to be resolved.

E. J. Board
St Albans
Herts

PRE-AMPLIFIER WITH NO T.I.D.

Potential builders of the Miloslavskij passive de-emphasis preamplifier (August issue) may have exploited the the ruling did confirm Fleming's legal title to the (rather gassy) diode valve.

Desmond Thackeray
University of Surrey
Guildford

MICROPROCESSOR PERIPHERALS

A problem exists in the design of circuits using the latest microprocessor peripheral Ics. I would like to suggest a solution which, although using one more pin of the package, would require little complication of the ic.

The problem is evident when several such peripherals interface to the same data bus, and this bus includes one or more sets of bi-directional bus buffers. In order to ensure that these buffers are always driving in the correct direction, the logic designer finds himself duplicating circuitry that must already exist inside the ic. Some peripheral chips put data on the bus for up to one of these buffers, reversing the direction of the relevant bus buffer, all these states must be decoded, and ORed together, along with similar lines from other peripheral chips on that section of the bus.

My suggestion is that a 'drivers active' function be brought out to a pin of each bus-interfacing device. Relevant bus buffers could be turned around by a simple OR of these few signals. Even greater simplicity could be achieved if the 'drivers active' lines were open-collector types, a wired-OR then being possible.

I feel sure that this line would also be useful in the debugging phase of microprocessor support circuitry where problems of bus conflicts and floating buses may have to be resolved.

E. J. Board
St Albans
Herts

REFERENCES


ELEMENT OR DIAMOND?

While experimenting in television during the "mechanical" period, I realised that the accepted theory of the "picture element", based on the chessboard idea, is a fallacy. I found that a continuously moving spot cannot resolve a picture detail as small as itself; it smudges along the traced line, generating a maximum frequency only two-thirds that calculated by the element-based line-standard formula. This was proved by the failure of the "low definition" broadcast to reach the frequency of 9Hz, the theoretical maximum for a picture with 2.100 elements (30 lines with aspect ratio 3:7) at 120 pictures a second. Only about 9kHz was achieved, yet the same erroneous formula was employed for the 405-line transmission, and is still the basis of the 625-line standard. "Line" still means "line of elements", with line-pitch "elemental".

My letter in Wireless World for July 1981 explained how practical engineers, with a calculated "high frequency" definition to achieve, focus spot-size to half-elemental (4/9) by reducing spot diameter to two-thirds of line-pitch. This is easily proved on any monochrome network, by reducing picture height until the traced lines touch the closed up lines leave about one-third of the screen dark.

I eventually found a spot shape which forms no visible structure, however large the spot: the "playing card" diamond. Cutting experimental discs (thin black card was adequate) I turned the original square "elemental" aperture on end, then extended it transversely to the scan direction, reducing it along the scan. Each field traced double-spaced lines (which just touched), and alternate lines "interlinked" their lines by half-overlap both ways. Diamond scan exposes pipers uniformly about line-centre, so two interlinking lines conceal structure. The line-free complementary scanning allows diamond size to be chosen for desired defini-
tion only, with resolution enhanced by the reduced scanning depth of the diamond.

The ideal "diamond" focus may be impossible electronically, and would be wasted on a 625-line picture. A close approximation is possible by extending the existing half-element spot vertically to points, while preserving it horizontally. The resulting pointed oval, resembling the contracted pupil of a cat's eye, would raise resolution to the standard's limit.

Agstematic focus has been tried but the "elemental line" taboo seems to have prevented any attempt at elongating the spot sufficiently to achieve complementary overlap. This inexpensive focus correction at camera and receiver would improve definition and remove all trace of visible structure from our screens.

A. O. Hopkins
Worthing
West Sussex

RADIO AMATEUR INVALID AND BLIND CLUB

May I bring to your attention the change in the title, secretary and address of the Radio Amateur Invalid and Blind Club?

Now celebrating its silver jubilee, the Club is formed of invalid and blind members interested in the hobby of amateur radio; their local representatives who undertake to help by visits, repairs and advice; and supporter members whose financial contributions enable help to be given. The sole condition of membership in any of the above categories is an annual subscription of £1 minimum for Radcom The Club newsletter which is issued every six weeks.

F. E. Woolley (Mrs)
Hon. Secretary
9 Rannoch Court
Adelaide Road
Surbiton
Surrey KT6 4TE

JOHN SCOTT-TAGGART

Your brief, but nostalgic, obituary on John Scott-Taggart (p.55 October 1979) recorded his prowess as an engineer. In his earlier days he was also a formidable showman. From the mid-twenties to the early thirties, thousands of experimenters were persuaded that the 'ST' series of circuits had supernatural powers.

The celebrated 'ST100' offered plenty of scope for compulsive twiddlers, with two tuning capacitors, plug-in coils with variable coupling, filament rheostats and a cat's whisker. Although it was essentially a solid reflex arrangement, Scott-Taggart showed real originality in circuit-diagram presentation. Scoring ordinary logic in layout, he produced bafflingly devious links.

One of the figures I have sent you is copied from an 'ST100' diagram, which involved 15 crossed wires. The other one is the same circuit, but as it would more commonly have been drawn 50 years ago - with only three crossovers [Diagrams supplied - Ed.] The contrast speaks for itself.

C. Leslie Thomson
Kingston
Edinburgh, 16

WIRELESS WORLD, JANUARY 1980
More on the scientific computer

Further details of the monitors

By J. H. Adams, M.Sc.

After publication of the scientific computer series (April to September 1979) there have been many requests for more information on the firmware. This article describes in more detail the machine code and BURP monitors in terms of hexadecimal machine code. Readers will need a hex print-out of the three p.r.o.m.s and the mnemonic to hex conversion tables published in the July 1979 issue of Wireless World.

Several readers have expressed incredulity at the thought of working directly in machine code rather than using assembly language mnemonics. However, the hex codes for 50 to 60 of the most regularly used operations can soon be learnt and, thanks to the logical distribution of codes to operations, many more follow from these. The once-in-a-megabyte ones such as IN D (C), ED 50 in hex, can be obtained from the conversion table. This does not rule out working in assembly language and using an assembler, or translating yourself, but in my experience the latter soon becomes tiresome and it is easier to write in hexadecimal.

When writing software it is useful to have a supply of the forms shown in Fig. 1. The instruction 18, a relative jump, should be pronounced one eight and not eighteen. Similarly, the second byte is one seven and definitely not seventeen.

If you want to jump forward with a relative jump, simply make the jump byte the number of bytes (up to 7F) over which execution must move. In this case 17 — 1 row and 7 bytes, to reach the target byte FF. For a jump back to the same target from the second 18, calculate the jump forward code to the next byte immediately under the target, 02 in this case, and then jump up row by row, decrementing the higher order hex character, I.e. from 02, F2, E2. When using a jump back the byte must be in the range 80 to FD (FE and FF serve no useful purpose).

Machine code monitor

Both monitors follow the same basic sequence as illustrated in Fig. 2. With the machine code monitor the base address of the Z80 stack is set, the address for the top corner of the screen is loaded into the DE register pair which is then used throughout the monitor as the destination pointer or vector for v.d.u. operations, and the message READY is printed by the subroutine at 03CE. This is one of several routines in the computer which draws data from the locations directly following the call of the routine. The program counter, which will have been pushed onto the stack, is exchanged with the contents of the HL register pair and then used as a pointer to that data before being exchanged back onto the stack, at the end of the routine, to cause a return to, in this case, 0010. The start procedure then clears the rest of the top line, resets the teletypewriter output flip-flop and, using the subroutine at 0355, reads in and encodes a command from the keyboard. As explained in Table 1, only the first and last letters are important to the subroutine. Whilst this limits the number of possible combinations which will produce different codes, a byte by byte comparison with a look-up table comprising all of the commands would use far too much p.r.o.m. space. After this has been achieved (001A), a comparison is made and if the code is not FC (the entry code for RUN) executions jump over 0D bytes for a further comparison and so on until a match is found, whereupon a block of instructions is executed before operation reverts to 0000 again.

<table>
<thead>
<tr>
<th>Address</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>0254</td>
<td>Sets tape interface tone to 2400Hz and then calls 255 long time delays — about 4 seconds.</td>
</tr>
<tr>
<td>0260</td>
<td>Transmits the byte in register A to the tape interface, preceded by a start bit and followed by two stop bits.</td>
</tr>
<tr>
<td>027F</td>
<td>Calls a new line and then prints the contents of HL on the teleprinter.</td>
</tr>
<tr>
<td>028E</td>
<td>Formats the hex byte in register A for printing as two characters on the teleprinter.</td>
</tr>
<tr>
<td>02EC</td>
<td>Prints a space on the teleprinter.</td>
</tr>
<tr>
<td>02F0</td>
<td>Calls a new line on the teleprinter.</td>
</tr>
<tr>
<td>0301</td>
<td>Prints the contents of the A register on the teleprinter.</td>
</tr>
<tr>
<td>0317</td>
<td>List subroutine. Entered at 0317, the starting address must be loaded in from the keyboard. Entry at 031D assumes the address is already in HL.</td>
</tr>
<tr>
<td>0336</td>
<td>A programmable time delay. The computer loops through six E3s, a long exchange instruction which, if used in pairs, does nothing but use up time. The number of loops is set by the byte immediately following the CALL in the original program. Each loop lasts 64s.</td>
</tr>
<tr>
<td>0345</td>
<td>Clears the top line and sets DE at 8000.</td>
</tr>
<tr>
<td>034E</td>
<td>Used to format results, as in FIND and COR, this rounds DE up to the next multiple of 8.</td>
</tr>
<tr>
<td>0355</td>
<td>The algorithm for encoding input commands. Returns with last letter of the command minus the first letter in register A.</td>
</tr>
<tr>
<td>0372</td>
<td>The formatter used in LOAD and LIST in machine code language.</td>
</tr>
<tr>
<td>0393</td>
<td>Clears the v.d.u., leaving DE unaffected.</td>
</tr>
<tr>
<td>0399</td>
<td>Displays HL and a space. Used in LIST, LOAD, FIND, COR and in BURP lists.</td>
</tr>
<tr>
<td>03AA</td>
<td>Displays the contents of A as a two character hex byte.</td>
</tr>
<tr>
<td>03C4</td>
<td>Calls a new line on the v.d.u. and clears the remainder of the current one.</td>
</tr>
<tr>
<td>03CE</td>
<td>Displays the string of characters following the call in the program block up to byte 1D.</td>
</tr>
<tr>
<td>03E6</td>
<td>Loads HL from the keyboard.</td>
</tr>
<tr>
<td>03E7</td>
<td>Loads A with a hex byte from the keyboard.</td>
</tr>
<tr>
<td>03F0</td>
<td>Reads in a single keyboard character and, if a letter adds 6, then truncates to four bit binary (used as part of 03E7).</td>
</tr>
</tbody>
</table>
An exception to this is for the code FC, the routine for which 001E jumps immediately to 0042. This avoids one of the subroutines which have to be located at particular points in the memory map. Several subroutines can be called by single byte instructions which are known in mnemonic form as RSTs. These were originally intended for use with the 8080 and the Z80's "8080 mode" interrupt response which, after receiving the interrupt, calls for the interrupting device to place one or more instruction bytes onto the data bus for execution. Although this mode is not used, the single byte calls are a useful space-saver where a subroutine may be short and often needed. The subroutine which is avoided in this case at 0020 is called by byte E7 and produces a space on the v.d.u. at address 0025 is a jump to a subroutine which would require more than eight bytes. It is inserted during the testing of machine code programs and when its RST byte EF is inserted into the program by using an ALT, it will suspend the execution of the program and display the contents of the HL, DE and AF registers, the point at which the EF was found, and the last entry onto the stack. Note that whilst there is not a specific subroutine at 0000, the one byte call CF for this address is used as an end command to a program. Although it does not make the same as 0000, because the stack is immediately re-defined at 0000, it has the same effect and saves two bytes.

The two interrupts also use fixed service routines. At 0038 is the maskable interrupt routine which reads in and stores number cruncher data using HL as a pointer. At 0066 the non-maskable interrupt's routine services the keyboard, first checking if the computer is at a HALT byte (76) and reading in the keyboard if it is or reseting the computer if it is not (006B is an example of a long relative jump). This particular software does not make use of the control characters available in ASCII except for the RETURN byte 0D, which it translates to 1F. Instead, it blanks off the top three bits of any codes above 3F (mainly the letters) at 007C and moves lower and upper case codes into the area 00 to 1F. This compression of the ASCII code into six bits produces bytes which are compatible with the v.d.u. character generator and this makes writing to the v.d.u., which occurs at many places in the monitors, a simple operation.

Beyond the service routines, the routines for the various operations in table 2 fit end to end up to 0233, with the exception of some unprogrammed space at 0130-9. This space may be used by overprogramming the jump byte 011F-10 and the ten bytes as required. Note that the LIST (01A4) routine is just a call to a subroutine at 0317 because an identical block of instructions are required as part of the ALT routine. As this is the last command code to be checked, the call is conditional on a match so that if the code is undefined, execution passes to 01A9 and a software reset.

### Table 2. Machine code routine starting addresses.

<table>
<thead>
<tr>
<th>Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>002F</td>
<td>FILL</td>
</tr>
<tr>
<td>0039</td>
<td>LOAD</td>
</tr>
<tr>
<td>010D</td>
<td>FIND</td>
</tr>
<tr>
<td>010C</td>
<td>FIND</td>
</tr>
<tr>
<td>0146</td>
<td>LIST</td>
</tr>
<tr>
<td>0042</td>
<td>RUN</td>
</tr>
<tr>
<td>004D</td>
<td>MOVE</td>
</tr>
<tr>
<td>0120</td>
<td>ALT</td>
</tr>
<tr>
<td>014F</td>
<td>COR</td>
</tr>
<tr>
<td>0226</td>
<td>READ</td>
</tr>
</tbody>
</table>

### Table 3. BURP subroutines.

<table>
<thead>
<tr>
<th>Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0400</td>
<td>Used in graph plotting. Converts a number stored in 1E00-F to the nearest integral value. Negative values are put to zero. Executes MM5719 instruction present in register A. The sequence checks that the 57109 is ready, outputs the instruction with the hold off, waits for the ready flag to go off and then puts the hold on again. Repairs 042E for the string of 5719 instructions following the call in the main program. The list is terminated by FF. Jumps over the next word in the program in line. Used in FOR statements to miss STEP and UNTIL.</td>
</tr>
<tr>
<td>042E</td>
<td>Converts a digit to its next form a table 65X63.</td>
</tr>
<tr>
<td>045A</td>
<td>Outputs the contents of the 57109 X register to locations 1FF4 - 1FFF and then reformats it into the location specified by the contents of register A at the call, i.e. 1E10 for 01 in A, 1E20 for 02 etc.</td>
</tr>
<tr>
<td>0460</td>
<td>Grap h plotting routine which scales the variables. It is inserted between the variable specified by the contents of A, by the declared maximum for that axis, and then multiplies by 126 before outputting to 1E00.</td>
</tr>
<tr>
<td>0466</td>
<td>Jumps any spaces in the text and then analyses the following for (a) operators (04FB) which are converted by algorithm to 57109 code and executed (b) numbers (050F) which are rearranged and then input to the 57109 (c) instructions (054F) which are encoded by algorithm and the result used as the address for the location in a look up table (positioned at the end of the (c) item). The 57109 instruction code can be found, drawn and executed (d) variables (0578) which are found on 0460 and entered as a series of 57109 instructions. When encoding the word standard algorithm two times first plus last is used but to compress the range of codes produced, those under 20 have 20 added and those above 50 are reduced by 10. This compressed byte is then added to 0784 which is used as a pointer to the instruction required. Some instructions need two bytes for their execution, the first being 20, e.g. 24 is SN but 20 24 is SNE. These are encoded in the table and detected at 0586 by 81 7 of the instruction being set. Handles the 57109 FR branch output which pulses low whenever one of the 57109 test instruction proves to be true. The subroutine starts the execution of the instruction in register A and then reads in the 6-bit data word from the 57109. The four digit output lines are blanked off so that only the READY and BR lines, both initially high, get through (0591). By continually re-reading and jumping back on even parity, the Z80 is effectively waiting for one of these two lines to become active. If the bit the FR line the Z80 outputs a NOP to the 57109 because, when tests prove true, the 57109 immediately looks for a new instruction and waits for its completion. If READY becomes active to indicate a failed test, the last procedure is jumped. Finally, the read in and masked byte which caused the exit from the parity checking loop, stored in register B as part of that loop, is read into A and masked for bit 6 so that the state of this line and hence the zero flag in the F register is set on a successful test.</td>
</tr>
<tr>
<td>05A9</td>
<td>With the HL register pointing to a variable in the text, and with that variable in register A, this subroutine computes the variable's address, formats it into 6 bits ASCII in the area 1E00-F and converts results in the range 0000 199 999 999 to floating point. The byte in the text is checked and, if a digit, is used as the mantissa digit count to be stored at 1F00 (063A). Whether or not the contents of 1F00 are then drawn out, the contents from 0641 to 0681 round off the figures after the decimal point to the extent indicated by this digit. Blanked figures are replaced by ASCII spaces. The mantissa is then sent to the v.d.u. and the text interrogated again, this time for a comma, which has the effect of suppressing the printing of any spaces and close packs the digits in the number (0693-7). Finally, at 06A3 an F for the exponent is looked for and if found the exponent is the number added to 0784 which is used as a pointer to the instruction required.</td>
</tr>
<tr>
<td>0688</td>
<td>Prepares the store area specified by the contents of A using 0714 and then reads in a number from the keyboard, converting standard and non-standard scientific and floating point conventions to the machines standard format.</td>
</tr>
<tr>
<td>0714</td>
<td>Prepares a number store by dumping 9 00S, 60F0s and a 3F. This means that 068B dump the input data into the store without having to worry about leading or trailing zeros or the non-existence of an exponent (0Fs being NOPs as well). The 3F terminates number entry to the 57109 as well as being a NOP therefore two consecutive variable inputs to the 57109 do not have to be separated by an ENTER as with reverse polish calculators.</td>
</tr>
<tr>
<td>0729</td>
<td>Algorithm for entering words from keyboard (two times first letter plus last).</td>
</tr>
<tr>
<td>0736</td>
<td>Inputs denary keyboard digits to binary in C.</td>
</tr>
<tr>
<td>074A</td>
<td>Converts A to denary denary and displays on v. d. u.</td>
</tr>
<tr>
<td>076D</td>
<td>Converts A to denary digit and displays on teletypewriter.</td>
</tr>
<tr>
<td>0772</td>
<td>Data for MOD command.</td>
</tr>
<tr>
<td>07AC</td>
<td>Forms the address for the start of a variable store area in HL from the variable code in A. Displays a number formatted by 05A9 in 1E00-F displaying E for OB, for OA, a space for OF, for OC and ASCII digits for 00 to 09.</td>
</tr>
<tr>
<td>07CD</td>
<td>The look-up table for the 57109 instructions.</td>
</tr>
</tbody>
</table>
Table 5. BURP routine starting addresses.

<table>
<thead>
<tr>
<th>Routine</th>
<th>Start Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOAD</td>
<td>0377</td>
</tr>
<tr>
<td>RUN</td>
<td>0392</td>
</tr>
<tr>
<td>INPUT</td>
<td>039A</td>
</tr>
<tr>
<td>GOTOS</td>
<td>03AF</td>
</tr>
<tr>
<td>GOSUB</td>
<td>03AE</td>
</tr>
<tr>
<td>NEXT</td>
<td>03AE</td>
</tr>
</tbody>
</table>

From 0254 to 03FF are the subroutines listed in Table 1. When necessary, the subroutines PUSH registers to be used solely within the subroutine and then POP them back before the return so that no interference is caused to data within the main program. Most subroutines are self-contained but some, e.g. 02EC, jump on to others for their completion. As subroutines are sometimes called within subroutines, within subroutines etc., the stack storage area, which extends into the r/w.m. from 1FD, should be left free to at least 1FC0 for the computer’s use. Like C7, other space savers will be found in the subroutines, e.g. AF to clear the register A instead of 3E 00, A7 to set the flags according to the contents of A. To save byte space some apparently unnecessary bytes appear, e.g. E3 at the start of the routine at 03C4 is included so that it and 03CE can share the same ending. Care is needed when writing subroutines because with a lot of PUSHing, POPping and EXchanging, taking place it is important to ensure that the bytes called back off the stack by the return command at the end of a subroutine are definitely the correct ones. I have found this to be the 280’s most adept way of erasing painstakingly developed programs. This type of error is common when a conditional return is used as in 634E which prints spaces until the lower three bits of DE are zero. Ideally this should have pushed AF initially as it uses A and F, but to also arrange for them to be restored on return would extend the routine to at least nine bytes. The EF described earlier is a very powerful tool for sorting out these problems.

BURP monitor

For the BURP monitor the first p.r.o.m. is solely for subroutines whilst the second contains the operating system which makes use of them. Details of the subroutines are given in Table 3. In BURP, program material is loaded from 0C00 on, the area 1E00 to 1E0F is used for the formatting of results to be printed and 1E10-F stores variable A and so on up to 1FB0-F which holds the array loop step. Table 4 shows the formatting used for the storage and printing of these different variables. Note that all results are stored scientifically to maintain eight digit accuracy. Although the MMS710 can operate in either mode, it is quicker to stay in the scientific mode and let the Z80 convert the results within the range 0.0001-99999999 to floating point for display.

At 0800 the stack pointer is set and DE is assigned as the screen pointer again. BURP is then displayed and the rest of the top line cleared. The mantissa digit count is set at 04 (0817) and the screen position reset to 8008 ready for the input of a command. 081E to 0823 is harmless nonsense and 0824 to 0837 resets the number cruncher by sending the operation 3F (NO OP) with the hold to the 57109 off, pausing for 8ms and then reapplying the hold. During this sequence the interrupt mode is set but as it is the masked one that is driven by the number cruncher, the somewhat capricious behavior of the i.c. before it has been reset has no effect on the rest of the system. The i.c. is then given a master clear (2F) and switched to the scientific mode (22) by a multiple executive subroutine at 0466 (0832).

At 0838 another command encoder is called to read in a command from the keyboard. The algorithm used here is two times first plus last, so once again only two letters are required. However, this algorithm is capable of producing a far greater list of codes and therefore reduces the chance of two words deriving an identical one. As with the low level monitor, routines entered by recognition of this code ensue, see Table 5. The start of the last of these, for the RUN command, reads in and encodes the line number input in the command and stores it in register C. The v.d.u. pointer is then set to 8040, the start of the second line, and C is incremented, pushed, popped, incremented and then pushed again. Four of these operations might seem to do nothing to C and on this occasion they do not. The total effect is to store the current line number on the stack. When the execution of a line is completed however, the next line number can be computed and saved by returning to 097F. After GOTOs, when A will hold the next line number, a pop to remove the old number followed by a jump to 0881 will load this as the next line to be executed. As all lines will terminate by jumping back to one of the locations (e.g. END) which returns to 0800), to avoid absolute jumps (i.e. jumps to specific addresses), relative jumps to these two critical points are string out through the third p.r.o.m.

A line of BURP is stored as the hex byte ED, the line number in hex, the actual data in modified ASCII and then the byte IF to signify its end. The end of the memory block in use is signalled by the byte CO. With the commands ADD, DEL, DUMP, LIST and RUN involving line numbers, the interpreter scans the program block up to C0 and looks for ED followed by the line number in question. During a RUN the next word in the line is encoded using the two times first plus last algorithm (0993) and again, the routines for all of the commands are strung end to end and each is preceded by an immediate compare, and a jump-on-not-zero (20 hex). The last command, HALT, compares at 080F and if a match is not made the computer jumps over the single byte 76 of the HALT routine and goes on to the next line by executing several relative jumps back to 097F. This explains why there is no routine for REM as it and any unrecognized first word on a line is just
Table 6. New features of the improved firmware.

<table>
<thead>
<tr>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.d.u. cursor on all modes.</td>
</tr>
<tr>
<td>DEL delete last character on all modes.</td>
</tr>
<tr>
<td>RETURN available in graphics mode.</td>
</tr>
<tr>
<td>Interface for ASR or KSR teleprinter (as printer and/or punch).</td>
</tr>
</tbody>
</table>

**BURP**

Extended IF statements. Any statement may be conditioned by IF.

Mathematical capability available in IF, FOR PRINT, WRITE, GRAPH and AXIS statements.

Printed strings in INPUT as well as PRINT statements.

Multiple statements—virtually unlimited numbers of statements may be written against a single line number.

This speeds execution and expands the effective statement capacity well beyond the 254 lines.

Extra maths functions; ABS makes current result positive INT blanks digits following decimal point FRAC blanks digits preceding decimal point RND places pseudo-random number into the MM57109.

No need for LET at the start of LET type lines, in a line, causes the computer to ignore the data following, up to the end of that line (alternative to REM).

**Hardware changes required**

The wiring of several spare keys.

The teleprinter interface shifted from $D_2$ to $D_0$, and $55V$ reduced to $5V$.

**P.r.o.m. required**

Complete with the graph plotting firmware, this will still fit into three 2708 e.p.r.o.m.

Micro show is bigger

Personal computers are prominent among the systems to be displayed and discussed at the Microsystems '80 conference and exhibition, January 30 to February 1. Sponsored by Wireless World and associated electronics and computer journals, this annual event has grown in size to such an extent that it has had to be moved from its hotel venue to the Wembley Conference Centre (opening hours, 0930 to 1800 hours each day).

The 1980 conference has a four-part programme ranging from an introduction to microprocessors to an overview of the latest developments in microelectronics. Topics include: technology update, micro processor software, controlling microprocessor projects, microprocessor applications, bridging the hardware/software gap, and microprocessors in process control.

The conference will concentrate on personal computers on its third day.

There will be buyers' forum sessions to help people in selecting goods and services, and a one-day appreciation course to introduce managers to the use of microprocessors in business and industry. Delegates' fee for the conference is £145.50, including v.a.t. and booking forms are obtainable from the organizers, Illiffe Promotions, Room 821, Dorset House, Stamford Street, London SE1 9LU (telephone 01-261 8113). The exhibition, with some 110 stands, is open to all at no charge, whether or not the visitor is a conference delegate.

**Literature Received**

Reference sheets on the world's electronics industry produced by Mullard, showing exports, consumption, production of a variety of products. Sheets can be obtained from Mullard, Ltd, Mullard House, Torrington Place, London WC1E 7HD.

WW401

Leaflet on the ZIP KDP computer terminal, comprising 30ch/s dot-matrix printer, keyboard and v.d.u., can be had from Data Dynamics, Data House, Springfield Road, Hayes, Middx.

WW402

Fourteenth edition of Intel News contains descriptions of an 8866 single-board computer, 1Mbit bubble memory and other items of interest in the computing field. Intel Corp (UK) Ltd, 4 Between Towns Road, Cowley, Oxford OX4 3NB.

WW405

Solid-state relay applications manual on specification, protection circuits, loading and failure modes, with typical circuits, is available from Hamlin Electronics Europe Ltd, Diss, Norfolk IP22 3AY.

WW404

Full ordering information on the component parts of the Elma collect knob range is available in broadsheet or wall-chart form from Radiatron Components Ltd, 76 Crown Road, Twickenham, Middx.

WW405

Signal-conditioning amplifiers in the SE 990 series are described in a leaflet now available from Spur Road, Feltham, Middx, TW14 0TD.

WW406

Data for meteorologists, oceanographers, and ecologists can be collected by sensors on ships, without attention from the crew, collated by a data collection platform and transmitted to a satellite for retrieval. The McMichael platform is briefly described in a new leaflet from McMichael Ltd, Wexham Road, Slough, Berks SL2 5EL.

WW407

Leaflet from Astralux gives full details of the 8000 series of opto-coupled, solid-state relays in 10, 20, 30 and 40A versions. Sales department, Astralux Dynamics Ltd, Brightlingsea, Colchester, Essex CO7 5SW.

WW408

Selection of test equipment for logic-testing is presented by Electroplan in a four-page leaflet, obtainable from Electroplan Ltd, PO Box 19, Orchard Road, Royston, Herts. SG8 5HH.

WW409

Various types of panel meter, counters, printers, etc., are described in a 48-page catalogue, produced by Teckmaton, Ltd, 58 Edgware Way, Edgware, Middx. HA8 8JP.

WW410

Brochures on the American Crown (Amcron) range of audio equipment can be had from the sole UK distributors, HHH PA Hire and Sales, Unit F, New Crescent Works, Nicoll Road, London NW16 9AX.

WW411

A collection of tools for bending and cutting component leads and for handling i.c. packages is detailed in a Wybar catalogue from Etraer International Ltd, Unit M, Portway Industrial Estate, Andover SP10 1LU.

WW412
Businesses have been built on our ferrites.

Ours included.

If you're a manufacturer, even the most inexpensive components must be checked out—and they'll let your product down. And it's particularly true of ferrites. Apex are the sole UK agents for one of America's largest ferrite manufacturers, Fair-Rite. Apex use Fair-Rite products in their own manufacture of wound components and know how good they are.

The range covers most shapes from torroidal and pot cores to E cores, shield beads and baluns. Full data is available on request.

The most useful kit in the business.

We've put together a kit of assorted ferrites that contains a versatile selection of ferrite cores that will enable designers of RF suppression devices and wideband transformers to optimise circuits and approximate final designs very quickly.

A comprehensive data kit is included that contains impedance vs frequency curves, attenuation curves and wideband transformer design data.

It costs just £10.00 (cheque or company order). It's really too good to miss.

Apex. Big enough to look after you. Properly.
Apex Inductive Devices, 27 Abbey Industrial Estate, Mount Pleasant, Alperton, Middlesex. Tel: 01-903 2944.
FEEDBACK

RATE — SWEEP — RANGE

feedback

Top marks in one clear sweep.

You'd expect a Sweep Function Generator from Feedback to contain a lot more features for your money. And you'd be right— the SFG606 with its crisp frequency marker does just that. It sweeps up to 4 decades of frequency — bi-directionally. So you can avoid problems of transient effects. It maintains low signal distortion with absolute precision over the entire sweep range. It features a choice of decade or octave sweep — so it's ideal for narrow band analysis. It provides sine, square or triangle outputs over the frequency range 0.01Hz to 1MHz.

And with that beautifully sharp, fine line frequency marker that gives you accurate determination of spot frequency on the display, the SFG606 really does score top marks. Read all about the SFG606 and all its companion test instruments in the Feedback 600 range. Send to Feedback for literature today.

Or contact our distributors

electroplan

P.O. Box 19, Orchard Road, Royston. Herts. SG8 5HH.
Telephone: Royston 4545.

The new SFG606 passes even the testiest tester's test.

WW — 014 FOR FURTHER DETAILS

there are transformers and...

Drake Transformers

OEM — let Drake Transformers advise you on a component specification and design to solve that special problem. Pre-production prototypes and development undertaken as necessary.

Well known over a quarter century for personal service and high-quality products, Drake specialise in the design and manufacture of transformers and other wound components for large and small quantity production.

Expertise and service put DRAKE TRANSFORMERS in a class of their own.

DRAKE TRANSFORMERS LIMITED
South Green Works, Kennel Lane
Billericay, Essex CM11 2SP
Telephone: Billericay (02774) 51155
Telex: 99426 (prefix Drake)

WW — 062 FOR FURTHER DETAILS
Two-metre s.s.b. and f.m. transceiver—4

Alignment procedure and operating notes

by G. R. B. Thornley, G2DAF

For satisfactory alignment the following test instruments will be required: a c.w. signal generator; an absorption wavemeter; an AVO Model 8 or equivalent; a diode probe valve-voltmeter; a digital frequency meter; and an audio oscillator.

It is advantageous to test and align as many units as possible before final assembly in the chassis, so the following instructions will be based on this method. Initially, each unit should be connected to a stabilized power supply, set to 12.7V, with a milliammeter in series to monitor the current drain and to ensure that there is no short circuit or fault condition on the circuit.

S.s.b. generator unit

Connect the power supply, still set to 12.7V, to the +12V TX terminal post on the s.s.b. generator board and wire an external 1-pole, 2-way switch in place of S4, with the pole connected to the power supply. Check that there is 9.1V feeding Tr1. Set the slider of R11 to mid position and connect the diode probe of the valve-voltmeter to the test point TP. Adjust the core of L1 for maximum carrier output — this will be in the range 0.3 to 0.5V r.m.s. Operate the temporary switch S4 to select crystals XL1 and XL2 in turn, and ensure that they are both oscillating at approximately equal amplitude.

Remove the valve-voltmeter probe and connect the digital frequency meter via a 5pF series capacitor to the test point TP. Switch to the i.f. stage Tr1 and Tr2 until the crystal is on exactly 10,701.5kHz. Next, switch to the h.s.b. crystal and adjust C9 until the crystal is on exactly 10,698.5kHz. (The author found that additional 20pF capacitors, C39 and C41, were necessary for the crystals used in the prototype, and these were soldered across C39 and C41 on the etched side of the p.c.b.) The i.f. gain is determined by the gate 2 potential of Tr1 and Tr2. Initially, set the R12 slider to mid position. Unbalance R11 by turning the slider to one end of the track, and adjust the cores of L10, L11 and L12 for maximum r.f. output. Monitoring by connecting the diode probe of the valve-voltmeter to the input connection of the s.s.b. filter (junction of C41 and R8), disable the carrier oscillator by removing the 12V connection to the temporary switch and ensure that the valve-voltmeter indicates a zero reading. If this is not the case, the i.f. stages Tr1 and Tr2 are unstable, and R12 requires adjusting to reduce the gate 2 potential of the transistors until stability is ensured.

Reconnect the 12V supply to the temporary switch and balance the diode modulator by adjusting R11 and C18 in turn to the point at which the valve-voltmeter indicates zero reading. Note that C41 is not connected by the p.c.b. and must be connected by a wire link to one side of R11. If adjusting C41 does not improve the modulator balance, transfer the link to the other side of R11.

With a short length of screened cable running along the top of the p.c.b., connect the "A out" terminal post to the "A in" terminal post. Transfer the valve-voltmeter probe to the "I.F. out" terminal post (output side of C9). Connect a microphone to the "I.F. out" terminal post and adjust R5 for maximum gain. If all is well, a whistle into the microphone will produce an s.s.b. signal and will deflect the pointer of the valve-voltmeter to approximately 0.25V r.m.s.

Connect an 8-ohm loudspeaker to the circuit, transfer the 12V supply to the +12V amplifier terminal post and adjust R3 for exactly 0.35V at the junction of R46 and R47. Open circuit the wire link between the test point TP and the ground plane, and connect the AVO, on the 1,000mA range, in lieu. Adjust R75 for a quiescent Tr13, Tr14 collector current of 20mA. Set the audio signal generator to 1.5kHz and zero output, and connect it to the "A in" terminal post (connection to C39). Advance the audio generator output to 100mV r.m.s. while watching the AVO reading, which should increase to 250-300mA. A clean undistorted note, at full volume, should be heard from the loudspeaker. Reduce the audio drive to about 100mA collector current and swing the audio generator output frequency from 300 to 3,000Hz. The sound amplitude should remain approximately constant and without distortion at any frequency. Remove the AVO and reconnect the link (Note that R56 is soldered across D13 on the etched side of the p.c.b.) Temporarily bridge the "A out" terminal post of the demodulator (junction of R46 and C40) to the "A in" terminal post of the audio amplifier using screened cable. Connect the 12.7V power supply to the +12V RX terminal post, check that the source rail is at 3.3V and set the a.g.c. rail to 5.5V by adjusting R56. Set the wiper arm of the balancing potentiometer R3 to mid position, connect the signal generator, set to exactly 10,700kHz to the "I.F. in" terminal post (input to C9) and advance the r.f. output until a 1.5kHz tone can be heard from the loudspeaker. Adjust the cores of L9, L10 and L11 for maximum output while progressively reducing the signal generator output to avoid overloading the demodulator and the audio stages.

Make a screened-cable link from C62 to the drain of Tr8, on the underside of the p.c.b. and temporarily connect R46 and R47 to a 1mA—movement S-meter. With no signal generator input, set the S-meter to zero by adjusting R6. This will alter the a.g.c.—line potential because R46 and R47 interact, so it will be necessary to reset R56. Repeat the two adjustments until the S-meter reads zero and the a.g.c. reads 5.5V. Set the signal generator output to 10mV and adjust the core of L13 for maximum S-meter reading. Reduce the signal generator output to 100µV. If all is well the meter should give about an S9 reading. When the transceiver is completed, R56, which controls the S-meter sensitivity, can be set to obtain an S9 reading for a 50µV two-metre-band signal. Reduce the signal generator output to zero, and the S-meter should return to zero. If it does not do this, it means that the carrier oscillator output is leaking into the i.f. amplifier. Connect C65 to one side of the balanced-modulator potentiometer, R46 and adjust R46 and C65 in turn to balance the modulator and obtain a zero indication on the S-meter. If adjusting C65 does not improve the balance, remove the link and connect C65 to the other side of R46. While making these adjustments ensure that the correct h.s.b. crystal (10,698.5kHz) is switched into operation. If balance cannot be fully obtained and C41 is at full capacity, wire a 25pF ceramic capacitor across C41 on the underside of the p.c.b. and readjust C65.

F.m. generator unit

Connect a 100µA f.s.d. S-meter to the SM terminal post of the f.m. generator board. Turn the i.f. gain control, R12, to
Fig. 18. S-curve for the CA3089E f.m. crystal discriminator

maximum, and inject exactly 10,700kHz, from the signal generator, into the "F.M. in" terminal post, at a level that starts to deflect the S-meter. (Note that the meter will read approximately 50µA with no signal input.) Adjust the cores of L14, L15 to obtain maximum S-meter reading. At the same time as the tuned circuits are brought into resonance, reduce the signal generator output to avoid overloading the i.f. stages.

Set the signal generator input to obtain an S-meter deflection of three-quarter full scale and connect the digital frequency meter in parallel with the signal generator so that the frequency can be monitored. Connect the AVO, on the 250µA range, to the two test points TP adjacent to IC1. If the meter does not show a reading, reverse the connecting leads. Check that the meter is indicating 10,700,000Hz and carefully adjust C11 until the AVO reading falls to 0µA. Carefully alter the generator frequency until the AVO reads 50µA and make a note of the frequency. Repeat for 100µA and 150µA and note these frequencies too. Go back to the 0µA reading and reverse the AVO connecting leads. Set the frequency until the AVO reads 50µA, note the frequency and again repeat for 100µA and 150µA. Plot the readings taken on graph paper to obtain the crystal discriminator S-curve. This should look like the graph shown in Fig. 18, and it should be noted that a signal deviation of plus or minus 10kHz produces a detector output of plus or minus 150µA. The curve should be symmetrical about the 10,700kHz centre, and have straight lines indicating low distortion. Note that the crystal XL4 must be cut for series resonance operation.

Connect the valve-voltmeter probe to "FM out" terminal post, and the +12V supply to the "+12V TX" terminal post. Set the slider of R49 to give maximum gate 2 voltage, and adjust the core of L19 for maximum r.f. output. Remove the valve-voltmeter and connect the d.f.m. to "FM out" terminal post. Adjust the core of L25 until the carrier crystal XL4 is exactly on 10,700,000Hz. Note that crystal XL4 must be cut for parallel resonance operation.

Wire the microphone to "Microphone in", and high impedance headphones to "Mod out". Set the slider of R17, for maximum audio gain. Speak into the microphone, and if all is well this should produce low-level crisp, clean audio in the headphones.

Phase-lock v.c.o. unit

The alignment instructions for the phase-lock v.c.o. unit assume that the three p.c.b.s and the MC7805 regulator have been assembled in the screening box, and the i.e.d. indicator D20 connected to C203 and C204. All interconnections should be made, and supply and switching terminal posts wired to the appropriate box via 1,000µF feed-through capacitors. Measure the output voltage of the MC7805 regulator and ensure that this is 5.0V.

With a soldered link, short circuit TP1 on the v.c.o. p.c.b. to the groundplane in order to disable the oscillator T39, apply the signal generator output to TP2, and connect the valve-voltmeter probe to "RF out" terminal post. Set the signal generator to 134.3MHz and adjust the core of L24 for maximum r.f. output. Transfer the valve-voltmeter probe to "V.C.O. out" terminal post and adjust core of L24 for maximum r.f. output.

Wire an external single-pole two-way switch S2 to C169 and C179 and +12V terminal posts. With a two turn link, couple the absorption wavemeter to L25 and set wavemeter to 62.5MHz. Set external switch S3 to the position that will connect XL4 into circuit, and adjust core of L25 for maximum r.f. output. Set S3 to connect XL4 into circuit, and with the wavemeter set to 63.0MHz ensure that the circuit is oscillating at approximately the same amplitude. Switch back and forth a number of times to be sure that each crystal "fires" first time — it may be necessary to slightly re-adjust the core of L25. With XL4 oscillating and wavemeter set to 125MHz, couple the two-turn link to L26, and adjust core of L49 for maximum output. Set the wavemeter to 126MHz, switch to XL4 and ensure that the r.f. output is approximately equal to 125MHz. If necessary, slightly readjust the core of L26.

Connect the d.f.m. to test point TP9, and with trimmers C171 and C172 trim each crystal as near as possible to the required frequencies 125,000kHz and 126,000kHz. Note that crystals for amateur use are normally supplied to a frequency tolerance of ±0.005% and it may not be possible to pull XL4 and XL5 completely on to the required frequency. Finally operate S3 a number of times, and ensure that both crystals operate without hesitation and without frequency jumping. Remove the d.f.m. and check the signal generator set to 9,300kHz to test point TP4, and the valve-voltmeter probe to "1.F. out". Adjust cores of L49 and L26 for maximum r.f. output.

Set the AVO to the 10V d.c. range, connect to "D.C. out" and observe reading which should be 4.9V. Remove the short-circuit link from TP9, and the AVO should now read 0.85V. With the external switch S3, select the 125MHz crystal and connect the signal generator set to 9.3MHz and 500mV r.f. output, to "V.F.O. in". Screw the core of L21 completely into the winding. The AVO will now read 4.9V. Slowly unscrew the core of L21 until the AVO indication drops from 4.8V to 2.9V. At this point the indicating l.e.d. will light. The loop is now locked.

Operate the external switch S3 to select the 126MHz crystal. The AVO should now read 4.5V and the l.e.d. should remain lit. Select the 125MHz crystal and tune the signal generator to 8.3MHz. The AVO should now read 1.6V with the l.e.d. illuminated. Switch to the 126MHz crystal and the AVO should read 2.9V with the l.e.d. illuminated.

It will be noted that with the 126MHz crystal selected and the v.f.o. (signal generator) input of 9.3MHz, the loop control voltage is 4.5V falling to 2.9V with a v.f.o. input of 8.3MHz. Swing the signal generator across the 1MHz tuning range and the control voltage will follow in step, within the above limits. Select the 125MHz crystal and repeat. The control voltage will follow in step within the limits of 2.9V to 1.6V. As a final check of reliable phase-lock loop operation, short circuit the "I.F. in" terminal post to chassis earth. This should cause the AVO reading to
change to 49V and the i.e.d. to cease illumination — loop unlocked. Immediately the short circuit is removed, the AVO should revert to its. original reading and the i.e.d. should illuminate — loop locked. Switch the 127V power supply on and off a number of times, and check that the loop always locks reliably from switch on, at any 8.3 to 9.3MHz input frequency.

For reliable operation the v.f.o. input should be not less than 500mV r.m.s. The i.f. input at "I.F. in" will only appear when the loop is locked, and this, measured with the valve-voltmeter diode probe, will be in the range 0.6 to 1.2V r.m.s., depending on the v.c.o. operating frequency (133.3 to 135.3MHz).

Note that it is important that the v.f.o. input drives Tr9 and the i.f. input drives Tr6 as shown. If these input connections are reversed the MC4044P phase detector will be disabled and the loop will not lock.

V.c.o. amplifier unit
Connect the signal generator set to 134.3MHz to "V.C.O. in", and the valve-voltmeter probe to "Out RX".
Adjust cores of L32 and L33 to obtain maximum r.f. output. Transfer valve-voltmeter probe to "Out TX" and check that both readings are approximately the same. The measured output should be in the range 500 to 700mV r.m.s.

V.f.o. unit
These alignment instructions assume that a 106:1 ratio gear drive is being used (i.e. 50.1 for 180 degrees rotation of C22), and that 40 turns of the tuning knob will change the v.f.o. by 1,000kHz, equal to 25kHz per turn.
Fully mesh the vanes of C22 and mark a reference point on the drum dial. Turn the tuning knob two complete turns clockwise. Mark a calibration point on the drum dial and number 0. This is 0kHz and is the start of the tuning drum scale. Now turn the tuning knob 40 complete turns, mark the calibration point on the drum dial and number 1,000. This is 1,000kHz and is the end of the v.f.o. tuning range.
Unscrew the cores of L32 and L33 so that they are outside the windings. Check that there is 8.5V feeding Tr40, Tr43 and Tr47. Connect the "V.F.O. out" terminal to the d.f.m. and with the dial at 0kHz adjust the dust core of L23 for an output frequency of 8,300kHz. Turn the drum dial to 1,000kHz and adjust C22 for 9,300kHz. These two adjustments interact with each other, and must be repeated until the d.f.m. readout is correct at each end of the tuning range. Once this has been achieved the drum dial can be calibrated each 100kHz with main divisions, and every 25kHz for intermediate divisions. Finally the tuning knob circumference is divided into 25 equal sections and numbered 0 to 24 so as to provide a calibration mark every 1kHz.
Disconnect the d.f.m. and replace with the valve-voltmeter probe and measure the r.f. output at 8,300kHz and 9,300kHz. The two readings should be approximately equal and in the range 0.9 to 1V r.m.s. (unloaded value). Set the v.f.o. output to 9,300kHz and screw in the cores of the low-pass filter L32 and L33 equally until the valve-voltmeter reading just begins to reduce. At this point unscrew each core by one turn. Alignment has been undertaken without any biasing potential on D31. When in normal operation with R36 connected to the "Calibrate" control, the mean potential on D31 will be about 2V and this will reduce the capacitance by approximately 10pF. The v.f.o. can be brought back to correct calibration by re-adjusting C22.

Receiver converter unit
Because a second signal generator is required for the heterodyning input (133.3 to 135.3MHz) to the receiver converter unit and the transmitter converter unit, it is at this stage an advantage to complete the construction by installing and wiring all units and panel controls in the main chassis — with the exception of the power amplifier.
Connect the valve-voltmeter probe to the "HET in" terminal and check that

Transceiver with top chassis rail removed to show detail of the s.s.b. generator p.c.b.

Top view of the transceiver showing, left to right, the s.s.b. generator p.c.b., the transmit-converter p.c.b. with screening box, the reduction drive gear box and v.f.o. assembly, and the power amplifier screening box.
Transmit converter unit

Fit a TO-5 clip-on heat sink to Tr_{59} and bend the vanes as necessary to clear the screening can of L_{32}. Check that the off-tune level is 500 to 700mV r.m.s. Set the slide of R_{41} as necessary to give equal voltages at source connection of Tr_{51} and Tr_{52}.

Set the transceiver tuning dial to 145MHz. Connect the valve-voltmeter probe to “HET in”, and check that the input level is in the range 500 to 700mV r.m.s. Set the slide of R_{224} to mid position. Connect 75ohm dummy load to “RF out” via two feet of coaxial cable, with the valve-voltmeter probe in parallel with the 75ohm load. Set the dust cores of L_{45} and L_{50} so that each core is just level with the top of the screening can. Connect the signal generator, set to 145MHz, to test point TP_3. Operate the “press-to-talk” switch and adjust the trimmers C_{267}, C_{277}, C_{376}, and C_{362} for maximum output. UnscREW cores of L_{45}, L_{47}, and L_{49} for maximum adjust C_{267}, C_{277}, C_{288}, and C_{285} for any improvement in output. Transfer signal generator to test point TP_3, and adjust cores of L_{48}, L_{47}, and L_{46} for maximum output.

Disconnect the signal generator from the test point TP_3. Connect the audio signal generator to the “Mic” input socket on the front panel, via a 40dB attenuator (1 megohm series arm, 1kohm shunt arm). Set the audio generator to 1.5kHertz, operate “press-to-talk” switch and advance the audio output to drive the converter until the valve-voltmeter just begins to show a reading. Adjust cores of L_{45} and L_{46} for maximum output. As the circuits are brought into resonance reduce the audio drive to ensure that the following stages are not overloaded.

Finally adjust R_{215} for equal Tr_{53} and Tr_{54} source voltage.

Power amplifier

On the power amplifier, first check that the damping resisters R_{59} and R_{50} have been wired across the f.c.s. to the bases of Tr_{59} and Tr_{50}. Unsolde the link between C_{286} and C_{326} and replace with a milliammeter wired to extension leads. Connect the +12.7V supply to the +12V terminal. Adjust value of R_{59} to obtain Tr_{57} collector current of 10mA. Reconnect the link between C_{286} and C_{326}.

Unsolde the link between C_{303} and C_{314}. Connect stabilised 20V supply to C_{303} with the milliammeter in series and adjust value of R_{59} to obtain Tr_{58} collector current of 40mA.

Connect a 20V supply to the +20V terminal with the milliammeter in series. Adjust value of R_{223} to obtain Tr_{59} collector current of 90mA. Reconnect the link between C_{298} and C_{314}.

Assemble the amplifier in the die-cast screening box, install in the main chassis, and complete all connections.

Connect a 750hm dummy load via a two foot length of coaxial cable to the junction of L_{46} and C_{312} with the valve-voltmeter diode probe in parallel with the 750ohm load. Wire a suitable ammeter in series with the 20V supply. Couple a 1.5kHz audio tone into the “Mic” socket via a 40dB attenuator. Set the output of the audio generator to zero and operate the “press-to-talk” switch. Tr_{58} and Tr_{59} should be drawing the combined quiescent collector current of 130mA.

Set all trimmer capacitors and Tr_{59} tuning and loading capacitors to half value. Advance the audio generator output to drive the transistor until a reading just begins to show on the valve-voltmeter. Adjust C_{380} and C_{384} for maximum output and immediately tune up C_{910} and C_{912}. Adjust C_{390}, C_{391}, C_{390} and C_{291} in that order. As the circuits are brought into resonance the ammeter reading will rise. Initially do not allow it to rise beyond 500mA by progressively reducing the audio drive as required. Now increase the drive from the audio generator to the maximum intended, which should be about 1.5 amps from the 20V supply and quickly re-adjust all capacitors for maximum r.f. output because they are all sensitive to the power level at which the associated transistor is running.

Disconnect the audio generator and plug the microphone into its socket. Whistle into the microphone to obtain maximum output reading on the valve-voltmeter, and at the same time reduce the microphone amplifier gain with R_{53} (on the s.s.b. generator p.c.b.) until the power output just begins to drop.

At full output (single tone) expect a reading on the valve-voltmeter of 30 to 35V r.m.s. across a 75-ohm dummy load. Set the “MODE” switch to the “FM” position, and adjust R_{59} (on the f.m. generator p.c.b.) until the power output just begins to drop.

Note that the continuous power output capability is limited by the available heat sinking. During the first weeks of operation it is a wise precaution to use a 20V power supply with an indicator ammeter. This enables the collector current of the power transistors Tr_{59} and Tr_{56} to be continuously monitored. If at any time the (zero signal) standing current starts to rise, it means that the transistors are being overloaded and denotes the onset of thermal runaway, (i.e., the dissipation is exceeding the capability of the heat sinking). Switch off immediately to allow the transistors to cool. Adjust the i.f. gain controls R_{53} (s.s.b.) and R_{59} (f.m.) as appropriate to give some reduction to Tr_{59} and Tr_{56} power levels.

Dust core locking

It is most important that all the dust cores are an interference fit in the former and will hold their setting, and the material used must hold the core firmly but must not become solid, in case re-adjustment should be necessary at some future date. Before commencing alignment it is recommended that the screwed threads of each core and former are smeared with zinc oxide (obtainable from any chemist). The author has used this method for many years without any problems.

Operating notes

It is worth noting that the transmit output from the f.m. generator unit is an interference fit in the former and will hold their setting, and the material used must hold the core firmly but must not become solid, in case re-adjustment should be necessary at some future date. Before commencing alignment it is recommended that the screwed threads of each core and former are smeared with zinc oxide (obtainable from any chemist). The author has used this method for many years without any problems.
c.w. carrier and the frequency modulation on the final 144 to 146MHz signal is derived from the V.F.O. Deviation is controlled by the microphone amplifier gain control potentiometer R9.17 (on the f.m. generator p.c.b.), and in the absence of a deviation meter, this can be set to accept amateur band requirements by "on-the-air" reports. The "CALIBRATE" control — nominally set at the mid position — will provide the required reference bias of 2 volts for the varicap diode in the V.F.O. unit.

For a final check on the s.s.b. carrier attenuation, connect the "Aerial" output socket to a 75ohm dummy load with the diode probe of the valve-voltmeter in parallel across the load. Set the valve-voltmeter to the 1.5 volt range and remove the microphone from its socket. Operate the "press-to-talk" switch, and if there is a reading on the valve-voltmeter this denotes carrier leakage. Carefully re-balance the transmit modulator on the s.s.b. generator p.c.b. by adjusting R71 and C10 in step, until there is zero reading on the valve-voltmeter.

For the c.w. operator, transmission is conveniently effected by keying an outboard transistorised 1kHz audio oscillator fed into the microphone input socket.

Both the receiver converter unit, and the transmission power amplifier will work equally well into a 50ohm aerial system.

Modifications

As a result of more than two years "on-the-air" experience, two modifications have been incorporated to improve the s.s.b. operating convenience. These are as follows:

1. A 10µF 10V capacitor across the end pins of R10 on the printed circuit side of the s.s.b. generator p.c.b. This delays the gate 2 potential of TR1 and TR2 and prevents the transmission of a small "splash" of carrier caused by the switching transient when relay RL1 changes over from "receive" to "transmit".

2. Relay RL1 has a spare set of contacts which can be used to speed up the receiver a.g.c. recovery time, for those operators who like fast "break-in" operation. Connect the pole (pin 12) to chassis earth and the by-pass contact (pin 13) to chassis earth via a 47µF 25V capacitor. With a length of PVC-covered connecting wire routed along the fold of the chassis rear apron, connect pin 12 to gate 2 of the a.g.c. amplifier TR1, (junction of R5 and R17 on the etched side of the p.c.b.) This modification shortens down TR1's gate-2 potential to zero when transmitting, and prevents the switching transient feeding from the 10.7MHz i.f. amplifier into the a.g.c. system at high level.

Conclusion

This transceiver has been designed to provide a high level of performance on both transmit and receive, together with a high standard of reliability and convenience of operation.

For the f.m.-only operator, construction can be greatly simplified by omitting the s.s.b. generator unit. Repeater operation on any channel in the 145 to 146MHz section of the band can be provided by installing two crystals 300kHz apart, in the phase-lock unit. (That is, 63.0MHz and 62.7MHz giving heterodyne frequencies of 126.0MHz and 125.4MHz.) The switching lines can be taken to a spare set of contacts on the chassis relay RL1, so that 126.0MHz is selected on "receive" and 125.4MHz on "transmit" for normal repeater operation. If reverse repeater operation is also required, it is only necessary to add a panel-operated, 2-pole 2-way switch and wire this so that the crystal switching lines can be reversed.

Because there is ample information in textbooks and other literature on stabilized power supplies, detailed constructional details have not been given. The two units used by the author incorporate simple series stabilization using BDY20 transistors with the usual BC108 and BZV88 reference diode, and have proved to be entirely satisfactory.

All prospective constructors are strongly advised to use — with the exception of the surplus S.T.C. 445-LQU 901B FM filter specified — only first class new guaranteed components and transistors.

Notes

Notes on Part 3. Component suffixes for L1 to L13 in Fig. 11 are incorrect and should read respectively: 53, 54, 55, 60, 57, 56, 59, 62, 61, 58, 63, 64, 65 and 66. C20 in line four of p79 should read C29. Fourth line of last column on p79 should read "... die-cast box are mounted vertically at either end of the chassis platform, and the squelch unit is mounted vertically on the rear panel." Caption to Fig. 16 on p80 refers to TR4 and TR5 and not TR207 and TR208 as shown. Component suffixes for C29 to C34 in Fig. 17 are incorrect and should read respectively: 200, 206, 203, 204 and 193. A table of d.c. voltage checks for this transceiver will be made available on request.

Books Received

Manual of Avionics, by Brian Kendall, is said by the publishers to enable the layman to acquire a working knowledge of radio navails, but to have as its primary aim the detailed analysis of electronics in civil aviation for the professional reader. The author, however, maintains that he has steered a middle course between the elementary and the mathematical analysis.

The book is certainly of interest to the layman, and is written at this level: it will probably not be of great help to the professional for the reasons given in the author's introduction — it is simply not possible to perform both tasks in one book. At the layman's level, it is extremely detailed, comprehensive and authoritative, if one bears in mind that the "avionics" of the title is restricted to communications and navigational aids, including radar.

A short historical chapter, which manages to cover everything from Clerk Maxwell to cavity magnetrons in 26 pages, is followed by seven chapters on air traffic management, radio telephony and direction-finding, short-range navails and radio landing systems, radar, and the hyperbolic systems and Doppler navigation.

For anyone interested in gaining a fairly superficial (in professional terms) idea of the control and navigation of civil aircraft, the book can be highly recommended for its comprehensiveness and authority — the author is Senior Air Traffic Engineer of the Civil Aviation Authority. It is published by Granada Publishing, PO Box 9, Frogmore St., Albans, Herts. at £10.

A Window in the Sky, by A. T. Lawton, is concerned with the possibilities opened up for astronomers by the use of equipment outside our atmosphere. In contrast to many works on astronomy, the book is not only immensely detailed and factual, it is also "a good read." Mr Lawton puts the case for extra-terrestrial instruments, discusses the techniques for putting them there and examines several possible 'sites' in space. When all the equipment is in place, there is then the problem of what to investigate and, after a detour into the physics of integrated circuits and optical and radio telescopes, the rest of the book is a survey of some of the astronomical phenomena already known and others only guessed at. The book is published in hardback by David and Charles, Brunel House, Newton Abbott, Devon, at £6.50.
Astables: Logic gate circuits

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

A widely quoted astable circuit using inverters from the c.m.o.s. logic family is shown, using one capacitor and one resistor. A modification using a second resistor $R_2$ is also well-known but $R_2$ plays no part in the frequency control; rather it isolates the protective diodes at the inverter input from the voltage step applied via the capacitor, thereby protecting the input and preventing the diodes from conducting heavily and disturbing the frequency. Because only two passive components are needed the circuit seems not to conform to any of types I to V (December issue). It does, however, contain a differentiator as in type IV, and though the amplifier gain is much less the behaviour should be similar in this respect. The other amplifier has an inverting gain of relatively small magnitude and this corresponds to the see-saw amplifier of type IV. Hence this apparently new circuit is in fact type IV whether the inverters be c.m.o.s., t.t.l. or e.c.l.

Another common form of astable circuit quoted in the literature uses three inverters and a single capacitor with no passive resistors. It is sometimes described in terms of a three-phase oscillator. Such circuits are used as sinusoidal oscillators with 60° phase-shift per stage and with feedback or attenuations to limit the gain of each stage such that oscillation is not excessive. The present circuit is then argued to be a development of this with one external capacitor to define a longer time constant and hence lower the frequency. It is not then clear how the other inverters contribute to the response and the circuit certainly seems quite different from types I to V. It is unwise to press arguments based on sinusoidal response too hard when applied to switching voltage, switching the output to zero and discharging the capacitor back toward the lower threshold. The op amp, and potential divider in type II comprise a non-inverting amplifier of finite gain. If the combination is replaced by a non-inverting logic buffer an astable action should again result. The missing factor is that the circuit must have a quiescent state in the capacitor's absence that brings it into the linear region. A grounded resistor is not valid for a logic gate, and is here replaced by a potentiometer. When set in the linear region oscillations commence—an additional series resistor can be used to set the frequency.
Astables: Logic gate circuits

**THEORY**

- Both gates must enter their linear region for the loop gain to reach unity and initiate regenerative feedback. If these regions correspond to a small range of input voltages centred on $V_o/2$, the analysis is simple. For low-gain inverters both the waveforms and frequencies are less precise. It is assumed that input conduction is avoided (or minimized) as shown.

  Under these conditions the outputs are anti-phase square waves with the transitions occurring as the differentiator input passes through $V_o/2$. On the positive going step this input is driven up to $V_o/2 + V_i = 3V_o/2$. At that instant the other end of the resistor is taken down to zero. Hence $V_i = -3V_o/2$ while $V_o = -V_o/2$

\[ t_r - t_i = \log_3 2 = 1.1 \tau \]

The second part of the cycle has the differentiator input driven to $V_o/2 - V_i = -V_i/2$ while the other end of the resistor rises to $V_o$. Hence $V_i = 3V_o/2$, $V_o = V_o/2$ giving an identical time interval.

Hence $T = 2 \tau \log_3 2 = 2.2 \tau$

If the circuit is interpreted as a phase-shift circuit using analysis as for a sinusoidal response, invalid results are shown.

- The modified form of the circuit has an inverter with a voltage-gain $>1$. Hence its output is saturated for most of the timing cycle, and though type $V$ structure, a modified analysis is required. Again the thresholds are assumed to be close to $V_o/2$ and the CR junction is driven to $3V_o/2$ and $-V_o/2$ on the transitions.

This leads to comparable values of period and frequency, viz $T = 2.2 \tau$.

Second-order effects are important at high frequencies where gate delays modify the response. In each case an additional large value resistor should be added in series with any gate/inverter input subject to voltage steps going outside the supply lines.

- The first-order response is identical with that of the previous circuit. The Schmitt trigger is assumed to have upper and lower threshold voltages $V_u$ and $V_l$. The time for the rising ramp is

\[ t_r - t_i = \log_3 \frac{V_u}{V_l} = \log_{10} \frac{V_u - V_l}{V_l} \]

and for the falling ramp $\log_3 \frac{V_l}{V_u}$

The period is $T = \log_3 \left( \frac{V_u - V_l}{V_l - V_u} \right) + \log_3 \left( \frac{V_l}{V_u} \right)$

\[ t_s - t_r = \log_3 \left( \frac{V_u - V_i}{V_i} \right) = \log_{10} \left( \frac{V_u - V_i}{V_i} \right) \]

But for symmetrically placed thresholds

\[ V_u + V_l = V_s \]

\[ \frac{V_u}{V_l} = \frac{V_s}{2} \]

\[ \frac{V_s}{2} = \frac{V_s}{V_l} = \frac{V_l}{V_u} \]

\[ T = \log_3 \left( \frac{V_u + V_l}{V_l} \right) = \log_{10} \left( \frac{V_u + V_l}{V_l} \right)^2 = 2 \log_{10} \left( \frac{V_u}{V_l} \right) \]

**EXAMPLES**

1. The c.m.o.s. astable has $R = 100k\Omega$ and is required to oscillate at 10kHz. Assuming that $R_s$ is large enough to avoid conduction choose a suitable value of capacitance stating any assumptions. The threshold of c.m.o.s. inverters is normally within the range 45 to 55% $V_s$. It is convenient to take the threshold as $V_s/2$.

\[ V_1 = \frac{3V_s}{2} \]

\[ V_s = \frac{V_s}{2} \]

\[ -V_s = \log_3 1.1 = 1.1 \tau \]

- Half-period $t_s - t_r = \log_3 \left( \frac{3V_s/2}{V_s/2} \right)$

\[ \frac{-V_s}{2} = \log_3 1.1 = 1.1 \tau \]

- Period $2 \tau = 0.2 \times 10^{-6}$

\[ C = \frac{100 \times 10^{-6}}{2.2 \times 10^5} = 470pF \]

To check the effect of the variable threshold, assume each inverter switches at 0.45$V_s$

\[ V_1 = V_s + 0.45V_s \]

\[ V_2 = 0.45V_s \]

\[ \text{First time interval} = \log_3 \left( \frac{1.45}{0.45} \right) = 1.170 \tau \]

The second part of the cycle has

\[ V_1' = -1.55V_s \]

\[ V_2' = -0.55V_s \]

\[ \text{Second time interval} = \log_3 \left( \frac{1.55}{0.55} \right) = 1.036 \tau \]

\[ T = 2.2 \tau = 2.206 \tau \]

This compares with a value of 2.197 for the symmetrical case if $\log_3 3$ is evaluated more accurately i.e. on changing the threshold by 5% of supply (or 10% of its initial value) the mark-space ratio changes from 1:1 to 1:1.12 a change of 13%, though the frequency changes by only 0.4%.

2. An astable is constructed with a c.m.o.s. Schmitt circuit having upper and lower thresholds of 3V and 6.5V at a supply voltage of 10V. Estimate the frequency of oscillation with an RC section having $\tau = 500 \mu s$.

\[ T = \tau \log_3 \left( \frac{V_1}{V_2} \right) + \log_3 \left( \frac{V_2'}{V_1'} \right) \]

\[ = \tau \log_3 \left( \frac{V_1 - V_2}{V_2 - V_1} \right) + \log_3 \left( \frac{V_2 - V_1}{V_1 - V_2} \right) \]

\[ T = 1.47 \tau, \ f = 1.36kHz \]

For symmetrically placed thresholds but with the same hysteresis of 3.5V.

\[ V_1' = 5 + 1.75 = 6.75 \]

\[ V_2' = 5 - 1.75 = 3.25 \]

\[ T = 2 \tau \log_3 \left( \frac{V_1}{V_2} \right) = 1.46 \tau \]

This result can be obtained from the general case above by substitution as in the analysis opposite.
Amplitude modulator

With a 555 connected in the astable mode the timing capacitor charges and discharges between $V_{cc} = 2V_{cc}/3$ and $V_c = V_{cc}/3$. By simultaneously increasing or decreasing $V_u$ to $V_c$ symmetrically about $V_{cc}/2$, amplitude modulation can be achieved. Resistor $R_3$ is a compromise between excessive drop under d.c. conditions and loading of op-amp $A_1$.

A. D. Teckchandani
Faridabad
India

Long duration timer

The two oscillators constructed from a 556 have periods $T_1 + t_1$ and $T_2 + t_2$, where the outputs of the oscillators are high during $T_1$ and $T_2$ and low during $t_1$ and $t_2$. Also, $t_1$ is much smaller than $T_1$ and $t_2$ is much smaller than $T_2$, but $T_1$ and $T_2$ are almost, but not quite, equal. When the supply is connected the oscillators start simultaneously and there is a long duration before the low periods of the oscillators overlap. When this occurs a short low pulse is produced by the 7400. The maximum interval between the pulses can be estimated as follows. Let $t_1 = t_2 = t$ and let $T_2 = T_1 + t$.

Simple waveform generator

For audio frequencies this waveform generator offers several advantages over the usual Wien bridge circuit. No amplitude stabilization is required, there are no spasmomatic interruptions to the output when switching range, and a range of 10-1 is easily achieved with a standard twin-gang potentiometer.

The integrator $T_1$, $T_2$, the emitter follower and the Schmitt trigger $T_3$, $T_4$ produce a triangular waveform at the collector of $T_3$. This output is of constant amplitude throughout the frequency range due to fixed triggering points. The triangular waveform also feeds a second integrator $T_6$, $T_7$ which produces a good sine wave of constant amplitude. The audio range is easily covered by three pairs of capacitors and the three outputs can be taken selectively to a single emitter follower.

F. V. Goodfellow
Southampton
**NEW PRODUCTS**

**Solenoid-operated cassette units**

Typical applications of two new solenoid-operated cassette mechanisms, the Symot models LW 104 and YME 1006, include remote data acquisition, automatic annunciation, and processing activities in security systems. The LW 104 has been designed for use with continuous loop cassettes and is manufactured in corrosion-resistant plastic with a close-fitting translucent dust cover. The control solenoid, which operates on either 6V or 12V d.c., pulls on the pinch wheel and head assembly. The standard motor is an electronically-regulated type with an external circuit. YME 1006 is an all-metal skeleton mechanism for use with either continuous loop or conventional compact cassettes. Three forms are available - play only, record/replay with rewind facility and record/replay with cue and review facility. A (specially compounded) rubber capstan pinch roller permits permanent tape engagement without damage or roller indentation. Mono tape heads are fitted as standard and motors are mechanically regulated at 6V or 9V d.c. Symot Ltd, 22a Reading Rd, Henley-on-Thames, Oxfordshire RG9 1AG.

**Diagnostic engine tester**

Diagnosis of engine timing and faults in the electrical system of petrol engines is the function of the SD-80 ignition tester manufactured by Albol Electronic and Mechanical Products. The unit is supplied from a 12V battery and the makers claim that, by its use, savings of about 10% can be made on petrol costs, although we assume that this presupposes that the engine is already operating below par. Functions covered by the tester include engine revs, ignition angle (with respect to t.d.c.), contact breaker make angle (dwell), battery voltage, h.t. voltage, plus two resistance checking ranges. The unit also powers a stroboscopic lamp for advance/retard measurement and dimensions are 250 x 310 x 170mm at a weight of 4.8kg (22lb). Price is £198 plus v.a.t. and a six-month guarantee is provided. Albol Electronic and Mechanical Products Ltd, 3 Crown St, London SE3.

**7-segment I.E.D. display**

Each of the seven segments of the Highland Electronics 31-019 I.E.D. display can be illuminated separately and the unit can be panel-mounted in a single 16mm diameter round hole. Terminations are provided on a miniature p.c.b. which is an integral part of the unit's construction and extends in a vertical plane from the moulded body of the display.

**Pocket frequency meter**

Mobile communications applications are the areas of use which Electroneplan quotes for the Labgear CM7044 portable frequency meter. This instrument covers the range 10MHz to 500MHz and it is powered by rechargeable batteries. A small antenna (with b.n.c. fitting) is provided enabling measurement of transmissions to be made without disturbing the transmitter or making internal connections. Readings are presented on a 7-digit I.E.D. display in two ranges - 10 to 50MHz and 50 to 500MHz. Electroneplan Ltd, PO Box 19, Orchard Road, Royston, Herts SG8 5HH.

**Radial component pre-former**

An automatically fed machine capable of forming and cropping up to 5000 components (radial capacitors and transistors) an hour is now available from Elite Engineering Ltd. The design of the machine allows the cropping and forming of components to the same form even where their bodies are different, without changing the tooling, although an interchangeable tooling permits most different transistors to be cropped and formed for insertion in p.c. boards. Radial lead capacitors can be hopper-fed if necessary or hand fed on to a belt if an especially difficult form is required. Demonstrations of the machine can be arranged or sample components sent to the makers for forming on standard...
tools. Peter J. W. Noble, Elite Engineering Ltd, Unit 3, Salten Lane, Fareham, Hants PO16 0TD.

**WW 305**

**Power supply and ni-cad charger**

Producing an output of 13.8V d.c. at 750mA for amateur radio transceiver operation and a second output at 46mA, constant current, for recharging nickel-cadmium batteries, the Lar Modules PS1200, permits trans-

mision from the base station while recharging is taking place. The transceiver output supply is regulated and all switching is automatic. Protection circuits are included and output 2 (charger) is at negative ground. LAP Modules Ltd, 27 Cookridge St, Leeds, LS2 3AG.

**WW 306**

**R.f.i. sealing paste**

Described as “extremely fine in texture, consisting of a high concentration of pure silver particles in silicone resin” by the makers, Emerson and Cumming (UK) Ltd, Eccoshield SX is a conduc-
tive, non-hardening sealant and gasketing material for use as an r.f. shield. Volume resistivity of the paste is less than 0.005-ohm and it can be used at tempera-
tures from -79°C to +400°F (-56°C to +204°C) with no ad-
verse effects. The paste’s consistency can be changed by thinning with toluene and the manufactu-
erer quotes its use on cover plates of conduct junction boxes, to replace knitted metal gaskets and on bolt threads where it can help to assure continuous electrical contact and to prevent cor-
rosion. The claim is also made, that structures sealed with Eccoshield have a measured insertion loss in excess of 100dB.

**WW 307**

**Mains socket tester**

Constructed in the form of a 13A mains plug top, a socket tester with a visual display which indi-
cates a variety of faults. If used in a domestic mains supply is available from Galetrek. The makers say that when the tester is plugged into a socket (any form, including 5A or 15A round pin, these are connected by a length of cable) the neon display indicates “correct,” “live fault,” “no earth,” “live/neutral

reversed,” “neutral fault,” and “live/earth reversed.” The tester costs £4.50 including v.a.t. and a-
a 3-phase remote tester is also available at £8.95 inc. v.a.t. Galetrek, Scotland St, Lanwrst, Gwynedd, LL26 0AL, North Wales.

**WW 308**

**Tape head demagnetizer**

Demagnetization of tape heads without the need to withdraw the demagnetizing yoke away from the head at a constant speed is the claim made by TKD for its battery-operated electronic head demagnetizer, type No. HD11. The defluxing operation can be carried out in 1s, and the yoke is adjustable to settings of 15° and 30° from the horizontal. The de-
sign of the unit also makes it possible to carry out defluxing of heads on many older models of tape recorder, some of which are difficult in terms of head access. TKD Tape Distributor (UK) Ltd., 11th Floor, Pembroke House, Wellesley Rd, Croydon, Surrey. WW 309

**Auto transformers**

A range of transformers intended for the adaptation of modernized equipment which has been imported from the US is now available from F. H. Radford Ltd. This comprises a series of single-
phase auto transformers for either 240 or 220V supply, this input being transformed to 115V, by means of a single connection change. Four basic models are available as 500, 1000, 2000 and 3000VA units, each of which is equipped with two American 15A 3-pin outlets and a 3-core output lead. F. H. Radford Ltd, 35 Char-
lotte St, London WIP 1HP.

**WW 310**

**Magazine storage rack**

A collapsible frame moulded from polythene and held together by four metal tubes constitutes the Multi-file magazine storage rack. The frame is designed to hold up to 24 issues of a fairly weighty A4 publication (such as Wireless World) although a few more can be squeezed in if required. Each magazine is fitted with two clips which pinch at either end of the spine, and located at the centre spread – these must be fitted carefully to avoid taring — and the journal is then hung by these polythene clips from the rails at each side of the frame. The price, ex works, is £5.50 each, including v.a.t. or £3.50 each per unit per 1000 and the rack is available in four col-
ours — brown, light grey, blue and yellow. Alternative colours and “house” branding can be arranged on orders over 5000 at extra cost. Multi-file Ltd, Sands Industrial Estate, Hillbottom Rd, High Wycombe, Bucks.

**WW 311**

**Long scale panel meter**

Applications requiring higher than usual accuracy are quoted by Bach-Simpson (UK) for its new range of panel meters feat-
turing a 250° pointer deflection angle. These meters, specified as 212D, for d.c. and 2143L, for a.c. (rectified) are self-shielded, per-
manent magnet moving-coil instru-
maments with non-magnetic

pivots and spring-backed jaws; zero adjustment is via the front pivot. The facia dimensions of these meters are identical to the Simpson “Century” range of 3½ in panel meters. Bach-Simpson (UK) Ltd, Tenant Estate, Wadebridge, Cornwall, PL27 6HD.

**WW 312**

**Noise blanking chip**

Designed for the removal of noise spikes from broadcast f.m. compo-
site signals before decoding, the Toko KB436 is claimed by the UK distributor, Ambit Inter-
national, to be capable of providing an improvement of approximately 25 to 30dB on the unblanked signal to noise ratio. This i.c. is specifically intended for the removal of short duration impulse noise such as that generated by a car’s ignition circuits or d.c. motors. In order to maintain the 19kHz pilot tone during blanking periods, a signal derived from the decoder v.c.o. is added to the input signal for a period determined by the setting of externally-controlled time constants. This method ensures that the blanking process does not impair the quality of the out-
put signal. Further information for alternative applications is available from the distributor and the one-off price of the i.c. is £2.53 excluding v.a.t. Ambit Inter-
national, 200 North Service Rd, Brentwood, Essex CM14 4SG.

**WW 313**
Finally, you can have all the advantages of DMMs and none of the disadvantages of analogues for about the same price.

Our new 169 is a tough, lightweight, battery-powered digital multimeter for use in the field or on the bench. It is a 3½-digit, full 5-function DMM with respectable .25% DC accuracy.

Its low-parts-count, high-efficiency design keeps power consumption to a minimum for longer component life and fewer failures. MTBF is 20,000 hrs. or about 10 years.

All 5 functions are fully protected - 1400V peak on DCV and ACV, 300V on Ω, 2A (250V) on DCA and ACA. The fuse is externally accessible for quick replacement. Extensive vibration stress-testing assures the 169 will stand up to all the mechanical shock and abuse normally associated with tough applications.

Cost-conscious ease of maintenance is so thoroughly designed into the 169 that only one calibration adjustment a year is required. That adds up to a cost-of-ownership no other competitive DMM can touch. For example, the 169 needs only one battery change per year at a cost of about £1.50.

When you factor in features like function and range announcement right on the display, auto-zero, auto polarity, 60% larger display than other DMMs and the easy-to-read, colour coded front panel, we think you'll get the point. No analogue meter or DMM can match the price/performance of the new 169. It costs £99 (plus VAT)

For information on the 169 or any Keithley DMM call (0734) 861287

Ex stock

WW - 659 FOR FURTHER DETAILS
**SIMPLY AHEAD - and staying there!**

**O.E.M. PLATE POWER AMPLIFIERS**

**MADE IN ENGLAND**

I.L.P. offer for prompt delivery, a range of O.E.M. Plate Power Amplifiers in three useful output ratings. These units are typical of I.L.P. design and manufacture — encapsulated circuitry, rugged construction, just five pin connections, trouble-free mounting, no output capacitors or other external components to be added, and operation from split line power source. PRICES ARE KEENLY COMPETITIVE. QUALITY AND MANUFACTURE OF THE HIGHEST POSSIBLE STANDARDS. Modules can also be manufactured to customer's own design.

<table>
<thead>
<tr>
<th>UNIT</th>
<th>PRICE FOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY 120P</td>
<td>£10.30</td>
</tr>
<tr>
<td>60W rms</td>
<td>£9.37</td>
</tr>
<tr>
<td>8Ω</td>
<td>£8.51</td>
</tr>
<tr>
<td>HY 200P</td>
<td>£13.18</td>
</tr>
<tr>
<td>120W rms</td>
<td>£11.98</td>
</tr>
<tr>
<td>8Ω</td>
<td>£10.89</td>
</tr>
<tr>
<td>HY 400P</td>
<td>£19.26</td>
</tr>
<tr>
<td>200W rms</td>
<td>£17.51</td>
</tr>
<tr>
<td>4Ω</td>
<td>£15.92</td>
</tr>
</tbody>
</table>

Sizes—

HYP 120P and HY 200P

116 x 50 x 23mm

HY 400P

116 x 75 x 23mm

**SOFTY**

**IN FACT IS AN INTELLIGENT EPROM PROGRAMMER**

with a range of serial and parallel inputs – plus a keyboard for manual entry.

SOFTY presents a hexa-decimal MAP OF MEMORY contents on a TV set. The user has an ASSEMBLER-FACILITY to manipulate the displayed data, and cassette-tape storage of working programs and useful routines.

When purchased as a microprocessor product development kit. Softy costs only £100.

For literature and the name of your local retailer, contact Delusion, P.O. Box 5, Dorchester, Dorset. DT2 7UB or Telephone 03902 700.

**WHOLESALE ELECTRONIC COMPONENTS**

<table>
<thead>
<tr>
<th>Stock</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU113</td>
<td>120</td>
</tr>
<tr>
<td>3k-Presets</td>
<td>2,000</td>
</tr>
<tr>
<td>TBA800</td>
<td>500</td>
</tr>
<tr>
<td>4700µF 16v Elec.</td>
<td>800</td>
</tr>
<tr>
<td>7448 TTL</td>
<td>1,600</td>
</tr>
<tr>
<td>16-Pin DIL Socket</td>
<td>5,000</td>
</tr>
<tr>
<td>Z-80 P10 4MHz</td>
<td>30</td>
</tr>
<tr>
<td>2708 EPROM</td>
<td>500</td>
</tr>
<tr>
<td>2114 SRAM</td>
<td>800</td>
</tr>
<tr>
<td>4116 DRAM</td>
<td>800</td>
</tr>
</tbody>
</table>

And many more. Companies invited to send SAE for our up-to-date price list.

Please phone for availability before ordering. All our prices include 15% VAT. Postage extra.

**STRUTT ELECTRICAL AND MECHANICAL ENGINEERING LTD.**

**ELECTRICAL COMPONENT DISTRIBUTORS**

3c BARLEY MARKET ST. TAVISTOCK DEVON PL19 0SF

Tel. TAVISTOCK (0622) 5439 Telex: 45263

WW—866 FOR FURTHER DETAILS
THREE FOR FREE FROM CSC

AVAILABLE FROM SELECTED STOCKISTS

ELECTRONICS BY NUMBERS

RAIN ALARM
You need never be caught out by the weather again. The rain alarm will emit a warning sound whenever there's rain or moisture in the atmosphere. The current drawn from the battery is negligible so it can be left switched on for up to a year.

WOBBLY WIRE GAME
All the fun of the fair, in your own home! Test your skill at building and playing this version of the popular game, where a 'wand' has to be moved from one end of a wire to the other without the loop at the end of the wand ever touching the wire.

HIGH QUALITY CONTINUITY TESTER
An invaluable piece of test gear for testing and fault finding circuits and wiring. Pure continuity checks can be carried out without being affected by adjoining circuitry. Want to get started on building exciting projects but don't know how? Now using EXPERIMENTOR BREADBOARDS and following the instruction in our FREE "Electronics by Numbers" leaflet, ANYBODY can build electronic projects.

Look at the diagram, select RI, plug it in to the letter numbered holes on the EXPERIMENTOR BREADBOARD, do the same with the other components, connect to battery and ANYBODY can build a perfect working project.

YOU WILL NEED
e.g. LED Bar Graph (a previous project component) EXP300 or EXP350
D1 to D15 — Silicon Diodes
R1 to R6 Resistors
LED 1 to LED 6 Light emitting diodes
For the full detailed instructions, including "Electronics by Numbers" circuit diagrams, simply...

Just clip the coupon
Give us your name and full postal address (in block capitals). Enclose cheque, postal order or credit card number and expiry date, indicating in the appropriate box (all the breadboards) you require.

TAKE THE COUPON TO YOUR NEAREST CSC STOCKIST OR SEND DIRECT TO US AND YOU'LL RECEIVE "THREE FREE PROJECTS FROM CSC".

IF YOU MISSED FREE PROJECT No. 1, 2, 3, etc. please tick the appropriate box in the coupon.

PROTO-BOARDS
The ultimate in breadboards for the minimum of cost. Two easily assembled kits.

PB6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips.

PB100 Kit complete with 760 contacts accepts up to ten 14-pin Dips, with two binding posts and sturdy base. Large capacity with Kit economy.

IT'S EASY WITH C.S.C.
TO RECEIVE YOUR FREE COPY OF PROJECTS 4, 5 and 6.

For immediate action
The C.S.C. 24 hour, 5 day a week service.
Telephone 0798 21882 and give us your Access, American Express or Barclaycard number and your order will be in the post immediately.

THE C.S.C. 24 HOUR SERVICE TELEPHONE (0798) 21882

With your Access, American Express, Barclaycard number and your order will be in the post immediately.

CONTINENTAL SPECIALITIES CORPORATION

CSC (UK) LTD.
Dept 7EE Saffron Walden, Essex CB11 3AG
Tel: Saffron Walden (0798) 21882, Telex: B17477
The 7208 600 MHz Mini Counter

**the quality low cost counter**

**FEATURES**
- All Metal Cabinet
- 8 Digit, 4" LED Display
- Built-in Prescaler
- Automatic Dp Placement
- Gate Light
- IC Sockets Included
- 240V or 12V Operation
- Proportional Control Crystal Oven (Optional)
- Built-in VHF-UHF Preamp
- Completely Portable with Rechargeable Batteries (Optional).

**AVAILABILITY**

SOTA COMMUNICATION SYSTEMS LTD.
26 CHILDWALL LANE, BOWRING PARK, LIVERPOOL L14 6TX
MEREYSIDE. TEL. 051-480 5770

**DESCRIPTION**

The Davis 7208 VHF-UHF Frequency Counter incorporates the latest LSI technology in a wide range portable instrument at a reasonable price. The 7208 offers outstanding features including an all metal cabinet for RF shielding, large 8 digit display, built-in prescaler, automatic DP and with the built-in VHF-UHF preamp the 7208 can directly measure low level RF signals from RF generators. The 7208 can also be operated completely portable with the Ni-Cad battery option. Price £145.00 + VAT.

**CALLERS AND MAIL ORDER**

40 Bartholomew Street, Newbury, Berks. Tel: 0635 30505

**SPECTRONICS**

**UV Eeprom-Erasing Lamp**
- PE14 Erases up to 6 chips. Takes approx. 19 mins. £56.00
- PE14+* Erases up to 6 chips. Takes approx. 19 mins. £76.58
- PE24+* Erases up to 9 chips. Takes approx. 15 mins. £111.22
- PR125* Erases up to 6 chips. Takes approx. 7 mins. £257.84
- PR320T* Erases up to 36 chips. Takes approx. 7 mins. £384.09
- PC1000* Erases up to 72 chips. Takes approx. 7 mins. £842.83

**ACORN**

**S100 at NEWBEAR**

- 2K CPU board £26.25
- 8K STATIC RAM BOARD £18.75
- DISK INTERFACE BOARD £26.25
- V.D.U. BOARD £18.75
- 2708/2716 EPROM BOARD £18.75

**RANGE OF MOTHERBOARDS**

- S100 CONNECTORS £3.95
- 8K A CPU 4MHz £13.99
- 8K A CPU 4MHz £10.00
- 8K A CPU 4MHz £10.00
- SC/MP 11 £8.88

**CALLERS ONLY**

220-222 Stockport Road, Cheadle Heath, Stockport Tel: 061 491 2290

SEND FOR OUR NOVEMBER CATALOGUE AND BOOK LIST.

**USA W-009 FOR FURTHER DETAILS**
### SEMICONDUCTORS
SEND YOUR ORDERS TO
DEPT. WW11, PO BOX 6, WARE, HERTS.
VISIT OUR SHOP AT: 3 BALDOWT ST, WARE, HERTS.
TEL: 0920 3182. TELEX: 817861

### TRANSISTORS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>A120</td>
<td>2N3904</td>
<td>$0.01</td>
</tr>
<tr>
<td>A121</td>
<td>2N3906</td>
<td>$0.02</td>
</tr>
<tr>
<td>A122</td>
<td>2N3907</td>
<td>$0.03</td>
</tr>
</tbody>
</table>

### THYRISTORS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>A200</td>
<td>2N7010</td>
<td>$0.02</td>
</tr>
<tr>
<td>A201</td>
<td>2N7012</td>
<td>$0.03</td>
</tr>
<tr>
<td>A202</td>
<td>2N7013</td>
<td>$0.04</td>
</tr>
</tbody>
</table>

### SILICON RECTIFIERS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>C200</td>
<td>IN4007</td>
<td>$0.10</td>
</tr>
<tr>
<td>C201</td>
<td>IN4007</td>
<td>$0.10</td>
</tr>
<tr>
<td>C202</td>
<td>IN4007</td>
<td>$0.10</td>
</tr>
</tbody>
</table>

### AUDIO MODULES

**Amplifiers**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>A100</td>
<td>5 watt amplifier module</td>
<td>$3.73</td>
</tr>
</tbody>
</table>

**Pre-amplifiers**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>P100</td>
<td>Stereo pre-amplifier module</td>
<td>$18.45</td>
</tr>
</tbody>
</table>

**Power Supplies**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>S125</td>
<td>Power supply (24 volts DC)</td>
<td>$1.72</td>
</tr>
</tbody>
</table>

### CMOS ICS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>C100</td>
<td>IC 4001</td>
<td>$0.26</td>
</tr>
<tr>
<td>C101</td>
<td>IC 4017</td>
<td>$0.31</td>
</tr>
<tr>
<td>C102</td>
<td>IC 4032</td>
<td>$0.38</td>
</tr>
</tbody>
</table>

### LEDS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>L100</td>
<td>Red LED</td>
<td>$0.10</td>
</tr>
<tr>
<td>L101</td>
<td>Yellow LED</td>
<td>$0.20</td>
</tr>
</tbody>
</table>

### CLIPS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>C100</td>
<td>1058 x 135 pack of 25</td>
<td>$0.10</td>
</tr>
</tbody>
</table>

### DISPLAYS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>D100</td>
<td>7 segment DIP 300 (200) height common anode module</td>
<td>$1.55</td>
</tr>
</tbody>
</table>

### SOCKETS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>S100</td>
<td>80A 2 pole 4 pin main switch</td>
<td>$0.10</td>
</tr>
</tbody>
</table>

### G.P. SWITCHING TRANSISTORS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>T100</td>
<td>150V 150A 600W</td>
<td>$1.72</td>
</tr>
</tbody>
</table>

### G.P. SILICON DIODES

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>D100</td>
<td>2N3904 2N3906 2N3907</td>
<td>$0.20</td>
</tr>
</tbody>
</table>

### METAL FOIL CAPACITOR PAK

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>M100</td>
<td>250uF 100V</td>
<td>$0.10</td>
</tr>
</tbody>
</table>

### JUMBO PAK SEMICONDUCTOR

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>J100</td>
<td>1000Km 10 channel mono graphic equaliser</td>
<td>$23.00</td>
</tr>
</tbody>
</table>

### ALL PRICES INCLUDE VAT: ADD 35p POST PER ORDER

JUST QUOTE YOUR ACCESS OR BARCLAYCARD NO.
NRDC-AMBISONIC UHJ

SURROUND SOUND DECODER
The first ever kit specially produced by Intregex for this British NRDC backed surround sound system which is the result of 7 years’ research by the Ambisonic team. W.W, July, Aug., ’77.
The unit is designed to decode not only UHJ but virtually all other 'quadrophonic' systems (Not CD4), including the new BBC HJ 10 input selections.
The decoder is linear throughout and does not rely on listener fatiguing logic enhancement techniques. Both 2 or 3 input signals and 4 or 6 output signals are provided in this most versatile unit. Complete with mains power supply, wooden cabinet, panel, knobs, etc.
Complete kit, including licence fee £49.50 + VAT or ready built and tested £67.50 + VAT

NEW S5050A STEREO AMP
50 watts rms-channel, 0.015% THD, S/N 90 dB, Mags/n 80 dB.
Output device rating 360w per channel.
Tone cancel switch. 2 tape monitor switches.
Metal case—comprehensive heatsinks
Complete kit only £63.90 + VAT.

INTRUDER 1 Mk. 2 RADAR ALARM
With Home Office Type approval
The original 'Wireless World' published Intruder 1 has been re-designed by Intregex to incorporate several new features, along with improved performance. The kit is even easier to build. The internal audible alarm turns off after approximately 40 seconds and the unit re-arms. 240V ac mains or 12V battery operated. Disguised as a hard-backed book. Detection range up to 45 feet.
Complete kit £49.50 plus VAT.

Wireless World  Dolby noise reducer
Trademark of Dolby Laboratories Inc.

Featuring:
● switching for both encoding (low-level h.f. compression) and decoding
● a switchable f.m. stereo multiplex and bias filter.
● provision for decoding Dolby f.m. radio transmissions (as in USA).
● no equipment needed for alignment.
● suitability for both open-reel and cassette tape machines.
● check tape switch for encoded monitoring in three-head machines.

Also available ready built and tested ........................................................................... Price £59.40 + VAT
Calibration tapes are available for open-reel use and for cassette (specify which) .............. Price £2.40 VAT
Single channel plug-in Dolby PROCESSOR BOARDS (92 x 87mm) with gold plated contacts and all components ................................................................. Price £9.00 + VAT

Please add VAT @ 15%

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

Intregex LTD.

*Please send SAE for complete lists and specifications
Portwood Industrial Estate, Church Gresley,
Burton-on-Trent, Staffs DE11 9PT
Burton-on-Trent (0283) 215432  Telex 377106
**S-2020TA STEREO TUNER/AMPLIFIER KIT**

**SOLID MAHOGANY CABINET**

A high-quality push-button FM Varicap Stereo Tuner combined with a 24W r.m.s. per channel Stereo Amplifier.

**Brief Spec.** Amplifier Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc.). THD less than 0.1% at 20W into 8 ohms. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section uses 3302 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88—104MHz. 30dB mono S/N @ 1.2-V. THD 0.3%. Pre-decoder ‘birdy’ filter. **PRICE: £59.95 + VAT**

**NELSON-JONES MK.2 STEREO FM TUNER KIT**

Improved performance with linear phase IF and second generation IC decoder.

**NELSON-JONES MK. I STEREO FM TUNER KIT**

A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter/dual IC IF amp.

**Brief Spec.** Tuning range 88—104MHz. 20dB mono quieting @ 0.75μV. Image rejection — 70dB. IF rejection — 85dB. THD typically 0.4%. IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

Compare this spec. with tuners costing twice the price.

Sens. 30dB S/N mono @ 1.2μV
THD typically 0.3%
Tuning range 88—104MHz
LED sig. strength and stereo indicator

**STEREO MODULE TUNER KIT**

A low-cost Stereo Tuner based on the 3302 FET RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC. Pre-decoder ‘birdy’ filter Push-button tuning

**PRICE: Stereo £33.95 + VAT**

**S-2020A AMPLIFIER KIT**

Developed in our laboratories from the highly successful “TEXAN” design. PC mounting potentiometers, switches, sockets and fuses are used for ease of assembly and to minimize wiring

Power on/off FET transient protection.

**PRICE: £35.95 + VAT**

**BASELINE NELSON-JONES TUNER KIT** £15.70 + VAT

**PHASE-LOCKED IC DECODER KIT** £4.47 + VAT

**BASIC MODULE TUNER KIT** (stereo) £18.50 + VAT

**PUSH-BUTTON UNIT** £6.00 + VAT

**PORTUS-HAYWOOD PHASE-LOCKED STEREO DECODER KIT** £8.80 + VAT

WW — FOR FURTHER DETAILS
West Hyde have the greatest range of instrument cases


MINIATURE PVC/Steel cases with hundreds of cases. Equipment can be accommodated in the lower half, which is forget to regime, compartmentalised, then the top cover of spring type. Plastic. Monster, page last included.

Send for catalogue

Prices are correct at time of going to press. Prices are one off in F.P.P., but not VAT. Discounts for quantities.

Send for catalogue

All West Hyde cases are available with substantial discounts for quantities. Most cases have discounts at 5, 10 and 25 off, discounts up to 25% at 100 off. Prices include P&P but not VAT, and are less 10% if collected on first two price breaks on cases only. Send for NEW catalogue. Prices correct at press date.

WEST HYDE DEVELOPMENTS LIMITED, Unit 9, Park Street Industrial Estate, AYLESBURY, BUCKS. HP20 1ET. Phone: Aylesbury (0296) 20441. Telex: 83570

WIRELESS WORLD, JANUARY 1980

RADIO SHACK LTD

Ham Bands with 1.5-30 MHz receive with built-in 150 MHz frequency counter plus option of 0.1 5 MHz receive and/or any transceivering application 1:80 MHz.

RADIO SHACK LTD

For Communications equipment including Trio products and Trio testgear.

We are situated just around the corner from West Hampstead Underground Station (Bakerloo line) a few minutes walk away, with West Hampstead Middle Region station and West End Lane on the Broad Street Line. We are on the following bus routes: 28, 59, 159. Hours of opening are 9-5 Monday to Friday. Closed for Lunch 1-2 Saturday we are open 9-12.30 only. World wide experts.

RADIO SHACK LTD

188 BROADHURST GARDENS, LONDON NW6 3AY


J E S AUDIO INSTRUMENTATION

Illustrated the Si 451 Millivoltmeter—pk-pk or RMS calibration with variable control for relative measurements. 50 calibrated ranges. £78.00.

Si452 Distortion Measuring Unit

£63.00

Si453 Low distortion Oscillator, Sin-Square—RIAA

£78.00

PRICES plus VAT

J. E. SUGDEN & CO. LTD. Tel. Clockheaton (0274) 872501

CARR STREET, CLOCKHEATON, W. YORKS BD19 5LA

WWW -- 037 FOR FURTHER DETAILS

STEREO DISC AMPLIFIER 3

A reference amplifier for disc monitoring and transfer when replay signals of the highest quality are required.

STEREO DISC AMPLIFIER

Please ring or write for six page specification leaflet.

Reviewed in November issues of Gramophone, Hi-Fi for Pleasure and Popular Hi-Fi.

Dominus

P.O. Box 1

Cranleigh, Surrey GU6 7JF. Tel. 04866 6477

WIRELESS WORLD, JANUARY 1980

WWW -- 037 FOR FURTHER DETAILS
GEARED MOTORS

100 RPM 115vba insil
115ins, 110 volt, 50Hz, 2A single phase, split phase gear motor, home appliance wheel is easily detached. Fan: 6" in dia. 4 leaf, 20 rpm. 120VAC. £25.00 (Inc. VAT & P). Suitable for domestic and industrial use. £40.00 (Inc. VAT & P). N.M.S.

GEARED MOTORS

4 in 115vba 1600w Motor, 35lb. inch. 7/8" rpm Electric motor. Approx. 25" inch. £25.00 (Inc. VAT & P). 25 rpm Wymondale Motor. Approx. 20" inch. £20.00 (Inc. VAT & P). Supplies come with transformer for 230-240v AC supply with a 115vba 230v socket. £35.00 (Inc. VAT & P). N.M.S.

56 rpm. 50b. inch
240v AC auxiliary motor, 2200 rpm, 4 leaf. £6.20 (Inc. VAT & P). £10.00 (Inc. VAT & P). N.M.S.

1400 rpm H.1, 3.0 Continuous 30" 1/4hp motor with an basic variable control mounted. £10.00 (Inc. VAT & P). £15.00 (Inc. VAT & P). N.M.S.

12V SHUNT 1/30HP PH MOTOR Continuously 6.000, rpm. Made in Yugoslavia. £25.00 (Inc. VAT & P). £30.00 (Inc. VAT & P). £40.00 (Inc. VAT & P). N.M.S.

PARVALUX 220-250v AC Motors Type 11.150 250w £13.00 (Inc. VAT & P) Total incl. VAT & P: £17.00 (Inc. VAT & P). N.M.S.

CITENO

RPM = 3700vba 373/15 220/240v AC 19 £8.50 (Inc. VAT & P) £11.00 (Inc. VAT & P) £13.50 (Inc. VAT & P) £17.00 (Inc. VAT & P). N.M.S.

CROUZET 220-240v AC 2hp asynchronous electric motor £2.00 (Inc. VAT & P) £2.50 (Inc. VAT & P) £3.00 (Inc. VAT & P) £3.50 (Inc. VAT & P). N.M.S.

HAYDON 220-240v AC gear reduction motor £2.00 (Inc. VAT & P) £2.50 (Inc. VAT & P) £3.00 (Inc. VAT & P) £3.50 (Inc. VAT & P). N.M.S.

BIG INCH

The precision built 3 hp, 350vba AC motor only 1 x 100 volt AC or 240 volt AC £25.00 (Inc. VAT & P) £30.00 (Inc. VAT & P) £35.00 (Inc. VAT & P) £40.00 (Inc. VAT & P). N.M.S.

REDUCTION DRIVE GEARBOX

AC W15 TUBULAR CAPACITORS Front end makes price. M/s install etc.

2.5... 4.0... 6.0... 8.0... 10.0... 15.0... 20.0... 30.0... 40.0... £4.00 (Inc. VAT & P) £5.00 (Inc. VAT & P) £6.00 (Inc. VAT & P) £7.00 (Inc. VAT & P) £8.00 (Inc. VAT & P) £10.00 (Inc. VAT & P) £12.00 (Inc. VAT & P) £15.00 (Inc. VAT & P) £18.00 (Inc. VAT & P) £20.00 (Inc. VAT & P). N.M.S.

VENNER TYPE" EARD TIME SWITCH

220/250v AC 3amp. 212 on 2/212 off, as any manually switchable. £3.00 (Inc. VAT & P). £3.50 (Inc. VAT & P). £4.00 (Inc. VAT & P). £4.50 (Inc. VAT & P). £5.00 (Inc. VAT & P). £6.00 (Inc. VAT & P). £7.00 (Inc. VAT & P). £8.00 (Inc. VAT & P). £10.00 (Inc. VAT & P). £15.00 (Inc. VAT & P). £20.00 (Inc. VAT & P). £30.00 (Inc. VAT & P) £50.00 (Inc. VAT & P). N.M.S.

SANGAMO WESTEN TIME SWITCH

Twin 220/250v AC 3amp. 212 On 2/212 off, as any manually switchable. £3.00 (Inc. VAT & P). £3.50 (Inc. VAT & P). £4.00 (Inc. VAT & P). £4.50 (Inc. VAT & P). £5.00 (Inc. VAT & P). £6.00 (Inc. VAT & P). £7.00 (Inc. VAT & P). £8.00 (Inc. VAT & P). £10.00 (Inc. VAT & P). £15.00 (Inc. VAT & P). £20.00 (Inc. VAT & P). £30.00 (Inc. VAT & P). £50.00 (Inc. VAT & P). N.M.S.

AEG TIMESWITCH

200/250AC 312 On 212 off. 24 hour, EMR/ideal storage. £18.00 (Inc. VAT & P) £25.00 (Inc. VAT & P) £30.00 (Inc. VAT & P) £40.00 (Inc. VAT & P) £50.00 (Inc. VAT & P) £75.00 (Inc. VAT & P) £105.00 (Inc. VAT & P). N.M.S.

AEG MAINS TIMER UNIT

Based on an electronic clock with 25 amp, single phase control which can be fixed to any mains or domestic wiring. £3.50 (Inc. VAT & P). £4.00 (Inc. VAT & P). £4.50 (Inc. VAT & P). £5.00 (Inc. VAT & P). £6.00 (Inc. VAT & P). £7.00 (Inc. VAT & P). £8.00 (Inc. VAT & P). £9.00 (Inc. VAT & P). £10.00 (Inc. VAT & P). £15.00 (Inc. VAT & P). £20.00 (Inc. VAT & P). £30.00 (Inc. VAT & P) £50.00 (Inc. VAT & P). £75.00 (Inc. VAT & P) £105.00 (Inc. VAT & P). N.M.S.

MINIATURE PROGRAMMABLE TIMESWITCH

With 4 contact switches, £12.00 (Inc. VAT & P). £15.00 (Inc. VAT & P). £18.00 (Inc. VAT & P) £20.00 (Inc. VAT & P) £25.00 (Inc. VAT & P) £30.00 (Inc. VAT & P) £40.00 (Inc. VAT & P) £50.00 (Inc. VAT & P) £75.00 (Inc. VAT & P) £105.00 (Inc. VAT & P). N.M.S.

MINIATURE 24-HOUR TIMESWITCH

German mfr. £22.00 (Inc. VAT). Suitable for mains AC only. £20.00 (Inc. VAT & P). 12 & 24 hour. £15.00 (Inc. VAT & P). 24 hour. £12.00 (Inc. VAT & P). £15.00 (Inc. VAT & P). £20.00 (Inc. VAT & P) £25.00 (Inc. VAT & P) £30.00 (Inc. VAT & P) £40.00 (Inc. VAT & P) £50.00 (Inc. VAT & P) £75.00 (Inc. VAT & P) £105.00 (Inc. VAT & P). N.M.S.
**PROBABLY THE MOST INEXPENSIVE QUALITY SIGNAL GENERATOR AVAILABLE TODAY**

Audio Range: 10Hz-100Khz, in four switched ranges.
Distortion: Extremely low. (0015% typical, @ 1Khz).
Output: 1v into 600G, with Fixed and Variable Anten.
Sine and Square Wave.
Based on a Linsley Hood design.
Battery or Mains.

**TELERADIO ELECTRONICS**
325 FORE STREET, EDMONTON, LONDON N9 0PE
01-807 3719
Closed Thursdays SAE for lists

**BUILD YOUR OWN HIGH QUALITY TURNTABLE**

Direct drive motor/die cast turntable pack -
£26.00 + £3.90 V.A.T.
including post & packing
(V.A.T. shown at present rate of 15%)
Further details of these top quality components in return for s.a.e. - or personal callers welcome.
This offer applies to U.K. & Northern Ireland only: ask for quote for export orders.

**Symot Limited, 22a, Reading Road, Henley-on-Thames, Oxfordshire. R9 1AG. Telephone (049-12) 2663.**

**WW — 020 FOR FURTHER DETAILS**

**K.A.C A150 MIXER AMPLIFIER**
150 WATTS SINE WAVE POWER

£149.50
inc. VAT

Mono, all purpose, reliable, strongly made (%" All frame).
Double anodised facia. Full electronic short circuit protection.
Six independent inputs: Dual Phono, RIAA, change-over fader for Discos.
Twin Jack output sockets: BD 150W; 40000W; 160 800W. (R.M.S.)

K.A.C. Electronic Inv. Ltd., 20 Priory St., Tonbridge, Kent CALL FOR DEM or PHONE (0732) 358109 FOR LEAFLET

**EURO VHF FM TUNERSET 7252**
The long experience of Larsholt Electronics is reflected in this superbly engineered VHF Band II varicap FM tunermodule. (As used in the Signalmaster Mk. 8.)

The four stage frontend employs dual gate MOSFET transistors for both RF and Mixer stages, providing the 7252 with a 1 UV sensitivity for 30dB S/I (m). The IF uses a dual ceramic IF filter, and provides all usual HiFi functions, of tuning meter drives, muting, AFC and AGC. THD is only 0.1%.

**LARSHOLT ELECTRONICS**
DK 4622
HAVDRUP - DENMARK

**WW — 81 FOR FURTHER DETAILS**

**Diacrom Spatula**

No other cleaner has all these advantages:

1. Only 100% pure, natural diamond grains are utilised.
2. Blades are treated with hard chrome to reinforce the setting of the diamond grains, to achieve lowercoing or breakaway during use. This process also prevents clogging of the diamond surface by residues resulting from use.
3. All-diamond blades are rectified to ensure an absolutely smooth photographic diamond grains which may rise above the surface. This eliminates all excessive scratching during use.
4. All diamond grains are rigidly calibrated to ensure a perfectly uniform grain size of either 200, 300 or 400.
5. The chrome gives a very weak co-efficient of friction and the rigidity of the nylon handle is calculated to permit proper utilisation and yet prevent potential on highly delicate relays.
6. Grain size 200, thickness 55/100 mm., both faces diamonded. For quick cleaning of industrial relays and switching equipment, etc.
7. Grain size 300, thickness 55/100mm., both faces diamonded. For smaller equipments, like telephone relays, computer relays, etc.
8. Grain size 400, thickness 26/100 mm., one face diamonded. For delicate relays and tiny contacts. Two close contacts facing each other can be individually cleaned, because only one face of the spatula is abrasive.

**Solo Distributors for the United Kingdom**

**SPECIAL PRODUCTS (DISTRIBUTORS) LTD**
81 Piccadilly, London W1V 0HL. Phone: 01-629 9556
As supplied to the M.D.D. U.K.A.E.A., CE.G.B. British Rail and other Public Authorities; also major industrial and electronic users throughout the United Kingdom.

**WW — 079 FOR FURTHER DETAILS**

**WW — 020 FOR FURTHER DETAILS**
INTO THE 80's WITH CATRONICS
TELETEX DECODERS!

READY-TO-BUILD
DECODER 

SALE

Specially reduced prices for ready-built Teletex Decoders... 
from only £160. Send SAE for details and current list.

KITS
including
ULTRASONIC
REMOTE
CONTROL

Kits and PCBs are now available for the Ultrasonic Remote Control unit as described in recent issues of W.W. Kit includes plated-through hole "Board S", RX and TX PCBs, all components and installation instructions.

Price only £67.92 + VAT + Post = £78.80 total

Character "Boarding" "49" Kit £26.62 total

New Facilities "Board 3" Kit for £39.00 total.

Catrons

All new kits contain all the printed circuit boards and components necessary to build the complete decoder.

A reprint of the series of articles is available at £1.95 (+ P&P). See included free comic kit.

Prices are for the Version with TEXSB INCLUDING VAT.

Everything covered by our THREE STAR GUARANTEE.

CATRONICS LTD.,
(Dep. 21)
Communications House,
20 WALINGTON SQUARE,
WALINGTON, SURREY.
Tel: 01-688 6700

W.W.-931 FOR FURTHER DETAILS

RECHARGEABLE BATTERIES

TRADE ENQUIRIES WELCOME

Full range available to replace 1.5 volt dry cells and 9 volt PP type, battery packs. SAE for catalogue and prices. £1.25 for booklet. "Nickle Cadmium Power," plus catalogue.

Write or call at:

SANDWELL PLANT LTD.
2 Union Drive, Balsmere
Sutton Coldfield, West Midlands 021-354 9764
See full range at TLC, 32 Craven street, Charing Cross, London WC2.

W.W.-939 FOR FURTHER DETAILS

Barrie Electronics Ltd.
3, THE MINORIES, LONDON EC3N 1BZ
TELEPHONE: 01-488 33168
NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL STREET

W.W.-931 FOR FURTHER DETAILS
Simply ahead...

ILP’S NEW GENERATION OF HIGH

I.L.P. modular units comprise five power amplifiers, pre-amp which is compatible with the whole range, and the necessary power supply units. The amplifiers are housed and sealed within heatsinks all of which will stand up to prolonged working under maximum operating conditions.

With I.L.P. performance standards and quality already so well established, any advances in I.L.P. design are bound to be of outstanding importance — and this is exactly what we have achieved in our new generation of modular units. I.L.P. professional design principles remain — the completely adequate heatsinks, protected sealed circuitry, rugged construction and excellent performance. These have stood the test of time far longer than normally expected from ordinary commercial modules. So we have concentrated on improvements whereby our products will meet even more stringent demands such, for example, as those revealed by vastly improved pick-ups, tuners, loudspeakers, etc., all of which can prove merciless to an indifferent amplifier system. I.L.P. modules are for laboratory and other specialised applications too.

PRODUCTS OF THE WORLD’S FOREMOST SPECIALISTS
IN ELECTRONIC MODULAR DESIGN

AVAILABLE ALSO FROM A NUMBER OF SELECTED STOCKISTS
and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER

VALUES OF COMPONENTS FOR CONNECTING TO HY5

THE POWER AMPLIFIERS

THE POWER SUPPLY UNITS

I.L.P. Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms - one with circuit panel mounted on conventionally styled transformer, the other with toroidal transformer, having half the weight and height of conventional laminated types.

HY5 PRE-AMPLIFIER

The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm, and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) Inputs, all with high overload margins. Active tone control circuits: 500 mV out, Distortion at 1KHz - 0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

£4.64 + 74p VAT

NO QUIBBLE 5 YEAR GUARANTEE
7-DAY DESPATCH ON ALL ORDERS
INTEGRAL HEATSINKS
BRITISH DESIGN AND MANUFACTURE
FREEPOST SERVICE
- see below

Please supply

Total purchase price £

I enclose Cheque □ Postal Orders □ International Money Order □

Please debit my Account/Barclaycard Account No.

NAME

ADDRESS

Signature

ELECTRONICS LTD.
FREEPOST Graham Bell House, Roper Close, Canterbury, Kent CT2 7EP, Telephone (0227) 54778 Telex 965780

WW - 98 FOR FURTHER DETAILS
AN INVITATION TO

Communications 80, the fifth in a series of international expositions dealing with the applications of communications and systems, particularly in the major growth areas of data and business communications which are being created by the converging technologies of computing and telecommunications. The other important themes of the exposition are PTT telecommunications, civil fixed and mobile radio and emergency communications.

Communications 80 will attract visitors from all over the world (from 69 countries at the last event in 1978) who will be coming to see the latest developments in communications technology displayed by leading international manufacturers. Many of the visitors will also attend the integral conference, organised by the Institution of Electrical Engineers in association with leading international learned societies, to learn about the latest technical advances in communications equipment and systems.

Communications 80, the world's leading international exposition in the field, is actively supported by the International Telecommunication Union - the world telecommunications authority representing 153 governments; the British government, through the Home Office, the British Post Office; Cable and Wireless Ltd; and the two main UK trade associations - the Electronic Engineering Association and the Telecommunications Engineering and Manufacturing Association.

Please make a note of the dates and venue of Communications 80 - Tuesday 15 April to Friday 18 April, 1980, at the National Exhibition Centre, Birmingham, England.

You cannot afford not to come if you make, use or specify communications equipment and systems.

I am interested in attending Communications 80.

Please send me details of exhibition
[ ] conference

Name

Position

Company

Address

Complete, detach and mail to
Tony Davies Communications
c/o Industrial and Trade Fairs Ltd, Radcliffe House,
Blenheim Court, Solihull, West Midlands B91 2BG, England.
Telephone: 021 705 6707 Telex: 337073

All mail to:
351 Edgware Road
London W2 England
Phone: 723 1088
Telex: 622324, Ref. 1400.

WIRELESS WORLD, JANUARY 1980
BSR DE LUXE AUTOCHANGER
Plays 12", 10" or 7" records. Auto-Selector; 60 second unit backed by BSR reliability. Stereo Cartridge. 200/250V AC 50/60Hz. £20
903 £10.60

HEAVY METAL PLINTHS
Can be used with BSR or Garrard decks. £3.50
Model "A" £2.50
Model "B" £2.80
TINTED PLASTIC COVERS
Stylish and practical for use with 12" or 10" records. £3.50
Model "A" £2.50
Model "B" £2.80

SINGLE CHANNEL SPEAKER
Ideally suited for use with caving device. £21
Cable included. £14.50

GARRARD HI-FI MINI CHANGER
3-speed stereo speaker
Plays all size records. £8.95 £1.60

ELAC HI-FI SPEAKER 8in. TWIN CONE
Large ceramic magnet. 10,000 0.5 with 5000 0.5. £16.50 £3.30
8 in. BAKELITE. £11.25 £2.25

HIGH VOLTAGE POWER PACK FOR MODELS
Ready made. Famous make. Will supply volt D.C. at 400mA.
With terminals and meters lead. £2.75 £0.50

POTENTIOMETERS
Wider to 2MO. L.C. or L.S. £5.95 £1.15
L. S. £2.95. £0.55
E. D. 49p. £0.05
85p.

EMI 13" x 8in. LOUDSPEAKERS
Wired cables included. crossover. 20, 30 or 40 Watt. £9.95 £1.95

MAINS OPERATED SOLID STATE AM/FM STEREO TUNER
200/240V AC Mains. F.M./A.M. Stereo Tuner £26
Covering M.W., A.M. 545-1550Kc. V.H.F., F.M. 88-100MHz
Full AFC and AGC on A.M. and £5.50 £1.10
Stereo Response Indicator. Built-in Pre-amp.
Input adjustable. £5.50 £1.10
by pre-set
control, Max. 10V 5000V. F.M. £10, 20k. £28 £5.60
Simulated Test panel. will match almost any amplifier. £28 £5.60
Size approx. 3.5 x 12 x 6 in.

Baker Loudspeaker "SPECIAL PRICES"

Baker LoUDSPEAKERS "SPECIAL PRICES"

Baker AMPLIFIERS
For PA Disco. General purpose with built-in mics and pre-amps.
50 watt 2 channels. £30. £6 £6

LOUDSPEAKERS. FAMOUS MAKES "SPECIAL PRICES"

GOODMANS TWIN AXIOM 8 inch dual cone loudspeaker: £85.00. £17 £3.40
20cm. £10. £2 £2
CROSSTOVERS: T W O - W A Y 3000 c/s or 3 or 8 ohm £18.03. 20 cm £409.00. 20 cm £82.00
LOUDSPEAKERS: PM 3 34cm. £18.50  £61.50  £11.95
Spcl. OFFER: £6.50. 2.5cm. 3cm. £21. £4.50
£21. 2.5 cm £4.50
GOODMA NS FUL L R A N G E  L O U D S P E A K E R S  £30. £6 £6
SUS WOOFER 8 in £14.00 £2.80 £2.80
MOON GENERAL 5 in £12. £2.40 £2.40
MCKENZIE DISCO GROUP 15 in. £18 £3.60 £3.60
Select DISCO GROUP. £15 £3.00 £3.00

TEAK VENEERED HI-FI SPEAKER CABINETS
For 331/3 or 8 in. speaker: £9.50 £1.90
For 8 in. speaker and tweeter: £8.50 £1.70
For other cabinets in stock. Phone your requirements
SEND TOCA COVERING MATERIALS. Samples Large S.A.E.
LOUDSPEAKER CABINET WADING 12 in. £20.00 £4.00

GOODMANS RUBBER SURROUND BASS WOOFER Standard 12in. 35cm. £35.00. £7.00 £1.40
15 in. £65.00. £13.00 £2.60
50cm. £17.50. £3.50 £0.70
100cm. £25. £5.00 £1.00
150cm. £40. £8.00 £1.60
Bass woofer £5.00 £1.00

BLACK PLASTIC CONSTRUCTION BOX with brushed aluminium finish. £5.00 £1.00

OLD ALUMINIUM FINISHED TYPE
Sizes 5 x 4 x 1" 85p. £0.80 £0.16
5 x 4 x 85p. £2.00 £0.40
5 x 4 x 85p. £3.50 £0.70
5 x 4 x 85p. £5.00 £1.00

JACK PLUGS Mono mini. £0.10 £0.02
JACK PLUGS Stereo plastic £0.10 £0.02
JACK PLUGS Mono mini. £0.10 £0.02
JACK PLUGS Stereo plastic £0.10 £0.02
FREE SOCKETS - CABLE and 3p. £0.05 £0.01
FREE SOCKETS - CABLE and 3p. £0.05 £0.01
FREE SOCKETS - CABLE and 3p. £0.05 £0.01
FREE SOCKETS - CABLE and 3p. £0.05 £0.01
FREE SOCKETS - CABLE and 3p. £0.05 £0.01
FREE SOCKETS - CABLE and 3p. £0.05 £0.01
s cop e for wideband brilliance modulation and an ideal format for visual inspection.

Typically a test word would be transmitted through a system with the output digital data applied as brilliance modulation to the FOR. The word marker triggers the timebase which would be adjusted to cover one word across the paper. The paper speed is adjustable to just successive words, thus producing a uniform pattern on a regular signal from a perfect system. Disturbances due to data change, errors and drop-outs are very obvious. Resolution and bandwidth are adequate to resolve 265 bits at 9600 bands.

Medelec Fibre Optic Recorders are also used for research and development in Video Imaging, Noise and Vibration, Transients and many other fields.

Inward looking FTIR

The use of a Fibre Optic Recorder in the unique Raster mode with wideband brilliance modulation allows digital data to be recorded in an ideal format for visual inspection.

Typically a test word would be transmitted through a system with the output digital data applied as brilliance modulation to the FOR. The word marker triggers the timebase which would be adjusted to cover one word across the paper. The paper speed is adjustable to just successive words, thus producing a uniform pattern on a regular signal from a perfect system. Disturbances due to data change, errors and drop-outs are very obvious. Resolution and bandwidth are adequate to resolve 265 bits at 9600 bands.

Medelec Fibre Optic Recorders are also used for research and development in Video Imaging, Noise and Vibration, Transients and many other fields.

Medelec Industrial Products

MEDELEC LIMITED
A Vickers Limited Company
Manor Way, Woking, Surrey
Tel: Woking (04862) 70331
Telex: 859141 Medlec G

WW - 615 FOR FURTHER DETAILS
The 14D-15 is the very latest addition to the Scopex range of brilliantly engineered, easy to use oscilloscopes. Here's what it offers:
- Large screen 10 cm x 8 cm
- Triggers on channels 1 and 2
- 2 mV — 10V/DIV sensitivity
- 3% accuracy — a Scopex speciality
- DC-15 MHz bandwidth over the entire screen
- Probe test output
- Wide time base range
- Switched mode power supply

Plus a host of well thought-out additional facilities, free delivery in the UK mainland and a very good price of £280 plus VAT.

Trust Scopex to get it right.

Scopex
Pixmore Avenue, Letchworth,
Herts. SG6 1JJ.
Telephone: 04626 72771.

WW-029 FOR FURTHER DETAILS
We are the Designer Approved suppliers of kits for this excellent design. The Author's reputation tells all you need to know about the circuitry and Hart expertise and experience guarantees all the engineering design of the kit. Advanced features include:

- High quality separate VU meters with excellent ballistics. Controls, switches and sockets mounted on PCB to eliminate difficult wiring. Proper moulded escutcheon for cassette aperture improves appearance and removes the need for the cassette transport to be set back behind a narrow finger trapping slot. Easy to use, robust Lenco mechanism. Switched bias and equalisation for different tape formulations. All wiring is terminated with plugs and sockets for easy assembly and test. Sophisticated modular PCB system gives a spacious, easily built and tested layout. All these features added to the high quality metalwork make this a most satisfying kit to build. Also included at no extra cost is our new HS15 Sendust alloy record/play head, available separately at £7.60 plus VAT, but included FREE as part of the complete kit at £81.50 plus VAT.

REPRINTS of the 3 articles describing this design 45p No VAT.
REPRINT of Postscript article 30p No VAT.

---

**VLF 900**

**VFL 910** Vertical front loading Super Hi-fi deck, as used in our new Linsley-Hood Cassette Recorder 2. £31.99 + VAT. Set of knobs £1.46 + VAT.

---

**LENO CASSETTE MECHANISMS**

We hold stocks of a range of Lenco tape transports for all uses, we can also supply spare parts. For example:

- CRV Motors complete £4.00 plus VAT.
- CRV Drive Belts 90p plus VAT.

**CASSETTE HEADS**

A large range of cassette heads for domestic, industrial and audio visual purposes is available from us. The very best stereo head that we can find is our HS15 Sendust Alloy Super Head. This has an even better high frequency response than our HS14 which it replaces. Unlike cheaper and ferrite types this excellent high frequency performance is combined with a high output, thus maintaining the best possible signal to noise ratio. Price £7.60 plus VAT, 4 TRACK Record/play head. Scans all 4 tracks on cassette tape. Suitable for auto-reverse mechanisms, film sync, quadrophasonics and many other purposes. Standard impedance £7.40 plus VAT.

Full details of these and other heads are in our lists.

ALL UK ORDERS ARE POST FREE

Please send 9x4 SAE for lists giving fuller details and price breakdowns.

---

**HART ELECTRONICS**

Instant easy ordering, telephone your requirements and credit card number to us on Oswestry (0891) 2894 Telex: 35681 Hartel G

---

**TV TUBE REBUILDING**

Faircrest Engineering Ltd., manufacture a comprehensive range of equipment for processing all types of picture tubes, colour and mono. Standard or custom built units for established or new businesses. We export world-wide and have an excellent spares service backed by a strong technical team.

Full training courses are individually tailored to customers' requirements.

For full details of our service contact Neil Jupp

**FAIRCREST ENGINEERING LTD.**

Willis Road, Croxdon, CR02XX.
01-684 1422, 01-689 8741

---

**PPM2: PEAK PROGRAMME METERS**

- Approved by broadcasting authorities in the U.K. and overseas for critical programme monitoring.
- Accurate in law and between all PPMs with minimal preset adjustment. Marginal adjustment is retained to allow compensation for the tolerance in scale markings between meter manufacturers and different meters from the same maker.
- Decay matching of all boards allows use with twin movements without phasing.
- Fast frequency response at all PPM marks and also below minimum calibration point.
- Gold-plated connector and flush input protected against static or static-wattage on the signal lines. Supply input protected against reverse polarity.
- Close tolerance components with excellent temperature and ageing characteristics used throughout.
- Sockets tested boards. Ernest Turner meters movements 640, 642, 643, and TWIN illuminating adaptors and illumination kits from stocks. Scallings available 1/7, IEC268-10A Type 11a 11b TEST 12 type 11b used by EBU and conforming to C CITT recommendation N15(1972) but not recommended by us except for EBU and following international standards.

**SURREY ELECTRONICS**

The Forge, Lucas Green, Cranleigh, Surrey GU6 7BG. Tel. (04866) 5997

---

**SUPER BARGAIN OFFER**

LENO FFR CASSETTE DECK
For those who missed our recent bargain CT4s we now are delighted to offer our New Lenco FFR Decks complete with motor speed and auto-stop control board fitted and tested. These will operate with any supply between 9 and 16 volts. This deck can be used for both record and playback applications and is fitted with an erase head. A mono record/play head is fitted and we can supply an extra stereo head, if ordered with the deck at the very special price of £2 plus VAT. We also supply, with each deck and completely FREE, one of our specially moulded escuchions. This deck would normally cost about £25 but we are able to offer them, while they last, at only £9.99 plus VAT.

---

**BAILEY 30 WATT AMPLIFIER**

We have now completely redesigned this popular amplifier to make it as easy to build as our latest kits. The power amplifiers are complete modules plugging into a power supply master board, all possible wiring has been eliminated but fuses have been maintained with the existing metal work to enable owners to update as they wish. Send for full details in our list.

---

**COME AND SEE US ON STANDS**

C9 & C10 AT BREADBOARD '79

Penylan Mill, Oswestry, Salop
Personal callers are always welcome but please note we are closed all day Saturday

---
### SEMICONDUCTORS

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>A915</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A916</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A917</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A918</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A919</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### VALVES

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>A920</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A921</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A922</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### BASES

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>B923</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B924</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B925</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B926</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### CRTs

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>C927</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C928</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C929</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### INTEGRATED CIRCUITS

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>I930</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I931</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I932</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Terms of business:** C.V.O. Portage and packing valves and semiconductors 30p per order. CRTs £1. All prices include VAT. Prepayment brings discount of 5%. In some cases prices of Mullard and USA valves will be higher than those advertised. Prices correct when going to press. Account facilities available to approved companies with minimum order charge £10. Carriage and packing: £1 on credit orders. Over 10,000 types of valves, tubes and semiconductors in stock. Quotations for any types not listed. S.A.E. Open to callers Monday-Friday 9 a.m.-5 p.m.
DISPLAY ELECTRONICS

Would like to wish all their customers and business associates a Very Merry Christmas and Prosperous New Year

Hi-Fi TONE ARM BARGAINS from Britain's Leading Audio Store

ARISTON 8A 100 — low mass, high quality arm. S shaped. Low compliance. Universal SME type Head Shell. Complete with anti-skating device. £15.95

AUDIO TECHNICA AT-1007 — S shaped arm. Low compliance magnesium universal headshell. Low capacitance. Perfect tracking. £29.95

ALL LEADING MAKES OF HI-FI AND MANY OTHER ACCESSORY BARGAINS AVAILABLE FROM THE COMMUNICATIONS CENTRE:

ALL GOODS SUPPLIED WITH FULL 2 YEARS GUARANTEE

274 Trafalgar Road, London, W11 6DD
Tel: 01-963 1360

www.americanaudio.co.uk
The superb 3.77 is the only choice in compact professional recorders.

Who says?
Hundreds of satisfied professional users—Broadcast authorities, studios, record companies, universities etc etc.

What makes it the best?
The 3.77 provides more performance and features for your £ than any other model. Like 3 speeds, flat metal facia with excellent editing facilities, 100% variable speed control, logic control with motion sensing, line-up oscillator.
Largest range of quality components in the U.K.—over 8,000 types stocked

ROHDE & SCHWARZ

MARCONI
TF 32080 TV Transmitter Sideband Analyser. TM 32081R UHF Converter for above. TF 1101 RC Oscillators £65. TF 1102 UHF swept generator £85. TF 10418 Valve Voltmeters £85. TF 1152A/1 Power meter. 25W 500MHz. £55. TF 22020 Power Meter. 100W. 250MHz. £85. TF 1020A 1 RF Test Set. £285. TF 11500 Pulse Generator £85. TF 11568 AM-FM Signal Generator £50. TF 12118/3 Signal Generator £175.

BECKMAN TURNS COUNTER DIALS
Miniature type (27mm diam), counting up to 15 turn "Helipots." Brand new with mounting instructions. Only £2.50 each. Wandel & Goltermann Equipment Level Meter 0-16000Hz. Level Oscillator 0-16000Hz. Level Transmitter 0.3-15000Hz. Carrier Frequency Level Meter ADVANCE CONSTANT VOLTAGE TRAYS

PYE RESISTANCE BOXES
5 decade resistance boxes measuring from 11.11 ohms to 0.001 ohm £20. LABORATORY OVENS—Gallenkamp. 3 cu. ft. £145. Also Morgan Grundy 1 cu. ft. £55. 20-WAY JACK SOCKET STRIPS. 5 pole type with two normally closed contacts. £2.50 each (+25p pp). Type 316 three pole plugs for above —20p pp. (pp free).

P. F. RALFE ELECTRONICS
10 CHAPEL STREET, LONDON, NW1
TEL. 01-723 8753

DC POWER SUPPLIES
'APT 10459/8, 12-14V. 5 Amps. £25. (+£1 pp).
'APT 10459/8, 24V. 5 Amps. £25. (+£1 pp).
'Multi-Range Dual supplies. Brand new with handbook. Pos. & Neg. 12V at 1A and 0.4A resp. Dims 9x4x5in. £10. (+£1 pp).
'Lambda Brand new with 5V. 4A. (110 AC Input through, so) £300. (+£1 pp).

FARNELL. Current limited. Dimensions 7x5x4in. Following range available. £25. @ 3 Amps. 13.17 Volts @ 2 Amps. 130 Volts @ 1 Amp. Price £15. (+£1 pp). All the above power supply units are 230V AC input. except Lambda type and are stabilised and regulated and fused. All are fully tested before despatch and guaranteed. All first class order throughout. As with all our equipment, there is a money back guarantee.

MODULATION METERS—AIRMEC 210 3-300MHz AM/FM. £400. RACAL 409 3-600MHz AM/FM.

'CENTAUR' INSTRUMENT COOLING FANS
Made by Rotron Holland. These are very high quality. Quiet running fans, especially designed for the cooling of all types of electronic equipment. Measures 4.5x4x1.5in. 115Vac 11Watts. The list price of these is over £100 each Also 230V available. £15. £4.00. (postage 25p. 230V £6.

Finger guards for above —50p each. Also small type Papit fans as above measuring 8x5x3cm. 2 cu. ft/min. 110V only £4.00 (+10p pp) 230V price for all these fans are now around £12.50 each!!
TELETYPES KSR33
Upper case ASCII with 20MA Loop. This is a printer with Keyboard (no Punch or Reader on this model). £225 each

BRUEL & KJOER EQUIPMENT
Audi0 Frequency SPECTROMETER type 2112 £175 ea.
BEAT FREQUENCY OSCILLATOR type 1011 £140
BEAT FREQUENCY OSCILLATOR type 1012 £130
AUTOMATIC VIBRATION EXCITER CONTROLLER type 1018 £90
AUTOMATIC VIBRATION EXCITER CONTROL type 1019 £90

POLARAD SPECTRUM ANALYSER
5" Display. These are supplied with STU 2 plug-in 1 to 4.5GHz £126 each.

MARCONI SPECTRUM ANALYSER Type TF1094
This gigantic but superb analyser covers from 100HZ to 30MHz with a 6Hz resolution. 5" display. Complete with trolley. £75 each.

CROWN replacement MOTOR for IBM GOLFBALL TYPEWRITERS. 110 volt 50Hz, 1300 rpm. £4.50 each P&P £1.50

STEPPING MOTORS
AUTO 36V OUTPUT 15V £1 each. Output 5V £1.5 each P&P £1.50
24V OUTPUT 8V, 6V 1.8A £2 each. 2V £2.5 each. Good quality £1.5 each P&P £1.50
15V OUTPUT 12V ±0.1% 5V £3 each P&P £1.50
£1.50 each P&P £1.50

TRANSDUCERS. 230V 620 Watts. Size 13x13" 1/8" dia. £1.80 P&P £1.50
BRIDGE RECTIFIER. 10 x 50p each. £1.50
PHOTODIODE DETECTOR. 8 x 1/2" dia. 25p each.
A SUPERIOR KEYBOARD. Size 3 x 2 x 2/16" high. 12 Alice Reed buttons. Blue buttons marked in green 0-9 and a stir with on-off. 95p each. 75p 10 per.
APPLIANCE. 17-way chassis mount edge connectors 1 x 0.5p each.
TRANSFORMERS. (Standard Marks Ltd). Secondary output.
60KV 125A £415.50
34KV 160A £440.50
60KV 200A £530.50
60KV 300A £750.50
60KV 400A £1150.50
120KV 250A £690.50.
25KV 1100A £600.50
120KV 300A £990.50
60KV 200A £750.50
60KV 300A £750.50
25KV 1100A £600.50
60KV 200A £750.50
60KV 300A £750.50
TRANSFORMERS.
60KV 125A £415.50
34KV 160A £440.50
60KV 200A £530.50
60KV 300A £750.50
60KV 400A £1150.50
120KV 250A £690.50
25KV 1100A £600.50
120KV 300A £990.50
60KV 200A £750.50
60KV 300A £750.50
25KV 1100A £600.50
60KV 200A £750.50
60KV 300A £750.50

C.LastName

WIRELESS WORLD, JANUARY 1980

TRANSISTOR INVERTER 115V 50/60 HZ INPUT
These are at 200HZ. They can be modified to be a watching power supply or to provide EMI for VDU, Oscilloscopes, etc. or the output core could be rewound to provide any voltage/current within the unit's rating. As supplied they have the following outputs. A schematic is provided. 35V x 4 x 81/4". All units are tested before dispatch. £2.25. P&P £1.50

TELEPHONES
NEW LOW PRICE £200 each.

HONEYWELL VDU
1920 Character Upper Case ASCII. With edit and block transmission. Limited quantities only.

OLIVETTI PRINTER & KEYBOARD type Te 300
with PUNCH & READER. Upper case ASCII with V24 Interface. 240 volt operation. £125 each

INFRA RED IMAGE CONVERTER type 9606 (CV 144)
114 x2. Diameter. Requires single low current 3KV to 6KV supply. Individually boxed. With data. £12.50 each P&P £7.50

Infra Red Lamps also advertised

CRYSTALS
19.2KHz FLAT PACK CASe. 60p each. 10 MHz B7G 50p each.

EX:K AVAL 46s in STeEL DISHs. NEW. CATHODE 1 1/4 step at 3 volts. New channel devices with holes for various device options. £2.50 each. Cased £4

LIST AVAILABLE AT WHITE OR PHONE

MINIMUM ORDER £3 value of goods. P&P or Carriage and VAT at 15% on total must be added to all orders

CALLERS VERY WELCOME STRICTLY BETWEEN 9am-1pm and 2-5pm Monday to Saturday to Mr. BARCLAY (VISA) and ACCESS taken. Official orders welcome.

CHITMEAD
NORWICH ROAD, READING
TELEPHONE NO. READING 669656
(2nd turning left past Reading Technical College in King's Road then right front — look right for door with "Spoked Wheel" sign."

At getonhistory.com
Our catalogue contains small metal enclosures for every application including the attractive new G range cases, with unique integrated chassis and sloping visor front and the inexpensive kit-form Veropak. We’ve also got circuit boards, accessories, module frames and plastic boxes – all to the highest standard to give your equipment the quality you demand. Send 40p to cover post and packing and the catalogue’s yours.

VERO ELECTRONICS LTD RETAIL DEPT.
Industrial Estate, Chandler’s Ford,
Hampshire SO5 3ZR
Tel: (0421) 62829

Wireless World wishes to apologise to all parties concerned for any inconvenience caused by the publication in the December 1979 issue, of an advertisement purportedly on behalf of Nevenco Ltd. This was published due solely to an error on the part of Wireless World and not as the result of an order by any advertiser.

VERO
Metal Cases

FOTOLAK
POSITIVE LIGHT SENSITIVE AEROSOL LACQUER
Enables YOU to produce perfect printed circuits in minutes!
Method: Spray cleaned board with lacquer. When dry, place positive master of required circuit on now sensitized surface. Expose to daylight, develop and etch. Any number of exact copies can be made from one master. Widely used in industry for prototype work.

FOTOLAK
Pre-coated Fibre-glass board
204mm x 114mm £1.50
204mm x 228mm £3.00
408mm x 228mm £6.00
467mm x 305mm £9.00

Plain Copper-clad Fibre-glass
Approx. 1.8mm thick sq. ft. £1.50
Approx. 1.0mm thick sq. ft. £1.75
Clear Acetate Sheet for making master. 260mm x 260mm 12p

Postage and packing 65p per order. VAT 15% on total

G. F. MILWARD ELECTRONIC COMPONENTS LIMITED
369 Alum Rock Road, Birmingham B8 3DR. Telephone: 021-327 2339
8K ON BOARD MEMORY!  5K RAM, 3K ROM or 8K RAM, 4K ROM (ink selectable). Kit supplied with 2K RAM, 3K ROM. System expandable up to 32K memory.

2 KEYBOARDS!  56 key alphanumeric keyboard for entering high level language plus 16 key Hex pad for easy entry of machine code.

GRAPHICS!  64 character graphics option — includes transparencies! Only £18.20 extra

MEMORY MAPPED  High resolution VDU memory using discrete TTL for extra flexibility. Has its own 2K memory to give 32 lines for 64 characters.

KANSAS CITY  low error rate tape interface.

COMPLETE KIT

Cabinets: Size 19.0" x 15.7" x 3.3"  Television by courtesy of Rumbelows Ltd., price £58.62

POWERTRAN


The kit for this outstandingly practical design by John Adams being published in a series of articles in Wireless World really is complete!

Included in the PSI COMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board, 2 keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer, 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.

PSI COMP 80 Memory Expansion System

Expansions up to 32K all inside the computer’s own cabinet!

By carefully thought-out engineering a mother board with buffers and its own power supply (powered by the computer’s transformer) enables up to 3 8K RAM or 8K ROM boards to be fitted neatly inside the computer cabinet. Connections to the mother board from the main board expansion socket is made via a ribbon cable.

Mother Board:  Fibre glass double sided plated through hole P.C.B. 8.7" x 3.0" set of all components including all brackes, fixing parts and ribbon cable with socket to connect to expansion plug £39.90

8K Static  RAM board  Fibre glass double sided plated through hole P.C.B. 5.6" x 4.8" £12.50

Set of components including IC sockets, plug and socket but excluding RAMs £11.20

2114 RAM (16 required) £9.00

Complete set of board, components, 16 RAMs £59.50

8K ROM board  Fibre glass double sided plated through hole P.C.B. 5.6" x 4.8" £12.40

Set of components including IC sockets, plug and socket but excluding ROMs £10.70

2708 ROM (8 required) £8.00

Complete set of board, components, 8 ROMs £78.50

Poppin Disk, PROM programmer and printer interface coming shortly!

Value Added Tax not included in prices

PRICE STABILITY: Order with confidence! Irrespective of any price changes we will honour all orders in this advertisement until December 31st, 1979. If this month’s advertisement is mentioned with your order. Errors and VAT rate changes excluded.

EXPORT ORDERS:  No VAT. Postage charged at actual cost plus 50p handling and documentation.

U.K. ORDERS: Subject to 15% surcharge for VAT. No change is made for carriage. Or current rate if changed.

SECURITY DELIVERY: For this special service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

UK Carriage FREE

POWERTRAN COMPUTERS
(a division of POWERTRAN ELECTRONICS)
PORTWAY INDUSTRIAL ESTATE  ANDOVER
ANDOVER HANTS SP10 3NN
(0264) 64455

2 MICROPROCESSORS  Z80  The powerful CPU with 158 instruction, including all of the 8080, controls the MM57109 number cruncher. Functions include +, —, x, /, square, roots, logs, exponents, trig functions, inverses, etc.

EFFICIENT OPERATION  Why waste valuable memory on sub routines for numeric processing? The number cruncher handles everything internally!

RESIDENT BASIC  With extended mathematical capability. Only 2K memory used but more powerful than most 8K Basics!

1K MONITOR  Resident in EPROM

SINGLE BOARD DESIGN  Even keyboards and power supply circuitry on the superb quality double-sided plated through-hole PCB.
Newnes Technical Books for the '80s

Available now:

Teletext and Viewdata
Steve A. Money
Audio Equipment Tests
Gordon J. King
Microprocessors for Hobbyists
Ray Colson
Radio and Electronic Laboratory Handbook
9th Ed. M.G. Scrogg and G.G. Johnstone
Two-Metre Antenna Handbook
F.C. Judd

£5.50 (US$12.50)
£6.50 (US$14.75)
£2.95 (US$6.75)
£17.95
£1.75 (US$4.00)
£3.95 (US$9.00)

Coming early in 1980:

Guide to Broadcasting Stations 18th Ed.
BSC
Introduction to Microcomputer Programming
P.G. Sanderson
Questions and Answers Amateur Radio
F.C. Judd
Beginner's Guide to Digital Electronics
I.R. Sinclair

£3.50 (US$8.00) approx.
£2.95 (US$6.75) approx.
£1.75 (US$4.00) approx.
£3.00 (US$6.75) approx.

And there will be more to keep you informed during the year.

For further particulars, write to:

Newnes Technical Books
Borough Green, Sevenoaks, Kent TN15 8PH
Tel: (0732) 884567

TERMINALS

INTEL Model 1051

* IBM GOLFBALL Typewriter
* RS232/V24 Interface
* Correspondence-quality upper/lower case
* Integral paper tape reader and punch
* Operates as Stand-alone typewriter
* Operates as self-contained word processor
* Selective EBCDIC coded
£425 plus VAT

COMPUTER APPRECIATION, 86 High Street, Bletchingley, Redhill, Surrey RH1 4PA
Tel: Godstone (0883) 843221

Dual output power supplies

Now you can get on-card dual output power supplies from Vero Systems in four versions:

** DUAL 5 Volts **
** DUAL 12 Volts **
** MIXED 5 and 12 Volts **
** MIXED 5 and 15 Volts **

The cards are designed to Eurocard standard size (100 x 150mm) to fit straight into your card or case front.

ORDER CODE:

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUAL 5V</td>
<td>£3.42</td>
</tr>
<tr>
<td>DUAL 12V</td>
<td>£3.90</td>
</tr>
<tr>
<td>DUAL 5-12V</td>
<td>£5.00</td>
</tr>
<tr>
<td>DUAL 5-15V</td>
<td>£5.00</td>
</tr>
</tbody>
</table>

Each supply is fully regulated with over voltage over current and thermal protection. Input voltage is 110/120/220/230/240 volts AC and both outputs are fully isolated from each other but may be connected to give different power rail configurations. The cards are supplied fully tested each one complete with 64 way indirect connector plug, card handle and connection chart.

VEKO SYSTEMS

VEKO SYSTEMS (ELECTRONIC LTD)
362 Spring Rd. Southampton Hants. SO9 5QJ
Tel: (0703) 44061 Telex: 477164

HOME COMPUTER BARGAINS

Full keyboard, cassette interface, use your TV as a monitor. Ohio Scientific Superbrain II fully built RS232-C and 25-pin serial offer now includes free power supply and mains kit £118.50 + 15% VAT. Contact: Service, Lincoln 2126.

SINCLAIR PRINTER Kit. New 100kHz scope £16.85, 30kHz sweep £14.25, print head £25.80, printed & unpacked kit £46.80 + 15% VAT.

KELSEY K102M TRANSFORMERLESS BALANCED LINE MICROPHONE AMPLIFIERS

Specifications

<table>
<thead>
<tr>
<th>Direct PCB mounting</th>
<th>Supply Voltage</th>
<th>±15V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Gain</td>
<td>48dB</td>
<td></td>
</tr>
<tr>
<td>Gain Control Range</td>
<td>36dB</td>
<td></td>
</tr>
<tr>
<td>Gain Reduction In Unbalanced Mode (Input to Terminal +)</td>
<td>10dB</td>
<td></td>
</tr>
<tr>
<td>Maximum Input Level (Impedance Mode, Input to Terminal +)</td>
<td>15dB</td>
<td></td>
</tr>
<tr>
<td>Input Impedance (Each-Input Terminal to Ground)</td>
<td>5Kohm</td>
<td></td>
</tr>
<tr>
<td>Optimum Source Impedance</td>
<td>200ohm</td>
<td></td>
</tr>
<tr>
<td>Maximum Output Frequency Response</td>
<td>±0.5dB Ref: 1KHz to 50KHz</td>
<td></td>
</tr>
<tr>
<td>Slow Roll Off</td>
<td>Better than 10V microsec</td>
<td></td>
</tr>
<tr>
<td>Homogeneity Distortion</td>
<td>Better than 0.02% Ref 1KHz</td>
<td></td>
</tr>
<tr>
<td>Common Mode Rejection Ratio</td>
<td>Better than 66dB</td>
<td></td>
</tr>
<tr>
<td>Equivalent Input Noise (Weighted)</td>
<td>Better than -125dB (ref Audio Bandwidth)</td>
<td></td>
</tr>
</tbody>
</table>

Recommended Output Loading

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>£340mm x 40mm x 20mm</td>
<td>48grams</td>
</tr>
</tbody>
</table>

KELSEY ACOUSTICS LTD 26 POWIS TERRACE, LONDON W11. TEL: 01-727 1046

WW - 083 FOR FURTHER DETAILS

BATTERY ELIMINATORS

2-way: type 6/170mA
300mA: type 3/14.5mA
Each offer now includes free power supply and mains kit £3.37, 3.93/8.79. Car converter 12V input output 40/78/130V 800mA £2.85.

SILICON POWER SUPPLIES

£28.15, 12V 1A £29.71, 12V 1.5A £29.76, 12V 2A £31.91, 12V 3A £34.06, 12V 4A £36.40, 12V 5A £38.72, 12V 6A £40.82, 12V 7A £42.92, 12V 8A £44.95, 12V 9A £46.90, 12V 10A £48.95. Over charger with safety circuit £5.85, 12V £6.80, 12V £7.80. Choice of ferrits to suit your application. Choose carefully.

DUAL OUTPUT POWER SUPPLIES

£28.15, 5V 1A £30.25, 5V 1.5A £32.34, 5V 2A £40.82, 9V 1A £42.92, 9V 1.5A £44.95, 9V 2A £46.90, 9V 2.5A £48.95, 9V 3A £50.90, 9V 3.5A £52.90, 9V 4A £54.90, 9V 5A £56.95. Stabilised 8-way types 3/4 £20.35, 300mA £21.15, 600mA £21.95, 1A £22.75, 2A £23.55, 3A £24.35, 4A £25.15, 5A £25.95, 6A £26.75, 7A £27.55, 8A £28.35, 9A £29.15, 10A £29.95. Invertor supply £26.75. 24V constant £7.45, 24V £7.35, 9V £6.85.

S TV GAME GAMES

£1.30.

COMPUTER GAMES

£22.95. COMPUTER GAMES

£3.40.

PUNCHS

£8.88.

LEVEL 2 BASIC 16K RAR

£10.60.

SCIENTIFIC SUPERBOARD

£16.72.

9V-0-9V 75mA with pub. JC 20 10.

CERAMIC CAPACITORS 50V £6.22, 22p to 47n rechargable balls.

ENTERPRISE PRO. CALCULATOR + ACCESSORIES

£11.00. Stabilised power bias 2.15V 1.3A £6.75, 2.5A £6.25, 3.0A £5.85, 3.5A £5.50, 4.0A £5.15, 4.5A £4.75, 5.0A £4.35, 5.5A £4.05, 6.0A £3.75.

AY-3-8603 CHIPS

£11.27.

AY-M500+ KIT

£29.76, ADAPTOR £3.40, £18.84.

84P, 92P, KIT

£2.95.

CHASSIS CHAMPION 6

£3.82.

EXP 350

£2.50.

SPELLER 8-WAY TYPES 3/4

£6.15.

STABILISED 8-WAY TYPES 3/4

£6.25.

OFFICIAL AND OVERSEAS ORDERS WELCOME. LISTS 24P POST.

WIRELESS WORLD, JANUARY 1980

www.americanhistoryarchive.com
YOUR LAST CHANCE to obtain Wireless World Circards. We still have some copies of the original Wireless World circuit cards, even though the companion bound volumes Circuit Designs 1 & 2 are out of print. Fill the gaps in your circuit files with these sets of 5 x 8in. (127 x 204mm) cards in plastic wallets — and at 1976 prices! These unique circuit cards normally contain descriptions and performance data of 10 tested circuits, together with ideas for modifying them to suit special needs.

*The two out-of-print volumes contained sets 1 to 10 and 11 to 20 of Circards.

1 Basic active filters 2 Switching circuits, comparators and Schmitts 3 Waveform generators 4 AC measurements 5 Audio circuits 6 Constant current circuits 7 Power amplifiers 8 Astable circuits 9 Optoelectronics 10

To: General Sales Department, IPC Electrical-Electronic Press Ltd., Room CP34, Dorset House, Stamford Street, London SE1 9LU.

Please send me the following sets of Circards:

£2 each, £18 for ten, inclusive.

I enclose cheque/money order for £

Make cheques payable to IPC Business Press Ltd.

Name

Address

Company registered in England. Registered Address, Dorset House, Stamford Street, SE1 9LU, England. Registered Number 677128
ELECTRO-TECH COMPONENTS LTD.
364 EDGWARE ROAD, LONDON, W.2. TEL: 01-723 5667

JVC-VICTOR HIGH FIDELITY STEREO CASSETTE TRANSPORT MECHANISM

ELECTRO-TECH COMPONENTS have secured a very large quantity of cassette transport mechanisms, equipped with all the latest improvements, as well as "SAN-ALLOY" type 1 micron record replay heads, and solenoid-controlled auto-stop action. These were manufactured by JVC-VICTOR of Japan to specification of TANDBORG OF NORWAY, for inclusion in a cassette deck costing over £250. This mechanism alone would normally cost over £60.

FEATURES:
- Close-tolerance, high-quality, top loading transport
- "San-Alloy" (SA type) R/P head
- Solenoid-driven autostop circuit
- Automatic head cleaning device
- Air damped "soft" cassette eject
- Miniature microwswitches for switching
- Pre-aligned heads and calibrated motor speed regulator built in
- Three-digit tape position counter
- PCB connectors and cables attached
- High-mass balanced flywheel with permanent lubrication spindle
- Full specifications for motor, heads, and switches available on request.

Price of above unit £14.95
Plus £1 P&P VAT Inc.

Regular readers of WIRELESS WORLD will know of the original LINSLEY-HOOD CASSETTE DECK design, published in May 1976. Subsequent articles by Mr. Linsley-Hood have confirmed that the design far exceeded his original expectations, so much so that he published a number of improvements, modifications, and additional features to the original design, which are now included in our Cassette deck kit, which is the only item available for the 8020A and 8022A at drop proof.

Incorporates low power CMOS
Meets tough military specs - indestructible
AC/DC
8 current ranges from 2mA - 2A
Mains driven relay switching
Twin positioning for AC and DC
A handsome soft carry case is available for the 8020A and 8022A at £7.

Price of Kit (without transport mech.) £15.95 plus £1.00 P&P VAT Inc.

Also available: A custom-designed case for the Kit, this is a fully screened enclosure, sloping panel, satin anodised, wood end panels, professional finish.

Price of Case £9.75 plus £1.00 P&P VAT Inc.

HERE IT IS! THE BRAND NEW 8022A HAND HELD DMM

Consider the following features:
- 6 resistance ranges from 200 ohm-20 ohm
- 8 current ranges from 2mA-2A
- 10 voltage ranges from 200 mV-1000V DC-200 mV-750V AC
- Digital size - weighting only 370 grams
- Full overload protection - will withstand 5x spikes
- Rugged construction - virtually unbreakable
- Meets tough military specs - deep proof
- In-line, pushbutton operation for simple, straight-forward operation
- Incorporates low power cross chop for low power consumption
- All this plus a 2 year full guarantee

For only £89
Carriage and insurance £3

Even more exciting, we now have the Fluke 8020A.

Identical in respect to the 8022A but in addition incorporates a conductance range from 2mS-200 nS.

£112
Carriage and insurance £3.00

A handsome soft carrying case is available for the 8020A and 8022A at £7.

TE200 R.F. SIGNAL GENERATOR

Accurately covers 120 kHz to 500 Mhz in 4 decades
Fully calibrated, Versatile R.F. Generator
240V AC
Dimensions: 140 x 215 x 130mm
£62.95 P & P £36

TAKED500 MULTIPLIER 20,000 OVP

A sturdy and reliable instrument. Has internal built-in 50A current lead. 50 - 1000 Ohm with 0.1 - 5.0A. 1.0 - 1000 Ohm with 0.5 - 50A. 50 - 1000 Ohm with 1.0 - 10A. £30.00 P & P £15.00

£30.00 P & P £20.00

PLEASE ADD 15% VAT TO ALL ORDERS CALLERS WELCOME

We are open 9 a.m. - 6 p.m.
Monday-Saturday
We carry a very large selection of electronic components and electro-mechanical items.

£10.95 P & P £7.50

LOW COST, AUTORANGING MULTI-FUNCTION COUNTER

- Autoranging in 9 frequency and general measurement modes
- Wide Frequency range - 0 Hz to 80 Mhz
- High sensitivity - 25 µV to 10 µV
- Digital LED display with leading zero suppression, automatic annulation and overload
- Optional internal battery pack providing 4 hours continuous operation
- Autorange or 24 gate time, all function by push button
- Four manually selectable gate times providing resolution to 0.1 Hz
- Sweep intervals in 10 events with overcoded indicator
- Optional input conditioner with switchable 1 MHz low pass filter and attenuator
- Flashed stainless steel cover with retaining string and handle
- Optional parallel data output with decimal point and annunciation
- Finished in high quality paint
- Set check

£175
Carriage and insurance £3.00

Trade and Export Enquiries Invited

Jet 1/2 20,000 OVP
AC volts 0.10. 10. 50. 100. 250. 500. 1000
DC volts 0.10. 10. 50. 100. 250. 500. 1000
2500 OVP 0.10. 10. 50. 100. 250. 500. 1000. Resistance 0.0 - 0.05. 0.5 - 250 MΩ
£10.95 P & P £7.50

Y225 0k 25,000 OVP
AC volts: 0.10. 50. 250. 500. 1000
DC volts: 0.05. 0.5. 2.5. 5. 10. 25. 50. 100. 200. 500. 1000
£49.95 P & P £32.95

£10.95 P & P £7.50

Carriage and insurance £3.00

- Special offers on selected items
- Offers change weekly
- Customers with orders £250.00 or over will receive a discount
- All prices include VAT of 17.5%
**WIRELESS WORLD, JANUARY 1980**

**Please send SAE for list.**

**Please add 30p p&p & VAT.**

**Government, Colleges, etc. Orders accepted.**

**TOLL-FREE WELCOME.**

---

**Please add P&P and VAT. All offers valid until 31/1/80 and subject to stocks.**

**SPECIAL OFFER**

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>£18/-100</td>
<td>2708</td>
</tr>
<tr>
<td>£16/-100</td>
<td>2716 (+5V)</td>
</tr>
<tr>
<td>£6/-50</td>
<td>7908/15</td>
</tr>
<tr>
<td>£5/-10</td>
<td>7930/12</td>
</tr>
</tbody>
</table>

We carry a large stock of 74 and 74LS TTLs, CMOS, Linear, Memories, etc. and can normally offer next day deliveries. We welcome orders for volume quantities both from local and overseas buyers.

---

**TECHNOMATIC LTD.**
17 Burnley Road, London N10
10 minutes from tube station (angle street parking)
Tel: 01-452 1500
Fax: 9228000
**ELECTRONIC KITS OF DISTINCTION FROM **

**DE LUXE EASY TO BUILD LINSLEY-HOOD 75W STEREO AMPLIFIER £99.30 + VAT**

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring whilst distortion is less than 0.01%.

**WIRELESS WORLD FM TUNER £70.20 + VAT**

A pre-aligned front end module makes this Wireless World published design very simple to construct and adjust without special instruments. Features include an excellent i.e. rejection push-button station selection as well as extremely variable tuning and a phase locked loop stereo decoder, incorporating active filters for 'birdy' suggestion.

**LINSLEY-HOOD CASSETTE DECK £79.60 + VAT**

This design, published in Wireless World, although straightforward and relatively low cost provides a very high standard of performance. There are separate record and replay amplifiers and switchable equalisation together with a choice of bias levels are also provided. The mechanism is the Goldring-Lenco CRV with electronic speed control.

**TRANSIENT 2000 SINGLE BOARD SYNTHESIZER**

As featured in Electronics Today International

The kit includes fully finished metalwork, fully assembled solid state cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or 15% metal film) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibre glass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of most soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!

**COMPLETE KIT ONLY £168.50 + VAT!**

Comprehensive handbook supplied with all complete kits! This fully described construction and tells you how to set up your synthesizer with nothing more than a multi-meter and a pair of ears! Virtually all the components are on the one professional quality fibre glass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of most soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!

**CHROMATHEQUE 5000 5-CHANNEL LIGHTING EFFECTS SYSTEM**

The versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is completely valid to say the least. You can run the unit as a straightforwad sound-to-light or have it store all the light at a speed dependent upon music level or front panel control setting or use the internal damped circuitry which produces home superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

**COMPLETE KIT ONLY £49.50 + VAT**

Kit includes fully finished metalwork, fibreless PCB controls, wire, etc. — Complete right through to the last nut and bolt!

**MrA200 100W MIXER/AMPLIFIER**

Featured as a constructional article in Electronics Today International the MrA200 is an exceptionally low-priced but professionally finished general purpose, rugged, high-power amplifier designed with minimal wiring making construction very straightforward. Kit includes fully finished metalwork, fibreless PCB's, controls, wire, etc. — Complete right through to the last nut and bolt!

**COMPLETE KIT ONLY £49.90 + VAT**

All kits also available as separate packs (e.g. P.C.B. component sets, hardware sets, etc.). Prices in FREE CATALOGUE
T20+20 AND T30+30
20W-30W AMPLIFIERS

SPECIAL PRICE FOR COMPLETE KIT £47.70 + VAT
AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

Followings success of our Wireless World FM Tuner Kit this cost reduced model was designed to complement the T20+20 and T30+30 amplifiers and the cabinet is, front panel format and electronic characteristics make this tuner compatible with either.

WE'VE MOVED!
NEW FACTORY UP! PRICES DOWN!

TRANSCIDENT DPX
As featured in Electronics Today International August, September
October, 1979 issues

DIGITALLY CONTROLLED, TOUCH SENSITIVE, MULTIO - VICE SYNTHESIZERS

The Transcident DPX is a digitally controlled, touch sensitive synthesizer very simple to operate, where the sophisticated sound is achieved by pulling strings on the keyboard and by switches on the panel.

In the panel, as shown in the detail, the volume and tone controls, separate for the brass and strings, are included.

In addition, the special circuitry makes the piano string sound very realistic. The strings themselves can be vibratoed, tremoloed and sped up. The strings can also be compressed, expanded and bent up to four different pitches.

In complete contrast to the Transcident DPX, the T30+30 is a simple, low cost design which can be constructed easily without special alignment equipment but which still gives a first-class output suitable for feeding any of your very popular amplifiers or any other high quality audio equipment. A phase-locked loop is used for stereo decoding and controls include switchable a/b, switchable muting and push-button diamond selection switchable by controls on the front panel. The unit matches well with the T20+20 and T30+30 amplifiers.

INCREASED CAPACITY AT OUR BIG NEW FACTORY MEANS MANY PRICES DOWN! ALL OTHER FROZEN!
Another superb design by synthesizer expert Tim Orr!

COMPLETE KIT ONLY £299.00 + VAT!
Now-highest quality copying at low cost

**OTARI DP4050 C2 cassette duplicator**

The first low cost copier to give you reliability and performance to professional standards. No other copier can match its precision engineering, and it is the only budget copier suitable for music programmes.

- One master, 2 slaves.
- Add on units available up to 11 slaves.
- Automatic rewind.
- Ferrite heads.
- 16:1 duplicating ratio.
- Modular slave decks with DC servo motors.

Also available: Reel to cassette version with 6 slaves.

**OTARI from ITA**

1-7 Harewood Avenue, Marylebone Road, London NW1. Tel: 01-724 2497. Telex: 21879.

---

**CHILTERN ELECTRONICS**

B.C.M. BOX 8085
LONDON WC1V 6XX

**PDP8 COMPUTERS:**
- PDP8E. Latest version with 16K Core, as new £800
- PDP81 8K with high speed tape reader/punch £450
- PDP81 and PDP8L 4K processors from £200

All above with teletype interface and ready to use — software available includes BASIC, FOCAL, FORTRAN, etc.

**TERMINALS:**
  - As new with keyboard £350
  - Without keyboard £200

**JUST ARRIVED FROM U.S.A....**
- INCOTERM SPD 10/25 Intelligent terminals. Top quality VDU with powerful computer. Memory 4K Core and 4K MOS. Two RS232 ports. Second video output. Detachable ASCII keyboard. Cost over £5,000. Offered at only £750
- TELETYPES/CENTRONICS PRINTERS/VDUs — lots more in stock from £50 to £500
- ELLIOTT Paper Tape Readers, 250 ch/sec optical £40
- IBM 8-level readers with step motor, no data £20

Add 15% for VAT. For more details please send SAE or ring Nigel Dunn on 0494 714483

---

**TAKE A DAY OFF**

R & D Effort, Production Holdups, Machine down time etc. by securing your copy of the VEROSPEED fully priced catalogue of stocked components from

**VEROSPEED**

Barton Park Industrial Estate, Eastleigh, Hampshire SO5 5RR
Tel: (0703) 618525
**Electronic Brokers**

49/53 Pancras Road London NW1 2QB Tel: 01-837 7781. Telex 298692

No.1 in Second User Minis & Peripherals

---

**DEC PDP11/40 SYSTEM**

PDP11 40 48KW Power Care Processor complete with KT11-D Memory Management

- 01 Asynchronous Interface
- RX1-D Disc Controller
- 0 RX3-D Drive

2 x 6/8 Rack Cabinets

Fully DEC-maintained - in immaculate condition £12,750 (or could be reconditioned to suit)

---

**ICL TERMINET 7075**

Typewriter-quality Keyboard Send/Receive Impact Printer providing full upper and lower case character set.

Switch-selectable print speeds of 10, 15 and 30cps.

112-column print line with seven-lead platen suitable for paper rolls or continuous stationary (paper width 12.85") Standard V.24 (RS222) interface £975.00.

---

**GE TERMINET 1200**

**TYPEWRITER QUALITY** Impact printer with switch-selectable print speeds of 10, 30 and 120cps. 80 print positions with adjustable pin-feed paper tractor, full upper and lower case ASCII character set, current loop (20mA) interface £695.

---

**BALL MIRATEL MONITOR**

9" diagonal P4 phosphor tube, resolution 120 lines. 12/24 volt 300kHz 24MHz Output voltage + 15V (short circuit protected) + 12V DC 12.6V rms Separately horizontal and vertical sync Supplied complete with high and low voltage power supplies, mounting and attractive moulded plastic housing including space for keyboard. Case dimensions - 20" x 18" x 7" (including keyboard space 20" x 7"). Full technical manual provided £95 (total including carriage and VAT £123).

---

**ASR33 and KSR33 TYPETYPES**

Input/Output terminals with 64 ASCII character set. 110 baud operation Paper tape punch/reader (ASR33 only). Choice of interface (20mA or RS232) KSR33 £125.00. ASR33 £650.00. Pedestal £30.00.

---

**DEC EQUIPMENT**

- PDP11/040D 9-slot 5¼" Processor with 8KW MOS and DL11W Interface. BRAND NEW SUR. PLUS £3,250.00
- PDP11/05 5¼" Processor with 8KW core memory £1,850.00
- RK05 Add-on disk drive £1,850.00

Large stocks of DEC modules and add-ons

---

**PRINTERS & TERMINALS**

- CENTRONICS 101 Matrix Printer £750.00
- COSSOR UNITELE II Virtual Display Unit £295.00
- HAZELTINE H-2000 Editing Visual Display Unit from £395.00
- SCOPE DATA Electrosensitive Printer £495.00
- TEXAS 725 Portable Terminal £695.00
- TEXAS 733/15 Terminal £1,485.00

---

**NEW ASCII KEYBOARDS**

**NEW LOW PRICES**

- KB756 56-station ASCII Keyboard mounted on P.C.B. £45.00 £53.48
- KB756MF As above, fitted with metal mounting frame for extra rigidity £50.00 £59.23
- KB710 10-key numeric pad, supplied with connecting cable £8.00 £9.78
- KB701 Plastic enclosure for KB756 or KB756MF £12.50 £15.24
- KB702 Steel enclosure for KB756 or KB756MF £25.00 £30.48
- KB2376 Spare ROM Encoder, KB15 Edge connector for KB756 or KB756MF £12.50 £15.24
- DC-512 DC converter to allow operation at 5V only (plugs in to P.C.B.) £7.50 £9.20
- KB771 71-station ASCII Keyboard including numeric/curser control cluster mounted in steel enclosure £95.00 £115.00
- DB25S Mating connector for KB771 £4.25 £5.46
- PERK 56-station ASCII Keyboard for PET. Complete with PET interface, built-in power supply and steel enclosure £145.00 £172.50

Discounts available for quantities

---

**MISCELLANEOUS**

- CALCOMP 565 Drum Plotters £1,250.00
- DIGITRONICS P120 Paper Tape Punches £75.00
- EMI 15" Diagonal TV Monitors £100.00
- SEALECTRO 11 x 20 Patch Boards £12.50
- SHUGART SA400 5¼" Floppy Disc Drives £195.00
- SHUGART SA800 8" Floppy Disc Drives £395.00

WW-120 FOR FURTHER DETAILS
Electronic Brokers
49/53 Pancras Road London NW1 2QB Tel: 01-837 7781. Telex 298694

ONLY SMALL SELECTION OF OUR VAST STOCKS SHOWN HERE — SEND FOR LATEST CATALOGUE
Electronic Brokers unique catalogue contains 62 pages plus update of second user Test Equipment, and Mini Computers and Peripherals. Vast lists of Signal Sources, Oscilloscopes, DVMs, Counters, Recorders, DEC Computers, VDUs, Teletypes, etc. Largest stocks — most cost effective.

LATEST EDITION JUST OUT. SENT FREE IN UK.
Airmail to overseas addresses £2.00

MARCONI INSTR.
£135.00

SOLARTRON
£975.00

HEWLETT PACKARD
£1850.00

WAYNE KERR
£695.00

MARCONI INSTRUMENTS
£600

PHILIPS
£950

UNLESS OTHERWISE STATED ALL EQUIPMENT OFFERED IN THE ELECTRONIC BROKERS 4-PAGE ADVERTISEMENT IS REFURBISHED AND IN THE CASE OF TEST EQUIPMENT ALSO CALIBRATED. TEST EQUIPMENT IS GUARANTEED FOR 12 MONTHS; COMPUTER PERIPHERALS FOR 3 MONTHS.

HOURS OF BUSINESS:
9 a.m.–5 p.m., Mon.-Fri.
Closed lunch 1-2 p.m.

A COPY OF OUR TRADING CONDITIONS IS AVAILABLE ON REQUEST.

WWW — 107 FOR FURTHER DETAILS

TO THE INQUIRIES OF CUSTOMERS TO THE EFFECT OF THE TAXATION OF ELECTRONIC EQUIPMENT, WE WISH TO STATE THAT TO DATE, NO CHARGE FOR VAT HAS BEEN PROPOSED BY THE BOARD OF INLAND REVENUE, AND IN THE CASE OF ELECTRONIC BROKERS, VAT IS NOT INCIDING ON ANY OF THE ITEMS OFFERED IN THIS CATALOGUE.
THE COMPLETE SOLUTION TO THERMOCOUPLE AMPLIFICATION

- Programmable Cold Junction Compensation
- Complete with Adjustments
- Platinum R/T Stability for C.J.C.
- Zero Suppression/Elevation Built in
- Gain from 100 to 10000 Built in

The Model TA100 thermocouple conditioning Unit is housed in a 50 x 50 x 15mm package and can be used to condition any type of thermocouple.

Simply dial in the Thermocouple sensitivity (in µV/°C), set gain and zero, and the Unit automatically corrects for the Thermocouple you are using.

Gone are problems of different electronics for different applications...

THE ONE ANSWER

CIL Electronics Ltd
14 Willowbrook Road,
Worthing BN14 8NA
Tel: Worthing (0903) 204646
Telex: B7515 WISCO G ATT CIL

To obtain further information circle number 47

Z & I AERO SERVICES LTD.
Head Office: 44a WESTBOURNE GROVE, LONDON W2 5SF
Tel. 727 5641

SPECIAL OFFER OF BRAND NEW USSR MADE MULTIMETERS

<table>
<thead>
<tr>
<th>TYPE</th>
<th>U4313</th>
<th>U4315</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity D.C.</td>
<td>20,000 o.p.v.</td>
<td>20,000 o.p.v.</td>
</tr>
<tr>
<td>Sensitivity A.C.</td>
<td>600 o.p.A</td>
<td>2,000 o.p.v.</td>
</tr>
<tr>
<td>D.C. Current A.C.</td>
<td>0.6mA-1.5A</td>
<td>50mA-2.5A</td>
</tr>
<tr>
<td>D.C. Volts A.C.</td>
<td>75mV-600V</td>
<td>50mA-2.5A</td>
</tr>
<tr>
<td>A.C. Volts Resistance</td>
<td>15V-600V</td>
<td>50mA-2.5A</td>
</tr>
<tr>
<td>Capacity</td>
<td>0.5 µF</td>
<td>1.5% D.C.</td>
</tr>
<tr>
<td>Accuracy</td>
<td>2.5% A.C.</td>
<td>4% A.C.</td>
</tr>
</tbody>
</table>

Price complete with pressed steel carrying case and test leads=
Packaging and postage=

<table>
<thead>
<tr>
<th>TYPE</th>
<th>U4324</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.C. Current</td>
<td>0.06-0.6-6.0mA</td>
</tr>
<tr>
<td>A.C. Current</td>
<td>0.3-3.3-30mA</td>
</tr>
<tr>
<td>D.C. Voltage</td>
<td>0.6-1.2-3.12</td>
</tr>
<tr>
<td>A.C. Voltage</td>
<td>3.6-15-60-150-300-900V</td>
</tr>
<tr>
<td>Resistance</td>
<td>1000-5.5-5000Ω</td>
</tr>
<tr>
<td>Accuracy</td>
<td>D.C. 2.5% A.C. 4% (of F.S.D.)</td>
</tr>
</tbody>
</table>

PRICE complete with test leads and fibreboard storage case £9.50
Packaging and postage £1.20

<table>
<thead>
<tr>
<th>TYPE</th>
<th>U4323</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>20,000 o.p.v.</td>
</tr>
<tr>
<td>Voltage ranges</td>
<td>2.5-1000V A.C./D.C.</td>
</tr>
<tr>
<td>Current ranges</td>
<td>0.05-900mA D.C. only</td>
</tr>
<tr>
<td>Resistance</td>
<td>5Ω-1MΩ</td>
</tr>
<tr>
<td>Accuracy</td>
<td>5% F.S.D.</td>
</tr>
<tr>
<td>Oscillator output</td>
<td>1kHz 50150 squarewave</td>
</tr>
<tr>
<td>Tested frequencies</td>
<td>465kHz sinewave</td>
</tr>
</tbody>
</table>

PRICE, in carrying case, complete with leads and manual=
Packaging and postage £1.00

THE 1978 CATALOGUE/PRICE LIST OF VALVES, SEMICONDUCTORS, PASSIVE COMPONENTS AND TEST EQUIPMENT IS AVAILABLE. PLEASE SEND P.O. for 10-30 FOR YOUR COPY

WW — 096 FOR FURTHER DETAILS

Z & I AERO SERVICES LTD.
Head Office: 44a WESTBOURNE GROVE, LONDON W2 5SF
Tel. 727 5641

SPECIAL OFFER OF BRAND NEW USSR MADE MULTIMETERS

<table>
<thead>
<tr>
<th>TYPE</th>
<th>U4313</th>
<th>U4315</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity D.C.</td>
<td>20,000 o.p.v.</td>
<td>20,000 o.p.v.</td>
</tr>
<tr>
<td>Sensitivity A.C.</td>
<td>600 o.p.A</td>
<td>2,000 o.p.v.</td>
</tr>
<tr>
<td>D.C. Current A.C.</td>
<td>0.6mA-1.5A</td>
<td>50mA-2.5A</td>
</tr>
<tr>
<td>D.C. Volts A.C.</td>
<td>75mV-600V</td>
<td>50mA-2.5A</td>
</tr>
<tr>
<td>A.C. Volts Resistance</td>
<td>15V-600V</td>
<td>50mA-2.5A</td>
</tr>
<tr>
<td>Capacity</td>
<td>0.5 µF</td>
<td>1.5% D.C.</td>
</tr>
<tr>
<td>Accuracy</td>
<td>2.5% A.C.</td>
<td>4% A.C.</td>
</tr>
</tbody>
</table>

Price complete with pressed steel carrying case and test leads=
Packaging and postage=

<table>
<thead>
<tr>
<th>TYPE</th>
<th>U4324</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.C. Current</td>
<td>0.06-0.6-6.0mA</td>
</tr>
<tr>
<td>A.C. Current</td>
<td>0.3-3.3-30mA</td>
</tr>
<tr>
<td>D.C. Voltage</td>
<td>0.6-1.2-3.12</td>
</tr>
<tr>
<td>A.C. Voltage</td>
<td>3.6-15-60-150-300-900V</td>
</tr>
<tr>
<td>Resistance</td>
<td>1000-5.5-5000Ω</td>
</tr>
<tr>
<td>Accuracy</td>
<td>D.C. 2.5% A.C. 4% (of F.S.D.)</td>
</tr>
</tbody>
</table>

PRICE complete with test leads and fibreboard storage case £9.50
Packaging and postage £1.20

<table>
<thead>
<tr>
<th>TYPE</th>
<th>U4323</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>20,000 o.p.v.</td>
</tr>
<tr>
<td>Voltage ranges</td>
<td>2.5-1000V A.C./D.C.</td>
</tr>
<tr>
<td>Current ranges</td>
<td>0.05-900mA D.C. only</td>
</tr>
<tr>
<td>Resistance</td>
<td>5Ω-1MΩ</td>
</tr>
<tr>
<td>Accuracy</td>
<td>5% F.S.D.</td>
</tr>
<tr>
<td>Oscillator output</td>
<td>1kHz 50150 squarewave</td>
</tr>
<tr>
<td>Tested frequencies</td>
<td>465kHz sinewave</td>
</tr>
</tbody>
</table>

PRICE, in carrying case, complete with leads and manual=
Packaging and postage £1.00

OUR 1978 CATALOGUE/PRICE LIST OF VALVES, SEMICONDUCTORS, PASSIVE COMPONENTS AND TEST EQUIPMENT IS AVAILABLE. PLEASE SEND P.O. for 10-30 FOR YOUR COPY

WW — 096 FOR FURTHER DETAILS
Appointments

Advertisements accepted up to 12 noon Monday, January 21st for February issue, subject to space being available.

DISPLAYED APPOINTMENTS VACANT: £10.00 per single col. centimetre (min. 3cm). LINE advertisements (run on): £1.50 per line, minimum three lines. BOX NUMBERS: 70p extra. (Replies should be addressed to the Box Number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London SE1 9LU.) PHONE: Neil McDonnell on 01-261 8596

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

ELECTRONICS TEST ENGINEERS

We need your skills to stay true to type

Staying true to type is our business. We're Linotype-Paul, world leaders in the design, development and marketing of an advanced range of photo-typesetting equipment. Our highly sophisticated computer-controlled machines are revolutionising the graphics industry and setting increasingly higher standards of type production. Keeping our systems on the leading edge of technology is our aim — and to back us in our efforts, we need more skilled electronics test engineers.

If you have 2-3 years experience of testing complex digital equipment, ideally reinforced by ONC or equivalent, you could build a great career with us. A knowledge of analogue circuitry would be an added advantage. The work is deeply interesting and stimulating — and never routine. Staff facilities include superb working conditions, sick pay scheme, a subsidised canteen and relocation expenses where appropriate. And salary structures are highly competitive.

Posts are open to both men and women. For full details, write or telephone to the Personnel Department, Linotype-Paul Limited, Runnings Road, Cheltenham. Tel. Cheltenham 45001.

Linotype-Paul

THORN CONSUMER ELECTRONICS LTD.

Advance Study Engineer

Thorn Consumer Electronics Limited, leading manufacturers of television and audio equipment in the U.K. wish to appoint an experienced Engineer for their Advance Study Group situated in the Research and Engineering Centre at Enfield.

The successful applicant will join a team investigating new ideas and systems including digital techniques and microprocessors as well as modern analogue methods.

He/she should preferably be under 35 years of age with a degree or H.N.C. or relevant experience, recent graduates will be considered.

Please apply in writing to:

The Personnel Manager (ASE/WW),
Thorn Consumer Electronics Limited,
Great Cambridge Road, Enfield, Middlesex EN1 1UL
or telephone 363 5353 extension 2201 for an application form.

UWIST

University of Wales

DEPARTMENT OF PHYSICS

ELECTRONICS AND ELECTRICAL ENGINEERING

M.Sc./DIPLoma Course IN ELECTRONICS

Applications are invited for places in the full-time one-year M.Sc. / Diploma course in Electronics commencing October 1, 1980.

Further details and application forms (returnable as soon as possible) may be obtained from the Academic Registrar, UWIST, C/1 3NU.
AMPEX CORPORATION, a world leader in analogue and digital data recording technology, has been designated the official supplier of video recording and magnetic tape products to the 1980 Moscow Olympics. Early in 1980 the Group’s Training Department in Reading will need an additional

INSTRUCTOR
IN BROADCAST TELEVISION COLOUR CAMERAS AND VIDEO TAPE RECORDERS

This is an opportunity to join a company in the forefront of technological innovation in a position involving contact with engineers from all over the world and some overseas travel.

The essential qualification are:

- experience as, or personality to become, an expert instructor training engineers of many nationalities.
- sound knowledge of advanced electronics, particularly in the broadcast television field.
- sound knowledge of foreign language would be useful.

An attractive salary and benefits package is offered.

Please telephone Clive Legg on Reading 85200, Ampex Great Britain Limited, Acre Road, Reading, Berks.
**Career Opportunities in Audio Electronics**

The UK operation of this international name in audio electronics manufactures a comprehensive range of professional noise reduction systems which is employed world-wide in the broadcasting,

**Application Consultants c. £9,000**

Reporting to the International Marketing Director, the prime responsibility will be the provision of a full technical consultancy to professional users. Major activities will include advice on installations and equipment compatibility in cinemas and studios; training installation and service technicians; distributor and end-user liaison; field servicing and trouble-shooting operational problems; and sound consultancy during film dubbing.

Candidates are likely to have a broad-based audio background ideally including practical experience in electronics, as well as professional recording and mixing. Essential personal qualities include the ability to work with considerable autonomy and flexibility to high professional standards. World-wide travel is involved for which a working knowledge of a European language would be an advantage.  Ref: AA57/1746WW.

**Production Engineers (Electromechanical & Electronic) c. £7,000**

Reporting to the Production Director, the principal responsibilities of these posts will include the introduction of new products to line production; production improvements; trouble-shooting; modification control; and liaison with the California-based R & D team. The electromechanical engineer will have prime responsibility for all mechanical aspects of production, with major emphasis on assembly processes; jig, fixture and tool design; and packaging. The electronics engineer will have responsibility for defining test procedures and for the design, development, specification, and/or procurement of test equipment. An analogue background is desirable. Candidates, probably in their mid-20s to 30s, will be of graduate or equivalent status, and should be able to demonstrate an ability to produce reliable, cost-effective solutions. Considerable autonomy is offered; experience gained in a small-company environment would be an advantage.  Ref: TE81/1747WW.

**Inspection Supervisor c. £7,000**

Reporting to the QA Manager, the Supervisor will assume full responsibility for inspection of 'in-house' assembly operations. Key tasks will be the motivation, control, training and development of the inspection team, and the preparation and analysis of inspection reports and quality investigations to improve both quality standards and cost-effective production. This post is likely to appeal to young electronics engineers (from age 23 years) who seek a stepping stone into line management. The attractive salaries will be supplemented by competitive benefits which include relocation assistance. Location: London SW9.  Ref: W61/7149WW.

Initial interviews are conducted by PA Consultants. No details are divulged to clients without prior permission. Please send brief career details or write for an application form, quoting the appropriate reference number on both your letter and envelope, and advise us if you have recently made any other applications to PA Personnel Services.
Electronic Engineers – What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £8000 p.a.

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

Please send me a TJB Appointments Registration form:

Name

Address

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

Tel: 0892 39388

(9228)
How to get second interviews without having first ones, you have to cut a few corners.

All too often, first interviews are unnecessary. You provide a mass of information for the second or third time. You’re screened by comparatively junior people. And you have to invent some excuse for being away from your own job at an inconvenient time. Second interviews are when it all happens. You meet the decision-makers and you know they’re interested. Lansdowne can save you from wasteful first interviews. Just fill in and send us this coupon and you will receive our ‘First Interview’ form. And, because we have access to the opportunities in over 3,000 companies, large and small, we can match you with the situations that might suit you.

The employer will then get in touch with you directly and invite you to what is, in effect, a second interview. From then on, it’s up to you. As you’d expect from Britain’s most professionally respected register, we maintain total confidentiality throughout. And you can specify those companies to which you do not want your particulars sent. Cutting corners could save you a great deal of time.

Why not cut a few right now?

Lansdowne Appointments Register, Design House, The Mall, London W5 5L.S. Tel: 01-579 2282 (24 hour answering service).

Our clients would like to meet men and women, aged 20-40 years, earning between £4,000 and £8,000, from any of the following areas — (please tick where appropriate).

☐ Service Engineers  ☐ Audio Engineers  ☐ Technicians
☐ Test Engineers  ☐ Sales Engineers

Name

Address

Lansdowne Appointments Register, Design House, The Mall, London W5 5L.S. Tel: 01-579 2282. (24 hour answering service).
**RADIO OFFICERS**

If your trade or training involves radio operating, you qualify to be considered for a Radio Officer post with the Composite Signals Organisation.

A number of vacancies will be available in 1980/81 for suitably qualified candidates to be appointed as Trainee Radio Officers. Candidates must have had at least 2 years' radio operating experience or hold a PMG, MPT or MRGC certificate, or expect to obtain this shortly.

On successful completion of 40 weeks' specialist training, appointees move to the Radio Office Grade.

**Salary Scales:**

<table>
<thead>
<tr>
<th>Trainee Radio Officer</th>
<th>Radio Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 19 £3271</td>
<td>Age 19 £3961</td>
</tr>
<tr>
<td>Age 20 £3382</td>
<td>Age 20 £4107</td>
</tr>
<tr>
<td>Age 21 £3485</td>
<td>Age 21 £4243</td>
</tr>
<tr>
<td>Age 22 £3611</td>
<td>Age 22 £4359</td>
</tr>
<tr>
<td>Age 23 £3685</td>
<td>Age 23 £4571</td>
</tr>
<tr>
<td>Age 24 £3767</td>
<td>Age 24 £4854</td>
</tr>
<tr>
<td>Age 25+ £3856</td>
<td>Age 25+ £5166</td>
</tr>
</tbody>
</table>

then by 5 annual increments to £6981 inclusive of shift working and Saturday, Sunday elements.

For further details telephone Cheltenham 21491 Ext. 2269, or write to the address below.

**TELEVISION PROJECTS ENGINEERS**

We have vacancies in our expanding Projects Section for Junior and Intermediate engineers. Responsibilities cover all stages of custom-built vision/audio switching system manufacture from customer liaison through design, production and test to final acceptance.

The positions offer the chance for energetic engineers with initiative to join a small, expanding company manufacturing and supplying electronic equipment to many professional TV broadcasters in the UK and Europe. A certain amount of travel here and abroad could be involved.

In particular this opportunity would suit engineers possessing some experience in electronic testing wishing to expand their horizons and gain experience in television broadcast systems.

In addition to a good salary the company offers profit-sharing and non-contributory pension schemes, free BUPA membership, a friendly environment in rural settings and excellent career prospects.

For more details contact David Steel at:

**MARTIN-BAKER (ENGINEERING) CO. LTD.**

has a vacancy for an

**ELECTRONIC TECHNICIAN**

**AT CHALGROVE AIRFIELD, OXFORD**

The successful applicant will be required to assist small team, on commissioning and operation of telemetry and instrumentation systems for ejection seat trials.

**QUALIFICATIONS** — Ability to make prototype units from rough drawings and test to specifications using standard test equipment. Knowledge and experience of U.H.F. Trans/Recs., tape recorders and logic systems.

(Gained as a radio amateur perhaps.)

Salary range £5500-£5700 per annum. Weekly paid 40-hour week. 22 days' holiday per year, non-contributory pension scheme after five years.


**Editorial writer for Wireless World**

**Wireless World** needs a new person on its editorial staff. Technical experience in electronics and/or communications and an ability to write are essential. The work is varied and includes writing technical news reports and other material, attending meetings, exhibitions, press conferences and other events, some abroad, and editing contributed technical articles. A good deal of freedom will be given to a person who shows ability and responsibility.

Preferred age range 25 to 35.

Write to: The Editor

**WIRELESS WORLD**

Dorset House, Stamford Street
London SE1 9LU
HNC Level Engineers

(Electrical or Electronic)

Train for the future as a Broadcast Transmission Engineer

Through our network of over 500 transmission stations the IBA is responsible for the transmission of all Independent Television and Local Radio services. With a steadily increasing number of stations, the preparations for the fourth television channel and more local radio stations now underway we are taking on increased responsibilities.

We take great pride in the fact that our system is one of the best in the world and great importance is placed on maintaining the efficiency of the service. To do this we have teams of highly trained and experienced engineers all over the country.

Internal promotions and continued expansion have created a number of opportunities for H.N.C. or H.T.C. or equivalent level engineers (male or female) to train for a challenging future. Our carefully devised training programme, which will commence this summer, can lead to a recognised Diploma and combines theoretical study and practical training. This comprehensive training is a step beyond traditional learning and gives a grounding in broadcast engineering that is second to none. Naturally, course fees, accommodation and meals will be paid during the course. A full driving licence is required, but if you do not already have one, we will assist you by arranging and paying for instruction.

On the satisfactory completion of the training programme, your salary will be £3,880 per annum and then rise annually to £7,280 per annum, with further progression to £8,202 per annum. (During the training period you will receive a salary of up to £4,700 per annum, depending upon experience.)

At higher levels it will be up to you to demonstrate your ability as promotions are based on internal competition – all of our Regional engineering managers started their careers at transmitting stations.

Employment benefits include Free Life Assurance and Personal Accident Schemes, a Contributory Pension Scheme, generous relocation expenses and subsidised mortgage facilities.

Please write or telephone Mike Wright for a fully illustrated information package and application form, at IBA, Crawley Court, Winchester, Hampshire SO21 2QA. Telephone: Winchester 822574.

IBA

INDEPENDENT BROADCASTING AUTHORITY
JUNIOR DEVELOPMENT
ENGINEERS
ELECTRONICS

John Player and Sons, a leading manufacturer of tobacco products, offers the opportunity to young electronics engineers to gain valuable practical experience in industrial electronics.

Vacancies exist for work in the Machinery Evaluation Section where new generation cigarette making and packing machines are undergoing pre-production trials. These machines are equipped with increasing numbers of modern electronic control circuits using the latest technological advances including microprocessors.

The successful applicants will undergo a period of familiarisation, look after specific machines during the evaluation period, be involved in the development of special features as well as devising evaluation aids and ultimately in the training of others in the maintenance of these machines on the production floor.

We are looking for men or women who are qualified to HNC or equivalent, and who have 2 years' experience in one or more of the following areas:

- electronic control and logic circuits
- process control systems
- microprocessors

A knowledge of the tobacco industry is not essential.

We offer a starting salary of £5,500 per annum together with other benefits associated with a large progressive company including relocation assistance where applicable.

Application forms can be obtained by phoning Nottingham (STD 0602) 787711 Extension 345 or writing to:

Lorna Blayney
JOHN PLAYER AND SONS
Nottingham NG7 5PY

Manufacturers of professional film and video equipment now need the following staff:

ELECTRONICS DESIGNER

An engineer with some experience is required to join a small design team working on a variety of projects. Fields of interest include logic, analogue and power control circuits. The level of work would suit a Graduate or someone with relevant design experience.

ELECTRONICS TECHNICIANS

There are vacancies for test personnel for fault finding and general testing of PCB's and equipment. Some experience of logic and analogue circuits is essential.

The above vacancies are suitable for men or women. If you are interested in either of them please telephone Nigel Gardiner on 01-543 3131, or come along and see us.

PAG GROUP
565 KINGSTON ROAD, RAYNES PARK
LONDON, SW20

Thorn Consumer Electronics Limited, leading manufacturers of television and audio equipment in the U.K., wish to appoint an experienced Design Engineer for their Research and Engineering centre at Enfield.

The successful applicant will join a team investigating new ideas and systems for the television industry and should have a degree or equivalent, with at least two years in television design, with some digital design experience, and be preferably under 35 years of age.

The ability to work on his/her own initiative, liaising with internal development departments and outside suppliers is essential.

Please apply in writing, stating age, experience and qualifications to:

The Personnel Manager, (DE/WW),
THORN CONSUMER ELECTRONICS LTD.
Great Cambridge Road, Enfield, Middlesex, EN1 1UL.

We need more high-calibre engineers conversant with current recording equipment. Applicants must be able to assume responsibility in return for attractive salary and secure future.

Apply: Chief Engineer
ITA, 1-7 Harewood Avenue
Marylebone Road
London, N.W.1
01-724 2497

Independent concern represented in 80 countries

SENIOR TEST AND CALIBRATION
ENGINEERS

With a background in RF and microwaves, experienced in analogue, digital techniques, logic and microprocessor controlled ATE.

also vacancies exist for

TEST & CALIBRATION ENGINEERS

with knowledge of one or more of the above techniques.

We offer an exceptional salary + Performance related bonus scheme + Training abroad + Prospects of promotion + A wide variety of work + A happy atmosphere

+ Non-contributory pension scheme + Subsidised restaurant.

Please write or phone to:
Mr. Z. Eres (Technical Manager) extension 43.

Electronic Instruments & Communications Equipment
aveley electric LTD
01-397 8771

come home, we need you here!

We have vacancies for ELECTRONICS ENGINEERS and a DRAUGHTSMAN

We are forming a Product Development group within our company here in Guernsey which will be involved in the introduction, appraisal, and design of new products aimed at our European Markets.

We are in the business of manufacturing data communications equipment including sophisticated microprocessor - based monitoring and test equipment.

We have immediate vacancies for Engineers with experience in one or more of the following areas:
- Systems, Analogue, Software, and digital design.
- We also have a vacancy for a Draughtsman with electronics experience.

Applicants, who must have Guernsey residential qualifications are invited to write to the Personnel Manager giving details of experience and qualifications.

Dynatech DATA COMMUNICATIONS LTD
Place du Commerce, Baust, St.Peter Port, Guernsey
Telephone 0481 28475
SOUTHERN ELECTRICITY
Littlewick Green, Maidenhead

SECOND ENGINEER
(TELECOMMUNICATIONS)

CHIEF ENGINEER'S DEPARTMENT
HEAD OFFICE

SALARY WITHIN THE RANGE £6,830-£8,955 PER ANNUN

Applications are invited for the above post in the Technical Services Section of the Chief Engineer's Department.

The successful applicant will be part of a team engaged in the design, commissioning, and subsequent maintenance of telecommunications systems throughout the Southern Electricity Board, and must be able to spend periods away from Head Office when carrying out these duties.

Schemes in progress include telecontrol, data communications, medium capacity microwave links, multi-channel line circuits and radio and line telephony systems. Applicants should have had experience in some of this work and preferably be in possession of suitable technical qualifications.

The successful candidate will be required to drive a motor vehicle which may be either a private car or a Board-owned car.

Appropriate relocation assistance will be provided.

Applications on forms obtainable from the Secretary, Southern Electricity, Southern Electricity House, Littlewick Green, Maidenhead, Berks, SL6 3QB, and returned to him quoting 76/79 by not later than January 11, 1980.

FIELD ELECTRONICS ENGINEERS

Gardline Surveys are a leading Hydrographic and Geophysical Survey Company providing shipping, offshore positioning and site investigation services to oil companies and other clients.

Due to continuing expansion we have vacancies for the following personnel:

SEISMIC ENGINEERS—with a strong electronics background, a familiarity with digital acquisition systems and preferably with marine or shallow marine operations.

UNDERWATER SYSTEMS ENGINEERS—with a sound background in electronics and an aptitude for practical work and fault finding. Gardline operates a variety of equipment including Huntec Deep Tow Boomer, E.G. and G. Sidescan Sonars, Magnetometers, Sparkers, etc. Experience with one or more of these systems is desirable but not essential.

POSITIONING ENGINEERS—with experience in the field of survey vessel navigation or oil rig positioning. Gardline operates a variety of positioning systems including Satellite Navigation, 2MHZ Systems, Syleids and Trisponder. A computer and track plotter are usually used in conjunction with the above equipment. Familiarity with digital techniques and the ability to fault-find desk top calculators would be an advantage.

Whilst formal qualifications are an advantage, experience and the ability to work effectively in a field environment is considered to be of prime importance. We expect our engineers to be adaptable and willing to learn to use systems that they are not familiar with at present.

Employment will be based at Great Yarmouth or if required Aberdeen. Operations are primarily North Sea based but there are good prospects of overseas employment through our branch offices in Houston and Sharjah (U.A.E.).

Salary is fully negotiable and with sea pay is likely to be around £9,000.

There is a company pension scheme and 4 weeks' annual leave plus roster leave accrued whilst at sea.

Applicants should write or telephone The Technical Manager, Gardline Surveys, Olmar House, Admiralty Road, Great Yarmouth, Norfolk. Tel. Great Yarmouth (0493) 50723.

All the others are measured by us...

At Marconi Instruments we ensure that the very best of innovative design is used on our range of communications test instruments and A.T.E. We have a number of interesting opportunities in our Design, Production and Service Departments and we can offer attractive salaries, productivity bonus, pension and sick pay schemes together with help over relocation.

If you are interested to hear more, please fill in the following details:

Name ____________________________ Age ____________________________
Address __________________________
Telephone Work/Home (if convenient) ____________________________

Years of experience

<table>
<thead>
<tr>
<th>0-1</th>
<th>1-3</th>
<th>3-6</th>
<th>Over 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

Present salary

<table>
<thead>
<tr>
<th>£2,500-</th>
<th>£3,500-</th>
<th>£4,500-</th>
<th>Over £5,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

Qualifications

None | C & G | HNC | Degree |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

Present job ____________________________

Return this coupon to John Prodger, Marconi Instruments Limited, FREEPOST, St. Albans, Herts, AL4 0BR. Tel: St Albans 59292.

Marconi Instruments
A GEC MARCONI ELECTRONICS COMPANY
**MINISTRY OF DEFENCE**

**Telecommunications Professional and Technology Officers III**

**FOR BRITISH FORCES GERMANY**

For (a) management and development planning for a private telephone network, (b) maintenance and repair of a multi-channel radio and relay network, (c) maintenance and repair of a colour TV transmission system. Candidates should be British Subjects, hold a current British driving licence, and must possess a City and Guilds certificate for telecommunications technical final or Part II (or intermediate plus 3 B subjects, which must include mathematics and tele-communications principles) or radio television and electronics technicians final or Part II, or an equivalent or higher acceptable qualification. Candidates must have served a recognised apprenticeship or had equivalent training and have at least three years' appropriate operating experience. Ex-Service candidates who do not fulfil the above requirements will be considered only if, after completing a course of approved technical training they have served for at least three years in an approved technical capacity in HM Forces with the rank of Staff Sergeant or equivalent. A knowledge of German, although not essential, would be an advantage.

Salary: £4984-£5551 (currently under negotiation) plus an allowance equal to Inner London Weighting of £780 and Foreign Service allowance ranging from £1365-£2810. There are additional grants and allowances dependent on individual circumstances.

For further information and an application form (to be completed and returned by 18th January, 1979) please write, quoting reference NW, to: Ministry of Defence, CM(S)3e/2. Room 317, Adelphi, John Adam Street, London WC2N 6BB, or telephone 01-217 4677/5128.

---

**GELLER BUSINESS EQUIPMENT LTD.**

**YOUR CAREER STARTS HERE**

This company, leading distributors of electronic point of sale systems and up market calculators, needs:

1. **JUNIOR ELECTRONIC TECHNICIAN**
   (aged 18 approx.) to train in fault locating and repair of printed circuit boards and associated equipment. Some formal qualifications desirable, but enthusiasm and ability to benefit from training are equally important.

2. **SENIOR ELECTRONIC TECHNICIAN**
   (aged 24 approx.). City & Guilds standard to work with 'state of the art' microprocessor based units. Following training, the work will involve modification and programming advanced electronic cash registers and educating users.

**THREE JOBS OFFER TOP PAY RATES AND FULL OPPORTUNITY TO DEVELOP TALENTS, FURTHER KNOWLEDGE AND ENCOURAGE THE ENTHUSIASM.**

**OUR TECHNICAL SECTION COMPRIS ES A SMALL GROUP OF YOUNG FRIENDLY PEOPLE, WHO WORK AS A TEAM AND DEVELOP THEIR ABILITY BY MUTUAL ASSISTANCE.**

Write fully or Telephone:

Norman Geller
GELLER BUSINESS EQUIPMENT LTD.
15 PERCY STREET
TOTTENHAM COURT ROAD
LONDON W1P 0EX
Telephone No. 01-580 1614
Senior Electronics Engineer

for component and standards evaluation

GEC-Computers is a world leader in the design, development and manufacture of highly sophisticated computers for both commercial and military applications.

Within the Techniques and Components Section of our Engineering Department at Borehamwood, we now require a Senior Electronics Engineer to work on a wide variety of components ranging from the latest semiconductor devices through to state-of-the-art printed circuit boards.

It's a job calling for a man or woman qualified to degree, HNC or equivalent level with several years sound practical experience of component and standards evaluation, application rules and packaging techniques. Specialist training can, however, be given where specific experience is lacking.

We offer a competitive salary; attractive benefits, including assistance with relocation expenses, and the opportunity of working in a challenging environment as a member of a highly professional team.


GEC Computers Limited

TEST/COMMISSIONING ENGINEER

To £6,500 plus car
MIDDLESEX

We make an extensive range of environmental test systems, covering every application from strain measurement to the vibration of vehicles and buildings.

If you are:
—self-motivated and self-reliant;
—qualified to HNC or equivalent in electronics/radio and TV, and also interested in mechanics;
—experienced in analogue and/or digital work;

Then we can offer you a wide variety of testing and commissioning experience, working with newly developed modular control systems, in house and also at customers’ premises in the U.K. and abroad.

SERVOTEST LIMITED
Sarsfield Road
Greenford, Middlesex UB6 7AA
Tel. 01-998 1552

DIAL 01-741 4011

Think of the Op Amp and the NAND Gate and your are through to:
CHARLES AIREY ASSOCIATES
4 Hammersmith Grove
London W6 ONA

CURRENT VACANCIES INCLUDE:

Chief Control Engineer for multi-million pound company engaged in the manufacture of roof tiles. Managerial ability as important as the ability to create a new generation of process automation products. Surrey. Excellent salary.

Young Entrepreneurial Engineers to join a multidisciplinary company with interests in radio-controlled target systems, range finders, aerospace products, etc. Good microprocessor hardware/software experience. Wilts. Salary — “What’s worth.”

INTEL Microprocessor Engineers for message switching systems based on a minicomputer and the INTEL 8080/85/86. Berks. Salary — to £9,000.

Digital Engineers for exceptionally advanced technology associated with an MPU control system for shipborne radars or early warning radar. To £9,000. Berks.

Computer Engineers for either technical support, or field service, permanent site or systems test. Vacancies throughout the U.K.

For further details, please contact:

Charles Airey Associates
4 Hammersmith Grove, London W6 ONA. Tel: 01 741 4011

"PROBABLY THE BEST KNOWN SUPPLIER OF ELECTRONIC ENGINEERS IN THE COUNTRY" Financial Times.
**ELECTRONIC ENGINEER**

We are a research laboratory engaged in detergency and toiletry projects which range from inception through development to pilot plant operation and are seeking to strengthen our instruments section by filling the following vacancy:

**INSTRUMENTATION DESIGN ASSISTANT**

An Electronics Engineer is required to join a Design team working on the development of scientific instruments. The job will require knowledge of analogue and digital techniques, together with some experience in applying microprocessors and interfaces to design problems. Applicants with City & Guilds, ONC, HNC or graduate qualifications will be considered. Day release will be offered to persons already following a suitable course. A progressive salary will be offered to the successful candidate and relocation where necessary. Flexible working hours operate in the Laboratory. Those interested should write or telephone for an application form quoting ref: PS 655 AMA.

The Employment Officer
Unilever Research
Port Sunlight Laboratory
Port Sunlight, Wirral
Mersyside, L62 4XN
Tel: 051-645 2000, Ext. 8408

Interested persons should write to the address below for an application form.

Employment Officer, Unilever Research, Port Sunlight Laboratory.
Port Sunlight, Wirral, MERSEYSIDE L62 4XN

---

**COMMISSIONING EDITORS**

£7000 negotiable

Butterworths, publishers of legal, medical, scientific and technical books, are looking for two experienced Commissioning Editors to develop lists of books on electronic engineering, electrical engineering and computers. One Editor will be required to work with professional engineers and academic staff to provide reference books, monographs and textbooks. The other is needed to take over and extend a programme of publishing for enthusiast constructors, personal computer users and electrical and electronic servicing personnel. Our modern offices are in pleasant rural surroundings about 50 minutes from London.

Please write to:
Linda Stammers,
Personnel Assistant,
Butterworth & Co. (Publishers) Ltd.,
Borough Green, Nr. Sevenoaks, Kent.

---

**OVERSEAS APPOINTMENTS**

**ELECTRONICS TECHNICIANS**

Petty-Ray Geophysical Division of Geosource is one of the leading companies in the field of oil exploration, and due to our ever-increasing workload, require single personnel, in the age range 21-25, who are looking for a varied and interesting career working overseas.

You should be educated to ONC/HNC in Electronics or C&amp;G Radio and TV Technician level, and on appointment, you will be assigned to one of our field crews either in AFRICA or the MIDDLE EAST for on-the-job training in the operation and maintenance of digital seismic recording equipment.

Candidates must be in possession of a current driving licence.

We offer a good starting salary which is paid NET, food and accommodation will be provided, and rest leaves are generous.

If you would like to have more information about these positions please write giving brief career details to the Personnel Officer.

GEOSOURCE
3/5 The Grove • Slough • Berkshire SL1 1QG

---

**ELECTRONIC SEISMIC ENGINEERS**

We are looking for young electronics engineers, with degree or equivalent qualifications, to join our marine seismic acquisition company. This is a field position, with the successful applicants joining the technical crew of our exploration vessel for on-board training in seismic techniques. They will start as Assistant Technicians with a salary of £6,000+ per annum, and one month’s leave after each two months on the crew.

The seismic industry offers an interesting career with world-wide travel, and rapid promotion for the right person.

Sefel Geophysical is a member of the Sefel Group, which has seismic processing centres in Houston, Denver, Calgary and London.

Please write with full curriculum vitae to:

Marine Manager
Sefel Geophysical
Turriff Building
Great West Road
Brentford
Middlesex TW8 9HY

(9946)
Radio Officers

With the Post Office Maritime Service, you can do the job you’re trained for, and still work close to home!

Several coast stations need qualified Radio Officers to carry out a wide variety of duties ranging from Morse and teleprinter operating to traffic circulation and radio telephone operating. It’s a secure job that pays well, and if you’re ambitious, the prospects of promotion to senior management are excellent.

You must have a United Kingdom Maritime Radio Communication Operator’s General Certificate or First Class Certificate of proficiency in Radio-telegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic. Preferably you should have some sea-going experience.

The starting pay at 25 or over will be about £5,381; after 3 years service this figure rises to around £7,087. (If you are between 19 and 24 your pay on entry will vary between approximately £4,229 and £4,937). Overtime is additional, and there is a good pension scheme, sick-pay benefits and at least 4 weeks' holiday a year.

For further information, please telephone Kathleen Watson on Freefone 2281 or write to her at the following address: ETE Maritime Radio Services Division ( ), ETEI71L2, Room 643, Union House, St. Martins-le-Grand, London EC1IA 1AR.

Post Office Telecommunications

Radio Communications

Electronics Engineers and Software Designers

Mid-Sussex – S. W. London Salaries up to £8,000

To join our expanding R&D Laboratories covering a wide range of R.F. spectrum, from L.F. to V.H.F. Equipment includes transmitters and receivers for marine- and land-based use, radio nav aids and radio monitoring remote computer-controlled systems.

Electronics Engineers should have experience in transmitter or receiver design, analogue or digital circuit design, microprocessor applications. Software Designers should be experienced Programmers with an interest in control, signal processing or navigational software.

Attractive salaries are complemented by excellent prospects and generous benefits.

Contact: David Bird, Redifon Telecommunications Limited, Brookhill Road, Wandsworth, London, S.W.18. Phone: 01-874 7281 (reverse charges).

Marine Radio Service Engineers

Glasgow, Aberdeen, Tilbury, Cardiff and Newcastle

International Marine Radio Co., a member of the STC Group of Companies, is engaged in the manufacture of high quality marine communication equipment. We have vacancies for Marine Radio Service Engineers in our Glasgow, Aberdeen, Tilbury, Cardiff and Newcastle Depots.

The work will be concerned with installation and service of communication equipment on board commercial vessels of all types.

Ideal candidates, male or female, will have had at least three years sea experience as a Radio/Electronics Officer. A company vehicle is provided for business and personal use.

For further details on these positions please contact: Jonathan Smith, International Marine Radio Co. Ltd., Inteco House, 302 Commonsld East, Mitcham, Surrey CR4 1YD Tel: 01-640 3400.

IMRC
Come to Somerset
to make the most of your Electronics experience

At Wells, EMI Electronics Limited are developing new 'state of the art' electronic systems. Current projects include microwave systems, radar signal processing, computer simulation and real-time software programmes.

Our established reputation for performance and reliability is dependent on quality requirements being incorporated in projects from inception to completion.

Due to expansion we have vacancies for:

**Project Quality Engineers**

To work with research, development and design teams with responsibility for ensuring that the engineering data produced complies with the quality requirements.

Applicants should be qualified to at least HNC standard and have previous experience in related fields.

**Test Gear Engineers**

To install, commission, calibrate and service a wide variety of proprietary and company designed test equipment.

Applicants should hold an HNC or equivalent and have practical experience of servicing, fault diagnosis and maintenance of modern complex electronic test equipment.

**Test Engineers**

To ensure that our microwave or digital assemblies and systems conform to design performance and quality standards.

Applicants should be qualified to at least City & Guilds final technician certificate standard and have relevant experience.

**Transformer Test Technicians**

To undertake reliability tests on R.F. Transformers and Chokes in a small batch production environment.

Necessary specialist training will be given to the appointed applicant who will have previous experience in similar fields.

**Technical Supervisor (Electrical)**

To plan and control the work of a team of electrical inspectors. Applicants should be qualified to at least ONC standard, be familiar with MOD electrical inspection requirements in the Electronics Industry and preferably have previous supervisory experience.

Starting salaries are commensurate with the importance of the posts, other benefits include subsidised meals, sports and social club and the opportunity to live and work in the heart of Somerset. Where appropriate, assistance with relocation will be discussed at interview.

In the first instance please write or 'phone Wells (0749) 72081 for an application form (quoting ref. no. W115) to D.K. Shires/F. M. Taylor, Personnel Department, EMI Electronics Limited, Wockey Hole Road, Wells, Somerset BA5 1AA.

---

**ARTICLES FOR SALE**

**EMI Electronics Limited, Wells, Somerset**

**TELEquipment**

- **E3011 Scope**, only nine months old, twin trace, variable time base, first-class order, £245 inc. VAT. Doreset (09297) 20695.
- **VHF Monitor Receivers**, Air or Marine band from £30. FM Business bands from £90. For leaflets send 50p P.O. to Stamps, Radio Communications Ltd. 13 Clus du Motier, St Sampson, Guernsey, Channel Isles.

**GWM Radio Ltd., 40/42 Portland Road, Worthing, Sussex. Tel. (0903) 34897 for surplus supplies. AVO 8 £40, Master P.MK3 with power, capacity and decibel ranges £22 inclusive p&p. Receivers, Atlante marine for AC, mains £115 plus carriage. £40 ex-Geve. Communications receiver for AC, mains, £55 plus carriage. Sound powered telephones £75 intrinsically safe, as new, 40ft pneumatic masts by Seac Clark £131. In original unopened makers box, gross weight 4 cwt. Radio telephones bought & sold. Many one off items in stock. No lists. We are worth a visit. (1973)**

**20 WELL** maintained recently serviced ASR-33 teletypes with 20mA interface for sale. In good working order. Each £60. Box No. 8030.

**Micro Computer — Nascom I with T4 monitor, power supply, built, tested, and working £150. — Phone Charles Frater, 01-937 3367. (1973)**

**JIN Computer tape** 'jin computer tape' can be used as video tape on some machines. Three teleprinter S.A. Phone for further details 0922 56055. MKS, 27 Upper Stone St, Maidstone, Kent. (1973)**
Production Manager
For Quad
£9,500+car
Huntingdon, Cambridgeshire

The Acoustical Manufacturing Company
produces amplifiers and loudspeakers under
the brand name "Quad" and is one of the world's
most respected hi-fi equipment manufac-
turers. "Quad" products have an enviable
reputation for quality and technical excellence.

We require a fully experienced Production
Manager to be responsible to the Managing
Director for all aspects of the running of a
medium sized manufacturing plant producing
domestic audio equipment at the rate of 1,000
units per week.

Candidates, male or female, should be aged
around 35 years with qualifications or experi-
ence at graduate level. The candidate should
have proven success in running an electronic
assembly plant coupled with experience of the
latest automatic assembly and test methods
and of metal finishing.

There is a good range of benefits, including
a non-contributory pension scheme, subsidised
restaurant and sickness provision. Huntingdon
offers a wide variety of reasonably priced
housing, recreational amenities are excellent
and London is within easy reach.

For an application form and Company infor-
mation, please write to or telephone The
Acoustical Manufacturing Co. Ltd., St. Peters
Road, Huntingdon PE18 7DB. Telephone 0480
55480.

ARTICLES FOR SALE

TO MANUFACTURERS, WHOLESALERS &
BULK BUYERS ONLY

Large quantities of Radio, TV and Electronic Components

RESISTORS CARBON & C/0 1/2, 1/4, 1/8, 1/5, 1 Watt from 1 ohm to
10 meg.

RESISTORS WIREWOUND. 1/2, 2, 3, 5, 10, 14, 25 Watt

CAPACITORS, Silver mica, Polystyrene, Polyester, Disc Ceramics,
Metalate, C280, etc.

Convergence Pots, Slider Pots, Electrolytic condensers. Can Types,
Axial, Radial, etc.

Transformers, chokes, hots, tuners, speakers, cables, screwed wire,
connecting wires, screws, nuts, transistors, ICs, Diodes, etc., etc.

All Knockout prices. Come and pay us a visit. Telephone 445 2713,
445 0749.

BROADFIELDS & MAYCO DISPOSALS
21 Lodge Lane, N. Finchley, London, N.12. 5 mins. from Tilly Ho Road

INVERTERS
High quality DC-AC. Also "no break" (2ms) static switch, 19th rack. Auto Charger.

COMPUTER POWER SYSTEMS
Intersmart Mains-Store Ltd.
P0851, London W11 3BZ
Tel: 01 727 7042 or 0225 31016

MSF CLOCK
New! Shows continuous Date, Hours, Minutes. Seconds. 8 digit LED, also parallel
RS232 output, microsecond after power failure. auto GMT/BST only, 5x6cm15cm, bulb.
400kHz tokhdr, 1000m range, all parts.

DIAGNOSIS & INSPECTION WIRE

OMNI-TELECOM胧lice-80 PIN BACK PANEL CONNECTOR

ELECTRICIAN'S HANDBOOK

THE MODERN BOOK CO.
Specialist in Scientific
& Technical Books
21-21 PRAED STREET
LONDON W2 1NP
0921 4917

Closing Sat. 1 p.m.

Situations Vacant

Situations Vacant

WIRELESS WORLD, JANUARY 1980
WE'VE FORMED A NEW R&D GROUP
to make our shaving products
even better

As one of Britain's leading manufacturers of Razor Blades, we are continuously looking into better ways to shave, better methods and systems of production, and on line control. So in the interests of speed and efficiency of communication, we are bringing our Research and Development teams together to form one multi-disciplinary group at our factory in Acton.

The group will be mainly concerned with the Research, Design and Development of new shaving systems and concepts. Join it in any of the following positions and we can promise you plenty of opportunities to apply your problem solving abilities to our modern technology.

Process Control Department
Senior Electronic Engineer

The successful candidate will head our Control and Instrumentation Group as Section Leader. The work involves the design and implementation of a wide range of systems from Research and Development instrumentation to Production line control systems. Candidates should have a degree or H.N.C. in electronics or control engineering plus several years' experience of practical electronic engineering.

Electronic Design Engineer

Applicants should have several years experience of practical circuit design both of analogue and digital systems. The work involves the design of a wide range of production line control systems, and specialised electronic equipment required by our Research and Development Departments.

We offer excellent salaries and all those benefits associated with a major organisation.

Interested men and women should write with details of age, qualifications and experience, or phone for an application form to: Senior Personnel Officer, Wilkinson Sword Ltd., 287 Acton Lane. London W4 5LE. Tel: 01-994 3666.

THE UNIVERSITY OF LEEDS, School of Medicine, The Electronics Workshop of the Multidisciplinary Laboratory, has a vacancy for a Grade 5 Technician. The successful candidate will assist in the repair, maintenance, development and construction of a wide variety of electronic equipment used both for teaching and research. The post would ideally suit applicants who have gained a basic grounding in electronics wish to broaden their experience and work with modern biological equipment, including medical instruments, in a stimulating environment. (Consideration will be given to appropriate cases for release on a relevant course). Applicants should hold an equivalent qualification and have a minimum of three years' relevant experience. Salary on the scale £1,152 - £1,550 a year (under review). Further information may be obtained from Dr J. Fourman, Multidisciplinary Laboratory, Medical and Dental Building, University of Leeds, Leeds LS2 9LT, tel. 31751, ext 7462, to whom applications in writing should be sent giving details of age, qualifications, experience and the names of two referees.

VIDEO SIGNAL EQUIPMENT required by Studio 99 Video, the leading independent production company in production control systems company. High level experience required and some knowledge of electronics knowledge essential. Ideal. Salary, company car, car phone Roger Bellis 01-328 3241.

VHF MONITOR RECEIVERS, Air or Marine band from £50. FM business band from £5. For leaded plugs and 50 p.G., not stumps, Radio Communications Ltd., 13 Clues Mt. St Sampson, Guernsey, Channel Isles.

ENCAPSULATING, cells, transformers, components, degassing, silica, polyester, resin, epoxy, vacuum wax casting for brass, bronze, silver, raw distorted true RMS, audio, all types. Please send for free trial self-adhesive, nailed and screwed in 10 minutes. Used for sachet piping.

P. U. R.

TELEPHONE ANSWERING machine available for outright purchase. Telephone Burton-on-Trent (0283) 47437.

SOLAR CELLS, bits, books and bargains. Send stamp for list or 50p for Solar Cell booklet and details. EDENCOM Ltd, 34 Nathan's Road, North Wembley, Middlesex HA9 RX.

EX-GOVT. TAPE RECORDERs:


TELETYPE 33 KSB 4/6.0 220A, 8 unit readers and punchers £20.25. Phone Braintree 2418.

TEKTRONIX 545 B and 1A1 plug-in £350. AR88 receiver £60. Phone: 0229 24029 (Carlisle).
**Experienced All-Round Video Engineer**

required for operational and maintenance work.

We are one of the leading video and audio companies in Belgium, distributing Sony, JVC, National, Barco, CV3, Shintron, Microtime, etc. The successful applicant will work in an enthusiastic team and will have the possibility to take charge of our technical department. Promotion prospects are excellent in this expanding company. We offer an attractive salary and 4 weeks' holiday a year.

Written application in the first instance, giving experience and qualifications can be sent for the attention of W. KLINKEMALLIE, Personnel Manager, and will be treated in strict confidence.

**VIDEOSCOPE**

Avenue Molière, 116
1060 Brussels
Belgium

---

**Test Engineers**

A rewarding outlook for the 80's

We at Tektronix are not modest about being the acknowledged world leader in Test and Measurement Instrumentation and at our Hoddesdon location in rural Hertfordshire we manufacture the world famous range of Telequipment oscilloscopes.

To keep our products to the highest possible standard we are looking for Technicians/Engineers qualified to at least ONC with two years' test and fault finding experience to component level, an enquiring mind and the ability to work on their own initiative.

Excellent salaries, profit sharing, generous holidays, sick pay, free life assurance, non-contributory pension and relocation expenses where applicable all add up to make Tektronix the best break you've ever had.

To get all the facts phone Norman Speckley on Hoddesdon 67151 or write to him at Tektronix UK Ltd, Pindar Road, Hoddesdon, Herts.

---

**WANTED**

Electronic Stockholders
Steenagen 812193
We purchase all types of Mechanical and Electronic Equipment and Surplus stocks.

---

**ARTICLES WANTED**

- Test equipment, receivers, valves, transmitters, components, cable and electronic store, any quantity. Prompt service and cash. Member of A.R.R.A.
- M & B RADIO
  86 Bishopsgate Street
  Leeds LS1 4BB
  0532-35649

---

**EQUIPMENT FOR SALE**

- SCOPES. TEK. 545B & CA 1200.
  Castle 4169 78111 1550 — Crawford 843685

---

**SPOT CASH**


---

**CLASSIFIED**

- TO ALL MANUFACTURERS AND WHOLESALERS IN THE ELECTRONIC RADIO AND TV FIELD
  21 LODGE LANE
  NORTH FINCHLEY, LONDON N12 8AJ
  Telephone Nos. 01-445 6749/445 2713
  After office hours 958 7624

---

**WANTED**

Valves, transistors etc. into cash. Contact COLES-HARDING & Co. 103 South Brink Wisbech. Cambs. 694-4139. Immediate settlement. We also welcome the opportunity to quote for complete factory clearance. (959)

---

**STORAGE SPACE**

Is expensive, why store redundant and obsolete equipment? For fast and efficient clearance of all test gear, power supplies, PC boards, components, etc. regardless of condition or quantity. Call 01-771 9413. 16529

---

**EQUIPMENT FOR SALE**

**WANTED**

Recording equipment of all types and varieties. (California, U.S.A.), Tel. (415) 232-7933. (9814)

---

**WANTED**

Electronic Stockholders
Steenagen 812193
We purchase all types of Mechanical and Electronic Equipment and Surplus stocks.

---

**WANTED**

Test equipment, receivers, valves, transmitters, components, cable and electronic store, any quantity. Prompt service and cash. Member of A.R.R.A.
With 38 years' experience in the design and manufacturing of several hundred thousand transformers we can supply:

**AUDIO FREQUENCY TRANSFORMERS OF EVERY TYPE**

**YOU NAME IT! WE MAKE IT!**

**OUR RANGE INCLUDES**
- Microphone transformers (all types).
- Microphone Splitter/Combiner transformers.
- Input and Output transformers.
- Direct Injection transformers for Guitar, Multi-Secondary output transformers.
- Bridging transformers.
- Line transformers, low frequency transformers to G.P.O. Isolating Test Specification.
- Tapped impedance matching transformers. Gramophone Pickup transformers.
- Audio transformers trimmed and tapped in. Micro-transformer transformers for PCB mounting.
- Experimental transformers.
- Ultra low frequency transformers. Ultra-linear and other transformers for VHF to Megahertz up to 500 and inductive low transformers.
- Smoothing Chokes.
- Filter Inductors.
- Amplifier to 100 volt line transformers from a few watts up to 1000 watts.
- 100 volt line transformers to speakers.
- 200 watt transformers (all powers).
- Column Loudspeaker transformers up to 300 watts or more.

We can design for **RECORDING QUALITY**, **STUDIO QUALITY**, **Hi-Fi QUALITY** or F.A.Q. QUALITY. Our PRICES are HIGHLY COMPETITIVE and we **SUPPLY LARGE OR SMALL QUANTITIES** and **EVEN SINGLE TRANSFORMERS**. Many standard types are in stock and normal dispatch times are short and simple.

**OUR CLIENTS COVER A LARGE NUMBER OF BROADCASTING AUTHORITIES, MIXING DESK MANUFACTURERS, RECORDING STUDIOS, HIGH-FREQUENCY BROADCASTERS & PUBLIC ADVERTISERS**.

**Firms**. Expert is a specialty and we have overseas clients in the **COMMONWEALTH E.E.C.,** USA, **MIDDLE EAST** etc.

Send for our questionnaire which, when completed, enables us to post quotation by return.

---

**SOWTER TRANSFORMERS**

Manufacturers and Designers

E. A. SOWTER LTD (Established 1943), Reg. No. England 303990
The Boat Yard, Cullingham Road, Ipswich IP1 2EG
Suffolk. P.O. Box 36 Ipswich IP1 2EL, England
Phone: 0473 52794 & 0473 213390

---

**CLASSIFIED ADVERTISING**

**RING NEIL McDONNELL ON 01-261 8508**

**SPEAKER KITS**

Two great new kits from KEF — the Speaker Engineers respected by HiFi enthusiasts all over the world.

One is based on the Model 104/48 and the other on the K9, a budget-price standing loudspeaker. We'll give you helpful advice and full instructions.

And you can have more goods the speakers are being completed by you.

**BADGER SOUND SERVICES**

46 Wood Street
Lytham St. Annes
Lancs FY5 1QG
Tel: 0253-729247

---

**PRINTED CIRCUIT MANUFACTURE**

Very fast, reliable service. Lowest prices. Prototypes welcome. Inhouse photography. Phone 04644-072 for instant quote or write to ARTBONICS LTD., 47/44 Ford Street, Moretonhampstead, Devon.

---

**USE A REAL KEYBOARD**

Brand new, built and tested, 60 keys in cluding shift and control, stepwise rows, typewriter style. Auto repeat UC + LC (ASCII code 244,575) (53 19 mc sec and VAT). S.a.s. for details TEMIATA Ltd., 57 Swanlowdale, Basildon, Essex.

---

**REPRESENTATIVE CIRCUIT BOARDS**

Printed Circuit Boards — Master layout — Photography — Legend printing — Reflow soldering — Flexible films — Conversion to glass — No order too large or too small — Fast turnaround on prototypes. After part service available NOW.

---

**TEST EQUIPMENT CALIBRATION AND REPAIR**

Quick turn round, attractive rates. Ring for details on Southendonsea (0753) 431 323

**DUTCHEGATE LTD.**

94 Alfredton Gardens, Sholing
Southampton

---

**CIRCUIT DRAUGHTING work**

By — Details. 061 246 4534

---

**PRINTED CIRCUIT BOARDS**

Manufactured single/double sided. From circuit diagrams to assembled and tested boards. Any intermediate stages of manufacture undertaken. 3 day turn round on prototypes.

— Phone Maldon (0621) 741580 or write to Venture Co. 4 The Drive, Maylandsea, Chelmsford, Essex CM5 4AB.

---

**SHEET METAL WORK**

One or general front panels, chassis, covers, boxes, prototypes. 1 off or batch work fast turnround. 81-449 2695. M Gear Ltd. 179A Victoria Road, New Barnet, Herts.

---

**DESIGN DEVELOPMENT MANUFACTURE**

We can offer a high quality, professional service, covering all aspects from original design to small batch production. Digital/Analogue prototypes welcome. For competitive pricing and quick delivery phone Mr. Flower, Digitalis Ltd., 9. Mildews Road, Goring-on-Thames, Oxfordshire. Tel: 048 14 3162.
TECHTRON

PCB AND SYSTEMS ASSEMBLY - LARGE AND SMALL BATCHES - BACK PLANE, PROTOTYPE AND PRODUCTION WIRING TO SPECIFICATION - PROMPT QUOTATIONS AND DELIVERIES

Park Farm, Hoxne, Diss, Norfolk. Tel: Hoxne 520

I.H.S. SYSTEMS

Due to expansion of our manufacturing facilities we are able to undertake assembly and testing of circuit boards or complete units in addition to contract development.

We can produce, test and calibrate to a high standard digital analogue and RF equipment in batches of tens to thousands.

Telephone to arrange for one of our engineers to call and discuss your requirements, or send full details for a prompt quotation.

TEL. 01-253 4562
or reply to Box No. WW 8237

COIL WINDING

Large or small PRODUCTION RUNS

AIRTROINCS LTD

GARDNER INDUSTRIAL ESTATE
KENT HOUSE LANE
BEXLEYHEATH KENT BR3 1UG
01-859 1147

PCB and ETCHING, small runs.
- Electronic Mail Order, Ramsbottom, Bury, Lancs. Tel. 076 882 3356.

CLASSIFIED ADVERTISEMENTS

Use this Form for your Sales and Wants

To "Wireless World" Classified Advertisement Dept., Dorset House, Stamford Street, London, SE1 9LU

PLEASE INSERT THE ADVERTISEMENT INDICATED ON FORM BELOW

NAME: .................................................................

ADDRESS: ................................................................

REMITTANCE VALUE............... ENCLOSED

PLEASE WRITE IN BLOCK LETTERS. CLASSIFICATION: ........................................ NUMBER OF INSERTIONS: .............
INDEX TO ADVERTISERS

## Electronic Brokers/Hameg Oscilloscopes

**Brand New**

- **Top Quality Performance & Value**

**HM 307**
- Single Trace DC-10 MHz, 5mV/cm. Plus built-in Component Tester.

**HM 312**
- Dual Trace DC-20 MHz, 5mV/cm. Sweep Speeds 40 ns to 2.5 cm Bx10 cm Display.

£149 £250

*Other models up to 50MHz bandwidth available. Prices and full specs on request. Full demonstration at our premises. Quick delivery.*

*Prices do not include VAT (15%) or Carriage.*

**INDEX TO ADVERTISERS**

**Appointments Vacant Advertisements appear on pages 133-151**

<table>
<thead>
<tr>
<th>Company</th>
<th>Price</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustical Mfg. Co. Ltd.</td>
<td>£149</td>
<td>14</td>
</tr>
<tr>
<td>AEL Crystals</td>
<td>£149</td>
<td>27</td>
</tr>
<tr>
<td>Aero Elec (AEL) Ltd</td>
<td>£149</td>
<td>27</td>
</tr>
<tr>
<td>Amphenol International</td>
<td>£149</td>
<td>112</td>
</tr>
<tr>
<td>Anex</td>
<td>£149</td>
<td>66</td>
</tr>
<tr>
<td>Apex</td>
<td>£250</td>
<td>85</td>
</tr>
<tr>
<td>Aspex Electronics Ltd.</td>
<td>£149</td>
<td>27</td>
</tr>
<tr>
<td>Atari Electronics Ltd.</td>
<td>£149</td>
<td>10</td>
</tr>
<tr>
<td>Barrie Electronics Ltd.</td>
<td>£149</td>
<td>107</td>
</tr>
<tr>
<td>BIB Hi-Fi</td>
<td>£250</td>
<td>Cover iv</td>
</tr>
<tr>
<td>Bi-Pak Semiconductors Ltd.</td>
<td>£149</td>
<td>101</td>
</tr>
<tr>
<td>Biro</td>
<td>£149</td>
<td>123</td>
</tr>
<tr>
<td>Butterworth &amp; Co. Ltd.</td>
<td>£250</td>
<td>26</td>
</tr>
<tr>
<td>Cambridge Learning</td>
<td>£149</td>
<td>4</td>
</tr>
<tr>
<td>Carston Electronics Ltd.</td>
<td>£149</td>
<td>24, 25</td>
</tr>
<tr>
<td>Cartier Associates</td>
<td>£149</td>
<td>28</td>
</tr>
<tr>
<td>Ciatronics</td>
<td>£149</td>
<td>107</td>
</tr>
<tr>
<td>Chilimad Ltd.</td>
<td>£149</td>
<td>128</td>
</tr>
<tr>
<td>Chintec</td>
<td>£149</td>
<td>7</td>
</tr>
<tr>
<td>CIL</td>
<td>£149</td>
<td>119</td>
</tr>
<tr>
<td>Circom No. 5</td>
<td>£149</td>
<td>123</td>
</tr>
<tr>
<td>Colcom Electronic Ltd.</td>
<td>£149</td>
<td>116</td>
</tr>
<tr>
<td>Communications '80</td>
<td>£149</td>
<td>15</td>
</tr>
<tr>
<td>Compex (Europe) '80</td>
<td>£149</td>
<td>30</td>
</tr>
<tr>
<td>Computer Appreciation</td>
<td>£149</td>
<td>110</td>
</tr>
<tr>
<td>Continental Specialities</td>
<td>£149</td>
<td>122</td>
</tr>
<tr>
<td>Crimson Elektrik</td>
<td>£149</td>
<td>10</td>
</tr>
<tr>
<td>Cropico Ltd.</td>
<td>£149</td>
<td>18</td>
</tr>
<tr>
<td>Datong</td>
<td>£149</td>
<td>15</td>
</tr>
<tr>
<td>Datronics Electronics</td>
<td>£149</td>
<td>114</td>
</tr>
<tr>
<td>Dominus</td>
<td>£149</td>
<td>104</td>
</tr>
<tr>
<td>Drake Transformers</td>
<td>£149</td>
<td>86</td>
</tr>
<tr>
<td>Eagle International</td>
<td>£149</td>
<td>17</td>
</tr>
<tr>
<td>Edcor</td>
<td>£149</td>
<td>34</td>
</tr>
<tr>
<td>Edystone Radio Ltd.</td>
<td>£149</td>
<td>10</td>
</tr>
<tr>
<td>Electronic Brokers Ltd.</td>
<td>£149</td>
<td>129, 130, 131, 152</td>
</tr>
<tr>
<td>Elec Tec Components Ltd.</td>
<td>£149</td>
<td>124</td>
</tr>
<tr>
<td>Electrometric Services</td>
<td>£149</td>
<td>26</td>
</tr>
<tr>
<td>Elecrovalue</td>
<td>£149</td>
<td>26</td>
</tr>
<tr>
<td>Emet/Belton</td>
<td>£149</td>
<td>15</td>
</tr>
<tr>
<td>Faircrest Eng.</td>
<td>£149</td>
<td>114</td>
</tr>
<tr>
<td>Farnell Instruments Ltd.</td>
<td>£149</td>
<td>28</td>
</tr>
<tr>
<td>Feedback Instruments</td>
<td>£149</td>
<td>86</td>
</tr>
<tr>
<td>Fyde Electronic Labs Ltd.</td>
<td>£149</td>
<td>22</td>
</tr>
<tr>
<td>GEC Semiconductors</td>
<td>£149</td>
<td>76</td>
</tr>
<tr>
<td>GEC-MO Valve</td>
<td>£149</td>
<td>27</td>
</tr>
<tr>
<td>Hameg Ltd.</td>
<td>£149</td>
<td>2</td>
</tr>
<tr>
<td>Harris Electronics (London) Ltd.</td>
<td>£149</td>
<td>22, 32</td>
</tr>
<tr>
<td>Hart Electronics</td>
<td>£149</td>
<td>114, 116</td>
</tr>
<tr>
<td>Henry's Radio</td>
<td>£149</td>
<td>110, 116, 120</td>
</tr>
<tr>
<td>H.T. Audio</td>
<td>£149</td>
<td>23</td>
</tr>
<tr>
<td>I.L.P. Electronics Ltd.</td>
<td>£149</td>
<td>98, 108, 109</td>
</tr>
<tr>
<td>Industrial Tape Applications</td>
<td>£149</td>
<td>117, 128</td>
</tr>
<tr>
<td>Intregro Ltd.</td>
<td>£149</td>
<td>102, 103</td>
</tr>
<tr>
<td>Intes Elc Elektronik Ltd.</td>
<td>£149</td>
<td>85</td>
</tr>
<tr>
<td>Internatl</td>
<td>£149</td>
<td>9</td>
</tr>
<tr>
<td>ITP/IEA</td>
<td>£149</td>
<td>116</td>
</tr>
<tr>
<td>K.A.C. Electronic Investment</td>
<td>£149</td>
<td>101</td>
</tr>
<tr>
<td>Kylebith Electronics</td>
<td>£149</td>
<td>122</td>
</tr>
<tr>
<td>Kelsey Acoustics Ltd.</td>
<td>£149</td>
<td>35</td>
</tr>
<tr>
<td>Kirkham Amplifier</td>
<td>£149</td>
<td>15</td>
</tr>
<tr>
<td>Langrex</td>
<td>£149</td>
<td>115</td>
</tr>
<tr>
<td>Lambolt Electronics</td>
<td>£149</td>
<td>104</td>
</tr>
<tr>
<td>Laser Electronics</td>
<td>£149</td>
<td>12</td>
</tr>
<tr>
<td>Legal Aid</td>
<td>£149</td>
<td>120</td>
</tr>
<tr>
<td>Letvers-Rich Equip Ltd.</td>
<td>£149</td>
<td>18</td>
</tr>
<tr>
<td>Llevol Electronics Ltd.</td>
<td>£149</td>
<td>9</td>
</tr>
<tr>
<td>Linda Electronics</td>
<td>£149</td>
<td>28</td>
</tr>
<tr>
<td>Lowe Electronics</td>
<td>£149</td>
<td>28</td>
</tr>
<tr>
<td>Maclan-Zand Electronics Ltd.</td>
<td>£149</td>
<td>21</td>
</tr>
<tr>
<td>Maplin Electronic Supplies</td>
<td>£149</td>
<td>Cover iii, 516</td>
</tr>
<tr>
<td>Marshall &amp; A. Sons (London) Ltd.</td>
<td>£149</td>
<td>118</td>
</tr>
<tr>
<td>Mebadir</td>
<td>£149</td>
<td>12</td>
</tr>
<tr>
<td>Microcircuits Ltd.</td>
<td>£149</td>
<td>21</td>
</tr>
<tr>
<td>Milward, G.F.</td>
<td>£149</td>
<td>20</td>
</tr>
<tr>
<td>Multisoldiers Ltd.</td>
<td>£149</td>
<td>Cover iv</td>
</tr>
<tr>
<td>Newbear Computer Store</td>
<td>£149</td>
<td>22, 108</td>
</tr>
<tr>
<td>Newtronics</td>
<td>£149</td>
<td>23</td>
</tr>
<tr>
<td>Olsen Electronics</td>
<td>£149</td>
<td>33</td>
</tr>
<tr>
<td>OMB Electronics</td>
<td>£149</td>
<td>33</td>
</tr>
<tr>
<td>PERA Ltd.</td>
<td>£149</td>
<td>107</td>
</tr>
<tr>
<td>Powertronics Electronics</td>
<td>£149</td>
<td>121, 126, 127</td>
</tr>
<tr>
<td>Precision Instruments</td>
<td>£149</td>
<td>19</td>
</tr>
<tr>
<td>Pyrex Components</td>
<td>£149</td>
<td>34</td>
</tr>
</tbody>
</table>

---

**OVERSEAS ADVERTISMENT AGENTS**

- **France & Belgium**: Norton Hillein, 50 Rue de Chemin Vert, F-91090, Boulogne, Paris.
- **Italy**: Giugli E. Elias-Kompas, s.s.a. — Servizio fotografico. Via Mariantonia 4, 20123 Milano.
- **Japan**: Mr. Inataki, Trade Media — ISP (Japan), 8-12, Azabu Heights, 1-5-10 Roppongi, Minato-ku, Tokyo 106.
- **Australia**: Mr. Victor A. Jaques, Elintron International, P.O. Box 34607, Los Angeles, Calif. 90034, USA — Telephone: (213) 521-6851 — Telex: 18-1059.
- **Canada**: Mr. Colin R. MacCulloch, International Advertising Consultants, Ltd., 1951 14th Avenue, Vancouver, B.C., Canada.

---

Printed in Great Britain by OB Ltd., Shepperd Place, Colchester, and Published by the Proprietors IPC ELECTRICAL ELECTRONIC PRESS LTD., Dorset House, Stamford Street, London, S.I. 8LU; telephone 01-290 8899. Wireless World can be obtained abroad from the following: INDEPENDENT, GORDON & GORDON LTD. INDIA: A. H. Wheeler & Co. CANADA, The Wex Davidson Subscription Service Ltd. Gordon & Guthrie Ltd. SOUTH AMERICA: Central News Agency Ltd; William Dawson & Sons Ltd. UNITED STATES: Eastern News Distribution Inc., 14th Floor, 111 Eighth Avenue, New York, N.Y. 10011.
This superb organ—build the first working section for just over £100. Full specification in our catalogue.


A range of highly attractive knobs is described in our catalogue. Our prices are very attractive too!

The 3800 synthesiser build it yourself at a fraction of the cost of one ready-made with this specification. Full details in our catalogue.

A pulse width train controller for smooth slow running plus inertia braking and acceleration. Full construction details in our catalogue.

A wide range of disco accessories at marvellous prices. Our catalogue has all the details.

A very high quality 40W per channel stereo amplifier with a superb specification and lots of extras. Full construction details in our catalogue.

A genuine 150W per channel stereo disco to build yourself. Full specification in our catalogue.

61-note touch-sensitive piano to build yourself. Full specification in our catalogue.

Multimeters, analogue and digital, frequency counter, oscilloscopes, and lots, lots more at excellent prices. See cat. pages 106 and 183 to 188 for details.

A range of highly attractive knobs is described in our catalogue. Our prices are very attractive too!

Send the coupon now!