

wireless world

MARCH 1974 20p

Electronic piano Horn loudspeaker design

Dial a Span

Australia 70 cents
Belgium Fr. 41.00
Canada 90 cents
Denmark Kr. 8.00
Finland Fmk. 3.50
Germany Dem. 3.50
Holland Dfl. 3.25
Israel Ls. 2.50
Italy L. 600
Malaysia M\$ 2.30
New Zealand 85 cents
Nigeria 50c
Norway Nkr. 6.50 inkl. Moms
Rhodesia 20 cents
South Africa ca 65 cents
Spain Ptas. 55.00
Sweden Sw. 4.25 inkl. moms
Switzerland Fr. 4.30
U.S.A. \$1.00

Long-term frequency stability of 2 parts in 10^7 – that's good!

Lock-in range of 1% makes synchronization simplicity itself!

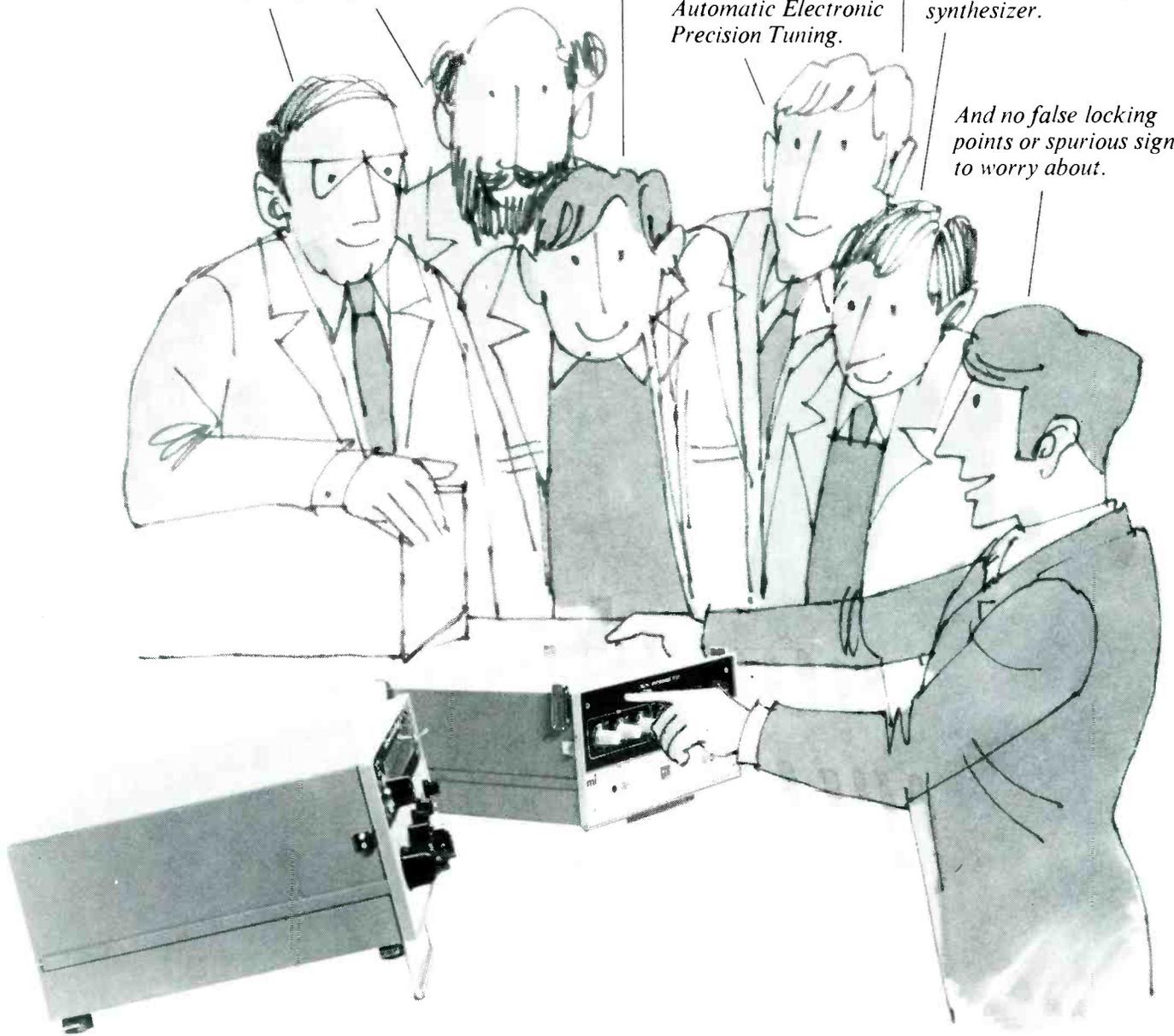
And there's no need for a frequency counter—the decade dials indicate directly the synchronized frequency in 100Hz steps to an accuracy of 2 parts in 10^7 —better and better!

Digital control of output frequency (after synchronization) over 1% range without retuning signal generator – better still.

You could call it Automatic Electronic Precision Tuning.

Best of all it's less than half the cost of a frequency synthesizer.

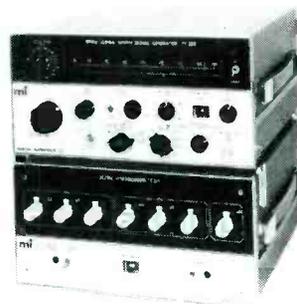
And no false locking points or spurious signals to worry about.



What is it?

It's the TF 2171 clip-on Digital Synchronizer—the first in a range of ancillary equipment designed to increase the usefulness of the TF 2015 – the signal generator that has a new performance/value standard. Together they give you:

- * long-term frequency stability of 2 parts in 10^7 .
- * a simple method of frequency setting to an accuracy of 2 parts in 10^7 in 100Hz steps by means of 7 direct-reading decade dials.
- * no false locking points and no spurious output signals.



* all this is added to the TF 2015's exceptional performance: accurate $1\mu\text{V}$ output over entire frequency range; attenuator accuracy of $\pm 1\text{dB}$ to 100MHz and $\pm 2\text{dB}$ to 520MHz, spurious radiation low enough to permit measurement at $0.1\mu\text{V}$ level; 10-520MHz frequency coverage. Directly calibrated fm and am facilities.

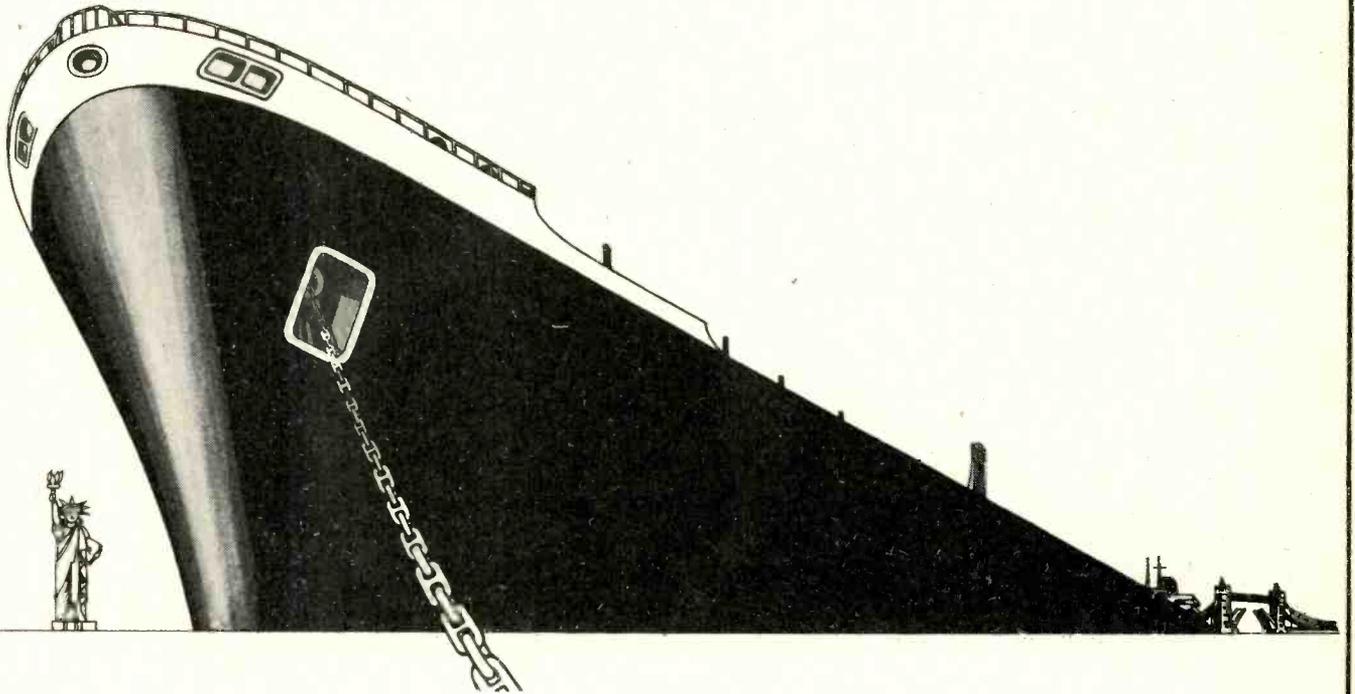
Add up these advantages, halve the cost of a synthesizer and you have the combined TF 2015 and TF 2171. If you are working with narrow band equipment—this combination has been designed for you. Ask us now for full descriptive literature.



Marconi Instruments Ltd.,
Longacres, St. Albans,
Herts, AL4 0JN, England.
Telephone: St. Albans 59292. Telex: 23350
A GEC-Marconi Electronics Company.

EEV AND
M-OV MARINE
RADAR TUBES

OURS ARE THE LONG DISTANCE TUBES.



60% of marine radars in the world rely on EEV and M-OV tubes. Because ours are the 'long distance' tubes which are made to last and last – even in the most arduous and varying environments.

EEV and M-OV offer one of the world's widest ranges of tubes for radar: magnetrons, hydrogen thyratrons, pulse modulator tubes,

klystrons, duplexer devices, cathode ray tubes.

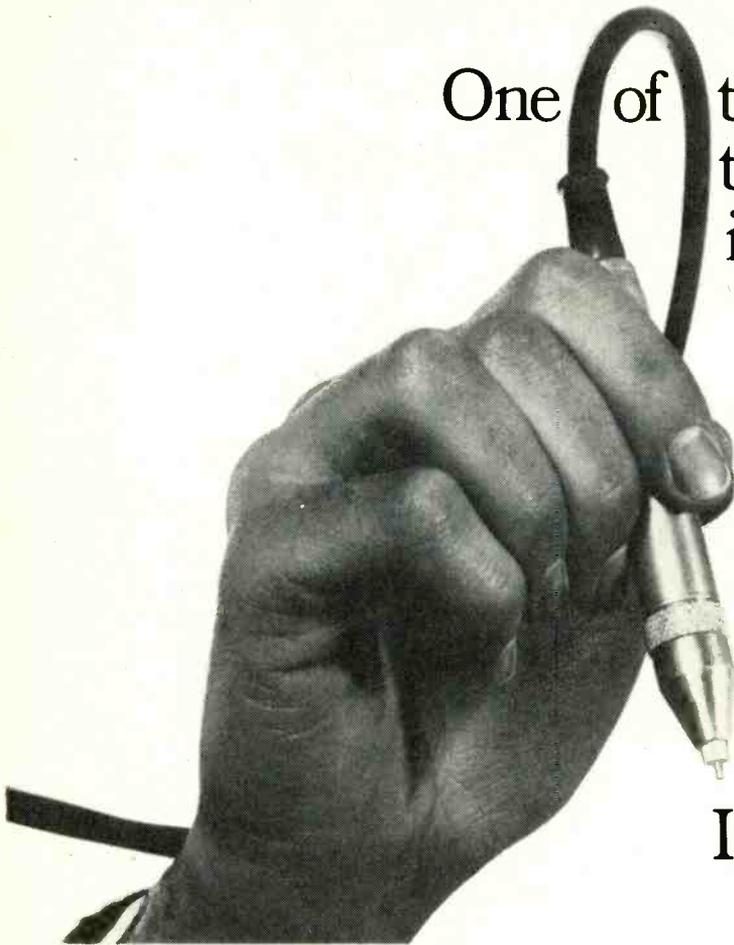
In fact, whatever marine radar tube you want – we make it. To the highest quality standards, and with a swift technical back-up and replacement service. Write for a complete list of EEV and M-OV tubes for marine radar. Or if you have a specific problem, telephone our Microwave engineers at Chelmsford.

EEV AND M-OV KNOW HOW.

ENGLISH ELECTRIC VALVE CO LTD, Chelmsford, Essex, England CM1 2QU. Tel: 0245 61777. Telex: 99103. Grams: Enelectico Chelmsford.
THE M-O VALVE CO LTD, Hammersmith, London, England W6 7PE. Tel: 01-603 3431. Telex: 23435. Grams: Thermionic London.

S&C 

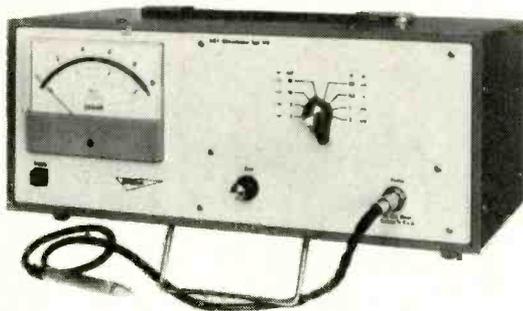
One of the many secrets of
the Dymar 1711
is right here.



In the probe.

The Dymar 1711 is a VHF/UHF Millivoltmeter with a number of clever, and extremely useful, differences.

Take the compact, lightweight RF probe. This houses two high speed rectifying diodes in a full-wave circuit. The resulting low level DC voltage is amplified in a low noise chopper-stabilized DC amplifier. The rectifying characteristic of these diodes is such that below approxi-



mately 30mV they follow a square law. The result? True rms response.

Then there are the special linearising circuits used on each of the eight voltage

ranges provided. These ensure completely linear readings between one-third fsd and full scale.

And, as you would expect from Dymar, the instrument is fully portable and provided with a comprehensive range of accessories.

Take a look at this brief spec.

Frequency range:	50kHz to 850MHz
Voltage range:	1mV fsd to 3V
Minimum reading:	300µV
RMS response:	True below 30mV

Need to know more? Use the Reader Reply Service or contact Dymar direct.

DYMAR

the name in radiotelephones

DYMAR ELECTRONICS LIMITED,
Colonial Way, Radlett Road, Watford,
Herts. WD2 4LA. Tel: Watford 37321.
Telex: 923035. Cables: Dymar Watford.

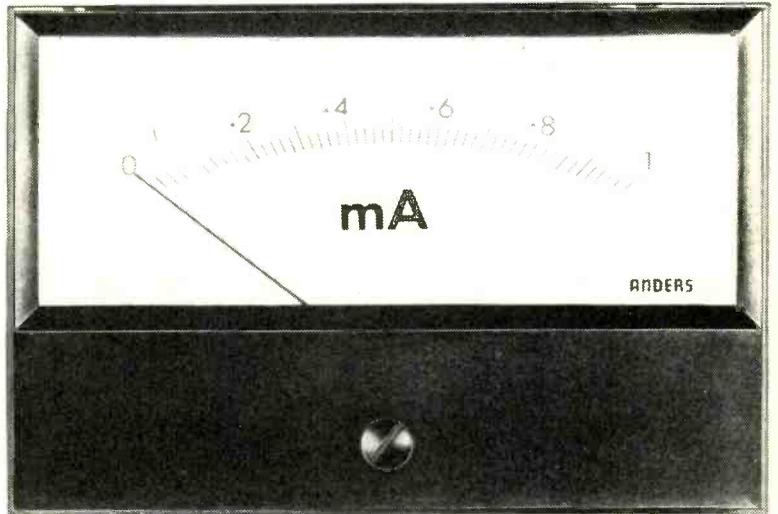
ANDERS MEANS METERS...

REGAL RANGE

- New 100° arc high quality meters at low prices.
- Rugged taut band construction — pivot and jewel available to order
- Sensitivities to 10 μ A
- Very competitively priced for OEM quantities
- Modern styled meters in matt black plastic cases with flattened arc giving long scale.

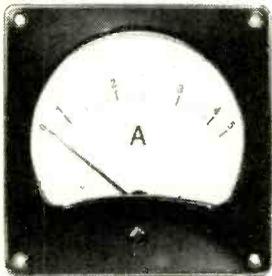
TWO MODELS

- R55 2.5in (63.5mm) Scale length
- R65 3.2in (81.3mm) Scale length

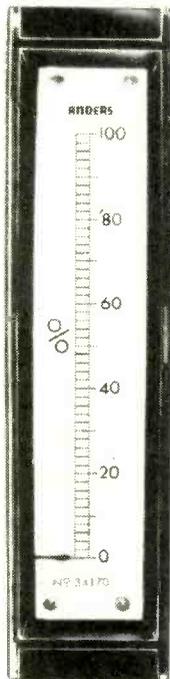


Anders provide what is probably the largest range of meters available from a single source in Europe: MC/MI, dynamometer, vibrating reed, electrostatic, etc. in over 100 case styles and sizes, a few of which are shown below.

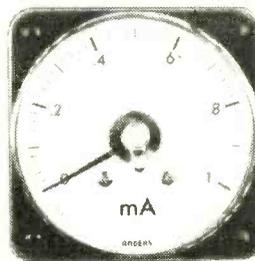
Popular models and ranges are stocked in depth while a specially equipped instrument department enables swift production of non-standard ranges and scales, to suit individual customer requirements, in large or small quantities.



Vulcan Moving Iron. 4 models, 1.5", 1.8", 2.7", 3.7" scales. Voltmeters, ammeters and motor starting meters.



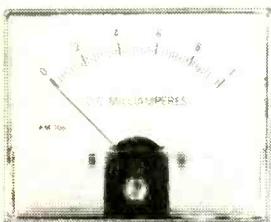
Profile 350 edgewise 4.3" scale. DC moving coil and AC moving coil rectified. Horizontal or vertical mounting.



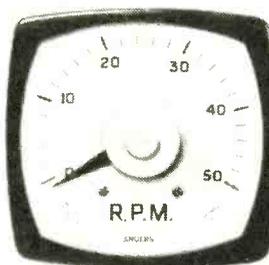
Oxford Long Scale 240°. 2 models, 5.5", 8" scales. DC moving coil and AC moving coil rectified.



Models KE1 and KE2 Miniature Edgewise Meters. Nominal scale lengths 1.2" and 2". Available in sensitivities from 50 microamps Moving Coil.



Kestrel Clear Front. 7 models, 1.3"—5.25" scales. DC moving coil, AC moving coil rectified, AC moving iron.



Stafford Long Scale 240° 6 models, 3.5"—11.5" scales. DC moving coil, AC moving coil rectified, AC moving iron. Also 98° scale.



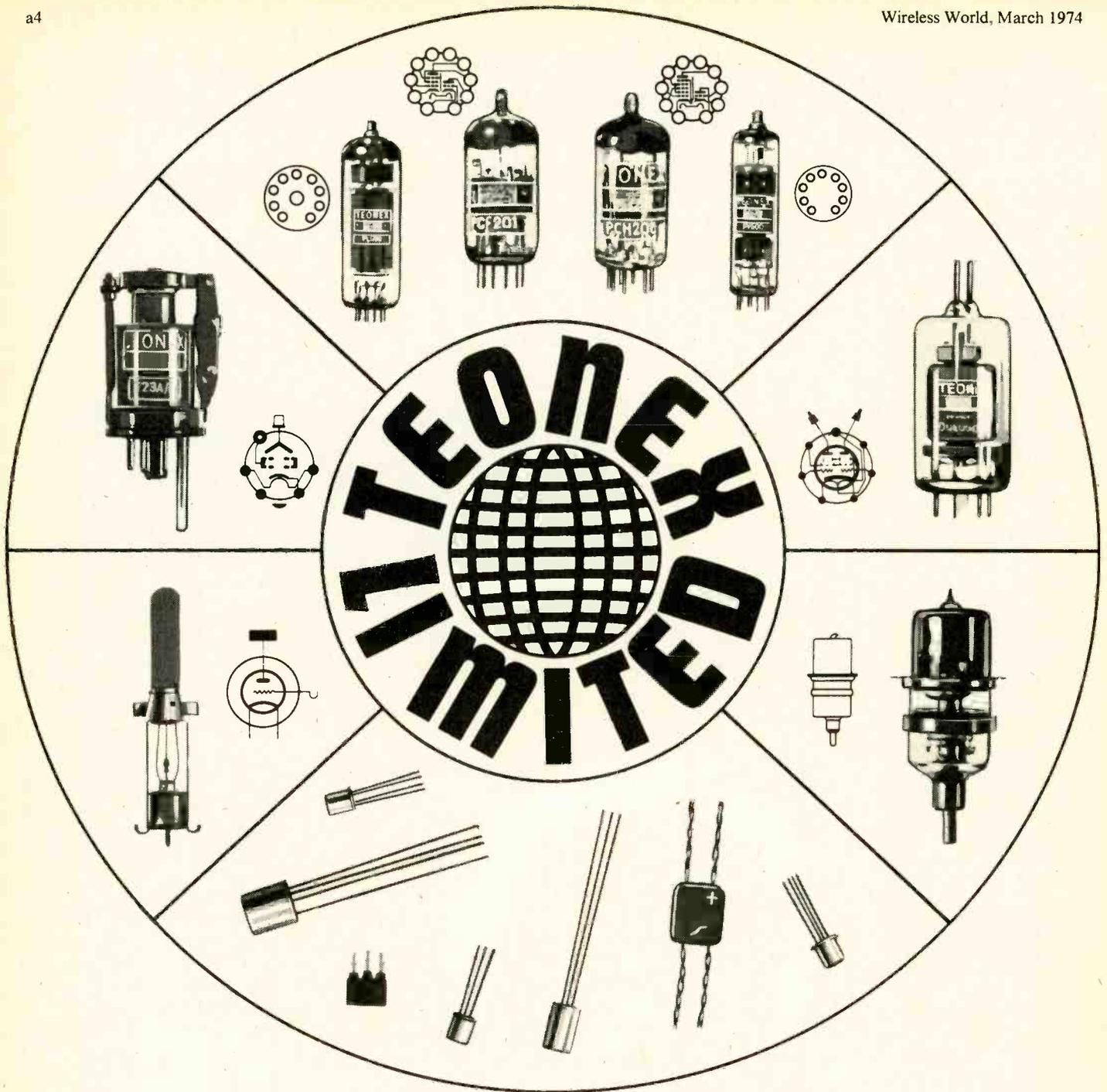
Lancaster Long Scale 240°. 2 models, 4", 5.5" scales. DC moving coil and AC moving coil rectified.

Send for fully illustrated catalogue.

ANDERS ELECTRONICS LIMITED 48/56 Bayham Place, Bayham Street, London, N.W.1. Telephone 01-387 9092.

Manufacturers and distributors of Electrical Measuring Instruments. Sole U.K. distributors of FRAHM Resonant Reed Frequency Meters and Tachometers. Manufacturers of purpose built electrical and electronic equipment to customers requirements.

WW—015 FOR FURTHER DETAILS



**Electronic valves (a comprehensive range)
 semi-conductors (a wide variety)
 integrated circuits... and now a comprehensive
 range of Hybrid Microcircuits. Prices on request.**

Teonex offers more than 3,000 devices. They are competitively priced and they are superlative in performance because the company imposes strict quality control. Teonex concentrates entirely on export and now operates in more than sixty countries on Government or private contract. All popular types in the Teonex range are nearly always available for immediate delivery. Write now for technical specifications and prices: Teonex Limited, 2a Westbourne Grove Mews, London W11 2RY, England. Cables: Tosupply London W11. Telex: 262256



**AVAILABLE ONLY
 FOR EXPORT**

Write the Specification of your perfect iron

and compare it with an Antex

low leakage and Precision for delicate equipment Interchangeable Bit Iron-coated large 25 watts?



MODEL X25 Soldering Iron 220-240 or 100-120 Volts. The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with its truly remarkable heat-capacity will easily "out-solder" any conventionally made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8". 2 other bits available 3/32" and 3/16". Totally enclosed element, ceramic and steel shaft. Bits do not "freeze" and can easily be removed. **PRICE £2.05** (rec. retail) P & P 10p. Suitable for production work and as a general purpose iron.

MODEL CCN 220 volts or 240 volts. The 15 watt miniature model CCN also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32". 4 other bits available 1/8", 3/16" 1/4" and 3/64" including Heat Shield. **PRICE £2.48** (rec. retail) P & P 10p.

MODEL C Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 3/64", to 3/16". Voltages 240, 220, 110, 50 or 24. **PRICE £2.05** (rec. retail) P & P 10p.

MODEL MLX KIT Battery operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet and with booklet "How to Solder". **PRICE £2.54** (rec. retail) P & P 12p.

ST3 Stand - This stand is made from high grade insulation material with a chromium plated strong steel spring. It is suitable for all models and replaces all previous stands. The two sponges at the side which are easily replaceable, serve to keep the soldering bits clean. Spare bits can be accommodated as shown on the illustration. **PRICE: £1.00** (rec. retail) P & P 10p.

MODEL G 18 watt miniature iron, fitted with long-life iron-coated bit 3/32". Voltage 240, 220 or 110. **PRICE £2.26** (rec. retail) P & P 10p.



MODEL SK.2 KIT Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32" heat sink, solder, and "How to Solder" booklet. **PRICE £3.25** (rec. retail) P & P 10p.



MODEL SK.1 KIT Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet. **PRICE £3.48** (rec. retail) P & P 12p.



ALL PRICES include VAT at 10%

Please send the following:

Please send the ANTEX colour catalogue

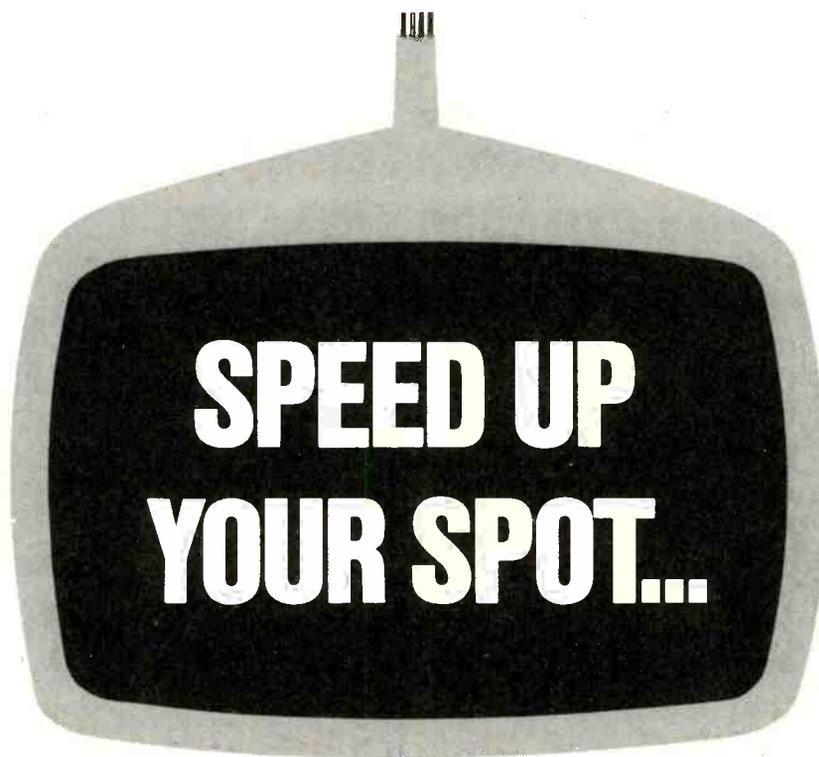
From radio or electrical dealers, car accessory shops or in case of difficulty direct from:
ANTEX LTD. FREEPOST PLYMOUTH PL1 1BR
(no stamp required) Tel 0752 67377.

I enclose cheque/P.O./Cash (Giro No. 258 1000)

NAME

ADDRESS

WW3



... AND SAVE POWER DRAIN, WEIGHT AND SPACE.

By introduction of new electron-optics in electrostatic deflection CRT's, THOMSON-CSF has overcome the limitations of current tubes: considerable increase of power drain of electromagnetic tubes for higher writing speeds, long gun and very high deflection voltages of conventional electrostatic tubes. While providing excellent resolution and brightness, this new generation of large screen electrostatic CRT's has spectacular advantages, due to unique

Characteristics	Unit	TH 8100 TH 8201	0EE 1333	TH 8000
Useful screen dimensions	mm	180 x 130	255 x 190	255 x 190
Tube length	mm	360	450	450
Post-acceleration voltage	kV	20	20	25
Deflection sensitivity (min.)	V/cm	10	6	10
Deflexion linearity (max.)	%	2	1	2
Beam current (peak)	μ A	30	30	50
Luminance (1)	cd/m ²	65	35	65
Line width	mm	0,4	0,5	0,4

(1) At 1 cm/ μ s and 50 Hz refresh rate

performances: high deflection sensitivity, bandwidth and writing speed, short gun. The very high deflection sensitivity results in a considerable size and price reduction of power supplies and deflection amplifiers: for the same screen size, power consumption may be reduced by 100 and volume by 3. These tubes can be provided with internal graticule for large screen oscilloscopy or without graticule for high speed alphanumeric or graphic monitors.



THOMSON-CSF

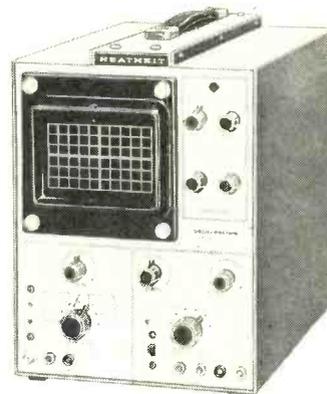
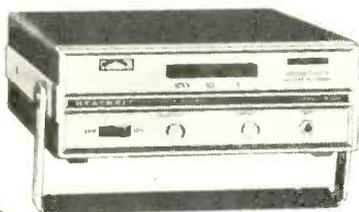
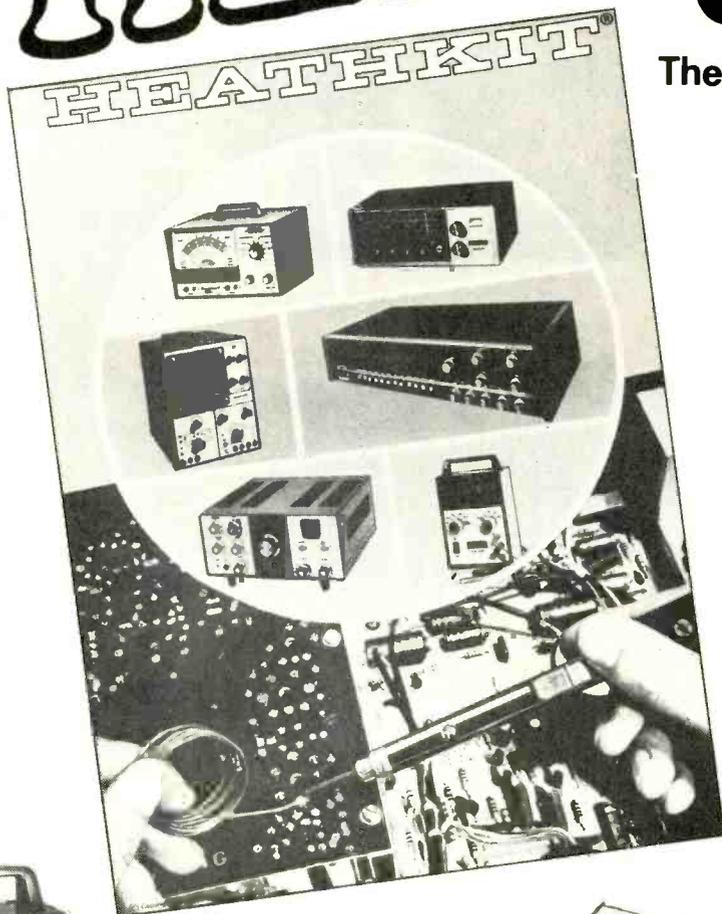
THOMSON-CSF ELECTRONIC TUBES LTD / BILTON HOUSE, UXBRIDGE ROAD, EALING / LONDON W5 2TT
TEL. (01) 579 5511 / TELEX : 25 659

France - THOMSON-CSF Groupement Tubes Electroniques / 8, rue Chasseloup-Laubat / 75737 PARIS CEDEX 15 / Tel. 566.70.04
Germany - THOMSON-CSF Elektronenröhren GmbH / Am Leonhardsbrunn 10 / 6 FRANKFURT/MAIN / Tel. 70 20 99
Italy - THOMSON-CSF Tubi Elettronici SRL / Viale degli Ammiragli 71 ROMA / Tel. 63 80 143
Japan - THOMSON-CSF JAPAN K.K. / Kyosho Building / 1-9-3 Hirakawa-cho / Chiyoda-ku / TOKYO / T 102 / Tel. 03 264-6341
Sweden - THOMSON-CSF Elektronör AB / Box 27080 / S 10251 STOCKHOLM 27 / Tel. 08/22 58 15
U.S.A. - THOMSON-CSF Electron Tubes, Inc. / 50 Rockefeller Plaza / NEW YORK, N.Y. 10020 / Tel. (212) 489.0400

FREE

HEATHKIT Electronics Catalogue

There's something for everyone
in the latest FREE Heathkit
catalogue



The FREE Heathkit Instrumentation Catalogue describes the latest Heathkit solid-state oscilloscopes, 120 MHz frequency counter with 8 digit readout, 3½ digit multi meter for measuring AC and DC voltage, current and resistance with automatic switching for DC polarity, Portable FET VOM with 53 ranges on 4 scales, FET/

transistor tester, plus many, many more Heathkit test instruments—all designed for easy assembly and kit-form savings. Send today for your FREE Heathkit catalogue, the world's largest selection of electronic kits—test, marine, amateur radio, b/w television, stereo hi-fi, automotive, home appliances, educational and more.

FREE Heathkit Catalogue

offers something for everyone.
Send for your copy today.

VISIT THE HEATHKIT CENTRES

LONDON
233 Tottenham Court Road.
GLOUCESTER (Factory & Showroom)
Bristol Road, Gloucester.



Please send me the FREE Heathkit catalogue

Name _____

Address _____

Heath (Gloucester) Limited
Department WW/3/74
Gloucester GL2 6EE
Telephone 0452 29451

HEATH
Schlumberger

SE Labs Dynamic

SM 2001 Digital Frequency Response Analyser (Transfer Function Analyser)

Four decade digital display in Cartesian, Polar or Log Polar form, from 0.00001 Hz to 1 kHz. Measurements in ratio or absolute terms. Remote programming for A.T.E. applications standard. Harmonic analysis capability. Suitcase format - easily portable. Fully floating and isolated input and output. Very high harmonic and noise rejection. Resolution to 0.1°. BCD output of all information standard.



SM 2003 Frequency Extension Unit

Extends the frequency range of SM 2001 up to 1 MHz. Also extends the harmonic measurement capability and reference synchronisation capability of the SM 2001/2 up to 1 MHz. Fully isolated input and output to the high frequency system under test.

SM 2004 Modulator Demodulator Unit

Provides for utilisation of SM 2001 with systems having modulated carrier input and/or output. Carrier frequency 50 Hz to 10 kHz. Modulation frequency 0 to 1 kHz. Fully floating and isolated inputs and outputs.



SM 2002 Reference Synchronizer

An internal fitment for the SM 2001 F.R.A. to enable synchronisation from external signals. Will synchronise from virtually any wave form of

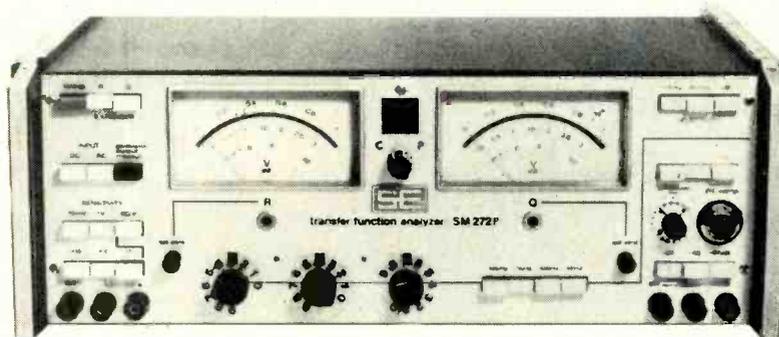
almost any amplitude. Permits the use of SM 2001 on systems with mechanical or hydraulic inputs. Extends the use of SM 2001 to closed loop testing or part system testing and also

to the measurement of the phase relationships between outputs of any two transducers or other sources.

Analysis

SM 272 Transfer Function Analyser

0.01Hz to 10kHz. Accuracy $\pm 1\%$ (D version). Optional analogue or digital read out. Much better than 40dB noise rejection. Dynamic range greater than 25 x FSD. Sine, triangular and square outputs. DC offset capability. Cartesian or switchable cartesian/polar display (P version). 10 millivolts sensitivity. Fully isolated input and output. Independent R / Q expanders for small angle accuracy. Very low cost.



SM 2008 Computer Interface

A complete package of software and hardware to enable computer control of SM 2001 for any system or frequency change.

SM 2006 Two channel converter (Accessory for SM 2001)

Accepts two separate channels from any system or vibrating structure and computes the phase and amplitude relationship between them. Enables both channels to go into correlated input with high noise rejection.

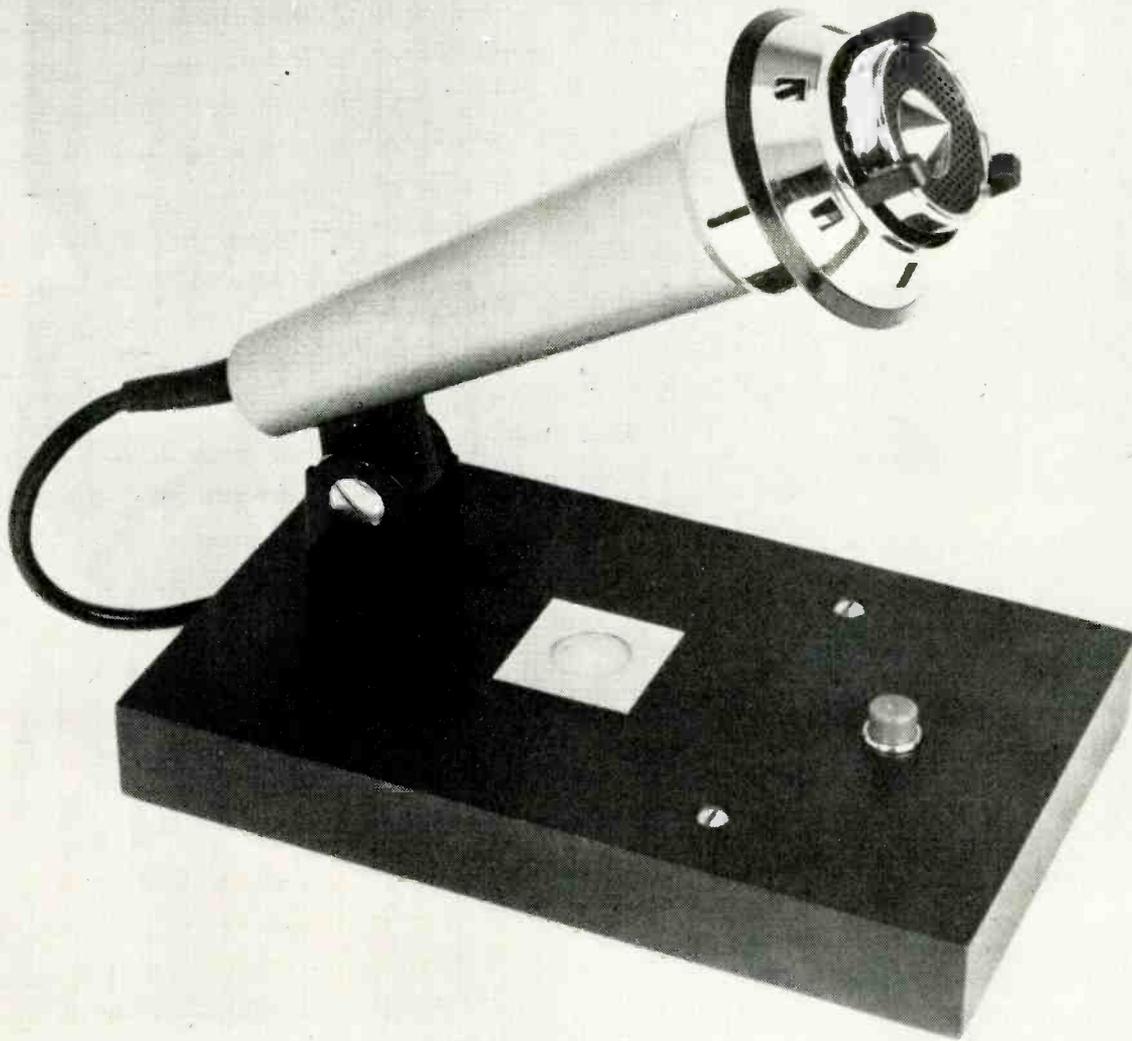
Available Soon

SM 2007 Plotter Interface

This unit provides for coupling the SM 2001 frequency response analyser directly into any standard XY recorder. The resultant plots can be of Bode or Nyquist type. Three outputs are provided, 1. Log frequency, 2. A co-ordinate or amplitude, 3. jB. co-ordinate or phase angle. A dynamic range control and automatic pen-lift are further features.

DST11

Miniature paging unit



BY AKG THE LEADING SUPPLIERS OF THE FAMOUS MICROPHONES CONSISTENTLY USED IN OUR T.V. BROADCASTING AND SOUND RECORDING STUDIOS.

This highly successful miniature paging unit has many possibilities. The DST11 paging unit incorporates a high quality directional microphone mounted on a solid base fitted with one or three push button switches and indicator light. Can be wired for remote control operating to work in conjunction with a relay.



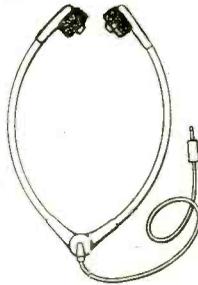
AKG 182/4 Campden Hill Road
London W8 7AS. 01-229 3695.

Years of research...

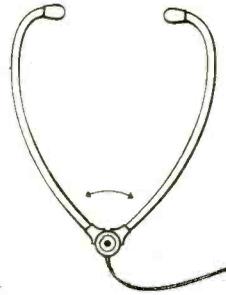
... on accessories for dictating machines, tape recorders,
tele-communications and electro-acoustic equipment, etc.



STETOCLIP
JUNIOR 60
HEADSET



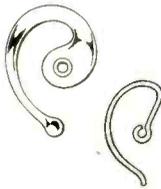
STETOCLIP
LIGHTWEIGHT
HEADSET



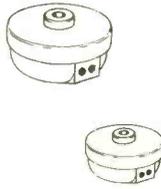
STETOCLIP
SENIOR
HEADSET



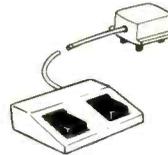
STETOMIKE
BOOM MICROPHONE
HEADSET



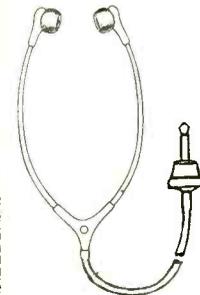
PLASTIC
EARHANGERS



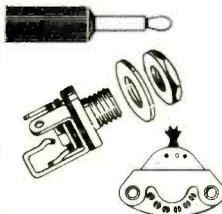
STANDARD &
SUB-MINOR
EARPHONES



FOOTSWITCHES



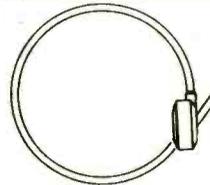
HOSPITAL
HEADSETS



2.5 mm and 3.5 mm
JACK PLUGS &
SOCKETS & SUB-
MINIATURE
SWITCHES



DANASOUND HEADSET



THROAT
MICROPHONE



DANASONIC
INDUCTION AUDIO
LOOP RECEIVER

Danavox
INTERNATIONAL

DANAVOX (GT. BRITAIN) LTD.
Electro-Acoustic Components and Hearing Aids
"BROADLANDS" BAGSHOT ROAD,
SUNNINGHILL, ASCOT, BERKS.
TEL: 0990 23732/6; TELEX 847584



Listening to music in the home

When we listen we become engrossed in the music and, with good equipment, we can often obtain the same satisfaction that we would enjoy in the concert hall. Of course, there are differences between the real and the reproduced. Many of these we recognise as such; we come to terms with them and they do not intrude. More serious perhaps are the distortions which we do not consciously notice but which are nevertheless continuously producing a contradiction between the

actual and the imagined. They produce listening fatigue, a condition detrimental to the true objective. These distortions have little to do with the popular conceptions of HI-FI or LO-FI sound; on the other hand they have much to do with good or bad engineering. Send postcard for illustrated leaflet to Dept. (WW) Acoustical Manufacturing Co. Ltd., Huntingdon PE18 7DB. Telephone (0480) 52561.

QUAD

will not be participating in the forthcoming Sonex Exhibition and regret any inconvenience to our customers.
 QUAD is a Registered Trade Mark.

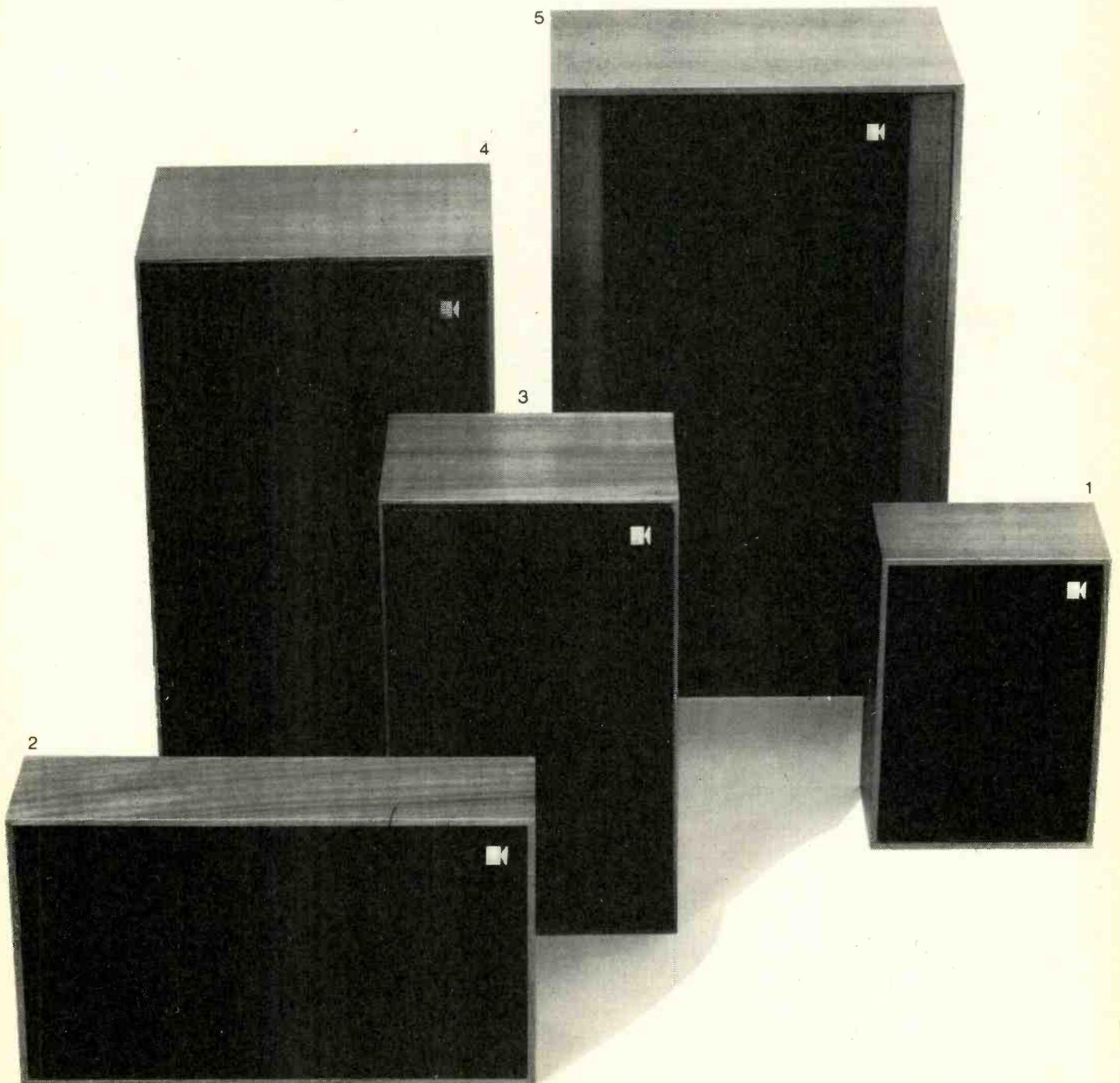
KEF KC SERIES

 **KEF ELECTRONICS LIMITED**
TOVIL MAIDSTONE ME15 6QP Tel 0622 57258
Registered in England No 702392

KEF offer you an excellent choice of loudspeaker systems whatever your requirements. The larger speaker systems such as the Concerto are capable of reproducing more extreme bass and handle higher amplifier power. The difference in sound between the largest and the smallest speaker system is subtle – the high quality and detailed engineering is evident throughout.

KEF believe that restricted space need not necessarily restrict performance – visit your KEF dealer and hear what we mean.

Full details of the Coda¹, Cantor², Chorale³, Cadenza⁴ and Concerto⁵ will be sent on request.



Mullard Crossens: making millions of

At Crossens, near Southport, Mullard produce magnetic components in quantity. Every year the plant converts nearly 5,000 tonnes of raw materials into many different products: about one third of the total output is exported. Approximately one half of the products are supplied to the British TV industry and comprise scan coil yoke rings, LOPT cores, loudspeaker magnets and other components: today, most British sets employ Mullard magnetic components.

Crossens, believed to be the largest single plant of its kind in Europe, employs some 750 people. Their skills in this specialist technology have developed out of more than 30 years' experience in the development and production of Magnadur, Ferroxcube, Ticonal and other Mullard brands which are household names to set designers.



magnetic components for TV

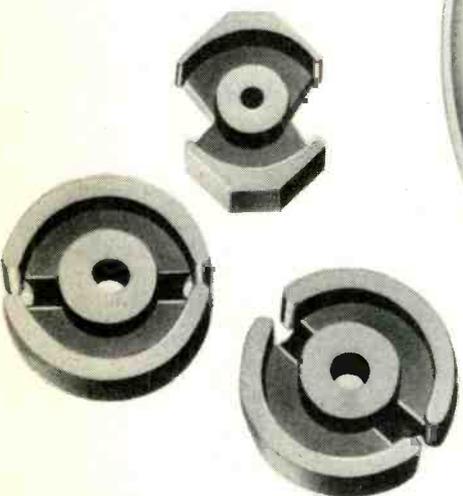


And their ability to mass-produce the 40 million components required by industry every year, to the highest standards of performance and reliability, helps British setmakers to produce the finest TV sets in the world.

**Components for
the finest colour
tv sets in the
world.**

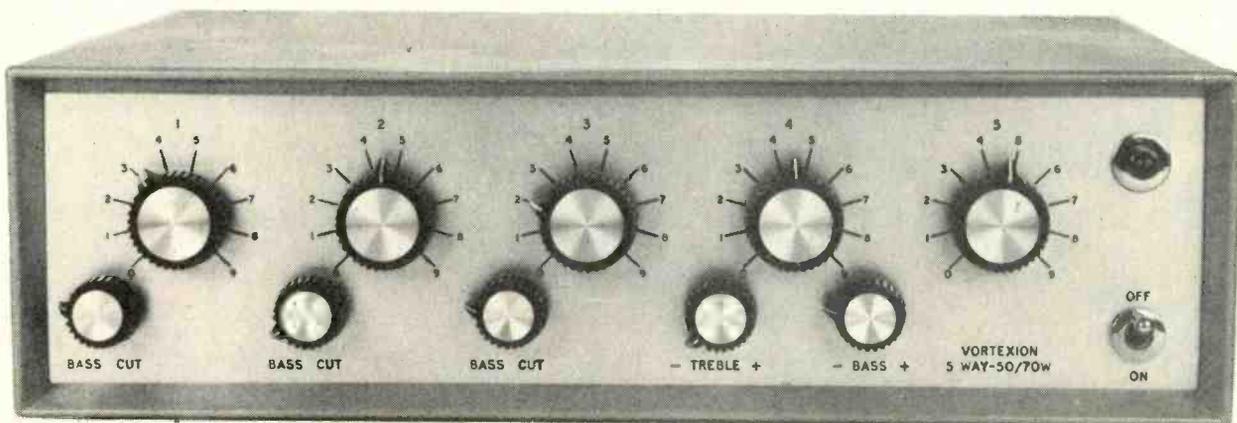


Mullard



Vortexion

QUALITY AMPLIFIERS FOR THE PROFESSIONAL



50/70 WATT ALL SILICON AMPLIFIER
WITH BUILT-IN 5-WAY MIXER USING F.E.T.s

£93.17
(VAT extra)

**50/70 WATT ALL SILICON AMPLIFIER
WITH BUILT-IN 4-WAY MIXER**

£96.80
(VAT extra)

100 WATT ALL SILICON AMPLIFIER

£139.15
(VAT extra)

THE 100 WATT MIXER AMPLIFIER

£42.35
(VAT extra)

20/30 WATT MIXER AMPLIFIER

£123.42
(VAT extra)

CP 50 AMPLIFIER

£163.35
(VAT extra)

200 WATT AMPLIFIER

PRICES
ON APPLICATION

F.E.T. MIXERS AND PPMs

Vortexion Ltd

TEL: 01-542 2814 and 01-542 6242-3-4 TELEGRAMS: 'VORTEXION' LONDON SW19
257-263 THE BROADWAY · WIMBLEDON · SW19 1SF

Testmatic answers testing problems



Edith Parker easily handles all the Testmatic work in a sub-assembly department of 32 people. When a board leaves that department, it's faultless.

If your product uses elaborate circuitry, it takes skill to faultfind by standard test department methods. But if you put skilled staff on repetitive work, you don't deserve to keep them.

Ansafone's answer was the Testmatic TM30. Repetitive work is what it thrives on—like all machines. It frees qualified staff to do what they were trained to do. And it has other advantages that are just as important.

Mr. S. P. Robinson, a Director of Ansafone states: "An obvious benefit of the Testmatic is that it helps us educate people working on assembly. If they get faulty boards back at once, they feel that much more involved and more responsible. In fact, we don't even see the Testmatic as a tool of the Test Department but as a tool of the Production Department."

Furthermore, the Testmatic makes money by saving time. Ansafone predict that it will help them reduce routine testing time by half. This is a cool and cautious estimate. There will be people

saying "I-told-you-so" if the saving turns out to be even more dramatic than that.

Once again, that is not peculiar to Ansafone. The common experience is that from the time the TM30 is set up ("set up" rather than "programmed," because the procedure is so simple), it pays for itself in months if not weeks.

The Wayne Kerr Testmatic TM30 tests circuit boards, cableforms, and sub-assemblies. Capable of 30 separate DC measurements, which it does in seconds. For complete information, post this coupon—or call Bognor Regis (02433) 25811.

Your name _____

Company Name _____

Address _____

Wayne Kerr

Post to Wayne Kerr, Durban Road, Bognor Regis, Sussex PO22 9RL.
Telex 86120 Cables: Waynkerr Bognor.

A member of the Wilmot Breeden Group.

WW—March



Mazda gets a new approval

Already seven sizes of Mazda monochrome tubes have received BSI approval for implosion protection to BS 417 (1972) Clause 18.

Rimguard construction always has given Mazda the edge. Now the new labels indicating BSI certification are additional evidence that Mazda gives top priority to safety as well as

to performance.

So we'd like to ask you a question. Because the answer could make quite a difference to your business – and your future.

The question is:

ARE YOUR REPLACEMENT TUBES AS SAFE AS MAZDA?

Thorn Radio Valves and Tubes Limited

MAZDA

Mollison Avenue, Brimsdown,
Enfield, Middlesex, EN3 7NS. Tel: 01-804 1201

THORN

Join the Digital Revolution

Digital Computer Logic and Electronics

A Self-instructional Course

C. P. Gane MA (Cantab)
A. W. Unwin BA (Cantab)

Book 1 Basic computer logic

Book 2 Logical circuit elements

Book 3 Designing circuits to carry out logical functions

Book 4 Flipflops and registers

Teach yourself the latest techniques of digital electronics

Computers and calculators are only the beginning of the digital revolution in electronics. Telephones, wristwatches, TV, automobile instrumentation — these will be just some of the application areas in the next few years.

Are you prepared to cope with these developments?

This course of four volumes — each 11 3/4" x 8 1/4" — guides you step-by-step with hundreds of diagrams and questions through number systems, Boolean algebra, truth tables, de Morgan's theorem, flipflops, registers, counters and adders. All from first principles. The only initial ability assumed is simple arithmetic.

At the end of the course you will have broadened your horizons, career prospects and your fundamental understanding of the changing world around you.

£2.95 A complete programmed learning course in 4 volumes



£2.95

including VAT, packing & surface post anywhere in the world. Payment may be made in foreign currencies. Quantity discounts are available on request.

Guarantee

If you are not entirely satisfied with Digital Computer Logic and Electronics you may return it to us and your money will be refunded in full, no questions asked.

**Designer
Manager
Enthusiast
Scientist
Engineer
Student**

This course is written to meet your needs in coming to grips with the theory and practice of digital logic and electronics. The programmed instruction system ensures a high level of retention of everything you learn.

To: Cambridge Learning Enterprises, 49 Main Street, Hartford, Huntingdon.

Please send me set(s) of Digital Computer Logic and Electronics at £2.95 for which I enclose cheque/PO/money order value

Name

Address

New Sounds!

New Sounds!



Introducing the new Martin Minidan & Microdan Speakers from Acos

The Microdan gives over 25 Watts from an enclosure which measures only 6 1/2" x 6 1/2" x 6 1/2" and the Minidan gives 30 Watts from an enclosure measuring only 6 7/8" x 6 1/2" x 11 1/4".

Thanks to the Martin construction technique which gives an extremely rigid cabinet, these high outputs are available from 5" full range units which produce a very forward sound of high ambience and true fidelity. Their high quality performance combined with compact size make them ideally suited for siting even on the smallest bookshelf to give maximum flexibility from Hi Fi or quadraphonic installations regardless of space.

Complete the coupon for details of your nearest dealer.



Acos for Sound Enjoyment

COSMOCORD

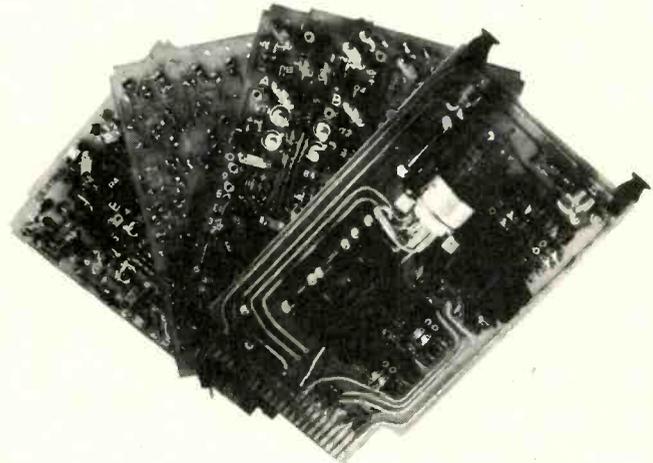
Cosmocord Ltd., Eleanor Cross Road, Waltham Cross, Hertfordshire. EN8 7NX
Telephone: Waltham Cross 27331 Telex: 24294

Please send me your new Martin Speakers Leaflet giving details of the Minidan and Microdan.

Name: _____

Address: _____

an excellent hand



OF SOLID STATE RELAY INTERFACES

To ensure the maximum flexibility in meeting today's Interface requirements Fairey Electronics have added to their range of Solid State Polarised Relays a series of Interface Boards retaining the same inherent reliability and long life. Within the series a Universal Board is available allowing the customer the choice of each side stable, one side stable or centre stable, and double or single current working.

FEATURES

- Isolation to BPO requirements
- 6 to 100 volts output single or double current working
- 3 to 100 volts input single or double current working
- No additional power supplies

TYPICAL APPLICATIONS

TTL logic to BPO tariff J lines

Single current Telegraph
Machines to BPO tariff J lines

— Signals to CCITT recommendation
V24 to BPO tariff J lines

— TTL logic or V24 signals to teleprinters

In meeting Interface requirements for widely diverse applications Fairey Electronics have built up experience and expertise which is almost unique in this field. Hardly an Interface remains a stranger and all can be solved.

For further details of our Boards and plug in Relays write to:

Fairey Electronics

POTTINGTON INDUSTRIAL ESTATE
BARNSTAPLE
N. DEVON. Tel. Barnstaple 5911 Telex 46337

Handful of relay know-how!



We are one of the largest manufacturers of Miniature Plug-in Relays in Europe.

Varley miniature plug-in relays including the Miniaturised Bi-stable polarised relay type VPR and Post Office approved relay type 23 are used and approved by most leading electronic manufacturers throughout the world. The reasons: PERFORMANCE, RELIABILITY, PRICE.

Varley go to great lengths to ensure a consistently high standard of performance and reliability in the manufacture of their range of relays. Ultrasonic cleaning is used throughout manufacture. Each relay is checked under dynamic conditions for contact performance and timing.

If you have a relay requirement or problem contact Varley Technicians now, or send the coupon for the Varley catalogue.

Varley®

Oliver Pell Control Ltd.

Cambridge Row, Burrage Rd., Woolwich,
London, SE18. Tel: 01-854 1422 Telex: 897071

Name _____

Company _____

Address _____

WW 3-74



Litesold Standard Models

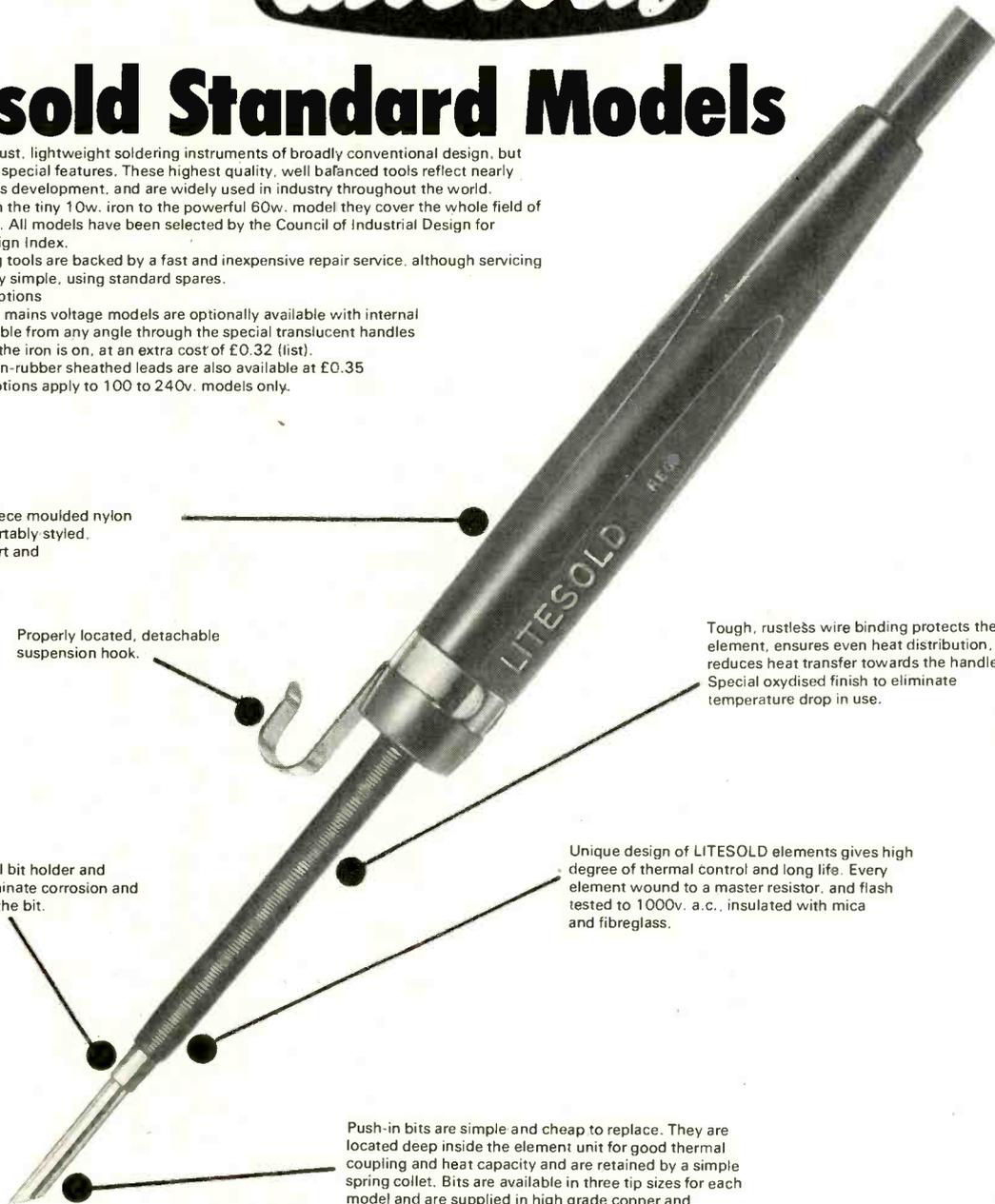
A wide range of robust, lightweight soldering instruments of broadly conventional design, but incorporating many special features. These highest quality, well balanced tools reflect nearly 20 years' continuous development, and are widely used in industry throughout the world. Ranging in size from the tiny 10w. iron to the powerful 60w. model they cover the whole field of light hand soldering. All models have been selected by the Council of Industrial Design for inclusion in the Design Index.

LITESOLD soldering tools are backed by a fast and inexpensive repair service, although servicing by users is extremely simple, using standard spares.

Additional Safety Options

LITESOLD standard mains voltage models are optionally available with internal neon indicators, visible from any angle through the special translucent handles and showing when the iron is on, at an extra cost of £0.32 (list).

Heat-resistant silicon-rubber sheathed leads are also available at £0.35 extra (list). These options apply to 100 to 240v. models only.



Unbreakable, one piece moulded nylon handle. Cool, comfortably styled, non-inflammable, dirt and chemical resistant.

Properly located, detachable suspension hook.

Tough, rustless wire binding protects the element, ensures even heat distribution, and reduces heat transfer towards the handle. Special oxydised finish to eliminate temperature drop in use.

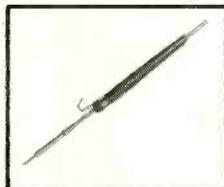
Tough stainless steel bit holder and element spindle eliminate corrosion and concentrate heat in the bit.

Unique design of LITESOLD elements gives high degree of thermal control and long life. Every element wound to a master resistor, and flash tested to 1000v. a.c., insulated with mica and fibreglass.

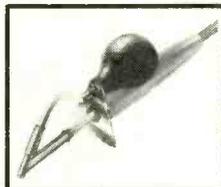
Push-in bits are simple and cheap to replace. They are located deep inside the element unit for good thermal coupling and heat capacity and are retained by a simple spring collet. Bits are available in three tip sizes for each model and are supplied in high grade copper and long-life types.



ETC/I Electronically Temperature Controlled System



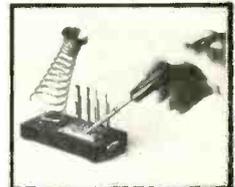
ADAMIN Ultra Miniature Irons 15w. and 18w.



Suction De-soldering Attachment (fits ETC/I and CONQUEROR)



Power Controlled Soldering System Type PC/I



CONQUEROR Lightweight Iron and spring stand

Send TODAY for FREE Catalogue with full details of this and other equipment.

LIGHT SOLDERING DEVELOPMENTS LTD

97-99 Gloucester Road, Croydon, Surrey

Tel: 01-689 0574/6

Technics introduce the true sound of music

No doubt your first question is, "Who on Earth are Technics?"

A good question.

Well, quite simply, we're stable-mates of National Panasonic.

In fact, we're the new hi-fi division of the largest manufacturer of electronics in Japan, Matsushita Electric.

Our sole aim in life is to find that elusive quantity: pure, unadulterated sound.

By and large, turntables, cassette decks, speakers, tuners and amps conspire against it.

What they usually offer is a medley of mechanical noises, rumble, wow and flutter.

We, on the other hand, have managed to minimise them.

Because of the enormous resources of our parent company, we were able to spend the necessary time and money developing equipment as free from audio blemish as possible.

As an example of our handiwork, just consider the specifications opposite for our SL110 direct-drive deck. Besides boasting a pretty impressive set of figures, it is, in our biased opinion, one of the handsomest decks around.

Mind you, at £154.95 (inc. VAT) it ought to be.

The choice of arm* has been left to you, so that you can achieve that final 'nth' of sound.

Even if it is of Julie Andrews.



Technics

NATIONAL PANASONIC (UK) LTD. 107/109 WHITBY RD. SLOUGH, BUCKS. TEL: SLOUGH 34522

*We would recommend the SME 3009 Series II

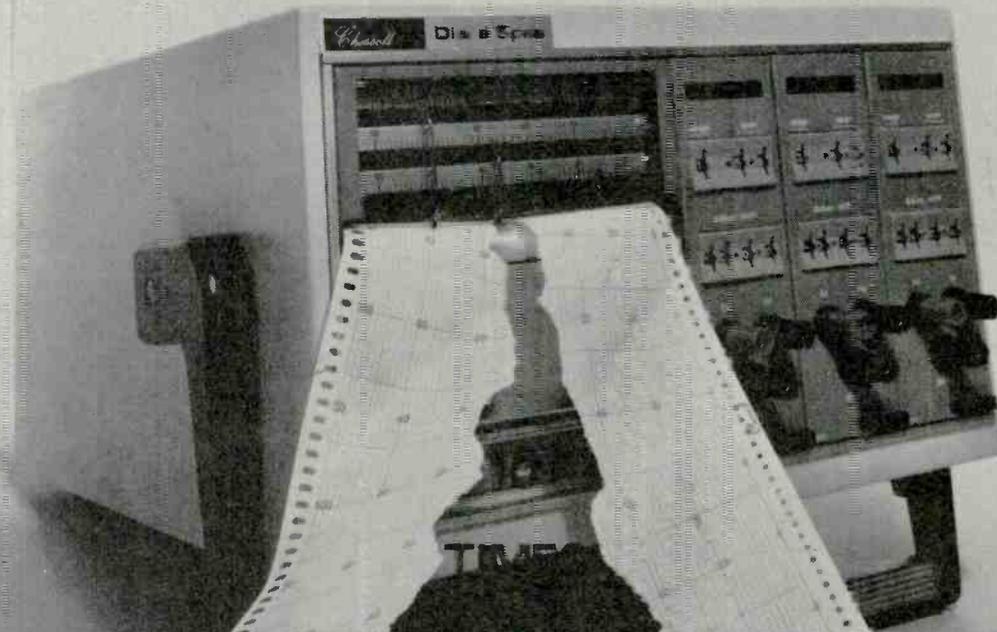
SPECIFICATIONS

- Type: Direct drive player system
- Turntable: Aluminium die-cast; 35cm (13⁷/₈") diameter 320 kg-cm² (109.5 lb-in²) inertial moment, 2 kg (4.4 lb) weight
- Turntable speeds: 33¹/₂ and 45 r.p.m.
- Motor: 20 poles (rotor) - 5 poles (stator) ultra low speed electronically commutated motor
- Power supply: AC 110, 120, 220, 240V 50 or 60 Hz.
- Speed change method: Electronic change
- Variable pitch control: Individual adjustment by variable resistor, ±5% adjustment range
- Wow and flutter: Less than 0.03% W RMS
- Rumble: Better than -55 dB (DIN A), -70 dB (DIN B)
- Build-up time: Within 1/2 rotation at 33¹/₂ r.p.m.
- Dimensions: 20¹/₈" x 7¹/₄" x 15¹/₂"
(W x H x D) (510 x 195 x 390 mm)
- Weight: 28.7 lb (13 kg) with dust cover
- Player base: Aluminium die-cast with audio insulated legs



TWO WAY STRETCH *by Chessell*

**DIAL-A-SPAN PROVIDES THE BREAKTHROUGH IN
THREE-CHANNEL PEN RECORDER FLEXIBILITY**



UPRESS ELEVATION

ON EACH OF 15 SPAN PER CHANNEL

1999 CALIBRATED DATUM SHIFT SETTINGS

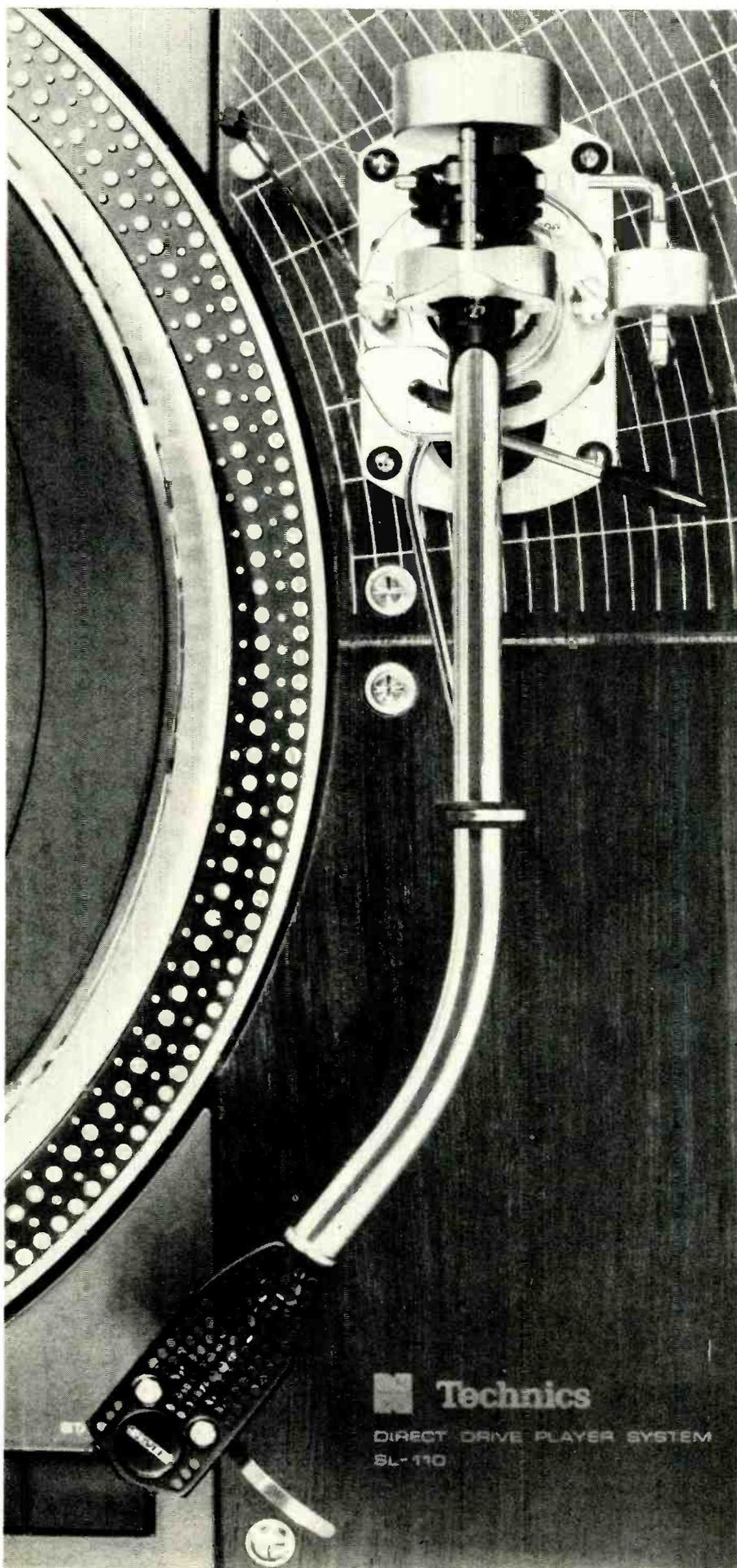
1 METRE CHART WIDTH RESOLUTION ON 100mm CHART

PLUS *Chessell* ENGINEERING - £475

CHESSELL LIMITED Broadwater Trading Estate - Worthing - Sussex

Tel. Worthing 205222

Telex 87114



3009 + SL110

This elegant direct drive unit with electronically commutated d.c. motor has only one rotating part.

The virtual elimination of mechanical vibration within the deck realises the full potential of arm and cartridge.

We have prepared an information sheet No. 12 detailing its use with our Series II Improved precision pick-up arms and a copy will be sent to you on request.

SME

The best pick-up arm in the world

Write to SME Limited
Steyning · Sussex · England
Telephone : Steyning (0903) 814321

TUBE TYPE	UNIT PRICE		TUBE TYPE	UNIT PRICE		TUBE TYPE	UNIT PRICE	
	DM	US \$		DM	US \$		DM	US \$
EM 82	1.75	—50	PCF 200 (16V9)	2.17	—87	ULTRON	2.34	—93
EM 84 (6FG6)	1.75	—50	PCF 201 (6L9)	2.37	—83	ULTRON	1.44	—58
EM 87 (6HL6)	2.31	—90	PCF 801 (8CG7)	1.59	—74	ULTRON	1.44	—58
EY 51 (6X2)	2.00	—80	PCF 802 (9JLV8)	1.58	—60	ULTRON	1.28	—51
EY 31 (8V3)	1.34	—53	PCF 805 (7GV7)	3.42	1.37	ULTRON	2.25	—90
EY 52	2.55	1.02	PCF 808	2.55	—95	ULTRON	1.25	—50
EY 53	1.54	—59	PCN 200 (3V9)	1.50	—58	ULTRON	1.60	—64
EY 56 (6S2)	1.51	—57	PCL 81	1.30	—52	ULTRON	1.10	—48
EY 57 (6S2A)	1.51	—57	PCL 82 (16A8)	1.25	—50	ULTRON	1.24	—50
EY 58 (6AL3)	1.55	—59	PCL 84 (15DQ8)	1.44	—56	ULTRON	1.40	—53
EY 520 A (6EC4A)	3.44	1.37	PCL 85 (18GV3)	1.75	—70	ULTRON	1.41	—55
EY 802	2.76	1.11	PCL 86 (14GW8)	1.53	—61	ULTRON	1.45	—56
EZ 2	3.52	1.44	PCY 200	2.81	1.04	ULTRON	1.41	—55
EZ 11	3.52	1.41	PCY 205	1.75	—70	ULTRON	1.45	—56
EZ 12	3.80	1.52	PCY 300	6.45	2.53	ULTRON	1.45	—56
EZ 35 (6X5)	1.00	—38	PD 510	2.00	3.60	ULTRON	1.45	—56
EZ 40 (6ST5)	1.00	—38	PF 88 (4CF8)	1.73	—70	ULTRON	1.50	—58
EZ 80 (2V4)	—30	—32	PFL 200 (16V9)	2.45	—95	ULTRON	1.98	—75
EZ 81 (6CA4)	—90	—38	PL 35 (25E5)	2.23	—88	ULTRON	1.83	—70
EZ 90 (6X4)	1.04	—43	PL 31 (21A8)	1.50	—58	ULTRON	1.54	—59
GY 501	1.50	—57	PL 32 (18A5)	1.50	—58	ULTRON	1.18	—45
GZ 32 (5V4G)	1.50	—57	PL 33 (15A8)	1.50	—58	ULTRON	1.18	—45
GZ 34 (5AR4)	1.50	—57	PL 34 (16CV6)	1.50	—58	ULTRON	1.18	—45
HAA 31 = 12AL5	1.50	—57	PL 95	1.73	—70	ULTRON	1.58	—60
HABC 80 = 19T3	1.50	—57	PL 500 (27GB5)	2.30	1.16	ULTRON	1.58	—60
HBC 30 = 12AT6	1.50	—57	PL 504	2.30	1.16	ULTRON	1.44	—56
HBC 91 = 12AU6	1.50	—57	PL 508 (17KW6)	2.96	1.18	ULTRON	1.70	—65
HCC 86 = 12AX7	1.50	—57	509 (40K38A)	5.70	2.28	ULTRON	1.78	—71
HF 80 = 12BE6	1.50	—57	519	7.10	2.84	ULTRON	2.30	—89
HF 30 = 12BD6	1.50	—57	521 (29K76)	3.81	1.44	ULTRON	1.28	—50
HK 90 = 12BE6	1.50	—57	PL 802	3.85	1.54	ULTRON	1.28	—50
HL 92 = 50C5	1.50	—57	PL 805	3.05	1.22	ULTRON	1.28	—50
HL 30 = 30A5	1.50	—57	PM 84	1.47	—57	ULTRON	1.44	—55
HY 90 = 35W4	1.50	—57	PY 81 (17Z3)	1.18	—45	ULTRON	2.35	—91
LC 300 (3HA5)	1.50	—57	PY 82 (19Y3)	1.10	—43	ULTRON	2.45	—93
LCC 82 (9AJ7)	1.50	—57	PY 83 (17Z3)	1.18	—45	ULTRON	1.41	—55
LCF 80 (6LN6)	1.64	—65	PY 88 (30AE3)	1.26	—48	ULTRON	1.60	—61
LCF 801 (5C37)	2.18	—87	PY 500 (42ED4)	3.28	1.31	ULTRON	1.60	—61
LCF 802 (6LXB)	1.64	—65	PV 500A (42EC4A)	3.28	1.31	ULTRON	1.45	—56
LCL 82 (11BMB)	1.75	—70	PY 800	1.52	—53	ULTRON	1.45	—56
LCL 84 (10A8)	1.75	—70	PY 801	1.32	—53	ULTRON	1.45	—56
LCL 85 (10A8)	1.75	—70	PC 80 (16V9)	1.57	—63	ULTRON	1.60	—61
LF 83 (4E5)	1.53	—58	PC 81 (16V9)	2.45	—98	ULTRON	2.40	—95
LF 184 (4E7)	1.53	—58	UBC 41 (14E7)	2.25	—90	ULTRON	1.41	—55
LFL 200 (11Y9)	3.75	1.50	UBC 81 (15RD7A)	1.40	—56	ULTRON	1.02	—41
LL 84 (10BQ5)	1.42	—55	UBF 80 (17G8)	1.44	—58	ULTRON	1.10	—48
LL 85	1.42	—55	UL 11	2.59	1.02	ULTRON	1.10	—48
LL 52	1.42	—55				ULTRON	1.10	—48
LY 81	1.42	—55				ULTRON	1.10	—48
PA50	1.42	—55				ULTRON	1.10	—48
PC 81	1.42	—55				ULTRON	1.10	—48
PC 82	1.42	—55				ULTRON	1.10	—48
PC 83	1.42	—55				ULTRON	1.10	—48
PC 84	1.42	—55				ULTRON	1.10	—48
PC 85	1.42	—55				ULTRON	1.10	—48
PC 86	1.42	—55				ULTRON	1.10	—48
PC 87	1.42	—55				ULTRON	1.10	—48
PC 88	1.42	—55				ULTRON	1.10	—48
PC 89	1.42	—55				ULTRON	1.10	—48
PC 90	1.42	—55				ULTRON	1.10	—48
PC 91	1.42	—55				ULTRON	1.10	—48
PC 92	1.42	—55				ULTRON	1.10	—48
PC 93	1.42	—55				ULTRON	1.10	—48
PC 94	1.42	—55				ULTRON	1.10	—48
PC 95	1.42	—55				ULTRON	1.10	—48
PC 96	1.42	—55				ULTRON	1.10	—48
PC 97	1.42	—55				ULTRON	1.10	—48
PC 98	1.42	—55				ULTRON	1.10	—48
PC 99	1.42	—55				ULTRON	1.10	—48
PC 100	1.42	—55				ULTRON	1.10	—48

Whatever your language is, we understand that you ask for quality. Our SQ-Series of Radio and Television tubes gives you safety at no extra cost.

Since 1955 we offer a complete line of both European and American type receiving and industrial tubes for worldwide export.

Our new price list WRS-16 is just off the press. Write us please, it's worth it!

ULTRON
 Electronic GmbH
 Schillerstr. 40
 8 München 15

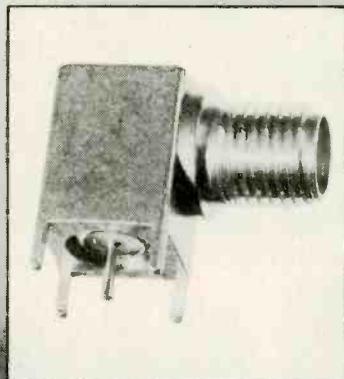
Phone 555321 • Telex 0522456

High quality specialised components

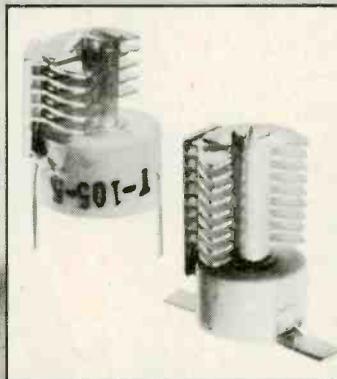
from



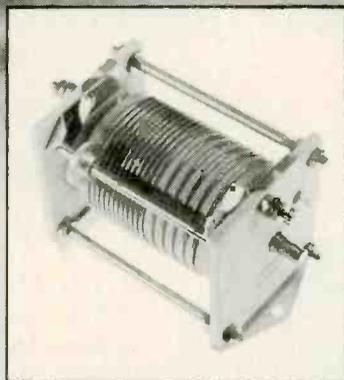
E F JOHNSON COMPANY



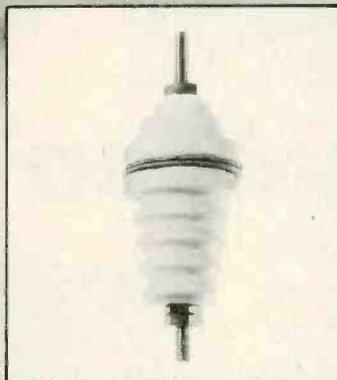
Coaxial connectors.
High quality miniature coaxial connectors with full SMA mating compatibility.



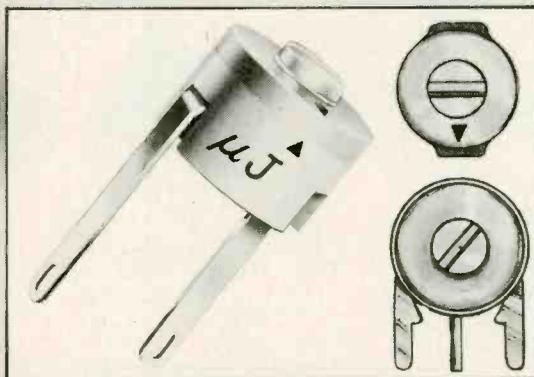
Airspace capacitors.
A wide range of miniature machined plate air variable capacitors offering extreme accuracy and high reliability.



Inductors – variable – fixed and special.



Ceramic insulators.
Through panel type.



Trimmer capacitors.
Miniature and sub-miniature ceramic and teflon trimmer capacitors.

Exclusive agent and distributor for United Kingdom. Europe also covered by existing chain of Vero Agents.



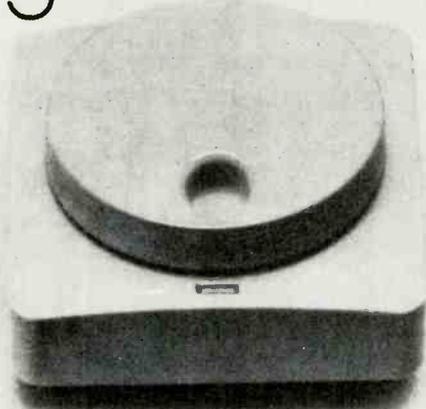
Vero Electronics Limited
Industrial Estate, Chandler's Ford,
Eastleigh, Hants. SO5 3ZR

Tel: Chandler's Ford 2952
Telex: 47551

Cool lighting **for hot parties.**

Velvet dim to full brightness at a touch of the finger. Off/on and infinitely variable.

Beta light glow makes switch easy to find in the dark and consumes no current.



Economical too!

As the light is progressively dimmed, so the current consumption drops – think of it as an electric tap. 300 watt capacity, straight replacement for standard light switch.

Complete kit of parts £2.80 or made up £2.90



Hot Ignition for cold mornings.

The Jermyn capacitor discharge ignition system.

Instant starting in all weathers. Even with a near flat battery, the unit will produce a full sized spark.

Just one of the many advantages of an electronic ignition system, the others are:

High energy spark even at maximum revs.

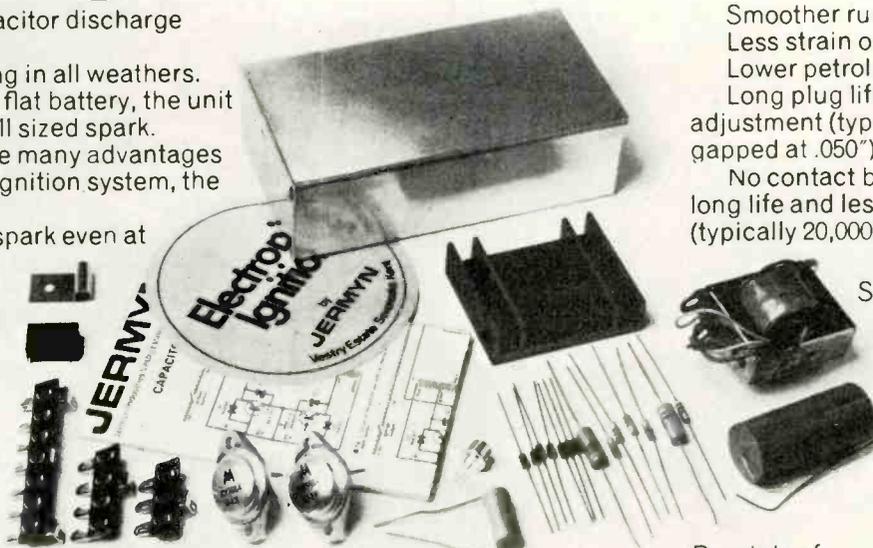
Smoother running.

Less strain on battery and starter. Lower petrol consumption.

Long plug life with infrequent adjustment (typically 20,000 miles, gapped at .050").

No contact breaker arcing giving long life and less adjustment (typically 20,000 – 25,000 miles)

STATE + or – earth when ordering.



Complete set of parts to build it yourself for only £7.75, as described in Practical Wireless and fully approved by the author.

Save 55p
Buy both for £10.00

Reprints of the two part feature are available at 25p.

To Jermyn Industries, 125 Vestry Estate, Sevenoaks, Kent.

All Prices Exclusive of VAT.

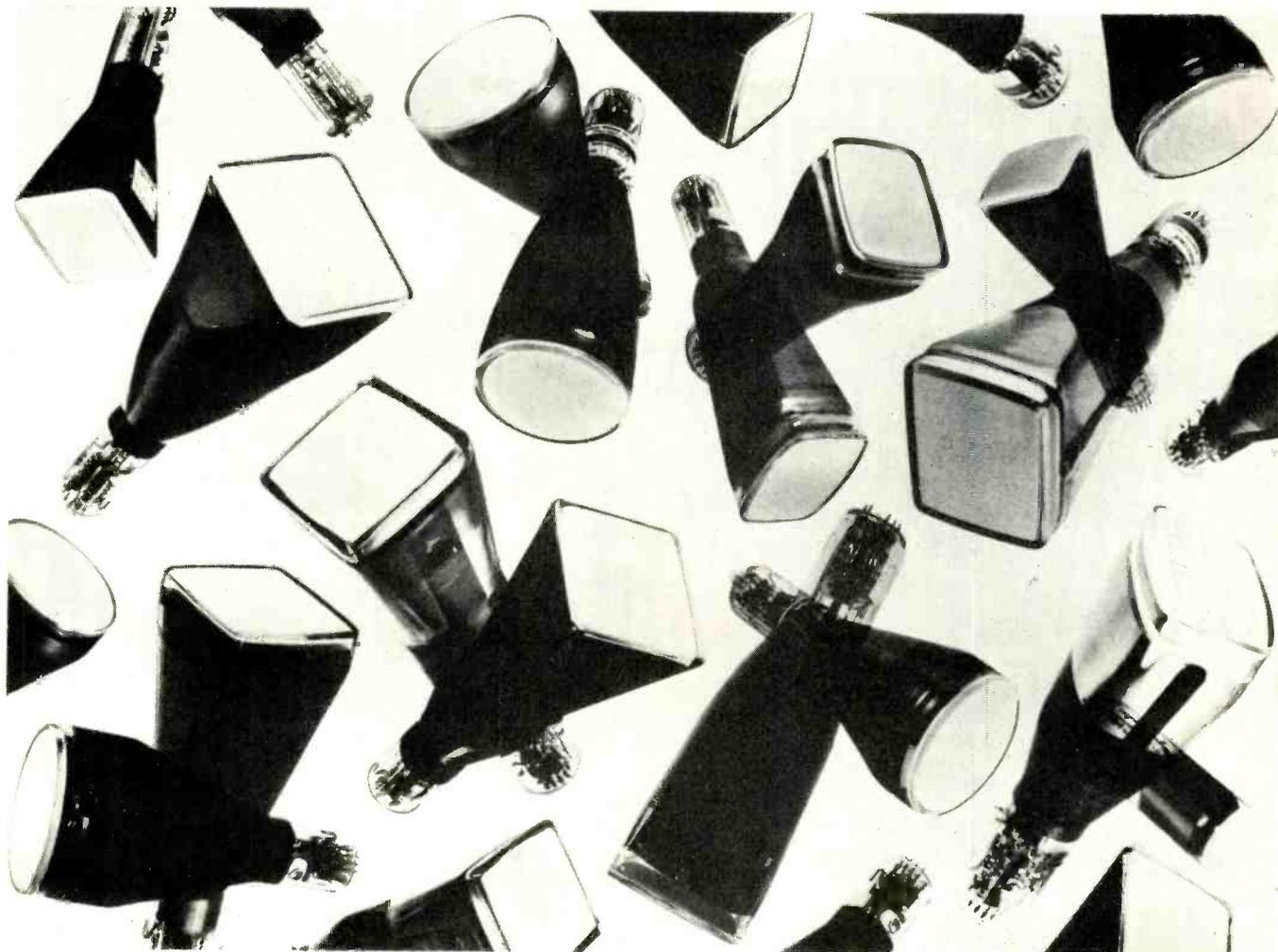
Please despatch return of post light dimmer kit light dimmer
Ignition Kits + or – earth £10 pair, Enclose cheque or postal order.

BLOCK CAPITALS

NAME

ADDRESS

JERMYN



The many faces of BRIMAR

reveal the biggest current range
of oscilloscope tubes in Europe.

Whenever it's a matter of designing or making an oscilloscope, remember one essential fact, Brimar have a complete range of tubes for operation up to 75/100MHz bandwidth. Many with ex-stock delivery.

The fact is: the current Brimar range of tubes is the largest in Europe — with as many as twenty-five different versions to choose from.

Brimar are continually revising and updating their range to meet the demands of the market. The latest additions are the D10-230 and D10-240 (4" compact flat faced tubes) and the D16-100 (XY plotter)

The quality of Brimar tubes is unquestionably good. Improve your scope — telephone or write for full or abridged data and prices 01-804 1201

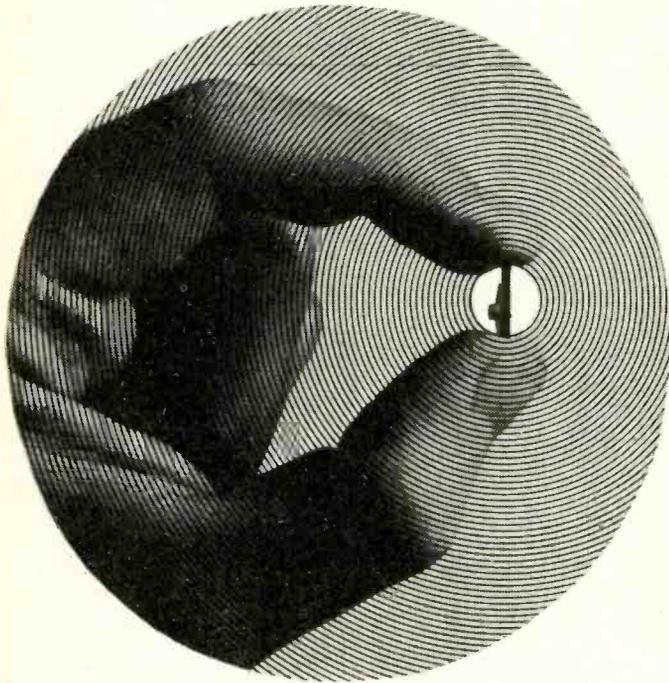
TYPES TO ASK FOR:

D3-130	D13-51	D14-172
D7-200	D13-471	D14-180
D7-201	D13-600	D14-200
D10-210	D13-601	D14-210
D10-230	D13-610	D16-100
D10-240	D14-150	SE4D
D13-30	D14-170	SE5/2A
D13-33	D14-171	SE5F
D13-47		



THORN RADIO VALVES & TUBES LTD.
Mollison Avenue,
Brimsdown, Enfield,
Middlesex EN3 7NS





Discon gives you the slimmest possible chance of failure.

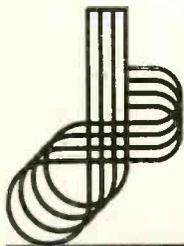
When you use Jackson 'Discon' Trimmers you're using the slimmest trimmers on the market. With a maximum thickness of only 2.8mm, capacitance ranges up to 40pF, a Discon miniature ceramic dielectric trimmer capacitor is space saving, with a high capacitance per unit of volume.

With Jackson you know you're using tried and tested components that will give perfect reliability over a long life. And you can have components custom made to suit your individual requirements.

With skilled personnel and modern equipment backed by 45 years of technical know-how, we are your guarantee of a reliable product.



Catalogue No. 10,000



Write for fully illustrated catalogue
**JACKSON BROTHERS
 (LONDON) LIMITED**

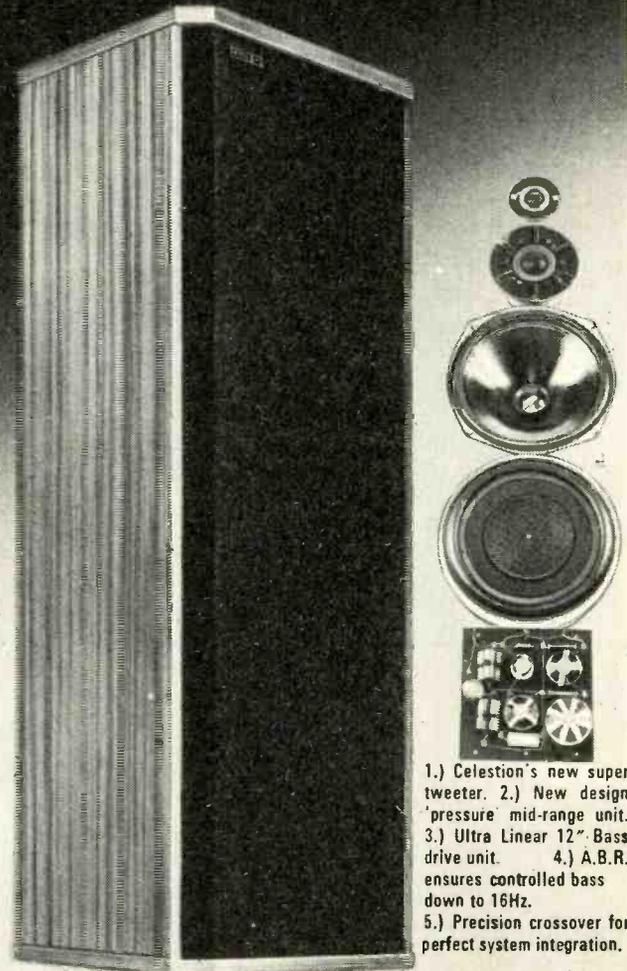
KINGSWAY, WADDON, CROYDON CR9 4DG.
 TEL: 01-881 2754/7. TELEX: 946849.
 U.S. OFFICE: M. SWEDGAL
 258 BROADWAY, NEW YORK, N.Y. 10007.

JB7

WW—031 FOR FURTHER DETAILS

Celestion Loudspeaker Engineering advances the state of the art to a new plateau.

Ditton 66 Studio Monitor



- 1.) Celestion's new super tweeter.
- 2.) New design 'pressure' type MF 500 (Mid-range Dome 'pressure' type) Ultra linear 12" Bass drive unit.
- 3.) A.B.R. ensures controlled bass down to 16Hz.
- 4.) Precision crossover for perfect system integration.

A new Loudspeaker of advanced design suitable for studio use and for home installations of the highest quality.

UNITS: HF 2000 (dome 'pressure' type) MF 500 (Mid-range Dome 'pressure' type) Ultra linear 12" bass driver and 12" ABR. The crossover has resulted from considerable research and crossover points are at 500 Hz and 5000 Hz 80 Watts Maximum, 4-8 ohm. This monitor loudspeaker system has an exceptionally wide and flat frequency response. Very low order harmonic and inter-modulation distortion. Precise response to transients. Beautifully maintained polar response ensures absence of unwanted directional effects and provides a highly satisfactory stereo image throughout the listening area. Matched pairs.

SIZE 45 x 15 x 11 1/2 Natural Teak or Walnut Cabinet

Celestion

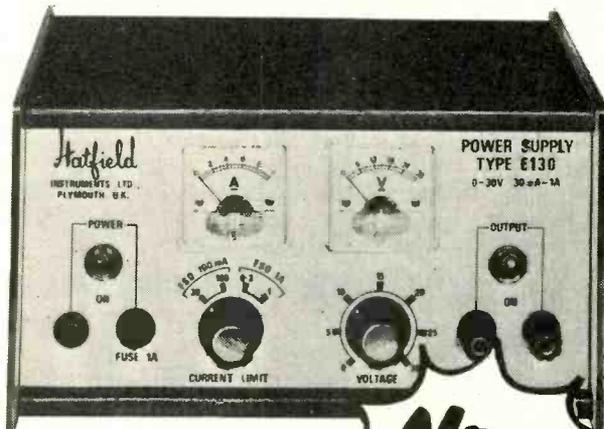


Loudspeakers for the Perfectionist

ROLA CELESTION LTD.
 DITTON WORKS, FOXHALL ROAD, IPSWICH, SUFFOLK IP3 8JP

WW—032 FOR FURTHER DETAILS

Low Cost BENCH POWER



from Hatfield

The 6130 variable d.c. power unit provides laboratories and test rooms with a new compact supply at an exceptionally low price. Among its many features are separate output and mains switching and individual voltage and current meter.

Price in Great Britain. **£29**

- Output Voltage 0-30V continuously adjustable
- Output Current 0-1 A with four current limit settings of 30mA, 100mA, 300mA, 1A Meter f.s.d. switched 100mA or 1A
- Input Voltage 220-250V 50-60Hz with tapings for 230, 240V
- Output Connections Two insulated screw terminals (incorporating 4mm plug sockets) spaced 25mm (1.0") apart
- Dimensions 190mm x 158mm x 152mm
7½" x 6¼" x 6"

HATFIELD
forward thinking in electronics

HATFIELD INSTRUMENTS LIMITED
Burrington Way, Plymouth PL5 3LZ, Devon.
Tel. Plymouth (0752) 772773/4
Grams: Sigjen, Plymouth. Telex: 45592

South-East Asia: for prompt service and deliveries, contact:
Hatfield Instruments (NZ) Ltd., P.O. Box 561, Napier, New Zealand.

WW-033 FOR FURTHER DETAILS

BULGIN

New Multi Range Collet Knobs and Accessories



CAPS
Four styles available which snap fit to knob tops.



KNOBS
Four different types available in five sizes.



ACCESSORIES
Pointers, Dials, Stators, Nut covers, all snap fitting to the knobs.

A new and versatile range of twenty collet fixing control knobs, together with various snap on accessories illustrated below, manufactured in Switzerland to our rigorous standards and only available from the House of Bulgin.

There are four basic styles: Circular Knob, Circular Knob with line, Wing Knob and Wing Knob with line. They are available from stock in light grey and black as standard, with dark grey and red versions to special order. Each knob style is available 10, 15, 21, 28 and 36mm diameter with collets accepting ¼" ø shafts as standard. Other shaft sizes to special order.

TYPICAL EXAMPLES OF THE KNOBS & A SELECTION OF THEIR ACCESSORIES.

Knobs



Circular type with or without indicator line.

Wing type with or without indicator line.

Caps



Flat type, available plain or with curved arrow.

Flat with indicator line.

Peaked cap type.

Pointers & Dials



Pointer, also arrow dials.

Transparent dials available with or without legending.

Stator



With fine or broad indicator band.

Nut Covers



Plain or with indicator line, for 10 and 15mm sizes.

STOP PRESS!

BULBS FROM BULGIN
A NEW ISSUE OF OUR
ILLUSTRATED PRICE LIST
IS NOW AVAILABLE

TECHNICAL LITERATURE AVAILABLE ON REQUEST. QUOTE: WW/6/74



A. F. BULGIN & CO. LTD.
ELECTRONIC COMPONENT MANUFACTURERS

BYE-PASS ROAD BARKING ESSEX IG11 0AZ
TEL: 01 594 5588 (12 lines) P.B.X. TELEX: 897255

WW-034 FOR FURTHER DETAILS

declon

POLYESTER SPEAKER FRONTS

*Declon speaker front material is a fully reticulated flexible polyester foam.

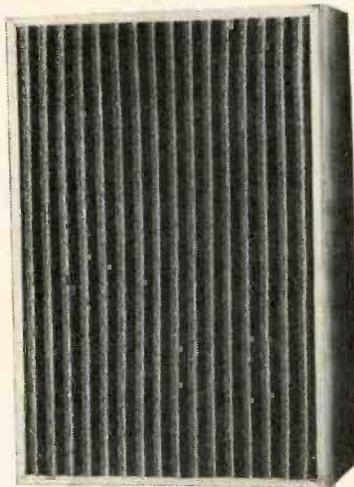
*Acoustically transparent over all audible frequencies.

DIAMOND PATTERN 3/4" Thickness Black or Brown

24" x 16" £2.97 each inc. VAT

36" x 18" £4.75 each inc. VAT

36" x 24" £5.61 each inc. VAT



*Attractive designs and colours.

*Washable. *Easily cut to size.

FLUTED PATTERN 3/4" Thickness Black or Brown

12" x 18" £1.90 each inc. VAT

24" x 16" £2.78 each inc. VAT

36" x 18" £4.56 each inc. VAT

36" x 24" £5.42 each inc. VAT

Obtainable from sole UK Distributors

AMTRON UK LTD., 4 & 7 Castle St. Hastings, Sx.

Telephone: HASTINGS 2875

The Great Sound of Vitavox

Nothing succeeds like success.

You met the new Vitavox power range last year. Its success was instantaneous, and has been growing ever since.

Good – but not good enough for us. We have been, and are, continuously improving our units. We want to give you the best value and performance – so now we offer you, improved on 1973, the latest...

- S3 Pressure Unit
- AK 156 Loudspeaker
- H.F. Horn
- Dividing Network

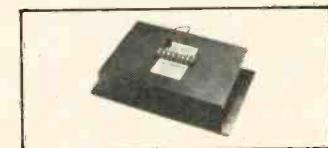
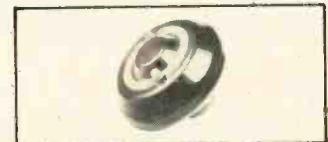
*The matchless range
-now better than ever...
Giving You...*

S
Sensitivity

P
Power

E
Efficiency

C
Craftsmanship



VITAVOX
Limited

Westmoreland Road,

London NW9 9RJ

Telephone: 01-204 4234

Please send me further information on your product range

Name _____

Company _____

Address _____

V2

Amplivox Minilite. Untouched by human ear.

New Minilite weighs a mere 50g. Yet it combines maximum operating efficiency with absolute wearer comfort.

With Minilite, Amplivox have avoided the problems of the old fashioned earplug inserts through ingenious use of an adjustable earpiece. An acoustic tube with sibilant filter replaces the heavier and more familiar boom microphone. Pressure pads are out too, instead there is a non-metallic headband with special bars that give stability without uncomfortable pressure.

Specified for Eurocontrol, Minilite is being widely used in air traffic control, aviation and communications control as well as other branches of industry. Minilite is, undoubtedly, the headset of the seventies. It's just one of the wide range of high-quality specialist products for civil and military use from Amplivox. No-one else offers so much for so little.

To find out more about the Amplivox range of communications products—write today stating your application requirements to:

Racal - Amplivox Communications Limited
Beresford Avenue, Wembley, Middx., England.
Tel: 01-902 8991. Cables: Amplivox Wembley.
Telex: 922101



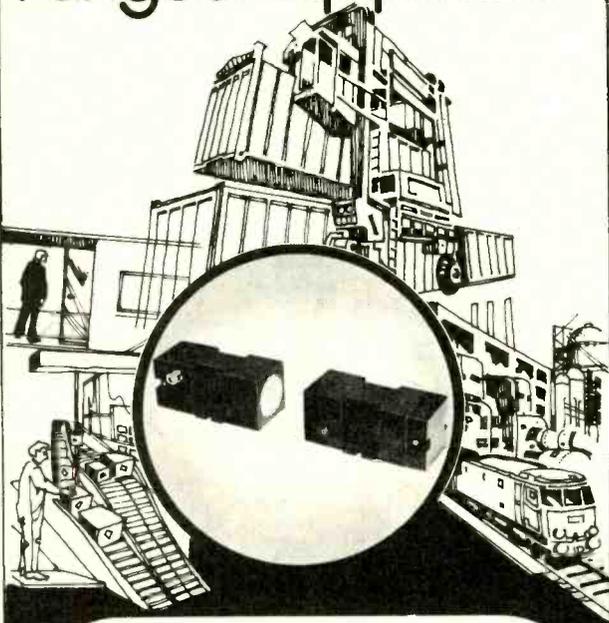
Racal - Amplivox Communications Limited, Beresford Avenue, Wembley, Middx., England.
Please send details of the Amplivox range of communications products:

Name _____
Company _____
Address _____

WW/3/74

Industrial Action with the JAMES SCOTT INDUSTRIAL

microwave range of equipments



The James Scott range of Microwave equipment now offers industrial users a greater choice of alternative systems in robust, industrial, cast aluminium housings, for a wide variety of applications.

The range is made up of standard sub-assemblies which can be permutated to suit individual application requirements.

Some Suggested Applications for these Units
 Level controllers; Proximity alarms; Small object counters; Process control systems; Positioning systems; Door opening systems; Safety barriers; Presence/detectors; Train control systems; Vibration sensing systems; Intruder alarms; Road vehicle systems.

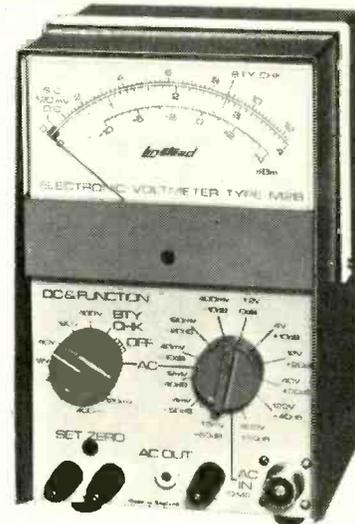
If any of the above are your problems or if you have a particular problem for which we could adapt a system please write or telephone for further information and technical literature to.



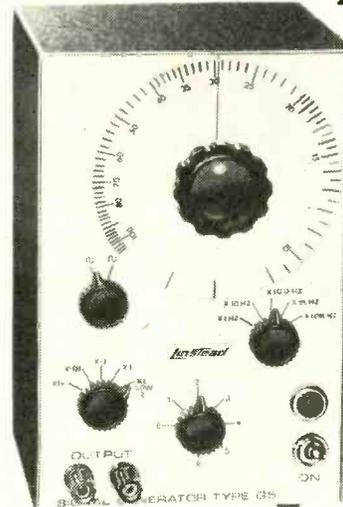
JAMES SCOTT
 (Electronic Engineering) Ltd
 CARNTYNE INDUSTRIAL ESTATE
 GLASGOW G32 6AB
 Tel: 041-778 4206

WW-037 FOR FURTHER DETAILS

Linstead Laboratory Instruments



M2B **WIDE RANGE MILLIVOLTMETER**
 High impedance millivoltmeter with 20 scales total measurement range 60 micro-amp a.c. to 400 volts d.c. 10-megohm input with overload protection and frequency range of 500 kHz.
£38.80



G5 **WIDE BAND SIGNAL GENERATOR**
 Sine-square wave wide band high power signal generator. 10 Hz-1 MHz. 0-6 volts r.m.s. 2 watts into 5 ohms incorporating short circuit protection.
NUFFIELD SPECIFICATION 181 **£32.80**

Linstead
 the best for less
 BRITISH MADE BY LINSTEAD

Linstead Electronics, Roslyn Works, Roslyn Road, London N15 5JB. Telephone: 01-802 5144
 Ireland, Lennox Laboratory Supplies Ltd., 3/4 South Leinster Street, PO Box 212A, Dublin 2.
 Denmark, Scantysik, 13-15 Hjørringgade, DK 2100, Copenhagen.
 Sweden, EMI Svenska A/B, Tritonvägen 17, Fack, 171 19 Solna 1.
 Norway, EMI Norsk A/S, Postboks 42 Korsvoll, Oslo 8.
 Malaysia, Laboratory Equipment Sdn. Bhd., P. O. Box 60, Batu Pahat.
 Benelux, A.S.E. Ltd., Nationalestreet 38, B-2000 Antwerp.

WW-038 FOR FURTHER DETAILS

REVOX**HS 77**

The high-speed Revox ($15/7\frac{1}{2}$ ips) is firmly established as standard equipment in the majority of London theatres, local radio stations, National broadcasting companies and recording studios. Available in a wide range of configurations including the full, half or quarter track models. Immediate delivery.

Options:

Sel sync £20 Varispeed £15

**Scotch 207 UK's
LOWEST PRICES**

**VHS 77 Sole Supplier**

WIDE BANDWIDTH. 40 Hz-40 KHz of particular interest to research establishments. TAPE DUPLICATION. The equalisation characteristics 17.5 and 35 μ Sec are such that a 1:1, 2:1 or 4:1 speed ratio will produce a copy tape of the same recording characteristic as the master. HIGH TAPE VELOCITY of 30 ips (76 cms) is invaluable for the analysis of data and transient information. Also 15 ips. TAPE ECHO 50 milli seconds or 100 milli seconds. Immediate delivery. Finance available.

NOTE NEW ADDRESS~**ITA****Industrial Tape Applications****5 Pratt Street, London NW1 OAE. Tel: 01-485 6162 Telex: 21879**

WW—039 FOR FURTHER DETAILS

From Goldring. New support for the belief that what goes into a record ought to come out of it.

The Theory is perfectly simple.

A good cartridge should take from a record all the subtle shades of original sound that are stored there, and re-create them for your enjoyment.

The Practice is a little more difficult.

Now Goldring bring the ideal closer with the new 820 series.

A brand new family of cartridges that builds on the advances already achieved by the Goldring 800 series. Providing cartridges that are not only capable of making the most of all that good recording can offer now, but have the capacity to keep pace with new developments in the art of quality recordings.

The 820 series retains the true transparency of sound and the true transduction techniques of earlier designs.

It brings advances in every aspect of design.

The small low-mass diamond point which is mounted on a new type of specially polished lightweight aluminium tube, combined with the new visco-elastic material used for the pivot pad, makes for greater tracking ability.

A special 'tie wire' minimises fore and aft stylus movement, reducing non-linear distortion to a minimum.

The total effect is a cartridge that, other equipment being equal, can narrow almost to vanishing point the difference between the original recording and the sound that comes out of your speakers.

There are three models in the range. The 820 with spherical stylus. The 820E and 820 Super E, both with bi-radial styli. Write for details and full specifications.

And satisfy yourself that 'what goes in comes out'.

The 820 — one of the models in the new range. Performance characteristics:

Sensitivity @ 5 cm/sec-1 KHz: 5mV.

Separation @ 1 KHz: 20dB.

Recommended playing wt. 2 grammes.

Stylus point radius: .0006" 15 μ .

Frequency range: 20Hz-20KHz.

**The new 820 series**

The expert's cartridge by **Goldring** ©

Goldring Limited, 10 Bayford Street, Hackney, London E8 3SE. Tel: 01-985 1152

WW—040 FOR FURTHER DETAILS

BRITAIN'S FASTEST SERVICE!

A SELECTION FROM OUR COMPREHENSIVE CATALOGUE



ALL ITEMS ARE BRAND NEW AND FULLY GUARANTEED

AA119	8p	BF180	35p	MFC9020	£2.12	VA1066s	15p	2N4441	70p
AC107	50p	BF195	15p	MJE371	85p	VA1077	15p	2N4444	£2.20
AC128	20p	BF196	15p	MJE520	65p	W005	25p	2N4871	44p
AC127	25p	BF200	35p	MJE521	82p	W01	26p	2N4990	60p
AC128	24p	BF254	14p	MJE2955	£1.06	W02	28p	2N4991	48p
AC128/AC176	44p	BF255	15p	MJE3055	68p	W04	27p	2N5245	45p
AC151	20p	BFK13	25p	MJ480	97p	W06	32p	2N5453(MPF103)	49p
AC152	25p	BFK29	32p	MJ491	£1.25	W08	41p	2N5455(MPF104)	49p
AC18	20p	BFK84	25p	MJ802	£4.12	ZTX107	12p	2N5455(MPF105)	48p
AC19	20p	BFK88	35p	MJ802/MJ4508	£8.56	ZTX108	11p	2N5758	£1.20
AC120	20p	BFK88	24p	MJ800	£1.80	ZTX300	13p	2N5777	45p
AC121	19p	BFK88	25p	MJ800	£1.80	ZTX302	12p	2N6027(013T1)	45p
AC122	10p	BFK87	30p	MJ1000	£1.50	ZTX303	15p	3N94	£1.30
AD140	60p	BFK68	24p	MK302	£4.44	ZTX304	23p	3N128	17p
AD149	60p	BFY50	22p	MMLM309K	£1.90	ZTX314	11p	3N140	92p
AD181	44p	BFY51	19p	MPF102	37p	ZTX320	30p	3N152	92p
AD182	44p	BFY52	20p	MPF103(2N5457)	49p	ZTX330	18p	741705	45p
AD181/182	88p	BFY53	17p	MPF104(2N5458)	49p	ZTX500	14p	741801L	34p
AF106	32p	BFY90	£1.20	MPF105(2N5459)	46p	ZTX501	15p	741705	£1.02
AF114	27p	BP101	£1.40	NKT0033	99p	ZTX502	19p	7231/14DL	£1.02
AF115	27p	BP129	£1.40	NKT211	25p	ZTX503	17p	747/14DL	46p
AF118	25p	BPX68	£1.50	NKT212	25p	ZTX504	45p	748/14DL	39p
AF117	25p	BR100	20p	NKT213	25p	1N914	4p	3015F	£1.50
AF118	44p	BRV39	45p	NKT216	46p	1N3754	20p	3015G	£2.00
AF124	25p	BSX19	16p	NKT217	50p	1N4001	4p	7400	24p
AF125	24p	BSX20	16p	NKT218	25p	1N4002	4p	7401	24p
AF126	24p	BSX21	16p	NKT223	27p	1N4003	5p	7402	24p
AF139	47p	BSY27	20p	NKT271	18p	1N4004	7p	7403	24p
AF188	40p	BSY29	25p	NKT274	18p	1N4005	7p	7404	30p
AF239	52p	BSY95A	£1.80	NKT275	20p	1N4008	8p	7405	30p
AF279	50p	BTY79/400R	12p	NKT279A	12p	1N4148	4p	7408	30p
ASV28	25p	BT108	£1.20	NKT281	29p	1N5400	14p	7410	24p
ASV27	30p	BY100	20p	NKT351	75p	1N5400	14p	7410	24p
ASV28	25p	BY127	22p	NKT401	78p	1N5404	18p	7420	36p
ASV29	30p	BZY88C3V3	10p	NKT402	83p	1N5408	25p	7420	24p
BA138	19p	C30V	10p	NKT403	71p	1S44	4p	7425	36p
BB103	20p	BZX61C7V5 to C30V	28p	NKT404	86p	1S920	7p	7430	24p
BB104	34p	BZY93C8V1	70p	NKT405	87p	1S940	8p	7440	29p
BB105	29p	BZY93C12V	70p	NKT408	69p	2N4004	23p	7442	£1.50
BB107	18p	BZY93C15V	70p	NMC409	£1.00	2N898	15p	7443	£1.74
BC107/BC177	38p	BZY93C18V	70p	NMC469	65p	2N897	17p	7444	£1.74
BC108	16p	CA3004	£2.03	NMC505	£3.00	2N898	30p	7445	£2.47
BC108/BC178	32p	CA3005	£1.35	NTG010	40p	2N708	10p	7446	£1.74
BC109	18p	CA3011	83p	0A19(N7G010)	40p	2N708A	12p	7447	£1.50
BC109/BC179	38p	CA3013	£1.17	0A4	17p	2N708	9p	7450	24p
BC109C	18p	CA3014	£1.37	0A79	8p	2N911	16p	7451	24p
BC117	15p	CA3018	72p	0A90	8p	2N914	20p	7453	24p
BC140	30p	CA3018A	83p	0A91	5p	2N918	42p	7454	24p
BC147	12p	CA3020	£1.39	0A95	5p	2N929	25p	7455	24p
BC148	11p	CA3028A	79p	0A200	6p	2N930	28p	7456	50p
BC149	47p	CA3035	£1.37	0C22	17p	2N1131	24p	7472	36p
BC157	13p	CA3043	£1.57	0C25	45p	2N1132	24p	7473	54p
BC158	12p	CA3044	£1.28	0C28	78p	2N1302	17p	7474	54p
BC159	13p	CA3048	70p	0C29	79p	2N1303	27p	7475	54p
BC147/157	25p	CA3048	£2.11	0C35	66p	2N1304	24p	7476	80p
BC148/158	23p	CA3052	£1.82	0C36	69p	2N1305	24p	7476	80p
BC149/159	25p	CA3053	47p	0C41	40p	2N1306	30p	7482	£1.04
BC167	11p	CA3065	£1.28	0C42	40p	2N1307	30p	7483	£1.58
BC168	10p	CA3088E	£1.24	0C44	20p	2N1308	34p	7488	39p
BC169	11p	CA3089E	£1.98	0C45	20p	2N1309	34p	7490	84p
BC169C	12p	CA3090G	£4.23	0C71	20p	2N1558(CR1/40IC)	71p	7492	£1.02
BC177	10p	CA3126	£1.80	0C72	20p	2N1613	15p	7492	£1.54
BC178	20p	CD4000AE	55p	0C75	25p	2N1711	15p	7493	90p
BC179	20p	CD4001AE	55p	0C76	25p	2N1893	54p	7494	£1.38
BC182	14p	CD4007AE	55p	0C77	40p	2N2218	33p	7495	98p
BC182L	14p	CD4009AE	£1.16	0C81	20p	2N2218A	44p	7496	£1.87
BC183	13p	CD4011AE	55p	0C81D	20p	2N2219	38p	7497	£2.78
AC153	28p	CD4012AE	55p	0C83	23p	2N2219A	53p	74107	62p
AC176	52p	CD4013AE	£1.11	0C84	25p	2N2268	17p	74121	51p
AC153/176K	52p	CD4015AE	£2.92	0C139	25p	2N2369	17p	74141	£1.20
AC187K	17p	CD4017AE	£2.92	0C170	25p	2N2369A	47p	74150	£4.02
AC188K	23p	CD4018AE	£2.92	0C171	30p	2N2484	12p	74151	£1.32
AC187/188K	40p	CD4020AE	£3.25	0CP71M	42p	2N2648	45p	74153	£1.62
BC187	27p	CD4024AE	£2.09	0RP12	50p	2N2664	44p	74154	£2.40
BC183L	14p	CD4027AE	£1.73	0RPF0	50p	2N2904A	49p	74155	£1.86
BC184	17p	CD4029AE	£4.12	0RP61	50p	2N2905	65p	74156	£1.86
BC184L	16p	CD4048AE	99p	0RP69	50p	2N2905A	74p	74190	£2.18
BC212	16p	CR1/051C	54p	PM7A2	£1.85	2N2924	18p	74191	£2.18
BC212L	16p	CR1/401C	71p	PM7A6	£2.50	2N2925	20p	74192	£2.09
BC238	10p	CRS3/05AF	£1.08	PN70	10p	2N2926	10p	74193	£2.09
BC238/308	20p	CRS3/40AF	£1.53	PN71	10p	2N3053	24p	74196	£1.80
BC257	11p	CZ6	17p	PN107	8p	2N3054	65p	74197	£1.80
BC258	10p	D10 (NTG010)	40p	PN108	8p	2N3055	65p	40250	66p
BC259	12p	HP5082	34p	PN109	8p	2N3228	£1.10	40309	60p
BC307	12p	HS822-33	45p	PN3819(2N3819)	20p	2N339 LA	29p	40310	60p
BC308	10p	HT841-33	£2.24	SL103A	50p	2N3525	£1.04	40311	42p
BCY30	25p	HT881-33	£2.90	SL403A (Rectifier)	60p	2N3702	14p	40312	62p
BCY31	48p	HT341-33	£1.02	SL803A	80p	2N3703	12p	40320	42p
BCY32	50p	IR2180	95p	ST2	20p	2N3704	12p	40360	56p
BCY33	20p	IRC20	48p	TAA283	£1.12	2N3705	12p	40381	45p
BCY34	25p	IRT64	£2.90	TAA293	97p	2N3706	12p	40382	45p
BCY38	30p	J4424	£2.08	TAA310	£2.25	2N3707	12p	40408	52p
BCY58	18p	MC1303L	£1.75	TAA320	75p	2N3708	12p	40407	40p
BCY70	15p	MC1305P	£2.80	TAA861	45p	2N3708	12p	40408	54p
BCY71	26p	MC1307P	£1.65	TAD100	£1.97	2N3710	12p	40409	62p
BCY72	14p	MC1310P	£2.95	TAD110	£1.97	2N3711	12p	40410	62p
BD124	75p	MC1330P	80p	TB4810S	£1.68	2N3773	£2.50	40420	£1.13
BD131	40p	MC1362P	£2.00	TIL112	£2.00	2N3819	20p	40488A	44p
BD132	40p	MC1468L	£4.20	TIL209	35p	2N3820	60p	40511	£1.92
BD131/132	80p	MC1488L	£2.88	TIP31A	60p	2N3823E	20p	40575	£1.54
BDY20	91p	MC4024P	£2.20	TIP32A	70p	2N3826	30p	40576	£1.46
BF115	25p	MC4044P	£2.20	TIP41A	85p	2N3866	28p	40600	70p
BF163	33p	MFC4000B	65p	TIP42A	£1.00	2N3904	£1.10	40601	70p
BF187	25p	MFC8030	£1.63	TIS443	30p	2N3906	28p	40602	45p
BF173	25p	MFC8040	£1.15	TRI	20p	2N4058	15p	40603	70p
BF177	29p	MFC8010	£1.38	VA1039	15p	2N4060	13p	40689	£1.00
BF178	31p	MFC8040	£1.24	VA1040	15p	2N4061	13p	40673	58p
						2N4062	13p	40739	£1.50

TEST METER

This compact, robust Meter contains a transistorized amplifier enabling a very high input impedance to be achieved (at least 200K ohms per volt).

DC & AC Ranges £27.50 each
Further details on request — ask for leaflet 06-351.

LOGIC CHECKER

The fast effective way of checking Digital DIL IC's. Checks DIL gates, flip-flops, counters shift registers, decoders, etc., etc.

Clip on logic plates clarify circuit state. No interference with circuit. Input impedance responds to one TTL load.

Instant display by LED's. Power supply automatically selected. Full instructions supplied with each device at **£25.85 each**

INTEGRATED CIRCUIT TEST CLIP

Indispensable aid to the engineer working with DIL IC's. For use with both 14 & 16 lead packages. Clips on to device under test. Can be used as a revolut tool. Accidental shorting of IC leads is eliminated & Capacitance effects at HF are negligible. **£1.95 each**

INTEGRATED CIRCUIT PINS

The lowest priced IC mounting available. Pin Sockets come in a reel, just drill your board at required centres, drop in pins and solder, break off frame holders — your DIL mounting is complete!!

Pin Sockets 1,000 pieces **£7.00**
Pin Sockets 100 pieces **£1.00**

TRANSDUCERS — ULTRASONIC

A new type of 40 kHz Ultrasonic Transducers designed to transmit and receive a 40 kHz signal. Supplied with transmitter/receiver circuits of a new design.

SOLD ONLY IN PAIRS
Type No. **83181** **NEW LOW PRICE £4.95 per pair**

CA3123E Superhet System with RF Amp, IF Amp, Mixer, OSC, g.c. Detector and Voltage Regulator. Ideal for car radio applications. **£1.80**

SEVEN WATT AUDIO AMP. I.C.

TBA810S £1.68
Featuring thermal protection. Ideal for car radio applications.

PACKAGED CIRCUITS

The complete range of Newmarket modules currently being featured in magazine articles. See catalogue for details.

ANTEX SOLDERING EQUIPMENT

X25/240v 25w iron, **£1.85** SK2/240v 15w kit **£2.95**
MLX 12v 25w kit, essential for car tool kit, **£2.30**
X50TC 240v 50w temperature controlled **£5.95**

ARROW SPECIALISE IN EDUCATIONAL AND GOVERNMENT ORDERS — See Catalogue for further details.

ARROW SERVICE PLUS

10% DISCOUNT OVER £4. NO POSTAGE AND PACKING. TOP-QUALITY PRODUCTS ALWAYS BY RETURN. COMPREHENSIVE CATALOGUE.

Important Notice All prices are exclusive of V.A.T.

this is Otari

From Japan's biggest manufacturer of Tape Duplication equipment, the DP4050 reel to cassette copier. Highest attainable in cassette performance. Foolproof operation for non-skilled personnel. Eight times copy speed. Complete relay-solenoid operation. Automatic cycle through Record-Rewind-Stop. Absolute consistency in manufacture through large volume production. Cassette to cassette version also available.



Otari MX7000 Master Recorder. From £879 excl. VAT

3-SPEED — $3\frac{3}{4}/7\frac{1}{2}/15$ ips or $7\frac{1}{2}/15/30$ ips. Electronic speed change. Cast aluminium deck — 1" thick. Sel-sync. Cannon inputs, optional balanced or unbalanced. Balanced line outputs. Built-in tone oscillator — 700 Hz or 10 kHz. Vu meter reads input, output or bias current. Equalisation and bias controls on front panel. Headphone output. F.E.T.S. all inputs. 2 or 4 channel.

Sole U.K. Distributors:

Scotch 207
UK's LOWEST PRICE

OTARI

NOTE NEW ADDRESS-

Industrial Tape Applications
5 Pratt Street, London NW1 OAE. Tel: 01-485 6162 Telex: 21879

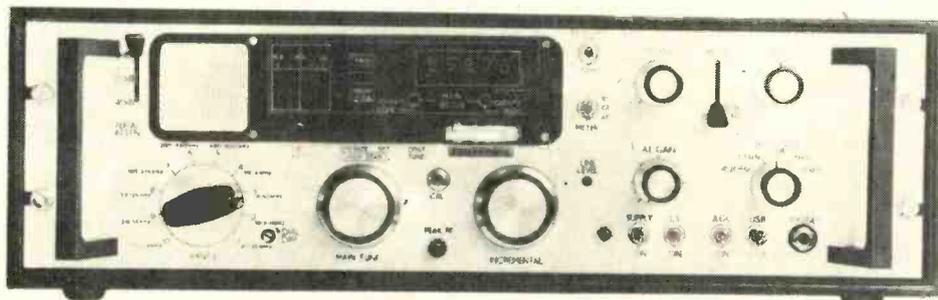
ITA

WW—042 FOR FURTHER DETAILS

Eddystone Radio



Now the EC958/7 High grade professional receiver



- Latest development of the 958 Series
- Fully tuned front end
- High stability
- Digital readout to 1 Hz
- ISB version available
- Integral unit for FSK (optional)
- Fixed — mobile — or maritime

10kHz to 30MHz

World-wide distribution

Illustrated brochure from:

Eddystone Radio Limited

Alvechurch Road, Birmingham B31 3PP Tel: 021-475 2231 Telex 337081

A member of Marconi Communication Systems Ltd

LTD/ED109

WW—043 FOR FURTHER DETAILS

LITTLE WONDER



THE MINITEST IS PREFERRED

The SEI MINITEST has made a remarkable impact in the pocket-sized multi-range meter market, by making itself a firm favourite with discerning people in the industry. Let's look into the reasons why.

First, the appearance. Diminutive, neat, wipe-clean plastic cover with pressed steel case. Controls are simple and easy to use.

Second, the range. The Minitest measures a.c. and d.c. voltages d.c. current and resistance over 20 ranges to a sensitivity of 20,000 and 2,000 ohms per volt d.c. and a.c. respectively.

Third, high voltage probes. These extend the range to 25 or 30kV d.c.

Little wonder the Minitest is preferred!

SALFORD ELECTRICAL INSTRUMENTS LTD

Peel Works, Barton Lane, Eccles,
Manchester M30 0HL.
Telephone: 061-789 5081. Telex: 667711.
A member company of GEC Electrical
Components Ltd.

S&C



WW—044 FOR FURTHER DETAILS

OVERSEAS AGENTS REQUIRED

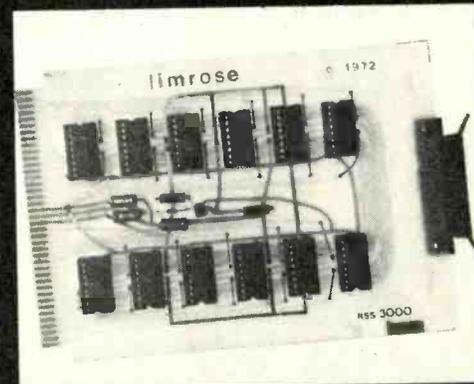
Established British Company has developed a new approach to Spectrum Analysis enabling them to offer a high grade reliable instrument at a fraction of the normal price.

The Spectrum Analyser is a self contained module useable with any general purpose oscilloscope. Any signal from 10 mhz to 850 mhz can be displayed and any multiple of signals up to 400 mhz width can be seen at any one time.

Resolution is better than 25 khz and the price is less than £100 (one hundred pounds sterling)/f.o.b. Importers already selling to schools, Universities, and companies involved in the R.F. field who are interested in receiving further information should write to

Box No. 3541

low cost memory card is easy to interface



RSS 3000 CARD
Random Access
256 Words
12 Bits or less
1 Microsec cycle
TTL Compatible
Expandable
Easy interfacing
LOW COST
£67.50 one off
plus VAT

Limrose's low cost Random Access Memory Card Type RSS 3000 uses 'static' memory chips and is very easy to interface with any equipment. All inputs and outputs are TTL compatible and no clock or timing considerations are necessary when reading or writing into the memory.

The RSS 3000 features a complete memory system on a single printed circuit board and measures 6½ Inch x 7½ Inch with a 43-way edge connector termination. Also available is a Memory Address Register for expansion up to 4096 words, and a power supply card suitable for driving up to four RSS 3000 cards at a time.

Fully decoded address lines, Tri-state output, simple asynchronous control lines and low cost makes this system ideal for use as a buffer store in small computers etc.

limrose electronics ltd.

8-10 KINGSWAY, ALTRINCHAM, CHESHIRE, WA14 1PJ

Tel. 061 928 8063

WW—046 FOR FURTHER DETAILS



Milliamps to Amps, Motorola leads with power devices.

Whatever your application and whatever your field, Motorola has the perfect power device for the job.

Automotive

Motorola leads with thyristors and transistors for high efficiency, high voltage ignition, and transistors for seat belt interlock systems.

Motorola improves reliability with transistorised voltage regulators and power rectifier bridges for alternators.

Computers

Motorola leads with low cost Darlington transistors, permitting CMOS and MOS to interface with large current devices—from milliamps to amps.

Motorola thyristors and triacs are in service in peripherals all over the world.

Consumer

Motorola leads with silicon, plastic and metal can transistors, and thyristors for TV convergence, deflection and power supply stages. And Motorola's NPN and PNP Darlington transistors are ideal for today's audio amplifiers.

Industrial

Motorola leads with a unique range of Beam-Fired thyristors for very high power DC to AC inverters.

Our high voltage power transistors and thyristors give smaller, more efficient switching power supplies.

And we're still very much committed to Germanium—the most economic solution for low voltage/high current applications.

Silicon or Germanium transistors—and there are 6 types of device construction available in plastic or metal packages—and monolithic Darlington mean that there's a reliable Motorola power device for every application.



MOTOROLA
Semiconductors

Motorola Semiconductors Ltd., York House,
Empire Way, Wembley, Middlesex. Telephone:
01-902 8836.

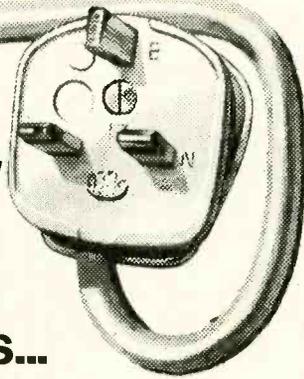
European manufacturing facilities at Toulouse
and East Kilbride.

Distributors: Celdis Ltd., Reading,
East Kilbride;

GDS (Sales) Ltd., Slough, Dublin;
Jermyn, Sevenoaks; Lock Distribution,
Oldham; Semicomps Ltd., Wembley.

Paris Components Show
Motorola: Aisle-E, Stand 82.

**plug into
Black Arrow
we have
some great
connections...**



When you want action in electronic components, plug into a newcomer: Black Arrow Electronics—the new name for Wirelect of Bristol.

Still a member of Edward Electronic Holdings Co. Still operating from Bristol. Still the same experienced team.

Only now the service is Nationwide.

This is a newcomer with great connections. Over 20 major manufacturers to call on, and still more in the pipeline. A big new warehouse, holding stock currently valued at £250,000—and growing. The ability through a policy which is based on action, not words, to take your order and turn it round faster than ever before.

Why not see how an electronic component supplier should operate. Pick up the phone and plug into Black Arrow.

A new name. A great service!

Our manufacturing connections:

- | | |
|----------------------------|--|
| A.E.I. Semiconductors Ltd. | Belling & Lee Ltd. |
| Avo Ltd. | Edgecombe Peebles Ltd. |
| A. F. Bulgin & Co. Ltd. | English Electric valve Co. Ltd. |
| Electrolube Ltd. | Hollingworth Terminals Ltd. |
| Evershed & Vignoles Ltd. | The M.O. Valve Co. Ltd. |
| J. Lucas (Electrical) Ltd. | Mullard Ltd. |
| Mallory Batteries Ltd. | R.C.A. (Values) Ltd. |
| Multicore Solders Ltd. | Rendar Instruments Ltd. |
| Shackman Instruments Ltd. | Taylor Electrical Instruments Ltd. |
| Vitality Bulbs Ltd. | Thorn A.E.I. Radio Valves & Tubes Ltd. |
| Weller Electric Ltd. | 20th Century Electronics. |
| Antex Ltd. | |

We can connect you with:

Circuit protection Crimp terminals Domestic valves C.R.T.'s I.C.'s Indicators Lamps Meters L.E.D.'s displays Passive components Plugs and sockets Soldering irons Switches Timers Tools and Kits Contact cleaning solvents Connectors Cores Instruments Industrial valves Knobs Mercury cells and batteries Lubricants and greases Metrohms Oscilloscope cameras Semiconductors Solder Safeblocs Test equipment Terminals

black arrow electronics

St. Thomas Street, Bristol BS1 6JW.
Or ring Bradley Davies (0272) 209313
We like dealing with people who have good connections—especially when the turnround of order is as fast as you say!

PLEASE SEND the new Black Arrow Electronics 200-page catalogue
PLEASE ASK the Black Arrow Engineer to 'phone and make an appointment
Entirely without obligation

Name

Company

Address

Tel

PLE1

WW—048 FOR FURTHER DETAILS

“Ampex and WHAT?...”

**The
JAMES SCOTT
Alignment Units
for D.R. and F.M.
Multi-Channel
Tape Recorders.**

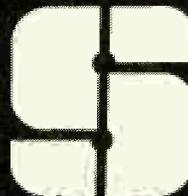


The F.M. Alignment Unit Type FMU/1 illustrated was designed at the Royal Radar Establishment, Malvern, to suit Ampex Recorders working on the IRIG intermediate band specification (using ES 100 Electronics) e.g. Model Numbers FR 1200, FR 1260, FR 1300, FR 1800L, FB 400, PR 500

If you have a sophisticated Ampex Recorder—Align it to the Manufacturers specification using our Alignment Units for D.R. & F.M. Systems.

Speedy and inexpensive

For Further information and Technical Literature Write or telephone.



**JAMES
SCOTT
(Electronic Engineering) Ltd**

CARNTYNE INDUSTRIAL ESTATE
GLASGOW G32 6AB
Tel: 041 778 4206

WW—049 FOR FURTHER DETAILS

audix
SOUND SYSTEMS AND ELECTRONICS

AUDIX AT THE WORLD'S BUSIEST INTERNATIONAL AIRPORT

FLIGHT DEPARTURE
INFORMATION AND
PASSENGER
ANNOUNCEMENT
SYSTEM, OPERATING
AT THE
INTERCONTINENTAL
TERMINAL 3
HEATHROW AIRPORT
LONDON

Another example of the complete system design and manufacturing service offered by Audix of Stansted.

Send for our catalogue.

The Acoustically matched 800 watt audio system includes automatic noise sensing announcement level adjustment devices, multi access and routing facilities, emergency back-up power supply and a range of loudspeakers including the unique Super Cardioid Golf Ball Speaker.

AUDIO
BY

Photo by permission of British Airports Authority.

audix

MANUFACTURERS OF
SOUND SYSTEMS AND
ELECTRONICS

AUDIX LIMITED · STANSTED · ESSEX CM24 8HS
TELEPHONE : BISHOP'S STORTFORD 813132
(4 lines) (STD 0279)

**M-OV
TETRODES**

TT 21, THE TUBE THAT GOES ON.

You could design yourself a reputation around this M-OV tube.

- It's the best beam tetrode you can buy.
- Offers lowest possible cost per watt.
- Communications transmitters all over the world depend – and go on depending – on the famous M-OV TT21.
- Characteristics: Frequency 30-60 MHz, Output Power 174W, Anode Dissipation 37.5W, Anode Voltage 1250V.



EEV AND M-OV KNOW HOW.

THE M-O VALVE CO LTD, Hammersmith, London, England W6 7PE.
Tel: 01-603 3431. Telex: 23435. Grams: Thermionic London. **S&C**

WW—053 FOR FURTHER DETAILS

Gardners line up

Line Matching Transformers from Standard to Super Fidelity

It's easy to choose the right Line Matching Transformer from the five Gardners ranges.

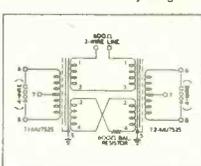


The Super Fidelity Series, with a frequency response of 10Hz to 80kHz – 0-5dB, gives the widest possible bandwidth for high accuracy instrumentation and recording applications.

Then there's the Wide and Extra Wide-band ranges. Outstanding performers with a frequency range 30Hz – 20kHz or more – for the 0-5dB points. Used a lot by broadcasting and recording companies throughout the world.

The Miniature and Standard ranges provide excellent bandwidth for most purposes. 30Hz – 22kHz for the 1-0dB points.

Except for the very smallest in the range, all Gardners Line Matching Transformers are fully magnetically shielded, giving very high hum rejection ratios.



Prices start from £2.29 (recommended retail price) and all types are usually available from stock.

Complete technical information is given in brochure GT 5 'Audio Frequency Transformers' which we'll be glad to send on request.

So accurate is the balancing of the windings on some of these transformers that, when used as pairs in a hybrid circuit (as illustrated) we can guarantee a rejection of better than -55dB over the frequency range 30Hz to 10kHz and normal rejection of up to 75dB may be expected.



Specialists in Electronic Transformers and Modular Power Supplies

GARDNERS

TRANSFORMERS LIMITED

Gardners Transformers Limited, Christchurch, Hampshire, BH23 3PN
Tel: Christchurch 2284 (STD 0201 5 2284) Telex: 41276 GARDNERS XCH

WW—052 FOR FURTHER DETAILS

The new Rank WOW & FLUTTER Meter Type 1742



Fully transistorised
for high reliability

Versatile

Meets in every respect all current specifications for measurement of Wow, Flutter and Drift on Optical and Magnetic sound recording/reproduction equipment using film, tape or disc

High accuracy

with crystal controlled oscillator

Simple to use

accepts wide range of input signals with no manual tuning or adjustment

Two models available:

- Type 1742 'A' BS 4847: 1972 DIN 45507 CC1R 409-2 Specifications
- Type 1742 'B' BS 1988: 1953 Rank Kalee Specifications

For further information please address your enquiry to

Mrs B. Nodwell

Rank Film Equipment, PO Box 70

Great West Road, Brentford

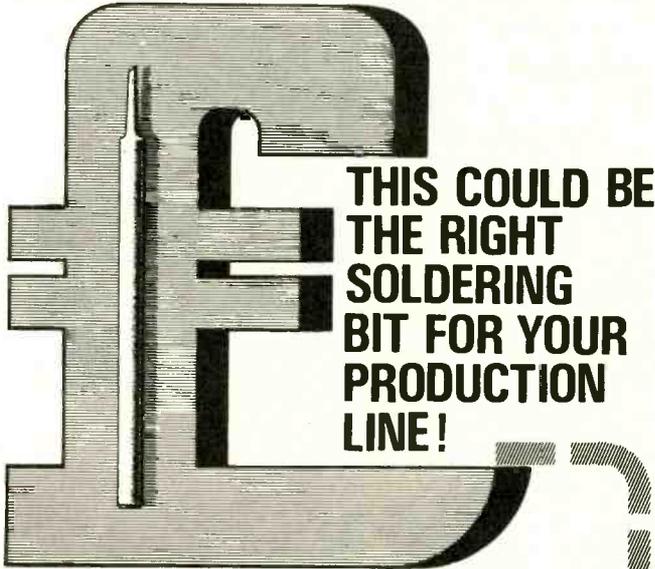
Middlesex TW8 9HR

Tel: 01-568 9222 Telex 24408 Cables Rankaudio Brentford



RANK FILM EQUIPMENT

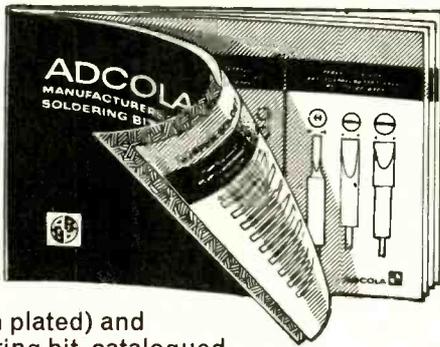
WW—094 FOR FURTHER DETAILS



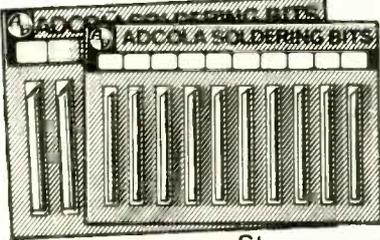
**THIS COULD BE
THE RIGHT
SOLDERING
BIT FOR YOUR
PRODUCTION
LINE!**

**study the possibilities in
ADCOLA'S NEW CATALOGUE!**

**100
Shapes
100
Styles
for you!**



Long life (iron plated) and copper soldering bit, catalogued by Adcola, giving you the most comprehensive range of British-made soldering bits yet! Face sizes from $\frac{1}{32}$ " to $\frac{3}{4}$ " Shank sizes $\frac{1}{8}$ " to $\frac{1}{2}$ ".



**Packaging
that
pleases**

Styrene packed soldering bits for easy identification
Package prevents damage to bits
Perforated for ease of dispensation

**ADCOLA PRODUCTS LIMITED, ADCOLA HOUSE,
GAUDEN ROAD, CLAPHAM, SW4 6LH
DEPT. WW8 SOLDERING BIT SALES.**
Please send me your latest soldering bit catalogue

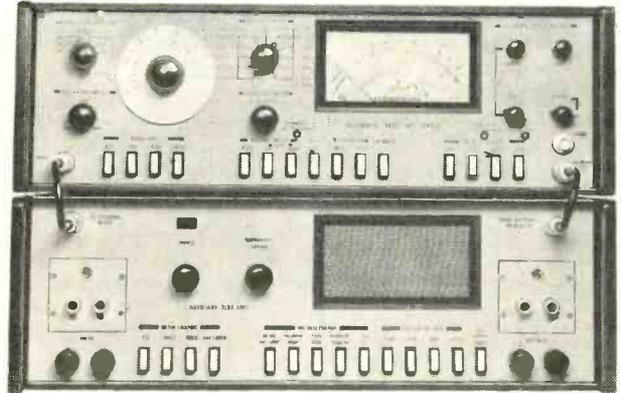
NAME: _____

ADDRESS: _____



WW-054 FOR FURTHER DETAILS

Audio Test Set



**for amplifiers, mixers
tape recorders**

Checks ... frequency response
signal/noise ratio
distortion
cross-talk
wow & flutter
drift
erasure
sensitivity
output power
gain
... in one compact unit.

Auxiliary Unit provides extra facilities for Studio testing.

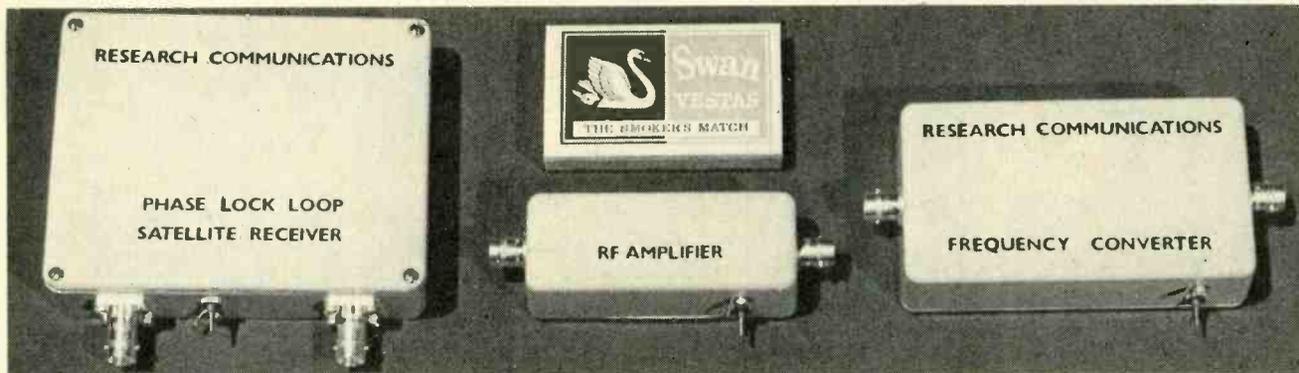
Send for leaflet RTS2

Ferrograph Company Limited Auriema House 442 Bath Road
Cippenham Slough Buckinghamshire SL1 6BB
Telephone: Burnham (062 86) 62511 Telex: 847297

FERROGRAPH

A member of the Wilmot Breedon group

WW-055 FOR FURTHER DETAILS



PHASE LOCK LOOP RECEIVERS

Type 1101 Satellite Band. 136-138 MHz.
1.5 dB. Noise Factor. High system gain. Automatic search and lock facility tunes receiver to satellite transmission in range without manual adjustment and enables several satellites to contribute to picture print-out without operator involvement over an extended period. Single channel or manual operation may also be selected. The unit is designed and rated for continuous duty monitoring service. The output drives facsimile picture equipment directly £280

Type 1202 Telemetry. 102 MHz.
AM. FM. multiplex FM. pulse. Automatic signal tracking and locking £280

Type 1203 Telemetry. 412 MHz. £350

Type 1302 Communications. Single or multi-channel. AM. FM. multiplex
FM. FSK. RTTY. SSB. CW. Up to 250 MHz. £270

Type 1303 250-470 MHz. £350

Type 1401 Radiometer. Type 1451 Interferometer. 81.5 MHz. 151.5 MHz. £260

Type 1402 Radiometer. Type 1452 Interferometer. 408 MHz. £340

Receiver size: 1101, 1202, 1302, 1401, 1451: 4½" x 3½" x 1½"
1203, 1303, 1452, 1402: 6½" x 4½" x 2½". Aluminium diecast case.

FREQUENCY CONVERTERS

Type 1051 Input frequency as specified in the range 1 to 250 MHz. £80

Type 1061 Input frequency as specified in the range 200 to 700 MHz. £120
Size: 4½" x 2½" x 1½". Aluminium diecast case.

RF AMPLIFIERS

Type 1014 **LOW NOISE FRT RF PREAMPLIFIERS**
Frequency: As specified in the range 1 to 250 MHz.
Bandwidth: As specified from 1% to 20% of centre frequency.
Noise Factor: 1.5 dB. @ 150 MHz.
Gain: 30 dB. @ 100 MHz. Adjustable £60

Type 1015 **LOW NOISE RF/IF AMPLIFIERS**
Frequency: As specified in the range 1 to 150 MHz.
Bandwidth: As specified from 1% to 40% of centre frequency.
Noise Factor: 1.5 dB. @ MHz.
Gain: 60 dB. @ MHz. Adjustable - 60 dB. £80

Type 1021 **TUNEABLE STRIPLINE PREAMPLIFIERS**
Frequency: 350 MHz. to 2 GHz. Continuous varicap tuning.
Bandwidth: Adjustable.
Noise Factor: 1.1 dB. @ 350 MHz. 2 dB. @ 1 GHz. 3 dB. @ 2 GHz.
Impedance: Adjustable.
Gain: 15 dB. @ 500 MHz. 10 dB. @ 1 GHz. £120

Types 1014, 1015, 1021.
Size: 3½" x 1½" x 1½". Aluminium diecast case.
Connectors: BNC, N, UHF, or as specified.
Weight: 4 oz.

V.A.T. applicable at the current rate excepting export orders.
Illustrated brochure available on request.

SPECIAL EMERGENCY SERVICE. An emergency service is now available for very rapid delivery of standard and special equipment. For further information telephone Mr. P. H. Strudwick, Faversham 2064.

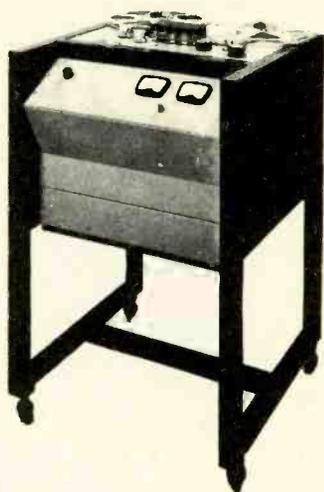
RESEARCH COMMUNICATIONS

PEEL HOUSE, PORTERS LANE, OSPRINGE, FAVERSHAM, KENT. ME13 ODR

Telephone: Faversham 2064

WW—056 FOR FURTHER DETAILS

BIAS ELECTRONICS



PROFESSIONAL RECORDERS

for broadcasting and studio use.
Our range includes console, transportable and rack mounting machines.
Mono-stereo ¼", 4 track ½", 4 track ¼" slow speed radio station loggers all to IBA requirements.

BIAS ELECTRONICS LTD.
572 Kingston Road, London SW20

WW—057 FOR FURTHER DETAILS

DC/AC SINEWAVE TRANSVERTORS
(transistorised Invertors/Convertors)



Many world famous car manufacturers such as FORD, BRITISH LEYLAND, including ROVER-TRIUMPH, VAUXHALL, develop their cars under exact laboratory conditions. The AC electric power to drive the precision instruments and computers is provided by Valradio Transvertors.

TYPE D12/400S

Type	Input Volts	Output	Price
C12/30S	12	115/230v 30W sine wave	£32.45
C12/60S	12	115/230v 60W sine wave	£43.60
D12/120S	12	115/230v 120W sine wave	£57.00
D12/200S	12	115/230v 200W sine wave	£81.80
D12/400S	12	115/230v 400W sine wave	£197.00
D24/500S	24	115/230v 500W sine wave	£197.00

All prices +10% VAT. All 50Hz ± ½Hz. Also available 60Hz ± ½Hz at same price.

For operating frequency and wave form sensitive equipment such as sound tape recorders, video tape recorders, professional film cameras, sensitive instruments, etc.

Other models available for inputs of 24, 50, 110 and 220 volts DC. Square waveform output also available, generally from stock. Send for informative brochure.

VALRADIO LIMITED
BROWELLS LANE, FELTHAM, MIDDLESEX
TW13 7EN, ENGLAND
TEL: 01-890 4242/4837

WW—058 FOR FURTHER DETAILS

NEW VAT INCLUSIVE PRICES

OVERSEAS CUSTOMERS DEDUCT ONE ELEVENTH.

AUDIO I.C.'S

Audio I.C. Leaflet No. 12 (Circuit data etc) FREE with I.C.'s 10p separately.

MC1303L Dual Pre-amp	£1.89	
MC1339P Low noise Dual Pre-amp Single	£1.29	
MFC4000 A or B 250mW	49p	
TAA300 1 Watt into 8n, 9v rail	£1.79	
LM380 2 Watt	£1.59	
SL414* 3 Watt NEW pin for pin replacement for SL4030	£1.76	
TBA800 5 Watt into 356	£1.59	
BHA0002 15 Watt	£3.95	
NE540L 35 Watt driver T099 Can	£1.32	
MC1310 Inductorless, phase-locked loop multiplex stereo decoder, supplied with FREE leaflet No 11 (available separately 10p)	£3.05	
MC1312 The I.C. CBS SQ Quadrasonic decoder Available, only with all components inc. veroboard & detailed leaflet. Price is all inclusive.	£6.49	
* See SL414 above. Also available, heatsink for SL414 or SL415 15p. Suitable stereo P/C Board 69p. SL415 (5 Watt Amp) £2.29 ZN414 with free leaflet No 11 £1.32		

74 Series TTL

INTERNATIONALLY KNOWN BRANDS
1st. GRADE DEVICES AT NEW
ROCK BOTTOM PRICES

SN7400	17p	SN7473	40p
SN7401	17p	SN7474	40p
SN7402	18p	SN7475	50p
SN7404	17p	SN7476	44p
SN7408	20p	SN7490	68p
SN7410	17p	SN7492	74p
SN7413	30p	SN7493	74p
SN7420	17p	SN74100	£1.82
SN7430	17p	SN74121	44p
SN7441	74p	SN74141	£1.10
SN7442	74p	SN74192	£2.15
SN7447	£1.01		

Cheapest Opto yet GaAsP LED's

LED 2. 0-125"	26p
LED 3. 0-175"	17p
LED 4. 0-125"	69p
LED 5. 0-175"	75p

Remember **Vat Inclusive Prices.**

PRICE BARRIER SLASHED LED READOUTS

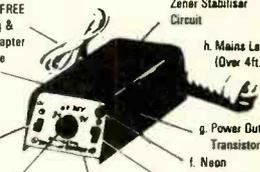
LITRONIX DL707 SERIES	
1/2" high characters 14pin Di ¹ Ref LED 1	also available + 1 Ref LED 1A
£1.99 + 20p VAT = £2.19	

Linears

8pin DIP	T099	14pin Dii
709	34p	35p
710	35p	39p
711	—	39p
723	45p	95p
741	42p	43p
747	—	92p
748	42p	43p
CA3046	95p	MVRSV (L005) £1.65
CA3075	£1.65	MVR12V (L036) £1.65
CA3082	£1.65	MVR15V (L037) £1.65
LM101H	£1.99	NE 555 99p
LM201H	£1.15	NE 560 B £4.92
LM301	£1.05	NE 561 B £4.92
LM307N	96p	NE 562 B £4.92
LM308K	£1.45	NE 565 £2.80
LM309K	£2.69	NE 566 £2.75
LM3900	77p	NE 567 £2.80
MC1330	88p	SG3402N £3.08
MC1350	83p	SL440 £2.89
MC1351	£1.10	TAA263 99p
MC1352	£1.10	TAA293 99p
MC1357	£1.59	TAA310 £1.37
MC1358	£1.69	TAA320 99p
MC1456G	£1.75	TAA350 £2.54
MC1458CP1	£2.42	TAA370 £5.15
MC1495	£5.65	TAA550 81p
MC1496N	£1.49	TAA570 £1.65
MFC6030A	£4.95	

new stabilised POWER PACK/CONVERTER

Switched 3, 6, 7½ or 9 Volts
Up to 400ma Output



Our Price £3.99 + p & p 20p
unstabliised version of above £2.99.
Other Eliminators (unstabliised)*

6 Volts @ up to 50mA	£1.65
9 Volts @ up to 50mA	£1.85
9 Volts (miniature) @ up to 50mA	£2.09
6 + 6 @ up to 50mA	£2.75
9 + 9 @ up to 50mA	£2.75
7½ Volts for cassette Players (Small)	£2.20
3, 4, 6, 7, 9, 12 Volts up to 4A	£3.75
Fully stabilised car battery Converter* giving switched outputs of 6, 7, 9 or 9v	£5.49

p & p on all models 20p

I.C. SOCKETS



Dual in line	Z16 Z46
8pin 13½p	28pin 30½p
14pin 15½p	36pin 39½p
16pin 17½p	40pin 44p
24pin 26½p	

CHROMASONIC electronics

Dept. 5.
56, Fortis Green Road, London, N10 3HN.

DIGITAL CLOCK



MM5314

12 or 24 hour. 4 or 6 digit
50 or 60Hz operation
leading zero supression
single voltage supply
similar to DIGITRONIC in
P.W. March 1973.
Only £7.99

INDUCTORS

LP1175 MULLARD 470khz
Block I.F. Filter
Now only £1.49

Denco (Clacton) Ltd. Maxi-Q Coils

Transistor Range
Series 1T to 5T inclusive
Blue; Yellow; Red & White
All 44p each

Dual Purpose Range:
Series 1 to 7 inclusive
Blue; Yellow; Red & White
All 44p each
1 to 5 Green 49p each

Ferrite Rod Aerials Medium & Long Wave
for 300pf & 500pf tuning (state which)
87p each

R.F. Choke Range 0.1uH to 19mH
For full details ask for leaflet No. 5
p & p 5p.

Veroboard

COPPERCLAD	PLAIN	EXTRA P & P
0.1"	0.15"	
2½ x 3½"	24p	12p
2½ x 5"	26½p	23p
3½ x 3½"	30p	30p
3½ x 5"	82p	63p
17 x 2½"	£1.10	86p
17 x 3½"	—	90p
17 x 5"	—	90p
Dip Breadboard 4.15" x 6.15"	£1.15	90p
Spot Face Cutter	44p	
Pin insertion Tool (State 0.1" or 0.15")	55p	
Terminal Pins (PK550)—State Size	20p	

Tuning Gangs



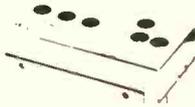
TYPE C804	TYPE O	TYPE OO
5pf	365pf	80p
10pf	365 + 365pf	96p
15pf	20B + 176pf	
20pf	with screen & trimmers	99p
25pf	61p	
50pf	66p	
60pf	79p	
75pf	79p	
100pf	75p	
	100pf	55p
	300pf	55p
	500pf	55p

3 1/2 decade DVM

Price includes data booklet (10p separately)

A State-of-the-Art Digital Voltmeter I.C. for only £7.79



 Mullard LP1186 Varactor diode tuned F.M. Tuning heart £4.15 as described in P.E. May 1973 LP1185 matching 1.F strip £4.85	 THE TEXAN 20 + 20 Watt Integrated stereo amplifier Kit superb state-of-the-art design by engineers of Texas Instruments £31.35 + p & p 49p	 SGS EA1000 3 Watt amplifier module Price including handbox and FREE HEATSINK (Quantity Discounts) Our Price £2.49	 A1005S F.M. tuner chassis, fully transistorised. 9 Volt positive earth operation Our Price £6.35	 A1018 F.M. Tuner, similar to A1005S but in oiled walnut case, black & silver fascia etc Our Price £12.99	 A1005MS Multiplex Stereo Decoder fully built & aligned to match A1005S Our Price £5.95
--	--	---	---	--	--

VAT INVOICES ON REQUEST

UNLESS SHOWN OTHERWISE P&P ON U.K. ORDERS IS 10p OVERSEAS ORDERS AT COST



Check in one direct move with Brandenburg's new HV meter

We thought it was about time somebody supplied *direct reading* meters for high voltage, so we've produced three—one for up to 5kV, one for 15kV and one for 30kV to complement our range of HV power supplies.

The meters are operated by two 9V internal batteries (800 hours life) linked with a built-in checking facility. Positive or negative ground is available, selected by a front panel switch. And, as with all Brandenburg products, there is a 12 months unconditional guarantee.

- Accuracy of 1% fsd over voltage range of 0-30kV d.c.
- Less than 1 μ A drawn at 30kV d.c.
- 4.5in (114 mm) scale mirror-backed meter.
- Temperature range 5-35°C.
- Dimensions only 7 x 8 x 5½in high (200 x 145 x 178mm).
- Recorder output.

Yet another Brandenburg piece in the
high voltage game

brandenburg

STABILISED HIGH VOLTAGE

Brandenburg Limited, 939 London Road, Thornton Heath, Surrey.
CR4 6JE, England. Tel: 01-689 0441 Telex: 946149

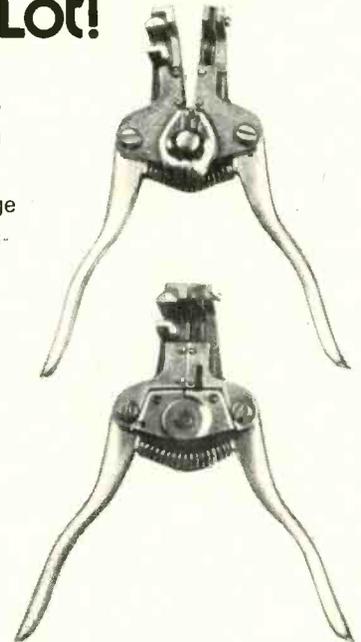
Agents or distributors in most principal countries.

P6437

WW—060 FOR FURTHER DETAILS

These Strippers Give You The Lot!

Speedex Wire Strippers give you everything you need for fast, efficient wire stripping. The range includes standard, semi-automatic and fully automatic models and seven different size cutting heads for all wire gauges from No. 8 to 30. They are also available as kits in tough plastic boxes complete with blades. Write now for illustrated literature.



SPECIAL PRODUCTS DISTRIBUTORS LIMITED,
81 Piccadilly, London W1V 0HL.
Tel: 01-629 9556. Cables: Specipro London.

WW—061 FOR FURTHER DETAILS

HEPWORTH ELECTRONICS

A DIVISION OF B. HEPWORTH & CO. LTD.

Bank Buildings, Kidderminster.

PRESENT

**ELECTRONIC
DEVELOPMENT
CORPORATION**

**AC-DC
PRECISION
CALIBRATORS**



DC milli Volt Calibrator MV105

THIS IS ONLY ONE UNIT FROM THE E.D.C. RANGE
OF MANUAL OR PROGRAMMABLE VOLTAGE
STANDARDS.

Tel: 0562 2212 or 3 for Data and Price

WW—062 FOR FURTHER DETAILS



Five days that can change your future

We're rather good at changing the future. After every I.E.A. exhibition, the world's never quite the same again!

Because the I.E.A. exhibition is the world's unique show window for the latest technical developments in process control instrumentation, automatic test equipment, electronic components, process control, production equipment, scientific instrumentation, computer hardware and data handling equipment.

And because each I.E.A. exhibition acts as a "think tank" for engineers from all over the world, who examine, compare and discuss the developments since the last exhibition.

The exhibition itself continues to escalate. Since its foundation in 1957 it has more than tripled in size. In 1972 it attracted over 700 companies from 22 countries, and 4,824 visitors from 69 overseas countries.

I.E.A. '74 is a special landmark - the first to be held since the setting up of the enlarged EEC.

Olympia, London

Olympia has good bus and underground connections with London's West

End, and is close to the West London Air Terminal. There is a multi-storey car park adjacent to the exhibition hall. Overseas

visitors will be provided with special amenities and facilities - information centres, lounges, interpreters and help with travel and accommodation.

Travel

To make your visit trouble-free and enjoyable, our official travel agents, Louis Duforest, will take care of your travel to London, hotel accommodation, and excursions. These can be booked individually or as a "package".

For full details of this comprehensive service, just fill in the coupon.

To Industrial & Trade Fairs Limited,
Commonwealth House, 1-19 New Oxford
Street, London WC1A 1PB, England.
Telephone: 01-242 9011. Telex: 262567.
Cables: Indatfa London WC1.

1. Please send me further details and complimentary tickets for IEA '74
2. Please send me details of the Conference
3. Please send me details of the special travel hotel accommodation and package deal facilities offered by the official IEA travel agent.

Name

Company

Address

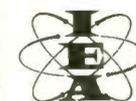
.....

.....

.....

International Instruments Electronics Automation Exhibition

13th-17th May 1974 Olympia,
London. Open daily 10.00-18.00



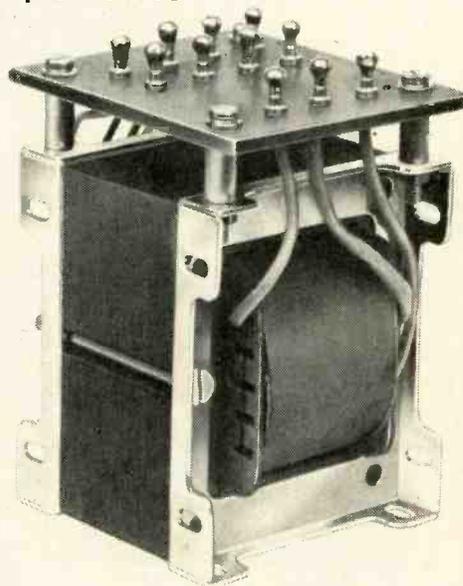
transformers

mains, audio, microphone, ferrite core and other wound components

A wide range of transformers manufactured in production quantities to customers individual requirements

Prompt Prototype Service available

TRANSFORMER WITH UNIVERSAL END FRAMES AND TURRET LUG CONNECTIONS



MICROPHONE TRANSFORMER IN MUMETAL CAN



TRANSFORMER WITH TWO HOLE CLAMP AND SOLDER TAG CONNECTIONS

Drake Transformers Limited

Telephone: Billericay 51155

Kennel Lane, Billericay, Essex.

WW—063 FOR FURTHER DETAILS

Z & I AERO SERVICES LTD.

THE MANAGEMENT ANNOUNCES WITH REGRET THAT DUE TO RISING COSTS AND STAFF SHORTAGES OUR MAIL ORDER SERVICE WILL HAVE TO BE CURTAILED. NO MAIL ORDERS WILL BE ACCEPTED BELOW £5.00 PLUS VAT, I.E. £5.50 VAT PAID. OUR EQUIPMENT WILL STILL BE AVAILABLE TO PERSONAL CALLERS ONLY AT OUR RETAIL BRANCH, 85 TOTTENHAM COURT ROAD AND TRADE COUNTER, 44A WESTBOURNE GROVE, W2, WHERE THE ABOVE LIMIT WILL NOT APPLY, MINIMUM ORDER CHARGE FOR ACCOUNT CUSTOMERS IS £10.00.

AC/DC TAUT SUSPENSION MULTIMETERS — MADE IN USSR



U4312; 39-ranges AC/DC Volts and Amps Sensitivity 667 o.p.v. Accuracy 1/1.5% £9.75
U4313; 31-ranges AC/DC Volts and Amps. Sensitivity 20,000 o.p.v./2,000 o.p.v. Accuracy 1.5/2.5% £10.50



U435; 30-ranges AC/DC Volts and Amps. Sensitivity 20,000 / 2,000 o.p.v. Accuracy 2.5/4% £8.75



U4341; 27-range multimeter, with AC/DC voltage and current coverage plus transistor tester giving current gain measurements from 10 to 350. Sensitivity 16,700/3,300 o.p.v. Accuracy 2.5/4% £10.50



U4324; 32 ranges AC/DC Volts and Amps. Sensitivity 20,000/4,000 o.p.v. Accuracy 2.5/4% £8.00



U437; 15-ranges AC/DC Volts, DC Amps only. Sensitivity 10,000/5,000 o.p.v. Accuracy 2.5/4% £4.95



U4323; 22 ranges AC/DC Volts, DC Amps only. Sensitivity 20,000 o.p.v. Built-in AF/IF oscillator, giving signal at 1KHz and 465KHz. Accuracy 5% £7.00

OUR NEW 1973/1974 CATALOGUE OF VALVES, SEMICONDUCTORS, PASSIVE COMPONENTS AND TEST EQUIPMENT IS NOW READY. PLEASE SEND £0.15 FOR YOUR COPY. EXPORT PRICE LIST AVAILABLE TO BONA FIDE FOREIGN CUSTOMERS.

Head Office:

44a WESTBOURNE GROVE, LONDON, W.2

Tel: 727 5641/2/3

Cables: ZAERO LONDON

Retail branch (personal callers only)

85 TOTTENHAM COURT RD., LONDON W.2. Tel: 580 8403

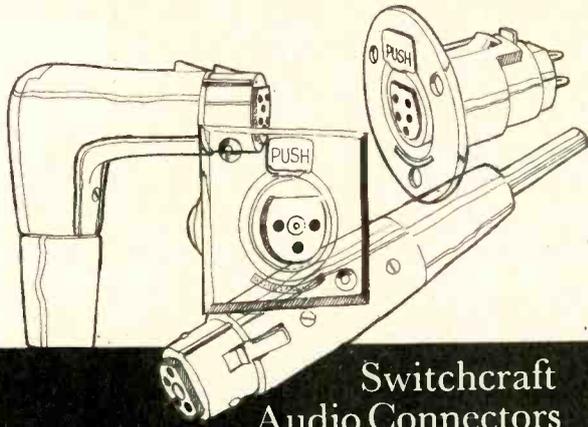
C.A.A. Approved for inspection and release of electronic valves, tubes, klystrons, etc.

WE WANT TO BUY:

SPECIAL PURPOSE VALVES. PLEASE OFFER US YOUR SURPLUS STOCK. MUST BE UNUSED.

TELEX 261306

WW—064 FOR FURTHER DETAILS



Switchcraft Audio Connectors

Complete range of Switchcraft audio connectors for all studio and ancillary equipments.

Versatile— 3, 4, 5 or 6 pole; wide variety of matching plugs receptacles; readily interchangeable with other leading makes.

Streamlined — simple positive snap-in connection; cable clamping and latch lock.

Safe— self polarisation; captive insert screw provides rigid assembly and electrical continuity; firm and constant ground contact between mating connector shells through the use of an exclusive Ground Terminal and Contactors.

Low Cost · Ex-stock · Quantity Discounts

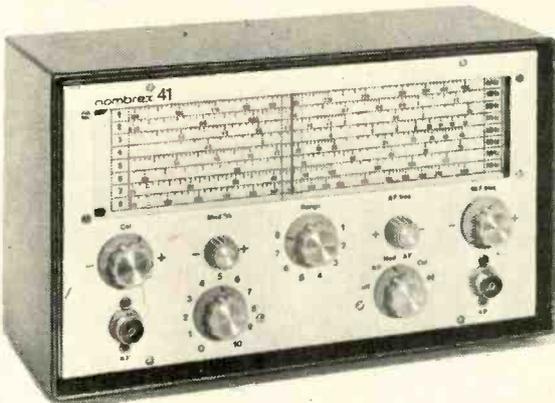
Write now for free descriptive literature.
Sole U.K. Agent for Switchcraft QG Connectors

F.W.O. BAUCH LIMITED

19 Theobald Street, Boreham Wood, Herts. WD6 1RZ. Telephone: 01 95340091

WW—065 FOR FURTHER DETAILS

nombrex



MÓDEL 41 R.F. SIGNAL GENERATOR Price £35.00.

PLUS 10% FOR V.A.T.

- ★ 150 KHz — 220 MHz on fundamentals.
- ★ 8 clear scales — Total length 130mm.
- ★ Spin-Wheel Slow Motion Drive 11 — 1 ratio.
- ★ Overall Accuracy — 2½%.
- ★ Modulation, Variable depth and frequency.
- ★ Internal Crystal Oscillator providing calibration checks throughout all ranges.
- ★ Mechanical scale adjustment for accurate alignment against internal 1MHz crystal oscillator.
- ★ Powered by 9V Battery.

Trade and Export enquiries welcome.

Send for full technical leaflets.

Post and Packing 35p. extra.

NOMBREX (1969) LTD., EXMOUTH, DEVON.

Tel: 03-952 3515

WW—066 FOR FURTHER DETAILS

P.C. BORED?

— not with the

DECON— DALO 33PC



A unique drafting aid for the electronics engineer enabling him to prepare in minutes a perfect PCB.

A fine-tipped marker charged with a free-flowing etch-resist ink. Simply draw the desired circuit onto copper laminated board—etch—clean.

The circuit is ready to use.

NO MESS — NO MASKING A perfect circuit every time!

The Decon-Dalo 33 PC marker is now available in France, Germany, Italy, Switzerland, Austria and all Scandinavian countries. Send for details of local supplier.

Please send me further details on the 33PC:

Name

Address

Post to: **DECON LABORATORIES LTD.**

FREEPOST

PORTSLADE, BRIGHTON, ENGLAND

(No Stamp Needed) Phone 0273 414371

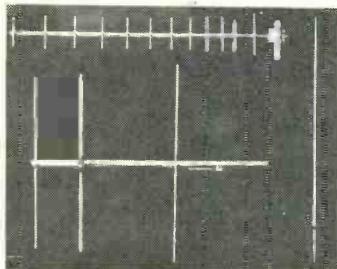
WW—067 FOR FURTHER DETAILS

ARE YOU LOOKING FOR **COMMUNICATION ANTENNAS**

HY-Q ANTENNAS LIMITED, a newly formed company with technical staff having 10 years experience in the development of radio telephone ship to shore, satellite tracking, telemetry and broadcasting antenna, together with a well equipped laboratory are now offering Professional Communication Antennas.

At this time we are able to offer VHF and UHF Yagis, Centre Fed Dipoles covering low and high bands and are rapidly developing further new ranges. Stocks are being maintained and in instances where your orders cannot be supplied from stock, we guarantee delivery within 7 days. We would greatly welcome your enquiries and details of specifications and prices may be obtained by telephoning in the absence of our printed catalogue.

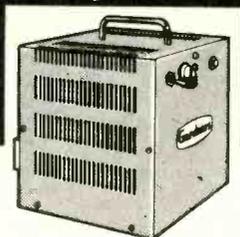
HY-Q ANTENNAS LIMITED,
Pondwood Close, Moulton Park Industrial Estate, Northampton.
Tel: Northampton 48129 Cable Address: Hikeant, Northampton, England.



WW—068 FOR FURTHER DETAILS

BIG BOOST FOR THE GARDNERS RANGE

50Hz 300VA Square Wave Inverters



If it's produced by Gardners it must be something special, and it is! Now available, models 107A and B are precision built inverters providing 240 volts a.c. from 12 and 24 volt battery systems.

Both models offer unusually high output ratings enabling the user to operate many conventional loads such as lighting and small power tools in situations where main power supplies are not available.

Gardners inverters are designed to drive any mains operated equipment which is not unduly sensitive to the difference between sine and square waveforms. Incandescent lamps, TV sets, electric drills are typical of a wide field of possible applications...

Both the 107A and B models are rated at 300VA (300W U.P.F.) and will accommodate reasonable short term overloads. Price £67 plus VAT. *Brochure GT 28 gladly sent on request.*



Specialists in Electronic Transformers and Power Supplies

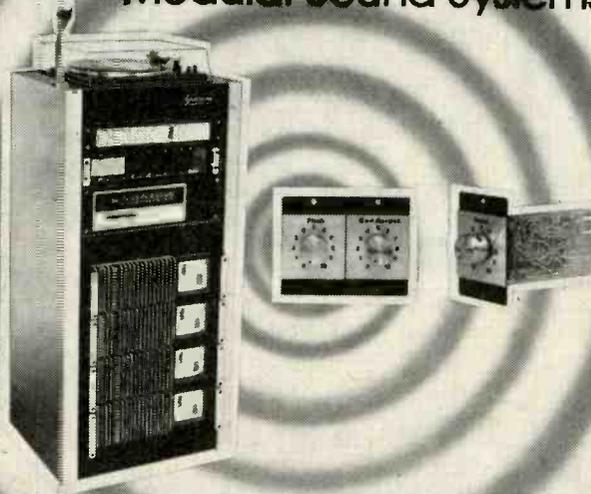
GARDNERS

TRANSFORMERS LIMITED

Gardners Transformers Limited Christchurch Hampshire BH23 3PN
 Telephone 02-015 2284 TELEX 41276 GARDNERS XCH.

WW—069 FOR FURTHER DETAILS

Grampian Series 7 Modular Sound Systems



GRAMPIAN REPRODUCERS LTD
 HANWORTH TRADING ESTATE,
 FELTHAM, MIDDLESEX.
 TELEPHONE: 01-894 9141.
 GRAMS: REAMP - FELTHAM

JACW/XA70

WW—070 FOR FURTHER DETAILS

The Avo B150 universal measuring bridge is no longer your best buy.

AVO JUST INTRODUCED THE B150 MK2.



The new battery operated Avo B150 Mk2 measuring bridge has all the features that made the B150 the finest you could buy, plus greater sensitivity. And an easier to use, better designed panel.

You still get the positive error-free digital readout. Still the same compactness. Still the same high standard of Avo engineering.

But the newly increased internal sensitivity makes possible the full range of d.c. resistance measurement using only the internal 9v battery supply.

You can also measure a wide range of inductance, capacitance and resistance at a frequency of 1kHz using the internal oscillator, or at other frequencies with an external source.

You can take it that there's no better bridge around.

So why look? Contact your nearest Avo distributor for further information.

Avo Limited, Archcliffe Road,
Dover, Kent, England.

Tel: Dover (0304) 202620.

AVO

THORN

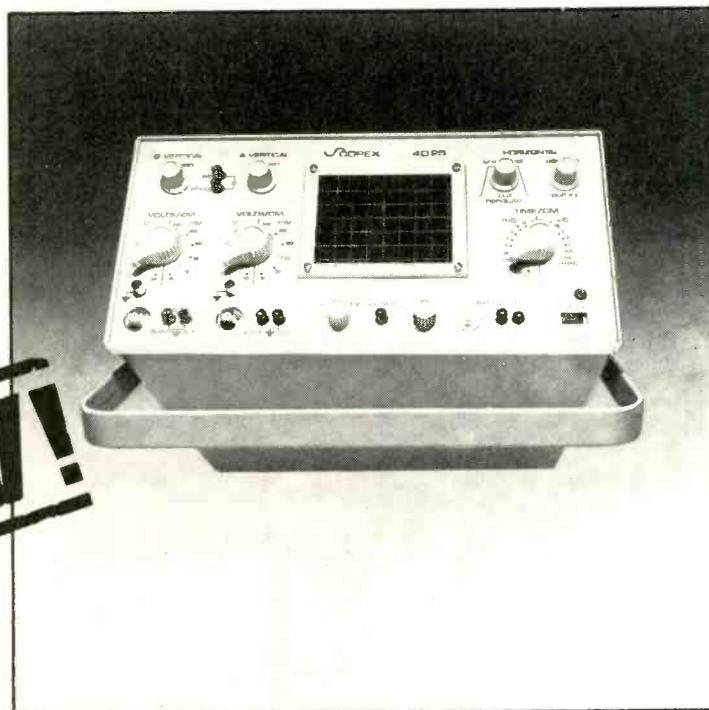
Thorn Measurement Control and Automation Division

WW—071 FOR FURTHER DETAILS

SCOPEX 4D-25

The precision scope for
the demanding engineer

3% accuracy — which just about summates this new 25MHz dual-trace instrument from Scopex. A professional scope by any standards — yet at £185 in a price bracket far below its design specification.



- * DC-25MHz, full screen
- * Measuring accuracy 3%
- * Signal delay on both channels
- * Trig level and polarity from one simple control
- * Wide timebase range 200 ns/cm to 200 ms/cm
- * Sensitivity 10mV/cm to 50 V/cm
- * High brightness PDA tube
- * Lightweight portability

Write now, or telephone:

Scopex Instruments Limited,

Pixmore Industrial Estate,
Pixmore Avenue,
Letchworth, Herts.

Tel: Letchworth 72771
(STD 04626)

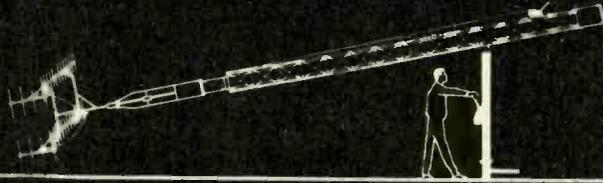
NEW!

SCOPEX

WW—072 FOR FURTHER DETAILS

DDL 4747

INSIST ON VERSATOWER



Acclaimed as the World's leading
telescopic tiltover tower in the
field of radio communication
Models from 25' to 120'



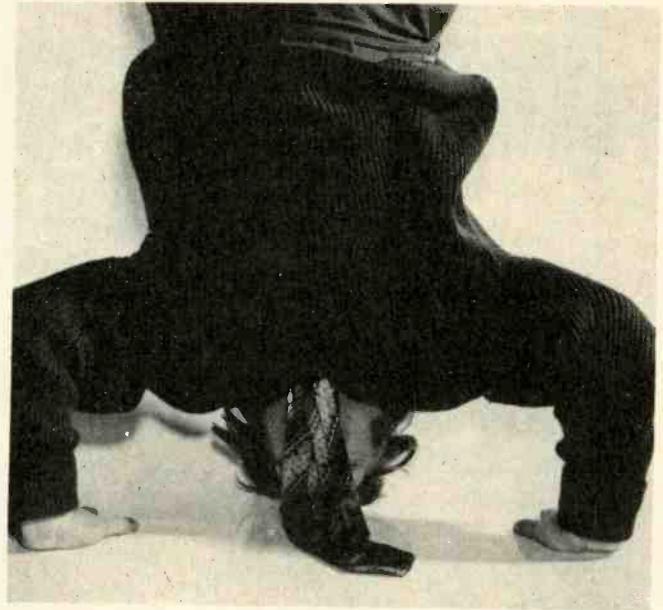
Look for the name
STRUMECH

Strumech Engineering Co Ltd
Coppice Side, Brownhills, Walsall, Staffs

OVERSEAS AGENCIES

- W. Germany** Kurt Fritzel,
6702, Bad Durkheim,
Sonnenwendstrasse 41
- Sweden** Pergus AB,
P.O. Box 755 181 07,
Lidingo 7.
- Switzerland** Megex,
8048 Zurich.
- Netherlands** Beker Telecommunication
Industrie bv,
P.O. Box 75,
Zeist.
- France** Vereduc Comminex,
2, Rue Hoseph—Riviere,
92400 Courbevoie.
- Italy** Carlo Prinz,
P.O. Box 176,
CH 6904,
Lugano.
- Denmark** Hans Holtman,
Sobakken 21,
Charlottenlund.
- Portugal** Alberto Maria Bravo & Filhos,
Praca De Londres 3, 3 D,
Lisbon 1.
- Sierra Leone** International Communication
Consultants (Sierra Leone) Ltd.,
4, Percival Street,
Freetown.
- Thailand** Vichien Pathana Ltd.,
428 / 1, Siphya Road,
Bangkok.
- South Africa** Vanrow Engineering (PTY) Ltd.,
P.O. Box 25601,
Denver TVL,
Bessemer & Wriggle Road,
Johannesburg.

WW—073 FOR FURTHER DETAILS



Texas Instruments have found a better way to find a pin outline

A brand new card index that takes the mental gymnastics out of I.C. layouts and trouble shooting.

The Texas Instruments Pin Configuration Guide will sit tidily on your desk. It contains 44 tab-indexed cards in a flip-top box. At your fingertips — over 250 devices covering series 74N and the popular 72 and 75N devices.

For the first time a set of pin configurations which show the package from the bottom as well as the top.

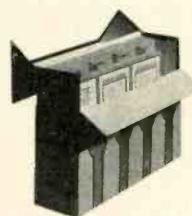
At regular intervals new cards will be produced to update and extend the system.

Texas Instruments — always looking for a better way.

TEXAS INSTRUMENTS
MS21 Manton Lane Bedford



Please send me. Pin Configuration
Guides at £1.50 each (including 30p P & P)
Total Cheque enclosed for £.



Name

Address

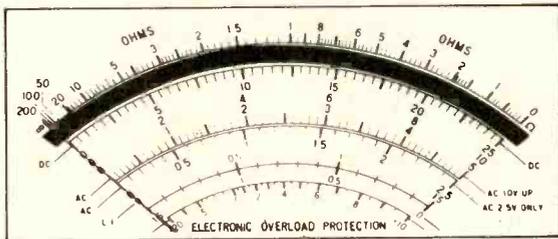
.

.

.

WW—074 FOR FURTHER DETAILS

Amps-Volts-Ohms db's-Transistor Test



In fact the meter you need for general laboratory bench or field use can be found in our range of Multimeters. All are competitively priced and include unique technical features. Deliveries are currently exstock. For full details send for our new brochure.



COSMOCORD

Cosmocord Ltd., Eleanor Cross Road, Waltham Cross, Hertfordshire.
Telephone: Waltham Cross 27331

WW-075 FOR FURTHER DETAILS

TWO NEW SOLDER SIPPERS MAKE DE- SOLDERING QUICK & EASY

Longs

Longs Ltd.
Hanworth Lane
Trading Estate
Chertsey Surrey
KT16 9LZ.



**A SUPER
PRESENT
ANYTIME!**

Maxi-Super HT 1810 and Maxi-Mini HT 1800 Solder Sippers

Designed for use when working or re-working P.C. Boards. Permits removal of molten solder from Multi-leg components, enabling easy extraction. The solder is 'sipped' through the nozzle, and automatically ejected when the instrument is next used. A Swiss precision instrument manufactured to a high degree of accuracy.

The anti-corrosive outside casing has a knurled finish for more positive grip, and encases plated internal parts.

The Maxi-Super has been designed with a 3.5 kg. spring action recoilless plunger, whilst the Maxi-Mini with its conveniently shaped operating button, has a 2.5 kg. spring action plunger, protected by a channel guard.

Both models have been designed with an easy-to-replace 'dupont' teflon screw-in nozzle.

PLEASE FORWARD
without obligation
further details.

PLEASE SUPPLY
Maxi-Super HT
1810 at £6.60

PLEASE SUPPLY
Maxi-Mini HT
1800 at £4.95

I enclose cheque value £ _____

NAME _____ POSITION _____

COMPANY _____

ADDRESS _____

SIGNED _____

Prices include VAT Reg. England 68496

WW-076 FOR FURTHER DETAILS

ENGINEERS!

WRITE FOR THE BOOK THAT CAN CHANGE YOUR WHOLE FUTURE

The B.I.E.T. guide to success should be read by every ambitious engineer. Do you want promotion, a better job, higher pay? "New Opportunities" shows you how to get them through a low-cost B.I.E.T. home study course. There are no books to buy and you can pay-as-you-learn. Send for this helpful 76 page FREE book now. No obligation and nobody will call on you. It could be the best thing you ever did.

CUT OUT THIS COUPON CHOOSE A NEW FUTURE NOW!

Tick or state subject of interest. Post to address below.

- | | | |
|--|---|--|
| <input type="checkbox"/> MECHANICAL
A.M.S.E. (Mech)
C & G Eng. Crafts.
C & G Fabrication
Diesel Eng.
Inst. Eng. & Tech.
Inst. Motor Ind.
Maintenance Eng.
Mechanical Eng.
Sheet Metal Work
Welding | <input type="checkbox"/> Work Study
Works
Management | <input type="checkbox"/> CONSTRUCTION
A.M.S.E. (Civil)
Architecture
Building
Carpentry & Joinery
Civil & Municipal Eng.
Constructional Eng.
Construction
Surveyors Institute
Council Eng.
Health Eng.
Hydraulics
Inst. of Builders
Inst. Clerk of Works
Inst. Works &
Highway Supers. |
| <input type="checkbox"/> ELECTRICAL &
ELECTRONIC
A.M.S.E. (Elec.)
C & G Elec. Eng.
C & G Elec. Inst.
C & G Elec. Tech.
Computer Elec.
Electronic Eng.
Electrical Eng.
Install. & Wiring | <input type="checkbox"/> DRAUGHTSMAN-
SHIP
A.M.I.E.D.
Electrical
Draftsmanship
Gen.
Draftsmanship
Jig & Tool Design
Technical Drawing | <input type="checkbox"/> PAINTING &
Decorating
Structural Eng.
Surveying |
| <input type="checkbox"/> MANAGEMENT &
PRODUCTION
Computer Prog.
Electronic Data
Processing
Estimating
Foremanship
Inst. Cost & Man.
Accountants
Inst. Marketing
Management
Motor Trade Man.
Network Planning
Personnel Man.
Production Eng.
Quality Control
Salesmanship
Storekeeping | <input type="checkbox"/> RADIO & TELE-
COMMUNICATIONS
C & G Radio/TV/
Electronics-
C & G Telecomm.
Technicians
Prac. Radio & Elec.
(with kit)
Radio Amateurs
Exam.
Radio Servicing &
Repairs
Transistor Course
TV Main & Serv. | <input type="checkbox"/> GENERAL
Agricultural Eng.
Council of Eng. Inst.
General Education
Pract. Slide Rule
Pure & Applied
Maths.
Refrigeration
Rubber Technology
Sales Engineers
University Ent. |

Coaching for many major exams, including C & G

**SEND FOR
YOUR FREE
BOOK NOW!
BRITISH INSTITUTE
OF ENGINEERING
TECHNOLOGY**



DEPT. BWW14 ALDERMASTON COURT, READING RG7 4PF

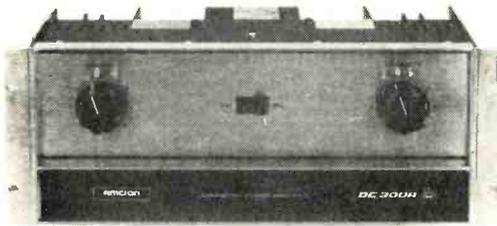
QL BWW14



NAME _____
BLOCK CAPITALS PLEASE
ADDRESS _____

OTHER SUBJECTS _____ AGE _____
Accredited by the Council for the Accreditation of Correspondence Colleges.

HIGH POWER DC-COUPLED AMPLIFIER



- ★ UP TO 500 WATTS RMS FROM ONE CHANNEL
- ★ DC-COUPLED THROUGHOUT
- ★ OPERATES INTO LOADS AS LOW AS 1 OHM
- ★ FULLY PROTECTED AGAINST SHORT CCT, MISMATCH, ETC.
- ★ 3 YEAR WARRANTY ON PARTS AND LABOUR

The DC300A Power Amplifier is the successor to the world famous DC300 which is so widely used in Industrial, and Research applications in this country. It is DC-coupled throughout so providing a power bandwidth from DC to over 20,000Hz. The ability of the DC300A to operate without fuss into totally reactive loads while delivering its full power, and maintaining its faithful reproduction of Pulse or complex waveforms has established the DC300A as the world's leading power amplifier. Each of the two channels will operate into loads as low as 1 ohm, and the amplifier can be rapidly connected as a single ended amplifier providing over 650 watts RMS into a 4 ohms load, and still providing a bandwidth down to DC. Below is a brief specification of the DC300A, but if you require a data sheet, or a demonstration of this fine equipment please let us know.

Power Bandwidth
Power at clip point (1 chan)
Phase Response
Harmonic Distortion
Intermod. Distortion
Damping Factor
Hum & Noise (20-20kHz)
Other models in the range: D 60 — 60 watts per channel

DC-20kHz @ 150 watts +1db. —0d.
500 watts rms into 2.5 ohms
+0, —15° DC to 20kHz, 1 watt 8Ω
Below 0.05% DC to 20kHz
Below 0.05% 0.01 watt to 150 watts
Greater than 200 DC to 1kHz at 8Ω
At least 110db below 150 watts

Slewing Rate
Load impedance
Input sensitivity
Input Impedance
Protection
Power supply
Dimensions
D 150 — 150 watts per channel

8 volts per microsecond
1 ohm to infinity
1.75 V for 150 watts into 8Ω
10K ohms to 100K ohms
Short. mismatch & open cct. protection
120-256V, 50-400Hz
19" Rackmount, 7" High, 9½" Deep



MACINNES LABORATORIES LTD

MACINNES HOUSE, CARLTON PARK INDUSTRIAL ESTATE,
SAXMUNDHAM, SUFFOLK IP17 2NL
TEL: (0728) 2262 2615

WW—077 FOR FURTHER DETAILS



sanwa MULTI TESTERS

USED THROUGHOUT THE WORLD, SANWA'S EXPERIENCE OF 30 YEARS ENSURES ACCURACY, RELIABILITY, VERSATILITY, UNSURPASSED TESTER PERFORMANCE COMES WITH EVERY SANWA

8 Months' Guarantee	Excellent Repair Service		
MODEL P2B	£9.76	MODEL AT45	£21.52
MODEL JP5D	£11.58	MODEL 380CE	£29.12
MODEL 360YTR	£15.28	MODEL N101	£31.81
MODEL U50DX	£15.80	MODEL 460ED	£35.89
MODEL A303TRD	£17.25	MODEL EM800	£31.05
MODEL K30 THD	£24.01	MODEL R1000CB	£75.27
MODEL F80TRD	£25.28	THESE PRICES ARE SUBJECT TO AN	

ADDITIONAL CHARGE OF 10% FOR V.A.T.

Cases extra, available for most meters, but not sold separately.

MODEL
U-50DX

Please write for illustrated leaflet of these and other specialised Sanwa meters

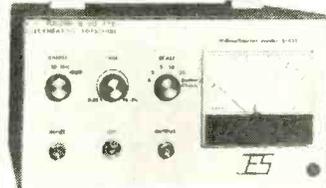
SOLE IMPORTERS IN U.K.

QUALITY ELECTRONICS LTD.

47-49 HIGH STREET, KINGSTON-UPON-THAMES, SURREY. KT1 1LP
Tel: 01-546 4585

WW—078 FOR FURTHER DETAILS

J E S AUDIO INSTRUMENTATION



Illustrated the Si 451 Millivoltmeter — pk-pk or RMS calibration with variable control for relative measurements. 40 calibrated ranges **£40.00**

Si 452 **£35.00**
Distortion Measuring Unit.
15 Hz — 20 KHz — .01%

Si 453 **£45.00**
Low distortion Oscillator.
Sine — Square — RIAA

J. E. SUGDEN & CO., LTD. Tel. Cleckheaton (09762) 2501
CARR STREET, CLECKHEATON, BD19 5LA

WW—079 FOR FURTHER DETAILS



MODEL 8 MK. V

CONTRACTORS TO H.M. GOVT. P.O. APPROVED

REPAIRS

7-14 DAYS SERVICE

TO SOLVE YOUR INSTRUMENT PROBLEMS
CONTACT

LEDON INSTRUMENTS LTD.

76-78 DEPTFORD HIGH STREET, LONDON, SE8. TEL: 01-692 2689
GLADSTONE WORKS, GLADSTONE ROAD, FOLKESTONE, KENT. TEL: (STD) 0303 57555

**OF ELECTRICAL
MEASURING
INSTRUMENTS**
Industrial and Precision Grade

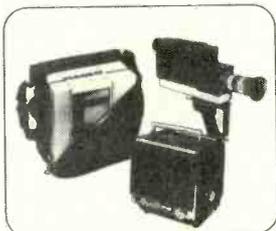


STOCKISTS
ALSO SUPPLIERS OF GEC
RISSO AND OTHER
MULTI-RANGE TEST SETS

WW—080 FOR FURTHER DETAILS

What the eye can't see, you can.

EMI-Sony Low-Light Television has all the advantages of conventional cctv systems. It is, however, up to 500 times more sensitive, making it ideal for low-light applications. Compact, lightweight, designed for hand-held or fixed operation. Full details or demonstration on request.



EMI MTV1
LOW-LIGHT TELEVISION

EMI ELECTRONICS LTD., Feltham Laboratories, Victoria Road, Feltham, Middlesex. Telephone: 01-890 3600 Ext. 307

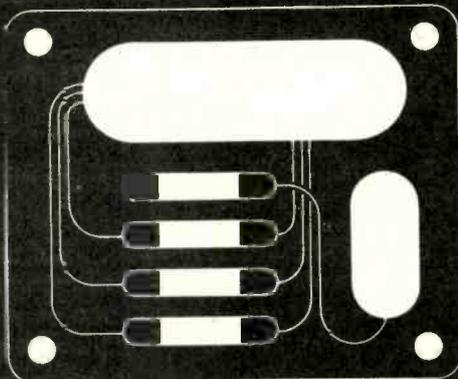
WW—081 FOR FURTHER DETAILS

Whether your needs run to one hundred high stability TCXOs, or one thousand monolithic crystal filters, or you just want ten thousand crystals in a hurry at the right price, Hy-Q Electronics are as close as your telex or telephone.

We've built a reputation for being up front. When quality, price and delivery are being considered, you don't have to accept eight week delays when you've thousands of dollars worth of equipment just waiting for crystals. Call Hy-Q for faster delivery!

You name it. We've got it!

and lots and lots of others, too.



P.O. Box 256
Franks-on
Victoria, 3199
Australia
Phone: 783 9611
Telex: 31630
Cables: HYQUE
Melbourne

P.O. Box 29,
Pasir Panjang
Singapore, 5
Phone 636477
Cables: HYQUESING
Telex: RS21427

Hy-Q

Electronics

WW—082 FOR FURTHER DETAILS

Infrared FILTERS

OCLI manufacture an extensive range of Infrared Filters covering the entire 1.0 to 30 micron spectral region.

Filters in these regions present an excellent solution to filtering out high-temperature radiation without appreciably limiting the signal from the source being observed. Moreover, they have proven capability over wide operating temperatures.

OCLI I. R. Filters are made to exact Customer specifications or a range can be supplied from stock.

Typical fields benefitting from OCLI I.R. Filters include:

- GAS ANALYSERS/DETECTION SYSTEMS
- INFRARED PASSIVE THERMAL IMAGING SYSTEMS
- FIRE DETECTION
- POLLUTION DETECTION
- OPTICAL PROXIMITY FUSES
- INFRARED SPECTROSCOPY
- INFRARED PHOTOGRAPHY
- SPACE RECONNAISSANCE

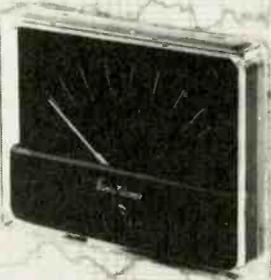
Write for the new OCLI catalogue and price list of stock I.R. Filters.

OCLI OPTICAL COATINGS LTD.
Hillerc Industrial Estate,
Dunfermline, Fife KY11 5JE.
Tel. Inverkeithing 3631
(STD C38-34 3631).

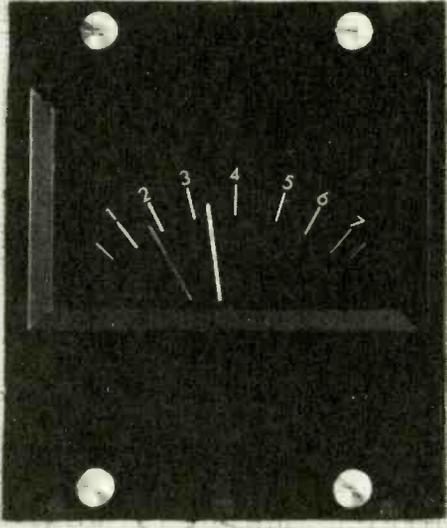
OC-19D

WW—083 FOR FURTHER DETAILS

AUDIO
LEVELS -----
PPMs
SINGLE



OR
TWINS



to all BBC
Specifications

Jernest Turner
ELECTRICAL INSTRUMENTS LTD
 CHILTERN WORKS
HIGH WYCOMBE
 BUCKS

HIGH WYCOMBE 30931/4

WW—084 FOR FURTHER DETAILS

ENGINEERS
FREE
YOURSELF FOR A
BETTER JOB WITH MORE PAY!



Do you want promotion, a better job, higher pay? "New Opportunities" shows you how to get them through a low-cost B.I.E.T. home study course. There are no books to buy and you can pay-as-you-learn.

The B.I.E.T. guide to success should be read by every ambitious engineer. Send for this helpful 76 page FREE book now. No obligation and nobody will call on you. It could be the best thing you ever did.

CUT OUT THIS COUPON
CHOOSE A BRAND NEW FUTURE HERE!
 Tick or state subject of interest. Post to the address below.

POST NOW

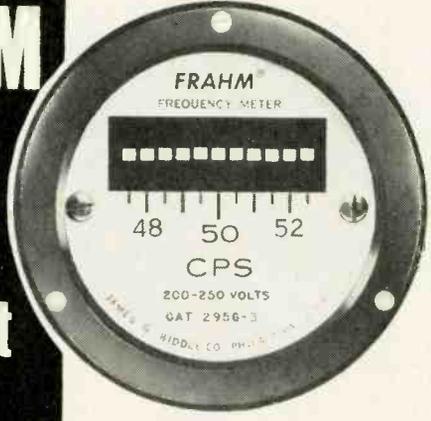
<input type="checkbox"/> BIET—Technatron Electrical	<input type="checkbox"/> C. & G. L.I. Radio	<input type="checkbox"/> TV Servicing Cert.
<input type="checkbox"/> Practical Radio & Electronics (Technatron)	<input type="checkbox"/> Post Master General	<input type="checkbox"/> 1st & 2nd class Certs.
<input type="checkbox"/> Electronic Engineering	<input type="checkbox"/> C. & G. Electrical	<input type="checkbox"/> Engineering Practise
<input type="checkbox"/> Television Maintenance & Servicing	<input type="checkbox"/> C. & G. L.I. Installations	<input type="checkbox"/> and Wiring
<input type="checkbox"/> General Radio & TV Engineering	<input type="checkbox"/> Radio Servicing, Maintenance and Repairs	<input type="checkbox"/> General Electrical Engineering
<input type="checkbox"/> City & Guilds Radio, TV Electronics Mechanics	<input type="checkbox"/> Society of Engineers	<input type="checkbox"/> (Electrical Eng.)
<input type="checkbox"/> Radio Amateurs	<input type="checkbox"/> Electrical Installations and Wiring	<input type="checkbox"/> C. & G. Electrical
<input type="checkbox"/> Practical TV	<input type="checkbox"/> C. & G. Electrical Technicians (Primary)	<input type="checkbox"/> C. & G. Telecommunications
<input type="checkbox"/> Colour Television	<input type="checkbox"/> Computer Electronics	

To B.I.E.T. BWW O1 Aldermaston Court, Reading RG7 4PF QK **BWWO1**

NAME (Block Capitals Please) _____
 ADDRESS _____
 Other subjects _____ Age _____
Accredited by the Council for the Accreditation of Correspondence Colleges.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

FRAHM



resonant reed FREQUENCY METERS

used as standards in many industries

- Accurate to $\pm 0.3\%$ or $\pm 0.1\%$ as specified
- Not sensitive to voltage or temperature changes, within wide limits
- Unaffected by waveform errors, load, power factor or phase shift
- Operational on A.C., pulsating or interrupted D.C., and super-imposed circuits
- Need only low input power
- Compact and self-contained
- Rugged and dependable

FRAHM Resonant Reed Frequency Meters are available in plastic and hermetically sealed cases to British and U.S. Government approved specification. Ranges 10-1700 Hz. Literature on these meters and Frahm Resonant Reed Tachometers available on request. Manufacture and Distribution of Electrical Measuring Instruments and Electronic Equipment. The largest stocks in the U.K. for off-the-shelf delivery.

ANDERS ELECTRONICS LIMITED
 48/56 Bayham Place, Bayham Street,
 London NW1. Tel: 01-387 9092

Anders means meters
 WW—085 FOR FURTHER DETAILS

NEW PRODUCT 240/115 VOLT CASED AUTO TRANSFORMERS

Smart Plastic coated steel cases with 3 core Power Lead, Fused, 115 Volt American outlet socket up to 500 Watts. Over 500 Watts, cable entry.
200 Watt £4.50 plus 38p Post.
500 Watt £8.26 plus 67p Post.
1000 Watt £12.50 plus 82p Post.
2000 Watt £23.50 plus £1.50 Post.
20 Watt version uncoated £2.02. (No fuse).



CASED AUTO TRANSFORMERS

240 Volt Mains to 115 Volts, smart steel cased units coated in tough resin, fitted with power lead, fuse and 115 Volt American type socket up to 500VA, above 500VA cable entry.
V.A. (Watts) POST PRICE
200 " £5.20 38p
500 " £9.50 67p
1000 " £14.70 82p
2000 " £27.40 £1.50
20VA version uncoated, no fuse— £2.40 30p

POWER UNIT Type P1076

Output switched 3, 4.5, 6, 7.5, 9 and 12 Volts at 500 mA D.C. Operates from 240 V mains, suitable for Radios, Tape Recorders, Record Players etc. Size 7.5x5.0x14.0 cm Price £3.95. Post 25p



BRIDGE RECTIFIERS

	
ONE AMP	TWO AMP
50 Volts 25p	50 Volts 35p
100 Volts 25p	100 Volts 40p
200 Volts 28p	200 Volts 45p
600 Volts 30p	400 Volts 50p
FOUR AMP	SIX AMP
100 Volts 55p	50 Volts 65p
200 Volts 59p	100 Volts 70p
400 Volts 65p	200 Volts 80p
600 Volts 75p	400 Volts 90p

A.S.P. LTD. BYRE HOUSE, No. 2 UNIT,

SIMMONDS ROAD, WINCHEAP, CANTERBURY, KENT TEL CANTERBURY (0227) 52436

ELECTRONIC MAINS TIMER

A reliable unit ideal for timing Bathroom / Toilet Ventilators, Stairway / Cloakroom Lighting etc Sockets up to 30 mins. delay before switching off. Delay: 1-30 mins. adjustable. Max Load: 400 VA or 1000 Watts resistive. Ivory Case: 3 1/2 in. x 3 1/2 in. x 2 in. Fittings Instructions included. Trade Price: £5.80. Post 20p.



POWER UNIT Type P6200

Supplying 6 or 9 Volt DC at 200 mA In moulded case forming a 2 pin 5 A mains plug. 2 metre output lead with 4-way multiplug giving 2.1 and 2.5 mm sockets and 3.5 mm plugs. Price £2.25. Post 10p.



MAINS KEYNECTOR

The safe, quick, connector for electrical appliances, 13 Amp rating, fused will connect a number of appliances quickly and safely to the mains. Ideal for testing, demonstrating, window displays, etc., Warning Light, interlocked to prevent connecting when live. Trade Price: £2.95. Post 25p.



TRANSFORMERS

SAFETY ISOLATING

Prim. 120/240V. Sec. 120/240V. Centre Tap with screen. V.A. REF. PRICE P. & P.

(WATTS)	No.	Cased	Open	P
60	149	—	3.40	38
100	150	—	3.80	30
200	151	9.20	6.80	52
250	152	11.18	8.70	65
350	153	13.00	10.40	80
500	154	14.63	12.00	£1 00
1000	156	28.22	24.97	£1 20
2000	158	55.90	50.40	—
3000	159	73.00	65.90	—

CASED VERSION in plastic coated steel case with Powerlead. Please state 115V or 240V output British or American outlet sockets up to 500VA. Over 500VA Cable Entry.



MINIATURE & EQUIPMENT

Primary 240V with Screen

VOLTS	MILLIAMPS	TYPE	PRICE	P. & P.
Sec. 1	Sec. 2	Sec. 1	Sec. 2	No.
3-0-3	—	200	238	1.12 10
0-6	0-6	500	500	234 1.30 10
0-6	0-6	1000	1000	212 1.53 22
9-0-9	—	100	—	13 1.12 10
0-9	0-9	330	330	235 1.30 22
0-8-9	0-8-9	500	500	207 2.04 30
0-8-9	0-8-9	1000	1000	208 2.78 10
15-0-15	—	40	—	240 1.12 10
0-15	0-15	200	200	236 1.30 10
20-0-20	—	30	—	241 1.12 10
0-20	0-20	150	150	237 1.30 10
0-15-20	0-15-20	500	500	205 2.70 38
0-20	0-20	300	300	214 1.60 22
0-20	—	3500	—	1116 3.00 40
20-12-0	—	700	—	—
12-20	—	(D.C.)	—	221 1.41 30
0-15-20	0-15-20	1000	1000	206 3.80 38
0-15-27	0-15-27	500	500	203 2.88 38
0-15-27	0-15-27	1000	1000	204 2.95 38

12 and 24 VOLT PRIMARY 200-240 Volts.

VOLTS	AMPS	TYPE	PRICE	P. & P.
12V	24V	No.	£	p
0.30	0.15	242	1.22	22
0.5	0.25	111	1.22	22
1	0.5	213	1.45	22
2	1	71	1.90	38
4	2	18	2.50	52
6	3	70	3.24	42
8	4	108	3.60	52
10	5	72	4.25	52
12	6	116	5.16	52
16	8	17	6.94	52
20	10	115	9.30	89
30	15	187	12.50	97
40	20	232	16.60	£1.00
60	30	226	20.50	£1.10

PLEASE ADD 10% FOR V.A.T.

30 VOLTS

AMPS	TYPE	PRICE	P. & P.
0.5	112	1.44	22
1	79	2.00	38
2	3	2.90	42
3	20	3.60	48
4	21	4.25	52
5	51	5.28	52
6	117	6.30	52
8	88	8.18	67
10	89	10.00	67

50 VOLTS

AMPS	TYPE	PRICE	P. & P.
0.5	102	1.92	30
1	103	2.80	38
2	104	3.90	42
3	105	5.25	52
4	106	6.80	52
6	107	10.00	67
8	118	12.90	97
10	119	16.00	97

60 VOLTS

AMPS	TYPE	PRICE	P. & P.
0.5	124	1.92	38
1	126	2.70	38
2	127	4.25	42
3	125	6.50	52
4	123	8.50	67
5	40	10.50	67
6	120	12.34	82
8	121	14.56	£1.00
10	122	17.65	£1.00
12	189	19.66	£1.10

WW—086 FOR FURTHER DETAILS

small size BIG performance

The New FP-71U TV Camera from Shibaden

Shibaden's new FP-71U TV Camera brings high quality results within the reach of every CCTV user. It is extremely compact—measuring less than 4" x 5" x 12" — yet the 2/3" separate mesh vidicon ensures pictures of exceptionally high resolution, (500 TV lines at centre). The lightweight body makes it superbly mobile, total weight is only 3.3 Kg, and the detachable 3" electronic viewfinder allows for extreme ease of focusing and composition, so it is the ideal camera for use both in the studio and on location.

The FP-71U features white clip circuitry to eliminate the saturation noise that occurs during recording and playback with a video tape recorder. Provision is made for external synchronisation where more than two cameras are used.

The FP-71U is equipped with an automatic light sensitivity control which takes over to control the light sensitivity in the range from 35 to 100,000 lux. (3.5 to 10,000 fc). This, together with the special C mount which gives free selection of lenses — wide angle telephoto and zoom help to ensure perfect results every time the FP-71U is in action.

If you would like to see a live demonstration or prefer to receive our technical data sheet, please contact Shibaden's Technical Service Department at 01-203 4242 or write to:

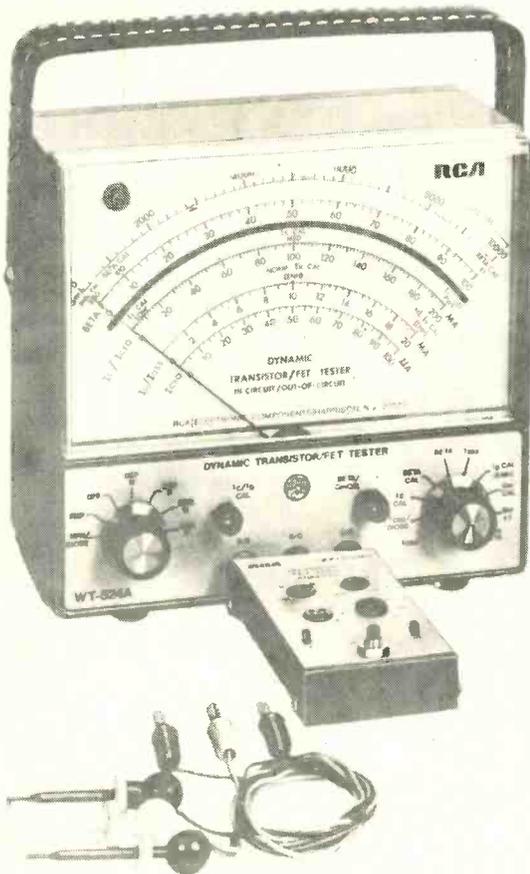


HITACHI SHIBADEN
(U.K.) LIMITED

BROADCAST & CCTV EQUIPMENT MANUFACTURERS
Lodge House · Lodge Road · Hendon · London
NW4 4DQ. Telephone: 01-203 4242/6

WW—087 FOR FURTHER DETAILS

New 'one for all' Transistor/FET Tester for only £86*



RCA introduces the WT-524A, a new "one for all" tester for solid-state devices. With it, you can measure AC^{*}beta—up to 5,000—of any bipolar transistor, and G_m—up to 100,000 μmhos—of any field-effect transistor (FET). And you'll do it with an accuracy of ±3%! It also checks diodes, SCRs and triacs—and can do the job in-circuit or out.

The large, easy-to-read 6½" mirrored scale meter of the new WT-524A features special scales for I_C, I_{CBO}, I_{DSS}, I_{CEO}, and I_D currents. Each tester also includes two universal socket adapters and three colour-coded test leads.

Try the new WT-524A for yourself. You'll appreciate its quality, accuracy and ruggedness. To buy: order from any Authorised RCA Distributor or from:

*Excluding V.A.T.

RCA
Limited
Electronic
Components

Sunbury-on-Thames
Middlesex
Phone: Sunbury-on-Thames 85511

WW—088 FOR FURTHER DETAILS

Just released in complete electronic kit form... THE FORGESTONE 400 a high quality colour television receiver.

A really up-to-the-minute kit with all these plus features

- | | |
|--|--------------------------------------|
| 9 integrated circuits | Thick film resistor units |
| Ready-built and aligned IF module | Glass epoxy printed circuit panels |
| High quality components | Fully isolated power supply |
| Plugs and sockets for easy panel removal | Each module kit available separately |
| Full technical construction manual | LT supply regulators |

*less cabinet which can be manufactured yourself from normal DIY sources.

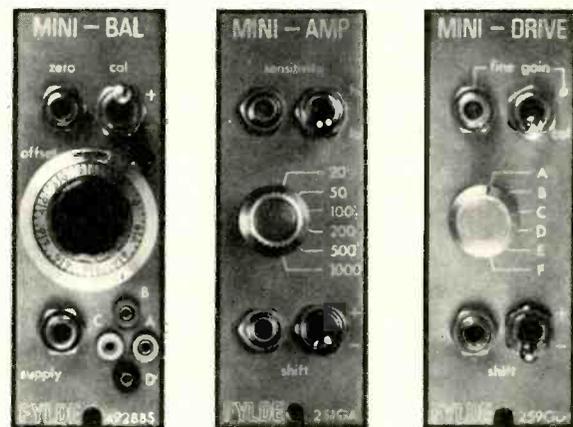
Send for further details of the Forgestone 400... the quality kit for the constructor of today.

Forgestone Components

Ketteringham, Wymondham, Norfolk
Telephone: Norwich 810453 (STD 0603)

WW—089 FOR FURTHER DETAILS

Transducer and Recorder amplifiers and systems



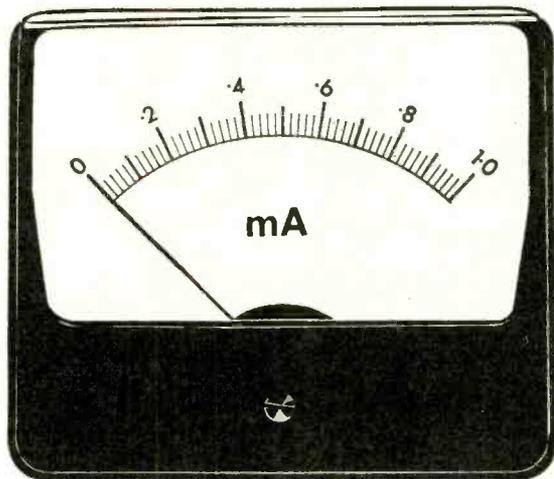
reliable high performance & practical controls individually powered modules—mains or dc option single cases and up to 17 modules in standard 19" crates small size—low weight—realistic prices.

FYLDE

Fylde Electronic Laboratories Limited
6/16 Oakham Court, Preston PR1 3XP
Telephone: PRESTON 57560

WW—090 FOR FURTHER DETAILS

METER PROBLEMS?



A very wide range of modern design instruments is available for 10/14 days' delivery.

Full Information from:

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

WW—091 FOR FURTHER DETAILS

ROGERS

AUDIO TEST EQUIPMENT

A comprehensive, versatile range of test equipment primarily designed for the measurement of high quality audio equipment, but with additional applications in the electronics industry in general. The equipment is of particular interest to the professional audio engineer, recording studios, broadcasting authorities and educational establishments.



DM344A Distortion Factor Meter. Designed to make accurate and rapid measurements of total harmonic distortion generated within high quality audio amplifiers, recording and transmission equipment. **Selling Price: Chassis — £132.50.c/w. Case — £140.00 + VAT.**

S324 Low Distortion Oscillator. Generates a pure sine wave and has been designed as a general purpose low distortion signal source. The primary application, used in conjunction with the DM344A, is the measurement of total harmonic distortion. **Selling Price: Chassis — £56.50.c/w. Case — £62.50 + VAT.**

AM324 AF Millivoltmeter. Designed for voltage measurements in the audio and low RF ranges and, principally for measuring low level signals in high impedance circuits. **Selling Price: Chassis — £64.00.c/w. Case — £70.00 + VAT.**



Model 'A' Noise Generator. A portable battery operated unit designed for carrying out listening tests on loudspeakers. 'Pink' or 'White' noise can be selected and output can be continuous or burst. Output is continuously variable. **Selling Price: £32.50 + VAT.**

Full Colour Literature describing the complete range may be had on request.

ROGERS DEVELOPMENTS (Electronics) LIMITED
4/14 Barmeston Road, London SE6 3BN, England
Telephone: 01-698 7424/4340

WW—092 FOR FURTHER DETAILS

1" and 1/2" Video Tape from Dixons Technical. At very non-technical prices.

Our 1/2" Tape range.	Recommended Price (Exc. VAT)	Dixons Price
SCOTCH 1/2" 2400 ft	£10.40	£8.50
SCOTCH 1/2" 3000 ft	£16.82	£13.50
BASF 1/2" 2400 ft	£10.75	£8.50
SHIBADEN 1/2" 2400 ft	£10.80	£9.10
DIXTEC CCTV 1/2" 2400 ft		£5.50

Now 1" tape at less than half price!

	Average recommended price (Exc. VAT)	Dixons price
1075 ft on 8" x 1" NAB Metal Spool	£15.00	£7.00
1500 ft on 8" x 1" NAB Metal Spool	£19.50	£7.50
2150 ft on 8" x 1" NAB Metal Spool	£20.75	£9.50
3000 ft on 9 3/4" x 1" NAB Metal Spool	£26.50	£9.50

All Dixtec Video Tapes are of the highest quality; we supply 1/2" in air-tight containers, also 1" on metal spools. Current stocks are high, but so is demand. We recommend you place your order quickly.

Please send me reels of Tape.

Size Length Dixons Price

TOTAL PRICE:

I enclose a cheque made payable to Dixons Technical Limited.

NAME

ADDRESS

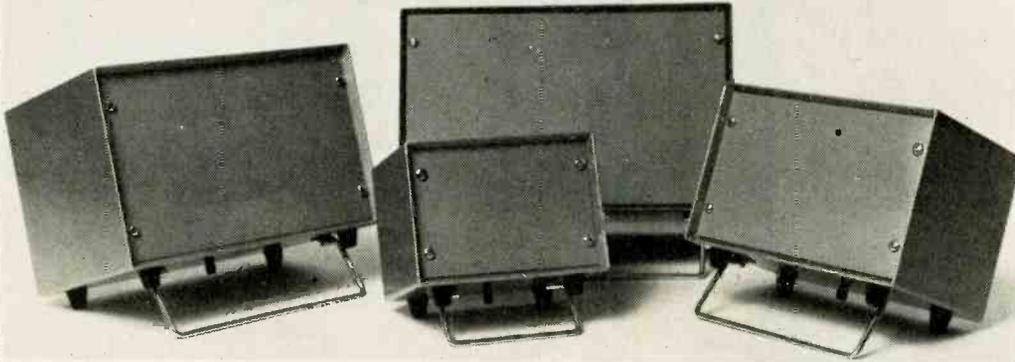
Dixons
Technical Ltd
OF SOHO SQUARE

WW/VT/3

WW—093 FOR FURTHER DETAILS

NEW STANDARD CASES from OLSON

NEW SERVICE FROM STOCK — DESPATCHED BY RETURN OF POST



Cases made from 20swg. zinc coated m/s. Front & rear panels 16swg. aluminium. Cases finished in Olive green hamertone with front panels in light straw shade 384. All cases fitted with ventilated rear panels and a very attractive chrome plated retractable leg can be fitted as an optional extra.

TYPE	WIDTH	HEIGHT	DEPTH	FRONT PAN DIM.	PRICE	LEG EXTRA
21	6½"	4½"	4½"	6" x 4"	£2.95	70p
22	8½"	5½"	5½"	8" x 5"	£3.30	70p
23	10½"	6½"	6½"	10" x 6"	£3.95	75p
24	12½"	7½"	7½"	12" x 7"	£4.30	75p

Our Trade Counter is open for personal callers from 9 a.m. to 5.30 p.m. Monday-Friday

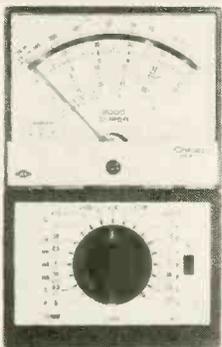
OLSON ELECTRONICS LTD., FACTORY NO. 8, 5-7 LONG ST., LONDON E2 8HJ.

POSTAGE EXTRA + 10% V.A.T.

TEL: 01-739 2343

WW—051 FOR FURTHER DETAILS

THE FRUITS OF CHINAGLIA EXPERIENCE



The SUPER 2000 HIGH IMPEDANCE MULTIMETER

Suited to field, workshop and laboratory use, the SUPER 2000 is a high sensitivity portable multimeter with a Grade 1 movement, clear and simple to read mirror scale and tough simple-to-use case. It features:

- HIGH SENSITIVITY 50k(Ω)/V d.c. 10k(Ω)/a.c.
- WIDE RANGES 0.15V up to 1.5kV d.c., 2.5V up to 1.5kV a.c., 20μA up to 5.0A d.c., 250μA to 2.5A a.c. Resistance up to 100M(Ω). Power 20dB up to 169dB.
- ACCURACY ± 2.5% a.c. and d.c.

Complete with case, leads and instructions.

£22.40

including VAT



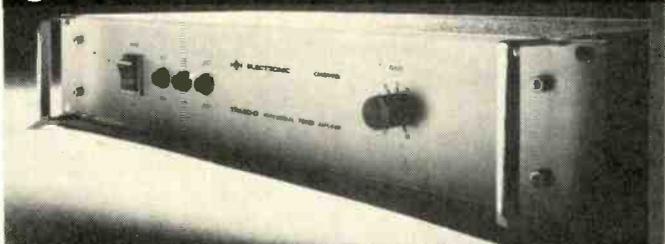
CHINAGLIA (U.K.) Ltd.

19 MULBERRY WALK, LONDON SW3 6DZ.
Tel: 01-352 1897

WW—095 FOR FURTHER DETAILS

TPA SERIES-D

integrated circuit power amplifier



TPA 50 - D Specification

- Power Output** 100 watts rms into 4 ohms
65 watts rms into 15 ohms
- Freq Response** ± 0.1 dB 20Hz to 20KHz into 15 ohms. -1dB at 150KHz
- Total harmonic distortion** Less than 0.04% at all levels up to 50 watts rms into 15 ohms
- Input sensitivity** 0cBm
- Noise** -100dB
- Rise time** 2 μ seconds
- Price** £59 plus V.A.T.

100V Line (C.T.) and balanced inputs available.

For full technical information contact:

H/E ELECTRONIC

CAMBRIDGE ROAD, MILTON, CAMBS
TELEPHONE CAMBRIDGE 65945/6/7

WW—096 FOR FURTHER DETAILS

DAVENPORT

New

FULLRANGE LINE SOURCE PUBLIC ADDRESS SPEAKERS



LAYOUT OF
SPEAKER UNITS

Twelve 8" x 5" elliptical
and one 12" twin cone

CABINET HEIGHT 66"



LAYOUT OF
SPEAKER UNITS

Eight 8" x 5" elliptical
and one 10" twin cone

CABINET HEIGHT 48"

A BROCHURE GIVING FULL SPECIFICATION, INCLUDING SPECIFIC SOUND PRESSURE LEVELS, FREQUENCY RESPONSE GRAPHS AND POLAR DIAGRAMS. AVAILABLE FROM THE MANUFACTURERS.

S. B. DAVENPORT LTD.
ELLES RD., FARNBOROUGH, HAMPSHIRE, ENGLAND
TELEPHONE FARNBOROUGH (HANTS) 514551

WW—097 FOR FURTHER DETAILS

PARKER SHEET METAL FOLDING MACHINES



Forms channels and angles down to 45 degrees which can be flattened to give safe edge. Depth of fold according to height of bench.

One year's guarantee. Money back if not satisfied.

Send for details:

A. B. PARKER

FOLDING MACHINE WORKS,
UPPER GEORGE STREET,
HECKMONDWIKE, YORKS.
Telephone 40 3997

BENCH MODEL

36" x 18 gauge capacity ... £40.00 carr. free

24" x 16 gauge capacity ... £38.00 carr. free

Also the well-known vice model of

36" x 18 gauge capacity ... £21.00 carr. free

24" x 18 gauge capacity ... £15.00 carr. free

18" x 16 gauge capacity ... £15.00 carr. free

Add 10% VAT to total price of machine

WW—098 FOR FURTHER DETAILS

**QUARTZ
CRYSTALS
- FAST!**



AEL GATWICK HOUSE, HORLEY, SURREY, ENGLAND
Tel: Horley (02934) 5353

Telex: 87116 (Aerocon Horley) · Cables: Aerocon Telex Horley

WW—099 FOR FURTHER DETAILS



Lyons pulse generators

Dual Channel 5MHz 10ns & 20MHz 5ns, 10V outputs, graduated verniers.

Single/double pulsers PRF to 50MHz, risetimes from 2ns, outputs to 50V.

the pulse source...



LYONS INSTRUMENTS

Lyons Instruments Limited
Hoddesdon, Herts. EN11 9DX Tel: 67161
A Claude Lyons Company

WW—100 FOR FURTHER DETAILS

TRANSISTORS				Type	Price	Type	Price	DIODES	
Type	Price	Type	Price	BF185	0-26	OC170	0-25	Type	Price
AC107	0-35	BC159	0-15	BF194	0-15	OC171	0-30	AA119	0-09
AC117	0-24	BC167	0-15	BF196	0-15	R2008B	2-05	AA129	0-20
AC126	0-25	BC168	0-13	BF197	0-17	R2010B	2-10	AAZ13	0-30
AC127	0-25	BC169	0-13	BF198	0-20	2N706	0-12	BA100	0-15
AC128	0-25	BC170	0-15	BF200	0-35	2N706 A	0-15	BA102	0-25
AC154	0-20	BC171	0-15	BF222	1-08	2N916	0-20	BA1104	0-30
AC176	0-25	BC172	0-14	BF241	0-20	2N918	0-42	BA115	0-12
AC187	0-25	BC176	0-16	BF256	0-45	2N1305	0-21	BA145	0-17
AC193K	0-30	BC177	0-20	BF257	0-49	2N2646	0-53	BA148	0-17
AC194K	0-32	BC178	0-20	BF258	0-66	2N2904	0-22	BA154	0-13
AD140	0-50	BC179	0-20	BF259	0-93	2N2904A	0-26	BA155	0-16
AD142	0-52	BC186	0-25	BF263	0-70	2N2905	0-23	BA156	0-15
AD149	0-50	BC187	0-25	BF337	0-35	2N2926G	0-13	BA157	0-25
AD161	0-38	BC261	0-28	BFT43	0-55	2N2926Y	0-12	BAX13	0-06
AD162	0-38	BC262	0-26	BFX29	0-30	2N3053	0-29	BB105B	0-45
AF114	0-25	BC263	0-25	BFX30	0-35	2N3054	0-55	BB105G	0-35
AF115	0-25	BC300	0-58	BFX84	0-25	2N3055	0-60	BR100	0-50
AF116	0-25	BC303	0-60	BFX85	0-26	2N3706	0-10	BY100	0-15
AF117	0-20	BC308	0-62	BFX88	0-24	2N3904	0-16	BY126	0-16
AF118	0-50	BC309	0-15	BFX98	0-26	2N3905	0-18	BY127	0-17
AF139	0-35	BC360	0-95	BFX99	0-25	2N3906	0-15	BY133	0-23
AF147	0-35	BD115	0-65	BFX99	0-25	2N4036	0-52	BY164	0-55
AF178	0-55	BD123	0-98	BFX99	0-25	2N4289	0-20	BY176	1-00
AF180	0-50	BD124	0-80	BFX99	0-25	2N4292	0-20	OA47	0-07
AF239	0-40	BD131	0-45	BFX99	0-25	2N5294	0-35	OA81	0-10
AL100	1-10	BD132	0-50	BFX99	0-25	2N5294	0-35	OA90	0-08
AL103	1-10	BD135	0-40	BFX99	0-25	2N5296	0-37	OA91	0-07
BC107	0-12	BD136	0-46	BFX99	0-25			IN914	0-07
BC108	0-12	BD137	0-48	BFX99	0-25			IN916	0-10
BC109	0-13	BD138	0-50	BFX99	0-25			IN4001	0-05
BC113	0-13	BD139	0-55	BFX99	0-25			IN4002	0-06
BC114	0-20	BD140	0-62	BFX99	0-25			IN4003	0-07
BC115	0-20	BD234	0-75	BFX99	0-25			IN4004	0-08
BC116	0-20	BDY20	0-99	BFX99	0-25			IN4005	0-09
BC117	0-20	BF115	0-20	BFX99	0-25			IN4148	0-05
BC125	0-22	BF121	0-25	BFX99	0-25				
BC126	0-20	BF123	0-28	BFX99	0-25				
BC132	0-15	BF125	0-25	BFX99	0-25				
BC134	0-20	BF127	0-30	BFX99	0-25				
BC135	0-15	BF158	0-25	BFX99	0-25				
BC136	0-20	BF159	0-27	BFX99	0-25				
BC137	0-20	BF160	0-22	BFX99	0-25				
BC138	0-20	BF161	0-45	BFX99	0-25				
BC142	0-30	BF163	0-45	BFX99	0-25				
BC143	0-35	BF167	0-25	BFX99	0-25				
BC147	0-13	BF173	0-25	BFX99	0-25				
BC148	0-12	BF177	0-30	BFX99	0-25				
BC149	0-14	BF178	0-33	BFX99	0-25				
BC152	0-25	BF179	0-33	BFX99	0-25				
BC153	0-20	BF180	0-35	BFX99	0-25				
BC154	0-18	BF181	0-33	BFX99	0-25				
BC157	0-15	BF183	0-44	BFX99	0-25				
BC158	0-13	BF184	0-26	BFX99	0-25				

ZENER DIODES	
(400mW)	(1 WATT)
12p each	18p each
3.0V-33V	3.3V-100V
STANDARD VALUES	STANDARD VALUES

MINIATURE BRIDGE RECTIFIERS			
V	2A	4A	6A
50V	0-36	0-45	0-52
100V	0-42	0-49	0-58
200V	0-44	0-54	0-64
400V	0-50	0-60	0-75

THYRISTORS AND TRIACS IN ISOLATED PLASTIC ENCAPSULATION						
TRIACS WITH TRIGGER						
	VRM	100V	200V	400V	600V	
1-6A		0-28	0-30	0-37	0-42	
4A		0-39	0-45	0-76	0-98	
6A		0-44	0-50	0-85	1-00	
8A		0-49	0-54	0-92	1-18	
10A		0-55	0-61	1-02	1-32	
16A		0-90	0-95	1-40	1-75	
TRIACS WITHOUT TRIGGER						
		100V	200V	400V	600V	
1.6A		0-24	0-26	0-31	0-35	
4A		0-37	0-43	0-73	0-94	
6A		0-42	0-48	0-80	0-98	
8A		0-46	0-51	0-88	1-12	
10A		0-52	0-58	0-97	1-27	
16A		0-87	0-88	1-32	1-75	
THYRISTORS						
		50V	100V	200V	400V	600V
1-6A		0-20	0-23	0-25	0-35	0-45
4A		0-26	0-30	0-38	0-60	0-75
6A		0-29	0-33	0-42	0-68	0-80
8A		0-32	0-38	0-47	0-75	0-90
10A		0-36	0-42	0-51	0-84	1-00
16A		0-45	0-53	0-66	1-05	1-25

PLEASE INCLUDE 10% FOR V.A.T. (U.K. ONLY)
P. & P. (UK ONLY) £0.07 PER ORDER
(OVERSEAS AIR MAIL) £0.70 PER ORDER
Please send S.A.E. for new lists.

THIS MONTH'S SPECIAL OFFERS
Miniature mains transformers: primary 240V, secondary 12-0-0-12V at 150mA. Dimensions: Width 46mm. Height 38mm. Depth 32mm. Mounting hole spacing 54mm. £1-05.
PAL Chroma Delay Line Type DLIE £1-65.

EAST CORNWALL COMPONENTS
P.O. BOX 4, SALTASH, CORNWALL

WW-101 FOR FURTHER DETAILS



ancom
LOGARITHMIC AMPLIFIER
TYPE
15LP-1
MADE IN ENGLAND

- ★ BRITISH MADE
- ★ EX-STOCK DELIVERY
- ★ SIX DECADES
- ★ SCALE FACTOR & REF LEVEL (adjustable)
- ★ 1nA to 1mA OPERATING RANGE (std)
- ★ TRUE LOGARITHMIC FUNCTION
- ★ SCALE FACTOR SLOPE 1v per DECADE
- ★ REF. LEVEL 0 Volts OUT for 1µA IN
- ★ ACCURACY ± 0.25 db
- ★ BUILT IN AMPLIFIER
- ★ ANTI-LOG MODULE AVAILABLE

ancom ltd devonshire street cheltenham, glos.

WW-102 FOR FURTHER DETAILS



CHECKMATE PROFESSIONAL TEST PATTERN GENERATOR

The unique test card edge enables the completely accurate picture alignment of colour and monochrome receivers without the need of a broadcast test pattern. The crystal derived patterns and waveforms make extensive use of digital i.c. logic. The stable and reliable 625 line high resolution patterns are crosshatch dot and white field. Full 2:1 interlace with complete synchronising and blanking waveforms. Continuous tuning over all channels in each band. B.N.C. video outputs into 75 ohms available for CCTV use on all models. Compact—8 X 3 X 6ins. Light weight—3½lbs.

Model CCH-1 UHF Bands IV & V	£69-00
Model CCH-V VHF Band 1	£70-00
Model CCH-V2 VHF Band II	£70-00
Model CCH-V3 VHF Band III	£70-00

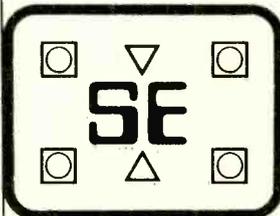
U.K. customers add VAT. Overseas customers CIF quotations on request.
Send for further information from the sole agents:

MANOR ENGINEERING
The School House, Crookham Common,
Newbury RG15 8EJ, England.
Telephone: Headley 487
Telegrams: MANORENG, NEWBURY.

WW-103 FOR FURTHER DETAILS

- Advanced off-air frequency reference. Phase-locked, with Signal Monitor. A lab standard £85.00 + VAT £8.50
- Signal source, type 1. Precision frequency reference £66.00 + VAT £6.60
- Osborne source (W.W. Jan '73), de luxe version £38.00 + VAT £3.80
- Kit for construction of an Osborne-based signal source £30.00 + VAT £3.00
- Full range of items for Quadrophony (full lists sent with all goods supplied)
- CBS-SQ Matrix Decoder using MC1312P (see W.W. Nov 1973) kit (½-hr. to build) £8.00 + VAT £0.80
- CBS-SQ Decoder as above, built and tested production board, uses MC1310P in holder, inc. LED £11.00 + VAT £1.10
- Advanced phase-lock-loop Stereo Decoder on board, regulator provision, typically 40dB separation.
Fits any set—full instructions supplied £6.95 + VAT £0.69
- Stereo Decoder, as above, but in kit form (about 60 mins to build) per pair £5.95 + VAT £0.59
- Superb 20W 8Ω Loudspeakers, as used for "P.E. Rondo", built in white or teak £42.00 + £2.00 carr. + VAT £4.40
- Easy-to-build Kits for above Loudspeakers, per pair £35.50 + £2.00 carr. + VAT £3.75
- Goldring G101/2 Turntable Chassis, less cartridge £22.90 + £1.00 carr. + VAT £2.39
- Deutsche-Elac STS 144/17 Cartridge, ideal high-quality, low-priced unit for Matrix quad £6.90 + VAT £0.69
- Instrument Cases, attractively featured with black Vinyl-covered steel top and sides, aluminium front and back panels. Exclusive!
- Case A 8" × 5" × 2" nom. £1.45 + VAT 14p. Case B 11" × 6" × 3" nom. £1.95 + VAT 19p. Case C 9" × 5" × 2½" £1.70 + VAT 17p.
- Handy little Aluminium Boxes, with lids and screws: Box 1—5¼" × 2¾" × 1½" = 42p. Box 2—4" × 4" × 1½" = 42p. Box 3—4" × 2¾" × 1½" = 42p. Box 4—5¼" × 4" × 1½" = 47p. Box 5—4" × 2½" × 2" = 42p. Box 6—3" × 2" × 1" = 34p. Box 7—7" × 5" × 2½" = 66p. Box 8—8" × 6" × 3" = 84p. Box 9—6" × 4" × 2" = 54p. BA bolts, nuts, washers: 0, 2, 4, 6, 8, 10 BA. 20p Pkt. of 10. All prices + VAT.

A FULL TECHNICAL AND AFTER-SALES-SERVICE IS PROVIDED. ALL UNMARKED PRICES POST FREE. AS MANUFACTURERS AND DISTRIBUTORS WE WELCOME TRADE AND EXPORT ENQUIRIES. COMMUNICATIONS CONSULTANTS... INSTRUMENT DESIGNERS... FOUR-CHANNEL SOUND SPECIALISTS.



Studio Electronics
 P.O. BOX 18 HARLOW
 CM 18 6SH ESSEX
 Telephone: Harlow (std 0279) 25457

RAPID REPLY ORDER

Please print clearly and detach coupon along the dotted line

- Q.A.F.R. £85.00 + VAT £8.50
- S.S.I. £66.00 + VAT £6.60
- D/L OS.S. £38.00 + VAT £3.80
- OS.S.K. £30.00 + VAT £3.00

- SQ-DEC. K. £8.00 + VAT £0.80
- SQ-DEC. B.&T. £11.00 + VAT £1.10

- PLL-DEC. B.&T. £6.95 + VAT £0.69
- PLL-DEC. K. £5.95 + VAT £0.59
- PR/LS/teak/white £44.00 + VAT £4.40
- 2K/LS/teak/white £37.50 + VAT £3.75
- G101/2 £23.90 + VAT £2.39
- STS 144/17 £6.90 + VAT £0.69

- Case A £1.45 + VAT 14p
- Case B £1.95 + VAT 19p
- Case C £1.70 + VAT 17p

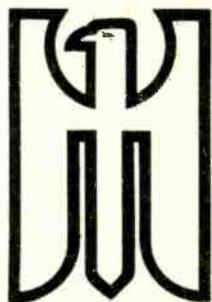
- Box No. Qty.....
- Box No. Qty.....
- BA Pkt. BA. Qty.....

Money enclosed £
 by cheque/P.O./M.O./bank draft.
 PLEASE LET US KNOW AFTER 7 DAYS IF YOUR ORDER IS NOT ACKNOWLEDGED.

NAME _____
 ADDRESS _____

WW3/74

WW—104 FOR FURTHER DETAILS



Phoenix Electronics (Portsmouth) Ltd.

Reg. Office:
 139-141 Havant Road,
 Drayton, Portsmouth, Hants.
 PO6 2AA.

afdec

Full member of AFDEC — the industry's association of franchised electronic component distributors. NOW — you can get the same service and range of products normally available to industrial customers. Brand new devices from the industry leaders in component manufacture — large stocks on our shelves. Our prices include VAT at the current rate — and carriage on all goods is free. Send for our catalogue and price list — we'll mail that to you free, too.

Please send your catalogue — free!

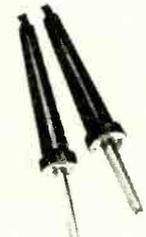
Name

Address

.....

.....

PROFESSIONAL QUALITY SOLDERING FOR EVERYONE!



We are official distributors for Adcola and Weller soldering equipment.
Weller 'Marksman' mains pencils:
 SP 25D 25W iron £2.00
 SP 25DK Iron kit, boxed, with tips, solder, etc. £2.55

Adcola 'Invader' mains pencils:
 L 646 23W iron £2.00

Weller 'Expert' soldering guns:
 8200D 'Instant' dual-heat gun, mains voltage £5.40
 8200DPK Soldering gun kit, with gun, spare tips, spanner, brush, solder, etc. in a smart carrying case .. £6.50



Adcola solder and braid:
 60/40 Solder, BS 441, resin-cored, 22 s.w.g., 30 ft. approx. £0.12
 Type AB Desoldering braid £0.80



We also carry extended ranges of soldering and desoldering equipment, spares, tips, etc. For the real professional, ask for our industrial ranges of temperature-controlled irons, low-voltage equipment, etc.

WW—105 FOR FURTHER DETAILS

**NEW
DESIGN**

ACTIVE FILTER CROSSOVER

FOR YOUR TOP FLIGHT SPEAKER SYSTEM

AS FEATURED IN WIRELESS WORLD Dec 1973

An essential and critical component in a high quality speaker system is the crossover unit conventionally comprising of a series of passive networks which unfortunately, through introducing reactive impedances between the amplifier and the speakers, result in the loss of the advantage of high amplifier damping factor and renders the speakers prone to overshoots and resonances. An elegant solution to this problem, described by D. C. Read in *Wireless World*, involves the use of a series of active filters splitting the output of the pre-amplifier into three channels, of closely defined bandwidth, each of which is fed to the appropriate speaker by its own power amplifier. A design for a suitable 20 Watt amplifier, based on a proven Texas circuit, was also described by Mr. Read. The printed circuit boards for this has been designed such that three amplifiers may be stacked and mounted together on a common heat sink to achieve a conveniently compact module.

ACTIVE FILTER

- Pack
- 1 Fibreglass PCB (accommodates all filters for one channel) 1.05
 - 2 Set of pre-sets, solid tantalum capacitors, 2% metal oxide resistors, 2% polystyrene capacitors 4.20
 - 3 Set of semiconductors 2.65
- 2 off each pack required for stereo system

SUITABLE ALSO FOR FEEDING ANY OF OUR HIGH POWER DESIGNS

READ/TEXAS 20w amp.

- Pack
- 1 Fibreglass PCB .70
 - 2 Set of resistors, capacitors pre-sets (not including O/P coupling capacitors) 1.10
 - 3 Set of semiconductors 2.40
- 6 off each pack required for stereo system
- 4 Special heat sink assembly for set of three amplifiers .85
 - 5 Set of 3 O/P coupling capacitors 1.00
- 2 off packs 4, 5 required for stereo system

POWER SUPPLY

FOR 20W/CHANNEL STEREO SYSTEM

- Pack
- 1 Fibreglass PCB 50
 - 2 Set of rectifiers, zener diode, capacitors, fuses, fuse holders 2.60
 - 3 Torodial transformer 4.95

ENQUIRIES WELCOME
For quality sets of speakers

PRE-RELEASE OFFER!

UNTIL APRIL 22nd
(Orders received after April 22nd subject to 10% VAT)

WE PAY YOUR VAT

Applies to goods advertised on this page only

POWERTRAN

SEE FOLLOWING PAGE

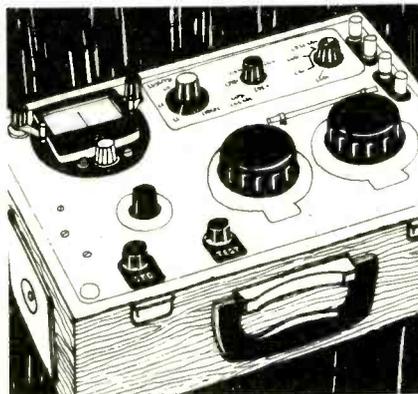
AVAILABLE FROM APRIL 23rd 1974. ORDERS DESPATCHED IN STRICT ROTATION FROM THAT DATE

WW-106 FOR FURTHER DETAILS

If you want the Cambridge Pot. phone Dover 202620

That's the 'phone number of Sullivan, manufacturers of the original Cambridge workshop pot that's designed for the testing and calibration of thermocouples and associated indicators and controllers.

It's completely portable. And now, fitted with the 3334 solid state dc detector, its rugged construction coupled with its ability to maintain its accuracy, makes it a must for either workshop or laboratory. And it weighs just 6.12 kg. You'll find the price is really competitive too.



Get in touch today for further detailed specification. Just telephone the number above or write to the address below.

Sullivan

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

Thorn Measurement Control
and Automation Division.

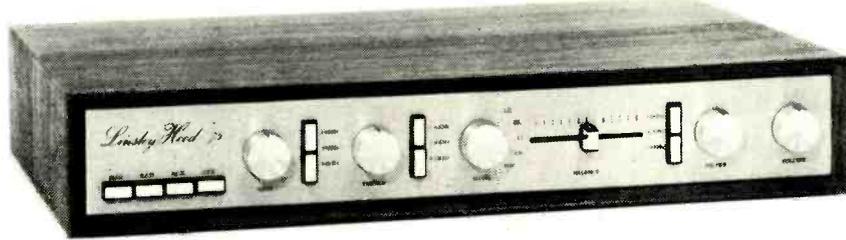
WW-107 FOR FURTHER DETAILS

Hi Fi News Linsley-Hood 75W Amplifier

DESIGNER APPROVED KIT

★ 75 WATTS PER CHANNEL
★ BANDWIDTH (3dB) 3HZ-40KHZ

★ DISTORTION LESS THAN 0.01%
★ UNCONDITIONAL STABILITY



FREE TEAK CASE with full kits

KIT PRICE only

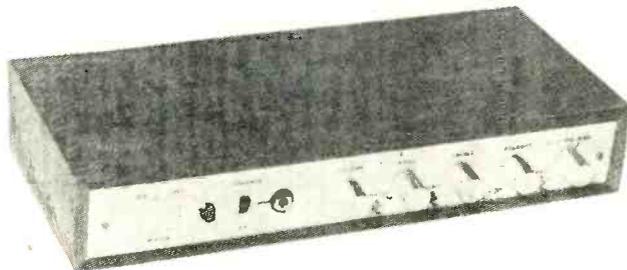
£56.60 POST FREE (U.K.)

Full circuit description in handbook

Pack	Price	Pack	Price	Pack	Price
1 Fibre glass printed circuit board for power amp.	£0.75	8 Set of potentiometers (including mains switch).	£1.55	13 Set of miscellaneous parts including DIN skts, mains input skt, fuse holder, interconnecting cable, control knobs	£3.25
2 Set of resistors, capacitors, pre-sets for power amp.	£1.50	9 Set of 4 push button switches, rotary mode switch.	£3.10	14 Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.	£6.30
3 Set of semiconductors for power amp. (highest voltage version).	£5.50	10 Toroidal transformer complete with magnetic screen/housing primary: 0-117-234 V, secondaries: 33-0-33 V 24-0-24 V.	£9.15	15 Handbook.	£0.30
4 Pair of 2 drilled, finned heat sinks.	£0.80	11 Fibre glass printed circuit board for pre-amp.	£1.10	16 Teak cabinet.	£7.35
5 Fibre glass printed circuit board for pre-amp.	£1.10	12 Set of resistors, capacitors, secondary fuses, semiconductors for power supply.	£2.70	2 each of packs 1-7 inclusive are required for complete stereo system.	
6 Set of low noise resistors, capacitors, pre-sets for pre-amp.	£2.70		£3.50	3a Set of semiconductors for Power Amp. (30W version).	£3.40
7 Set of low noise, high gain semiconductors for pre-amp.	£2.10			3b Set of semiconductors for Power Amp. (50W version).	£5.30

Toroidal T20 + 20 ★ WITH TOROIDAL TRANSFORMER ★ 20 WATTS PER CHANNEL

Developed from the famous Practical Wireless TEXAN.



FREE TEAK CASE and HANDBOOK with full kits

KIT PRICE only **£28.25** POST FREE (U.K.)

Pack	Price	Pack	Price
1 Set of all low noise resistors	£0.80	7 Set of all semiconductors	£8.25
2 Set of all small capacitors	£1.50	8 Special Toroidal Transformer	£4.95
3 Set of 4 power supply capacitors	£1.40	9 Fibre Glass P.C. Panel	£2.50
4 Set of miscellaneous parts including DIN sockets, fuses, fuse holders, control knobs etc.	£1.90	10 Complete chassis work, hardware and brackets	£4.20
5 Set of slide and pushbutton switches	£0.90	11 Preformed cable/leads	£0.40
6 Set of potentiometers and selector switch	£1.45	12 Handbook	£0.25
		13 Teak Cabinet	£2.75

SEMICONDUCTORS

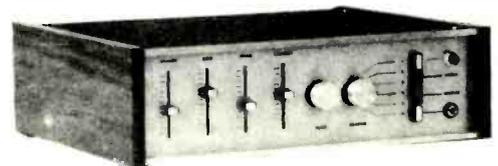
2N699 0.25	2N4058 0.12	BC214L 0.14	MPSA66 0.40	TIP33A 1.00
2N1613 0.20	2N4062 0.11	BCY72 0.13	MPSU05 0.60	TIP34A 1.50
2N1711 0.25	2N4302 0.60	BD529 0.85	MPSU55 0.70	TIP41A 0.74
2N2926G 0.10	2N5087 0.42	BD530 0.85	SN72721P 0.58	TIP42A 0.90
2N3053 0.15	2N5210 0.54	BDY56 1.60	SN72748P 0.58	TIP3055 0.60
2N3055 0.45	2N5457 0.45	BF257 0.40	TIP29A 0.50	1B08T20 0.50
2N3442 1.20	2N5459 0.45	BF259 0.47	TIP30A 0.60	1B40K20 1.40
2N3702 0.11	2N5830 0.30	BFR39 0.25	TIP29C 0.71	1N914 0.07
2N3703 0.10	40361 0.40	BFR79 0.25	TIP30C 0.78	1N916 0.07
2N3704 0.10	40362 0.45	BFY50 0.20	TIP31A 0.60	IS920 0.10
2N3705 0.10	BC107 0.10	BFY51 0.20	TIP32A 0.70	5B05 1.20
2N3706 0.09	BC108 0.10	BFY52 0.20		
2N3707 0.10	BC109 0.10	MJ481 1.20		
2N3708 0.07	BC125 0.15	MJ491 1.30		
2N3709 0.09	BC126 0.15	MJE521 0.60		
2N3710 0.09	BC182K 0.10	MPSA05 0.30		
2N3711 0.09	BC212K 0.12	MPSA12 0.55		
2N3819 0.23	BC182L 0.10	MPSA14 0.35		
2N3904 0.17	BC184L 0.11	MPSA55 0.35		
2N3906 0.20	BC212L 0.12	MPSA65 0.35		

COMPONENT PACKS FOR W.W. AMPLIFIER DESIGNS

30W BAILEY	
Pk. 1 F/Glass PCB	£0.65
Pk. 2 Resistors, capacitors, pots	£1.75
Pk. 3 Semiconductor set	£4.70
30W BLOMLEY	
Pk. 1 F/Glass PCB	£0.70
Pk. 2 Resistors, capacitors, pots	£2.15
Pk. 3 Semiconductor set	£5.60
20W LINSLEY-HOOD	
Pk. 1 F/Glass PCB	£0.70
Pk. 2 Resistors, capacitors, pots	£2.40
Pk. 3 Semiconductor set	£3.35
60V REGULATED POWER SUPPLY	
Pk. 1 F/Glass PCB	£0.65
Pk. 2 Resistors, capacitors, pots	£1.40
Pk. 3 Semiconductor set	£3.10
BAILEY-BURROWS PRE-AMP	
Pk. 1 F/Glass PCB	£1.60
Pk. 2 Resistors, capacitors, pre-sets, transistors	£4.95
Pk. 3R Rotary potentiometer set	£1.60

For further details on the above and other designs including 100W amplifier and Stuart Tape Recorder write for FREE LIST.

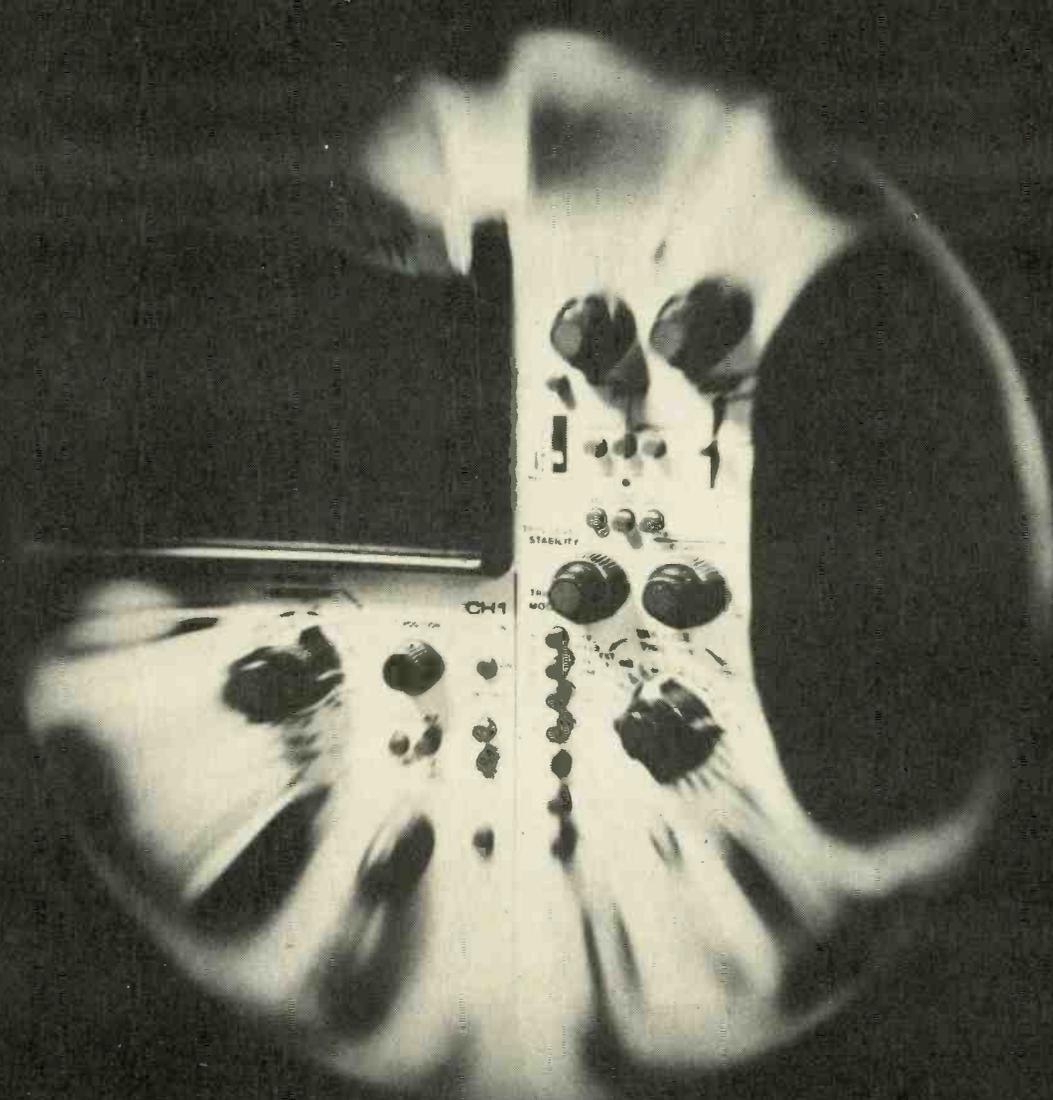
METALWORK SYSTEM FOR WIRELESS WORLD AMPLIFIERS



Designed to house Bailey, Blomley or Linsley-Hood Class AB amplifiers with simple or regulated power supplies and Bailey Burrows pre-amp. Options of standard or hum reducing toroidal mains transformer. Also rotary control version. Details in price list.

For FREE LIST write NOW!

Dept. W-02
POWERTRAN ELECTRONICS
PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3NN



Still the lowest cost Storage Oscilloscope in the world, the DM64

When Telequipment first produced the DM 64 in 1972 they ventured that, at £336* it was probably the lowest cost dual trace storage oscilloscope in the world. Now a year and countless users later, it can still be rated as the lowest-cost storage oscilloscope in the world.

In keeping with Telequipment's tradition for offering high performance at a sensible price, this instrument features storage time of up to one hour, a bandwidth of 10MHz at 10mV/div sensitivity, X-Y operation by switching vertical amplifiers, and a timebase range of 2 sec/div - 100ns/div in 23 calibrated positions.

*Exclusive of VAT



- Bistable storage or conventional displays
- Up to 250cm/ms writing speed
- Single-shot storage
- X-Y and invert facilities
- 8 x 10 cm display
- Small-size, lightweight

Write or contact us now for full details and to arrange a demonstration so that you may see for yourself the true value of the DM 64

Tektronix U.K. Ltd.,
 Beaverton House, P.O. Box 69,
 Harpenden, Herts.
 Telephone: Harpenden 61261 Telex: 25559

wireless world

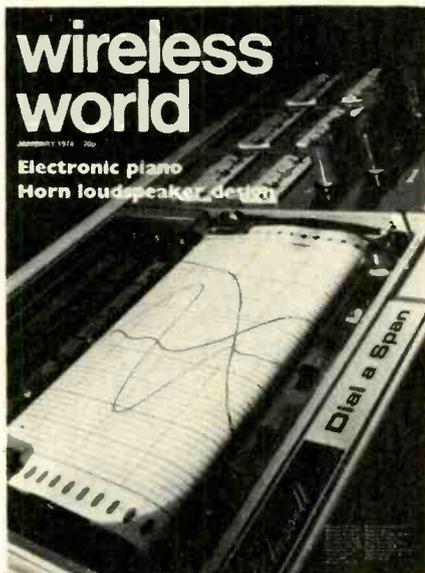
Electronics, Television, Radio, Audio

MARCH 1974 Vol 80 No 1459

SIXTY-THIRD YEAR OF PUBLICATION

Contents

- 1 Social Responsibility in Communications
- 2 The Value of School Projects *by E. R. Laithwaite*
- 4 An f.e.t. Curve Tracer *by L. G. Cuthbert*
- 6 News of the Month
- 8 Electronic Piano Design — 1 *by G. Cowie*
- 14 Conferences and Exhibitions
- 15 Letters to the Editor
 - Hi fi equipment standards
 - Surround-sound with headphones
- 18 Circuit Ideas
 - Unusual class A amplifier
 - Deflection coil driver
- 19 Horn Loudspeaker Design — 1 *by J. Dinsdale*
- 24 Literature Received
- 25 Microwave Landing Aid
- 26 Sixty Years Ago
- 27 Audibility of Phase Distortion *by B. B. Bauer*
- 29 Simple f.m. Modulator/Demodulator for a Magnetic Tape Recorder *by B. D. Jordan*
- 31 Multimeters *by B. Sexton*
- 39 Television Broadcasting from Satellites — 2 *by D. B. Spencer and K. G. Freeman*
- 44 Checking Peak Inverse Ratings *by J. M. Osborne*
- 45 Circards — 12: Wideband amplifiers *by J. Carruthers, J. H. Evans, J. Kinsler & P. Williams*
- 48 H.F. Predictions
- 49 Electronic Calculator Components Offer
- 50 Announcements
- 51 Motional Feedback in Loudspeakers *by H. D. Harwood*
- 52 New Products
- 56 World of Amateur Radio
- a115 APPOINTMENTS VACANT
- a152 INDEX TO ADVERTISERS



The cover picture shows overlapping traces on a three-pen recorder made by Chessell Ltd. Thumb-wheel selectors provide 450 sensitivities and 1999 datum shift settings.



I.P.C. Electrical-Electronic Press Ltd
Managing Director: George Fowkes
Administration Director: George H. Mansell
Publisher: Gordon Henderson

© I.P.C. Business Press Ltd, 1974

Brief extracts or comments are allowed provided acknowledgement to the journal is given.

Price 20p. (Back numbers 40p.)

Editorial & Advertising offices: Dorset House, Stamford Street, London SE1 9LU.
Telephones: Editorial 01-261 8620; Advertising 01-261 8339.

Telegrams/Telex, Wiworld Bisnespres 25137 London. Cables, "Ethaworld, London S.E.1."

Subscription rates: *Home*, £4.35 a year. *Overseas*, 1 year £5; 3 years £12.50 (U.S.A. & Canada 1 year \$13, 3 years \$32.50) Student rates: Home 1 year £2.18, 3 years £5.55. Overseas, 1 year £2.50; 3 years £6.25 (U.S.A. & Canada 1 year \$6.50, 3 years \$16.25).

Distribution: 40 Bowling Green Lane, London EC1R 0NE. Telephone 01-837 3636.

Subscriptions: Oakfield House, Perrymount Rd, Haywards Heath, Sussex RH16 3DH. Telephone 0444 53281. Subscribers are requested to notify a change of address four weeks in advance and to return envelope bearing previous address.

**EEV
CAMERA
TUBES**

EEV LEDDICONS. THE ACCURATE COLOUR TUBES.

The EEV Leddicon is the advanced tube that is accurately made with high purity materials. The benefits of EEV's attention to accuracy are exceptional ease and speed of line up, tube consistency and dependability.

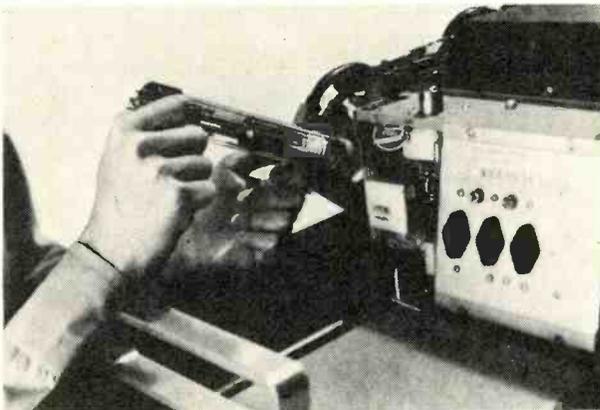
Accurate registration, geometry.

Perfect colour registration can be achieved in seconds on a good camera - automatic, semi-automatic or manual. Precise grey scales, the toughest test of a camera tube, are easy with the Leddicon. Geometry, too, is precise: a clear picture every time.

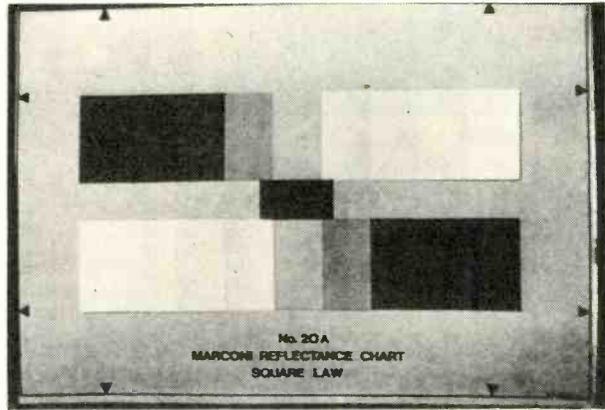
A good image gets around.

Leddicons are in use with most major colour networks - BBC, IBA, CBS, ABC, ABC Australia, NZBC, SRG Switzerland, ORTF France, Polish TV, ORF - Austria, Czechoslovakia TV etc. The tube has a good image. And so does EEV service. Leddicons are available from EEV agents in all markets.

Every station needs EEV Leddicon accuracy. For information and data contact your EEV agent or EEV at Chelmsford, England.



Insert to image in seconds.



Quick accurate pictures with the accurate tube - EEV's Leddicon.

Photoconductive camera tubes with high sensitivity lead oxide target, for high definition pick-up in monochrome and colour broadcast cameras. Features of these tubes include very short lag, low dark current and unity gamma.

Type	Application	Construction
P8000	Monochrome	30mm diameter, integral mesh
P8000B	Blue channel	
P8000G	Green channel	
P8000L	Luminance channel	
P8000R	Red channel	
P8001	Monochrome	30mm diameter, separate mesh
P8001B	Blue channel	
P8001G	Green channel	
P8001L	Luminance channel	
P8001R	Red channel	
P8003	Red channel	30mm diameter, separate mesh with extended red response
P8005	Monochrome	30mm diameter, separate mesh with light bias
P8005B	Blue channel	
P8005G	Green channel	
P8005L	Luminance channel	
P8005R	Red channel	
P8008	Monochrome	30mm diameter
P8021	Monochrome	Mechanically interchangeable with 1-inch separate mesh vidicons
P8021B	Blue channel	
P8021G	Green channel	
P8021L	Luminance channel	
P8021R	Red channel	

EEV AND M-OV KNOW HOW.

wireless world

Social Responsibility in Communications

Editor:
TOM IVALL, M.I.E.R.E.

Deputy Editor:
PHILIP DARRINGTON

Technical Editor:
GEOFFREY SHORTER, B.Sc.

Assistant Editors:
BILL ANDERTON, B.Sc.
BASIL LANE

Drawing Office:
LEONARD H. DARRAH

Production:
D. R. BRAY

Advertisements:
G. BENTON ROWELL (*Manager*)
Phone 01-261 8339

KEITH NEWTON
Phone 01-261 8515

A. PETERS (*Classified Advertisements*)
Phone 01-261 8508 or 01-928 4597

"Men themselves make their history but in a given environment which conditions them" wrote Friedrich Engels in the 19th century. In the present century the "given environment" is increasingly being shaped by technologists. Electronics and communications engineers in particular are changing that part of the environment which most strongly conditions the humanity of man — the available means for using symbols and messages. The invention of printing led to one cultural revolution. Telecommunications, broadcasting and audio-visual records are resulting in a new cultural revolution, according to a recent book "Communications Technology and Social Policy"*. If this is so, electronics and communications people bear an immense responsibility — in providing the means for influencing man's most central notions of his own existence, values, priorities and relationships. Are they in fact conscious of this responsibility?

The book draws attention to the variety of ways in which broadcasting, among other forms of communication, is being extended and modified, not merely by the provision of more channels but by cable distribution, satellite transmitters and cassette and disc records. One paper argues that this proliferation of communication "outlets" will lead to the "deprofessionalization" of broadcasting organizations — a process comparable with what has been occurring for some time in the church. "There will be little room for the professional elitism that thrived in the situation when the broadcaster not only could presume he knew what was best for the public but was also encouraged to do so by those interested in keeping control over popular culture" say the authors Gurevitch and Elliott. In another paper Dennis Gabor (the inventor of holography) suggests that the increase of programme choice will probably produce a cleavage in the public: "The educated will choose more and more cultural features, the culturally deprived even more pornography and violence. The technologist could no more than enlarge the choice". Throughout the book the communications engineer appears as a shadowy figure apparently with no will of his own, a mere instrument by which technological change manifests itself.

Of course the technologist can shelter behind the consideration that his job is only to provide the means of communication, not to control the uses to which they are put. From a blinkered point of view this is true. From a wider point of view, if the technologist makes a living (or perhaps a profit) from co-operating in providing and developing the means of communication, either through public corporations or through the commercial system, he is in partnership with the users and therefore has a social responsibility whether he likes it or not. So far, unlike some scientists (*viz.* the British Society for Social Responsibility in Science) he has not been very vocal about this involvement. We invite him to have his say through this journal.

* An international collection of 36 papers by technologists, social scientists, educators, communications experts and the like, published by John Wiley & Sons Ltd., Chichester, Sussex, price £9.00.

PROJECT



Project is a new venture for Wireless World and originated with our belief that the future of electronics lies with the young, and secondly from the knowledge that the journal has been used on innumerable occasions, by schools, colleges, universities and industrial training centres, to provide tutorial material unobtainable elsewhere.

These columns will contain news, information, projects and product information specifically relating to educational electronics and electronics in education. Much will be of interest to the young and the beginner and is intended to be so, but more importantly it will be written with all the authority and experience of Wireless World behind it.

Finally Project is intended as a point of contact between industry and educationists with an electronics interest. We would welcome news, articles, reports and letters for possible use in the journal.

Future Project features will include a report on Link, the scheme which puts voluntary industrial advisers in touch with schools; university radio and television stations; an article describing the radio astronomy project at the Gypsy Hill College at Kingston-upon-Thames and some fascinating new experimental projects for readers to undertake.

The Value of School Projects

by E. R. Laithwaite, D.Sc., Ph.D., F.I.E.E., F.I.E.E.E.

Professor of Heavy Electrical Engineering, Imperial College, London

While the rate of increase of technical and scientific knowledge continues itself to increase with time, the Physics syllabus of an Examining Board stays remarkably stable. I know that many parents are surprised to find that the "A" level Physics paper contains questions on the same topics that were contained in the syllabus when they themselves took the examination, perhaps 25 years ago. Some solid-state electronics will probably have been added, and a dusting of particle physics, just to prevent the Board from appearing decadent, but in the main the same method of teaching is pursued and the pupils, one fears, are subjected to the same set of so-called "experiments", in which the result is never in doubt before the first reading is taken.

I have discovered the basic reasons for this conservative outlook, partly by being Chairman of the Advisory Committee for Physics for one of the Examining Boards for several years, and partly by being a member of the Schools Science and Technology Committee. One of the activities of that Committee was to set out on a fact-finding exercise to discover why school science and electronics teaching was not keeping pace with the demands of a modern technological society.

At first, I thought that the Advisory Committees of Examining Boards had a

free hand to change the syllabus which was entirely in their care, I was told fairly quickly that certain changes in syllabus which I proposed "would never get past the Schools Council". I deduced that the Schools Council was an overlord to all the Boards, which was why the standards of "O" level or "A" level exams were much the same whatever the Board.

Not a bit of it! Every Examining Board, I discovered through the S.S.T.C., was a private company and therefore a law unto itself. Like other commercial enterprises, the one thing every Board feared was losing customers, and the easiest way to lose customers was to change the syllabus — why? — because the average, grossly underpaid school teacher had long ago lost enthusiasm for his subject and could not be bothered to learn new material. No, I am being unfair, even to the *average* teacher. If only a minority of lazy science teachers existed, they would be the ones who would write angry letters to the Board threatening to change to another Board if the syllabus were changed. This undoubtedly was cause number one.

The second cause too, I soon unearthed. I was very quickly told that I could not introduce new material (such as the magnetic circuit concept) which involved a new approach to an old topic "for", I was told, "there are no readily

available, cheap text books which the teacher can use." I had to agree that this was a strong argument. I reported my findings to the S.S.T.C. who promptly sent for a sample of publishers who, when asked if they would welcome the opportunity to publish books containing new science teaching methods, gave us a unanimous "no", for the simple reason that "there was no syllabus which demanded it, so the book would not sell". — Stalemate!

The third reason came to light when I wanted my committee to delete permanent magnetism, as being too difficult for school children. The chief examiner hesitated to doubt my wisdom in this but told me gently that if we deleted the magnetometer, in particular, "there would be nothing to set for the practical exam". His counsel was wise, as I found out all too soon. Set a practical question which requires a rubber band and out of perhaps 400 schools will come questions as to what its dimensions should be, its maximum tension, and "where can we buy them?" (or in dire cases with *what* can we buy them?). But magnetometers present no problem — *all* schools have magnetometers!

The school project is likely to be afflicted similarly for the same reason as just outlined, for school apparatus accounts do not run to buying much new

apparatus. At universities, of course, things are better, but the emphasis here is on theory at its highest level and a few years ago no less a place than the Massachusetts Institute of Technology scrapped its electrical machine laboratory in the belief that tomorrow's engineers could learn all they needed from Generalized Machine Theory, which was extremely fashionable at the time. The only thing wrong with Generalized Machine Theory and all its kind is that they represent the ultimate in "organization" of a subject and without, of course, admitting it, they do so in the belief that all the knowledge in their particular subject is now acquired. This stifles any hopes of fostering curiosity and imagination among students of all ages. They become acclimatized to the idea, among others, that nearly all can be explained by theory and that if their experiments, such as they are, disagree with the theory, they must repeat the experiments until they get them "right".

The answer to all this, I am sure, lies with the interesting project, however simple, provided it has the necessary air of mystery to make it exciting. If only we could convince our students that when their measurements failed to confirm the existing theory they may be standing on the threshold of a new era in science, all their laboratory work would take on a new look. First perhaps we should design experiments specifically to discredit theory which has been simplified to make it palatable. The extension of theory just to the point of personal ability exists at all levels of academic achievement. It is still fashionable in engineering departments of universities to take a known problem to which a known solution exists to a reasonable degree of accuracy, and re-specify the data in such a way that the solution is now only possible using the most up-to-date computing machine available, for just as long as the department can afford. A paper is then published on the results, on the strength of which the postgraduate student hopes for higher honours.

The problem of encouraging inventiveness and of teaching the next generation the facts about science begins at school, and therefore should be tackled at school. In sixth form applied mathematics the "good book" says that the frictional force between bodies which are in contact, but moving relative to each other, is μR where R is the normal reaction between the bodies and μ is the "coefficient of friction" which is constant. This leads at once to the idea that if a body is placed on a horizontal plane which is thereafter tilted to greater and greater angles, slipping will occur at a given angle, irrespective of the mass of the body. This angle is known as the "angle of friction", thereby implying that it is a constant for any given pair of surfaces.

So cut blocks of metal, the first of which has dimensions $2 \times 2 \times \frac{1}{2}$ in, the second $1 \times 1 \times \frac{1}{2}$ in, the third $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{4}$ in and so on down to perhaps $\frac{1}{8} \times \frac{1}{8} \times \frac{1}{32}$ in. Place these blocks with one of their

large faces in contact with a flat piece of glass or plastic sheet and begin to tilt slowly. According to the theory all should begin to slide together. In practice, the first attempts suggest that they are likely to move off in any old order, but after each block has been carefully polished and the glass cleaned with spirit, the blocks will be found to start off in strict order of size, largest first. The student is then encouraged to seek out his own better theory which will fit more practical situations than the simpler one. We have to confess that at school level certainly, and at higher levels in lesser degree, we teach physical subjects to just the right level to make good examination questions!

There are however some encouraging signs. My own speciality in engineering is "linear motors". No sooner had I become a director of a company which manufactures these articles than I was asked to put my mind to the task of designing a kit of parts to operate with a linear motor and provide as much scope for variation of experiment as there is scope for creating models in Meccano. What they wanted could be described as an "electromagnetic construction kit". This is happily now available and I hope will encourage specialists in other subjects to produce similar apparatus.

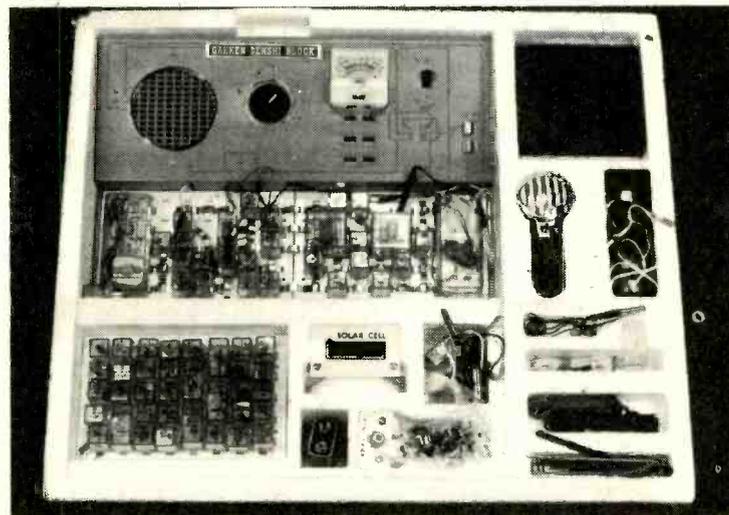
But note how the pressure to do this came from industry and not the teaching world. Industry knows that only in this way can it hope to avoid the shock which, at present, generally occurs when schooldays (where life is simple and "correct") end and industry or commerce (where life is complex and *always* incorrect!) begins. The Schools Science and Technology Committee was, however, very conscious of the value of project work in schools and early in its existence the Committee took under its wing the excellent work being carried out at Loughborough by Geoffrey Harrison and his colleagues which was initiated

by the Schools Council under the title "Project Technology". The S.S.T.C. were sufficiently impressed by certain facets, notably the publications distributed to schools, that when Schools Council money ran out, they arranged for continuation of these facets to be financed through the Standing Conference on Schools' Science and Technology — a body set up specifically as the result of S.S.T.C. activity. Among the other works of the S.C.S.S.T. is that of setting up "local centres" where industry and schoolteachers may meet, exchange views, be lectured at, but perhaps most of all, where surplus raw materials from local firms can be distributed to local schools for the widening of project scope within school laboratories.

School projects could be described as "coming face-to-face with Nature" and as such are a "must" at this time. One word of caution only would I venture. "Man shall not live by bread alone" says the Bible, and school science cannot live by projects alone. Complementary to the more formal teaching they must always be and not a substitute for it, nor an end itself. The greatest asset of school projects is the way in which they can creep up on a child and persuade him to become first a little curious, then definitely interested and perhaps finally fanatical about a subject which, if introduced through the more usual teaching channels, he would find entirely unpalatable.

More and more we need women in the engineering professions and again the school project can be the start of it. It is the opinion of most members of S-S.T.C. that most children really make their minds about their future careers between the ages of 10 and 13. It is here that we must teach girls especially that technology did more than invent the atom bomb and is therefore not all bad. It is here perhaps most of all that the school project must be geared to make its impact.

An educational electronic kit, one of a series priced from £6 to £26 available from Elektroniks, 408 St. John's Street, London E.C.1. WW 390 for further details.



PROJECT

An F.E.T. Curve Tracer

by L. G. Cuthbert

Although the junction field effect transistor is not part of any A level Physics syllabus, there are several advantages in spending a short time teaching its basic circuit properties. In cases where the triode valve is taught as the main electronic device a study of the f.e.t. could well follow this as it has many valve-like properties, yet gives students the chance of using a modern electronic circuit element. However, many schools are now using the bipolar transistor at A level and here the f.e.t. could well be studied first since it is a much simpler device to use, thus enabling students to grasp basic concepts without being put off by complications.

To study the characteristics of the circuit properties of a device it is not necessary to know why or how it works, only what it does. Therefore, the f.e.t. will be treated as a "black box" with three terminals and the characteristics show the relationships between the voltages and currents at the terminals.

The symbol for an n-channel j.f.e.t. (there is also a p-type where all the polarities are reversed) is shown (Fig. 1). For normal circuit operation the voltages applied to the terminals are:

- source—connected to earth
- drain—to a positive voltage
- gate—to a negative voltage. This is very important as the f.e.t. may be destroyed if the gate is made positive.

The gate acts as a control terminal and controls the amount of current that can flow between drain and source. As the gate is made more negative, less current flows until eventually no current at all will pass from drain to source. The f.e.t. is a useful device because a small change in gate voltage can produce a fairly large voltage change in a resistor connected to the drain, thus acting as an amplifier. (Fig. 2)

by Ohm's law

$$V_{out} = V_{DD} - I_D R_D$$

change in $V_{out} = \Delta V_{out}$

$$= R_D \Delta I_D$$

amplification is $R_D \Delta I_D / \Delta V_G$

Quantitative information about the effect of gate voltage on drain current is given by the transfer and output characteristics. These are very similar to the pentode valve curves and in fact the same small signal equivalent circuits can be used for both f.e.t.

and pentode, although the symbols used are different.

The f.e.t. is therefore a very simple device to teach and experiments based on valves can be easily modified to use an f.e.t., thus giving the advantage that pupils are not investigating an obsolete device. In the current second year Applied Electronics course at Queen Mary College, circuit concepts are discussed initially with f.e.t.s and then extended to bipolar transistors.

The most useful of the two characteristics shown in Fig. 3 is the output one and it is also the more impressive when displayed on an oscilloscope. Thus, for simplicity, the

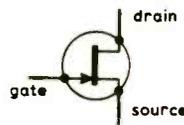


Fig. 1. The symbol for an n-type j.f.e.t.

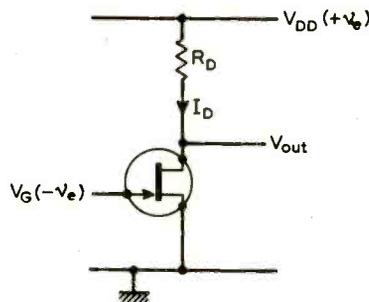


Fig. 2. The f.e.t. as a common source amplifier where, by Ohm's Law, $V_{out} = V_{DD} - I_D R_D$, the change in $V_{out} = \Delta V_{out} = R_D \Delta I_D$ and amplification is given by $R_D \Delta I_D / \Delta V_G$.

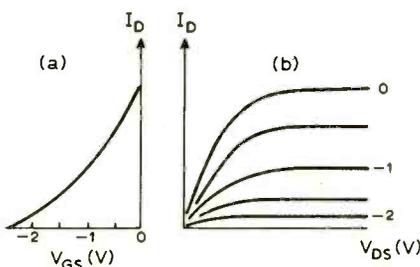


Fig. 3. The characteristics of a j.f.e.t.

project described in these notes will concentrate only on displaying the output curves although it is quite possible to modify the system to display the transfer characteristic or, for that matter, the curves for a bipolar transistor.

The curve tracer as a system

The output characteristic is a plot of drain current against drain-source voltage for different (equal increment) values of gate voltage. Thus the basic system for displaying these curves needs to be as shown in Fig. 4. However, there are several points that affect the system and lead to simplification in some parts and a more complicated design in others.

1. The drive ramp need not be a linear function of time since the plot is of current against voltage. A highly non-linear ramp does, however, mean that the oscilloscope beam will take significantly different times to cover the same distance on the screen, thus making the brightness of the trace vary.

2. The gate voltage must not be greater than zero. To avoid inadvertent damage to the transistor protection should be provided to prevent V_G becoming positive.

3. The maximum drain current of many f.e.t.s is about 10mA which is within the maximum current capability of a general purpose integrated circuit operational amplifier. This is helpful because the amplifier suggested is short circuit protected (i.e. its output can be shorted to earth or the power supply without damage) and this is a very useful asset for a project being built by students. If a discrete component amplifier were used, separate protection would have to be provided.

4. In the real world nothing ever happens instantaneously so that the ramp and staircase waveforms have the form shown in Fig. 5(a). If the gate waveform is triggered by the falling edge of the ramp waveform it will be changing during the flyback of the ramp voltage and may still be changing during the start of the next cycle and therefore not only would the flyback of the oscilloscope trace follow a different path but the start of the next trace could be distorted. Admittedly the flyback trace will be faint because it occurs much faster but it still, un-

fortunately, is visible. This can be improved by using an "intermediate" triggering waveform (Fig. 5(b)) so that the gate voltage is held constant over the whole of one ramp and the flyback and then the beam is held at the origin while the gate voltage is changed. A further benefit is that the origin is brightened, since the trace is kept there for a relatively long period, thus emphasising its position.

A block diagram of the complete system, taking account of these points, is shown in Fig. 6. The drain current is determined by measuring the voltage developed across a small resistor in series with the drain. Since the drain voltage is measured at the drain terminal, the small resistor has no effect on this measurement, but the potential drop across it will very slightly reduce the voltage at the drain.

Details of the circuit, construction, setting-up and sources of component supply will appear in the next issue of *Wireless World*.

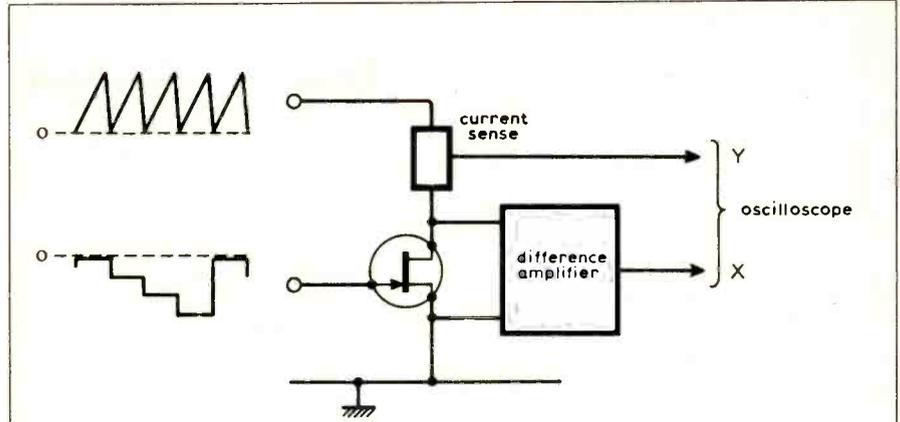


Fig. 4. Basic curve tracer system.

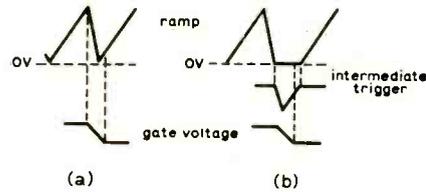


Fig. 5. Elimination of the flyback trace using an intermediate trigger. The time scale is exaggerated for clarity.

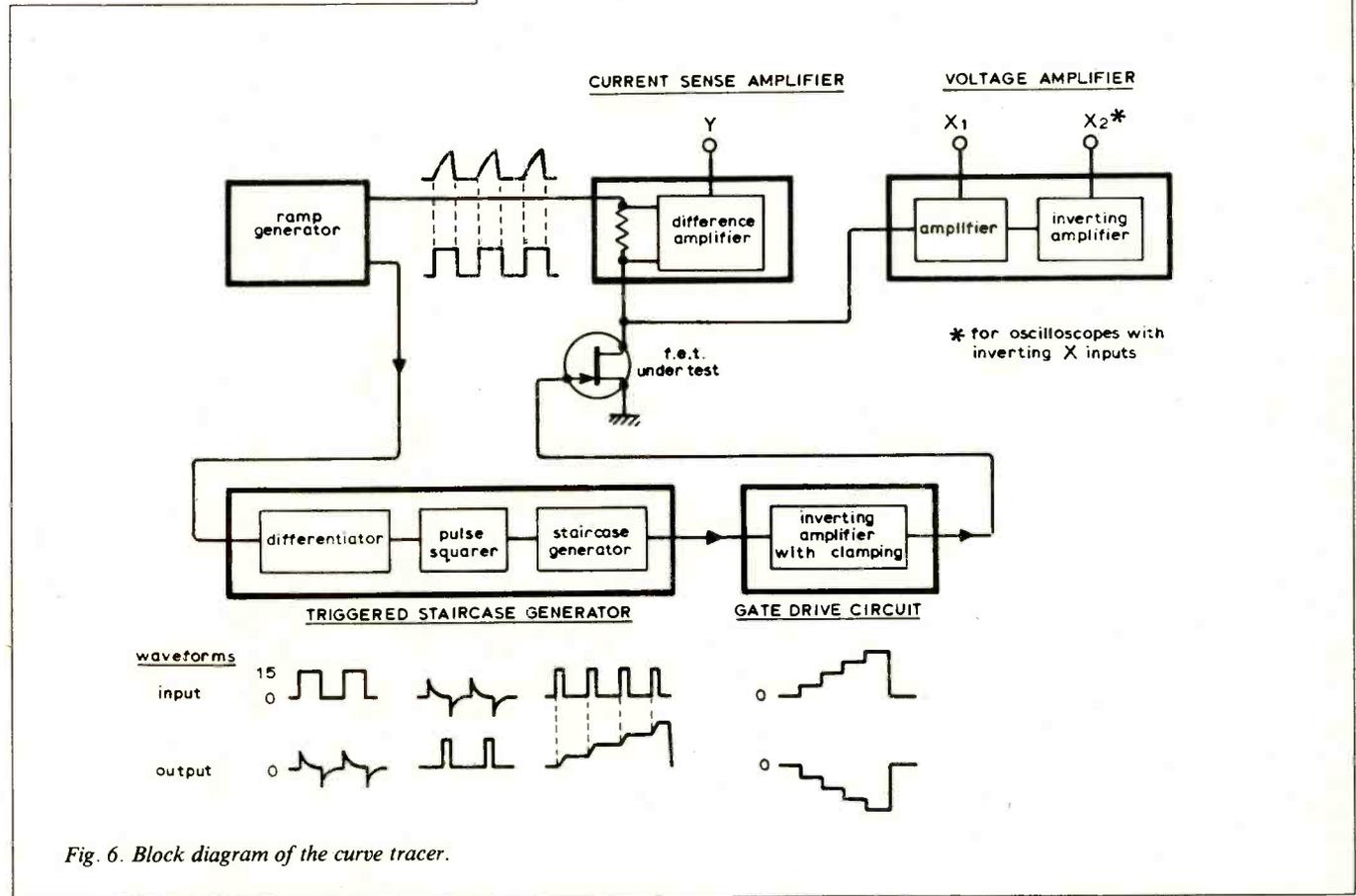


Fig. 6. Block diagram of the curve tracer.

News of the Month

Component shortage — broken promises

Component buyers are being fed too many delivery promises and not enough facts on the realities of product availability. This was the essence of a statement made by buyers at a recent meeting held by AFDEC, the distributors' association. Although accepting that distributors have no option other than to accept delivery information supplied by their principals, they believe that the situation is sufficiently serious to merit a far more militant stand by distributors against principals supplying either worthless or no information.

A significant factor in the current shortage situation is the amount of "double ordering" which has taken place to safeguard supplies. Distributors can plan to meet almost any eventuality, but they need two basic contributions from buyers. The first is a firm statement of requirements over as long a period as possible. The second is a reduction in the time now being taken to settle accounts enabling

distributors to maintain stocks at a high level.

AFDEC suggested that, if buyers decide to be honest about their "double ordering", distributors can then reasonably increase demands upon principals without having to face the problems of suddenly carrying vast stocks of products for which orders have suddenly been cancelled.

On a practical point, both buyers and distributors expressed concern about the lack of information from manufacturers on the handling of certain new products. A prime example is the m.o.s. circuit which was introduced with very little warning about the sensitivity of such devices. It was suggested that suitable markings on both the packaging and the devices themselves might overcome some of the handling difficulties still being experienced in this area.

Radiopaging market opens

Redifon Telecommunications have received a licence to manufacture and sell in the U.K. a pocket radiopager developed by the Martin Marietta Aerospace Company of Orlando, Florida. The product will be marketed under the name "Redipage". The system has a computer located at a central telephone exchange controlling a network of unattended transmitters sited throughout the required area. A caller wishing to contact the user of the pager will dial a ten-digit number from any telephone.

An experimental public system has been in operation by the Post Office in the Reading area (see News of the Month, "Radiopaging by telephone", Feb. 1973, p.58) and its success is currently being evaluated.

The Redipage system is based on high

speed digital transmissions, each transmitter being allocated one time slot out of a sequence of eight in an eight second transmission cycle. By this means, degradation of the service by mutual transmitter interference is completely eliminated.

Installation of the pagers is expanding rapidly in the U.S. and Martin Marietta have recently announced an order for a central computer controlled system and an initial 10,000 pagers in New York City.

Reformation for broadcasting

Siemens has developed a radio receiver system for the reception of transmissions made using the independent sideband (i.s.b.) system¹, suggested by the Hamburg Institute for Radio Engineering. I.s.b. modulation is a variant of s.s.b. modulation, offering the same advantages as the latter in suppression of interference and reduction of distortion due to fading and inefficient band utilization, but also enables a broadcasting station to double its number of programme channels. The system allows the transmission of two independent programmes over the two sidebands of a carrier. The advantages of i.s.b. can thus be used to prevent the increasing mutual interference between a.m. broadcasting stations, which is devaluing their prime advantage of long range.

I.s.b. modulation is incompatible with present radio sets on m.w. and l.w. and Siemens has made two suggestions for an i.s.b. receiver, the two designs differing only in the method used for suppressing the unwanted sideband. The first version uses phase-compensated carrier regeneration, produces sideband suppression of 40dB and is compatible with d.s.b., s.s.b. and i.s.b. modulation. The second version includes two i.f. filters with consequent higher i.f. selectivity, which means fewer filters in the a.f. section. The second system is also fully compatible.

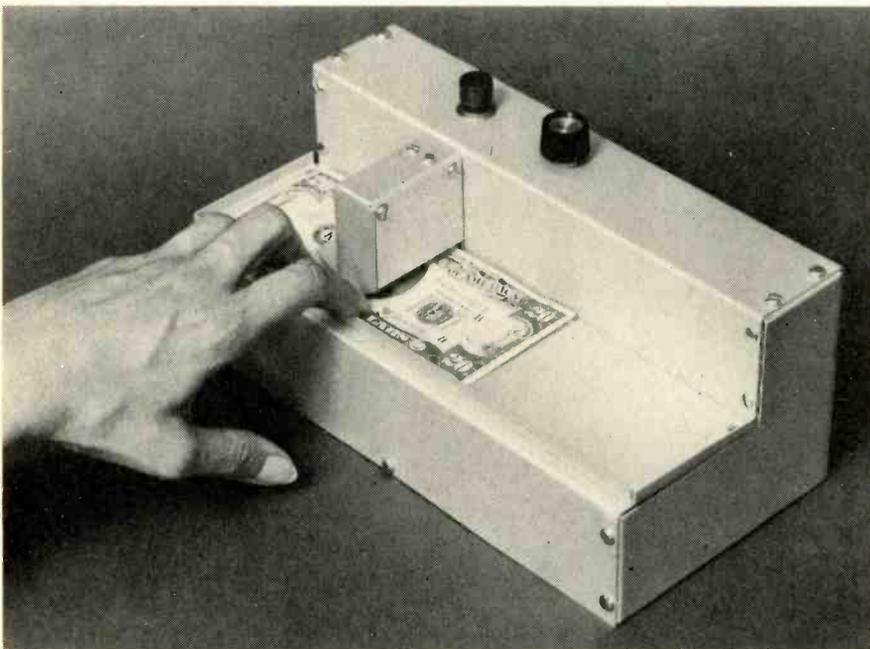
1. Langer, E., "AM Broadcasting System Reform, a New Chance for European Radio Setmakers", *Siemens Components Report*, Vol. VIII No.5, Nov. 1973, pp.108-111.

Dot-scan television system

A closed-circuit television system using a pseudo-randomly scanned matrix of dots to produce the display has been developed by Mullard Research Laboratories and the MEL Equipment Co.

The system was developed for the Royal Aircraft Establishment, who need to simulate different types of scan in their examination of new matrix-type and mechanical systems. It is possible, for instance, to simulate the effect of a sensor using an array of infra-red devices, or to investigate the appearance of multiple-interlaced displays. Areas of different resolution may be displayed on the same scan.

Electrostatic deflection is used in



Paper money identifier for blind persons. See news item.

camera and display, and the spot is allowed 262,000 possible positions in a 512×512 matrix. A digital pattern generator controls the spot position, being applied to camera and display with a delay to allow for the propagation time of the video information. Speed of deflection of the spot is such that it can move between any two positions in less than 200ns. Movement of the spot is programmed by the use of cards and two 49-word digital stores, which may be controlled by computer.

Mobile recording for Island

Island Studios have begun the operation of a 24-track mobile recording unit in the U.K. The 3M company supplied the recorder, model M79 whose control panel can be detached and used remotely at a distance up to 30ft away from the console. The mixing desk (30 inputs, 24 outputs) was produced by Helios Electronics. Complete with kitchen and fridge, sleeping accommodation, heating and air conditioning, the 32ft long, 8ft wide vehicle cost £75,000. Let's hope that the present materials shortage in the recording industry does not damage the justification of this cost.

Money identifier for the blind

A reliable paper money identifier to aid blind business persons has been developed from NASA technology. The device identifies paper money by its sound "signature". As a bank-note passes under a light source, a photo-transistor measures changes in the note's light patterns. These changes are converted into beeping sounds by an oscillator. Since each denomination of paper money has a different pattern, a different series of tones is given off. These differences are easily identified after about three hours' practice. NASA technology which led to development of the device stems from a technique for the semi-automatic inspection of microfilm records first reported in 1969. The Marchak Engineering and Manufacturing Co., Austin, Texas, produces the device commercially. A photograph of the device is shown opposite.

Static problem eliminated

A static eliminator bar manufactured by 3M United Kingdom is in use at the EMI record pressing factory. At the plant, records are produced on injection moulding machines. A hot plastic copy is taken from the highly-polished metal master disc, is then partially cooled, trimmed and ejected for packing into sleeves. Despite rigorous precautions, a high static charge was generated as the pressings separated from the metal master. By fitting the bar near the rotary trimmer, static charge dust

and dirt particles from the trimming process are removed.

The model 201 anti-static bar is a self powered, compact device, with no moving parts or wires, that causes localized ionization of the air, producing a conductive path to drain off any charges on an adjacent surface. The bars emit nuclear energy from radioisotopes of polonium 210 which is safely contained in tiny ceramic beads. The source emits positively charged alpha particles which ionize the surrounding air molecules.

Roadside emergency Help Box

A system for roadside emergencies called the Help Box has been evaluated in the U.S. which uses a radio transmitter instead of the more usual landline-connected roadside telephone. The unit has been developed by the American District Telegraph Company of New York.

The stranded motorist cannot speak to anyone, but several advantages are claimed for the system. Pulling down a vertical cover to the horizontal exposes a choice of four buttons to press—fire, ambulance, police and car trouble. The appropriate button is pushed and the lid closed.

Moving the lid generates electromagnetically enough electricity to power the transmitter for 2.5secs, during which time the Help Box sends a tone coded message to a central receiving point. The transmitted signal contains information on the box location and the service required.

All boxes use the same v.h.f. or u.h.f. frequency, the chances of two boxes transmitting at the same instant being very small. The central console can accommodate up to 9,999 box codes.

The system seems ideal for roads carrying heavy traffic which, unlike motorways which have a landline emergency call-box service installed when the road is built, do not have a roadside emergency service. The ADT non-battery radio system is claimed to be vandal proof and cheaper to install and maintain than line systems, due mainly to the absence of cable laying costs. A further application could be in protecting residential and shopping areas against crime.

Enquiries should be sent to the U.K. division, Electric Protection Services, 26 Old Bailey, London EC4M 7HL.

Cross-channel phone hop — stage two

The first sod has been cut on the Tolsford Hill, near Folkestone, site for a new Post Office radio tower which will greatly enlarge Britain's busiest single international telephone link — a 30-mile microwave radio "hop" across the English Channel to France.

The radio mast already standing on Tolsford Hill has been strengthened to take more aerials. This is the first step in a two-stage programme — the second will be the setting-up of the new tower — which will enlarge the route's call-carrying capacity under major Post Office plans to keep pace with rapidly increasing demand for communications with Europe. It will be ready for service in 1975, when the old mast will be taken down.

This route, from the Tolsford Hill microwave station to its French counterpart at Fiennes, near Loos, handles calls to and from France — people in Britain make nearly four million calls there a year — and carries many international calls routed across France to other countries, principally Italy, Switzerland, Spain, Greece and Yugoslavia.

Britain's international telecommunication services are doubling every five years. Communications with the Continent account for the biggest slice of the Post Office's international telephone traffic. Of the 25 million overseas calls from Britain last year, 20 million were to mainland Europe. By 1975, 77 million telephone calls a year will be flowing between Britain and the Continent.

The new tower will be 64m (210 ft) high, with six galleries, triangular in plan, spaced at 6m (30 ft) intervals.



Impression of the observation and communications tower, Toronto, Canada, which when completed will be 1805ft high — the tallest self supporting structure in the world.

Electronic piano design

Simple touch-sensitive piano using ready-made keyboard — 1

by G. Cowie, B.Sc.

The instrument described is a simple touch-sensitive electronic piano which is small and portable. The circuitry is designed on a modular basis using i.c.s extensively and is not difficult to construct. It generates tones by an oscillator-divider system, the tones being keyed by individual touch-sensitive key circuits. Costing around £70 to build, the design is believed to be the most cost-effective available, in terms of what it is intended to do, and a commercial instrument with this touch-sensitive feature would seem to cost at least £300.

This design was built to fill a real need; if there had been an acceptable instrument on the market I would have bought it instead of spending three months and £50 in making one. I was learning to play the piano and wanted an instrument of my own for practice. As I live in furnished flats, moving frequently, a full-sized upright just was not practicable. The alternatives were a "mini" piano or an electronic piano. I ruled out the first on finding that second-hand instruments were surprisingly expensive because of the demand; moreover they were not portable enough.

This left electronic pianos. I looked at several but they cost a lot of money and I did not like them. The trouble is that they all have the same artificial keying action in which pressing the key beyond a certain point suddenly generates a note of fixed loudness. On the cheaper instru-

ments the note cannot be held after the key is released.

I wanted an instrument which behaved just like a string piano, even if it did not sound much like one. The prototype is quite true to my original intentions: if you play loud the sound comes out loud, if you play very softly the sound hardly comes out at all. In playing a chord, one can make some notes loud and others soft at the same time. There is a "loud" pedal which can be used to sustain notes after the key is released, and the sound dies away just as in a real piano.

The low notes have long decay time constants, and the high notes have very short time constants. The tone is a bit like that of an electric piano, a harpsichord, and an electric guitar. Most listeners find the tone pleasant; it is much less harsh than that of a real piano. In any case to imitate a grand piano perfectly would

be very difficult. Most important of all, the instrument is about the size of a large suitcase and light enough to be carried by one person.

The essential feature of the design is that the volume of sound generated depends on how fast the key is pushed down, a feature not then available to my knowledge on any other electronic piano. This feature is what makes a pianoforte what it is, and its importance was impressed on me by a musician friend with whom I discussed the project. In simple terms, the effect is to add a new dimension, that of loudness, to the sound. Although I made no attempt to vary the tone along with the volume, the characteristics of the human ear and of the power amplifier cause such an effect with my instrument. I find the instrument sufficiently interesting to play that I have not found it necessary to add tone-shaping circuits though this could be done quite easily. The only extra is a swell pedal which is useful for increasing the dynamic range. Functionally, the instrument is much the same as a string piano, except that there is no "soft" pedal. Purists may argue that the key action is not the same as that of a real piano. Strictly speaking this is so, but the art of playing the electronic piano is so similar to the art of playing a real one that there is no difficulty in changing from one to the other.

To produce an electronic imitation of a real piano would be an ambitious undertaking, and potentially an uneconomic one. If the imitation is to be useful by reason of its small bulk and competitive cost then compromises are necessary. The sound that a piano makes has a complex harmonic content. This is not an insuperable difficulty in itself, but the harmonic content varies according to the loudness with which the note is struck, and with time; it is also different for notes of different pitches. Loudness of course varies with time, with a fast attack and slow decay. As if this weren't enough



to contend with, most of the notes employ two or three strings which do not vibrate in perfect unison.

The keys of a piano have a characteristic feel when pressed down by the finger: there is a constant resisting force caused by the weight of parts on the inner end of the key, a reactive component caused by the inertia of the fast-moving hammer, and a small amount of friction. The harder one tries to play, the greater the reactive part of the opposing force becomes. From the musician's point of view this characteristic of the piano is most desirable, as it makes it easier to exploit the touch-sensitive loudness which is inherent in the piano. The faster the key goes down, the faster the hammer moves, the harder the hammer hits the strings, the louder the sound. Music tutors exhort one to think of the key speed rather than the pressure. Technically this makes sense as only the final speed of the hammer matters and it is easier to accelerate it by a smooth pressure than by jabbing the key (and the music sounds better). In this piano design, each key is linked to its own timing circuit so that sound output depends on the average velocity with which a key is pushed down.

Various electronic pianos are on the market. Those priced competitively with respect to conventional uprights seem to adopt similar solutions to the problems outlined above. Keyboards are similar to those used in electronic organs, with the same touch, and most of the instruments are not touch-sensitive at all. One infers that the acoustic waveforms are square waves treated by low-pass filters, and by high-pass filters for special effects. All have the right sort of fast attack, slow decay as this is very easy to effect for square waves. Again by inference the frequency generation is done by oscillators and dividers as in electronic organs.

Design considerations

After preliminary thought and discussion, I decided that my electronic piano would be touch-sensitive, have a sustain pedal, use square-waves as the working waveform, and have twelve master oscillators, using t.t.l. 7493 integrated-circuit frequency dividers to generate the lower pitches. On seeing ready-made organ keyboards and keyswitches I decided to use these and, as five octaves is a standard size, that the little-used top and bottom octaves of the conventional 88-note piano keyboard could be dispensed with. This simplifies the work considerably and makes the finished instrument significantly smaller and lighter.

The essential features of electronic key circuit are shown in Fig. 1. The key position must be determined electrically, to control an envelope shaper whose output is used to modulate the amplitude of a continuous-pitch waveform. Tone is determined by the pitch waveform, and attack and decay are determined by the envelope. As the piano is to be touch sensitive then the initial height of the envelope must be variable.

A number of envelope waveforms are shown in the Fig. 2. These show a note played and released, a note played and

Table 1. Fundamental frequencies for C-C keyboard

Octave section	C	B	A	A	G	G	F	F	E	D	D	C
1 (osc. freq.)	2093	1975	1865	1760	1661	1568	1480	1397	1318	1244.4	1174	1108
2 (1st div.)	1046.4	987.7	923.3	880.0	830.6	783.8	739.8	698.4	659.2	622.2	587.2	554.2
3 (2nd div.)	523.2	493.8	466.2	440.0	415.3	391.9	369.9	349.2	329.6	311.1	293.6	277.1
4 (3rd div.)	261.6	246.9	233.1	220.0	207.6	196.0	185.0	174.6	164.8	155.6	146.8	138.6
5 (4th div.)	130.8	123.4	116.5	110.0	103.8	98.0	92.5	87.3	82.4	77.8	73.4	69.3
6 (5th div.)	65.4	61.7	58.2	55.0	51.9	49.0	46.2	43.6				

N.B. For modified C-C keyboard (see text) or an F-F keyboard, range is 43.6Hz to 1397Hz.

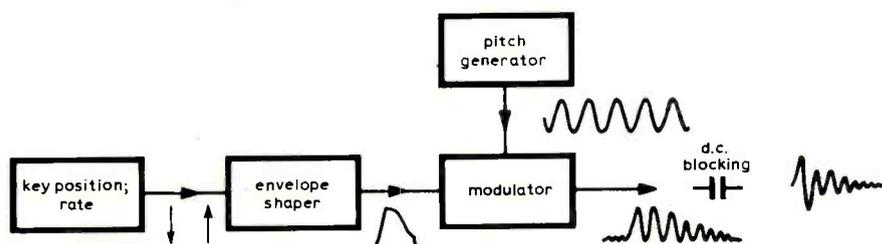


Fig. 1. Key switching and rate information provides an envelope that modulates signals from a pitch generator (c.w. oscillator).

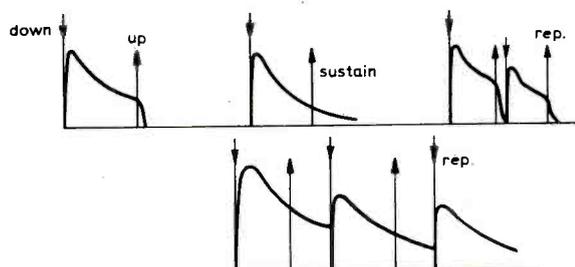


Fig. 2. These envelope waveforms are determined by switches actuated by keys and the sustain pedal. Diagrams show single and repeated notes with and without sustain action.

sustained, and notes repeated without and with sustain. Generally, electrical key contacts are used to signal the states "up", "down" and "moving" and this can be done by a single contact moving between two busbars. But I found that the simplest and cheapest system must use more contacts to simplify the electronics. An electronic piano must have an electronic switch to block the pitch signal when it is not required; in my circuit a diode is used.

Twelve oscillators generate the twelve pitches for an octave, and the pitches for lower octaves are obtained by dividing by 2, 4, 8, 16 (Table 1).

The oscillators use operational amplifiers instead of LC circuits — it is cheaper to buy op-amps than to buy special coils. Also, the op-amp circuit is easier to design and can be tuned by a cheap pre-set potentiometer. A detailed discussion of this type of oscillator is given in *Electronic Engineering*, Nov.1971, page 54. Complex m.o.s. microcircuits are now available which will produce the twelve top-octave frequencies when driven by a radio-frequency master oscillator. Thus all the key pitches are synchronized with the master oscillator and the organ or piano never needs retuning. Such a device would add about £3 to the cost of the project

and a suitable (optional) module will be described in part 3 of this article.

Regulated supplies of +5 and -5 volts are provided as a regulated 5-volt supply was needed in any case for the t.t.l. divider circuits. The advantages of integrated-circuit frequency dividers over discrete dividers in cost, time, space etc are such as to make them the only choice. About half of the piano circuitry is inside the divider i.c. packages.

I devoted much thought to making the key circuits as simple as possible. As there are sixty-one key circuits, elimination of even one component could save hours of work and pounds of hard cash. Wood was the obvious choice of material for the case. The case is styled after my own conception of how an electronic piano should look, and has no lid as this wasn't essential and would not fit into the design. There is more room at the rear of the case than is strictly necessary; this was deliberate in that making the case too big would cause nothing like as much trouble as making it too small.

Circuit Description

Fig. 3 is a schematic diagram of the complete circuitry which is too complex to be drawn in full. Under the keyboard

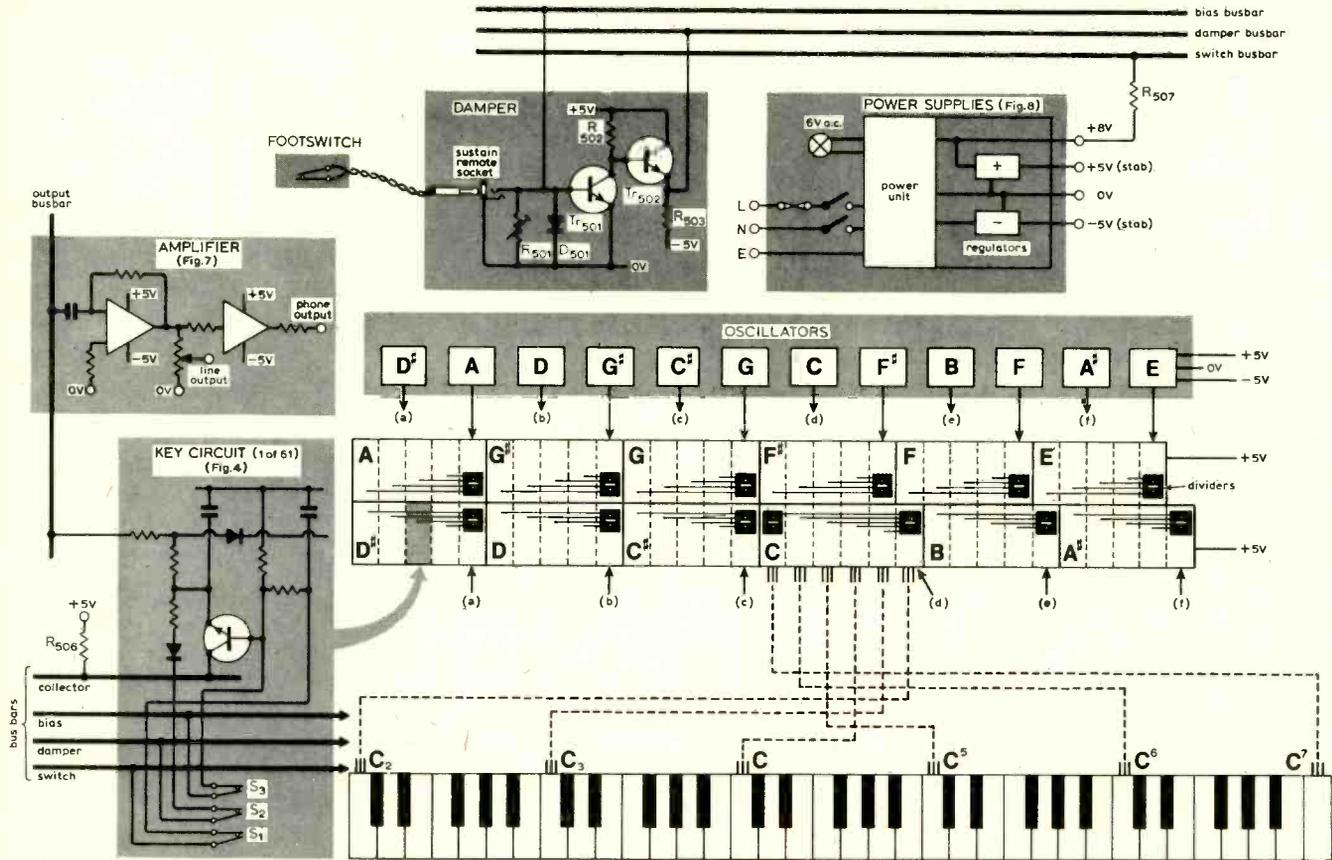


Fig. 3. Time between S_2 and S_1 , S_3 opening as the key is pressed determines loudness of sound, achieved with the key circuit. Twelve RC oscillators feed 12 dividers (shown above keyboard in diagram), giving 60 of the 61 tones for modulation by the key circuits. For a five-octave keyboard 61 tones are actually required, the additional tone (C⁷) being provided by a 13th divider, as the i.c.s will only divide by a maximum of 16. Outputs from the key circuits are mixed in the amplifier via the output busbar. Three of the busbars run alongside the keyboard so that three keyswitch leads can be directly soldered to them.

are 61 sets of three normally-closed gold-plated wire switches, one set being shown. One pole of each switch is connected to one of three busbars which run under the keyboard. The other poles are wired to a key circuit, which is one of a letter-group of five as there are five octaves; and there are twelve letter-groups. There is a sixth note C for which an extra key circuit and an extra divider to give $\div 32$ provided.

Each letter-group of key circuits is fed with signals from an oscillator and frequency divider. The key circuit for one note is drawn in full to show the interconnections.

To each of the 61 keyswitches six connections are made. Three of these are common busbars (bias, damper, switch), and the other three are bias, damper, and switch signal lines and all go to one key circuit, linking the key to the electronics.

The power supply feeds +5 volts to the oscillators, frequency dividers, summing preamplifier and output amplifier and, via a resistor, to the collector bus which feeds all 61 key circuits. It also feeds an unregulated +8-volt supply to the switch bus, and -5 volts to the oscillators and amplifiers.

The output bus is a virtual earth line

fed from all 61 key circuits. The bias and damper buses are controlled by the sustain pedal.

Key circuits

Though the key circuits appear simple (Fig. 4), each has three sections which are more or less analogous to parts of a string piano. Components C_1 , R_1 , R_2 , S_1 , S_2 , form a velocity-measuring circuit which gives the piano its touch-sensitive property. The charge in C_1 , when the key is depressed, represents hammer velocity. Transistor Tr_1 provides isolation between the input and output sections of the circuit — the equivalent in a real piano is a device allowing the hammer to fall back. Capacitor C_2 has a charge representing the vibrational energy of a string. Components D_2 , S_3 , R_3 form the damper circuit, which may be disabled to give a sustain action. Diode D_1 blocks the pitch signal when the circuit is on standby and, when the circuit is active, forms a chopper and output circuit with R_4 and R_5 . The discharge times of capacitors C_2 vary to imitate the peculiarity of the string piano whereby bass notes die away more slowly than the treble.

Velocity section. Standby operation is as follows: current flows from the switch busbar, which is at about +8V, through S_1 , R_1 , S_2 , to the bias busbar at about +0.7V, so that Tr_1 is just cut off. Capacitor C_2 is charged to about +0.4 V. When the key is partway depressed, contacts S_1 and S_3 open, and C_1 discharges toward +0.7V, with a time constant of 18ms. (This is a critical time constant that influences the playing properties of the instrument.) When the key is almost fully depressed, S_2 opens and the remaining charge in C_1 passes through R_1 into the base of Tr_1 , which conducts heavily, causing a corresponding charge to appear in C_2 . If R_2 were not included in the circuit, then S_2 having opened, a capacitance of C_1 times the gain of Tr_1 would be added to C_2 ; R_2 ensures that C_1 always discharges faster than C_2 .

When the key is released, S_2 closes first, S_3 closes discharging C_2 , and S_1 closes, recharging C_1 from the other 60 capacitors in parallel. The resulting current surge does not damage the contacts as they will handle up to 2A at low voltages, and the power factor of the capacitors is very poor. All the contacts have so far survived 21 months of use. The action of the circuit is such that when

the key is pressed very swiftly, C_1 loses potential by only a volt or so, and a potential of nearly five volts appears on C_2 . When the key is pressed very lightly, C_1 discharges almost to the bias voltage, so that a very small charge is delivered to C_2 .

Envelope section. Capacitor C_2 , having been charged, begins to discharge in pulses through R_4 , D_1 and the 7493 i.c. (Fig 5) with a time constant $2R_4 C_2$. A square chopped signal appears across R_4 and is taken out via R_5 ; the amplitude of the signal being C_2 voltage minus D_1 volt drop. The t.t.l. divider outputs have two transistors in a sort of class B arrangement so source; in the piano circuit this is a nuisance and is blocked by D_1 . In the low state it acts as a current sink to ground. The voltage applied to the output must not exceed 5V.

This diode chopper was chosen because it is the simplest modulating circuit with a precisely definable output and a low feed-through of pitch signal in the off state. The impedance of this section is low to reduce the effect of D_1 leakage and capacitance in its off state. Hence C_2 must be relatively large. The impedance of the velocity section is relatively high to minimize standing currents, hence a current amplifier Tr_1 is necessary.

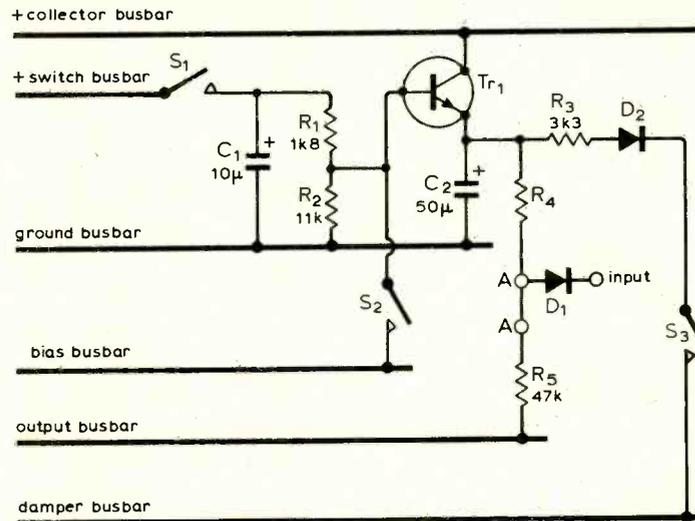
Damper section: When the key is released, S_3 closes, discharging C_2 through R_3 and D_2 . The value of R_3 is made large enough to avoid a key click. A sustain action is effected by raising the potential of the damper bus so that no current can flow into it through D_2 , and so C_2 discharges through the chopper, irrespective of the key position. Normally, R_3 , D_2 drain some leakage current from C_2 . The sustain allows capacitors C_2 in circuits on standby to charge up slightly via Tr_1 until D_1 begins to conduct. To suppress this chorus effect, the bias busbar potential is reduced.

Resistor R_4 varies from $1k\Omega$ (top C) to $15k\Omega$ (low C) — Table 3 lists values.

Oscillator circuits

The 12 oscillators use operational amplifiers in a precision relaxation oscillator circuit (Fig. 5). The output of the op-amp switches between nearly the positive and negative supply voltages. When the output has just gone positive, the negative input voltage starts to change positively as charges. When it reaches the positive input voltage, $V_0 R_1 / (R_1 + R_2)$, the inverting action causes the output to fall negatively, almost instantaneously. The circuit has a bridge configuration which almost eliminates the effect of load and supply voltage. At the instant of switching a differential voltage of $2V_0 R_1 / (R_1 + R_2)$ exists at the amplifier inputs, which limits the ratio R_1/R_2 that can be used at the chosen supply voltage with 709 series op-amps (but not 741 types). Sources of drift in the circuit include offset voltage and bias current changes.

Supplies of +5V, -5V were chosen to simplify the power supply and buffer circuits. This has rendered the oscillators



$$C = \frac{6}{f} \text{ to } C = \frac{60}{f} \pm 20\%$$

$f = \text{frequency in Hz}; C \text{ in } \mu\text{F}$

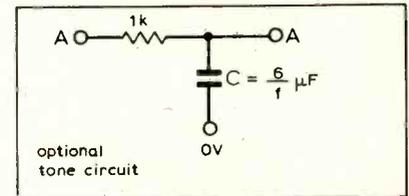


Fig. 4. Key circuit (one of 61) acts as envelope shaper and modulates input from the dividers to feed amplifier via busbar. The three busbars wired to the three switches run alongside keyboard switches. Optional tone circuit was used on the bottom twelve keys of the author's design to make low tones less harsh.

Table 2. Oscillator resistance values

Pitch	Frequency (Hz)	Nom. tuning R (kΩ)	Use (kΩ)
C [♯]	1108	36.5	33 + 4.7
D	1174	34	33 + 4.7
D [♯]	1244.4	32	30 + 4.7
E	1318	30	27 + 4.7
F	1397	28	27 + 4.7
F [♯]	1480	27	24 + 4.7
G	1568	25	24 + 3.3
G [♯]	1661	24	22 + 3.3
A	1760	23	22 + 3.3
A [♯]	1865	21	20 + 3.3
B	1975	20	18 + 3.3
C	2093	19	18 + 3.3

more sensitive to ripple and one-sided supply voltage changes. Frequency depends on the values of R_{201} , R_{202} , R_{203} , R_{204} , and C_{201} , and is set by R_{203} (Fig. 6). High-stability components are required.

A buffer circuit R_{205} , Tr_{201} is incorporated as the load of the divider input and the discharge current from the top-octave key circuits may be as much as 6.6mA, which is more than the op-amp can be guaranteed to drive. The 7493 i.c. divides the oscillator frequency by 16 and has outputs for 2, 4, 8, divisors also. It changes state for an input transition from high to low, and has two reset inputs, one of which must be grounded for operation as a divider or counter. The outputs will sink more than 16mA ample for driving the key circuits. Eleven of the oscillator and divider circuits are as shown, but for C an overall divisor of 32 is required and so the output ÷ 16 is wired to the input of another divider stage whose output then feeds low C.

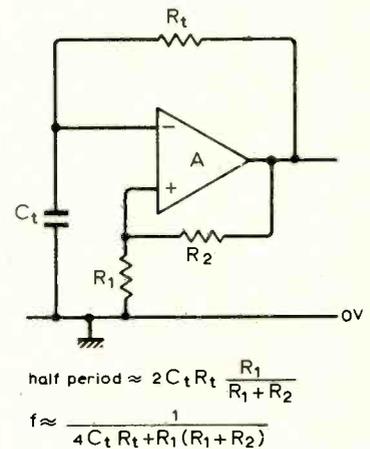


Fig. 5. Relaxation oscillator uses bridge configuration to keep effects of load and supply voltage changes to a minimum.

Summing preamplifier

The summing circuit is a standard op-amp arrangement. Capacitor C_{401} (Fig. 7) blocks the d.c. component of the output, i.e. the C_2 voltages which would be summed to about 25V. Resistor R_{401} is not mounted on the board but at a suitable point among the key circuits, thereby using the differential inputs to minimize pickup of unwanted signals. The headphone amplifier likewise is a fairly standard discrete-component op-amp with complementary emitter-follower output. It can be readily altered to drive various loads.

Table 3. Decay time constant resistor values (R_i in Fig. 4). (61 resistors needed.)

Note	Octave section					
	1	2	3	4	5	6
C						(low C)
B	}	1k	1.8k	3.3k	5.6k	10k
A [♯]						
A						
G [♯]	}	1.2k	2.2k	3.9k	6.8k	12k
G						
F [♯]						
F						
E	}	1.5k	2.7k	4.7k	8.2k	15k
D [♯]						
D						
C [♯]						

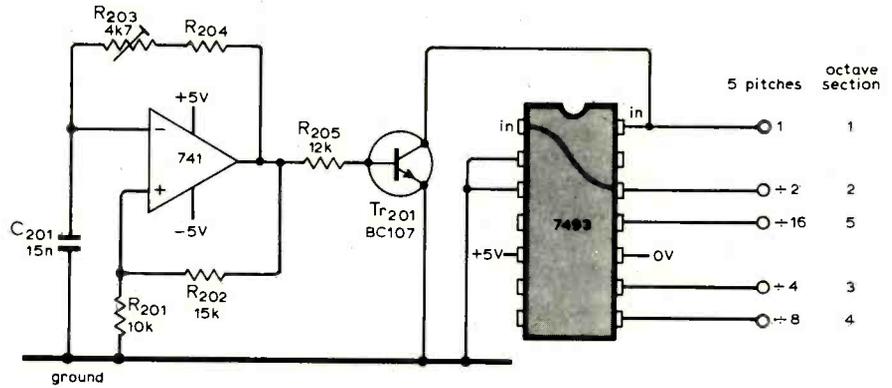


Fig. 6. One of 12 RC oscillators which feed the 12 dividers, giving five octave-related tones for each of 12 notes.

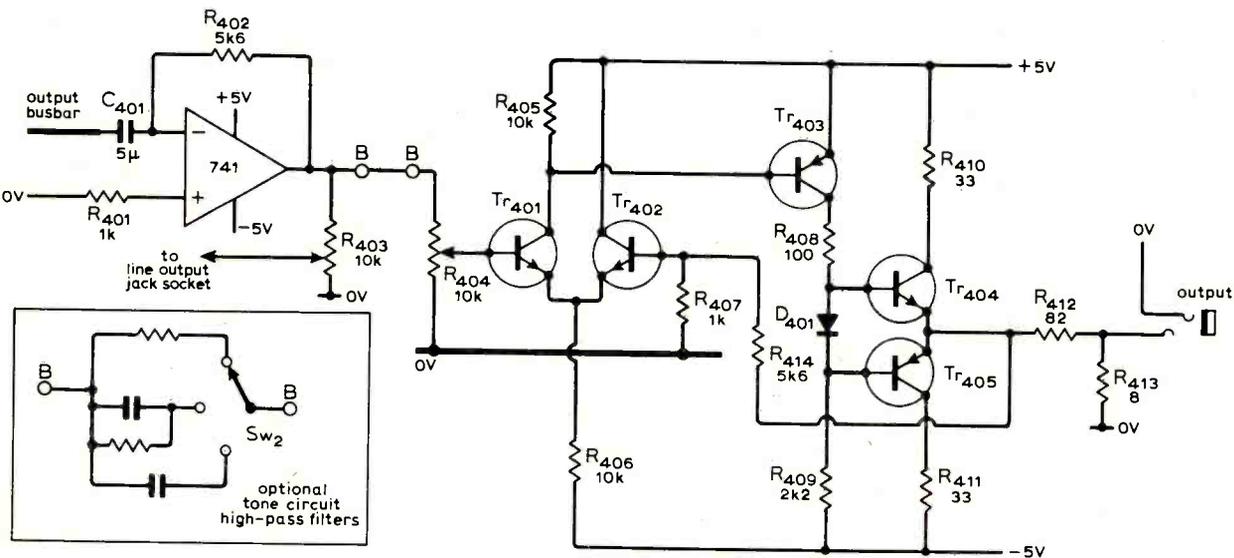


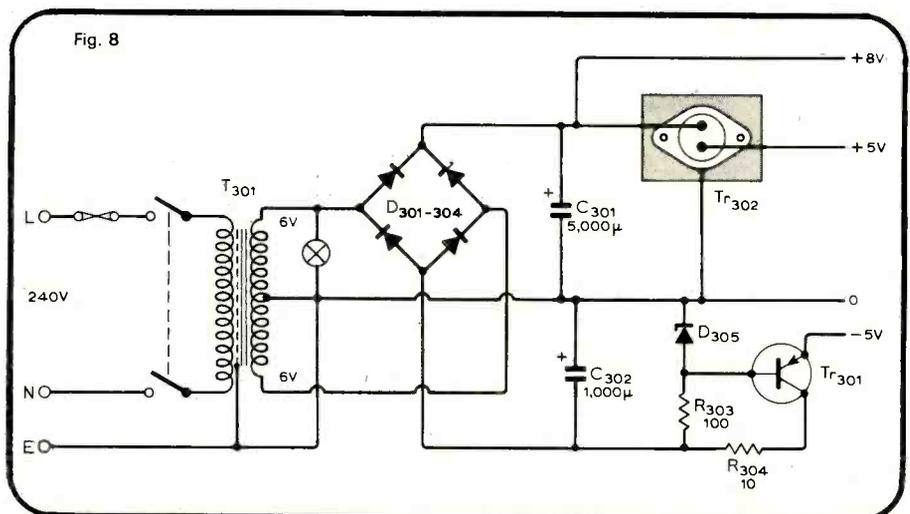
Fig. 7. Amplifier accepts inputs from 61 key circuits via output busbar. Discrete-component amplifier can be omitted if headphone operation is not needed.

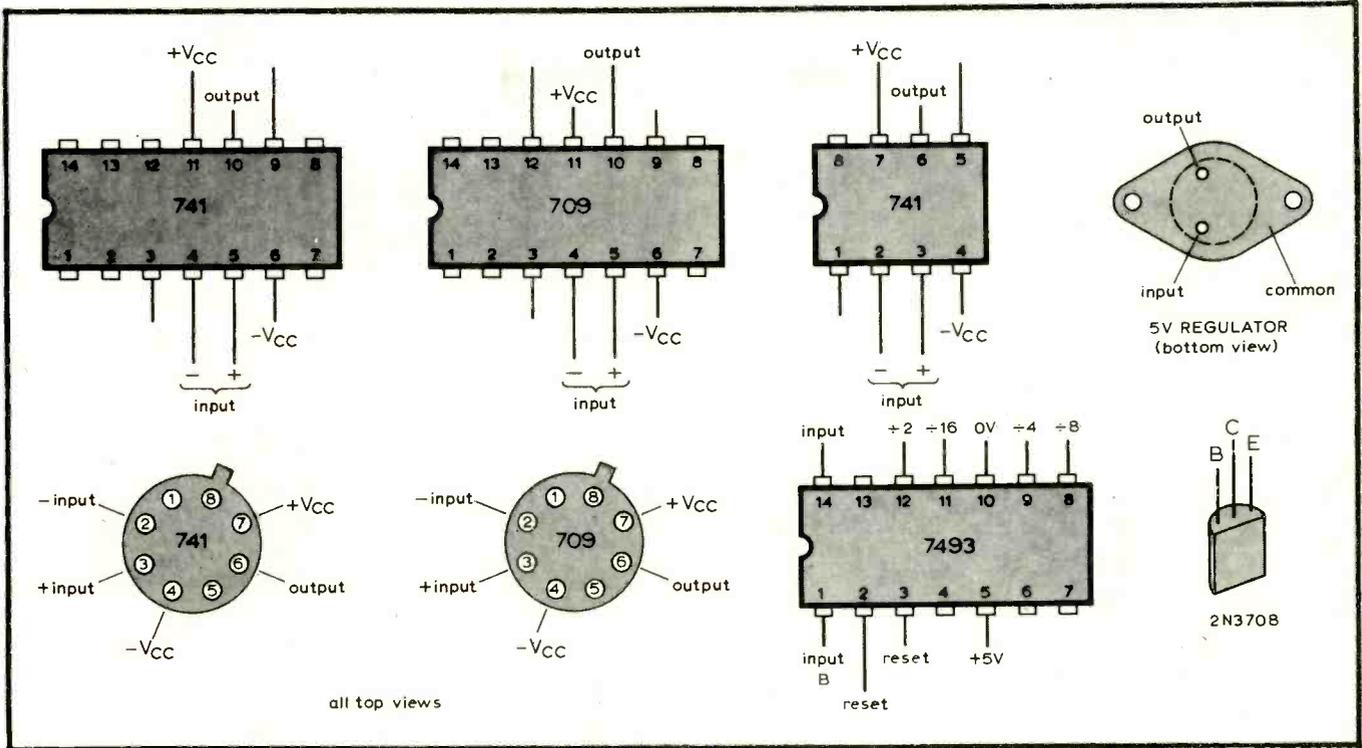
Power supply

The power supply unit (this page) provides regulated voltages of +5V at 600mA, -5V at 50mA, an unregulated +8V at 250mA, and a low-voltage a.c. to light an indicator lamp. The twin full-wave rectifier arrangement produces two "raw" d.c. supplies with a minimal voltage loss across diodes. A simple discrete-component regulator is used for the negative line, and an integrated regulator is used for the positive supply to maximize reliability. The t.t.l. divider circuits may be ruined if a regulator failure causes their supply voltage to exceed 7V. Regulated supplies assist in maintaining the frequency stability of the oscillators.

Busbar lines

A number of wires feed signals and power to all parts of the piano circuitry (Fig. 3.) These wires are for the +5V regulated power line, the -5V regulated line, ground potential, the switch bus fed via a resistor from the unregulated





+ supply, the output bus, the bias bus and the damper bus.

The bias bus is returned to ground via a rectifier diode and trimming potentiometer in parallel, so that the bus voltage may be finely adjusted. When the sustain pedal is pressed, thus closing a remote switch, the bias voltage is reduced, cutting off Tr_{501} whose base is connected to the bias bus. An emitter-follower Tr_{502} is used to control the damper bus, whose potential is 0.7V below that of Tr_{501} collector. Therefore when the sustain pedal is depressed, the damper bus potential rises by 5V to +4.3V.

Keyboard

The keyboard used in the prototype is a five-octave plastics-keyed C-C electronic organ keyboard of Italian origin, supplied by Elvins Electronics. Other keyboards may be obtained, e.g. from Harmonics Ltd and from Kimber-Allen, and if these are used some of the cabinet dimensions may have to be altered.

For musical reasons it is most preferable that the keyboard be F-F with low F at 43Hz. I believe that such keyboards may now be obtained to order. With a C-C keyboard, one has the option of modifying it to F-F by cutting away the bottom five notes and re-attaching them at the top of the keyboard.

Converting the C-C keyboard. Unhook the springs from the bottom ends and poke out the pivot wire. Put the keys aside in order. Cut the frame flush with low F and cut off the top C mountings also. Rearrange the C-E portion at the top of the keyboard with the top C (now top F) above it, and repair the saw cuts with sheet metal and self-tapping screws, being sure to get the key spacing

exactly right. Replace the keys on the board, threading the pivot wire from the bottom end. A similar operation can be performed on the Kimber-Allen keyboard. If you are at all doubtful about cutting up the keyboard, it would

be better to order the F-F version. As the pitch of the mountings varies over an octave, it is not possible to simply shunt the keys down the board. *Constructional details will be continued in a subsequent article.*

Parts summary

Power supply (Fig. 8)

- Panel fuseholder and 0.5A fuse
- Illuminated push-on, push-off switch (0.5A, 250V)
- 6.3 plus 6.3-V, 1.5-A transformer, or 9-0-9V, 1A (Osmabet)
- Bridge rectifier for 30V, 2A
- Capacitors — 1000 and 5000 μ F 16V

- 100 μ F 6V
- Resistors — 10 and 100 Ω , $\frac{1}{2}$ -watt
- Regulator 5V, 600mA (RS Components)
- BZY88-C5V6 zener diode
- BCY38 transistor
- Three-way mains panel socket (Bulgin)
- Oscillators and dividers (Fig. 6)**
- 709 or 741 op-amps (twelve)
- 2N3708 or BC107 transistors (twelve)
- Capacitors — 15nF 5% polystyrene (twelve)
- Resistors — 10k, 15k 18k, 30k Ω , 2% (two each)
- 20k, 22k, 24k, 27k, 33k Ω , 2% (two each)
- 12k Ω 20% (twelve)
- preset pots (pref. w.w.) 3.3k, 4.7k Ω (six each)

7493 i.c. dividers (thirteen)

Preamplifier (Fig. 7)

- 741 op-amp
- Capacitor 50 μ F 6V
- Resistors — 1k, 5.6k Ω , 10% (two each)
- 10k preset carbon pot

Headphone amplifier (Fig. 7)

- 2N3708 or BC107 — Tr_{401} , Tr_{402}
- OC203 — Tr_{403}
- 2N3703 — Tr_{404}
- 2N3705 — Tr_{405}
- OA200 silicon diode
- Resistors — 8.2, 33 (two), 82, 100 Ω , 10% (two each)
- $\frac{1}{2}$ -watt
- 1k, 2.2k, 5.6k, 10k Ω (two), 10%
- 10k preset carbon pot

Busbar terminations (Fig. 3)

- Resistors — 3 Ω , 5W (R_{506})
- 3 or 18 Ω , 5W (R_{507})
- 1k Ω (R_{503})
- 22 Ω variable (R_{501})

- 1A silicon diode (D_{501})
- 2N3703 or 2N3903 (Tr_{501} , Tr_{502})

Key circuits (Fig. 4)

- Capacitors — 10 μ F 10V (sixty one)
- 50 μ F 6V (sixty one)
- Resistors — 1k (R_1), 10 or 11k (R_2), 3.3k Ω (R_3)
- $\frac{1}{2}$ -watt, 5% (sixty one each)
- see Table 3 for R_4 values (sixty eight needed)
- 47k Ω (R_5), $\frac{1}{2}$ -watt 5% (sixty one)

- BFY50, BFY51, BFY52 or 2N697 (sixty one)
- OA200 (D_1 , D_2) silicon diode

Hardware

- Keyswitches gold-plated type (sixty two) and keyboard from Elvins Electronics at 8 Putney Bridge Road, London SW18 1HU. Alternative keyboards from Harmonics Ltd, PO Box 32, Chiselhurst, Kent BR7 5RU. Alan Douglas, 4 Lees Barn Road, Radcliffe-on-Trent, Notts.
- Veroboard 17 x 5 x 0.1in (three)
- Vero pins (200)
- Vero track cutter and pin inserter
- Edge connector, 16-way 0.1-in pitch (two)
- Flex — 10/0.1mm 50 metres p.v.c. ins. (two)
- 16/0.2mm 5m } p.v.c. ins.
- 24/0.2mm 3m } assorted colours
- Tinned copper wire — 22 s.w.g. 3m
- 20 s.w.g. 1m

- Jack sockets and plugs
- Tagstrip — 6-way (two) and 12-way
- Pushbutton switch (to stand 100lb load)
- $\frac{1}{4}$ -in grommets
- Cable clamps

1974 Conferences & Exhibitions

Further details are obtainable from the addresses in parentheses

LONDON

Mar. 25-27 West Centre Hotel
Coil Winding International '74
 (Electromation Exhibitions Ltd, Cleveland House, 344a Holdenhurst Road, Bournemouth, Hants)
 Mar. 29-31 Post House Hotel
Sonex '74

(British Audio Promotions Ltd., 31 Soho Sq., London W1V 5DG)

May 19-23 Bloomsbury Centre and Hotel Russell
IREDA Radio Show 1974
 (Victor Brand Associates, 256 Wimbledon Park Road, London, SW19)

July 1-5 Savoy Place
Precision Electromagnetic Measurements

(The 1974 CPEM Secretariat, c/o The Conference Dept., I.E.E., Savoy Place, London WC2R 0BL)

July 9-12 Imperial College
1974 URSI Symposium on Electromagnetic Wave Theory

(Conference Dept., I.E.E., Savoy Place, London WC2R 0BL)

July 12-14 Goldsmith College
The History of Electrical Engineering

(I.E.E., Savoy Place, London WC2R 0BL)

July 15-19 City University
1974 Frontiers in Education

(Conference Dept., I.E.E., Savoy Place, London WC2R 0BL)

July 23-31 Imperial College
8th International Congress on Acoustics

(International Congress on Acoustics, 47 Belgrave Square, London SW1X 8QX)

July 23-26 Savoy Place
Circuit Theory and Design

(Conference Dept., I.E.E., Savoy Place, London WC2R 0BL)

Sept. 23-27 Grosvenor House
International Broadcasting Convention

(International Broadcasting Convention, I.E.E., Savoy Place, London WC2R 0BL)

Sept. 24-26 Brunel University
Minicomputer Forum

(Online, Brunel University, Uxbridge, Middlesex)

Oct. 22-24 Savoy Place
Linear Electric Machines

(Conference Dept., I.E.E., Savoy Place, London WC2R 0BL)

Nov. 26 & 27 Savoy Place
Plastics in Telecommunications

(The Plastics Institute, 11 Hobart Place, London SW1W 0HL)

Dec. 3-5 Savoy Place
Power Electronics — Power Semiconductors and their Applications

(Conference Dept., I.E.E., Savoy Place, London WC2R 0BL)

BRIGHTON

May 7-9 Metropole Convention Centre
Electrical Insulation Conference

(Electrical and Electronic Insulation Association, 8 Leicester St., London WC2H 7BN)

June 4-7 Metropole Convention Centre
Communications '74

(ETV Cybernetics Ltd, 109 Kingsway, London WC2B 6UP)

Aug. 27-29 University of Sussex
Control of New Forms of Guided Land Transport

(Conference Dept., I.E.E., Savoy Place, London WC2R 0BL)

Nov. 5-8 Metropole Convention Centre
Automatic Testing 74

(Network, 84 High Street, Newport Pagnell, Bucks MK16 8EG)

COVENTRY

May 14 & 15 Lanchester Polytechnic
Physiological Measurement

(Departments of Electrical Engineering and Biological Studies, Lanchester Polytechnic, Priory Street, Coventry CV1 5FB)

EDINBURGH

Sept. 10-14 University of Edinburgh
Ferroelectricity
 (Dr H. Montgomery, Physics Dept., The University, Kings Buildings, Mayfield Road, Edinburgh EH9 3JZ)

GUILDFORD

Apr. 8 & 9 University of Surrey
Leaky Feeder Radio Communication Systems
 (Miss A. J. Perkins, Dept. of Electronic & Electrical Engineering, University of Surrey, Guildford, Surrey)

HATFIELD

July 15-26 Hatfield Polytechnic
Vacation school on Signal Processing in Modern Telecommunication Systems
 (Divisional Secretary (Electronics), I.E.E., Savoy Place, London WC2R 0BL)

LANCASTER

Aug. 1 & 2 University of Lancaster
Microwave Acoustics
 (The Institute of Physics, 47 Belgrave Square, London SW1X 8QX)

LIVERPOOL

Apr. 17-19 University of Liverpool
Negative Ions
 (The Institute of Physics, 47 Belgrave Square, London SW1X 8QX)

Sept. 18 & 19 University of Liverpool
Electrostatics: Fundamentals, Application and Hazards
 (The Institute of Physics, 47 Belgrave Square, London SW1X 8QX)

MANCHESTER

Apr. 3-4 UMIST
Metal Semiconductor Contacts
 (The Institute of Physics, 47 Belgrave Square, London SW1X 8QX)

NOTTINGHAM

Sept. 9-14 University of Nottingham
Magnetic Resonance and Related Phenomena
 (Professor E. R. Andrew, Dept. of Physics, The University, University Park, Nottingham NG7 2RD)

Sept. 16-19 University of Nottingham
European Solid State Device Research Conference (ESSDERC 1974)
 (The Institute of Physics, 47 Belgrave Sq., London SW1X 8QX)

OXFORD

Apr. 1-4 University of Oxford
Vacation school on Functional Analysis for Engineers
 (Secretary, Institution of Electrical Engineers, Savoy Place, London WC2R 0BL, quoting the reference LS/CA)

SOUTHAMPTON

Apr. 8-11 University of Southampton
Computer Aided Design
 (Conference Dept., I.E.E., Savoy Place, London WC2R 0BL)

Apr. 8-11 University of Southampton
CADEX '74
 (Electronic Engineering Association, 8 Leicester Street, London WC2H 7BN)

SWANSEA

Mar. 26-29 University College
Atomic and Molecular Physics
 (The Institute of Physics, 47 Belgrave Square, London SW1X 8QX)

July 8-11 University College
Aviation Electronics
 (Symposium Secretary, SERT, 8-10 Charing Cross Road, London WC2H 0HP)

OVERSEAS (March-May)

Mar. 26-29 Copenhagen
AES Convention
 (Robert Sorensen, Kinovox, Industrievvej 9, 3540 Lyng, Denmark)

Apr. 1-5 Liege
Radio Communication in Mines, Roads and Tunnels
 (Institut National des Industries Extractives, Rue de Chera, B-4000 Liege, Belgium)

Apr. 1-6 Paris
International Electronic Components Exhibition
 (S.D.S.A., 14 rue de Presles, 75740 Paris Cedex 15, France)

Apr. 2-4 Las Vegas
Reliability Physics
 (J. Vaccaro, Rome Air Development Ctr., RBRP, Griffiss AFB, N.Y. 13441, U.S.A.)

Apr. 2-5 Montreux
Electro-optics
 (Mack-Brooks Exhibitions Ltd, 62-64 Victoria Street, St. Albans, Herts A11 3XT)

Apr. 16-18 New York City
Optical and Acoustical Micro-electronics
 (Polytechnic Institute of Brooklyn, Microwave Research Institute, 333 Jay Street, Brooklyn, New York 11201, U.S.A.)

Apr. 21-24 San Francisco
Circuits and Systems Theory
 (Dr. S. P. Chan, Dept. of Electrical Engineering and Computer Science, University of Santa Clara, Santa Clara, California 95053, U.S.A.)

Apr. 21-26 Los Angeles
SMPT Spring Conference
 (Society of Motion Picture & Television Engineers, 862 Scarsdale Ave., Scarsdale, N.Y. 10583, U.S.A.)

Apr. 22-26 Amsterdam
Eurocon '74
 G. Gaikhorst, c/o F.M.E., Nassaulaan 13, The Hague, Netherlands.

Apr. 29-May 1 Orlando
Southeastcon '74
 (Claude E. Jones, Mail Point 417, Martin Marietta Corporation, P. O. Box 5837, Orlando, Florida 32805, U.S.A.)

May 14-17 Toronto
Intermag
 (International Magnetics Conference, Box 82, Coopersburg, Penna. 18036, U.S.A.)

May 20-23 Ottawa
Subscriber Loops and Services
 (Mrs. Jean Higgerty, Bell-Northern Research, P.O. Box 3511, Station C, Ottawa, Canada K1Y 4H7)

May 20-24 Davos
Biotelemetry
 (International Society on Biotelemetry, Swiss Federal Institutes of Technology, Lausanne EPFL, Switzerland)

May 21-23 Rosemont, Ill.
Coil Winding Chicago '74
 (Coil Winding International Exhibitions (Norglebe Ltd), Cleveland House, 344a Holdenhurst Road, Bournemouth BH8 8BE, Hants, England)

May 29-31 Atlantic City
Frequency Control
 (U.S. Army Electronics Technology & Devices Lab. (Ecom), Fort Monmouth, N.J., U.S.A.)

Letters to the Editor

Noise measurement and dB

Discussion in recent issues on the performance of feedback amplifiers in respect of distortion and, more especially, of noise has been most interesting but, to my mind, rather confusing and inconclusive.

Letters and articles by, among others, Messrs J. Linsley Hood, H. P. Walker, J. Stuart, J. Fison and E. F. Taylor indicate a certain amount of mutual misunderstanding and a possibly misplaced reliance upon theoretical predictions based upon rather abstract mathematical exercises. As a one-time practising design engineer, I sometimes feel that if I read one more self-confident prediction invoking Boltzmann's Constant I shall run screaming.

May I suggest that many readers, myself emphatically included, would be most interested and directly assisted in their work by a lengthy article — or, more probably, a short series — giving in a factual way the results of *measurement* of noise produced by a variety of circuits and of individual types of components both active and passive, and more especially dealing with the construction and use of apparatus for noise measurement which would lie within the capacity of the individual constructor and technician?

I have met, here and there, a tendency to regard such measurements as impossible for anyone not backed by an array of expensive and complex commercial equipment and a formidable budget. I doubt that this is true, and it tends to restrict practical testing into too few channels. Further, it leads to unquestioning acceptance of pronouncements from well-equipped authorities, when personal tests could be more rewarding. It has been my experience over many years that the engineer who too easily accepts, without experimental check, the calculated results of the theoreticians is in serious danger of knowing for a fact something that just is not so.

Arising from the foregoing, may I make a request? Could some of your contributors refrain from the growing practice of treating the decibel as an absolute electrical unit, rather than as the ratio — well or ill-defined — which it actually is? For example, a writer discussing the matching of tuners to amplifiers derives a simple formula and continues

“... where X is the signal strength in dB ...”. There we part company and I retire from the struggle for comprehension, murmuring “dB referred to *what?*”. Signals, including unwanted ones like noise and hum, should surely be expressed in volts, amperes, or fractions thereof; most of us are probably capable of converting to dB referred to some other signal or quantity if that seems helpful.

F. G. Canning,
Portsea,
Australia.

Hi-fi equipment standards

In your November 1973 issue the drafts for the coming British hi-fi standard have been compared to the German hi-fi standard DIN 45500. On this occasion DIN 45500 has been typed “mid-fi”. This cannot be accepted without response.

Reading and judging the DIN hi-fi standard without knowledge of the methods of measurement and their conditions will lead to erroneous assumptions. DIN 45500 has been worked on and established during the years 1963 to 1966 and partially revised in 1972. The original purpose of the standard was and is to give the consumer (who pays) the means of comparing and judging what hi-fi equipment he buys. This means furnishing the consumer with data he can use and compare. It does not mean establishing a standard with levels as high as can be achieved by the present state of the art. This has remained unchanged. The DIN values are absolute minimum values and must be met, without any exceptions or tolerances whatsoever, in all points by all units of hi-fi equipment of a certain series. Furthermore, if a manufacturer claims better specifications than DIN for his product, such better specifications must be measured according to DIN 45500 and must also be fulfilled by all units of the series. Consequently in design always the rule of “worst case condition” applies. The addition of all tolerances in construction material, e.g. semiconductors, capacitors, is included in the definition “worst case condition”. It must not be overlooked that DIN furnishes two criteria: minimum requirements *and* uniform measuring methods. The latter is deemed a necessity for making competition transparent. When designing an amplifier under application of today's technology and consideration of the “worst case condition” with the goal of observing the 1% t.h.d. limit set forth by DIN, the product finally manufactured will then display a t.h.d. of 0.15% or better. It would be highly unfair to the consumer to make him pay more money for an amplifier processing programme material and driving loudspeakers having, as a rule, a t.h.d. considerably higher.

The matter is different when looking into signal-to-noise ratio. Everyone having to do with high fidelity knows that one of the most unpleasant experiences is the hiss accompanying a stereo broadcast. Please

permit me to quote in comparison the relevant figures as demanded by DIN 45500 and the BSI standards draft for radio tuners. On first sight the figures for weighted and unweighted signal-to-noise ratio appear to be the same. In reality there are considerable differences, explained by the following facts: In the BSI standard the noise levels are related to a deviation of 22.5 kHz, whereas in DIN a deviation of 40 kHz is set as a measuring condition. This makes the British standard stricter by 5 dB. The BSI provides for measuring conditions according to IEC publication 268/3. Up to the present, in Germany measuring conditions are set forth in DIN 45405. This standard demands, for weighted signal-to-noise ratio, the application of a weighting curve which raises frequencies around 5000 Hz up to 8 dB from zero. The measuring instrument for this purpose must have a quasi peak-to-peak indication. The peak-to-peak indication and the weighting curve according to DIN 45405 result in a measurement 10 dB lower than if measured according to IEC 268/1, clause 7.2, 7.3 and 7.5, i.e. this particular DIN condition of measurement is 10 dB stricter than BSI (IEC). BSI and DIN provide for a weighted signal-to-noise ratio of 54 dB. If measuring methods according to IEC were applied, DIN would have to quote 59 dB on account of the different measuring methods as outlined above. A figure of 54 dB obtained by measurement according to BSI would directly correspond to a figure of 49 dB measured according to DIN. The figures make evident the influence of the different measuring methods. In contrast to DIN, the BSI standards draft does not differentiate between mono and stereo operation. It furnishes only conditions for mono operation. However, with f.m. reception the problem is not hiss on mono reception but hiss on stereo reception. This is the reason why DIN provides for an antenna level of 3.3 nW for both conditions, whilst BSI puts down 0.39 nW for mono only. A possible conclusion would be to propose for a future IEC standard a figure of 60 dB for weighted signal-to-noise ratio measured according to IEC (also BSI) and an unweighted signal-to-noise ratio figure between 46 and 48 dB (IEC/BSI), applying to mono *and* stereo reception.

Similar conditions exist with the signal-to-noise ratio figures for amplifiers. The BSI draft provides that the total noise output power shall not exceed μ W. DIN provides for an unweighted signal-to-noise ratio of 50 dB related to an output power of 50 mW per channel, measured at a position of the gain control which produces 50 mW output power with the signal sources 5 mV for low impedance pickup heads and 500 mV for tuners, tape-recorders, etc.; inputs (for measurements) being terminated for high impedance inputs with 47 k Ω in parallel with 250 pF and for magnetic pickups with 2.2 k Ω . Also, this unweighted signal-to-noise ratio has to be measured with an instrument with quasi peak-to-peak indication according to the measuring methods described in DIN 45405. Comparison: BSI indicates 1μ W.

This equals 2 mV applied to a 4-ohm speaker. This 2 mV amounts to a signal-to-noise ratio of 47 dB related to a signal of 50 mW, measured according to IEC 268.1, clause 7.3. The same measurement according to DIN results in a figure of 38 dB for unweighted signal-to-noise ratio, as well as weighted signal-to-noise ratio. This means that the DIN method of measurement is so much stricter that a measuring figure unfavourable by 9 dB shows, compared to BSI, where actually the same condition exists. Also, here it should be considered establishing an unweighted signal-to-noise ratio of 55 to 56 dB. Measuring conditions: Volume control adjusted to between the position 50 mW and the position for rated power, always produced by an input reference signal for high impedance inputs of 500 mV and for magnetic pickup inputs of 5 mV; inputs (for measurements) being terminated as described above. All measurements according to IEC 268.

Measurements and tests made by independent and neutral German hi-fi magazines and test institutes reveal very often that equipment by well-known manufacturers around the world show testing results below or just achieving the moderate respective minimum figures set forth by DIN 45500.

The British draft for the future IEC standard shows that it is made by people knowing their business. It is correct that in some points the BSI draft sets forth stricter conditions. It is clear that today DIN 45500 can be made stricter in some points without making the product dearer. Admittedly the designing audio engineer very likely has to put in some more brainwork to meet such stricter standards.

The hope is justified that in the near future the international experts will arrive at a universal standard for hi-fi equipment, enabling the consumer (who pays) to judge a piece of hi-fi equipment from any country simply by comparing figures meaning the same. This will certainly promote the cause of hi-fi.

Heinrich Fischelmayer,
Zirndorf,
W. Germany.

Editor's note: Mr Fischelmayer is the chairman of the working group on household hi-fi audio equipment in the German Standards Institute (DIN).

Frequency shifter for howl suppression

The method advocated by M. Hartley Jones in "Frequency shifter for howl suppression" (July 1973 issue) is doubtless effective for speech, but whether it is acceptable for music is perhaps a subjective matter. A less obtrusive and less elaborate method is the use of tunable tone filter(s) of adjustable bandwidth, many designs of which are outlined in *W.W. Circards* — Series 1; use of the twin-T filter for a particular application is also described in "Designing a low-frequency

active notch filter", N.B. Rowe, *Electronic Engng.*, April, 1972. Ready-built active filters are already on the market. In many halls it is observed that tendency to howling occurs chiefly at a particular frequency, so that the availability of even one such filter may enable gain to be usefully advanced at other frequencies without noticeable distortion.

K. J. Young,
Derby.

Using c.m.o.s. devices

I was interested in the recent correspondence on the problems of handling c.m.o.s. and f.e.t. devices. I wonder what percentage are damaged beyond repair before being wired into apparatus.

Recently I was in a component shop in the Edgware Road, London, area when I heard mention of "f.e.t.". I was intrigued to observe the assistant produce some from a plastic tray with pins separated (no sign of a keeper) and lay them on a glass counter and finally pack them into a plastic bag!

I couldn't but wonder whether any of them survived!

In the light of such an experience, the idea of using special soldering irons and conducting benches seems ludicrous. Or is it? Whilst I have had my share of defunct f.e.t. devices, I am now wondering whether it was, indeed, my fault...

Ronald G. Young,
Peacehaven,
Sussex.

Model railway control system

Most model locomotives are driven through a worm drive which is non-reversible. This prevents the loco from coasting when the power is removed as at (f) in Fig.1 of P. Cowan's article in the November issue. The addition of a large flywheel to the motor shaft helps to some extent but it is usually difficult to find room inside the cramped loco body.

Mr Cowan suggests improving the conventional motor by "sawing out the armature slot". If this is done the armature collapses into small pieces. If he means sawing out the armature "tunnel" to take a ring-field magnet then how does he propose to retain the bearing plates at either end? My advice is leave well alone!

The Hornby ring-field motor is far too large to use as a replacement motor and is also not very reliable. Stalled current can be as high as 2A with some of these motors, giving a power dissipation of 12W for T_{r28} and T_{r31} , double the 6W suggested.

Another problem concerns the total current given in Fig.2. This is just over 3A (with the loco running normally, I assume). As a scale modeller the rail section I use is 0.9mm \times 1.8mm nickel silver with a large "groove" down each side — in fact an exact scale version of 95lb bullhead rail. The cross-sectional

area of this rail is less than 1.5mm² and even for copper the quoted working current is less than 2.5A.

Regarding coaches, where do you put the electronics? The inside is detailed with seats and passengers and all the underframe details are there, leaving no room for a heatsink and transistors. Also, no self-respecting railway modeller — as opposed to those who "play trains" — uses Trix coaches as they are to a different scale from the locos.

Finally price! I have about 15 locos and 35 coaches at present (in varying stages of construction) and my layout requires 3 main controllers. The total cost for the separate units for each item would be prohibitive if I could find room in each loco for two pieces of electronic circuitry, a motor and drive and an ear-piece without displacing the crew and cab fittings.

I feel that this system is not a viable proposition for the serious model enthusiast who can achieve the same, if not better, results for a much lower cost by other electronic circuits.

R. A. Ganderton,
Dunstable,
Beds.

One-off printed circuit boards

While developing distributed circuit u.h.f. amplifiers, I found that necessary modifications could be easily and quickly made by covering the copper clad board with Sellotape or Fablon, then cutting round the required circuit shape with a scalpel and peeling the areas to be etched.

Using this method, lines as narrow as 250 μ m are possible, even using boards with 20 μ m of copper. The masking is unaffected by most common etching solutions and the circuit can be drawn on the mask using a fine pointed fibre tip pen.

I wonder why manufacturers do not produce copper clad board already masked. It would protect the copper from dirt and oxidation, which makes etching more difficult, and provide a surface for easy and clear marking out of mechanical as well as electrical details.

The method is of course equally applicable to conventional circuit boards.

M. R. Yeo,
UWIST,
Cardiff.

Surround-sound with headphones

While I and a small group of tape recording friends were pleased to see Sennheiser's recordings specially made for headphone listening brought to the attention of readers (Nov. issue, p.544) we feel too much emphasis has been placed on the dummy head, as though it alone were the reason for the success of the recordings. The dummy head may be very impressive, it may even give a subtle improvement, but we find that the biggest improvement is made by the position of the microphones.

To recap on the main objection usually raised against headphone listening: two sounds of equal loudness produced from two separate sources, provided that they are in phase, will appear as one central sound. If the two sound sources are a pair of headphones, the point between the two is, of course, inside the head. Stereo sound, recorded so that the main difference in position of sounds is achieved by the polar diagram of the microphones feeding a different level to each channel, will just swing the sound from side to side inside the head. This will happen if the recordist makes the mistake of trying to position the microphones as nearly as possible in the same place. Of course, when listening via loudspeakers, the sound "over there" is quite acceptable. Surprisingly it is possible to move the sound outside of the headphones, without the complication of a dummy head or the doubtful dependence on fortuitous interpretation by the listener.

The transformation of the headphone stereo sound requires moving the microphones from the "crossed heads" arrangement to, well, "crossed tails" comes to mind as a suitable expression, so that the transducer elements in the microphones are spaced at 150mm or so. To maintain the "image" the same way round, the microphone leads must reverse channels. It is, of course, easier to position the microphones on their mounting bracket pointing away from each other, and the cables, now sprouting from the microphones near the upright of the stand, can be led away more tidily than when the microphone heads are crossed. It is also interesting to note that, because of the physical size of microphones, it is not practical to bring the two transducers into one place in any case, and this results in a variety of positions with a common variation one above the other, and although it is possible to listen with one's head over to one side, it is not possible to maintain the horizontal polar pattern achieved by the vertically mounted microphones!

So, by the simple expedient of moving the microphones, the sound for the headphone listener has been opened out at least as much as is done by adding a derived difference signal rear channel through several good quality loudspeakers to straight loudspeaker stereo; and whereas the sound over such a loudspeaker system does not properly convey position (although usually an improvement over stereo alone) the two channels on the headphones give accurate 360 degree information to the listener. It would seem that the small but critical time difference, perceived when listening to live sounds, in the arrival of sound at each ear, can in fact be recorded by correctly positioned microphones. This time difference can be included in the loudness difference established by the two microphones and, when presented to each ear without loudness or time difference distortion, the spatial effect is very close to reality. Sounds from the rear appear to come quite solidly from the rear, even if they are being heard for the first time,

and it is rather worrying to find that the spatial effect including the sense of "behind" is actually increased with S.T.C. 4033A microphones switched to "ribbon", even though they can be used as cardioid. This aspect of the performance does not at first make sense if one is thinking from the point of view of simulating the human ear with the microphones, but of course David Hafler has shown that ribbon or "figure of eight" polar diagrams for the microphones will increase the difference signal for side emanating sounds, since the rear of the ribbon is out of phase with the front. It would seem reasonable to suggest that the brain can detect a phase difference between two sounds presented simultaneously, giving us a preference for this information when it is available. This difference signal is not the reason for the sound moving to the outside of the headphones, and relatively inexpensive microphones such as the A.K.G. D19 still give an excellent result.

The success of recordings made in this manner seems to indicate that more attention could be given to the relationship between the microphone spacing and the loudspeaker spacing, so that the time difference that would have been heard several feet behind the microphones is preserved by the recording and played back over the loudspeakers, even though an anomaly will always exist for sound coming from behind the microphones for replay in this manner. This line of thought can be projected further into an explanation for the improvement of stereo with a derived difference rear channel, based on the fact that loudspeakers spaced several feet apart cannot reproduce the sound field of two microphones mounted fairly close together, even though small differences in the microphone position are inaudible. The difference channel, in all its various guises, has an output which coincides with some point along the centre line of the main left and right loudspeakers, and thus, far from increasing the apparent sound source, it has in effect reduced the difference in the sound from the two main loudspeakers, as perceived by the listener, until the position they appear to be in is much more like the position of the two microphones on one stand. Therefore there appears to be an important relationship between the time interval heard by the listener's two ears and the instantaneous phase of the signal. If this can be understood, it may well be a bigger step forward than quadruphony.

John C. Tugwell,
Southend,
Essex.

Radiating coaxial cables

We have read with interest your correspondence relating to the use of radiating coaxial cables in communication systems (Sept. and Nov. issues 1973).

Mr Avery refers to the attenuation of "loose braid" (*sic*) cables in v.h.f. and u.h.f. systems under conditions of contamination by dirt and moisture. As manufacturers of radiating cables using

both types of coupling mechanism, i.e. holes (apertured tape outer conductors) and reduced cover ("open") braids, we have carried out extensive tests on both types of cable and have found no evidence to support the contention that the latter types are susceptible to the effects of adverse environmental conditions.

From tests of attenuation carried out at v.h.f. and u.h.f. we have found that open braid cables laid on the ground, against wall surfaces, covered with wet mud, and immersed in water, exhibit no change in linear attenuation as compared with cables suspended in air clear of external objects. With our apertured tape cable a small increase can be observed at u.h.f. with the cable immersed in water.

Our experimental evidence is supported by the satisfactory performance of working installations, in particular systems operating in NCB mines where braided radiating coaxial cables have been extensively used, in some cases under very adverse conditions.

We are, of course, referring to braided cables specifically designed for this service, where the braid design has been developed to achieve the necessary balance between radiation and linear attenuation, an important requirement in long systems. The open weave cables referred to by Mr Goddard, presumably television downlead type cables having braids with optical cover of the order of 60%, are not designed for these applications.

J. L. Goldberg and A. J. Willis,
BICC Ltd,
Helsby, Cheshire.

Soldering-iron leakage

To-day soldering iron manufacturers make quite a big issue about the leakage to earth of their soldering irons, claiming that this can damage transistors and similar devices. This I am sure is perfectly true. What I would like to know is what is the maximum permissible leakage at which an iron can safely be used on transistors. The reason is that I shall then be able, when I am offered a soldering iron, to ask the manufacturers if it measures up to this particular specification.

I think, to-day, any iron that does not meet this requirement is only suitable for soldering kettles!

A. Sproxtton,
Home Radio (Components) Ltd,
Mitcham,
Surrey.

Thank you all readers who have written enquiring about the absence of the January and February issues (see announcement on p.30). It's nice to know we have been missed!

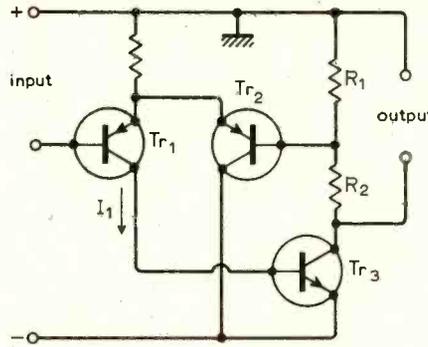
Editor

Circuit Ideas

Novel 5-watt class A amplifier uses three-transistor feedback circuit

There are seemingly endless ways of making a feedback loop using two or three transistors. One configuration which has proved valuable is shown on the right. A fraction $R_1/(R_1+R_2)$ of the output p.d. is compared with the input in the long-tailed-pair Tr_1 and Tr_2 , and the resulting current I_1 controls the current source Tr_3 . In one application (below) a cheap voltage stabilizer was produced, in which the output p.d. is little less than the unstabilized p.d. and in which the ripple is low (usually incompatible requirements).

In another application the circuit was used to make a 5-W a.f. amplifier



operating in class A. The usual emitter resistor (bottom) is now combined with the choke d.c. resistance in the collector circuit where it continues to provide d.c. stability with less nuisance value. The peculiar arrangement of C , C and R feeding the loudspeaker keeps the feed capacitors properly polarized as the output p.d. swings above and below zero level. A single capacitor could be used instead if the loudspeaker were returned to the negative supply, but power supply ripple would then find its way into the feedback loop.

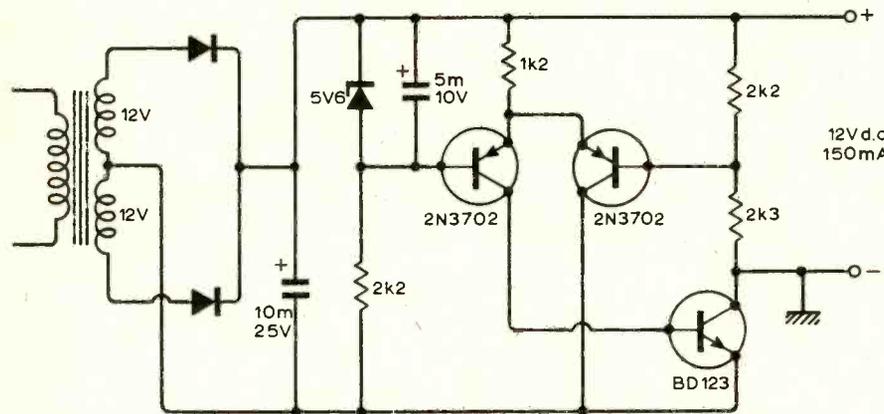
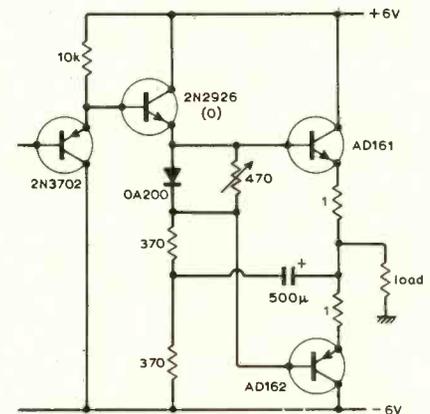
R. H. Pearson
North East London Polytechnic

Deflection coil driver for slow-scan television

The circuit shown was developed for use in the line timebase amplifier of a slow-scan television system operating at 4Hz. The

most unusual feature is the use of an emitter follower in the driver stage. This together with the first transistor was needed to match the output impedance of the unijunction oscillator used to provide the sawtooth waveform: such a circuit gives a large output voltage at high impedance. The amplifier drives the deflection coils of an old 17-in television tube, which have a resistance of about 5Ω . The diode and variable resistance provide slight forward bias for the output pair; the capacitor applies part of the base input to their emitters, enabling them to provide some voltage gain.

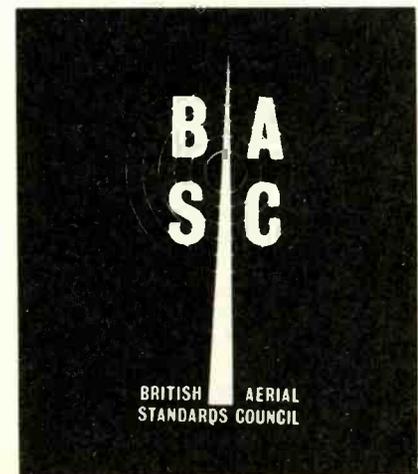
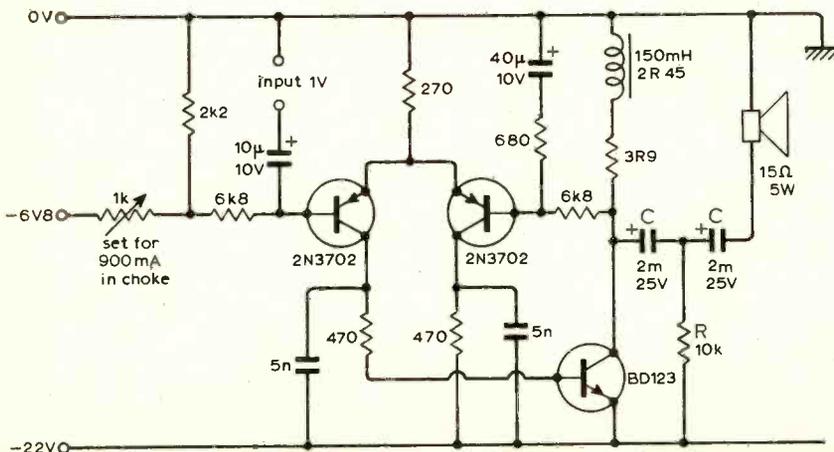
M. Hadley
Sutton Coldfield

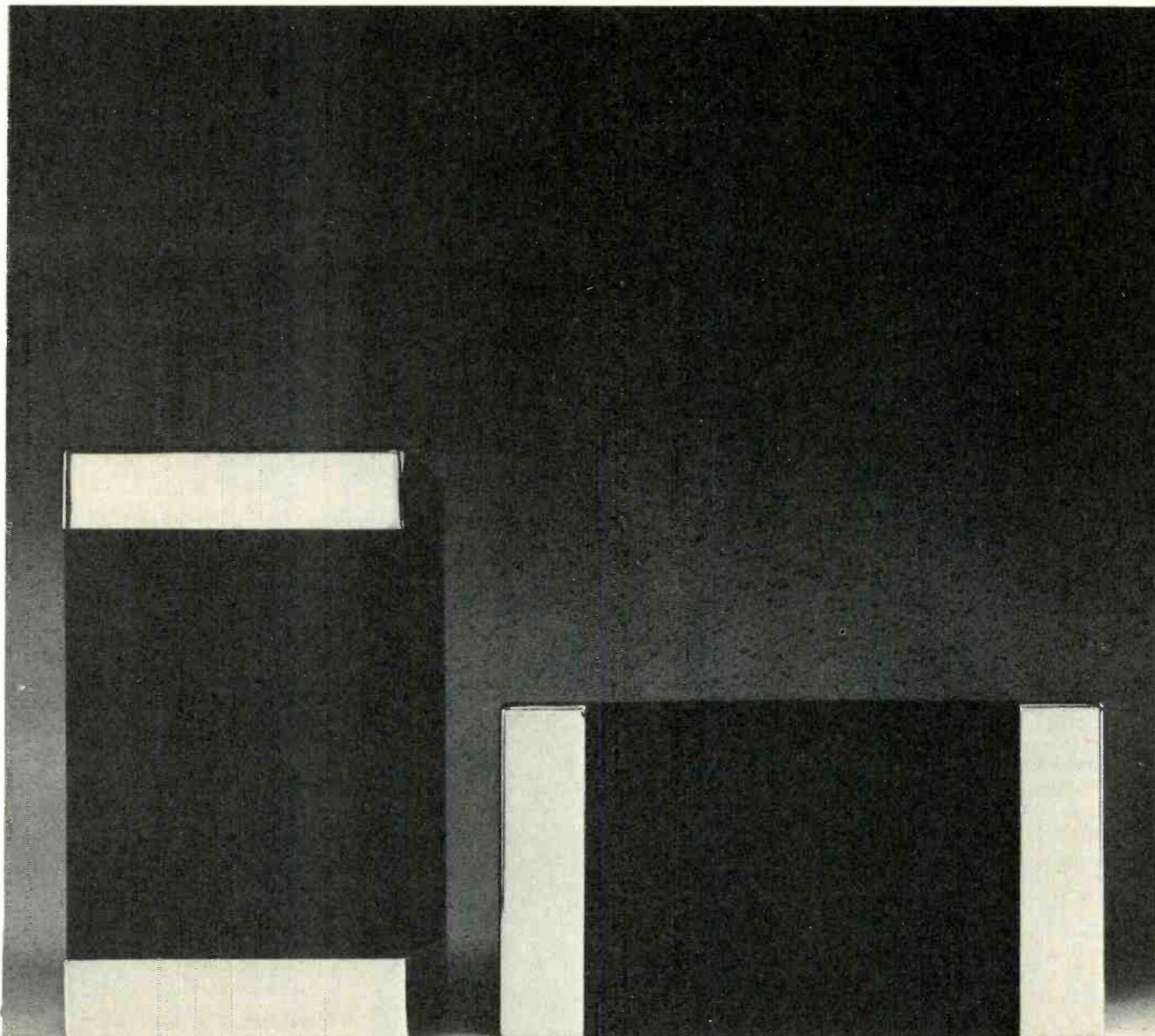


Aerial seal of approval

Shown here is the new motif which is to be used by members of the British Aerial Standards Council. It will be seen on packaging and point of sale material going out to dealers as soon as existing stocks of packaging material have passed through the production pipelines.

The B.A.S.C. hopes that its "radiation pattern" symbol will quickly become a familiar sight in all places where television aerials are sold as "... the sign of a good aerial".





The Ultimate Draws a Little Closer

How can the qualities of the new Gale GS401A be conveyed? Not in words, certainly. To assess this new speaker, there's nothing for it but to go along to a dealer. He will tell you first that the GS401A carries a seven year guarantee. Then, when you've admired the handsome exterior created by Jon Bannenberg in matt black and chrome, we suggest you use some test equipment. All you have to do is take a good pair of ears. This delicate apparatus will tell you that, for a speaker only 23½ x 13 x 10½ inches, the GS401A combines an unusually high power handling with breathtaking clarity. You will also need a favourite record. Preferably the one you use to impress your friends with the quality of your existing equipment. The one with prominent percussion and a wide dynamic range. We have only one serious anxiety. With the GS401A being the breakthrough it is, we worry that you simply won't believe the evidence of your ears. At the time of going to press, the Gale GS401A can be seen at the following franchised dealers only.

Grahams Electrical Ltd 86-88 Pentonville Road London N1
 Hampstead Hi-Fidelity 91 Heath Street Hampstead London NW3 6SS
 Thomas Heinitz Music in the Home 35 Moscow Road London W2
 Henry's Radio Limited 354 Edgware Road London W2
 REW (Audio Visual) Co Centre Point London WC1
 Studio 99 81 Fairfax Road London NW6
 Audio Systems 23 South Street Dorking Surrey
 Audio Impressions Ltd 32 High Street South Dunstable Beds
 Complete Audio Systems 32 Grove Road Eastbourne Sussex
 Hi Fi Corner 1 Haddington Place Edinburgh EH7 4AE
 Guildford Hi Fi 270 Upper High Street Guildford Surrey
 Audio Systems 28 Queens Parade Queen Street Horsham Sussex
 Audio Systems 18 High Street Lewes Sussex
 Unilet Products Ltd Compton House 35 High Street New Malden Surrey
 KJ Leisuresound Ltd 101 St Albans Road Watford Herts

GALE

Gale Electronics & Design Limited 39 Upper Brook Street London W1Y 1PE

WW-111 FOR FURTHER DETAILS

The Sinclair Cambridge... no other calculator is so powerful and so compact.

Complete kit-£24.95!

(PLUS VAT)

The Cambridge – new from Sinclair

The Cambridge is a new electronic calculator from Sinclair, Europe's largest calculator manufacturer. It offers the power to handle complex calculations, in a compact, reliable package. No other calculator can approach the specification below at anything like the price – and by building it yourself you can save a further £5.50!

Truly pocket-sized

With all its calculating capability, the Cambridge still measures just $4\frac{1}{2}'' \times 2'' \times \frac{1}{16}''$. That means you can carry the Cambridge wherever you go without inconvenience – it fits in your pocket with barely a bulge. It runs on U16-type batteries which gives weeks of life before replacement.

Easy to assemble

All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our service department will back you throughout if you've any queries or problems.

Total cost? Just £27.45!

The Sinclair Cambridge kit is supplied to you direct from the manufacturer. Ready assembled, it costs £32.95 – so you're saving £5.50! Of course we'll be happy to supply you with one ready-assembled if you prefer – it's still far and away the best calculator value on the market.



Features of the Sinclair Cambridge

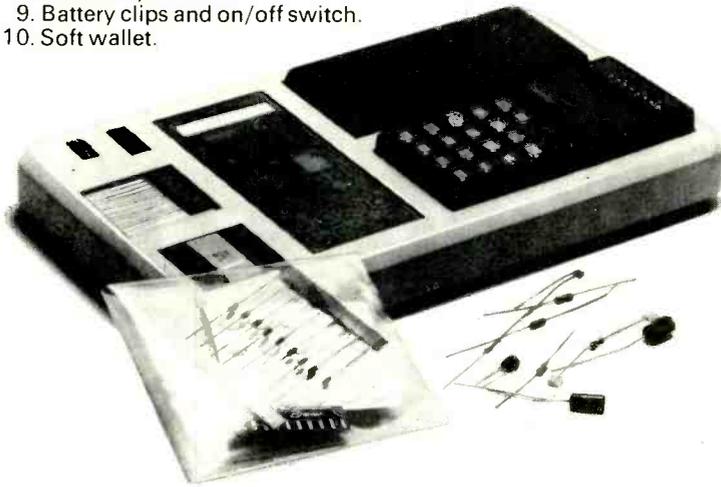
- *Uniquely handy package. $4\frac{1}{2}'' \times 2'' \times \frac{1}{16}''$, weight $3\frac{1}{2}$ oz. Smart black and tan styling.
- *Standard keyboard. All you need for complex calculations.
- *Keys react with positive click when pressed.
- *Clear-last-entry feature.
- *Automatic ('implied') constant – no need for separate operating button.
- *Common-sense ('algebraic') logic – enter calculations just as you write them.
- *Calculates to 8 significant digits; fully floating decimal point positions itself automatically.
- *Clear, bright 8-digit display.
- *Unwanted zeros are suppressed.
- *Display flashes to indicate overflow.
- *Operates for weeks on four U16-type batteries.

A complete kit!

The kit comes to you packaged in a heavy-duty polystyrene container. It contains all you need to assemble your Sinclair Cambridge. Assembly time is about 3 hours.

Contents:

1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



Actual size!

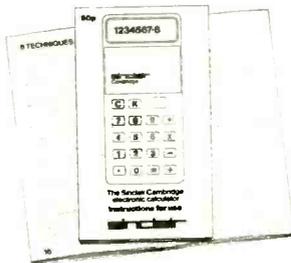


4½in long x 2in wide x 11/16in deep

This valuable book – free!

If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

But if you want to get even more out of it, you can go one step further and learn how to unlock the full potential of this piece of electronic technology.



How? It's all explained in this unique booklet, written by a leading calculator design consultant. In its fact-packed 32 pages it explains, step by step, how you can use the Sinclair Cambridge to carry out complex calculations

Why only Sinclair can make you this offer

The reason's simple: only Sinclair – Europe's largest electronic calculator manufacturer – have the necessary combination of skills and scale.

Sinclair Radionics are the makers of the Executive – the smallest electronic calculator in the world. In spite of being one of the more expensive of the small calculators, it was a runaway best-seller. The experience gained on the Executive has enabled us to design and produce the Cambridge at this remarkably low price.

But that in itself wouldn't be enough. Sinclair also have a very long experience of producing and marketing electronic kits. You may have used one, and you've almost certainly heard of them – the Sinclair Project 60 stereo modules.

It seemed only logical to combine the knowledge of do-it-yourself kits with the knowledge of small calculator technology.

And you benefit!

Take advantage of this money-back, no-risks offer today

The Sinclair Cambridge is fully guaranteed. Return your kit within 10 days, and we'll refund your money without question. All parts are tested and checked before despatch – and we guarantee a correctly-assembled calculator for one year.

Simply fill in the preferential order form below and slip it in the post today.

Price in kit form: £24.95 + £2.50 VAT. (Total: £27.45)

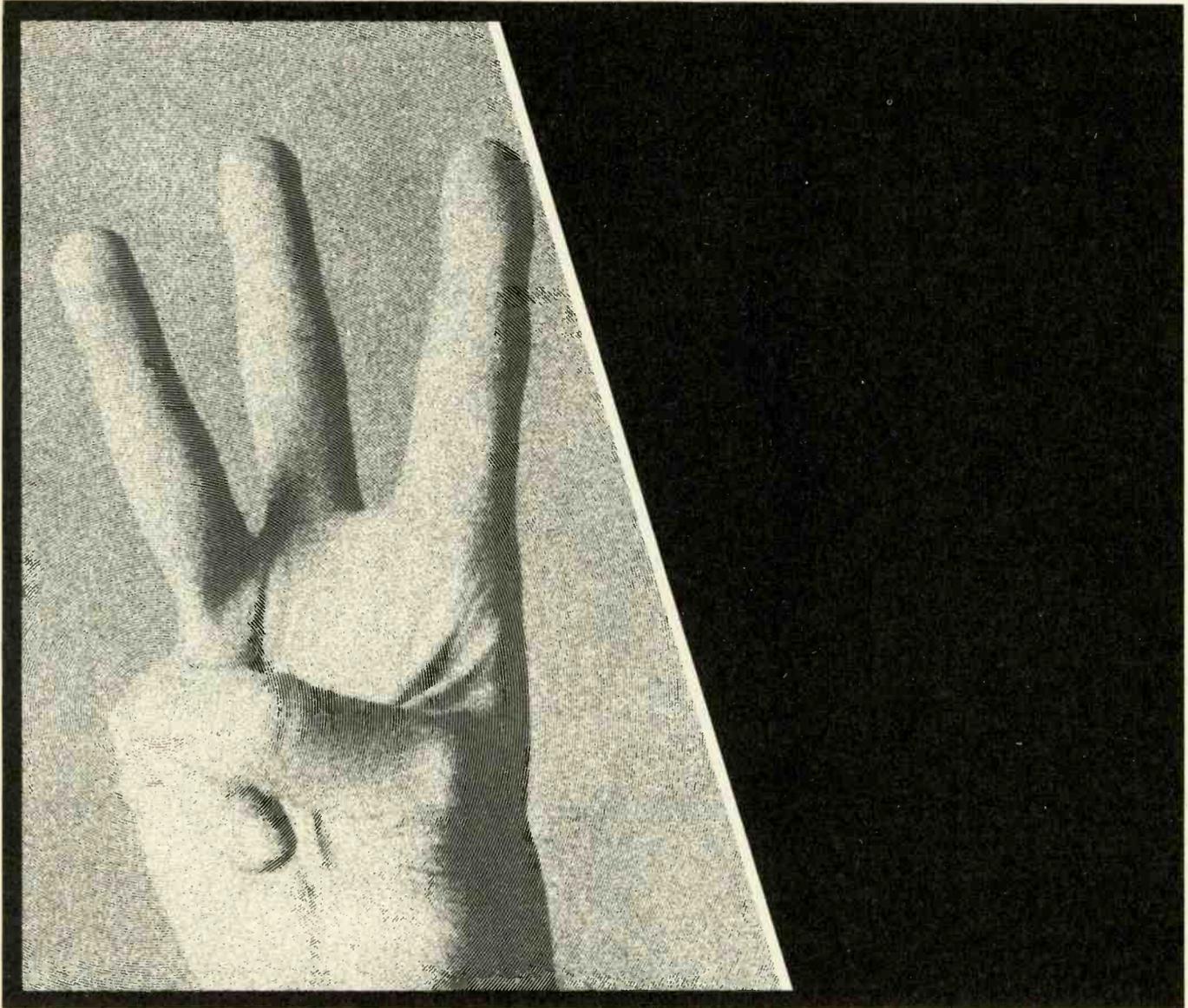
Price fully built: £29.95 + £3.00 VAT. (Total: £32.95)

To: Sinclair Radionics Ltd, London Road, St Ives, Huntingdonshire, PE17 4HJ		WW/3/74
Please send me		Name _____
<input type="checkbox"/> a Sinclair Cambridge calculator kit at £24.95 + £2.50 VAT (Total: £27.45)		Address _____
<input type="checkbox"/> a Sinclair Cambridge calculator ready built at £29.95 + £3.00 VAT (Total: £32.95)		_____
*I enclose cheque for £ _____, made out to Sinclair Radionics Ltd, and crossed.		_____
*Please debit my *Barclaycard/Access account. Account number _____		_____
*Delete as required.		_____
		PLEASE PRINT

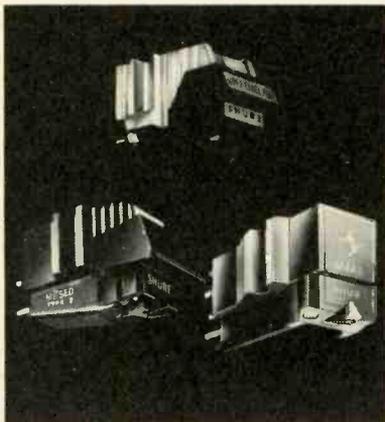
sinclair

Sinclair Radionics Ltd, London Road, St Ives, Hunts.
Reg. no: 699483 England VAT Reg. no: 213 8170 88

WW-112 FOR FURTHER DETAILS



Best. Best. Best.



Permit us this momentary bit of self-indulgence, because our intentions are pure: to assist you in choosing the best pickup cartridge for your hi-fi system, within the practical limitations of your audio budget. To begin, if you feel uncomfortable with anything less than state-of-the-art playback perfection, we heartily recommend the Shure V-15 Type III, a cartridge of such flawless performance it is the perfect companion to the finest turntables and tone arms available today — and those coming tomorrow. At a more moderate level of performance and price, we suggest the Shure M75ED Type 2, a superb performer second in trackability only to the Type III. For optimum performance with a limited budget, the yeoman Shure M44E is for you. All in all, these are three great ways to enjoy music with the kind of system you have decided is best for you.

Shure Electronics Limited
 Eccleston Road, Maidstone ME15 6AU
 Telephone: Maidstone (0622) 59881

WW-113 FOR FURTHER DETAILS



Horn loudspeaker design

Three articles summarizing the development of design theories and concluded with two systems for construction

by J. Dinsdale, M.A., M.Sc.

Cranfield Unit for Precision Engineering

After a period in the infancy of the gramophone when it was universally employed, the horn loudspeaker has fallen from popularity, due probably to its relatively large size, complexity of manufacture and hence high cost. Although full-range horn systems are used today only by a small number of enthusiasts, most experts are unanimous in acclaiming their virtues as loudspeaker enclosures, especially their high degree of realism and "presence". These articles examine briefly the history of the exponential horn loudspeaker and discuss the theory of horn-loading and the technical requirements of a good design. Comprehensive data are included for a wide range of horns, together with outline designs for a large and a small horn, suitable for domestic use.

The ideal exponential horn consists of a straight circular tube whose cross-sectional area increases logarithmically along its length from a small throat (at which is mounted the loudspeaker) to a large mouth. Extreme bass notes demand a mouth of very large area (20 to 30 sq. ft) and a horn at least 20ft in length, whereas extreme treble notes require a horn with dimensions of only a few inches. For this reason most wide-range horn systems will incorporate a number of separate loudspeakers, each with its individual horn of appropriate length and mouth area. To accommodate these horn combinations within a cabinet of reasonable size, the bass and middle horns are generally of square cross-section and are "folded" into a complicated pattern. Unfortunately, the inevitable restrictions and compromises introduced by these departures from a straight axis and circular section can cause serious variations in the frequency response, and much of the art of horn design is concerned with achieving a product of reasonable overall size and cost, without sacrificing any of the astonishing realism which is obtainable from the ideal horn.

The efficiency of a horn system will be typically between 30 and 50%, a figure to be compared with 2 or 3% for a bass-reflex enclosure and less than 1% for a totally-enclosed box.

The principal reasons for the evident lack of popularity of the horn probably lie in its dimensions and cost. The overall size of a bass horn, even when folded into a cabinet of reasonable shape, will be larger than a bass-reflex or infinite baffle enclosure of

comparable specification. But although one reads occasionally of straight horns up to 20ft long, excellent results may be obtained from horns of more moderate dimensions; for example a complete horn system may be folded into an attractive cabinet of volume only 6 cu. ft, a not unreasonable size for domestic listening. The cost of horn enclosures is often considered to be prohibitive, and it is true that there is considerably more work in constructing a folded horn than in other enclosures; furthermore, this is work best performed by craftsmen and not easily adapted to "production-line" methods. Nevertheless, the building of a folded horn is by no means outside the capability of a competent do-it-yourself enthusiast, and it is to these individuals that the practical designs will be directed.

Although the early acoustical gramophones or phonographs employed horns of one type or another to couple the diaphragm to the listening room, and the early electrical reproducers of the 1920s and '30s also used horns, thereafter the horn suffered a setback from which it has never recovered. Certainly, a few companies market horn loudspeaker enclosures, and the occasional articles in the technical press^{1,2} stir up a passing interest, but unless one resorts to the masterly academic treatises by Olson³ or Beranek,⁴ or reverts to pre-1940 publications, there is very little information available for the enthusiast who wishes to both design and construct a horn. Recent experience gained by Telfer and others^{5,6} has reinforced the author's opinion that there are many audio enthusiasts who would be interested in constructing a horn enclosure.

After a brief historical survey, these articles examine the theory behind the horn-loaded loudspeaker enclosure and explain the basic points to consider when designing horns. The various compromises adopted by different workers are discussed, especially in the area of folding techniques, and the effects of these compromises on audio quality are studied. Finally, outline designs for two domestic horns are given: a "no-compromise" horn to suit the most fastidious (and enthusiastic) listener, and a "mini-horn" which provides a more limited performance for those with smaller living rooms (and bank balances), and which, while no more obtrusive than most commercial loudspeaker cabinets, will provide extremely clear and natural reproduction.

Background

It has been known for many thousands of years that when sound is passed through a tube with a small throat and a large mouth, it experiences an apparent amplification, and from Biblical times man has used rams' and similar naturally occurring horns both as musical instruments and as megaphones. Thomas Edison attached a tin horn to his primitive phonograph in 1877 to couple the minute vibrations of the diaphragm to the air load in the listening area, and to the majority, the term "gramophone horn" conjures up an image of the early gramophones or phonographs designed between about 1890 and 1912, all of which utilised an external horn.

A variety of expansion contours were employed for these early horns, mainly straight conical horns in the earliest machines, but the later gramophones of this period employed large flaring horns with either straight or curved axes depending on the overall length of the horn and the general design of the complete equipment. An analysis of these early horns, carried out in the light of modern acoustic knowledge, reveals a lack of understanding at that time of the operation of the horn as an acoustic transformer. This is surprising since Lord Rayleigh had analysed the "transmission of acoustic waves in pipes of varying cross-section" in Articles 265 and 280 of his classic treatise "Theory of Sound", published in 1878.⁷

Lord Rayleigh gave the analysis in Art. 281 for the passage of sound through a conical pipe, and he also made the interesting statement that "when the section of a pipe is variable, the problem of the vibrations of air within it cannot be generally solved". For some years after publication, Lord Rayleigh's results were purely of academic interest, but more general interest was aroused about the turn of the century by the early gramophones, most of which used external conical horns, as in the early HMV "dog" models.

After 1912, a number of manufacturers introduced internal horns with a degree of folding to enable cabinets of reasonable size to be used, and these models held the consumer market during the following 12 years, on account of their compactness and suitability as pieces of furniture. (Even in those early days, the enthusiast must have had

problems in persuading his wife to provide house-room for a large unfolded external horn.)

In the early 1920s a number of designers carried out theoretical analyses based initially on the work of Lord Rayleigh, but extending the work to be more applicable to the full audio range at domestic listening levels. Among these early analyses must be mentioned the work in America by A. G. Webster⁸ in 1920, by C. R. Hanna and J. Slepian⁹ in 1924 and by P. B. Flanders¹⁰ in 1927. In Britain independent analyses were carried out by P. Wilson in 1926 writing in *The Gramophone* magazine and later with A. G. Webb in "Modern Gramophones and Electrical Reproducers", and also by P. G. A. H. Voigt¹² in 1927.

All of these analyses, except the last, were based on an exponential contour, and were derived from a statement in Art.265 of Rayleigh's treatise. Webster had worked out an approximate theory for other types of horn and had deduced that the exponential was the optimum contour. All these analyses made the assumptions that (a) the cross-section is circular, (b) the axis is straight, and (c) all wavefronts are plane.

However, while it may be reasonable to assume plane wavefronts at the throat of the horn, it is clear that the wavefront at the mouth will be curved (as if a balloon were emerging from the horn, being inflated at the same time). Wilson, who had independently derived the analysis of the exponential horn in 1926 working from Rayleigh's treatise, later published a modified form on the assumption that the wavefront would assume a spherical shape always cutting the

contour of the horn and its axis at right angles.

This assumption, that the curvature of the wavefront would gradually increase from zero (the initial flat wavefront at the throat), satisfies also the condition specified by Hanna and Slepian and later by I. B. Crandall¹³ that the wavefront as it emerges from the open end will be equivalent to that provided by a spherical surface, as opposed to that produced by a flat piston. Voigt, however, had commenced his analysis on the assumption that wavefronts within the horn will be spherical and of the same radius throughout their progression through the horn. This assumption leads to a tractrix curve for the horn contour, and both theoretical considerations and very careful listening tests by the author and others tend to support the claims of the tractrix as the optimum horn contour. The mathematical basis of the exponential and tractrix curves is discussed in a later section of this article.

During the 1920s, 30s and 40s a large number of experimenters investigated methods of folding horns into small enclosures for domestic gramophone reproducers, and the records of the Patents Office bear witness to the ingenuity of man at overcoming conflicting conditions in the search for perfect sound reproduction. These designs for folded horns enjoyed a greater or lesser degree of success according to a number of factors including the performance of the loudspeaker motor. Nevertheless, it must be repeated that they were almost invariably of square or rectangular cross-section, and the axis was no longer straight and thus any resemblance between their actual perform-

ance and theoretical considerations was to some extent coincidental.

The advent of the moving coil loud-speaker in 1927 and electrical amplification stimulated further advances in the design of horns, which, because they now no longer had to be connected to the acoustical tone-arm, were freed of many of the earlier constraints. Many loudspeaker motor units were designed specifically for horn loading, and it was not until World War II that interest in the horn lapsed in favour of the bass reflex, infinite baffle and other types of loading systems which, although they had the peripheral advantages of smaller physical size, greater ease of design and manufacture and hence lower cost, were decidedly inferior in terms of musical realism.

During this time the designs of Voigt in Britain and of Klipsch¹⁴⁻¹⁸ in America continued to attract considerable support, especially the ingenious method evolved by the latter in adapting a doubly-bifurcated bass horn design to utilize the acoustic advantages inherent in corner positioning, a design which has now become a classic. Others at this time were experimenting with horn-loaded loudspeakers, notably J. Enoch and N. Mordaunt (whose design was subsequently incorporated in the Tannoy "Autograph" and "GRF" enclosures). Lowther (using a modern version of Voigt's high-flux motor unit) and J. Rogers (whose horn-loaded mid-frequency ribbon is still regarded by many as the ultimate in sound reproduction in this range) and one must not overlook the contributions of H. J. Crabbe¹⁹ and R. Baldock²⁰ in more recent times.

However, it must be emphasised that the multiple reflections, absorptions, resonances and changes of direction inherent in folded horns, together with the uncertainty of function of non-circular sections must inevitably alter the performance of such horns from that of the straight, circular-section horn on which the design may have been based.

Recent years have seen a minor resurgence in the popularity of the horn, caused perhaps by the search for "perfect sound reproduction", and there are many who hope that this trend will continue.

A very readable account of the early history of the horn loudspeaker has been given recently by P. and G. L. Wilson.²¹

General theoretical principles

The following section deals principally with the exponential contour, which is the basic expansion curve used in most high quality horn loudspeakers, and the tractrix, which has a more complicated formula, but with a dominant exponential component—indeed the two curves are virtually identical from the throat to about midway down the horn.

Determination of flare contour

The theory of the conical horn was originally worked out by Lord Rayleigh, but the first serious attempts to establish a practical working formula for the exponential horn were not made until 1919 and the years following. The basic formulae for the transmission of sound waves through horns have been given in modern terms by V. Salmon²²

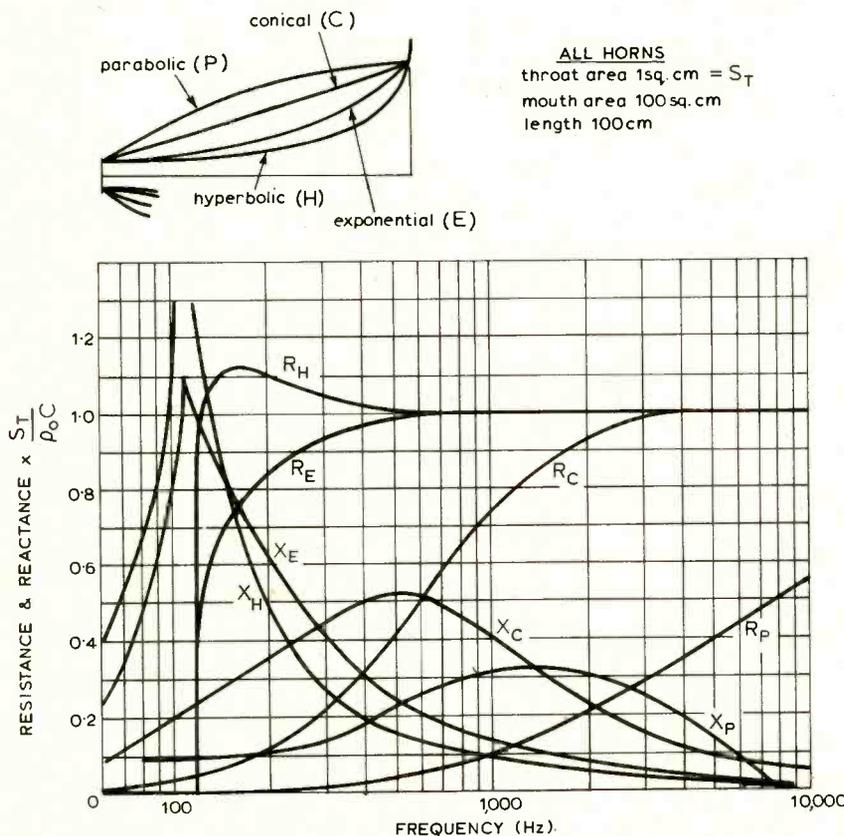


Fig. 1. Acoustical resistance and reactance against frequency at the throats of a series of infinite horns of different contour.

and others. Beranek⁴ has plotted the acoustical resistance and reactance against frequency at the throats of a series of infinite horns of different contour with identical cross-sectional areas at the throat and at a given point along the axis of the horn, and the resulting curves are shown in Fig. 1. For optimum loading of the loudspeaker motor, it may be shown that the impedance presented by the throat of the horn should be entirely resistive and of constant value throughout the working frequency range, i.e. the sound transmission should be of unity "power factor". Examination of the curves in Fig. 1 shows that the exponential and hyperbolic contours satisfy this condition most closely.

However, a further condition to be satisfied is that of minimum distortion at the throat of the horn, caused by "air overload". When a sound wave is propagated in air, a series of harmonics will be produced, thereby distorting the waveform. This occurs because if equal positive and negative changes in pressure are impressed upon a mass of air, the resulting changes in volume will not be equal; the volume change due to an increase in pressure is less than that due to an equal decrease in pressure. The rapid expansion and compression of air caused by the propagation of sound waves takes place adiabatically, i.e. there is no net transfer of heat, and the pressure and volume are related by the formula $pV^\gamma = \text{constant}$, where

- p = pressure
- V = volume
- γ = adiabatic gas constant (approx. 1.4 for air under normal room conditions)

This curve has been plotted in Fig. 2, together with a superimposed large sinusoidal change in pressure to illustrate the corresponding distorted change in volume.

If the horn were a long cylindrical pipe, distortion would increase the further the wave progressed towards the mouth. However, in the case of a flaring horn, the amplitude of the pressure wave decreases as the wave travels away from the throat, so for minimum distortion the horn should flare out rapidly to reduce the pressure amplitude as early as possible after the sound wave has left the throat. From this viewpoint it is apparent that the parabolic and conical contours will generate the least distortion due to air overload, and that distortion will be highest for the hyperbolic horn, because the sound wave must travel a further distance before the pressure reduces significantly.

Further inspection of Fig. 1 shows that the acoustical resistance of the hyperbolic horn lies within 10% of its limiting value over a larger part of its working frequency range than that of the exponential horn, and for that reason the hyperbolic horn provides rather better loading conditions to the loudspeaker motor. However, in view of the considerably higher air-overload distortion of the hyperbolic horn, the exponential or one of its derivatives is generally chosen as a satisfactory compromise between the hyperbolic and conical contours.

In cases where the advantages of a long

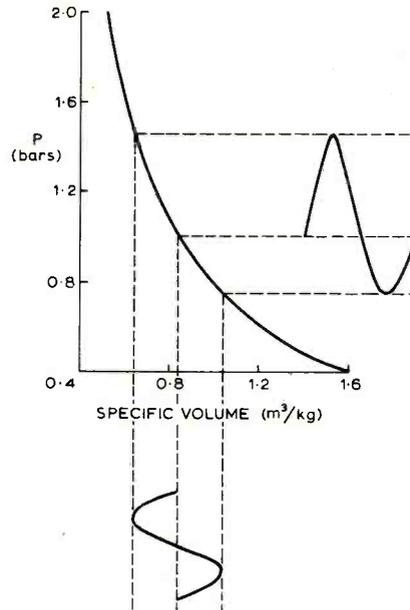


Fig. 2. Adiabatic pressure/volume relationship for air.

slow flare rate are required without the attendant high air-overload distortion, Olson³ has shown that a horn can be made up of a series of manifold exponential sections, commencing with a very short stub of high flare rate at the throat (to minimize distortion) which leads into a longer section of lower flare rate and thence to the main horn of very low flare rate. Klipsch has referred to this technique as the "rubber throat" in his paper on corner horn design.¹⁴ The mouth acoustical impedance of each exponential section is designed to match the throat impedance of the preceding section, right along the chain. Practically any acoustical impedance relationship with frequency may be obtained by this technique, but the procedure is complicated, and the additional effort cannot generally be justified for domestic horns.

Determination of mouth area

The acoustical resistance and reactance of the exponential horn have been plotted on a normalized scale in Fig. 3, which shows that

the acoustic impedance is entirely reactive below a frequency given by

$$f_c = \frac{mc}{4\pi}$$

where c = speed of sound; m = flare constant which appears in the basic exponential horn formula

$$S_x = S_T e^{mx}$$

where S_x is the area at distance x from throat; S_T is the area at the throat.

The frequency f_c , known as the cut-off frequency, is the lowest frequency at which the horn will transmit acoustical power, and thus the flare constant defines the lower frequency of transmission by a given horn. The flare constant may be calculated for any given cut-off frequency, and the horn profile may then be constructed. The above statement refers strictly only to horns of infinite length. In horns, as in cylindrical tubes, wavefronts of sounds whose wavelength is large compared with the mouth diameter tend to be reflected back into the horn where they interfere with successive wavefronts. Just as the loading of the loudspeaker motor by the throat of the horn must be largely resistive over the working frequency range for the smooth efficient transfer of acoustical energy, so must be the loading presented to the mouth of the horn by the surrounding air. Beranek has shown⁴ that for the radiation impedance of the mouth to be mainly resistive, the relationship $C/\lambda > 1$ must hold, where C is the circumference of the mouth of the horn and λ is the wavelength of the lowest note to be transmitted. If the mouth of the horn is not circular, it will behave in a similar way for equal mouth areas, i.e. if $C = 2\pi r_m > \lambda_c$ is the limiting condition

$$\text{and } S_m = \pi r_m^2 > \frac{\lambda_c^2 c}{4\pi} r_m > \frac{\lambda_c}{2\pi}$$

where λ_c = cut-off wavelength; r_m = mouth radius; S_m = mouth area.

Thus a horn of square section may be employed provided the mouth area exceeds $\frac{\lambda_c^2}{4\pi}$. Hanna and Slepian had examined from

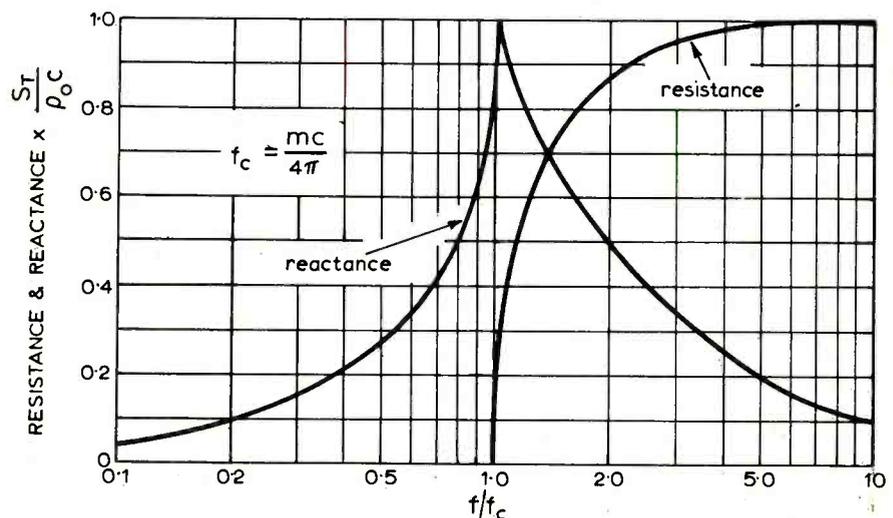


Fig. 3. Acoustical resistance and reactance of an exponential horn.

a different standpoint the behaviour of wavefronts at the mouth of the horn, and deduced that reflection was a minimum when the slope of the profile was 45° (i.e. included angle of 90°). This will be so where the mouth circumference equals the cut-off wavelength of the horn. It also illustrates the importance of distinguishing between the values of flare constant used for calculating exponential increase in area, and in plotting the profile of the actual horn. Fig. 4 (after Olson) illustrates the effect of foreshortening the horn to a length less than

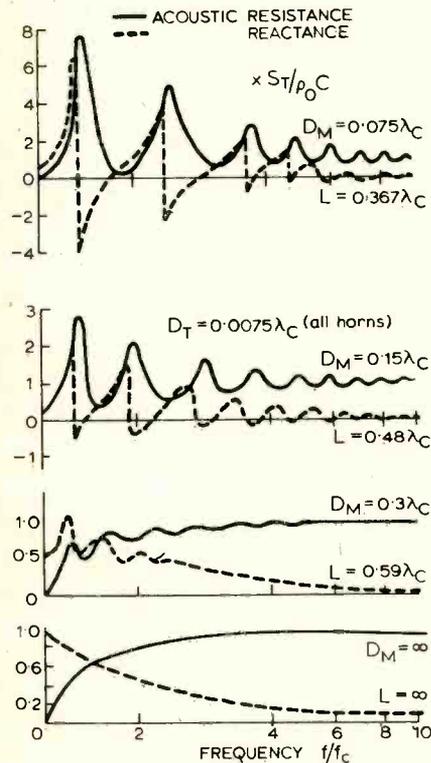


Fig. 4. Performance of foreshortened horns. Reflections at the mouth cause peaks and troughs in the frequency response near to cut-off.

the ideal. When the mouth circumference becomes less than the cut-off wavelength, reflections at the mouth cause objectionable peaks and troughs in the frequency response at frequencies near to cut-off, and if, in a given design, the mouth dimensions are restricted, it is generally preferable to increase the cut-off frequency to a value which allows the correct mouth area to be adopted, rather than to accept the uneven bass response illustrated in Fig. 4.

Plane and curved wavefronts

Hitherto, the assumption has been made that successive wavefronts remain plane throughout their propagation through the horn. However, along a straight circular section horn the wavefront must be normal to the axis, and also normal to the walls. (If the wavefront were either approaching or receding from the walls, energy would be either absorbed or supplied; alternatively, the composite wavefront resulting from the original wavefront and its reflection will itself be normal to the walls.) Thus wavefronts transmitted along a cylindrical tube will be plane, while wavefronts transmitted down a conical horn will be spherical. It is therefore clear that the wavefront emerging from an exponential horn will possess a degree of curvature, and that the conventional calculations made on the assumption of the exponential increase of plane wavefronts will be in error (in practice, the actual cut-off frequency will be somewhat altered from that derived theoretically, and the profile errors of the horn are not excessive).

The correct approach to the design of a horn in which the areas of successive wavefronts expand according to a true exponential law is not certain, since any horn profile chosen will *per se* determine the contour of the wavefronts within it, and in general this contour will be different to that originally assumed. Wilson¹¹ decided to assume spherical wavefronts of increasing curvature from zero (plane wavefronts) at the throat of the horn, and on this basis he cal-

culated a modified contour which lies just inside and very close to the true exponential. Fortuitously, if a papier mâché horn is made on a solid former designed to a true exponential contour, the shrinkage of the papier mâché when drying converts the horn very closely to Wilson's modified form. Nevertheless, the prime assumption has been made that wavefronts are spherical and of changing curvature, and it is by no means certain that this is the case.

The tractrix contour

Voigt, in his 1927 patent, had proceeded on the more elementary assumption that the wavefronts within the horn must be spherical and of the same radius throughout their propagation through the horn. He based this assumption on the reasoning that if the curvature increases from plane waves (zero curvature) at the throat to a certain curvature at the mouth, then a point on the axis must travel at a faster rate than a point at the wall. Since the entire wavefront must travel at the speed of sound (assumed to be constant throughout the horn) the wavefront has no alternative but to be spherical and of constant radius. This requires that the horn contour should be the tractrix.

The tractrix is the involute of the catenary (the curve adopted by a uniform heavy chain suspended between two points at the same level) and is the curve traced out by a load being dragged along by a man moving in a straight line not passing through the load. It is not the "pure pursuit" curve traced by a missile which always travels towards an escaping target, as is often mistakenly supposed. The length of a tractrix horn of mouth circumference λ_C , may be expressed as the cut-off wavelength

$$x = \frac{\lambda}{2\pi} \log_e \frac{\frac{\lambda}{2\pi} + \sqrt{\left(\frac{\lambda}{2\pi}\right)^2 - y^2}}{y} - \sqrt{\left(\frac{\lambda}{2\pi}\right)^2 - y^2}$$

where y is the radius

cf. the equivalent exponential,

$$x = \frac{\lambda}{2\pi} \log_e \left(\frac{\lambda}{2\pi y} \right)$$

Both these curves are shown in Fig. 5.

It will be seen that the tractrix has a dominant exponential term which becomes less significant towards the mouth; in fact for the first 50% of their length the exponential and tractrix contours for a given cut-off frequency and throat area are virtually identical, but thereafter the tractrix flares at an increasingly greater rate until it attains its fully developed mouth at 180° included angle. In view of the complex nature of the formula, the best way to construct a tractrix is by graphical means, as shown in Fig. 6. The curve thus derived may be used to provide ordinates for the tractrix horn, after some smoothing of the slight discontinuities inherent in the graphical construction.

Whereas the tractrix terminates when the angle between the horn and the axis is 90° (180° included angle), the true exponential goes on to infinity in both directions. The

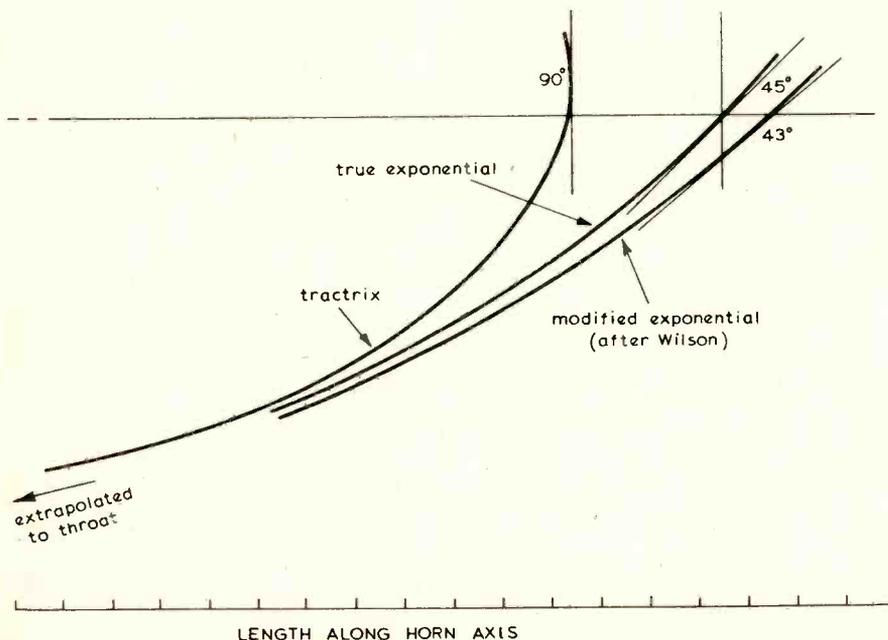


Fig. 5. Comparison of the exponential and tractrix contours.

tractrix horn for given throat and mouth dimensions is thus shorter than the equivalent exponential. It has been suggested that with the full tractrix terminating in a mouth of 180° included angle, the sound appears to originate from a point just inside the mouth, where the included angle is only 90°. There is thus some evidence that the tractrix may be terminated prematurely at this point, and if this is done, the mouth perimeter will be 90% of the wavelength at cut-off, as shown in Fig. 5, which compares the true and modified exponentials and the tractrix contours.

Efficiency

The efficiency of an exponential horn loudspeaker is determined by a large number of parameters, and a comprehensive treatment has been provided by Olson.³ Typical efficiencies of bass horns can be as high as 50%, while mid-frequency and treble horns can have efficiencies of over 10%, and these figures compare very favourably with bass-reflex enclosures (efficiency 2 to 5%) and infinite baffles (efficiency generally less than 1%). The extremely high efficiency of the horn is not necessarily of value in enabling amplifiers of lower output power to be used. Indeed, some class B output stages may produce a higher distortion level in horns because they need only be operated within the first 10% of their capability, at which low levels the effects of crossover distortion are more pronounced.

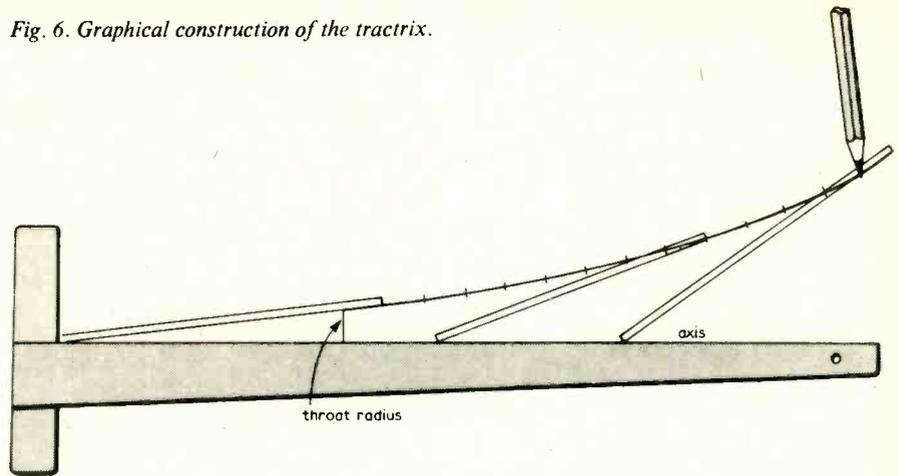
The principal advantage conferred by the horn's high efficiency is that for a given loudness the amplitude of movement of the loudspeaker motor is appreciably less than with other enclosures. The effects of non-linearities in the magnetic field and suspension are therefore greatly reduced, and there is less tendency for "break-up" of the cone to occur. Thus the relatively high distortion products normally produced by the loudspeaker motor will be minimized, and, provided the horn itself does not introduce distortion, extremely high quality sound can be radiated.

A further advantage resulting from this reduction in amplitude of movement of the cone is that a form of inter-modulation distortion, caused by variation of the volume of the cavity between the loudspeaker cone and the throat of the horn, may be reduced to negligible proportions.

Tuning the throat cavity

The cavity, which must inevitably exist between the loudspeaker diaphragm and the throat of the horn, plays an important function in the design of horn systems, since it can be used to limit the maximum frequency to be transmitted. Although the lower frequency limit may be set with some precision by the flare rate of the horn, in conjunction with the mouth area, the upper frequency limit is ill-defined, being determined by a combination of (a) unequal path lengths between different parts of the diaphragm and the throat of the horn, (b) internal cross reflections and diffraction effects within the horn, especially when the horn is folded, (c) the high frequency characteristics of the motor unit itself, and (d) the effective low-pass filter characteristic presented by the cavity between diaphragm and throat.

Fig. 6. Graphical construction of the tractrix.



Using a straight edge of length equal to the final mouth radius, the tractrix curve is constructed of a series of tangents, length not greater than 1/10 the mouth radius, starting at the throat.

It may be shown that a cavity of fixed volume behaves as an acoustic reactance of value

$$\frac{S_D^2 \rho c^2}{2\pi f V}$$

where S_D = area of diaphragm, V = volume of cavity, ρ = density of air, c = speed of sound, f = frequency.

When the cavity is placed between the diaphragm and throat, it behaves as a "shunt capacitance" across the throat itself, and thus by choosing the correct parameters, the cavity/throat combination acts as a low-pass filter at a frequency which may be set by making the cavity impedance equal to the throat impedance at the desired frequency,

$$\text{i.e. } \frac{S_D^2 \rho c^2}{2\pi f V} = \frac{\rho c S_D^2}{S_T}$$

where S_T = throat area, f = desired upper frequency limit, whence

$$V = \frac{c S_T}{2\pi f}$$

The volume of the cavity may therefore be calculated to provide high-frequency roll-off at a point before the poorly-defined effects (a) to (c) stated above become significant (Fig. 7).

A further benefit resulting from the use of a cavity tuned to prevent mid and high frequencies from entering a bass horn at the rear of a loudspeaker is that the efficiency of transmission of these frequencies by the opposite side of the loudspeaker is greatly increased, thus improving the performance of a mid/high frequency horn mounted at the front of the loudspeaker.

The considerations affecting the practical determination of the upper and lower frequency limits of a particular horn will be considered in more detail.

Loading the rear of the loudspeaker motor

Mention has already been made of distortion resulting from the non-linear expansion/compression characteristics of air. This effect is accentuated when a loudspeaker is horn-loaded on one side only, because the

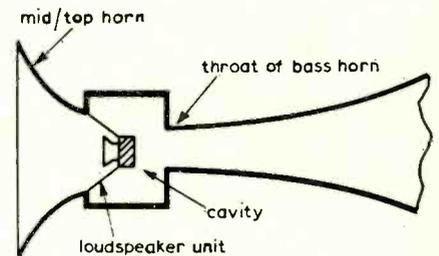


Fig. 7. Effect of the throat cavity in limiting high frequency performance.

constant resistance characteristic of the throat acts only against excursions of the cone in the forward direction; when the cone moves back it is against a far lower load and hence the excursion will be larger. The ideal way of eliminating this distortion is to load both sides of the loudspeaker by equal horns, or to employ a bass horn for loading the rear of the cone and a middle/top frequency horn to load the front. The design of the mini-horn, to be described, utilizes this feature.

An alternative solution favoured by many designers is to load the rear of the loudspeaker by a sealed compression chamber, the effect of which is to provide a loading similar to the horn. The compression chamber thus reduces the effects of non-linearity due to uneven loading on each side of the loudspeaker diaphragm, and also presents a better resistive load to the diaphragm because a closed chamber on the opposite side of the diaphragm to the horn itself acts as an "inductive" reactance which tends to balance the "capacitive" reactance presented by the mass reactance of the throat impedance at low frequencies.

Klipsch states¹⁴ that the volume of this cavity is given by the throat area multiplied

by the speed of sound divided by 2π times the cut-off frequency. This is readily shown as follows:

The air chamber reactance is given by

$$\frac{S_D^2 \rho c^2}{2\pi f_c V}$$

where S_D = diaphragm area, V = volume of air chamber.

The throat reactance at cut-off is

$$\frac{\rho c S_T^2}{S_T}$$

where S_T = throat area.

Equating these,

$$V = \frac{c S_T}{2\pi f_c}$$

However, some observers claim that the use of a compression chamber detracts from the realism of the reproduced sound, and advocate either double horn-loading or a combination of horn-loading with direct-radiation from the other side of the diaphragm; in other words, the most realistic reproduction occurs when both sides of the diaphragm are allowed to radiate.

Summary

In summarizing this section, it is clear that there is no universal formula applicable to any aspect of horn design. The reason for mentioning the alternative approaches and for providing a comprehensive list of references is to stimulate others to experiment in those areas where to a large extent results must be evaluated subjectively by very careful comparative listening tests *a posteriori*.

To quote Wilson:²¹ "It cannot legitimately be assumed that a horn incorporated in a cabinet has the precise characteristics of any particular type of straight horn, whether exponential, hyperbolic, catenary or tractrix, even though their dimensions have been used as guides in its construction. The multiple changes of direction, coupled with reflections and absorptions and internal resonances, are always such as to destroy any legitimate comparison. Every internal (horn) enclosure construction must be judged on its merits as revealed by measurement and by listening tests."

(To be continued)

REFERENCES

1. Crabbe, H. J., "A Concrete Horn Loudspeaker System, Mk. 2". *Hi-Fi News*, Oct.-Nov. 1967.
2. "Toneburst", "Low-cost Horn Loudspeaker System", *Wireless World*, May 1970 and Jan. 1972.
3. Olson, H. F., "Acoustical Engineering", van Nostrand, 1957.
4. Beranek, L. L., "Acoustics", McGraw-Hill, 1954.
5. Cohen, A. B., "Hi-Fi Loudspeakers & Enclosures" 1st Edition Rider, 1961.
6. Telfer, G., Private communication, Nov. 1972.
7. Strutt, J. W., Lord Rayleigh, "Theory of Sound" Pt. 2, Macmillan, 1878.
8. Webster, A. G., *Proc. Nat. Acad. Sci.* Vol. 6 (1920).

9. Hanna, C. R. & Slepian, J., "The Function and Design of Horns for Loudspeakers", *J.A.I.E.E.* Vol. 23, Feb. 1924.
10. Flanders, P. B., British Patent No. 245,415, 24th March 1927.
11. Wilson, P. & Webb, A. G., "Modern Gramophones and Electrical Reproducers", Cassell 1929.
12. Voigt, P. G. A. H., British Patents Nos. 278,098 (1927), 351,209 (1930), 404,037 (1934), 435,042 (1935).
13. Crandall, I. B., "Vibrating Systems and Sound", van Nostrand, 1926.
14. Klipsch, P. W., "A Low-frequency Horn of Small Dimensions", *J. Acous. Soc. Am.* Vol. 13 No. 2, Oct. 1941.
15. Klipsch, P. W., "Improved Low-frequency Horn", *J. Acous. Soc. Am.* Vol. 14 No. 3, Jan. 1943.
16. Klipsch, P. W., "A High-Quality Loudspeaker of Small Dimensions", *J. Acous. Soc. Am.* Vol. 17 No. 2, Jan. 1946.
17. Klipsch, P. W., "A New High-frequency Horn", *I.E.E. Trans. Audio*, Nov.-Dec. 1963.
18. Klipsch, P. W., "Loudspeaker Developments", *I.R.E. Trans. P.G.A.*, May-June 1953.
19. Crabbe, H. J., "Design for a Folded Corner Horn", *Wireless World*, Feb. 1958.
20. Baldock, R., *Hi-Fi News*, Vol. 11, April 1967.
21. Wilson, P. & G. L., "Horn Theory and the Phonograph", presented to 83rd meeting of Acoust. Soc. Am., April 1972.
22. Salmon V., "Generalized Plane Wave Horn Theory", *J. Acoust. Soc. Am.* Vol. 17 No. 3, Jan. 1946.
23. Klipsch, P. W., "Loudspeaker Performance", *Wireless World*, Feb. 1970.
24. Harwood, H. D., "Speakers in Corners", *Wireless World*, April 1970.
25. Klipsch, P. W., "A Note on Acoustic Horns", *Proc. I.R.E.*, July 1945.
26. Wood, A., "The Physics of Music", Methuen 1944.
27. Moir, J., "High Quality Sound Reproduction" 2nd Edition, Chapman & Hall, 1961.

Literature Received

GENERAL INFORMATION

A catalogue which uses no words and which is, therefore, international, is obtainable from Keyswitch Relays Limited, Bendon Valley, Garratt Lane, Wandsworth, London SW18 4LZ.....WW401

Technical and sales information on miniature switches (including illuminated types), circuit breakers, rotary stud switches and audible indicators (annunciators) is presented in a new catalogue from Highland Electronics Limited, 33-41 Dallington, Street, London EC1V 0BDWW402

Electroforming techniques and new nickel alloy production methods are among the subjects discussed in Issue 38 of *Inco Nickel*, published by International Nickel Limited, Thames House, Millbank, London SW1P 4QF.....WW403

We have received the new Antiference catalogue, which contains descriptions of a full range of radio and television aerials, and folders on a new range of fringe-area v.h.f. aerials and improved folded dipole ranges. Antiference Limited, Aylesbury, Bucks.WW404

A wall-chart showing a range of lever-operated, magnetic and inductive limit switches is obtainable from Herbert Controls and Instruments Limited, Spring Road, Letchworth, Hertfordshire.WW405

Issue No.98 of the Tin Research Institute review *Tin and its Uses* contains articles on solderable finishes, plastic plating, long-life soldering bits and hot tinning. The publication can be obtained from the Tin Research Institute, Fraser Road, Greenford, Middx., in English, French, German, Italian, Spanish and Japanese editions.WW406

A catalogue describing panels, socket boards, connectors and racks has been sent to us by Tekmar Electronics Ltd., 102 High Street, Harrow-on-the-Hill, Middx., HA1 3LP. Power supplies and crystal oscillators are also included in this Dual-in-line Socket Board and Packaging Hardware catalogue,WW407

Lasky's have produced their 1974 catalogue, which contains information on a range of audio, television and communications equipment, together with a selection of test equipment. Lasky's, Audiotronic House, The Hyde, London NW9 6JJ.....WW435

Public address equipment, including amplifiers, microphones, mixers, speakers and accessories is described in a new brochure from Eagle International, Precision Centre, Heather Park Drive, Wembley, MiddlesexWW436

The latest issue of the RS Components catalogue is now available, additions being miniature i.e.s, an i.c. timer and a 5W audio amplifier i.c. among many others. RS Components Ltd, P.O. Box 427, 13-17 Epworth Street, London EC2P 2HA.....WW437

EQUIPMENT

We have received a leaflet on the Bloodhound detector for gas, smoke and combustible vapours from P. H. Electronics, Sandwich Industrial Estate, Sandwich, Kent CT13 9LN.WW408

Information on a range of digital frequency meters, including one 32MHz instrument which performs this function only and is very simple to use, is contained in leaflets published by Radio Control Specialists Limited, National Works, Bath Road, Hounslow, TW4 7EE.WW409

The third issue of *OMR News*, devoted to products and their applications in the field of optical mark recognition data-capture techniques has just been published by Data Recognition Limited, Loverock Road, Battle Farm Estate, Reading Berks. RG3 1DX.WW410

High-voltage d.c. insulation testers and fault locators are described in a catalogue sent to us by Hipotronics, Inc., Route 22 — Brewster, New York.....WW411
Varactor-tuned solid-state oscillators operating in the range 0.2 to 20GHz are the subject of a catalogue published by Watkins-Johnson International, Shirley Avenue, Windsor, Berkshire.WW412

The PEP400 series of scan converters and image storage units is described in a leaflet published by Princeton Electronic Products, Inc., P.O. Box 101, North Brunswick, New Jersey 08902.WW413

We have received from CAI Limited, 95A High St., Rickmansworth, Hertfordshire, a booklet on their minicomputer — the Naked Mini — which is a complete computer on one printed-circuit board. It is also available in a cased version.WW414
A new catalogue available from Eagle International, Precision Centre, Heather Park Drive, Wembley HA0 1SU describes their full range of audio equipment and specifications.....WW434

A range of digital panel meters for the measurement of voltage, current, temperature and time and for counting events is presented in a leaflet produced by Newport Laboratories Inc. The equipment is distributed by Keithley Instruments Ltd, 1 Boulton Road, Reading, Berks.....WW430

Voltage dividers, attenuators and decade boxes are the subject of a new brochure sent to us by Danbridge (U.K.) Ltd, Sherwood House, High Street, Crowthorne, Berks.....WW431

APPLICATION NOTES

A brochure, obtainable from Penny and Giles Limited, Mudeford, Christchurch, Hampshire, gives design information on the use of zener barriers with intrinsically safe equipment installed in hazardous atmospheres.WW415

A manual on the application of Accuride telescopic drawer slides has been published by the Accuride Division of Imhof-Bedco Limited, Colne Way Trading Estate, By-Pass, Watford, Herts, WD2 4NE.WW416

An application note entitled "Numeric and Alpha-numeric Display using the ZM1251 Dot Matrix Display Tube" is obtainable from Computer Electronics Division, Mullard Ltd., Mullard House, Torrington Place, London WC1E 7HD. Requests for copies should be on company letter-heads and should quote reference TP1341.WW417

Microwave Landing Aid

Flexible Doppler system which could replace ILS as an aeronautical navaid

This year the Royal Aircraft Establishment will be starting feasibility studies of a microwave landing aid which could eventually replace ILS (Instrument Landing System) as the principal aircraft landing aid of the world's airports. The new aid, known as MLS (Microwave Landing System), will provide positional information for aircraft by means of the Doppler frequency shift principle, the frequency shift being produced by relative movement between a moving source of radio waves on the ground and a receiver in the aircraft.

This microwave Doppler system has already been proposed by U.K. authorities to the International Civil Aviation Organization (ICAO). Now, an agreement between Plessey Radar, the Ministry of Defence, the Civil Aviation Authority and the Department of Trade and Industry will enable the system to be further developed and submitted complete to ICAO with the support of flight trials. Plessey are building experimental equipment for the studies with Standard Telecommunication Laboratories as sub-contractors.

Aviation people have been aware of shortcomings in ILS for a good many years. First of all there is its inflexibility: aircraft must fly in straight paths down fixed radio beams generated by "localizer" (azimuth) "glideslope" (elevation) and "marker" beacons. Another problem is that ILS cannot be employed on all runways at an airport because it uses ground reflections to form the radio beams, and these, therefore, are vulnerable to irregularities of the site. The "localizer" propagation path in particular is vulnerable to noise caused by re-radiation from fixed and moving objects (e.g. airport buildings and aircraft taking-off) and by locally generated interference. Such problems could be mitigated by the use of narrower radio beams, but at the v.h.f. and u.h.f. used this would require very large aerial arrays. ILS uses broad beams and obtains the required precision by interpolation from the cross-over of the beams. This confines the region of proportional guidance to a narrow sector and so prevents ILS from providing the aircraft approach procedures

envisaged for the future, for example, glideslopes arranged for noise abatement, approaches for STOL and VTOL aircraft, curved approaches for traffic sequencing, and "missed approach" guidance.

Alternatives to ILS have been under consideration for some years. For example in May 1967 we reported on "Correlation Protected I.L.S."¹ and in May 1972 on the interferometric system MADGE (Microwave Aircraft Digital Guidance Equipment)² both of which work at microwave frequencies. The first has fallen by the wayside, while the second is intended mainly for military airfields. A further microwave system, now being considered at the same time as MLS, uses narrow radio beams which are scanned either mechanically or electronically across the required space in azimuth and elevation. These beams have to be encoded to indicate their instantaneous pointing angle.

The main advantages of the Doppler MLS, as well as of the scanning beam system, over ILS are greater flexibility of

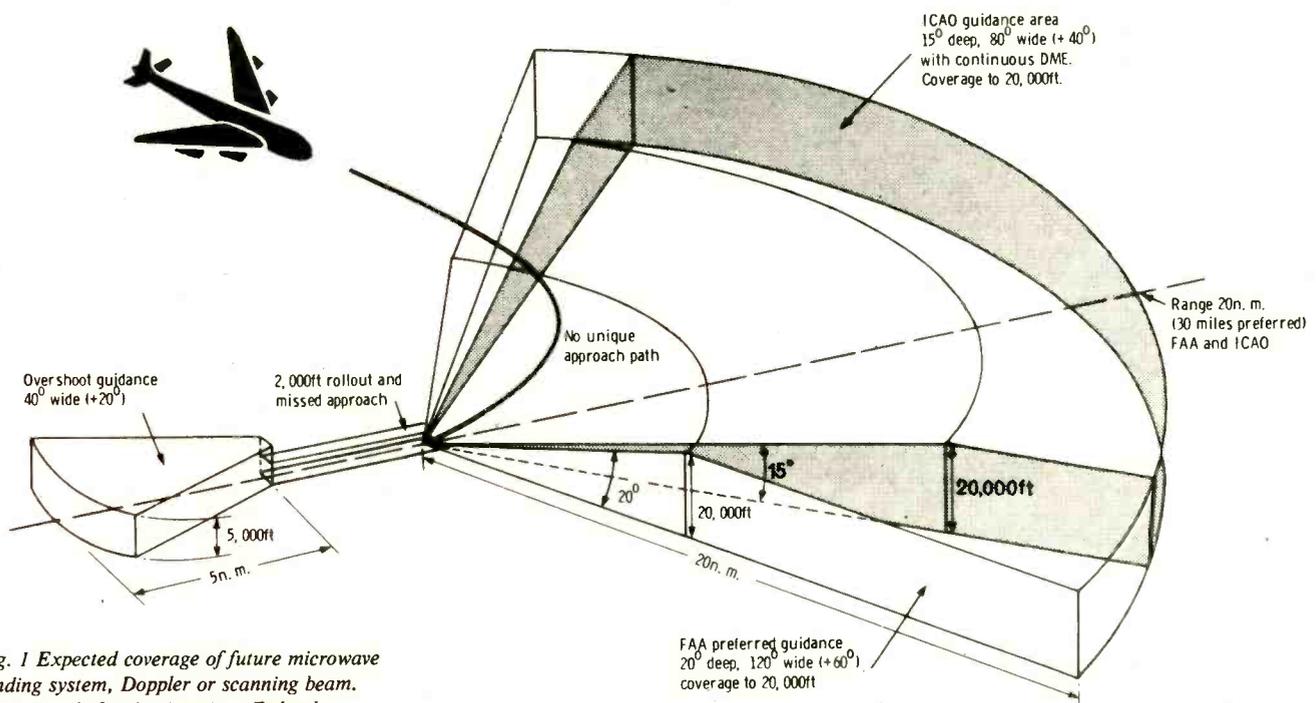


Fig. 1 Expected coverage of future microwave landing system, Doppler or scanning beam. (FAA stands for the American Federal Aviation Agency.)

operation and freedom of siting. They will handle aircraft descending in curved approach paths over a wide range of angles in both azimuth and elevation as shown in Fig.1. This wider operational coverage will also facilitate the landing of STOL and VTOL, private and business aircraft, and will provide landing and "missed approach" guidance in all-weather operations for new generations of aircraft.

The path finding principle of the Doppler system is based on a ground transmitter (in the frequency range 5000-5250MHz) which provides a linearly moving radiating source. In fact the linear movement is simulated by switching a source of radiation, element by element, along a multi-element antenna array. When the source reaches the end of the array it is returned to the beginning, starting again and giving a scanning action. This is provided for both azimuth and elevation. The azimuth array, for example, is approximately 7.5m long (about 120 wavelengths) and has 64 elements with a nominal spacing of 1.86 wavelengths. Referring to Fig.2, when the radiating source is approaching the aircraft receiver from the left, as a result of the Doppler shift the received frequency is higher than that of the transmitted frequency; when it reaches the position shown the received frequency equals the transmitted frequency, and when the source is receding from the receiver, to the right, the received frequency, as a result of the Doppler shift, is lower than the transmitted frequency. The Doppler shift frequency, which we shall call f_D , is actually proportional to both the relative velocity of source and receiver, which we shall call V , and the wavelength of the source which we shall call λ . In Fig. 3, for example, the Doppler frequency as measured in the aircraft receiver is given by $f_D = (V/\lambda) \sin \theta$.

In the receiver f_D is measured, while V and θ are known, so it is possible to obtain $\sin \theta$. and hence the angular position of the aircraft in relation to the ground antenna array. Because of the scanning action of the radiating source the energy spectrum of the transmitted signal consists of a number of lines. The envelope of this spectrum as received in the aircraft exhibits a strong peak at a particular f_D and this provides part of the information to define the angular position of the receiver as explained. The width of this peak is an inverse function of the array aperture and represents the beam width of the array. The received signal, after detection, is "decoded" by a tracking filter followed by a zero crossing counter which gives a digital measure of f_D . The tracking filter eliminates the effects of multi-path signals which are outside the main beam. The Doppler frequency information is finally converted into parameters acceptable to the aircraft's navigation system. These include outputs in digital and analogue form for absolute approach angles, offset from demanded angles and various "flags" and warnings.

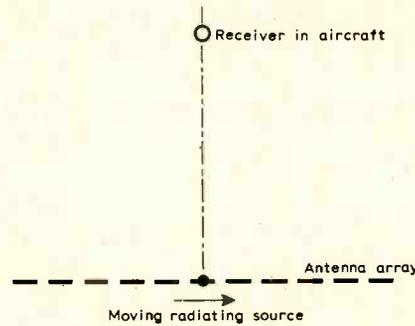


Fig 2 Basic illustration of Doppler effect resulting from a linearly moving radiating source on the ground.

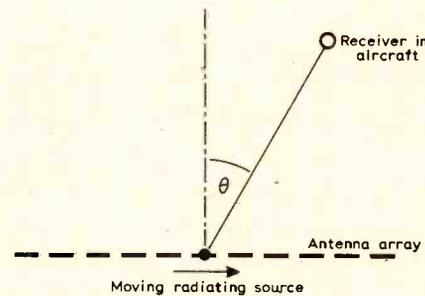


Fig. 3 Doppler frequency f_D depends on the relative velocity of moving source and airborne receiver, the wavelength of the radiating source and the angular relationship between the airborne receiver and the antenna array.

Of course a complication is introduced by the fact that the airborne equipment is moving as well as the ground radiating source. Unless special steps were taken the accuracy of the Doppler frequency measurement would be affected by the Doppler shift arising from the receiver movement. This problem is overcome by radiating from the ground a second signal, called a reference signal, from a fixed source on the antenna array and at a frequency offset by a small increment from the scanning frequency. Thus the airborne receiver's movement affects both the main signal and the reference signal equally. The receiver in fact detects a beat frequency between the two, and this can be achieved with high accuracy because the uncertainty regarding the transmitted frequency is removed and narrow band processing can be used.

There are 200 channels available for the system in the allocated 5 GHz frequency band, each 600kHz wide. In a channel, the spectrum space is divided into four sub-channels: one for forward azimuth transmission, using frequency division multiplex, centred at 540kHz above the lower channel edge; one for elevation at 290kHz also using f.d.m.; one at 415kHz for data transmission again using f.d.m.; and one at 120kHz, using t.d.m., providing a back azimuth service and auxiliary signals for azimuth and elevation.

References

1. "ILS for Automatic Landing". *Wireless World*, May 1967, p.218.
2. "Could MADGE replace ILS?" *Wireless World*, May 1972, p.212.

Sixty Years Ago

Viewing the beginnings of commercial radio communications from sixty years on, one gains the impression that even such an unbelievable development as "wireless" still found an entrenched body of opinion which regarded the technique as an interesting toy. This impression is lent weight by the news items and articles which appeared in *Wireless World* with the purpose of bringing to the attention of readers the sea rescues and commercial and military benefits conferred by the use of radio. One would have hardly thought, for instance, that the value of wireless in bringing help to distressed ships needed much comment, and yet in January 1913 there was lengthy reporting on the performance of the Marconi system in the *Volturo*, which burnt in mid-Atlantic.

At the less disastrous end of the traffic stream, readers were offered proof that wireless had come to stay based on the new-found facility with which bananas could be scheduled to arrive at Covent Garden in prime condition. The wireless was used to call assistance in the event of breakdown in the banana ship, thereby avoiding the effects of delay on "this delicious and nutritious fruit".

We have previously remarked (September 1973) on the severe tone adopted by the editor of the 1913 letters column. To redress the balance, we give the following extract from a page of advice by "our irresponsible expert". "Amateur (Tooting). — Carborundum is used in the Marconi crystal receiver. It has been found that this substance resists mildew very well and is not easily bent. It acts by virtue of its high resistance. The current finds such difficulty in passing through one way that it does not think it worth while to go back again. The current is thus rectified and produces a tick in the telephones. The Fleming valve acts in a similar way by making things hot for the current. We hope this is clear".

Telephoning at 6,000 words a minute

The first step towards providing a service in mid-1975 for the transmission of digital information over telephone circuits at a rate of 4,800 bits/s for the cost of a telephone call has been taken by the Post Office. The new Datel 4800 service will carry the equivalent of about 6,000 words per minute. The Post Office has placed a contract with Plessey Telecommunications Research for the design and development of a modem to operate at this data transmission rate. Prototypes should be delivered in 1974.

The highest rate of transmission available so far is provided by the Datel 2400 service at 2,400 bits/s.

Audibility of phase distortion

Pulse testing of all-pass phase shift networks, loudspeakers and human heads

by Benjamin B. Bauer
CBS Laboratories

The intense interest aroused in scientific circles by matrix quadruphony has resulted in a careful scrutiny of all its components, most important among them being all-pass phase-shift networks (or "psi-networks" as we like to call them). After presentation of our paper on quadruphony at the Audio Engineering Society Meeting in Rotterdam¹, a discussion was held about wave-shape changes that had been observed in testing psi-networks with square waves. We acknowledged the existence of these changes, but replied that at no time had we noticed audible distortion with psi networks (the results of psychoacoustic testing in which such networks were randomly introduced in paired comparisons being governed strictly by chance²), and concluded by stating that square waves did not seem to be useful for testing psi networks (or, for that matter, loudspeakers). This paper expands our views on this subject.

As every electronics engineer knows, psi networks have been used in audio communications for many years without the slightest perceptible ill effect. Traditionally, they have been utilized for production of single sideband modulation; an important application in modern a.m. and f.m. broadcasting technology is for "symmetrizing" speech waves to increase the modulation index — a psi network sold in the U.S.A. under the trade name "Symmetrapeak" is commonly used for this purpose. Also, a widely employed scheme for producing monophonic records from, and for compatible broadcasting of, stereophonic programs utilizes differential psi networks in the two channels of the stereophonic source.

Prior to the introduction of the SQ system by CBS, the action of psi networks was carefully reviewed at our laboratories using music, speech, square waves, triangular waves, and Gaussian noise sources. These were applied to loudspeakers with the psi network in and out of the circuit. At no time have any of our listeners been able to detect the slightest audible difference. These experiments, naturally, did not prove that some all-pass networks might not be capable of altering the quality of sound — they simply meant that the psi networks we designed had not produced such alterations. I presume that similar tests have been

performed by Mr Itoh of Sansui³ and by Drs Cooper and Shiga of Nippon/Columbia⁴ with their systems of matrix quadruphony which also use psi networks. Additionally, one should mention the work of Dr Manfred P. Schroeder, who studied psi networks and established criteria for their audible performance⁵.

Impulse testing of psi networks

Let us take a typical psi network of the type used for matrix encoding and study its impulse characteristics. As an example, we selected a 10-pole network used in an SQ encoder, with straight-line phase shift

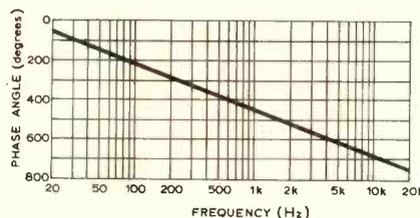


Fig. 1 Typical phase shift function, $\psi(f)$ of psi network used in SQ encoders.

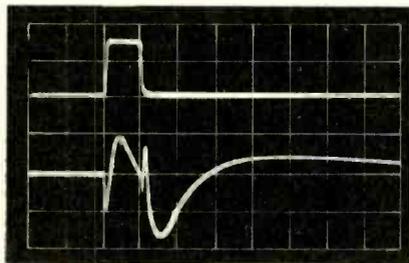


Fig. 2 The response of the psi network of Fig. 1 (lower trace) to a 1ms rectangular pulse (upper trace).

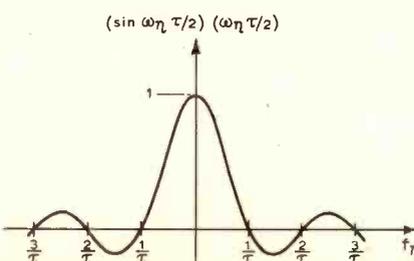


Fig. 3 The plot of $(\sin \omega_n \tau / 2) / (\omega_n \tau / 2)$

versus log-frequency characteristic from 20-20,000 Hz, shown in Fig. 1. The sine-wave response of this network is flat within 0.25 dB over the audible range and its harmonic and intermodulation distortions are virtually unmeasurable. However, if a rectangular wave, e.g., of 1ms duration, is applied to it, the output has little resemblance to the input, as seen in Fig. 2. The alteration of shape obviously is caused by differential phase delays.

We know, of course, through the use of the Fourier transform, that a single rectangular pulse may be represented in the frequency domain by a continuum from minus to plus infinity with amplitude distribution following the law $(\sin \omega_n \tau / 2) / (\omega_n \tau / 2)$ shown in Fig. 3, where ω_n is the angular frequency, $2 \pi f_n$, and τ is the pulse length in seconds, or by an equivalent line structure in the event of periodically generated pulses. With a 1ms-wide pulse, the nulls occur at 1 kHz intervals. Any presumption that such a continuum can fairly be used for visual assessment of the performance of a psi network used for conventional speech and music clearly is unwarranted, especially since the presence or absence of the network does not perceptibly influence the audible quality of sound.

Nevertheless, visual inspection of the effect of psi networks upon pulses is, at times, desirable as when one wishes to measure system overload capability or time delay. Some years ago, while developing tests for loudspeakers, similar consideration led us to search for a pulse which would fairly represent the reaction of an acoustical system to transient signals. Reviewing the available signals, one finds at one extreme the delta pulse of infinitesimal duration which is equivalent, in the frequency domain, to a uniform cophase amplitude distribution extending from minus to plus infinity; and at the other, a continuous sine wave signal extending from minus to plus infinity in the time domain, equivalent to a single line-frequency. Either extreme is obviously uninformative. A limited-frequency continuum appealed to us as a reasonable compromise since the delay characteristics of the waves within such a packet would be more or less uniform. In the time domain the limited-bandwidth pulse resembles a bell-shaped amplitude-

modulated sine wave, not unlike the shape of the transient sounds of some musical instruments.

An easy way to obtain the desired function is to pass a 100 μ s or shorter pulse through a 1/3-octave bandpass filter. Fig. 4 shows what happens when such a test signal produced through a filter with a mid-frequency of 1000 Hz (top curve), is passed through the psi network (bottom curve). We note that the packet of waves passes through the network with practically no change in the shape of the envelope, albeit the phase relationship at midpoint, predictable from the curve in Fig 1, is modulo 360° , or $450^\circ - 360^\circ = 90^\circ$.

Impulse performance of loudspeakers

Since we commonly use loudspeakers to judge sound quality, the performance of loudspeakers with impulsive sounds becomes a matter of interest. Fig 5 shows the response of a high-quality monitor loudspeaker to the 1 μ s rectangular pulse. A small microphone with flat frequency response placed approximately 18in from the loudspeaker grille picks

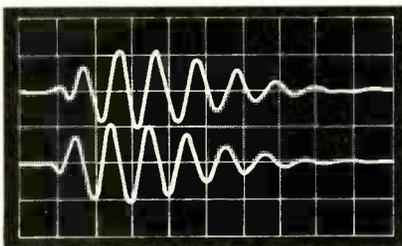


Fig. 4 A bandpass-filtered delta pulse (lower trace) with the bandpass-filtered delta pulse passed through the psi network (upper trace).

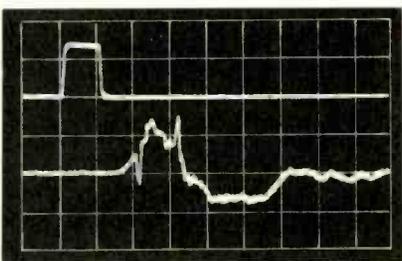


Fig. 5 The response of a high quality loudspeaker (lower trace) to a 1 μ s rectangular pulse (upper trace).

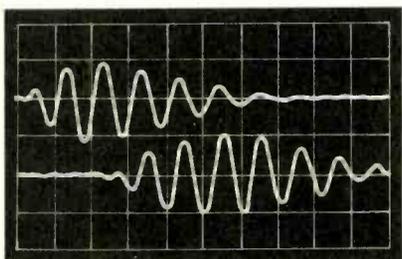


Fig. 6 The bandpass-filtered delta pulse (upper trace) compared with the response of a high quality loudspeaker to the same pulse (lower trace).

up the reproduced pulse. The time delay, (1 μ per division), clearly corresponds to the transit time from the loudspeaker to the microphone, plus a small delay within the loudspeaker proper. The reproduced pulse is quite similar to that exhibited by the psi networks but with some added perturbations.

By applying the 1000-Hz centred 1/3-octave filtered packet of waves to the loudspeaker, the result shown in Fig 6 becomes similar to that obtained with the psi network, except that the envelope delay corresponding to the microphone-speaker distance again is noted. The response curve of this particular loudspeaker exhibits a slight hangover, suggesting a somewhat underdamped condition. In CBS Laboratories' high fidelity components testing programme, such 1/3-octave band-limited pulses are regularly used for loudspeaker testing⁶. Comparing the shapes of the input and output pulses allows us to study such diverse factors as magnetic dissymmetries, mechanical nonlinearities, acoustical reflections, etc. which otherwise would be difficult to detect.

Having established that psi networks and loudspeakers share similarities with respect to impulsive sounds, one is led to conjecture whether there might not exist an opportunity for improving the performance of both classes of devices. Here we open the door to a debate which probably will continue for a long time to the delight of hi-fi enthusiasts and magazine editors alike.

Will the ultimate perfection of psi networks and loudspeakers, if it were theoretically possible, lead to significant improvements in fidelity? Even to conjecture about this question requires that we define what is meant by audible fidelity in the reproduction of impulsive sounds. Some years ago we measured the interaural delays caused by the human head as a function of frequency and azimuth of sound arrival⁷. The delays were calculated from phase measurements at the ear canal entrances at low frequency, but high-frequency measurements were difficult to perform because of rapid phase changes caused by minuscule head motions, also exhibiting inconsistencies which probably were related to differences between phase and group velocities. Later we attempted to use acoustical pulses with the thought of obtaining group delay characteristics. The results were similar to those exhibited by the psi networks and loudspeakers. Thus, even if one were able to design these latter components to transmit visually unaltered rectangular pulses, the diffraction around the head might prevent the audible effect of such change from being significant, except possibly at very low frequencies.

Conclusion

In conclusion, careful auditing of speech, music, impulsive repetitive sounds and Gaussian noises reproduced with and without psi networks through high quality loudspeakers convinced us that the types

of networks we use are not a cause of discernible changes in quality. With respect to distortions occasionally reported by some observers, one is tempted to wonder if an unrelated factor such as a change in frequency response, amplifier overload, etc., might not in fact have been the assignable cause. The phase shifts or time delays exhibited by our psi networks simply have turned out to be inaudible.

Presumably, we should be grateful to Messrs. G. S. Ohm and H. L. F. Helmholtz who discovered that phase does not influence timbre⁸, even if a number of distinguished investigators have described subsequent experiments designed to demonstrate that phase changes can result in alterations of timbre⁹. Schroeder¹⁰ maintains that small or no subjective changes will be produced by variations of phase spectrum which leave the envelope of the stimulus invariant. The latter condition is attained with the impulse we used in testing psi networks as demonstrated by Figs 4 and 6, and which we believe fairly represents the impulsive sounds of speech and music. But even the timbre of square waves is unaltered with our psi networks, we conjecture, because loudspeakers and human heads introduce similar differential delays in the path of the signal. Evidently more research into this problem is needed.

References

1. Benjamin B. Bauer, Richard G. Allen, Gerald A. Budelman, and Daniel W. Gravereaux, "Quadraphonic Matrix Perspective — Advances in SQ Encoding and Decoding Technology," presented at 44th Meeting of the Audio Engineering Society, Rotterdam, Netherlands, February 22, 1973.
2. Benjamin B. Bauer and Paul Milner, "Some Psychoacoustic Phenomena Related to Quadraphonic Reproduction," presented at the Meeting of the Acoustical Society of America in Boston, Mass., April 10-13, 1973.
3. Ryosuke Itoh, "Proposed Universal Encoding Standards for Compatible Four-Channel Matrixing," *J. Audio Eng. Soc.*, Vol. 20, pp 167-173, (April 1972).
4. Duane H. Cooper and Takeo Shiga, "Discrete-Matrix Multi-channel Stereo," *J. Audio Eng. Soc.*, Vol. 20, pp. 346-360 (June 1972).
5. Manfred R. Schroeder, "An artificial stereophonic effect obtained from a single audio signal", *J. Audio Eng. Soc.*, Vol. 6, pp. 74-79. Also personal communication.
6. Benjamin B. Bauer, "Speaker tests can be relevant to the listening experience", *High Fidelity*, Vol. 20, pp. 42-49. June 1970.
7. Benjamin B. Bauer, and Emil L. Torick, "Diffraction and interaural delay of a progressive sound wave caused by the human head" (Abstract), *J. Acous. Soc. Am.* Vol. 36, p.1933(A), 1964.
8. Herman L. F. Helmholtz, "On the sensations of tone", Dover Publications Inc., New York 1954, 2nd ed., pp.33, 126.
9. David S. Stodolsky, "The standardization of monaural phase", *I.E.E.E. Trans. Audio and Electroacoustics*, Vol. AU-18, p.288 (1970).
10. Manfred R. Schroeder, "New results concerning monaural phase sensitivity" (Abstract), *J. Acous. Soc. Am.* Vol. 31, p.1579 (1959).

Simple f.m. modulator/demodulator for a magnetic tape recorder

by B. D. Jordan

Institute for Advanced Studies, Dublin

This unit offers an extension of the facilities of a domestic tape recorder to permit its use as an instrumentation recorder employing f.m. principles. The design involves no modification of the tape recorder and thus allows a wide field of application with various makes and types of machines.

Magnetic tape as a medium for recording v.l.f. signals or signal levels, suffers at least two serious limitations when using direct recording methods. First, the frequency response rarely extends below about 50Hz and, second, amplitude instability occurs, caused mainly by surface inhomogeneities in the tape. For the purposes of handling analogue data, where the d.c. component of the signal must be preserved, it is necessary to incorporate some form of signal modulation into the recording process. Most of the commercially available instrumentation tape recorders employ f.m. modulation and many of these have specifications that include a frequency response of d.c. to 2MHz as well as a great many other facilities that may not be required.

The instrument described was designed to provide a tape recorder with f.m. modulation giving a frequency response of d.c.-800Hz for recording v.l.f. phenomena and utilizing a domestic recorder at a tape speed of 9.1cm/sec. At this tape speed the tape recorder has a frequency response of about 50Hz-6.0kHz. The carrier frequency was chosen to lie in the midband region, i.e. 3kHz so that amplitude variations in the tape recorder output would not be excessive within the expected range of frequencies to be handled. In order to minimize the effect of wow and flutter due to the transport system, a reasonably large depth of modulation is desirable. A frequency deviation of about $\pm 30\%$ of the carrier was found to be satisfactory.

An integrated phase locked loop, Signetics type NE565, was used as both modulator and demodulator. Fig. 1 illustrates the principle of the phase locked loop. An f.m. signal, f_s , is fed to a phase comparator whose reference is the output of a voltage controlled oscillator, f_o . The phase comparator is a balanced multiplier which produces the sum, $(f_s + f_o)$ and difference $(f_s - f_o)$ frequencies of the input f.m. signal and the voltage controlled oscillator output. When the loop is in lock, the v.c.o. duplicates the input frequencies so that $f_s - f_o = 0$, and the output of the phase comparator contains a d.c. component which is proportional to the phase difference between the

input signal and the v.c.o. output. A low pass filter removes the sum frequency component and the remaining d.c. voltage is amplified and used to control the v.c.o. frequency in such a manner as to maintain $f_s = f_o$. It is this controlling or error voltage which constitutes the demodulated signal.

The modulator

One of the outstanding features of the NE 565 is the high linearity and wide dynamic range of the v.c.o. These characteristics make the device particularly attractive as a modulator. For this purpose the loop can be opened by disconnecting the v.c.o. output from the phase comparator reference input. The modulating signal can then be applied directly to the v.c.o. input, or if required, advantage can be taken of the high gain d.c. amplifier, by applying the modulating signal to the signal input of the phase comparator. The reference input should be returned to earth in this mode of operation. The low pass filter can be omitted by disconnecting C_2 .

The Fig. 2 shows the complete circuit. The v.c.o. is a relaxation type of oscillator the free running frequency, f_o being determined by the external capacitor, C_1 , and the charging current controlled by R_1 . The frequency f_o can be calculated from the expression

$$f_o = \frac{1}{4R_1C_1}$$

C_1 can be any value, but R_1 has an optimum value of about 4k Ω so as to maintain minimum linearity error. So for our system,

with $f_o = 3\text{kHz}$, $C_1 = .021\mu\text{F}$. The conversion factor K for the v.c.o. is given by

$$K = \frac{50f_o}{V_{cc}} \text{ radians/sec/volt}$$

In our case $f_o = 3\text{kHz}$ and $V_{cc} = 6\text{V}$. $K = 2\text{kHz per volt}$. Therefore in order to limit the depth of modulation to $\pm 30\%$ ($\pm 900\text{Hz}$ maximum frequency deviation), the control voltage at the v.c.o. input must not exceed 0.9V peak to peak. The gain of the d.c. amplifier can be varied by means of the feedback resistor R_2 . Thus the depth of modulation can be fixed for a given input by means of R_2 .

Demodulator

In this mode of operation the phase locked loop is closed by reconnecting the v.c.o. output to the phase comparator reference input. The low pass filter is formed by connecting C_2 between pin 7 and the power rail.

The capture range, f_c of the p.l.l. (i.e. that range of frequencies about f_o over which the loop can acquire lock) is given by

$$f_c = \frac{1}{\pi} \sqrt{\frac{32\pi f_o}{\tau V_{cc}}}$$

τ is the time constant of the l.p. filter formed by C_2 and an internal resistance of 3.6k Ω . The tracking range f_t of the p.l.l. is that range of frequencies about f_o over which the v.c.o. once having acquired lock, will maintain lock with the input signal and is given by

$$f_t = \frac{8f_o}{V_{cc}}$$

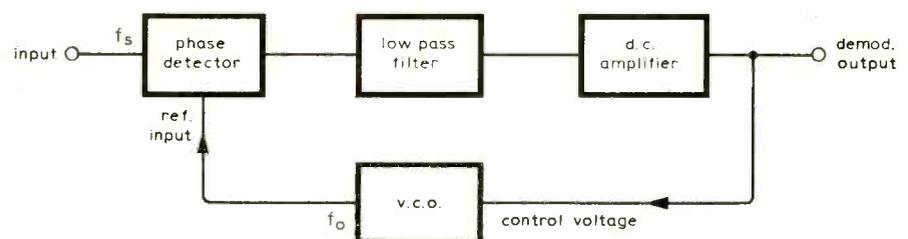


Fig. 1. Block diagram of the phase lock loop.

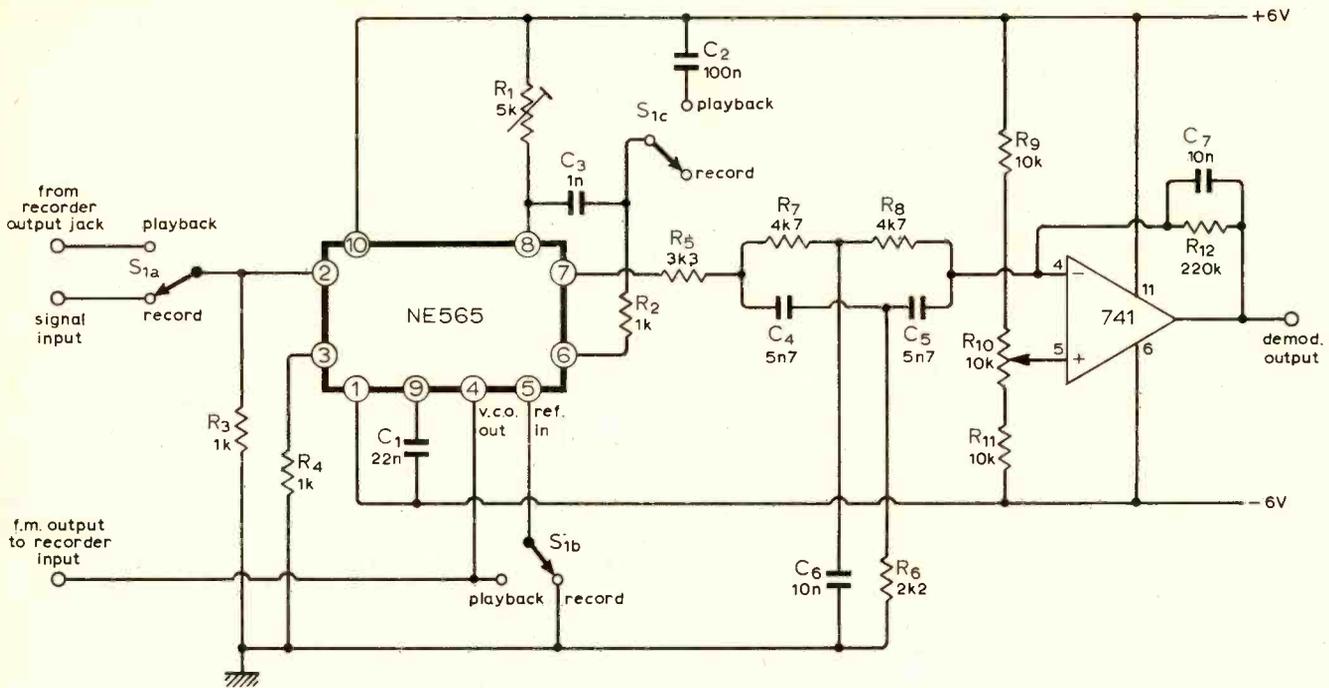


Fig. 2. The complete modulator/demodulator circuit.

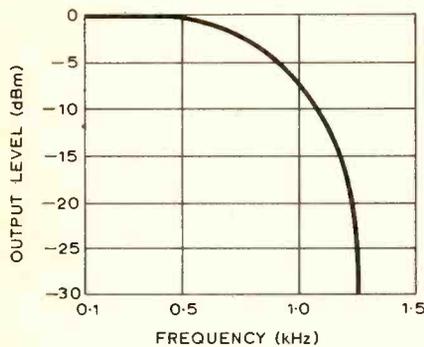


Fig. 3. The system frequency response.

To eliminate the residual unwanted sum frequency component present in the demodulated output, a balanced *T* filter is incorporated in the output. This was found to be most effective when tuned to $2f_c$. This is followed by a low pass active filter which has a cut-off frequency at 800Hz. Because the demodulator of the p.l.l. output is referenced to the positive power rail there is always a standing d.c. potential of about $0.125 V_{cc}$ below the positive power rail. This can be cancelled out by means of the level shifting facility incorporated in the active filter.

Performance and testing

The system was tested using an Akai Model XV tape-recorder at a tape speed of

9.1cm/sec and a carrier frequency of 3kHz. Fig. 3 shows the frequency response of the system. This test was made by recording an f.m. signal produced by applying tones of 5mV peak to peak from 1.0Hz to 1.5kHz to the input. This recording was then played back and the demodulated signals were measured with an oscilloscope. A d.c. test was made by applying d.c. levels from -5mV to +5mV to the input. On playback the linearity error of the reproduced levels was less than 0.5%.

A two-channel system was constructed on a printed circuit board and mounted together with power supply in an instrument case measuring 10 x 7 x 6in. No special layout precautions were found to be necessary. The system was incorporated in a 2-channel d.c. photometer.

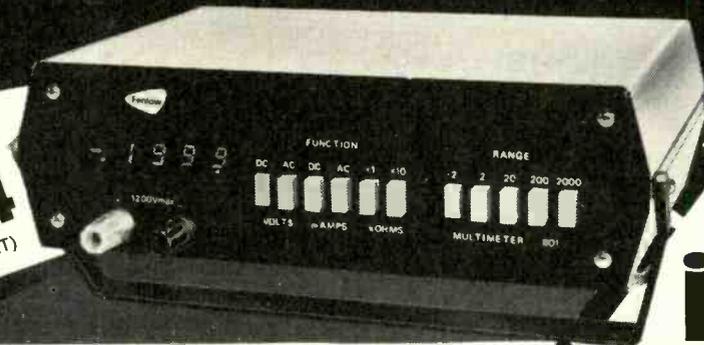
WE'RE BACK!

Apologies to readers and advertisers for the absence of January and February issues of Wireless World. This was due to severe difficulties in the printing industry. However, we are back with this enlarged March issue which we are confident is up to our normal standard. It includes all the regular features plus the two special articles on an electronic piano and on horn loudspeaker design announced in our December 1973 issue and in press advertisements.

The present issue has a slightly smaller page size than normal—about half an inch shorter. This was made necessary by a change of printing arrangements and problems of paper supply. It does not, however, mean that there is any less reading matter on a page. We shall revert to our normal page size as soon as possible.

If you can't believe this multimeter value...

NEW Fenlow 801...
£114
 (EX. VAT)
 More DMM than you ever expected for...



try it out!

We're confident... once you get your digits on this exciting new 3½ digit multimeter, you'll be more than convinced. By advanced design with latest I.C. techniques, Fenlow have achieved a *guaranteed* performance that beats everything at the price. ★ Big, bright readings at 12½/sec. ★ 26 ranges measuring DC and AC voltage, current, and resistance. ★ Input impedance of 50,000 megohms and DC accuracy of ±.1%. ★ 80 dB series mode rejection from patent strobe-locking design hitherto exclusive to high-priced D.V.M.'s. With auto-zero, the 801 is ready for instant action. Ask us by filling in the coupon how you can obtain the 801 on a 15 day approval without obligation. Or use the reader reply service for full data first.

Please send me details how I can obtain the 801 digital multimeter on a 15-day approval without obligations.



Bryans Southern Instruments

Bryans Southern Instruments Limited, Willow Lane, Mitcham, Surrey CR4 4UL, England. Tel: 01-648 5134 Telex: 946097 Grams: Bryans Croydon

NAME _____
 COMPANY _____
 ADDRESS _____

Bryans Southern Instruments Ltd.
 Company Registration No. 348627, England

WW—114 FOR FURTHER DETAILS

NEW DYNAMCO MULTIMETER WITH °C RANGE



- A 10000 scale, six function multimeter powered by mains or internal battery.
- Push button operation for function and range selection.
- Measurement functions: 100µV to 1kV DC, 100µV r.m.s. to 500V r.m.s. AC, 100nA to 1mA (5A with shunts) DC, 100nA r.m.s. to 1mA r.m.s. (5A with shunts) AC, 0.1ohm to 5Mohm, -50°C to +200°C.
- The 610 incorporates a custom designed MOS-LSI analogue-to-digital converter and its large size 7-segment display gives excellent readability.
- Basic UK price £155.



A Subsidiary of Automatic Oil Tools Ltd
DYNAMCO (AOT) LIMITED
 CENTRAL WAY ANDOVER HANTS ENGLAND
 Telephone: (0264) 65961/8 Telex: 47107

WW—115 FOR FURTHER DETAILS

Competitively priced, quality guaranteed MICROFLAME gas torches

WELDMASTER

A compact convenient torch for both Oxygen/Gas and Air/Gas for welding, soldering or brazing with: Oxygen or Air and Acetylene, Propane, Butane, Natural Gas, Town Gas or Hydrogen. Flame temperatures from 1200°F to 5000°F. Wide range of attachments. from £9.00 + VAT (nozzles extra).

MICRO WELDMASTER

With micro jewelled welding nozzles and injector system. 6000°F flames from .03" (.9mm) for fusion welding metals down to .002" (0.05mm). from £8.80 + VAT

CUT MASTER

Original lightweight design cutter. Use with Oxygen/Gas or Oxygen/Acetylene on mild steel. Four pre-heating nozzles, four cutting nozzles

paired for optimum conditions for cutting thinnest steel plates, up to 1" (25mm). Useful where access is difficult. from £11.60 + VAT (nozzles extra)

PLASMASTER

Professional well balanced tool, weight 4ozs, low operating costs, wide control range, for Hot Gas Welding and Heat Sealing of Thermoplastics. Triple connections for Air, Gas and Nitrogen, gives non oxidising, hotgas jet at controlled velocities, temperatures between 200°C and 500°C. from £13.60 + VAT (nozzles extra)

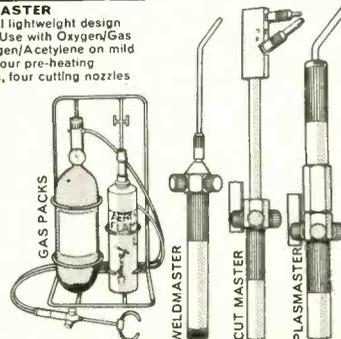
PORTABLE OXY GAS PACKS

The Portable Oxy/Gas Pack Plus the Microflame Torch of your choice gives you the opportunity of the right 5000°F flame just where and when you want it. The pack has saved its own cost in transport and manpower in just one service call. The Butane Cartridge is expendable, the Oxygen Cylinder is refillable, and by using our optional Charging Adaptor No. 5000A you may do your own refilling in your home or workshop.

The 230 litre Oxygen Cylinder has 10 hours capacity with the No 4 welding tip, or 1 hour with the No 8 twin tip. 320 gramme Butane lasts about three times as long. from £40.00 + VAT

The range of Microflame torches are marketed world-wide, and a comprehensive range of torches, accessories and spare parts are usually available from stock.

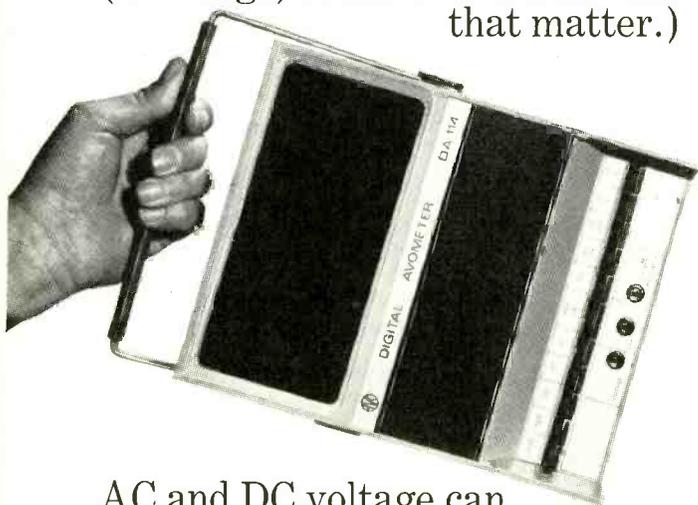
Write or phone to order, for more information, or for our comprehensive range of fully descriptive literature, to the sole UK distributor: **MICROFLAME (UK), LTD.** ABBOTS HALL, RICKINGHALL, DISS, NORFOLK. TEL: BOTESDALE (STD 037 989) 555



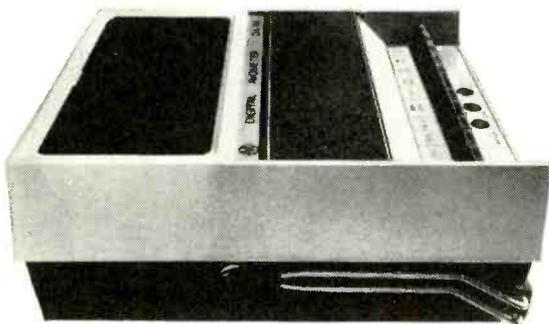
WW—116 FOR FURTHER DETAILS

The Avo DA114

Over two years of development experience has made the Avo DA 114 the one portable, solid state, digital multimeter that stands up on its own. (Or hangs, reclines or lies flat for that matter.)



AC and DC voltage can be measured between 100mV and 1kV full range, ac and dc current between 100 μ A and 1A full range and resistance between 100 Ω and 1M Ω full range with an overrange availability between 1000 and 1999 (except on 1kV and 1A ranges).

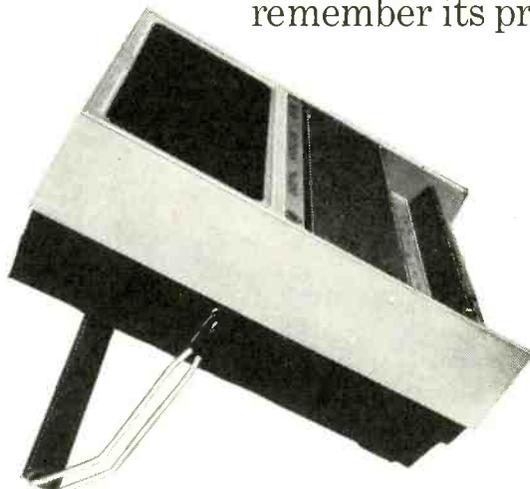


We've completely redesigned and styled it and packed it with features to win you over to digital multimeters.

Note its piano key switches. Functionally simple yet elegant.

Appreciate its non-blink display, its automatic zero correction and, thanks to a breakthrough in instrumentation techniques, its improved stability.

Rely on its internal self-check and calibration system for true peace of mind. And if that wasn't enough, remember its price.

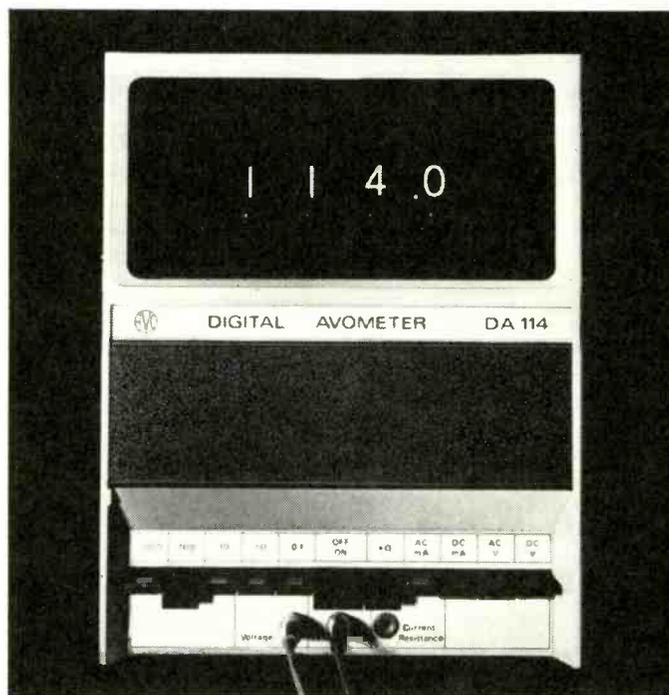


Just £103.50 (UK trade price) for the mains model and £135 for the battery/mains model.

For full specification and name of nearest stockist please write to:

Avo Ltd., Avocet House, Dover, Kent. Tel: Dover (0304) 202620. Telex: 96283.

Avo



Another of the new AVOMETER generation.

Multimeters

A survey of analogue and digital multi-function meters currently on the U.K. market

by Brian Sexton

The application of a voltage across a resistance produces a current — a well-known phenomenon rationalized some time ago by a Dr Ohm, who presented the results of his researches to the world in the form of his familiar Law. Simple though the law is, it is still the basis of the circuit. Whatever one's interest in electronics, at some point one needs to know voltage, current or resistance. The instrument used to determine these quantities is usually an analogue or digital multimeter — a short-hand expression meaning an instrument capable of measuring at least voltage and current, and usually resistance.

The analogue, or moving-pointer instrument was the sole method of measurement until a few years ago, when digital techniques became common in all branches of the art. It is not proposed to go into the "analogue versus digital" argument here — both types of meter have their advantages. The overwhelming advantage of a digital meter is its reading accuracy; a pointer instrument can be reliably read to within around 1% of full-scale, whereas a digital display presents no problem in this respect. (One assumes that the measuring accuracy is sensibly related to the reading accuracy.) This feature is, of course, gained at the expense of complexity and digital meters cost, at the very least, twice as much as a good-quality analogue meter. On the other hand, the much simpler pointer instrument will be a perfectly suitable meter for the great majority of work, the electronic variety, using amplifiers to increase sensitivity and input impedance, increasing its usefulness to compare with that of some digital equipment.

The analogue multimeter is a fairly straightforward instrument, its specifications being readily understood. Digital multimeters, in contrast, use a different type of circuit altogether, the requirements of a moving-coil meter display and a digital readout being totally divorced. The circuitry and operation of digital meters have brought a host of "digital" terms to specifications and to clear up any confusion that may exist, it is proposed to deal briefly with the commoner terminology.

Analogue-to-digital converters

Although self-explanatory, the a.-to-d. converter is the heart of a digital meter and merits some attention. By means of this circuit, the input analogue (voltage, current or resistance) is converted into one of several forms of digital representation, which can be indicated by a digital display. It takes many forms, but the commonest is the dual-slope integrator, a method of conversion pioneered by Solartron. In this circuit, the input signal determines the slope, in one direction, of a Miller (Blumlein) integrator, the slope in the other direction being dictated by a very precise reference voltage. During the known time interval that the integrator is under the control of the input, pulses are gated to a counter and displayed to represent the input. The integration in both directions reduces the effect of amplifier drifts and clock frequency variations, the accuracy of the result depending chiefly on the precision of the reference voltage. The time interval during which the input controls the integrator is held to one complete cycle of the mains waveform, i.e. 20ms, so that any 50Hz or harmonics thereof picked up at the input are effectively cancelled in the integrator.

Several other methods of conversion are in use, but the system described accounts for the majority of instruments at present in use.

Autoranging

Some of the more elaborate instruments are automatic to the fullest extent in that they will select the range providing maximum resolution when the input is connected and will display the sign of the measured quantity. Less expensive equipment often displays the sign and indicates when the input exceeds the selected range limit. A further aid to ease of operation is afforded by "leading zero suppression", which simply means that display elements reading zero to the left of the first significant figure are suppressed. For instance, 001.8 would become 1.8.

Display

The cold-cathode numerical indicator tube is still the most used type of display, although light-emitting diode (l.e.d.) arrays are coming into greater prominence of late. The dot-matrix l.e.d. display possesses the advantage that the failure of one diode does not result in the complete loss of one digit.

Flicker on digital indicators is not now a problem. Several years ago, when t.t.l. latched bistables became available cheaply, the stored display was adopted, wherein the last reading is displayed until a new one is obtained, with no rapid counting being visible. Liquid crystals are also coming into favour.

Resolution

Digital meters are often described as, say, $3\frac{1}{2}$ -digit instruments. This somewhat bizarre designation refers to the way in which a two-fold increase in the range can be obtained by the use of an indicator tube which shows either "0" or "1" for the most significant digit. The normal range limit would be set at perhaps 0999mV: with the addition of the "half" digit it becomes 1999mV, the additional electronics being much simpler than for a full digit. The value of the least significant digit is the resolution.

Outputs

It is fairly common practice to provide the displayed reading as an output in binary-coded decimal form, particularly when the instrument is to be used as part of a data-collecting system. The outputs may also be used to drive a printer.

A.c. measurements

Some instruments, analogue or digital, are called "true-r.m.s. meters". In many voltmeters, sinusoidal inputs are rectified, the resulting signal applied to the measuring circuits corresponding to the average value of the sinusoid, although the display is calibrated to read r.m.s. So long as the input remains sinusoidal, this trick is valid, but any departure from this shape causes an error in the reading. Consequently, some manufacturers either introduce correction circuitry or use special a.c. to d.c. converters, providing an output corresponding to the r.m.s. value of any shape of input waveform.

In the short directory which follows, only salient performance figures are given; space does not allow more detailed description.

For the same reason, only one or two instruments from each manufacturer have been included. Prices given are exclusive of v.a.t., which is charged at 10%.

Advance Electronics Ltd, Raynham Road, Bishop's Stortford, Herts.

The DMM2 digital instrument provides for the measurement of alternating and direct voltage and current, and resistance in 17 ranges. Functions are selected by push-button, and the 3½-digit neon-tube display has an automatically-positioned decimal point. Overrange and reverse polarity indicators are provided. Power is obtained from a.c. mains, external 12V d.c. or a rechargeable battery pack.

Ranges

V d.c./a.c.	200mV 2V 20V 200V 1kV
Resolution d.c./a.c.	100µV 1mV 10mV 100mV 1V
Accuracy d.c.	± 0.1% to ± 0.2% of reading ± 0.1% to ± 0.15% f.s.
Accuracy a.c.	± 0.3% to ± 0.4% of reading ± 0.15% to ± 0.2% f.s.
Input R d.c.	10M
Input Z a.c.	(1MΩ and 150pF) to (10MΩ and 40pF)
I d.c./a.c.	200µA
Resolution d.c./a.c.	100nA
Accuracy d.c.	± 0.3% reading ± 0.2% f.s.
Accuracy a.c.	± 0.5% reading ± 0.5% f.s.
R	200Ω 2kΩ 20kΩ 200kΩ 2MΩ
Resolution	100mΩ 1Ω 10Ω 100Ω 1kΩ
Accuracy	± 0.3% to ± 0.4% reading ± 0.15% f.s.
Price	£99

WW500 for further details

Avo Ltd, Archcliffe Road, Dover, Kent. CT16 9EN.

Little needs to be said about the well known Avo 8. The Mark 5 version is more accurate (1% of f.s.d. on all d.c. ranges, and 2% of f.s.d. on all a.c. ranges). It has a new movement and new cut-out. An interesting point is that the d.c. sensitivity remains unchanged. Apparently, so many thousands of service and instruction manuals relate their test voltage readings to the Model 8 sensitivity of 20,000Ω/V that it has been retained to avoid misleading results. The price is £40.30.

The Avometer Type DA114 digital meter is a 3½-digit instrument with automatic zero drift cancellation, a built-in operational check and a calibration facility. DA114M is mains-powered, the rechargeable battery/mains model being designated DA114B. Overrange and polarity reversal are indicated.

Ranges

V d.c./a.c.	100mV 1V 10V 100V 1kV
Resolution d.c./a.c.	100µV 1mV 10mV 100mV 1V
Input R d.c.	Between 10MΩ and better than 1000MΩ
Input Z a.c.	1MΩ in parallel with not more than 20pF
Accuracy d.c.	± (0.1% to 0.2%) of reading ± 1 digit
Accuracy a.c.	± 1% of full range, or ± 1% of reading on overrange
I d.c./a.c.	100µA 1mA 10mA 100mA 1A
Resolution	0.1 1 10 100 1k
Accuracy d.c.	± (0.3% to 0.5%) of reading ± 1 digit
Accuracy a.c.	± 0.3% rdg ± 1% full range, or ± 1.3% of reading on overrange
R	100Ω 1kΩ 10kΩ 100kΩ 1MΩ
Resolution	0.1Ω 1Ω 10Ω 100Ω 1kΩ
Accuracy	± 0.5% rdg ± 1 digit
Price	(DA114M) £103.50. (DA114B) £135.

WW501 for further details

Bach-Simpson (U.K) Ltd, Trenant Industrial Estate, Wadebridge, Cornwall, PL27 6HD.

Overload protection is strongly featured in the new 260-6P analogue multimeter. The various protective devices include, fuse, varistor and a transistor switch with overload circuit breaker. The instrument has 27 ranges of resistance, alternating and direct voltage and current measurement. These ranges can be extended by a series of 10 plug-in units which enable the basic instrument to be used for various functions including transistor testing, temperature testing and milliohm measurement. An optional plug-in unit provides alternating current measuring facilities up to 250A.

Ranges

V d.c.	250mV 1V 2.5V 10V 50V 250V 500V 1kV
Input R	20,000Ω/V
Accuracy	± 2% f.s.d.
V a.c.	2.5V 10V 50V 250V 500V 1kV
Input Z	5,000Ω/V
Accuracy	± 3% f.s.d.
I d.c.	50µA 1mA 10mA 100mA 500mA 10A
Accuracy	± 2% f.s.d.
R	2kΩ 200kΩ 20MΩ
Price	£34.50

WW502 for further details

G. & E. Bradley Ltd, Electral House, Neasden Lane, London N.W.10.

The Type 196 four-digit multimeter measures resistance and alternating and direct voltage within the frequency range 20Hz to 100kHz. Overrange facilities on all functions extend each range by 50%. The maximum reading is 1500V d.c. and 15MΩ but is limited to 1200V r.m.s. on the maximum V a.c. range. The overrange condition is indicated by a "1" digit incorporated in the polarity indicating tube. Fully guarded input circuits give a common-mode rejection on d.c. ranges of more than 140dB at 50 to 60Hz and d.c. Common and series mode rejection is better than -60dB on a.c. and mains frequency series-mode noise rejection is better than -60dB on d.c. ranges. Five neon display tubes are used for readout with polarity indicated automatically. Sampling rate is 10 times per second irrespective of mode selected and hold facilities are provided.

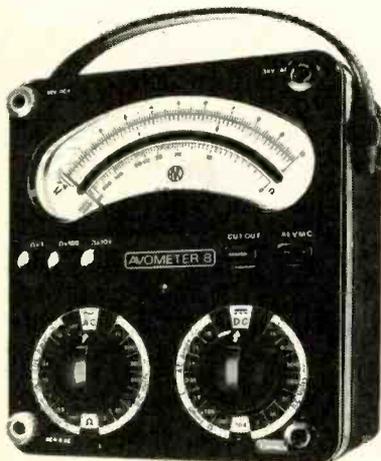
Ranges

V d.c.	100mV 1V 10V 100V 1kV
Resolution	10µV 100µV 1mV 10mV 100mV
Input/Z	10GΩ 10GΩ 10GΩ 10MΩ 10MΩ
Accuracy	± 0.01% of reading ± 1 digit
V a.c.	1V 10V 100V 1kV
Resolution	100µV 1mV 10mV 100mV
Input Z	1MΩ shunted by less than 50pF (all ranges)
Accuracy	± (0.1% to 0.4%) of reading ± 1 digit (depends on range and frequency)
R	100Ω 1kΩ 10kΩ 100kΩ 1MΩ 10MΩ
Resolution	0.01Ω 0.1Ω 1Ω 10Ω 100Ω 1kΩ
Accuracy	± 0.1% of reading ± 1 digit
Price	£395

WW503 for further details

Cosmocord Ltd, Eleanor Cross Road, Waltham Cross, Hertfordshire EN8 7NX.

The model 12 battery-powered analogue multimeter has a slide switch for range selection and a colour coded scale to facilitate reading. In addition to voltage, current and resistance ranges, the instrument has



Avometer 8, Mark 5



Digital Avometer DA114



Bach-Simpson 260-6P multimeter

two transistor checking ranges "LI" and "LV" (low current and voltage) which enable the impedance of junctions to be determined at different current levels.

Ranges						
V d.c.	0.25V	2.5V	10V	50V	250V	1kV
Input R	20 kΩ/V					
V a.c.	—	—	10V	50V	250V	1kV
Input Z	5kΩ/V					
I d.c.	50μA	25 mA	250 mA			
R	3 kΩ	30 kΩ	300 kΩ	3MΩ		
"LI"	52 mA	5.2 mA	520 μA	52 μA		
"LV"	1.5V	1.5V	1.5V	1.5V		
dB	-20 to +22dB		-6 to +36 dB		+20 to +50 dB	
Price	£7					

WW504 for further details

Dana Electronics Ltd, Collingdon Street, Luton, Beds.

The 4300 digital multimeter has 4-digit plug-in l.e.d. readout with +100% overranging and leading-zero suppression, the intensity of the display being automatically adjusted to suit prevailing ambient light conditions. The instrument can be powered by either mains or battery. When battery-powered, a switch position provides for digital readout of battery voltage; a chart on the battery case converts battery voltage to the approximate unused battery time remaining, and automatic shut-off at battery voltage recharge level prevents battery damage and the possibility of incorrect readings.

Ranges	
V d.c./a.c.	0.1V (d.c. only) 1V 10V 100V 1kV
Resolution	0.01% of range (10μV on 0.1V d.c. and 100μV on 1V a.c.)
Input R d.c.	1GΩ (0.1V and 1V ranges) 10MΩ (other ranges)
Input Z a.c.	1MΩ shunted by 100pF
Accuracy d.c./a.c.	Range, temperature and time dependent
I d.c./a.c.	100μA 1mA 10mA 100mA 1A
Accuracy d.c./a.c.	Range, temperature and time dependent
Resolution	10nA on 100μA range
R	1kΩ 10kΩ 100kΩ 1MΩ 10MΩ
Resolution	0.01% of range (0.1Ω on 1kΩ range max.)
Accuracy	Range, temperature and time dependent
Price	£299

The 5800A is a five-digit instrument capable of measuring direct and true r.m.s. values of alternating voltage, the ratio between two alternating voltages, two direct voltages between resistance and direct voltage or direct and alternating voltage, and will perform four-wire resistance measurements, or direct and alternating voltage, all but direct voltage and ratio determination requiring the addition of ancillary units.

Ranges	
V d.c.	1V 10V 100V 1000V
Resolution	10μV 100μV 1mV 10mV
Input resistance	1GΩ 10GΩ 10MΩ 10MΩ
Accuracy	±0.008% of reading + 0.002% f.s. (long term)
Ratio	mV, V d.c., ohms or V a.c. to V d.c.
Price	£1,595

WW505 for further details

Eagle International, Precision Centre, Heather Park Drive, Wembley, HA0 1SU.

The company's current catalogue contains details of some 13 analogue multimeters ranging in price from £4 to £50. At the top end of the price range, the K200 f.e.t. voltohmmeter has a claimed input resistance of 10MΩ on both d.c. and a.c. voltage ranges. Frequency response is 20Hz to 3MHz ± 1 dB.

Ranges	
V d.c./a.c.	0.3V 1V 3V 10V 30V 100V 300V 1kV
I d.c./a.c.	30μA 300μA 1mA 3mA 10mA 30mA 100mA 300mA
R	500Ω 5kΩ 50kΩ 500kΩ 5MΩ 500MΩ
Price	£46.70

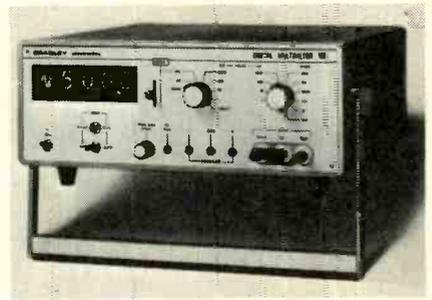
WW506 for further details

Farnell Instruments Ltd, Sandbeck Way, Wetherby, Yorkshire, LS22 4DH.

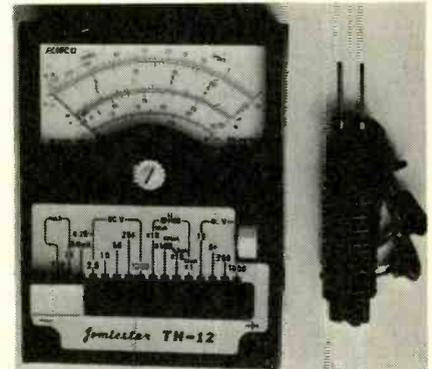
The company produces a digital measuring system which favours individual modules for separate parameters rather than a combined instrument. Three mainframes (for 3, 4 and 6 digit display units) are used to accept plug-in measurement modules covering direct and alternating voltage, resistance, capacitance, frequency, counting and timing. A feature of the DCV100 d.c. voltmeter module is its ability to discriminate between a.c. and d.c. signals. This is accomplished by input filtering, a photo-chopper stabilized operational amplifier and a precision gate. The mainframe costs between £125 and £199, depending on the number of digits and other facilities.

Ranges	
V d.c.	99.9mV 0.999V 9.99V 99.9V 999V
Resolution	100μV max. or 0.1% f.s.d.
Input R	10MΩ ± 1%
Accuracy	0.1% of reading ± 1 digit
Price	£75

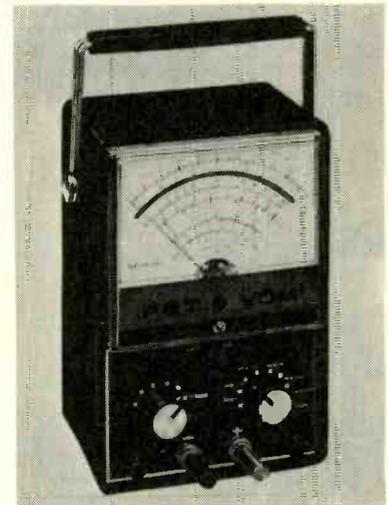
Bradley 196 digital multimeter



Cosmocord 12 analogue multimeter



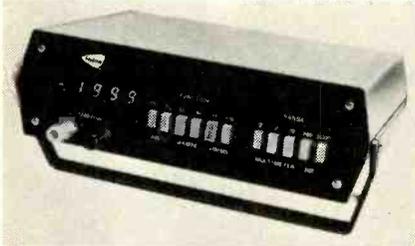
Eagle International K200 electronic multimeter



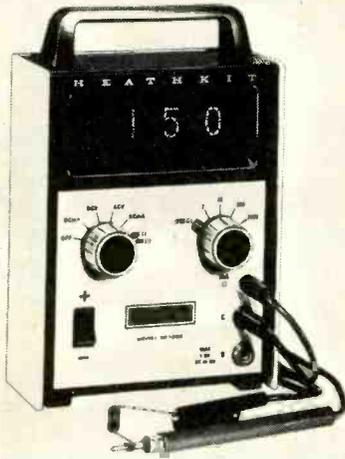
Farnell DCV100 d.c. voltmeter module and mainframe



Farnell DOM100 ohmmeter module



Fenlow 801 digital multimeter



Heathkit IM-1202 digital multimeter



Hewlett Packard HP970A digital multimeter

Hewlett Packard 3490A digital multimeter



The DOM 100 ohms module provides for the measurement of resistance from 999mΩ to 1GΩ full-scale. The measuring circuit is a self-balancing bridge with a front-panel lamp to indicate when the bridge comes to balance. Remote sensing terminals are provided for lead resistance compensation. The resistance of inductive windings can be measured and the power applied to components being measured is less than 1mW.

Ranges	
R	999mΩ to 999MΩ (in 10 decade ranges)
Accuracy	
(Less than 1Ω)	± 0.2% of reading ± 1 digit
(1Ω to 10MΩ)	± 0.1% of reading ± 1 digit
10MΩ to 100MΩ	± 0.2% of reading ± 2 digits
100MΩ to 1GΩ	± 0.5% of reading ± 1 digit
Price	£110

WW507 for further details (DCV100)

WW508 for further details (DOM100)

Fenlow Agents: Bryans Southern Instruments Ltd, Willow Lane, Mitcham, Surrey, CR4 4UL.

The Fenlow model 801 has an auto zero facility which allows the instrument to be ready for use within 30 seconds of switching on. Voltage, current and resistance are covered and readout from the 3½-digit storage display is by seven-segment fluorescent tubes. On d.c. ranges, series mode rejection is 80dB and common mode rejection is 126dB. These figures are maintained during ± 2% mains frequency variation.

Ranges					
V d.c./a.c.	200mV	2V	20V	200V	1200V
Resolution	100μV	1mV	10mV	100mV	1V
Input R d.c.	1GΩ	10GΩ	10MΩ	10MΩ	10MΩ
Input Z a.c.	(as d.c. but with 100pF on 20V, 200V, 1200V ranges)				
Accuracy d.c.	± (0.1% of reading + 0.5% f.s.)				
a.c.	± (0.5% of reading + 0.1% f.s.)				
I d.c./a.c.	200μA	2mA	20mA	200mA	2A
Resolution	100nA	1μA	10μA	100μA	1mA
Accuracy d.c.	± (0.3% of reading + 0.05% f.s.)				
a.c.	± (1% of reading + 0.1% f.s.)				
R	200Ω	2kΩ	20kΩ	200kΩ	2MΩ
Resolution	100mΩ	1Ω	10Ω	100Ω	1kΩ
Accuracy	± (0.2% of reading + 0.05% f.s.)				
Price	£114				

WW509 for further details

Hartmann & Braun (U.K.) Ltd, Moulton Park, Northampton, NN3 1TF.

A wide range of instruments are available from this company. Many are perhaps more suitable for power engineering applications such as the interesting Elavi which measures alternating current and voltage, active current I cos φ, cos φ, sin φ frequency and resistance. Among the lighter current instruments is the Elavitron 1 electronic multimeter with analogue readout. The instrument presents a resistance of 200kΩ/V in the ranges between 1V and 100V.

Ranges						
V d.c./a.c.	0.3V	1V	3V	10V	30V	100V
I d.c./a.c.	0.1mA	1mA	10mA	30mA	100mA	300mA
R	1kΩ	100kΩ	10MΩ			
Price	£37					

WW510 for further details

Heathkit: Heath (Gloucester) Ltd, Gloucester, GL2 6EE.

This kit company has several multi-function meters available. Usually the buyer has the alternative of an assembled version, but the new IM-1202 digital multimeter is offered in kit form only. The instrument has ranges for the measurement of resistance, d.c./a.c. voltage and current. Frequency range is 25Hz to 10kHz. Cold cathode tubes are used for readout and a pseudo memory ensures a non-blinking display.

Ranges				
V d.c.	2V	20V	200V	1kV
Resolution	10mV (lowest range only)			
Input R	1MΩ			
Accuracy	1% ± 1 digit			
V a.c.	2V	20V	200V	700V
Resolution	10mV (lowest range only)			
Input Z	1MΩ			
Accuracy	1½% ± 1 digit			
I a.c.	2mA	20mA	200mA	2A
Resolution	10μA (lowest range only)			
Accuracy	1½% ± 1 digit			
I a.c.	2mA	20mA	200mA	2A
Resolution	10μA (lowest range only)			
Accuracy	1½% ± 1 digit			
R	200Ω	2kΩ	20kΩ	200kΩ
Resolution	1Ω (lowest range only)			
Accuracy	2% ± 1 digit			
Price	£39.60			

WW511 for further details

Hewlett Packard Ltd, 224 Bath Road, Slough, Bucks, SL1 4DS.

The 3490A multimeter is a five digit integrating instrument which uses a dual slope integrating technique. The basic instrument measures d.c. voltages, a.c. voltages (20Hz to 250kHz) and resistance. Ohm measurements can be made using the four-wire conversion technique to eliminate errors due to test lead resistances. Ranging is automatic on all functions. Sixteen frontpanel self tests are designed to assist calibration and fault finding. Each test interrogates an internal parameter and displays the results on the frontpanel. Results are compared with proper values given on a pull-out instruction card. Among the tests are a series of logic tests and measurement of the reference voltage. The display is of the dot-matrix type. Extra optional facilities are available, for instance, the provision of a ratio measurement mode and a sample/hold option.

Ranges

V d.c.	0.1V 1V 10V 100V 1kV
Input R	more than $2 \times 10^{11} \Omega$ on 0.1V to 10V ranges $10M\Omega \pm 0.15\%$ on 100V and 1kV ranges
Accuracy (24 hours)	$\pm(0.005\%$ of reading $+ 0.001\%$ of range) on 0.1V range $\pm(0.004\%$ of reading $+ 0.001\%$ of range) on 1V to 1kV ranges
V a.c.	1V 10V 100V 1kV
Input Z	$2M\Omega \pm 1\%$ parallel with 65pF
Accuracy (24 hours)	$\pm(0.24\%$ of reading $+ 0.05\%$ of range) between 20 to 50Hz
Price	£761

The HP970A is a digital multimeter designed to be held in the hand. It is self-contained, using a rechargeable battery pack, and presents the readings on a miniature i.e.d. dot-matrix display at the forward end of the unit. The display can be inverted electronically. Ranging is automatic, as is the indication of polarity and placing of the decimal point, which maintains units of volts and kilohms.

Ranges

V d.c.	0.1V 1V 10V 100V 1kV
Input R	$10M\Omega \pm 5\%$
Accuracy	$\pm(0.7\%$ of reading $+ 0.2\%$ of range)
V a.c.	0.1V 1V 10V 100V 1kV
Input Z	$10M\Omega \pm 5\%$ with less than 30pF
Accuracy	$\pm(2\%$ of reading $+ 0.5\%$ of range) 45Hz to 1kHz
R	1k Ω 10k Ω 100k Ω 1M Ω 10M Ω
Accuracy	$\pm(1.5\%$ of reading $+ 0.2\%$ of range)
Price	£137.50

WW512 for further details (3490A)

WW513 for further details (HP970A)

Keithley Instruments Ltd, 1 Boulton Road, Reading, Berks.

The company has recently announced the Model 190 a.c./d.c. digital multimeter which has $5\frac{1}{2}$ digit resolution and 0.005% basic accuracy. Features include 100% overranging, $1G\Omega$ input resistance and built-in binary-coded decimal outputs. Measurement ranges cover four of a.c., four of d.c. and five of resistance. The a.c. and d.c. voltage measurements cover 8 decades, from 10 μ V per digit to 1000V full scale in four ranges. Resistance measurements cover 9 decades from 1k Ω to 20M Ω full scale (10m Ω to 100 Ω per digit). A useful feature, when simultaneous data readings must be recorded from several instruments, is the output hold control which can be used to retain data in the display and the digital output. Model 190 costs £399.

WW513 for further details

Levell Electronics Ltd, Park Road, High Barnet, Herts.

The TM9BP is an electronic analogue multimeter providing measurement facilities from 3V or 3pA full-scale, and resistance to $1G\Omega$. All ranges (including resistance) are linear and have large overload ratings. Features include high input impedance and high a.c. rejection on voltage ranges, low voltage drop on the current ranges (10^{-3} V at 1nA, 0.1V at 1mA) and low test voltage (3mV at f.s.d.) on the linear resistance ranges. Power consumption is low, resulting in a very small warm-up drift and a life of 1000 hours from a self contained battery. The d.c. amplifier has 100% series negative feedback applied on the 1V range, high stability metal film resistors attenuating the negative feedback for ranges below 1V. A recorder output is included and switch selects centre zero or left zero.

Ranges

V d.c./a.c.	3 μ V 10 μ V 30 μ V . . . same intervals to . . . 1 kV
Accuracy	$\pm 1\% \pm 1\%$ f.s.d. up to 100 M rising to $\pm 10\%$ at 1 G
Input Z	$> 1 M\Omega/\mu$ V up to 10 mV; $> 10 G\Omega$ from 30 mV to 1V; 100 M Ω above
I d.c./a.c.	3 pA 10 pA 30 pA . . . same interval multiples to . . . 1 A
Accuracy	$\pm 2\% \pm 1\%$ f.s.d. ± 0.3 pA
R	3 Ω 10 Ω 30 Ω . . . same interval multiples to . . . 1 G Ω
Accuracy	$\pm 1\% \pm 1\%$ f.s.d. up to 100 M Ω rising to $\pm 10\%$ at 1 G Ω
Price	£93

WW514 for further details

Linstead Electronics, Roslyn Works, Roslyn Road, London N15 5JB.

The company market a range of instruments for industrial measurement, laboratories, universities, technical colleges and schools. The M2B is a d.c./a.c. analogue millivoltmeter providing 20 ranges from 1.2mV (120mV d.c.) to 400V full scale, d.c. or a.c. within a frequency range from 10Hz to 500kHz. A decibel scale is also provided for plotting amplifier response, transfer functions, etc.

Ranges

V d.c.	120 mV 400 mV 1.2V 4V 12V 40V 120V 400V
Input R	Varies from 2 M Ω at 30 mV to 7.5 M Ω at 400 mV. Other ranges 10 M Ω
Accuracy	$\pm(2\frac{1}{2}\%$ + $2\frac{1}{2}\%$ f.s.d.)
v.a.c.	1.2 mV 4 mV 12 mV 40mV . . . then as for V d.c. ranges
Input Z	10 M Ω
Accuracy	$\pm(2\frac{1}{2}\%$ + $2\frac{1}{2}\%$ f.s.d.)
Price	£35

WW516 for further details

Marconi Instruments Ltd, St. Albans, Herts.

The TF2670 3 $\frac{1}{2}$ -digit multimeter is suitable for test room and laboratory measurements of voltage, current and resistance. Decimal point position is indicated automatically by lamps switched by the range selectors. Range overload and reversed polarity conditions are shown by warning indicators. The a-d system uses the dual integration technique, the reference voltage being derived from a low drift Zener with a low temperature coefficient so that the instrument is largely insensitive to moderate variation in ambient temperature. Counting and storage functions are performed by a single large scale integrated circuit. The instrument can be powered by mains, external direct voltage supply or by a rechargeable battery box attachment.

Ranges

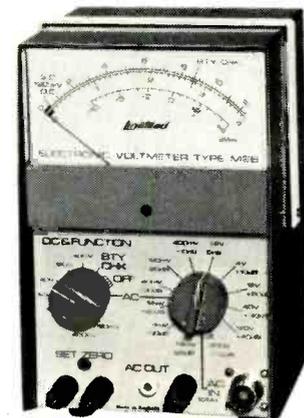
V d.c.	200 mV 2V 20V 200V 1 kV
Resolution	100 μ V 1 mV 10 mV 100 mV 1V
Input R	10 M Ω all ranges
Accuracy	Varies from $\pm 0.1\%$ to 2% of reading and $\pm 0.1\%$ to 0.15% f.s.d.
V a.c.	200 mV 2V 20V 200V 1 kV
Resolution	100 μ V 1 mV 10 mV 100 mV 1V
Input Z	1 M Ω and 40-150 pF
Accuracy	Varies from $\pm 0.3\%$ to 0.4% of reading and $\pm 0.15\%$ to 0.2% f.s.d.
I d.c.	200 μ A 2 mA 20 mA 200 mA 2A
Resolution	100 nA 1 μ A 10 μ A 100 μ A 1 mA
Accuracy	$\pm 0.3\%$ of reading $\pm 0.2\%$ f.s.d. all ranges
I a.c.	200 μ A 2 mA 20 mA 200 mA 2A
Resolution	100 nA 1 μ A 10 μ A 100 μ A 1 mA
Accuracy	Varies from $\pm 0.3\%$ to 0.7% of reading and $\pm 0.3\%$ to 0.5% f.s.d.
R	200 Ω 2 k Ω 20 k Ω 200 k Ω 2 M Ω
Resolution	100 m Ω 1 Ω 10 Ω 100 Ω 1 k Ω
Accuracy	$\pm 0.4\%$ of reading $\pm 0.15\%$ f.s.d. on 200 Ω range. Other ranges $\pm 0.3\%$ of reading $\pm 0.15\%$ f.s.d.
Price	£99

WW517 for further details

Keithley 190
digital
multimeter



Linstead M2B
electronic d.c./
a.c. voltmeter



Neuberger

Agents: Kadem Electrical Ltd, 711 & 715 Fulham Road, London SW6 5UN.

The PKD4 set of measuring and testing instruments is a somewhat unusual approach to multi-function measurements. It consists of a basic moving coil indicator which accepts adaptors in the form of plug-in modules. Up to 12 different modules are separately available, covering d.c./a.c. voltage, d.c./a.c. current, resistance, a multi-range d.c. amplifier, a transistorised a.c. voltmeter and static and dynamic testers for n-p-n and p-n-p transistors. The meter has two linear scales, 0 to 10 and 0 to 30 (for a.c. and d.c. measurements) and a third non linear scale marked in ohms and decibels. Adaptors are colour coded for quick identification and the ranges of PA2 (V d.c.), PA3 (I d.c.), PA4 (V a.c. and I a.c.) and PA5 (resistance) modules are as follows.

Ranges	
PA2	
V d.c.	60 mV 150 mV 300 mV 1V 3V 10V 30V 100V 300V 1 kV 3 kV
Input R	20 kΩ/V
Accuracy	1%
PA3	
I d.c.	100 μA 300 μA 1 mA 3 mA 10 mA 30 mA 100 mA 300 mA 1A 3A 6A
Accuracy	1%
PA4	
V a.c.	3V 10V 30V 100V 300V 1 kV
Input Z	333Ω/V (on 3V and 10V ranges) 2 kΩ/V (remaining ranges)
Accuracy	1%
I a.c.	3 mA 30 mA 300 mA 1A 6A
PA5	
R	1 kΩ 100 kΩ 10 MΩ
Accuracy	1%
Price	£220

WW518 for further details

Pye Unicam Ltd, York Street, Cambridge CB1 2PX

Released only in January 1974, the 4-digit (max.9999) PM2424 digital multimeter measures resistance, d.c. and a.c. (40 Hz to 50 kHz) voltage and current with automatic ranging. Ranging time per range is 200 ms to 330 ms. Dual slope a-d conversion is used, and sampling rate is 3 to 5 samples/sec.

Ranges	
V d.c.	1V 10V 100V 1 kV
Resolution	100 μV 1mV 10mV 100mV
Input R	More than 1GΩ on 1V and 10V ranges. 10 MΩ above.
Accuracy	±0.01% reading ±0.01% f.s. ±1 digit
V a.c.	1V 10V 100V 500V
Resolution	100 μV 1 mV 10 mV 50 mV
Input Z	1 MΩ in parallel with 10 pF (all ranges)
Accuracy	Depends on range and frequency
I d.c.	1 mA 10 mA 100 mA 1A
Resolution	100 nA 1 μA 10 μA 100 μA
Accuracy	±0.2% reading ±0.01% f.s. ±1 digit on all ranges except 1A where it is ±0.3% reading ±0.01% f.s. ±1 digit
I a.c.	1 mA 10 mA 100 mA 1A
Resolution	100 nA 1 μA 10 μA 100 μA
Accuracy	±0.5% reading ±0.2% f.s. ±1 digit on all ranges except 1A where it is ±0.7% reading ±0.2% f.s. ±1 digit
R	1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ
Resolution	100 mΩ 1Ω 10Ω 100Ω 1 kΩ
Accuracy	Depends on range
Price	Not released

WW519 for further details

Racal Instruments, 26 Broad Street, Wokingham, Berks

Model 314A is a general purpose electronic voltmeter for measuring alternating voltage (25 mV to 300V), direct voltage (±5 mV to ±300V) and resistance (100Ω to 1 GΩ). An optional a.c. high voltage probe is available. The instrument is N.A.T.O. approved.

The 9070 Digital Universal Meter measures alternating or direct voltages from 100 μV to 1.1 kV together with a.c. and d.c. current and resistance, and costs £211.

WW520 for further details

RCA Ltd, Sunbury-on-Thames, Middlesex TW16 7HW.

The WV38A analogue multimeter measures resistance, direct current, d.c. and a.c. voltages and audio signals in dB units. Extra low 0.25V and 1V d.c. ranges are included. Frequency response (reference 1kHz) of the a.c. voltmeter is within 0.5dB from 10Hz to 50kHz from 2.5 to 50V full-scale.

Ranges	
V d.c.	0.25V 1V 2.5V 10V 50V 250V 1 kV 5 kV
Input R	20 kΩ/V
Accuracy	±3% f.s.d.
V a.c.	2.5V 10V 50V 250V 1 kV 5 kV
Input Z	5 kΩ/V
Accuracy	±5% f.s.d.
I d.c.	50 μA 1 mA 10 mA 100 mA 500 mA 10A
Accuracy	±3%
R	R×1 R×100 R×10,000
Price	£32.50.

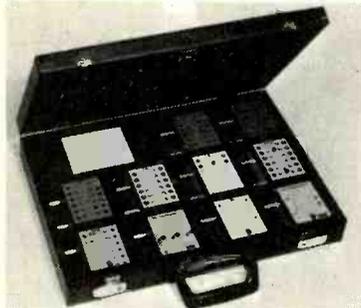
WW521 for further details

Salford Electrical Instruments Ltd., Peel Works, Barton Lane, Eccles, Manchester M30 0HL

The Super 50 Mark 2 Selectest multi-range meter has three scales with a mirror inset and knife edge pointer to eliminate parallax errors. Current and voltage scales are 0 to 100 with 100 divisions and 0 to 25 with 50 divisions. The third scale, 0 to 1000 ohms, covers all three resistance ranges. The outer scale is 6 in (152 mm) long. Ranges are selected by two rotary, electrically-interlocked, multi-position switches capable of continuous rotation in either direction. The 2.5 kV ranges in the following table are on separate terminals.

Ranges	
V d.c.	250 mV 2.5V 10V 25V 100V 250V 1 kV
Input R	2.5 kV 20 kΩ/V
Accuracy	±1.5% (I.E.C. Class 1.5)
V a.c.	2.5V 10V 25V 100V 250V 1 kV 2.5 kV
Input Z	2 kΩ/V
Accuracy	±2.5% (I.E.C. Class 2.5) f.s.d. at 50 Hz
I d.c.	50 μA 250 μA 1 mA 10 mA 100 mA 1A 2.5A 10A
Accuracy	±1% (I.E.C. Class 1.0)
I a.c.	25 mA 100 mA 250 mA 1A 2.5A 10A
Accuracy	±2.5% f.s.d. (I.E. C. Class 2.5) at 50 Hz
R	2 kΩ 200 kΩ 20MΩ
Accuracy	±3% (zero to mid scale reading) ±5% (mid scale to ½ f.s.d.) ±10% (½ f.s.d. to f.s.d.)
Price	Approximately £37.

WW522 for further details



Neuberger PKD4 multi-function modular measuring set



Racal 9070 digital multimeter

Pye PM2424 digital multimeter



Sanwa

Agents: Quality Electronics Ltd, 47/49 High Street, Kingston-upon-Thames, KT1 1 LP.

The 460-ED is an analogue multimeter with a 10 μ A meter movement giving a d.c. sensitivity of 100 k Ω /V. Frequency coverage on ranges of 30V a.c. and below is 50 Hz to 100 kHz, and 10 kHz for other a.c. voltage ranges. At the inherent 100 k Ω /V sensitivity, the instrument measures up to 300V d.c. Above this, a high voltage probe is available to measure up to 30 kV at a sensitivity of 16.6 k Ω /V.

Ranges

V d.c.	0.3V	3V	12V	30V	120V	300V
Input R	100 k Ω /V					
Accuracy	$\pm 2\%$					
V a.c.	3V	12V	30V	120V	300V	1.2 kV
Input Z	5 k Ω /V					
Accuracy	$\pm 3\%$					
I d.c.	12 μ A	0.3 mA	3 mA	30 mA	300 mA	1.2 A
Accuracy	$\pm 2\%$					
I a.c.	1.2 A	12 A				
Accuracy	$\pm 3\%$					
R	5 k Ω	50 k Ω	500 k Ω	50 M Ω		
Price	£29.72					

WW523 for further details

Sinclair Radionics Ltd, London Road, St Ives, Huntingdonshire. PE17 4HJ.

The Sinclair DM1 3½ digit multimeter is suitable for d.c. measurements ranging from 1 mV to 1 kV and 1 nA to 1A and a.c. measurements ranging from 1 mV to 1 kV and 1 μ A to 1A. Accuracy varies from 0.4% on the d.c. voltage scale to 1% on the a.c. voltage scale. Full scale error amounts to ± 2 digits. The instrument is priced in the region of £49, and when launched in December 1972 was claimed to be the first digital multimeter to be directly price competitive with professional quality analogue meters.

Ranges

V d.c.	1V	10V	100V	1000V
Resolution	1mV	10mV	100mV	1V
Input resistance	1 G Ω			
Accuracy	$\pm 0.5\%$ of reading			
V a.c.				
Accuracy	$\pm 1\%$ of reading			
I d.c.	1 μ A to 1A			
Max. res.	1nA			
I a.c.	1mA to 1A			
Max. res.	1 μ A			
R	1k Ω to 1M Ω			
Max. res.	1 Ω			

WW524 for further details

The Solartron Electronic Group Ltd, Farnborough, Hampshire.

When using the fully automatic 7040 digital multimeter, the user selects the function, subsequent operations being fully automatic. The instrument itself samples the input, selects the correct range, illuminates the unit indicator and decimal point as appropriate and displays the measured value together with its polarity. Leading zero suppression is applied. Common mode noise and series (normal) mode noise rejection are achieved by the use of a fully floating input stage with good isolation and integration over an integral number of mains cycles. The integration period is 100 ms, giving high rejection of 50 Hz, 60 Hz and 400 Hz without the use of filters.

Ranges

V d.c.	100 mV	1V	10V	100V	1 kV
Resolution	10 μ V	100 μ V	1 mV	10 mV	100 mV
Input R	1 G Ω	1 G Ω	1 G Ω	10 M Ω	10 M Ω
Accuracy	$\pm (0.02\% \text{ to } 0.03\%) \text{ reading } \pm 1 \text{ to } 2 \text{ digits}$				
V a.c.	100 mV	1V	10V	100V	700V
Resolution	10 μ V	100 μ V	1 mV	10 mV	100 mV
Input Z	1 M Ω with less than 100 pF (all ranges)				
Accuracy	$\pm 0.2\% \text{ reading } \pm 2 \text{ to } 10 \text{ digits}$				
I d.c.	10 μ A	100 μ A	1 mA		
Resolution	1 nA	10 nA	100 nA		
Accuracy	$\pm 0.05\% \text{ reading } \pm 1 \text{ to } 3 \text{ digits}$				
R	1 k Ω	10 k Ω	100 k Ω	1 M Ω	10 M Ω
Resolution	100 m Ω	1 Ω	10 Ω	100 Ω	1 k Ω
Accuracy	$\pm 0.05\% \text{ reading } \pm 1 \text{ to } 3 \text{ digits}$				
Price	£195				

WW526 for further details

Smiths Industries Ltd, Industrial Instrument Division, Waterloo Road, Cricklewood, London. NW2 7UR.

Multimeter 3 is a portable instrument designed around a 24-position rotary switch. A.c. and d.c. ranges are identical except for additional low d.c. voltage and current ranges. Volts, resistance and current ranges are selected by push button. Unidirectional components such as electrolytic capacitors and semiconductors can be tested without the need to reverse

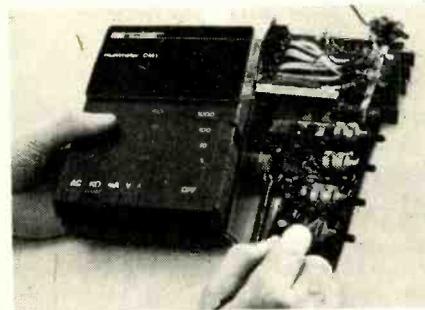
leads or terminals — press buttons select the polarity of test voltage and meter movement. A safety cut-out which operates within 5 ms to 10 ms reacts to the rise time of the applied signal, not the movement of the pointer, breaking the circuit before the pointer reaches full scale. The cut-out is equally sensitive in the forward or reverse direction.

Ranges

V d.c.	0.1V	0.3V	1V	3V	10V	30V	100V	300V	1 kV
Input R	31.6 k Ω /V								
Accuracy	$\pm 1\%$ f.s.d.								
V a.c.	0.3V	1V	3V	10V	30V	100V	300V	1 kV	
Input Z	5 k Ω /V								
Accuracy	$\pm 1.5\%$ f.s.d. (25 Hz to 1 kHz)								
I d.c.	30 μ A 0.1 mA 0.3 mA . . . in same multiples to . . . 10A								
Accuracy	$\pm 1\%$ f.s.d.								
I a.c.	0.3 mA . . . and then same ranges as I d.c. to . . . 10A								
Accuracy	$\pm 1\%$ f.s.d. (25 Hz to 1 kHz)								
R	500 Ω	50 k Ω	500 k Ω	5 M Ω	50 M Ω				
Price	£38.50								

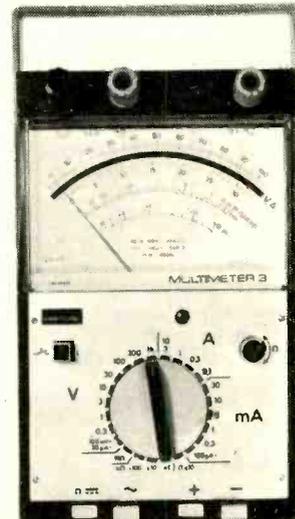
WW525 for further details

Salford Super 50 Mark 2 Selectest multimeter



Sinclair DM1 digital multimeter

Smiths Multimeter 3



Tekelec-Airtronic Agents: REL Equipment & Components Ltd, Croft House, Bancroft, Hitchin, Herts SG5 1BU.

A d.c. multimeter with a 3½-digit display, the TE923 possesses voltage, current and resistance ranges. Grounded or floating operation (500V) is provided for and the input can be offset by up to ±50µV. An analogue output of 1V is available and an optional digital output is possible. A further option is the TE380, which provides an alarm signal when the reading is either within or outside two preset limits.

Ranges

V d.c.	100µV to 1kV f.s.
Resolution	0.1µV to 1V
Input R	100kΩ to 100MΩ
Accuracy	±0.1% reading, ±1 digit
I d.c.	100nA to 1A
Resolution	0.1nA to 1mA
Accuracy	±0.2% reading, ±1 digit
R	100Ω to 1GΩ
Resolution	0.1Ω to 1MΩ
Accuracy	Range dependent
Price	Not available

WW530 for further details

Wessex Electronics Ltd, Stover Trading Estate, Yate, Bristol, BS17 5QP.

The California Instruments 8300 offers frequency measurement up to 1MHz in addition to handling alternating and direct voltage and current, and resistance. A l.e.d. dot-matrix display is used and a comprehensive printer output is provided.

Ranges

V d.c.	100mV	1V	10V	100V	1000V (50% overrange on highest ranges)
Resolution	10µV	100µV	1mV	10mV	100mV
Z _{in}	1000MΩ		10MΩ	10MΩ	
Accuracy	±0.01% of reading ±0.01% f.s.				
V a.c.	100mV	1V	10V	100V	1000V (50% overrange on highest ranges)
Resolution	10µV	100µV	1mV	10mV	100mV
Z _{in}	Less than 0.5% loading of 1kΩ source up to 10kHz				
Accuracy	±0.45% of reading ±0.05% f.s.				
I a.c.					
I d.c.	100mV	1V	10V	100V	1000V
Accuracy (d.c.)	±0.03% of reading ±0.02% f.s.				
(a.c.)	±0.7% of reading ±0.05% f.s.				
R	100Ω	1kΩ	10kΩ	100kΩ	1MΩ
Resolution	10mΩ	100mΩ	1Ω	10Ω	100Ω
Accuracy	±0.02% of reading ±0.02% f.s.				
Frequency	1kHz	10kHz	100kHz	1MHz	
Z _{in}	Less than 0.5% loading of 1kΩ source up to 10kHz				
Accuracy	±0.01% reading ±0.01% f.s.				
Price	£850				

WW527 for further details

West Hyde Developments Ltd, Ryfield Crescent, Northwood Hills, Northwood, Middlesex. HA6 1NN.

Imported from Italy, the TS140 analogue multimeter is somewhat unusual in that it does not employ a selector switch for its 50 ranges. Instead, insertion of the test lead plugs is arranged to operate internal switches. It is claimed that the method possesses long term mechanical reliability. In addition to the voltage, current and resistance ranges listed in the following table, the instrument measures reactance, frequency and capacitance. Accessories are available for measurement of light (0 to 20,000 lux), heat (-25°C to +250°C) and e.h.t. up to 25 kV d.c.

Ranges

V d.c.	0.1V	1V	3V	10V	30V	100V	300V	1kV
Input R	20 kΩ/V							
V a.c.	1.5V	15V	50V	150V	500V	1500V	2.5/5 kV	
Input Z	4 kΩ/V							
I d.c.	50µA	500µA	5mA	50mA	500mA	5A		
I a.c.	250µA	50mA	500mA	5A				
R	1kΩ	10kΩ	100kΩ	1MΩ	10MΩ			
Price	£15.50							

WW528 for further details

Z & I Aero Services Ltd, 44A Westbourne Grove, London, W2 5SF.

Imported from U.S.S.R., multimeter Type U4323 has V, I and R facilities plus an oscillator output which produces a 1kHz square wave, and a 465 kHz sine wave modulated by 1 kHz square wave.

Ranges

V d.c.	0.5V	2.5V	10V	50V	250V	500V	1kV
Input R	20 kΩ/V						
V a.c.	2.5V	10V	15V	250V	500V	1kV	
I d.c.	0.05mA	0.5mA	5mA	50mA	500mA		
R	1kΩ	10kΩ	100kΩ	1MΩ			
Accuracy	5% f.s.d.						
Price	£7						

WW529 for further details

Active filters for loudspeakers

Addition and correction

Values for the capacitors C₃ and C₄ shown in Fig. 4 of the article published in the December 1973 issue should be

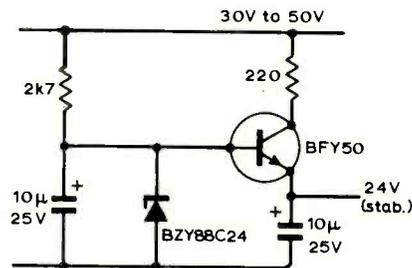
C ₄	h.f.	10µF
C ₃	h.f.	10µF
C ₄	m.f.	25µF
C ₃	m.f.	25µF
C ₄	l.f.	50µF
C ₃	l.f.	150µF

Components are shown on the active filter card for a power supply regulator not included in the circuit diagram. It is recommended that the transistor mounted above the 2k2 pot on the power amplifier circuit board is a plastic 2N3904 which can be clipped under the output transistor heat sinks. The lead marked "to (-ve) of l.s. & coupling C" on the power amplifier layout (Fig. 6) should read "to (-ve) of l.s. coupling C". Cut off frequencies, for the 12dB/octave filters should be $1/2\pi\sqrt{R_1 R_2 C_1 C_2}$.

Listening tests conducted by the author, comparing the active design with a passive network, produced the following comments from him:

"Convinced theoretically that the active filter approach is better, I needed assurance that it sounded better. With the help of many discerning friends, listening tests were carried out. A remote push-button was used to compare reproduction through active or passive filters. Nobody was told whether the active filter was in circuit when the button was pressed or released, but without exception all preferred the sound produced via the active filter. The remarks made were: 'It is less harsh, the sound is clearer, the cymbal comes through cleanly, the piano notes have no overhang,' etc. The difference is small, but it is unmistakably there. The advantages are particularly apparent on certain types of music which contains plucked bass, piano and percussion instruments—that is, pieces with high transient energy. With some other types of music, it was admittedly hard to tell which was which."

Components of the "on-board" power supply regulator.



No half measure!

a77



D.C. VOLTS
100 μ V to 1000V

D.C. VOLTS
1 μ V to 1000V

A.C. VOLTS
10 μ V to 1000V

EVENTS TO
1 MILLION COUNTS
PER SECOND

FREQUENCY
to 8MHz

FREQUENCY
to 100MHz

RESISTANCE
.001 Ω to 1,000M Ω

CAPACITANCE
1pF to 10,000 μ F

TIME INTERVALS
0.01mS to 1
MILLION SECONDS

D.C. CURRENT
0.1nA to 10A



The Farnell Digital Measuring System provides a wider range of measurement than is generally possible with digital multimeters.

There's a choice of 3, 4 or 6 digit main frames and any module may be used with any frame. The module slips into the main frame on runners and is secured by a locking shaft. Simply and quickly in this way, the instrument is converted to measure voltage, frequency, period, events, resistance, capacitance etc.

An obvious choice when equipping a new laboratory because the display section and power supplies are bought just once—in the main frame. Additional functions are obtained at far less cost than complete single purpose digital instruments by purchasing the required modules.

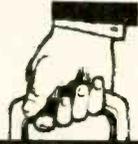
To obtain a 16 page brochure describing this equipment contact:-

FARNELL INSTRUMENTS LIMITED,
TELECOMMUNICATIONS DIVISION,
SANDBECK WAY, WETHERBY, YORKSHIRE.
TELEPHONE 0937 3541 · TELEX 557294

LONDON OFFICE: TELEPHONE 01-802 5359



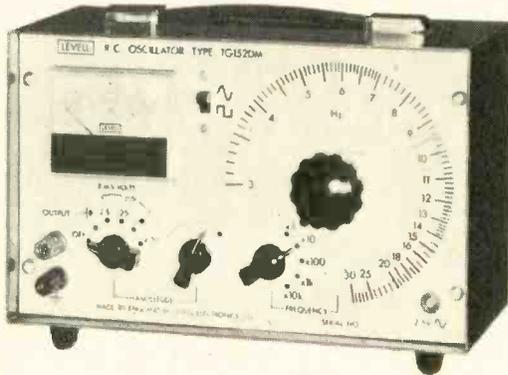
LOW COST RC OSCILLATORS



LEVELL
PORTABLE INSTRUMENTS

SEE US ON STAND No. 645
AT THE I.E.A. EXHIBITION

ANALOGUE



FREQUENCY 3Hz to 300kHz in 5 ranges.
ACCURACY $\pm 2\% \pm 0.1\text{Hz}$ up to 100kHz, increasing to $\pm 3\%$ at 300kHz.
SINE OUTPUT 2.5V r.m.s. down to $< 200\mu\text{V}$.
DISTORTION $< 0.2\%$ from 50Hz to 50kHz.
SQUARE OUTPUT 2.5V peak down to $< 200\mu\text{V}$.
SYNC. OUTPUT 2.5V r.m.s. sine.
METER SCALES 0/2.5V & $-10/+10\text{dB}$ on TG152DM.
SIZE & WEIGHT 7" high x $10\frac{1}{2}$ " wide x $5\frac{1}{2}$ " deep. 8 lbs.

TG152D	TG152DM
Without meter. £46	With meter. £56



FREQUENCY 1Hz to 1MHz in 12 ranges. Acc. $\pm 2\% \pm 0.03\text{Hz}$.
SINE OUTPUT 7V r.m.s. down to $< 200\mu\text{V}$ with $R_s = 600\Omega$.
DISTORTION $< 0.1\%$ to 5V, $< 0.2\%$ at 7V from 10Hz to 100kHz.
SQUARE OUTPUT 7V peak down to $< 200\mu\text{V}$. Rise time $< 150\text{ns}$.
SYNC. OUTPUT $> 1\text{V}$ r.m.s. sine in phase with output.
SYNC. INPUT $\pm 1\%$ freq. lock range per volt r.m.s.
METER SCALES 0/2V, 0/7V & $-14/+6\text{dBm}$ on TG200M & DM only.
SIZE & WEIGHT 7" high x $10\frac{1}{2}$ " x $5\frac{1}{2}$ " deep. 10 lbs.

TG200	TG200D	TG200M	TG200DM
Sine O/P	Sine & Sq. O/P.	Sine O/P + meter.	Sine & Sq.O/P + meter.
£55	£58	£65	£68

DIGITAL



FREQUENCY 0.2Hz to 1.22MHz on four decade controls.
ACCURACY $\pm 0.02\text{Hz}$ below 6Hz
 $\pm 0.3\%$ from 6Hz to 100kHz
 $\pm 1\%$ from 100 kHz to 300 kHz
 $\pm 3\%$ above 300 kHz.
SINE OUTPUT 5V r.m.s. down to $30\mu\text{V}$ with $R_s = 600\Omega$
DISTORTION $< 0.15\%$ from 15Hz to 15 kHz.
 $< 0.5\%$ at 1.5Hz and 150kHz.
METER SCALES 2 Expanded voltage & $-2/+4\text{dBm}$.
SIZE & WEIGHT 7" high x $10\frac{1}{2}$ " wide x 7" deep. 12 lbs.

TG66B	TG66A
Battery model. £150	Mains & battery model. £170

LEVELL ELECTRONICS LTD.
Moxon Street, High Barnet, Herts. EN5 5SD
Tel: 01-449 5028/440 8686

Prices include batteries and U.K. delivery. V.A.T. EXTRA.
Optional extras are leather cases and mains power units.
Send for data covering our range of portable instruments.

Television Broadcasting from Satellites

Conclusion of a two-part series describing 12GHz satellite TV receiver design

by D. B. Spencer, Ph.D and K. G. Freeman, B.Sc., A.Inst.P., M.I.E.R.E.

It was concluded in our previous article that broadcasting of television signals from a geostationary satellite is feasible at both u.h.f. and s.h.f. Transmission in the u.h.f. band which has been allocated to satellite broadcasting (620-780MHz), will probably be chosen by the developing countries, whereas developed countries which have an existing u.h.f. terrestrial television service will probably use the s.h.f. allocation (11.7-12.5GHz for Region 1, Europe, U.S.S.R. and Africa). Considerations of the transmitter power requirements and channel allocation problems led to the conclusion that such systems would almost certainly use wideband frequency modulation. Possible f.m. 12GHz receiver designs and microwave technologies will now be considered and these will be illustrated by reference to experimental receivers which have been constructed. Although u.h.f. receiver design will not be discussed specifically, the i.f. processing circuits (amplification, limiting and demodulation) together with a.f.c. techniques are of general application. The tuner required for the u.h.f. system will be similar to that used as the second converter of the s.h.f. double superhet receiver.

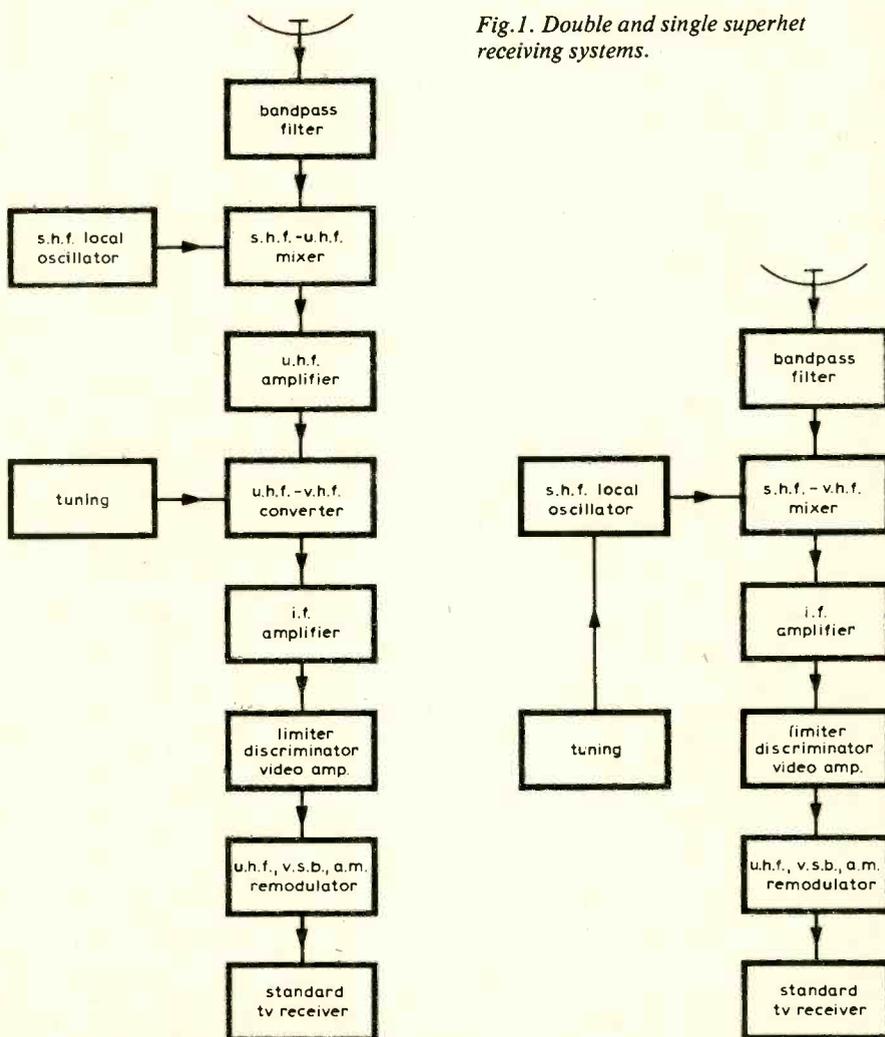
Receiver design problems

Apart from cost, which as with all consumer products is of prime importance, a number of important factors affect the design of 12GHz f.m. satellite television broadcast receivers. Either direct reception of the signals in the home or some form of community reception could be used. In both cases the need would initially be for a converter capable of providing a u.h.f. (or possibly v.h.f.) a.m. signal suitable for feeding the standard television receiver which is already in most homes. In the long term specially designed receivers can be envisaged to which the input may be at video or as f.m. at a v.h.f. or u.h.f. intermediate frequency.

Future trends such as the use of several receivers in one home, video tape recorders and also possible local cable TV must be borne in mind. It is also necessary to take into account the possible development of a system of data transmission within the existing broadcast signal, such as that proposed by the B.B.C./I.B.A.^{2,3}. The domestic television receiver may also

be called upon to act as the visual display unit of a domestic data link system. All of these factors may affect the packaging of the parts of the satellite broadcast receiver. Since part of the receiver will probably be near the aerial there would be a need to supply power, and in some cases, a tuning and a.f.c. voltage, up to this unit. The most convenient and elegant solution would be to use the existing u.h.f. television down-lead for these signals together with the satellite signal.

Although 800MHz of bandspace has been allocated at 12GHz to countries in Region 1 it is likely that transmissions to any particular country will be grouped within only part of this band. This eases the constraints on receiver design. We have assumed for this study that all programmes to any one country will be within 400MHz of bandspace. Assuming a 30MHz channel spacing this allows a gap of 90MHz between each programme which should be more than adequate in order to provide adjacent channel rejection.



a) double superhet

b) single superhet

Fig.1. Double and single superhet receiving systems.

There are two principal types of receiver suitable for s.h.f. satellite broadcast reception; these are the single and double superhet. In the single superhet design the incoming s.h.f. signal is converted to an intermediate frequency which allows amplification, limiting and demodulation to be accomplished directly. The double superhet consists of two converter stages. The first converts the s.h.f. to a lower frequency at which it is amplified and passed to a second mixer which produces the required intermediate frequency. Two types of double superhet can be considered. In one, the first local oscillator is fixed and a broadband first i.f. amplifier is employed which passes all the required satellite signals. The second oscillator is then tuned to provide reception of the required programme. The alternative form of double superhet has a tunable first local oscillator and a narrow-band first i.f. amplifier which passes only the required programme. A fixed second local oscillator in the second mixer provides the necessary second i.f.

Due to the restricted space available here it is impossible to go into the various advantages of the two types of double superhet in detail. However, if the problems of local oscillator re-radiation, image rejection and cost are considered it seems probable that the first local oscillator will be fixed in frequency and the second tuned.

Fig. 1 shows possible double and single superhet designs. In the case of the double superhet the incoming 12GHz signals are mixed with an s.h.f. local oscillator. The resultant u.h.f. signals are passed through an amplifier to a second mixer where they are mixed with a tunable u.h.f. oscillator to produce a v.h.f. i.f. This frequency modulated signal is amplified and limited before being demodulated to produce a video output (with 6MHz inter-carrier f.m. sound). A u.h.f. a.m. modulator then produces a signal which is suitable for insertion into the aerial socket of a standard television set. An a.f.c. signal derived from the frequency discriminator controls the frequency of either local oscillator. The single superhet receiver produces a low i.f. directly from the 12GHz incoming signal; this is then processed as indicated above.

A problem which is common to both single and double superhet designs is the rejection of the image frequency. (A mixer produces an output for signals spaced at the i.f. away both above and below the local oscillator frequency. Only one of these signals is wanted, the other is known as the image frequency.) In the case of a 30MHz bandwidth f.m. television signal a protection of approximately 30dB is required against an interfering signal whether it be co-channel or image channel interference. Image channel protection is provided by a combination of the contributions from the receiver selectivity, receiver directivity and the position and directivity of the interfering transmitter. Sufficient first image rejection can be provided reasonably easily with the double superhet design since the high first i.f. places the image frequency bands well away from the wanted signal. This is

indicated in Fig. 2a. The first i.f. lies between 500 and 900MHz and, if a low local oscillator is assumed, the image band lies between 10.4 and 10.8GHz. The design of a band-pass filter which will pass only the wanted signals is relatively simple. Selectivity must also be provided before the second mixer to reject the second image; this should be achievable using existing techniques.

In the single superhet design a v.h.f. i.f. has to be chosen as low cost amplification, limiting and discrimination circuits would otherwise not be possible. This makes image rejection more difficult. Fig. 2b shows the variations of the signal, local oscillator and image frequencies for a similar tuning range to that assumed for the double superhet. An i.f. of 70MHz has been assumed for the purpose of illustration together with a 30MHz signal bandwidth. The signal frequency range is 11.8-12.2GHz and if a low local oscillator is assumed this varies between 11.745GHz and 12.145GHz (see Fig. 2c). An image frequency band from 11.69GHz to 12.09GHz must be rejected.

It is apparent that the selectivity demanded before a conventional mixer calls for a high-Q tunable s.h.f. filter. This must have a bandwidth of 70MHz and 110MHz away from the band edge it must have some 30dB of attenuation. A filter based upon a Yttrium Iron Garnet (YIG) device may provide a suitable solution. At the present time, however, such filters are rather expensive, lossy and also temperature dependent. (A YIG filter consists basically of a small sphere of magnetic material (Yttrium Iron Garnet) which exhibits a gyromagnetic resonance effect. The sphere is positioned in a circuit

so that it will couple power between the input and output only at its resonant frequency. The frequency at which this occurs depends upon the magnetic field in which the sphere is situated and this can be varied to provide tuning.)

Perhaps a more elegant solution to the problem of image rejection could be the image rejection mixer. This should be amenable to mass production techniques and it will be considered in more detail later.

Another problem which may have to be solved in the receiver design is that of the prevention of excessive local oscillator power radiation. This again can more easily be solved in the double superhet design where the local oscillator frequency is fixed and sufficiently far removed from the required signal band so that a filter is readily made. In fact this filter could also provide image band rejection. In the case of the single superhet, a filter solution is difficult. An attractive approach might be the inclusion of a non-reciprocal device, such as an isolator, before the mixer. This would pass signals from the aerial but attenuate the local oscillator signal from the mixer. However, it is possible that by suitable allocation of frequencies the local oscillator frequency can be made to lie between channels and be relatively untroublesome.

Receiver aerial

The aerial must be considered as an integral part of the receiving system. Its supply and fixing may well prove to contribute a significant proportion of the overall system cost. For individual (domestic) reception the aerial required would probably be a 75cm diameter parabolic dish or an aerial of similar performance. This would have a beam-width of about 2°. A community receiver aerial might well be twice the size of an individual receiving aerial with a subsequent smaller acceptance angle. In both cases they would have to be mounted to withstand all weathers, whilst maintaining a high positional accuracy. As the satellite transmitter would be in an equatorial orbit, it would have to point approximately South with an elevation angle varying from, for example, 23° in Northern Scotland to 33° in Southern England. The surface profile of a parabolic aerial would have to be accurate to the order of 2mm.

As large numbers of aerials would eventually be required it may be possible to produce them, at a reasonable cost, using a plastic moulding technique. A conductive coating would have to be added to provide a reflecting surface. Similar techniques may be feasible for the construction of the aerial feeder and this could incorporate a bandpass filter.

Microwave front end

Since even a short length of low-cost s.h.f. feeder will incur significant signal attenuation and installation costs, the microwave portion of the receiver will be located at or near the aerial. It

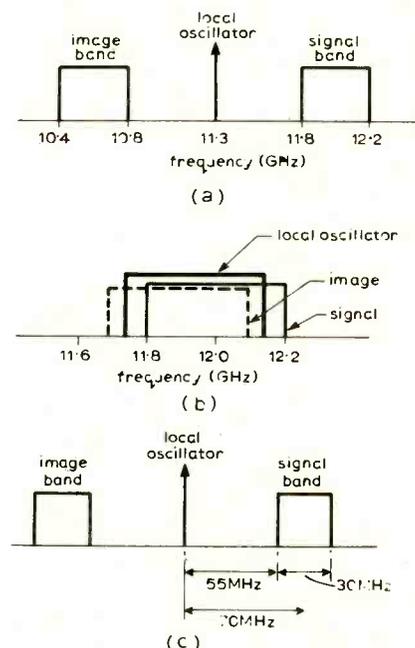


Fig. 2. Diagrams showing the relationship of the signal, image and local oscillator bands in (a) double superhet (b) single superhet (c) indication of the final image filtering problem.

will comprise a mixer with local oscillator followed by some low noise i.f. amplification. Because of the exposed position of this "head-unit" it will have to be designed to withstand all the rigours of the climate.

The mixer may well be constructed using a strip-line technique as this should be compatible with high volume, low cost production. Two such techniques are currently in general use, known as "Tri-plate" and "Microstrip"; they have both been described recently in *Wireless World*³. Tri-plate consists of a sandwich construction of ground plane, dielectric, circuit lines, dielectric and a second ground plane. Microstrip consists of a single ground plane and dielectric upon which are laid the circuit lines. Tri-plate and Microstrip are illustrated in Fig. 3. For our early experimental work with Tri-plate we used 1.5mm irradiated polyolefin as a dielectric which was backed with copper ground planes (this material is generally known as polyguide). Our later work concentrated on the Microstrip technology, in which the circuits consisted of an alumina substrate with gold ground plane and circuit lines.

All the experimental mixers were of the balanced variety as these are easier to make using strip-line techniques than the apparently simpler single-ended type. The fact that a balanced mixer rejects local oscillator amplitude noise comes as an unnecessary bonus as the i.f. signal limiter will do this anyway.

Some means must be found to apply signal and local oscillator voltages across the mixer diodes. At microwave frequencies this is achieved by means of hybrid rings, which are shown in suitable forms for Tri-plate and Microstrip circuits in Fig. 4(a) and 4(b) respectively. In the Tri-plate version a signal applied to port (1) is divided equally between ports (3) and (4), the two signals being in phase.

A signal applied to port (2) is similarly divided between ports (3) and (4) but in this case there is a 180° difference between the two outputs. In the Microstrip hybrid-ring a signal applied to either port (1) or port (2) is divided between ports (3) and (4). The outputs are of equal amplitude but differ by 90° in phase in each case. A mixer is constructed by taking ports (3) and (4) to a pair of diodes and applying signal and local oscillator voltages to ports (1) and (2).

The microwave mixer requires a local oscillator power of the order of 10mW in the region of 11.5GHz. This can be obtained directly from one of a number of semiconductor two terminal bulk effect devices. Perhaps the best known, and certainly the most widely used, are the avalanche diode and the Gunn device. The avalanche oscillator requires a supply of some 60V and produces more power than is necessary. A Gunn oscillator on the other hand needs only an 8V supply and it produces the right amount of power.

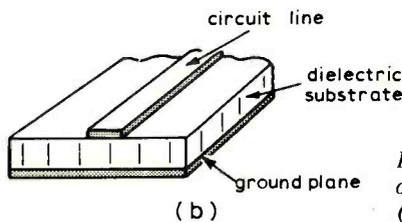
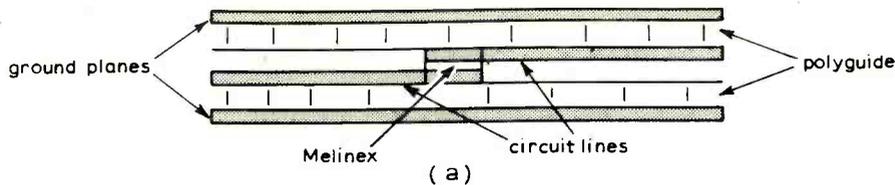


Fig.3. Schematic diagram of (a) a section of triplate showing a series capacitor and (b) microstrip.

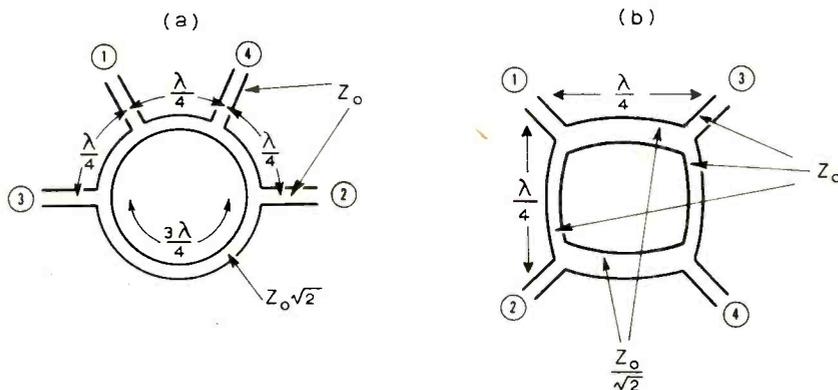


Fig.4. Hybrid ring suitable for (a) triplate construction and in (b) microstrip construction.

The local oscillator may be fixed tuned in the case of the double superhet but it must be electronically tunable if the single superhet approach is adopted. (Electronic tuning is possible by the addition of a varactor diode to the resonant circuit of the oscillator.) The temperature stability of Gunn oscillators is generally poor — typically of the order of 1MHz/°C. As the oscillator would be exposed to wide temperature variations, mounted as it is near the aerial, large frequency variations would occur. Fortunately it appears that the application of a.f.c. using the existing wideband frequency discriminator, together with some temperature compensation, would probably provide adequate frequency stability. Although our experimental receivers used varactor tuned Gunn oscillators, it is interesting to note that experimental transistors have already been made which will oscillate at 12GHz.

A typical 12GHz mixer followed by a low noise i.f. amplifier will have a noise figure of the order of 9dB, whether it be the single superhet 12GHz/v.h.f. mixer or the first mixer of the double superhet. This noise figure could be improved by several decibels if the mixer were preceded by a low-noise s.h.f. amplifier. Even with current progress in microwave transistor development, the realization of such an amplifier at a reasonable cost in the near future seems unlikely, but it may well be available by the time that a 12GHz service is implemented.

The output from the head unit will be either a v.h.f. or u.h.f. f.m. signal. This has to be taken to the remainder of the satellite broadcast receiver which will probably be adjacent to the TV set. How this may be accomplished and how power can be fed to the head unit (adjacent to the aerial) depends to a certain extent upon the design of the receiver. These problems will be dealt with in more detail as we go on to consider the double and single superhet designs in more detail.

Double superhet

From several points of view the most attractive receiver design appears to be the double superhet which has a fixed s.h.f. oscillator and a tunable u.h.f. oscillator. In a practical receiver a head unit would provide wideband conversion of the received signals to the u.h.f. band together with a broadband low-noise u.h.f. amplifier. The amplifier would prevent cable losses in the u.h.f. downlead and subsequent stages from degrading the system noise performance. Drift in the frequency of the fixed tuned s.h.f. local oscillator due to ambient temperature changes could be compensated for by the application of a.f.c. to the second local oscillator.

D.c. power has to be fed to the head-unit to drive the local oscillator and the low-noise i.f. amplifier. There are two principal ways in which this can be obtained. The first being directly from the mains electrical supply via a

power unit situated perhaps in the attic or loft. The alternative and perhaps the more attractive solution would be to derive this power from the portion of the receiver adjacent to the TV set and feed it up the cable which is used to bring the u.h.f. signals down from the head-unit. If the cable which exists in many homes, from the terrestrial TV aerial system to the TV set, could also be used for the satellite signals then this would prove economical as well as aesthetically pleasing. Problems, however, occur such as possible interference between the satellite u.h.f. f.m. intermediate frequency signals and the terrestrial u.h.f. a.m. signals.

The u.h.f. f.m. intermediate frequency signal from the head unit must be further processed to arrive at a signal which is compatible with a television receiver. A second mixer is necessary to convert the u.h.f. signal down to a v.h.f. signal which may be more easily amplified, limited and demodulated. As the v.h.f. processing circuits are generally applicable to both double and single superhet designs these will be considered later after a discussion of the single superhet.

An important advantage of the double superhet is that a single head-unit could provide a number of outlets in a home, allowing several programmes to be received simultaneously. As a result of this the double superhet approach could also form the basis for a community distribution system. Distribution could be made at u.h.f. as f.m. signals, or these signals could be demodulated and then remodulated onto a u.h.f. carrier as amplitude modulation in a form compatible with a conventional TV set.

Single superhet

The single superhet receiver design is shown in Fig. 1(b). In order that extensive use may be made of integrated circuit techniques a low i.f. must be chosen. As has been discussed earlier this makes the problems of oscillator radiation and image rejection more difficult to solve.

A possible solution to the problem of image rejection is the image rejection mixer⁵, which is shown in schematic form in Fig. 5. In this the incoming signal is split and fed in quadrature to two balanced mixers. The i.f. outputs from the mixers are combined in quadrature giving cancellation of the image signal components. An experimental, microstrip, image-rejection mixer uses a tri-plate, meander line hybrid to produce the necessary 90° of phase change at the i.f. A wireline hybrid (basically a screened lead which contains a pair of balanced conductors) is also suitable and has been used in an experimental receiver. The image rejection which is achievable is typically of the order of 24dB.

A disadvantage with the single superhet design is the need to tune the s.h.f. local oscillator for channel selection. This can be achieved electronically by the addition of a varactor (variable capacitance diode) into the tuned circuit of the oscillator. However, this may result in

a degraded performance as the varactor will lower the circuit Q making the oscillator more temperature sensitive and increasing the f.m. noise.

To avoid an increased system noise figure due to loss in the down lead, and also to provide a signal sufficiently large so that it will not be degraded by stray terrestrial transmitter pick up, amplification would also be provided at the i.f. in the head unit. The head unit must be supplied with power and a tuning voltage together probably with an a.f.c. signal, preferably all via the coaxial signal downlead cable. This is possible using fairly simple circuit techniques. It might be thought possible to use an existing u.h.f./v.h.f. downlead cable on a shared basis with u.h.f. terrestrial transmissions. However, this is unlikely, as although v.h.f. 405-line TV transmissions may well have closed down by the advent of satellite broadcasting these frequencies may well be re-allocated to terrestrial broadcasting.

With the single superhet approach only one satellite programme can be received in the home at any time. A single superhet receiver is, therefore, not particularly suited to a community system as this would have to have as many s.h.f./v.h.f. mixers as there were programme choices. These mixers would have to be preceded by a low noise amplifier and probably a large receiving aerial to make up for the signal loss due to the power splitting between

the multiple mixers. Although the single superhet may upon initial examination appear to be the simplest solution it is thus seen to hold real disadvantages when compared to the double superhet.

I.F. signal processing

The requirements for i.f. selectivity, amplification and f.m. demodulation are, in general, similar for both the double and single superhet designs. However, the double superhet will need a second mixer to convert the u.h.f. first i.f. down to a v.h.f. second i.f. It will require a tunable local oscillator and sufficient selectivity in order to reject the second image. These are similar problems to those encountered with conventional u.h.f. TV tuners. A low noise u.h.f. amplifier will be included in the head-unit and if this has sufficient gain the noise figure of the u.h.f. converter will not be important.

The choice of the final i.f. will be a compromise between the desire to use i.c. techniques and the need to achieve adequate selectivity and, for the double superhet, adequate second image rejection. At present, an i.f. centred in the range 30-80MHz is probably optimum. If full use is to be made of the available frequency allocation then it would be split into a series of adjacent channels as shown in Fig. 6. If the final i.f. centre frequency is an integral number of half channel widths (b.w./2) then the image channels occupy one full frequency channel,

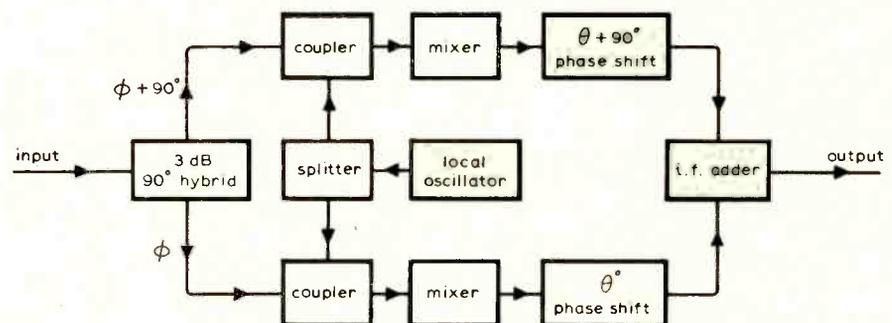


Fig.5. Outline of the image rejection mixer.

channel	A	B	C	D	E
	b.w.				
I i.f. = b.w.	signal	l.o.	image		
II i.f. = 3/2 b.w.	signal		l.o.	image	
III i.f. = 2 b.w.	signal			l.o.	image
IV i.f. = (n+1)/2 b.w. (n positive integer)	signal		l.o.	image	

Fig.6. Allocation of the image channel for various intermediate frequencies.

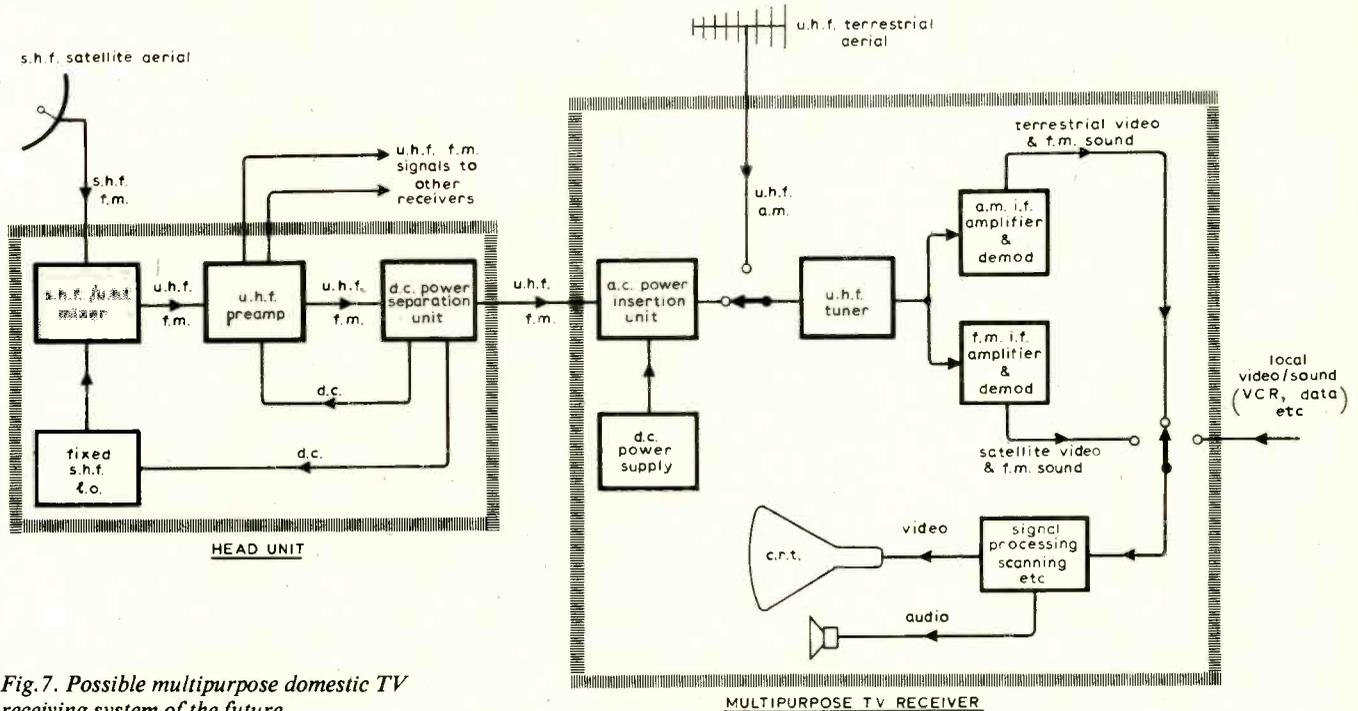


Fig. 7. Possible multipurpose domestic TV receiving system of the future.

otherwise they occupy parts of two frequency channels. For a given image protection the second situation makes allocation of service areas to give continuous coverage of the earth's surface more difficult.

Although this constraint upon the choice of the final i.f. could well apply to the single superhet it is unlikely to apply to the double superhet as sufficient image rejection can probably be provided by the selectivity of the second mixer. If local oscillator radiation is a problem with the single superhet design, choice of the i.f. to be $(2n+1)$, b.w./2, where n is again an integer, will cause this to fall at channel boundaries and it should be relatively untroublesome. In the case of the double superhet sufficient local oscillator radiation protection could probably be obtained in a band-pass filter before the first mixer and this could also provide first image rejection.

The i.f. response must provide acceptable phase and amplitude response within its passband consistent with adequate adjacent channel rejection, to permit efficient use of the available bandspace. The relationship, for example, between signal bandwidth and the filter bandwidth and response must be considered with reference to the differential phase and gain distortions in the demodulated signal. It is possible that in time new developments such as acoustic surface wave filters may prove to be an attractive solution to the filter problem as these could have constant amplitude and group delay response in band and rapid roll-off at the band-edge. It is clear that receiver design problems must be considered before fixing the signal parameters and channel allocations.

Apart from the low-noise input for the single superhet the i.f. amplifier can be integrated as can be the whole of the double superhet second i.f. As signal

strengths over the service area will not vary by more than a few dBs the limiter has only to work over a small dynamic range and this too can be integrated.

A variety of techniques are available for the demodulation of an f.m. signal: these can be grouped into three fundamental classifications as slope, phase shift, and pulse counting discriminators. The slope discriminator makes use of the amplitude versus frequency response of one resonant circuit or alternatively two resonant circuits which have slightly different resonance frequencies. The phase shift discriminator relies on the phase versus frequency characteristic of a resonant circuit or transmission line. A pulse counting discriminator is based upon the generation of a pulse of constant area each time the signal crosses the zero axis; these pulses are then integrated to provide the original modulation. During the course of our experimental work we have tried several different types of broadband f.m. discriminators but the most successful to date appears to be the pulse count discriminator. This type should be amenable to complete integration as it does not rely upon inductors or transmission lines. Our latest experimental, discrete, discriminator has an output voltage versus input frequency characteristic which is linear to well over 100MHz.

Automatic frequency control

Automatic frequency control will almost certainly be required to cope with oscillator drift. The wideband frequency discriminator used for signal demodulation can also form part of the a.f.c. circuit to provide a wide catching and holding range. The a.f.c. circuit must have low d.c. drift and the i.f. signal frequency corresponding to black level on the picture must be maintained constant by some form of line gating technique. (The d.c. content of a video signal is not constant

with time and without such a gating circuit wider i.f. and discriminator bandwidths would be needed.)

Receiver packaging and interfacing

The problems of packaging the 12GHz receiving system into a head unit and a unit adjacent to, or in, the domestic television set is interrelated with the problem of taking a signal into the television set. As the chassis of present television receivers is connected directly to the mains supply these problems are complicated by the need to consider the safety requirements.

If we consider a present day standard television receiver then the satellite receiver must generate a u.h.f. a.m. signal by remodulation if it is to be completely compatible. Due to problems which may occur in certain sets which use a.f.c. controlled tuners, a vestigial side-band signal may be necessary. Where a slight modification of the standard receiver is possible other techniques may be used. For example, we have successfully coupled the video and sound sub-carrier signals directly into a U.K. receiver which has a single video detector. An optoelectronic coupler was used to provide suitable isolation of the input leads from the receiver chassis. Opto-couplers are now available which provide adequate isolation and have bandwidths extending to several megahertz.

Unfortunately the present trend in television receiver design is towards the use of synchronous demodulation using i.c. techniques which make direct entry at video more difficult. However the growing need for inputs from other sources such as video tape recorders etc., may well change this situation.

In the long term most of the satellite broadcast receiver might be incorporated in a dual or multi-purpose television receiver. The signal from the 12GHz head

unit could then enter the receiver as a u.h.f. or v.h.f. f.m. signal. One possible system, in which a single head unit could be used to drive a number of receivers, is outlined in Figure 7.

Obviously other configurations can also be envisaged. It is therefore likely that the domestic television receiver will ultimately be rather different from its present form. However, it should be emphasized that if 12GHz f.m. satellite television broadcasting is introduced it will supplement the existing services, not replace them. There is therefore no question of present day receivers being made obsolete and one would expect that for many years after the inception of a satellite service, converters would be available which would provide signals compatible with conventional u.h.f. a.m. receivers.

Conclusions

With the present pace of technological progress and the various needs which exist for the expansion of television broadcasting it seems likely that within the next decade we may see the use of satellite television broadcasting direct to the home, or at least to community receiving systems, in at least one country in the world. We have therefore attempted in these two articles to look at some of the problems which may be encountered, together with certain aspects of possible receiver design.

Developing countries with no existing u.h.f. (or even v.h.f.) terrestrial service are likely to adopt the u.h.f. allocation (620-780MHz) for satellite broadcasting. On the other hand, developed countries with existing v.h.f. and u.h.f. terrestrial services which require more channels will be obliged to choose the s.h.f. allocation (11.7-12.5GHz for Europe). In either case it is almost certain that wideband frequency modulation will be employed. As far as the U.K. is concerned it should be emphasized that although satellite broadcasting at 12GHz will be technically feasible within a few years it is unlikely to be used for at least a decade and probably longer. Sufficient v.h.f. and u.h.f. bandspace is available in this country for the provision of up to six terrestrial television channels provided that the present v.h.f. transmission can be phased out.

Because the success of satellite broadcasting will depend crucially upon the availability of sufficiently cheap receivers we have concentrated upon the problem of receiver design — particularly in relation to the use of the new 12GHz band. Although we have made only passing reference to the necessary advances in satellite, power source and transmitter technology — especially the development of high power sources at 12GHz — these are obviously no less important.

With regard to the reception of 12GHz it seems likely, particularly in the early stages when costs may be higher, that there would be a strong preference in urban areas to adopt community reception. The growing desire to avoid the pollution of housing estates by a proliferation of

aerials would be a factor in favour of this. However, in rural areas, individual receivers would be necessary because of the high cost of community systems in such situations. Moreover, even in urban areas there would ultimately be some demand for individual reception. Thus although the majority of the population might be able to receive their signals via a community system a truly national service would require a broadcasting system capable of individual reception. Because this may have implications for the choice of broadcast parameters we have therefore concentrated upon the problems of designing individual 12GHz receivers. In any case, the design of a community system can be regarded as a logical extension of an individual one.

Although some development of microwave components for cheap mass-production will obviously be necessary, current studies indicate that suitable devices capable of meeting the receiver requirements already exist. Of the two principal designs discussed the double superhet appears to offer significant advantages over the single superhet, particularly in the case of a community system or a multiple outlet home system. With either approach the i.f. processing circuits can make extensive use of integrated circuit techniques for amplification limiting and demodulation with resultant cost advantages. In our view, therefore, given sufficient impetus, satellite television broadcasting to the home at 12GHz is technically capable of realization. Whether it will indeed become a reality depends upon other factors, beyond the scope of these articles.

References

1. "TV Information Service", *Wireless World*, Vol. 79, May 1973, p. 222.
2. C.C.I.R., "Conclusions of the interim meeting of study groups 10 (broadcasting service (sound)) and 11 (broadcasting service (television))"—C.C.I.R. Geneva, 5-8 July 1972—Part 2, Report 215-2.
3. Hosking, M. W., "The realm of microwaves. Part 2. Microwave transmission lines", *Wireless World*, Vol. 79, March 1973, p. 137.
4. Gunn, J. B., "The Gunn effect", *International Science and Technology*, No. 46, Oct. 1965, p. 43.
5. Wilds, R. B., "Microwave two phase converters for imageless receivers", *Microwave Journal*, Vol. 4, No. 9, Sept. 1961, p. 84.

Checking peak inverse ratings

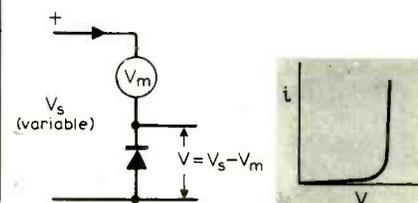
by J. M. Osborne
Westminster School

It is sometimes necessary to find the breakdown voltage of a semiconductor device, either because it is unknown or to determine how far above the manufacturer's rating one can go with an individual item.

It is possible to determine this non-destructively with no more than a high resistance voltmeter and a variable voltage supply. The voltmeter serves as a current limiter as well as measuring both leakage current and (by subtraction) the applied voltage. The procedure is to connect the voltmeter in series with the device and apply the variable voltage supply. The voltmeter will read zero so long as there is no leakage current. As the variable voltage supply is raised there comes a point where the voltmeter reading starts to rise. Let us suppose that the meter is a 10kΩ per volt on the 1 kV range. If it reads 50 V then the leakage current is 5 microamps. Suppose that the supply voltage is 750 V; then the voltage across the device is 700 V which may be taken as the breakdown voltage. If the device was a silicon rectifier, it should be safe to run it in a circuit with p.i.v. of 600 V although the manufacturer's safe rating for this type number might only be 400 V.

Likewise the collector-base rating of a germanium power transistor can be determined. With germanium devices the leakage is much greater; the point to take is that at which the voltage across the device ceases to rise significantly, i.e. the voltmeter reading increases in step with the supply voltage above this point. Suppose the voltmeter reading increased from 10 to 20 V while the supply increased from 50 to 62 V; this indicates that the leakage current increases from 10 to 20 microamps as the voltage across the collector-base rises from 40 to 42 V. One could install the transistor with some confidence in a circuit with a 35-V rail.

The voltmeter can be used to measure the voltage of the variable voltage supply, if it is not metered. This is of course much more cumbersome. If the supply has a high internal resistance, e.g. a high resistance potentiometer across a high voltage supply, then allowance might have to be made for the current taken by the voltmeter by loading the supply with a resistance drawing, say, 1 mA.



Current i is determined by interpreting the V_m reading in microamps. A 10,000 ohm per volt meter has a full scale deflection of 100 microamps on all voltage ranges.

Wideband amplifiers

Introducing wideband techniques; circuits and their performance are discussed in detail in series 12 of Circards

by J. Carruthers, J. H. Evans, J. Kinsler & P. Williams

Paisley College of Technology

Wideband amplifiers are extensively used in instrumentation and communication systems where the signals to be handled may be of an analogue or a digital nature. Such amplifiers are required to provide fairly equal amplification of a large range of frequencies with a lower frequency limit of zero or nearly zero. The high-frequency behaviour of the active devices must be considered in conjunction with the passive network elements to design an amplifier with required characteristics.

Many different circuit models are available for such devices, but not all are necessarily useful. Consider, for example, the bipolar junction transistor models shown in Fig. 1. The three versions of the intrinsic low-frequency equivalent circuit shown in (a), (b) and (c) are highly-idealized models that focus attention on the basic active properties of the device. The low-frequency T and h-parameter models shown in (d) and (e) are more useful, but are unsatisfactory for predicting amplifier performance in the region of its upper cut-off frequency.

Models that are useful for high-frequency design must provide a more realistic representation of the transistor as a network element. The high-frequency model one chooses is often determined by availability of data, personal preferences and experience or whether the parameters of interest are readily determined by measurement. Fig. 2(a) shows the hybrid equivalent circuit which is a reasonable compromise between accuracy and complexity and which may be reduced to simpler forms for low-frequency and high-frequency calculations.

In high-frequency transistors, r_{ce} and $r_{b'c}$ are often sufficiently large to be neglected, the former being much larger than the load impedance and the latter much greater than the reactance of $C_{b'c}$ at high frequencies. The simplified form of Fig. 2(b) is often sufficiently accurate for assessing high-frequency performance and this may be reduced to that shown in Fig. 2(c), where C_{in} consists of $C_{b'e}$ in parallel with the Miller effect equivalent of $C_{b'c}$. The base spreading resistance $r_{bb'}$ and the product $g_m r_{b'e}$ may normally be assumed to be independent of the operating point, g_m increasing and $r_{b'e}$ decreasing as I_E increases. The value of $C_{b'e}$ increases with I_E and the depletion-layer capacitance $C_{b'e}$ varies as $1/(V_{CB})^{1/2}$ to $1/(V_{CB})^{1/3}$.

To obtain a wide bandwidth with the simple cascade of common-emitter stages shown in Fig. 3, the collector coupling re-

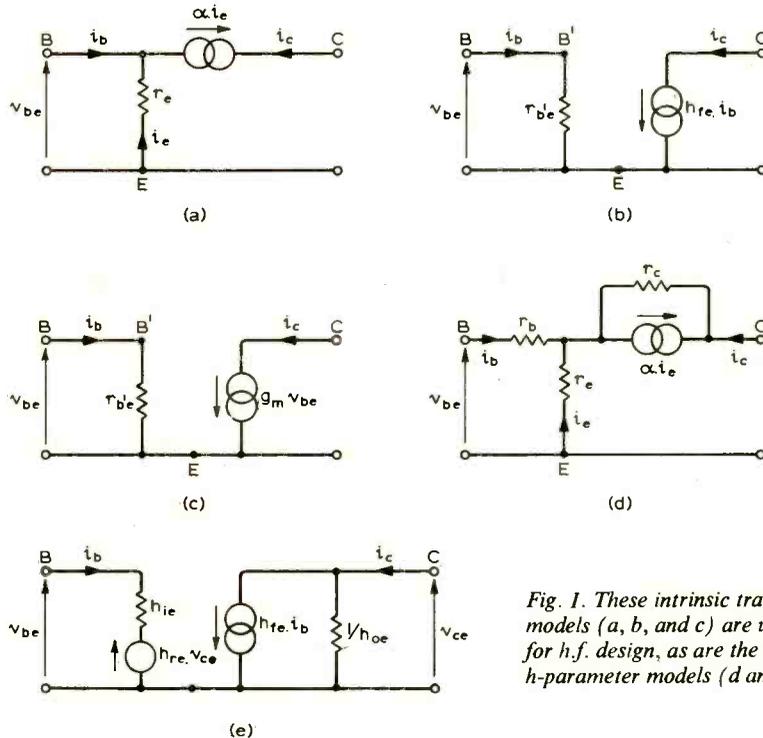
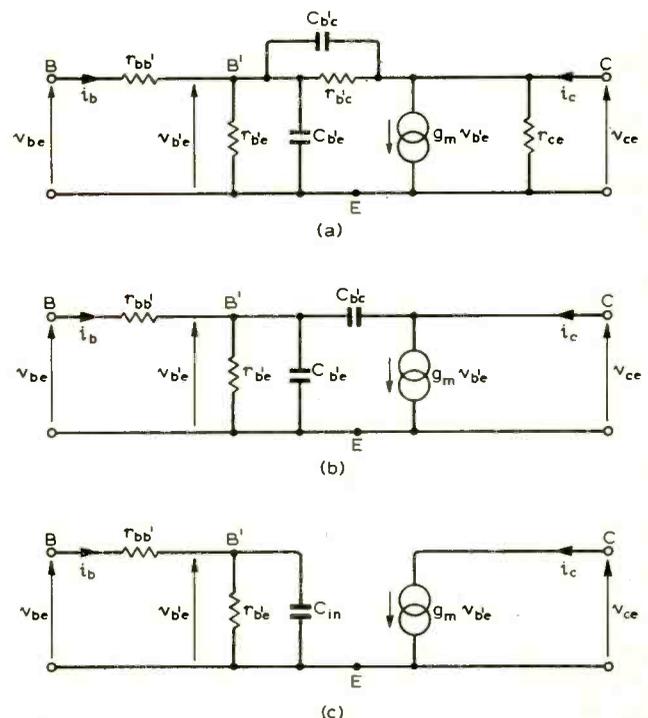


Fig. 1. These intrinsic transistor models (a, b, and c) are unsatisfactory for h.f. design, as are the T and h-parameter models (d and e).

Fig. 2. The hybrid equivalent circuit (a) is a reasonable compromise between accuracy and complexity, and may be simplified for h.f. work to (b) and even (c).



sistors must be made small compared with the input impedance of the following stage, the capacitive component of which causes the gain to fall at high frequencies. Further reduction of R_C to exchange gain for bandwidth is limited by the presence of $R_{bb'}$. Also, if the gain per stage is reduced, more stages must be cascaded to achieve a desired amplifier gain and it becomes increasingly difficult to maintain the overall bandwidth which shrinks as the number of cascaded stages increases. The gain-bandwidth product of the transistors (f_T) attains a maximum value at a particular value of emitter current, which is often small. Adjusting the emitter current of each stage to its optimum value may result in a small signal-handling capability if significant distortion is to be avoided.

Several techniques are available for improving the achievable stage gain-bandwidth product, the simplest of which is the inclusion of an inductor to compensate for the falling response due to transistor input capacitance. The stages in Figs. 4(a) and 4(b) are said to be shunt-peaked and series-peaked respectively, the latter being far less effective in improving gain-bandwidth product. The effect of the shunt-peaking inductor is illustrated in Fig. 5 and by correct design the stage bandwidth, for a given gain, can be improved by a factor of about two without lifting the high-frequency gain above its low-frequency value. Too large a value of L results in overcompensation which produces overshoot and ringing in the transient response. Amplifiers using a number of these stages in cascade may suffer from instability and prove difficult to align.

This problem may be alleviated by making the effective load on each transistor resistive. Referring to Fig. 6, this can be achieved by considering L and R_C to be in parallel with the series equivalent of the CR input network, making R_C equal to the equivalent series input resistance and designing L to produce the same short-circuit time constant for each of the parallel branches. A disadvantage of this constant-resistance cascade is that it is no longer possible to vary a network element to adjust amplifier gain or bandwidth, which must be attempted by variation of the transistor parameters, e.g. by adjusting the individual collector currents. The foregoing techniques have the disadvantage that all the cascaded stages interact, any change in the design of one stage normally requiring changes in the others.

As the input capacitance, including that due to Miller effect, plays an important part in limiting the achievable bandwidth, a design approach that attempts to eliminate the effects of internal feedback is useful. The cascode amplifier shown in Fig. 7 employs this technique and it may be considered as a common-emitter common-base cascade. The common-base stage has a very low input impedance, so the common-emitter stage has a current gain approaching h_{fe} and a very small voltage swing at its collector, resulting in a large reduction of the internal feedback between collector and base. The bandwidth of the common-emitter stage approaches f_β and as that of the common-base stage is much larger, the cascode pro-

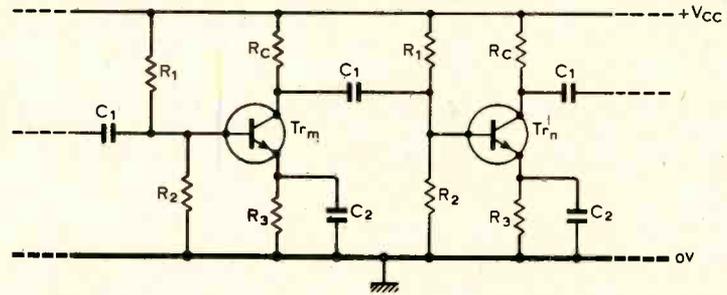


Fig. 3. Reducing R_C and increasing the number of stages can reduce overall bandwidth and give poor signal handling.

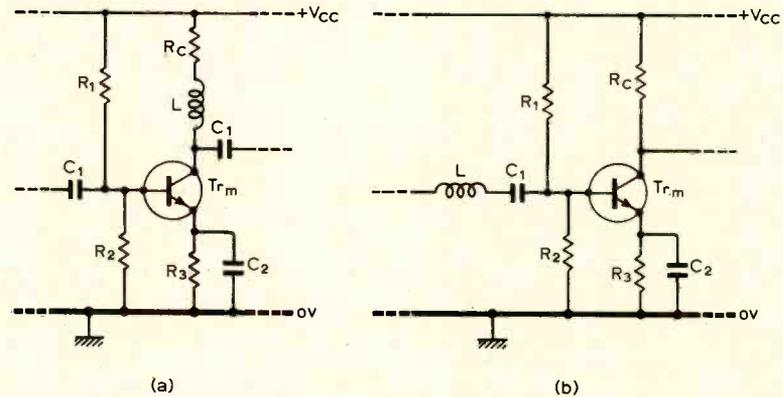


Fig. 4. Simplest way of improving bandwidth is to add shunt (a) or series (b) compensation. Effect of shunt peaking—the most effective—is shown in Fig. 5.

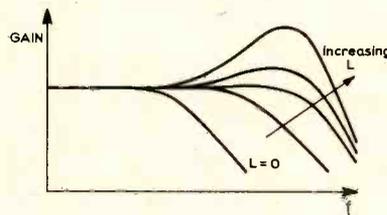


Fig. 5. Too large a value of L in Fig. 4(a) results in overshoot and ringing.

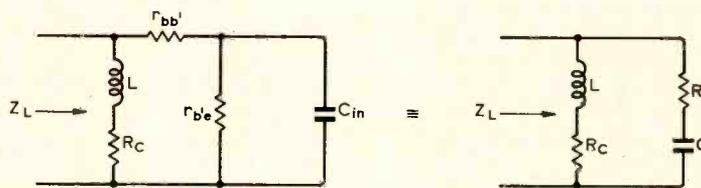


Fig. 6. To avoid instability in cascaded circuits of Fig. 4(a), the transistor load can be made resistive.

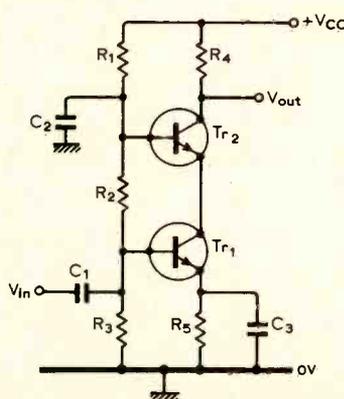


Fig. 7. Cascode circuit minimizes effect of internal feedback.

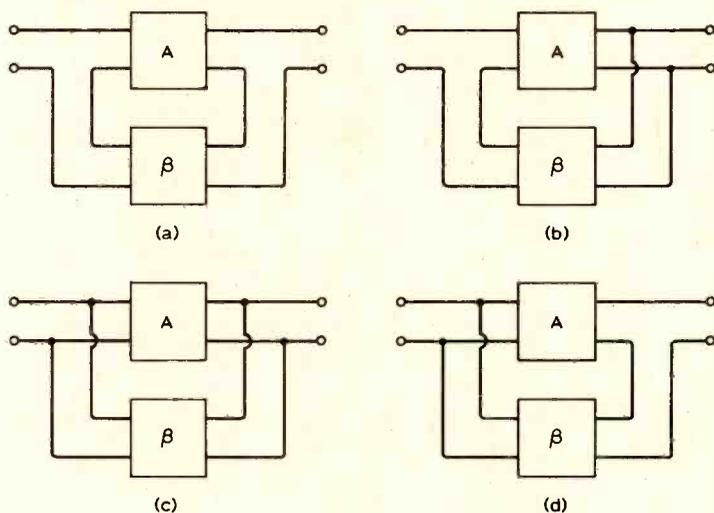


Fig. 8. Four basic ways of increasing bandwidth using negative feedback.

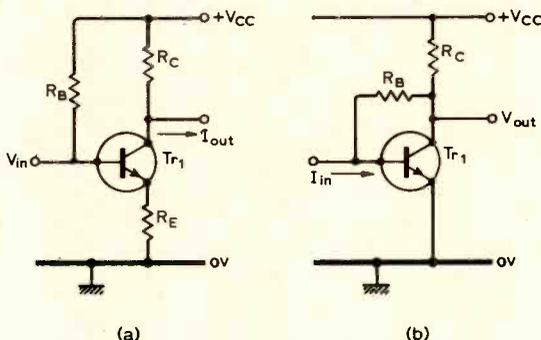


Fig. 9. Series and shunt feedback applied to a single stage.

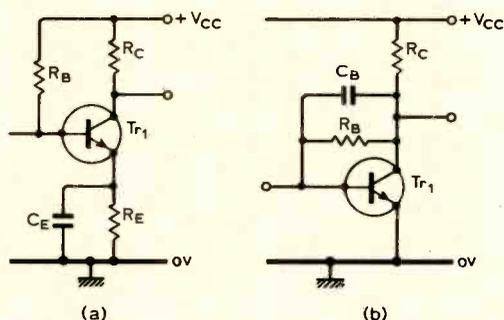


Fig. 10. Peaking capacitors improve h.f. response of Fig. 9.

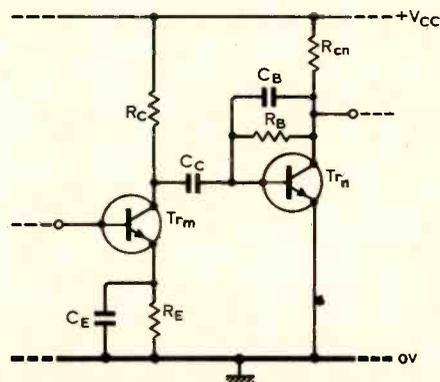


Fig. 11. Deliberate mismatching of impedances can improve stability.

vides the voltage gain and current gain of a common-emitter stage with a wider bandwidth than that obtainable with a simple common-emitter amplifier.

Satisfactory design of wideband amplifiers usually requires the interaction between individual stages or elementary building blocks to be negligible, or definable, the mid-band gain to be stable and input and output impedances to be adjustable to desired values. Use of feedback in the design allows these criteria to be approached without undue concern for the variations in transistor parameters and permits bandwidth to be extended at the expense of gain in a controllable manner. While the reduction in gain is a disadvantage it is not an expensive price to pay, bearing in mind the benefits obtained and the relatively low cost of adding extra feedback stages to meet the overall gain requirement.

Another disadvantage of feedback is the increased possibility of oscillation, which may be avoidable at the design stage by using a sufficiently accurate circuit model. In a multi-stage amplifier designed for the highest possible bandwidth before the application of feedback, the cut-off frequencies of all stages will normally be similar. Hence there is a near certainty that the combined phase shift can reach 180° while the magnitude of the gain is well in excess of unity. To remove this possibility, by deliberately setting one of the cut-off frequencies much lower than the others, negates the original requirement for maximum pre-feedback bandwidth. General-purpose operational amplifiers, such as the 741-type, have internal stages with high cut-off frequencies, but a dominant lag at about 10Hz has to be introduced to cope with the possibility of 100% feedback.

Four basic feedback configurations may be used to create elementary building blocks. Fig. 8 shows these configurations which may be described in terms of the method in which the feedback is derived and applied. Thus, (a) is series-derived series-applied, (b) is shunt-derived series-applied, (c) is shunt-derived shunt-applied and (d) is series-derived shunt-applied. Alternative descriptions of these configurations are in common usage e.g. (a) transimpedance feedback, series-series or simply series, (b) voltage-ratio feedback or series-shunt, (c) transadmittance feedback, shunt-shunt or simply shunt, and (d) current-ratio feedback or shunt-series. Other descriptions include the use of the terms current feedback or voltage feedback. In the former case the signal fed back is proportional to the output current but may itself be a current or a voltage. With voltage feedback the feedback signal is proportional to the output voltage. All four arrangements have the property of increased bandwidth and reduced gain compared with the open-loop values. The input and output impedances become modified as shown in the table, shunt derivation (application) reducing the output (input) impedance and series derivation (application) increasing the output (input) impedance.

The two types of single-stage feedback, series and shunt, are shown in Fig. 9. In Fig. 9(a) the load impedance should be low and the input supplied from a voltage source

H.F. Predictions for March

The charts are based on a predicted Solar Index of 17, a considerable change since February 1973 when the measured value was 47. The Solar Index used here is known as IF2 which towards sunspot minimum is generally numerically the same as the more commonly used index of 12 month smoothed sunspot numbers known as R12. However, unlike sunspot numbers it is possible for IF2 to have low negative values at sunspot minimum and this may well be the case at the end of this year. Predicted disturbed days are March 8th to 18th.

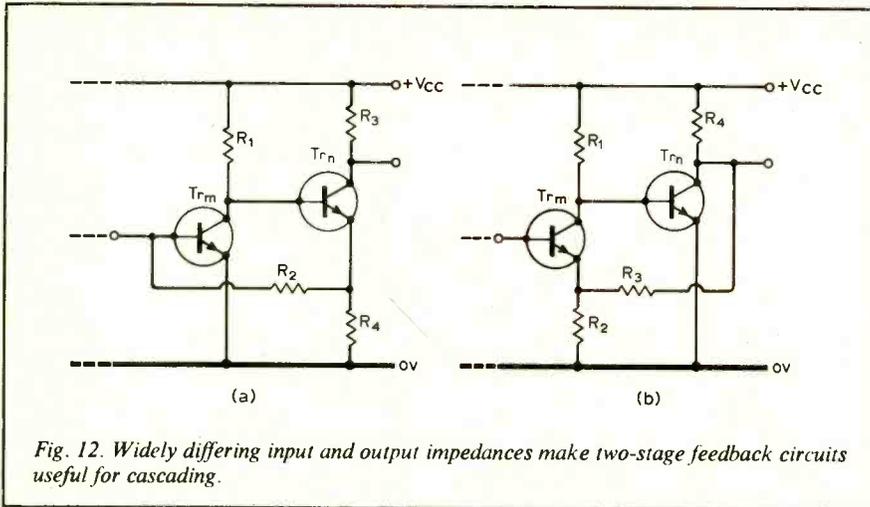


Fig. 12. Widely differing input and output impedances make two-stage feedback circuits useful for cascading.

whereas in Fig. 9(b) the load impedance should be high and the amplifier input should be from a current source. The high-frequency response of these elementary blocks may be improved by the addition of peaking capacitors as shown in Fig. 10.

Source and load impedance requirements for stable gain with single-stage feedback can be met by purposely creating a large mismatch between cascaded stages, i.e. by alternating series and shunt feedback stages as shown in Fig. 11. With this arrangement gain-bandwidth product is high, low-frequency gain may be determined with reasonable accuracy by multiplication of individual stage gains, and there is little interaction between stages. Feedback applied to two stages can offer similar merits, Figs. 12(a) and 12(b) showing series-derived shunt-applied and shunt-derived series-applied configurations respectively. Both networks have widely differing input and output impedances and are therefore attractive as basic building blocks for cascaded stages.

Although discrete devices may be used in a multistage realization, the availability of integrated-circuit transistor arrays, containing about five transistors with parameters inherently reasonably matched, are very attractive for many designs. Integrated circuits are available in the form of a long-tailed pair which can be operated as single-ended or differential-input wideband amplifiers by the addition of external passive components that allow a high degree of flexibility in the selection of gain, bandwidth and signal-handling capability.

Other integrated circuit versions provide emitter-follower input and output transistors to make the input and output impedances high and low respectively. Integrated wideband power amplifiers can be obtained providing bandwidths up to about 8MHz and outputs of about 14V pk-pk. Integrated circuits containing pairs of cascode amplifiers and some with gating facilities are also very useful as wideband amplifiers. Modern integrated-circuit logic gates designed for high-speed switching applications may also be usefully employed as low-cost wideband amplifiers by setting the quiescent conditions in a linear part of the transfer characteristic and employing feedback to define the gain.

Feedback type	Z_{out}	Z_{in}
Fig. 8(a)	increases	increases
Fig. 8(b)	decreases	increases
Fig. 8(c)	decreases	decreases
Fig. 8(d)	increases	decreases

How to get Circards

Order a subscription by sending £9 (U.K. price; £10.50 elsewhere) for a series of ten sets to:

Circards
I.P.C. Electrical-Electronic Press Ltd
General Sales Dept.
Room 11
Dorset House
Stamford Street
London SE1 9LU

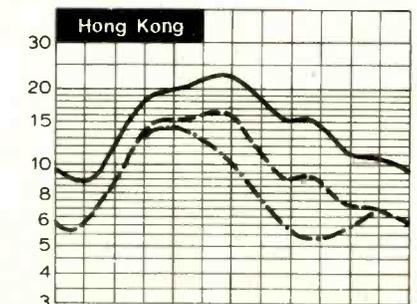
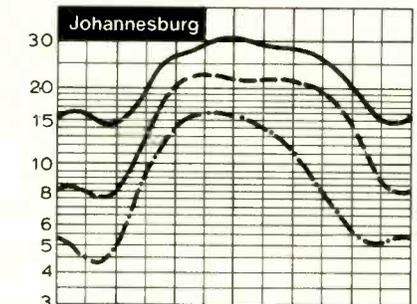
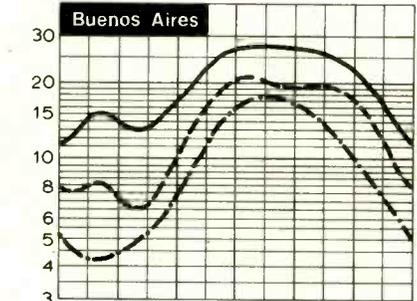
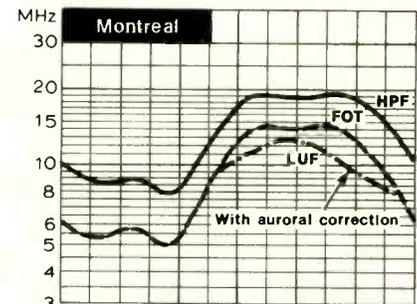
Specify which set your order should start with if not the current one. One set costs £1 U.K. and £1.15 elsewhere, postage included.

Cheques should be made payable to I.P.C. Business Press Ltd.

Topics covered in Circards are

- 1 active filters
- 2 switching circuits (comparators & Schmitts)
- 3 waveform generators
- 4 a.c. measurement
- 5 audio circuits (equalizers, tone control, filters)
- 6 constant-current circuits
- 7 power amplifiers (classes A, B, C, D)
- 8 astable circuits
- 9 optoelectronics: devices and uses
- 10 micropower circuits
- 11 basic logic gates
- 12 wideband amplifiers

Subsequent issues will cover alarm circuits, digital counters, pulse modulators. Introductory articles in *Wireless World* indicate availability of Circards, which are normally ready for despatch on the 14th of the month, and the Circard concept was outlined in the October 1972 issue, pages 469/70.



G.M.T.

Electronic calculator components offer

“Custom built” calculating systems economically feasible for Wireless World readers

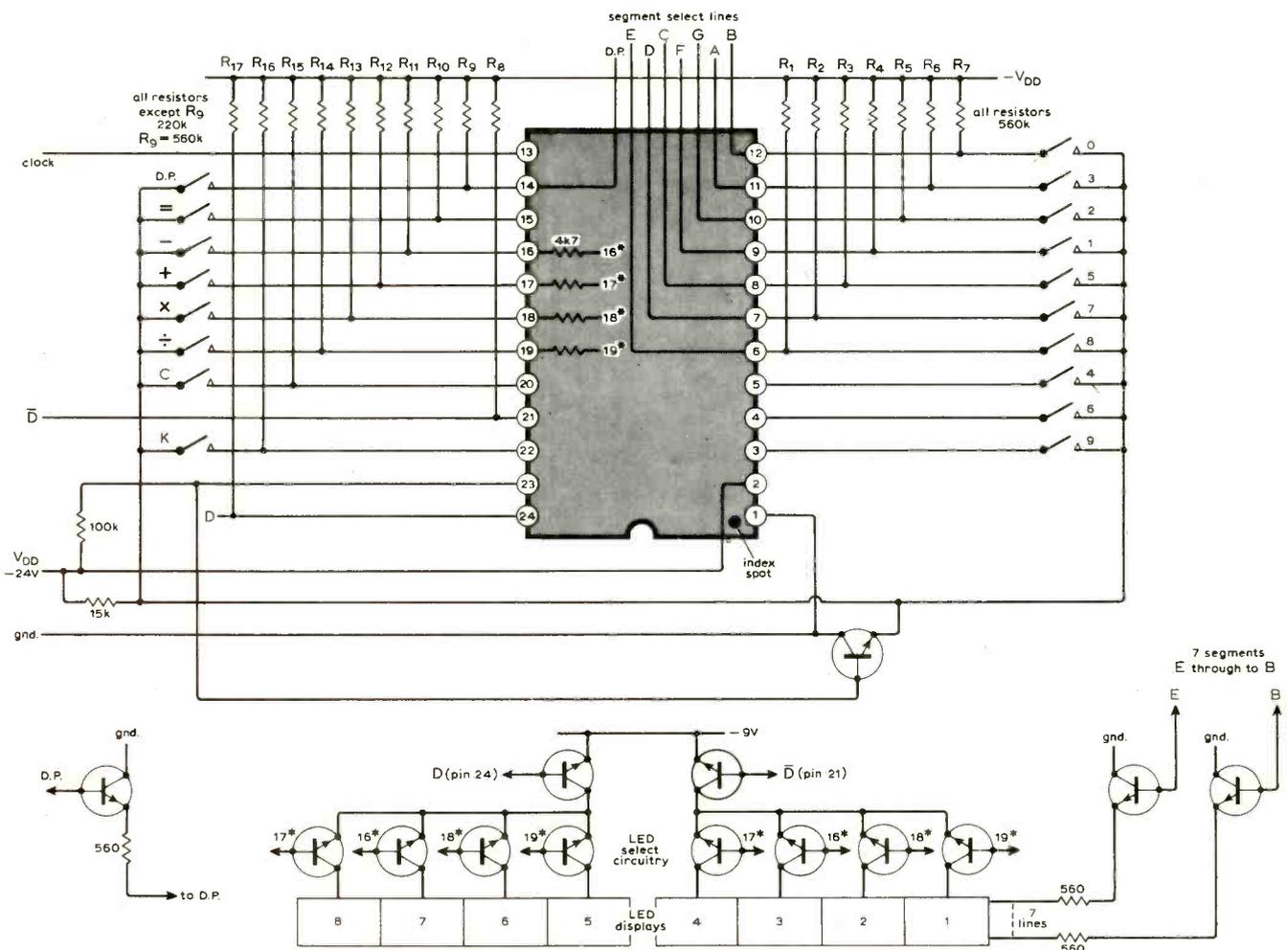
Over the past two years the great advances that have been made in m.o.s. l.s.i technology and solid-state display technology have brought about a “calculator revolution”. There is now a proliferation of low-cost instruments of varying degrees of calculating power and there are several kits available. While these undoubtedly cater for the majority of users (and pockets), we have been aware for some time now that there are certain individuals whose needs have not been met. These are people — whose involvement with electronics may be professional or amateur — who wish to construct a calculator for a “dedicated”

application, say, in a laboratory, or to a personal design which might incorporate other equipment.

While the prices of ready-made models and kits have fallen rapidly, the one-off prices of the essential components, the m.o.s. integrated circuit and the displays, have not reflected this in any way. These components are often difficult to obtain at the one-off level. The reasons for this are understandable since the high design and development costs of complex m.o.s. circuits have to be paid for as quickly as possible by their application to equipment with a high volume of production. It is only

economic sense for an m.o.s. manufacturer to think (and price) at quantity levels of hundreds of thousands, and the one-off quantity and price simply has no relevance to him. The one-off price of one well known series of calculator chips is still quoted as £29.00 although they are incorporated in finished machines costing very little more and even less.

One manufacturer who has seriously considered the one-off market is General Instrument Microelectronics. In April 1973 this firm dramatically reduced the one-off prices of its C500 series of devices and the first type in the series, the C500



Wiring diagram for using the C500 i.c. and eight l.e.d. displays. (D.P. stands for decimal point.)

8-digit integrated circuit, came down by about half to £13.70. As a result of this *Wireless World* has been able to make arrangements with Semicomps Ltd for the supply of a "package" of components (not a complete kit), consisting of one 8-digit calculator i.c. and eight 7-segment l.e.d. alpha-numeric displays, at an advantageous price (see panel).

The calculator i.c. Housed in a 24-lead dual-in-line ceramic package, the C500 m.o.s. integrated circuit provides all the electronics needed to perform the arithmetic functions of a four-function calculator. Arithmetic operations are performed algebraically* and the device can handle chain calculations. The "constant" facility operates on all four functions. This feature enables a partial result to be stored by simply pressing a K contact at any time. Thus, for example, a result can be made a divisor without the need to re-enter it. The i.c. can be used as a simple up/down counter by entering 1 as a constant and actuating the + or - inputs. Raising to a power is achieved by entering the number as a constant and actuating the \times function the required number of times.

The decimal point is fully floating, which, apart from convenience, can make a significant increase in the accuracy of the result after chain calculations.

The need for overflow or underflow indication is eliminated by the fact that during computation the exponent of all numbers from $1.0000000 \times 10^{-20}$ to 9.9999999×10^{79} is retained. Dividing by powers of 10 will retrieve the decimal point.

A useful simplification is that a "clear" (C) contact can perform three different functions. Operation followed by the entry of a number clears the calculator. Operation followed by the actuation of a "function" contact clears the previous entry only. Thirdly, operation followed by the actuation of a "constant" (K) contact clears a constant and allows a chain calculation to proceed where it is no longer needed.

The number of pins on the i.c. (24) has been kept low for a chip of such complexity by a system of multiplexing. As can be seen from the diagram, certain pins are used for both inputs and outputs. The i.c. generates a strobe pulse at pin 23 which is fed to all keyboard contacts used with the i.c. If any contact is closed during this pulse then the appropriate input is entered. The strobe pulse occupies only a very small proportion of the clock period, the rest being used to actuate the display. Keyboard contact bounce protection is incorporated, enabling very simple keyboards to be used. Simple spring-loaded push switches would prove satisfactory.

Construction of a versatile calculator is relatively simple and requires only a clock generator of 80 to 100Hz, 18 low-cost plastic n-p-n transistors (e.g. ZTX300) and 27 resistors.

The l.e.d. display. This device, type MAN 3 made by Monsanto, is of flat pack construction and has staggered leads which facilitate interconnection.

Details of the Offer

1 — eight-digit calculator i.c. (General Instrument Microelectronics, Type C500), plus

8 — seven-segment l.e.d. alpha-numeric displays (Monsanto, Type MAN3).

Data sheets are supplied.

Price for the "package" offer: £14.00 plus 10% VAT. (In this arrangement individual items cannot be supplied separately.) Not a limited offer.

Orders with cash to: Semicomps Ltd., 5C Northfield Industrial Estate, Beresford Avenue, Wembley, Middx., HA0 1SD.

Purchasers are advised to observe standard m.o.s. device handling precautions as discussed in recent *Wireless World* correspondence (Oct., Nov., Dec. Letters). The C500 device should not be removed from its black conductive foam packing until it is finally required for assembly.

* Positive values produce no sign on the display whereas negative values produce a minus symbol to the left of the most significant digit.

Announcements

Weir Electronics Ltd, producer of power supplies, has announced the formation of a wholly owned subsidiary, Weir Electronic Instruments Ltd, Durban Road, Bognor Regis, Sussex, for the manufacture and marketing of a range of low-cost instruments. It is intended that the first series of low priced laboratory instruments will be introduced early in 1974.

Surrey Electronics, 24 The High Street, Merstham, Redhill, Surrey RH1 3EA, are providing circuit boards and kits for the Hartley Jones "Frequency Shifter for 'Howl' Suppression" described in the July 1973 issue of *Wireless World*.

Lowther Acoustics Ltd, Lowther House, St. Mark's Road, Bromley, Kent, have recently moved their manufacturing division to larger premises in Maidstone. The company state that they will be offering a 24-hour reconditioning service on their loudspeakers including diaphragm replacement.

Bach-Simpson (U.K.) Ltd have announced the appointment of Electroplan Ltd, P.O. Box 19, Orchard Road, Royston, Herts, SG8 5HH, as distributors in the U.K. for their model 260-6p taut band multimeter and its range of accessories. The agreement covers all small quantity orders.

Under a recent agreement between Spin Physics Inc. and SE Labs (EMI) Ltd, North Feltham Trading Estate, Feltham, Middlesex, analogue tape recorder users may obtain replacement headstacks for most standard wideband analogue recording systems including Ampex, Bell & Howell, Hewlett Packard, Leach, Winston, Mincom and SE Labs. These replacement headstacks are tipped with a four-element magnetic alloy, "Spinalloy", claimed to have twice the life of Sendust.

HY-Q Antennas Ltd, Moulton Park Industrial Estate, Northampton is offering v.h.f. and u.h.f. aerials in the range up to 1.5GHz. A 48-hours guaranteed delivery service is offered to customers.

Competition results from West Hyde Developments: 1st A. Barr, Lefney Products; 2nd B. F. Martin, Mullard Research Laboratories.

"Hi-Fidelity '74" will be held at the Heathrow Hotel, Bath Road from 27th to 31st March inclusive. The first two days are for trade only and the new exhibition will run concurrent with the annual Sonex show. Organizers of Hi-Fidelity '74 are Pysier Britex (Swift) Ltd.

Orders for over £200,000 worth of v.h.f. radio alarm equipment have been awarded to the Mobile Radio division of GEC-Marconi Electronics by the Home Office. The units consist of portable intruder alarms, feeding decoder displays at a central point via existing v.h.f. radio systems.

Applications for the 1974 **Hudswell Research Awards** must reach the Institution of Electrical Engineers before March 31, 1974. The awards are to support research in electrical and electronic science and engineering by members of any I.E.E. class who are registered as U.K. research students.

The Institution of Electrical Engineers is to organize a vacation school on "L.f. and d.c. electrical measurement practice", which will be held at the University of Lancaster between the 7th and 9th of July, 1974. Co-sponsors of the school will be the British Calibration Service, the Institution of Electronic and Radio Engineers and the Institute of Electrical and Electronic Engineers. Theory and techniques of measurement up to 100kHz will be covered at a level suited to professional engineers.

Professor Sir Hermann Bondi, K.C.B., F.R.S., F.R.A.S., chief scientific adviser to the Ministry of Defence, will deliver the Twelfth Annual Lecture of the I.E.E. Electronics Division at Savoy Place at 5.30 p.m. on 13th February 1974. The title of his lecture will be "Electronics and human beings".

About People

Royal Society

At the Anniversary Meeting of the Royal Society on November 30, Sir Martin Ryle, F.R.S. was awarded the Royal Medal. Sir Martin is well-known for his work in radio astronomy, in particular for the development of interferometry aerial arrays, which have made possible the correlation of many radio sources with visible objects. The radio catalogues which have been produced as one result of this work are now standard references. One of Sir Martin's greatest contributions has been the building up of a laboratory at Cambridge in which outstanding work has been possible.

The Mullard Medal was awarded to Professor C. W. Oatley, O.B.E., F.R.S., emeritus professor of electrical engineering at Cambridge in recognition of his contribution to the development of the scanning electron microscope, which has been used to study the performance of semiconductor devices when voltages are applied and to display magnetic domain structures, among many contributions to physical and biological science.

Royal Television Society

Huw Wheldon, O.B.E., M.C., B.Sc. (Econ), who is managing director of BBC Television, has been elected a vice-president of the Royal Television Society. Mr. Wheldon has been closely associated with the programme side of television, notably with the "Monitor" arts review and later as assistant head of Talks (General) and as head of Documentary Programmes. In 1963, he was awarded the Television Society's Silver Medal.

The Institution of Electrical Engineers

George Millington, M.A., B.Sc., F.I.E.E. has been awarded the 1974 Faraday Medal for his theoretical studies of radio wave propagation. The medal is awarded without regard to nationality, country of residence or Institution membership.

Wilfred Bennett Lewis, C.B.E., F.R.S.C., Ph.D., F.R.S. has been elected to Honorary Fellowship of the Institution in recognition of his contributions to the development of wartime radar and of nuclear energy.

The Rt. Hon. the Lord Penney of East Hendred, O.M., K.B.E., M.A., Ph.D., D.Sc., F.R.S. has been elected Honorary Fellow for his work in the advancement of technological education and in the development of nuclear energy.

Motional feedback in loudspeakers

“There is no new thing under the sun”, Solomon, Eccles., Ch. 1, verse 9

by H. D. Harwood, B.Sc.
B.B.C. Research Department

This article was written as a result of reading the account in *Wireless World*¹ of a commercial embodiment of motional feedback in loudspeakers. This is a subject which has exercised the minds of loudspeaker designers for some time, but it may not be appreciated by all readers for just how long. In my card index, which is selective, not comprehensive, the earliest mention of this subject is a patent No. 231,972, awarded to P. G. A. H. Voigt as early as Jan. 29th, 1924. It may shake many persons, who thought that negative feedback came in with Black and Nyquist ten years later, to realise that the principles and advantages of feedback were appreciated, at least by some persons, as long ago as that, and indicates that what Black and Nyquist did was to place a matter of general knowledge on a formal and sound theoretical basis rather than to originate it, which is what I had been taught. Perhaps our academic readers could supply even earlier references to the use of negative feedback in circuits, but it is remarkable that not only were the advantages of feedback already known at this date but also that it should be applied to as intractable a subject as a loudspeaker.

Voigt used a bridge circuit to extract the motional impedance from the loudspeaker terminals and applied the corresponding feedback to a grid. It was therefore velocity feedback and although it would damp out the primary resonance, would give a 6dB/octave bass cut. On the other hand, he was aware of the effects on distortion as he quotes “. . . circuits where by the change of impedance with change of frequency of the loudspeaker or equivalent circuit is caused to alter the reaction into the grid circuit in such a manner as to compensate for the distortion of the said loudspeaker”.

The next reference I have is to a patent by A. F. Sykes, No. 272,622, dated March 20th, 1926. He describes the use of an auxiliary coil or even a microphone to sense the loudspeaker output and refers to a separate coil mounted on the centre pole piece so that the e.m.f. directly induced into his pick-up coil is cancelled. This again would yield velocity feedback.

Then comes a patent by M. Trouton, No. 320,713, dated Aug. 10th, 1928. He uses capacitive pick-up elements to give a

feedback signal which is compared either with the displacement of a very light dummy transducer or with the original signal. He seems to be the first to recognise the need for transposing the signals to give feedback proportional either to velocity or acceleration.

These three cases are mentioned in detail to give an idea of the thoughts on the subject prior to Black and Nyquist's classical papers on feedback. The use of an accelerometer for sensing the cone motion is not mentioned until later.

To obtain a uniform frequency response in the bass, the acceleration of the cone should be held constant, but it does not matter in essence whether the means of obtaining the feedback gives a signal proportional to amplitude, velocity or acceleration as it is simple to derive one from the others. There are, however, certain disadvantages in obtaining the feedback in particular ways.

Voigt's method of using the motional impedance is very attractive but falls down in several ways. The first is the need for compensating the change in resistance of the voice coil as it warms up under the influence of programme, and the compensation must have the same time constant as that of the voice coil without consuming appreciable amounts of power. Furthermore, if the frequency range extends beyond a few hundred hertz the complex variation with frequency of the inductive part of the voice coil impedance must also be taken into account, as it does not behave as a simple inductance owing to the solid iron core. Finally and fundamentally almost impossible to deal with, is the limited length of uniform magnetic flux between the pole pieces. When the amplitude (at low frequencies) of the voice coil exceeds the magnetic field length the average flux cut by the coil decreases. This causes the back e.m.f. to be reduced and, as has been shown², the amplitude of the cone is therefore *increased* contrary to what one would expect. The falling off in back e.m.f. and therefore feedback will, however, cause the driving voltage also to be increased, thus compounding the non-linearity.

The moving coil method of Sykes does not need the temperature compensation of the previous item but to avoid magnetic non-linearity effects the magnetic field

length available to the pick-up coil must exceed the maximum excursion likely to be used. This involves a rather bulky and expensive additional magnet assembly and, together with the need for accurate compensation of the unwanted directly induced voltage, rules it out on economic grounds.

The electrostatic method of Trouton is relatively simple, but with the large amplitudes involved a considerable spacing between electrodes would be necessary. Even then a push-pull type of pick-up would probably be needed to obtain a linear signal; this would also obviate the need for accurate alignment of the cone relative to the pick-up points.

This leaves us with the accelerometer method which has the advantage of giving directly the signal desired, provided the relatively heavy mass can be coupled to the cone or voice coil former without the intervening struts resonating in the frequency range of interest or without undue loss of sensitivity.

Having now decided on one or other of the means of pick-up the next step is to limit the frequency range over which feedback can usefully be applied to that over which the cone behaves as a simple piston, as it is only the motion of the voice coil which is sampled and cone break-up is not at all controlled by it. This places an upper limit which depends on the cone design and the feedback as to be rapidly* removed above this frequency without causing conditions of instability or creating a rise in output near the cross-over frequency. A similar problem arises in the bass where it is desirable to restrict the frequency range, because of limitations in amplitude. Depending on the cone size and therefore the directivity, it may be also advisable to increase the feedback with rising frequency to compensate for the otherwise rising frequency response and this increases the problem of a rapid crossover.

Finally, having solved all the technical problems in applying the feedback, the question arises as to what we really have gained.

The first facile answer is, of course, an extended bass response. In fact, this extended response could more easily, and

* The average slope cannot exceed 10dB/octave for reasons of stability.

more cheaply, have been obtained by means of a passive equaliser connected ahead of the power amplifier. It should be made clear at this point that using feedback has not essentially changed the loudspeaker unit one iota, so that if equalisation, by any means, is applied to the bass to the tune of, say, 10dB, then 10dB extra power has to be applied to the voice coil. Now this may not matter at low power levels, but if a 10 watt amplifier is needed for the mid-band and it is expected to radiate the same sound pressure in the bass, an amplifier capable of supplying 100 watts will be necessary, and of course the voice coil too must be capable of taking it without burning out. This fact of life applies whether the equalisation is provided by means of feedback or by a simple circuit, and is probably the reason why a 40 watt amplifier is provided with the 8in unit in the article previously mentioned. Some amelioration is provided by the fact that the peak programme spectrum falls off in the bass³, but it still remains that the same power has to be applied whether feedback is used or simple equalisation.

The next point is that if feedback is used a closed cabinet must also be used, for the loading imposed upon the cone by a vented cabinet implies that a constant acceleration from the cone is no longer wanted and the advantages of this loading on the cone motion are therefore not available to the designer.

It must be conceded that waveform distortion can be considerably reduced. Hence non-linearity due to a small closed cabinet, short magnetic field or non-linear suspension can all be reduced to very small proportions. However, in a good conventional design none of these factors need to be a cause of *audible* distortion and it is largely a question of economics as to whether money is best spent on producing a good design of this type or on providing a cheaper unit using feedback with the necessary accompaniment of having to always buy an associated amplifier with the loudspeaker.

At the moment it is an open question, but with a growing tendency for power amplifiers to be built into loudspeaker cabinets, the day may come when such an attachment is commonplace, although at present it is generally supplied with those more expensive units which have least need of feedback.

To conclude, the use of feedback over a loudspeaker unit is as old as feedback itself, but possesses no magical properties. The market place will decide whether it is the best way of achieving its object.

References

1. "Motional Feedback Loudspeaker", *Wireless World*, Vol. 79, Sept. 1973, pp. 425, 426.
2. Harwood, H. D., "New BBC Monitoring Loudspeaker," *Wireless World*, March, April, May, 1968, see Fig. 12.
3. Harwood, H. D., "Loudspeaker Distortion Associated with Low-frequency Signals", *Jour. Audio Eng. Soc.*, November 1972, Vol. 20, No. 9, see p. 721.

New Products

Recorder module

A low noise, high sensitivity module, claimed to be more versatile than any other recorder amplifier available, has been developed by Oxford Instruments for their '3000 series' single- or two-pen potentiometric recorders.

The new module offers a range of input facilities including $\times 20$ f.s.d. zero offset. Twenty separate input ranges are provided from 50V to 100V f.s.d. with continuously variable sensitivity adjustment.

Other special features include: voltage and current adjustment for source impedance correction, electrical zero adjustment and reverse polarity switch. Oxford Instruments, Osney Mead, Oxford OX2 0DX.

WW 301 for further details

18mm vidicon tube

The Electron Tube Division of EMI Electronics Ltd has introduced an 18mm vidicon, type 9831.

It is designed to operate in standard 18mm scan and focus coil assemblies and is primarily intended as a direct replacement in existing compact television cameras. Features include a low wattage heater, separate mesh construction and improved processing of the target layers offering better shading characteristics and sensitivity. The tubes are produced to very close limits and are individually tested immediately prior to despatching to the customer.

With this type of vidicon, EMI claim that the size and weight of the associated scan-



WW 301

ning assembly can be considerably reduced. Specialized formats will include non-browning faceplate versions for use in fields of nuclear radiation. A version with a fibre optic faceplate, for direct coupling to an intensifier, eliminates the need for an intermediary coupling lens, providing a much higher light transmission. An ultra-violet sensitive target layer will be available for use in microscopy and for inspection of items which are surrounded by intense red heat. Because this has negligible dark current, it permits the signal current to be integrated over a period of time and enables the tube to be used for low-light scientific purposes. EMI Electronics Ltd, 243 Blyth Road, Hayes, Middlesex.

WW 303 for further details

Swept function generator

The Model 750 function generator with internal sweep from Clarke-Hess Communications Research Corporation offers all standard function generator outputs plus an adjustable wide range ramp generator, together with tone burst, external f.m., and phase lock synchronization capabilities. In addition to providing sine, square, or triangular outputs over the dial controllable range from 1Hz to 2MHz, the Model 750 can supply swept frequencies from below 1/10th of the lowest dial setting up to twice the upper dial setting. For example, on the 20kHz range, the output may be swept from below 10Hz to above 40kHz. Overall operation is thus possible from 1 millihertz to 4MHz. The internal ramp (sweep) generator is variable in frequency from 1kHz down to 1 millihertz (periods from 1ms to 1000s) in four ranges. Three sweep width ranges allow reasonably accurate variation of the sweep width from twice the dial setting down to less than 1% of the dial setting. The internal sweep may free run, single shot, or be triggered from an external source. The rear panel contains sync. and tone burst input sockets, the $\times 1$ range low frequency expand switch, and the sweep trigger input. The ramp generator supplies 0



WW 304

to 5V from a 600 Ω impedance. The main generator provides two 50 Ω outputs separated in level by 30dB, the high output supplying up to 20V p.p. into an open circuit. Price £298 plus v.a.t. Lysons Instruments Ltd, Hoddesdon, Herts.

WW304 for further details

Adjustable video delay unit

Matthey announce the introduction of the UN360 adjustable video delay unit. Fitted with BNC connections as standard, the unit has a range of delays from 10ns to 325ns in 5ns steps by switches, and a fine trim of ± 4 ns by screw adjustment. This unit can therefore be used for delaying signals up to and beyond 360° of phase at colour sub carrier in either PAL or SECAM, or N.T.S.C. systems. The response of amplitude/frequency is controlled to within 0.2dB ripple up to 5.5MHz to preserve transmission quality video signals.

The unit can also be used in series with the Silver Star video delay units (separate data sheet available), having fixed delays of 50ns, 200ns, 500ns, or 1000ns. The UN360 can be used as a timing tool, a temporary delay line, or a permanent delay installation. Matthey Printed Products Ltd, William Clowes Street, Burslem, Stoke-on-Trent ST6 3AT.

WW306 for further details

60MHz oscilloscope

Tektronix has introduced a series of general purpose oscilloscopes designated the 5400 series. A range of measurement capabilities are provided by 17 plug-in units. For the full 60MHz bandwidth with the optional c.r.t. digital readout facility, the basic units are the 5403 three plug-in mainframe, D40 non-storage display module, 5A48 dual-trace amplifier, and 5B42 delayed-sweep time base. The 5A48 provides 5mV/div sensitivity at 60MHz and 1mV/div at 25MHz. Two 5A48 dual trace amplifiers can be used together for four-trace displays. The 5B42 time base features sweep rates up to 0.1 μ s/div and a $\times 10$ magnifier gives a fastest sweep rate of 10ns/div. Fifteen other plug-ins (without c.r.t. readout capability) include a dual-trace sampling

unit covering up to 1GHz at 1mV/div sensitivity, a differential amplifier offering 10 μ V/div sensitivity and a 100,000:1 common mode rejection ratio, a differential comparator amplifier with measurement accuracy up to 0.2% — and many others. By using two 5A14N four-trace amplifiers, up to eight traces can be displayed with a bandwidth of 1MHz. Since the 5403 mainframe has three plug-in compartments, multi-function capabilities can be arranged by selection from the present total of 17 plug-in units, and more of these units are to be announced soon. Modular construction enables the 5403 oscilloscope to be converted conveniently from cabinet to standard 5 $\frac{1}{4}$ in rackmount configuration. The price of the 5403 mainframe with D40 display unit and c.r.t. readout facility, is £631.90 (£443.60 without readout). The prices of the 5A48 dual trace amplifier and 5B42 time base are £242.20 and £309.30 respectively. (All prices exclusive of v.a.t.) Tektronix U.K. Ltd, P.O. Box 69, Beaverton House, Harpenden, Herts.

WW313 for further details

Lab power supply

Just introduced by Coutant Electronics are two twin-output, continuously-variable power supplies in the L Series of laboratory units. Designated the LQT 100 and LQT 200, the former offers two 0–30V outputs at 1A, while the latter provides two 0–15V outputs at 2A.

Each metered unit may be used in a constant current or constant voltage mode, and their outputs can be switched in series or parallel, as well as in a master or slave configuration — particularly useful for differential operational amplifier circuits where common tracking is employed.

The type LQT also has the following principal specifications: mains regulation 0.01% + 1mV, constant voltage (c.v.), or +1mA constant current (c.c.); load regulation 0.03% + 3mV (c.v.) or +3mA (c.c.); ripple voltage 0.005% + 0.5mV pk-pk; ripple current 0.01% + 1mA pk-pk; transient response less than 10 μ s; operating temperature range +10 to +45°C; and temperature coefficient 0.02% per °C. Each unit measures 185 × 135 × 150mm, weighs 5.5kg and costs

£79. Coutant Electronics Ltd, 3 Trafford Road, Reading, RG1 8JR.

WW302 for further details

Universal measuring bridge

Avo Ltd announce the introduction of the Universal Measuring Bridge Type B150 Mark 2. This model incorporates not only all the popular features of the earlier model but also greatly improved sensitivity. This improved sensitivity now enables the full range of resistance measurement available to be determined under d.c. conditions using only the 9V internal battery supply.

Capacitance may be measured up to 1199 μ F, inductance up to 119.9H, and resistance up to 11.99M Ω at a frequency of 1000Hz using the internal oscillator, or at frequencies between 20Hz and 30kHz using an external source. To facilitate the testing of electrolytic capacitors, provision is made for the connection of an external polarising voltage of up to 350V.

Mechanical digital in-line display of the measured value is retained. When the bridge is balanced the digits and range symbols, indicating the component value, are displayed automatically. This presentation of the component value is claimed to provide maximum reading accuracy, as all multiplying factors are eliminated.

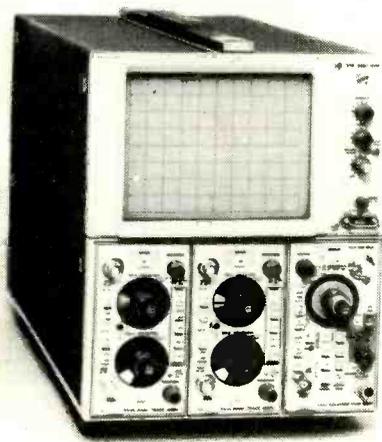
This battery operated bridge has a carrying handle for portability and a fold-away stand on the base allowing the instrument to be inclined at a convenient angle if required. Avo Ltd, Avocet House, Archcliffe Road, Dover, Kent.

WW312 for further details

Capacitor design kit

A hybrid circuit capacitor engineering design kit has been introduced by Union Carbide U.K. Ltd. The kit comprises 280 Kemet tantalum and ceramic chip capacitors together with technical literature. It is priced at £45.

The tantalum chip portion of the kit contains 80 T400 series capacitors in 20 different CV ratings and 10 case sizes. The ceramic chip portion contains 200 capacitors in both BX and NPO dielectric and in six popular case sizes. All chips feature a copper barrier layer that enables them



WW 313



WW 302



WW 312

to withstand the severe temperatures associated with solder reflow circuit assembly techniques. The tantalum chips will withstand assembly temperatures of 300°C for 20 minutes. Union Carbide U.K. Ltd, 8 Grafton Street, London W1A 2LR. WW 308 for further details

Digital controlled current source

A dual-range, digitally-programmable current source, the Hewlett-Packard Model 6145A, provides current outputs from -9.999 to +9.999mA at compliance voltages up to 100V d.c. In the times-one range (± 9.999 milliamperes), resolution is $1\mu\text{A}$, accuracy is $1\mu\text{A}$, and programming speed is $300\mu\text{s}$. An active guard circuit eliminates internal leakage currents so that output voltage can be measured without drawing current from the load.

The 6145A can be programmed from a remote four-digit 8421-b.c.d. source, or locally using front-panel thumbwheel switches.

The Model 6145A can be programmed by computers, programmable calculators, or other digital sources. It satisfies all requirements for system use with:

- Optically isolated digital inputs and outputs that eliminate ground loops.
- Internal storage of all digital input data that eliminates the need to refresh the supply.
- Flexible interface circuitry that ensures compatibility with many programming sources.
- Programmable voltage limiting that protects the supply and the load. The voltage limit can be programmed to any of eight discrete levels. A separate "clear" line programmes the minimum voltage limit.
- Feedback signals to co-ordinate the transfer of output data and tell the computer if an overvoltage condition has occurred.
- External analogue input to provide the ability to modulate the programmed output current with a.c.

Programmed inputs to the Model 6145A include 16 bits for current magnitude, 1 bit for sign, 3 bits for voltage limit, 1 bit for voltage "clear" and 1 bit for range.

The Model 6145A digital current source costs £1450. An interface kit is available for interfacing the current source with Hewlett-Packard computers. It consists of a plug-in computer/output card, interconnecting cables and driver software. Hewlett-Packard Ltd, 224 Bath Road, Slough, Bucks, SL1 4DS.

WW310 for further details

Marine radiotelephone

EMI Marine has introduced a marine radiotelephone which incorporates all 57 v.h.f. international channels with the addition of 10 private channels when required. Naval and military communications are covered by the equipment, which has full Post Office approval and has been environmentally tested.

The radiotelephone features data controlled frequency selection, a method of digital frequency synthesis needing only four crystals aided by a miniature computer to control the 134 frequencies required — a technique which previously has been limited to satellite and military communications. Designated the AP759, and offering full duplex, semi-duplex and simplex operation, the equipment is manufactured by A.P. Radiotelephone, Copenhagen.

Dual-watch facilities are included as standard. This means that two pre-selected channels may be constantly monitored, with one-second intervals between switching. When a message is received, the system automatically "locks on" to that channel and holds it until the message has been completed. It then reverts to the monitoring mode. The skipper can override the system manually if required.

Another feature of the AP759 is that the standard single unit (which is complete in itself as an international radiotelephone) may be simply converted into a 4-station system, for inclusion in different areas of the vessel, i.e. skipper's cabin,

navigator's area, communications room, bridge, etc. Each station has access to the full 57 + 10 channel unit as described, with any station being the master station, which can override the other three. Full indication is given by four coloured lights on each station control panel as to which station is in use at any time.

The radiotelephone units are compactly designed, measuring $132 \times 380 \times 165\text{mm}$ and have facilities for two extra handsets, and two extension speakers. Distances between individual stations can be up to 200 feet and operating supplies are either 12 or 24V d.c. (completely isolated) or ships' voltages of 100 d.c. or 230 a.c. Price £695 for a complete single system. EMI Marine, Cramptons Road, Sevenoaks, Kent.

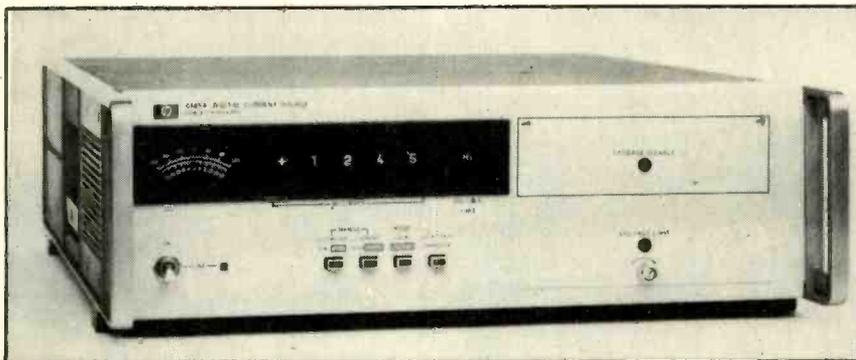
WW311 for further details

Scientific calculator

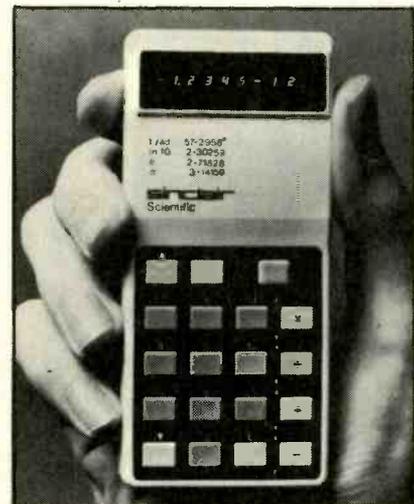
Sinclair Radionics have launched their scientific pocket calculator at the Consumer Electronics Show in Chicago. The 12-function Sinclair Scientific is similar to the recently introduced Cambridge, but has an "upper and lower case" keyboard enabling all twelve functions to be obtained using only four function keys.

Apart from the normal operators, plus, minus, divide, multiply, the following additional functions are provided: \log_{10} , antilog_{10} , sine, cosine, tan, arcsin, arccos and arctan. Post fixed operators provide full flow calculation facility on all functions.

The entry and result are displayed as a five-digit mantissa and a signed two-digit exponent ranging from 10^{-99} to 10^{99} . The calculator chip was the result of new algorithms for transcendental function devised by Clive Sinclair and special programming techniques by Nigel Searle. This enabled the use of a fairly conventional calculator chip which is, however, exclusive to Sinclair. Price will be £49 plus v.a.t. and first supplies are expected for the U.K. and Europe by the end of March. Sinclair Radionics Ltd, London Road, St. Ives, Huntingdonshire PE17 4HJ. WW 391 for further details



WW 310



WW.391

Solid State Devices

Each section under the title of Solid State is devoted to the new semiconductor products offered by one manufacturer or distributor. The type number and device title is given in bold type, followed by a brief description of features or application. The section is terminated with reader reply card numbers associated with the device numbers of types.

L120, L121 s.c.r. and triac controls. These i.c.s by SGS-Ates are complete control systems for thyristors and triacs, using phase control (L120) or burst control (L121). Both units can be operated from a.c. mains or d.c. and generate pulse for direct application to the control element gate. The outputs are short-circuit protected. The circuits are in 16-pin dual-in-line packs and operate between 0°C to 70°C.

BF679/BF680 u.h.f. pair. The two devices are p-n-p silicon planar transistors in one SOT-37 package and are designed to act as r.f. amplifier and mixer/oscillator in varicap-tuned television front-ends. They are pin-compatible with germanium equivalents. The units possess a noise figure of 3.5dB at 3mA and 800MHz and can operate at a junction temperature of 150°C and 24V supply.

BF479 u.h.f. transistor. Designed for use in p-i-n diode tuner, the BF479 operates at high collector currents, giving a noise figure of 4dB at 10mA and 800MHz. See article in August 1973 issue, pp 375-7.

L129/130/131. These are three voltage regulators in the three-lead SOT-32 plastic package, offering load regulation of better than 1% of 60dB ripple rejection and overload/short circuit protection. Output voltage of L129 is 5V for 7.5V to 20V input, L130 gives 12V for an input of 14.5 to 27V and L131 puts out 15V for 17.5 to 27V. Currents are 850, 720 and 600mA respectively. The only external component needed is an output capacitor.

M24 static r.o.m. is a 4096 bit static read only memory in the silicon-gate technology. The memory is organized in 512 words of 8 bits. The unit is t.t.l. compatible and the outputs can from ORed. Access time is 500ns.

M250 rhythm generator. This device is arranged as a r.o.m., having an internal decoder to select one of 32 rows, which allows 12 rhythms, driving eight outputs to be programmed.

TDA1200 radio chip. An integrated circuit providing a complete f.m. i.f. amplifier up to the detector. Included in the system are squelch, a.f.c. and delayed a.g.c., stereo switching, tuning meter drive and

a supply regulator. The circuit is in 16-pin dual-in-line form. SGS-Ates Planar House, Walton St., Aylesbury, Bucks.

WW 317 L120, L121
WW 318 BF 679/BF680
WW 319 BF479
WW320 L129/130/131
WW 321 M24
WW 322 M250
WW323 TDA1200

XR-2567 tone decoder. This is a twin version of the Exar XR-567 tone decoder, and includes a voltage regulator in 16-pin ceramic d.i.p. The unit is intended for frequency decoding in multiple tone communication systems, the centre frequencies extending from 0.01Hz to 500kHz. The outputs, which are logic compatible, can sink up to 100mA at 26V.

LM354A audio amplifier. This 4W amplifier by EEP is an integrated unit intended for use in television receivers and can tolerate a range of supply voltages from 6 to 24V. The unit features a directly-coupled input and high input impedance and requires a minimum of external components. A 14-lead d.i.p. is used with an integral heat-sink.

LH300 Series voltage regulators. These units were designed by EEP to power m.o.s. integrated circuits and require neither external components nor adjustment. Each unit will supply up to 1A and output voltages are fixed at 12V (LH312), 15V (LH315) and 24V (LH324).

CY2035 Series d-a converters. Using thin-film resistor networks and low-drift operational amplifiers, these Cycon units have a short settling time and low linearity drift (0.0005%/°C). The output range is selectable and both ends of the range can be adjusted. Versions available are CY2035 (8-bit), CY2135 (10-bit) and CY2235 (12-bit) and the units take the form of an encapsulated module with pins on 0.1in. centres.

COM 2502 receiver/transmitter. A m.o.s./l.s.i. module by Standard Microsystems which performs functions associated with asynchronous data communication. Word length, parity mode and number of stop bits are programmable and notable among the other features are double buffering, start bit verification, input protection and tri-state outputs. The COM 2601 is similar but is intended for synchronous operation.

KR2376-XX keyboard encoder r.o.m. This circuit will encode keyboard closures from an 11 × 8 matrix to a 1-bit code. Data and strobe tin-state outputs interface directly with t.t.l., d.t.l. and m.o.s. logic.

CY1010/1011 instrument amplifiers. These are two Cycon bipolar input op-amps which are small enough to be sited near remote transducers to reduce noise pick-up. Common-mode rejection is as high as 140dB, voltage offset drift is 1 V/°C and input bias current 30 A. The input and output are both differential. The price of the CY1010 is £13.20, and that of

the close tolerance CY1011 is £21.45. The units measure 1.52 × 1.15 × 0.61 in. Rastra Electronics Ltd, 275-281 King Street, Hammersmith, London W6 9NF.

WW324 XR-2567
WW325 LM 354A
WW326 LH 300
WW327 CY2035
WW328 COM 2502
WW329 KR2376-XX
WW330 CY1010/CY1011

LM/122/222/322 timers. This is a wide-range timer (microseconds to hours) with a built-in voltage regulator providing immunity to supply variations between 4.5 and 40V. The output drive is from a "floating" transistor, which makes for ease of interfacing, and is provided with a reverse circuit to give an "on" or "off" output during the timed interval. The devices are to be had in TO-5, flat-pack or d.i.p. form and operate between -55°C and +125°C (LM122) or -25°C and +85°C (LM2229).

LM555 timer. This device is intended for precision timing, pulse generation, delay generation, pulse position modulation or ramp generation. It requires a minimum of two external components and the output which is t.t.l. compatible, can source or sink 200mA. The 555 is available in a metal-can version or in dual-in-line form. Stability is better than 0.005% per degree centigrade.

LM139A/239A/339A quad comparators. The packages each contain four separate voltage comparators with voltage offsets of less than 2mV. The units were designed to use single power supplies, although the split type of supply can be used. The range of permissible common-mode voltages includes ground, even when a single rail is in use. LM139A will interface with t.t.l. and c.m.o.s., while the LM339A, when used with dual supplies, will interface with m.o.s. logic. The output is in the form of an open collector transistor, many of which can be ORed together.

74C160/161/162/163 c.m.o.s. counters. A series of binary (161/163) and decade counters with synchronous or asynchronous clear and internal look ahead carry. The circuits are endowed with all the advantages of c.m.o.s. (high noise immunity, wide supply tolerance, etc.), and are available in 54C, 64C and 74C versions. National Semiconductor (UK) Ltd, The Precinct, Broxbourne, Herts.

WW350 LM122 timer series
WW351 LM555 timer
WW352 LM139A quad comparator
WW353 74C160 series counters

GPL 120/121/122 l.e.ds. Three gallium phosphide yellow light-emitting diodes are announced by Plessey. The GPL120, which is encapsulated in clear plastic, produces an intensity of 4.7 millicandelas at 20mA, and can be pulsed at 1A for much higher intensities. The devices differ in the material used for encapsulation. Plessey Optoelectronics and Microwave Unit, Wood Burcote Way, Towcester, Northamptonshire.

WW333

World of Amateur Radio

More repeaters . . . more licences

For almost 18 months GB3PI near Cambridge has been the only amateur repeater station in the U.K. But the MPT has now agreed to authorize a second 144 MHz repeater, GB3BC, covering the Bristol Channel area from a site near Pontypool. In addition applications for three more f.m. repeaters are being considered; one would be in the Malvern hills; the second at the Crystal Palace in south London; and the third probably near Alton, Hants. The southern counties station is being prepared by the 50-strong U.K. FM Group (Southern) and, if authorised will be either at the Four Marks water tower near Alton (650 ft a.s.l.) or at Hannington; it would be based on a Storno CQF600 25-watt solid-state unit, accessed by 1750 Hz tone burst, and including emergency shut-down systems which can be operated manually or over a radio link.

The combined total of Class A and Class B licences now exceeds 19,000: 14,866 Class A; 4272 Class B — plus 253 amateur TV and 4176 mobile licences. This is just a shade less than the total in West Germany where there are over 20,000 amateurs including 900 issued to non-Germans. In the past five years the number of British Class A licences has risen by about 1500 (+ 12%); Class B by about 3000 (+ 230%). Reciprocal licences in the G5AAA series for overseas amateurs visiting Britain are now being issued for periods of six instead of three months.

American incentive licensing has significantly increased the number of amateurs holding the privileged extra and advanced licences; during the period 1967 to 1972 extra class licences rose by 148%, advanced class by 59%, while technician class decreased by 12% and conditional class by 20%.

New band plans for v.h.f.

As a result of recommendations of the v.h.f. managers of the national societies making up the I.A.R.U. Region 1 Bureau, new band plans for the 144, 432 and part of the 1296 MHz bands will be introduced from February 1, 1974 and are intended to apply voluntarily to amateurs throughout western Europe.

For British amateurs perhaps the most

radical change is the abandonment of the long-established U.K. system of geographical zoning on the grounds that this releases a wider spectrum of frequencies for general use. Other important changes include the moving of s.s.b. operation lower in the bands and the suggestion that local operation be confined to the higher frequency parts of each band.

In general each band will follow a similar pattern not unlike that used on h.f. bands. The lowest 150 kHz of each band will be reserved for c.w.; then will come s.s.b. with no fixed upper edge but merging into the sections intended for longer distance contacts on other phone modes; local operation and f.m. repeaters are placed towards the higher frequency ends of the bands, with the exception of 145.845 to 146 MHz which is allotted to space satellites.

Segments are reserved for moonbounce (first 10 kHz); random meteor scatter (144.1 and 432.1 MHz); rtty (long distance) 144.6, 432.6, 1296.6 MHz; rtty (local) 145.3, 433.3 and 1297.3 MHz; mobile calling 145.5 MHz. Beacons will be moved to 144.15 MHz \pm 25 kHz and immediately below 432.05 and 1296.05 MHz; repeater inputs 145 to 145.225 MHz, with 600 kHz spacing to provide outputs between 145.6 to 145.825 MHz. Local operation should be above 145 and 433 MHz.

The launching of a new band plan, involving the recommendation that many thousands of amateurs should voluntarily change crystal frequencies and should use different frequencies for local and long-distance working, is clearly an ambitious undertaking. One result may be to encourage more use of variable frequency techniques and single-channel working. It will be interesting to see how quickly and how effectively the new plans come into general use.

Tvi and reverse-tvi

Some 1242 (1 $\frac{1}{4}$ %) of the 69,270 radio and television interference complaints investigated by the Post Office during 1972 were ascribed to amateur transmitters; this compares with 1027 in 1971, 1161 in 1970, 1442 in 1969 and 1151 in 1968. An unwelcome feature is the doubling in interference to u.h.f. television: 348 complaints compared with 173 in 1971 and 65 in 1970. Many amateurs had hoped that with the coming of three-channel u.h.f. television, television interference (tvi) would rapidly fade into history, but it is clear that many present-day tv receivers do not cope well with strong local signals even when these are far removed in frequency from the tv stations. But Band I still accounts for about half of all tvi complaints.

Amateurs will also note with interest an MPT comment that radiation from tv receiver timebases causing interference to long and medium-wave radio reception has increased significantly "owing to mains-borne r.f. voltages from the semiconductor controlled power supply units

of some large screen colour tv receivers". Certainly in the London suburbs there now seems a higher than ever level of timebase interference extending up through the h.f. bands. Against this the amateur can claim no protection unless it is at a level that affects the reception of local broadcasting stations.

Death of "Paragon Paul"

A direct link with the original spanning of the Atlantic by amateur signals has vanished with the death at the age of 84 of Paul ("Paragon Paul") Godley, formerly 2ZE. In November 1921, as a leading American amateur, he came to Britain for the Transatlantic Tests, bringing with him a ten-valve Armstrong "supersonic heterodyne" receiver. He first set up station at Wembley but was discouraged by the high noise levels and departed for Scotland. There in a tent at Ardrossan on the wind-swept west coast he erected an 850 ft Beverage aerial and — fighting off the depressing effects of a heavy cold and the flickering oil lamps — succeeded during the Tests in receiving one Canadian and 27 American amateurs. The first call he logged was 1AAW which seems to have been a pirate station, and the first positive identification of an American station was actually made by the British station 2KW of Sale (Messrs W. R. Burne & Co).

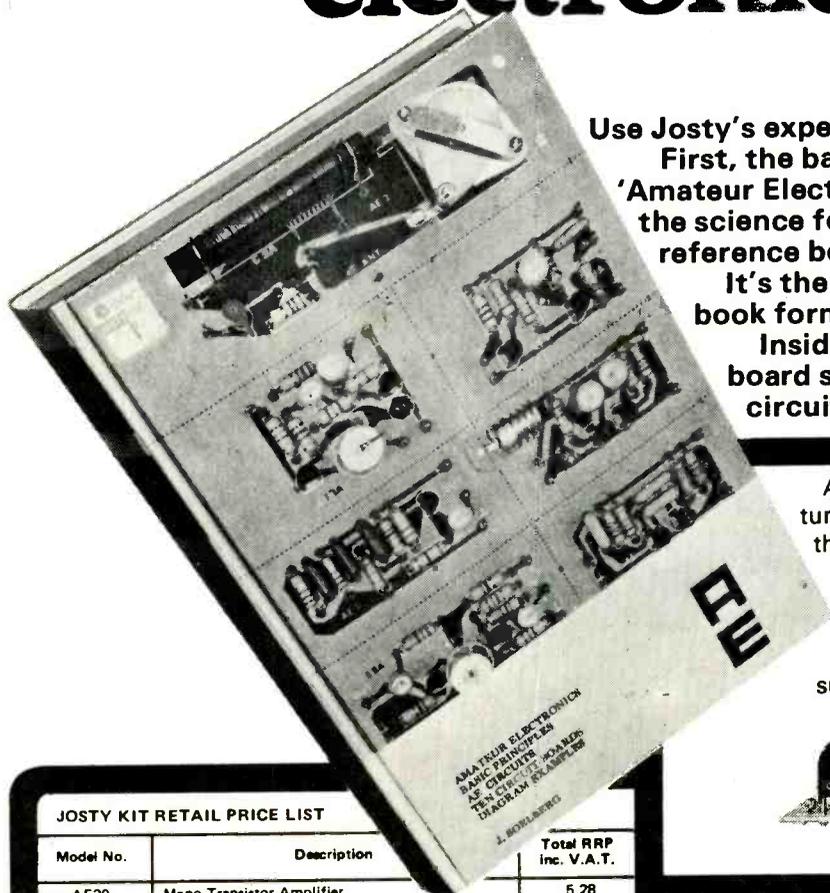
In a lecture to the Wireless Society of London he reported the rapid progress of amateur radio in the United States and said: "One has far greater hopes of being able to travel greater distances on the shorter wavelengths than on higher wavelengths". But it is doubtful whether these words made much impression on the British amateurs who were then fighting hard to retain their allocation at 1000 metres, threatened by complaints of interference to Croydon Airport.

In brief

Pye Telecommunications Contest Group, operating portable in Wales on the 70, 144, 432 and 1296 MHz bands, won the 1973 R.S.G.B. VHF National Field Day M. P. Hawkins of Chelmsford was the victor in the 1973 National DF Final, successfully finding three carefully concealed 1.8 MHz transmitters 7, 4 $\frac{1}{2}$ and 10 miles from the starting point, in a period of 2 hours 18 minutes Over 1800 different amateurs used the Oscar 6 satellite in its first year in orbit, about 1000 of them outside the United States The GB3GEC beacon located on the premises of the M-O Valve Company for a number of years has closed down "If you choose a band segment of 100 kHz in the h.f. spectrum, within that segment you can accommodate 1000 c.w. signals, or 333 narrow-shift rtty, or 100 wide-band rtty, or 33 s.s.b. signals, 16 d.s.b., 16 n.b.f.m. or 3 wideband f.m. signals" — A. Prose Walker, W4BW of the F.C.C.
PAT HAWKER, G3VA



Josty~the brains behind electronic success!



Use Josty's experience.

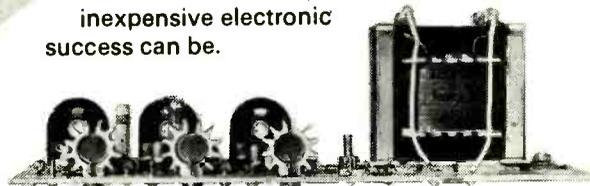
First, the background knowledge you need is in 'Amateur Electronics' – the programmed guide to the science for the beginner and a valuable reference book for the professional.

It's the nearest thing to private tuition in book form and it's only £3.30.

Inside every copy there's a free circuit board suitable for use with ten different circuits.

Among the dozens of Josty Kits—amplifiers, tuners, filters, receivers—you'll find some out-of-the-way items that are just as easy to assemble. Like the AT65 Psychedelic Light Kit, only £16 complete.

Look at the full price list and see just how inexpensive electronic success can be.



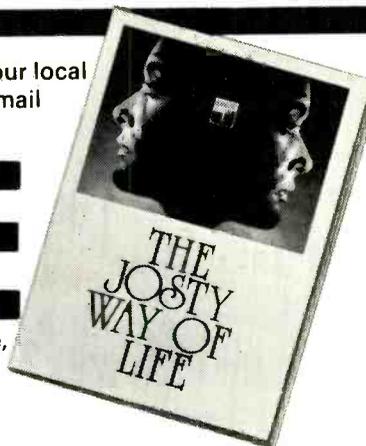
JOSTY KIT RETAIL PRICE LIST

Model No.	Description	Total RRP inc. V.A.T.
AF20	Mono Transistor Amplifier	5.28
AF25	Mixer	3.96
AF30	Mono Transistor Pre-Amplifier	2.87
AF35	Emitter Amplifier	2.50
AF80	Small 0.5 W Amplifier for Microphone	4.65
AF305	Intercom	8.28
AF310	Mono Amplifier (for Stereo use two)	6.50
M160	Multivibrator	1.88
M1302	Transistor Tester	9.30
M191	Vu-Meter	5.01
M192	Stereo Balance Meter	5.47
LF380	Quadrophonic Device	12.50
AT60	Psychedelic Light Control, Single Channel	8.58
AT85	Psychedelic Light Control, 3 Channel	16.00
AT25	Window Wiper Robot	6.40
AT30	Photo Cell Switching Unit	6.27
AT50	400w Triac Light Dimmer Speed Control	5.28
AT56	2,200w Triac Light Dimmer Speed Control	7.59
AT5	Automatic Light Control	2.84
GU330	Tremolo Unit for Guitars, etc.	8.25
HF61	Diode Detector	3.66
HF75	Frequency Modulated FM Transmitter	2.97
HF75	FM Transistor Receiver	3.16
HF310	FM Tuner Unit	17.39
HF325	De-Luxe FM Tuner Unit	26.53
HF330	Stereo Decoder for use with HF310 or HF325	10.95
GP310	Stereo Pre-Amp to use with 2, AF310	23.39
GP312	Basis Circuit Board	12.60
GP304	Basis Circuit Board	5.44
HF380	Aerial Amplifier for LW to VHF	5.54
HF395	Broadband Aerial Amplifier	1.94
NT10	Power Supply 100m/a 9V Stabilised, 12v Unstabilised	6.76
NT300	Professional Stabilised Power Supply	13.76
NT305	Voltage Converter	4.95
NT315	Power Supply 240V a.c. to 4.5 - 15V d.c. 500m/a	10.52
AE1	Output Stage 100mW	1.82
AE2	Pre-amplifier	1.39
AE3	Diode-receiver	2.20
AE4	Flasher	1.20
AE5	Astable Multivibrator	1.16
AE6	Monostable Multivibrator	1.12
AE7	RC Generator	1.17
AE8	Bassfilter	1.09
AE9	Treblefilter	1.09
AE10	CCIR - filter	1.09

All items available from your local Josty Kit stockist or from mail order addresses below.

FREE

Ask for the free catalogue, 'The Josty Way of Life'.



Mail Order Addresses:

G. W. Smith & Co. (Radio) Limited, Unit 4, The Hyde Industrial Estate, The Hyde, London NW9 6JJ.

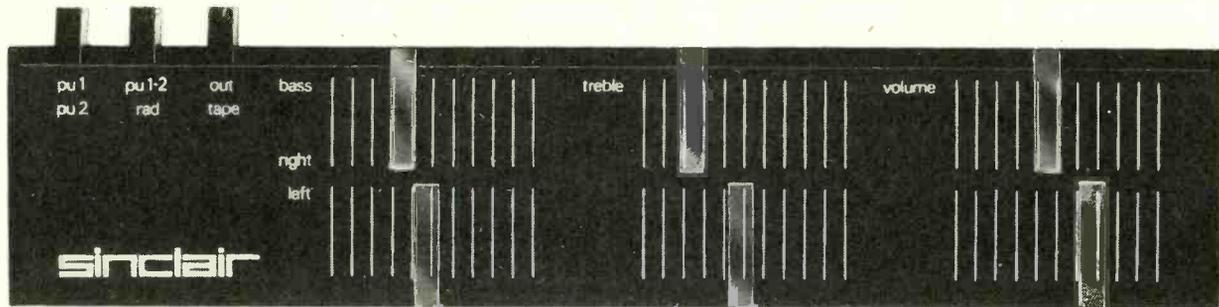
Newmart Electronics, Altham House, Belmont Street, Landsdown Road, Monton, Eccles, Manchester M30 9PA.
Television, 414 Catcote Road, Hartlepool, Co. Durham.

Sole UK distributors:

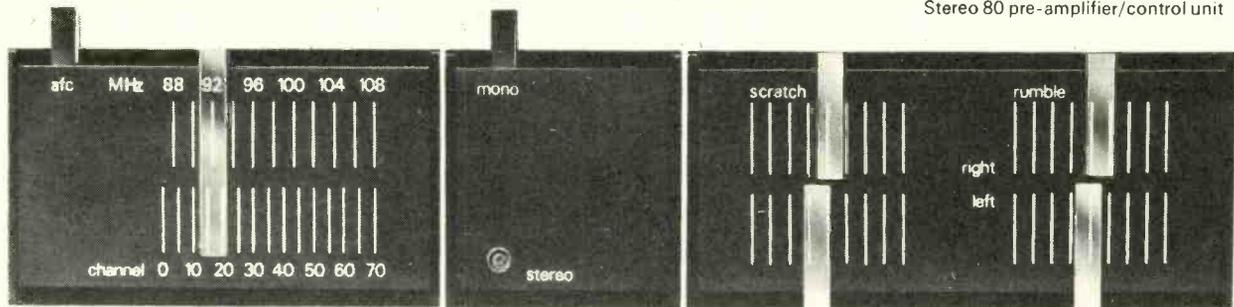
JOSTY (UK) LTD
P.O. BOX 68, BOROUGH ROAD,
MIDDLESBROUGH, TEESSIDE

Sinclair Project 80

exciting



Stereo 80 pre-amplifier/control unit



Project 80 tuner

Stereo decoder

Project 80 Active Filter Unit (AFU)

only $\frac{3}{4}$ " deep x 2" high

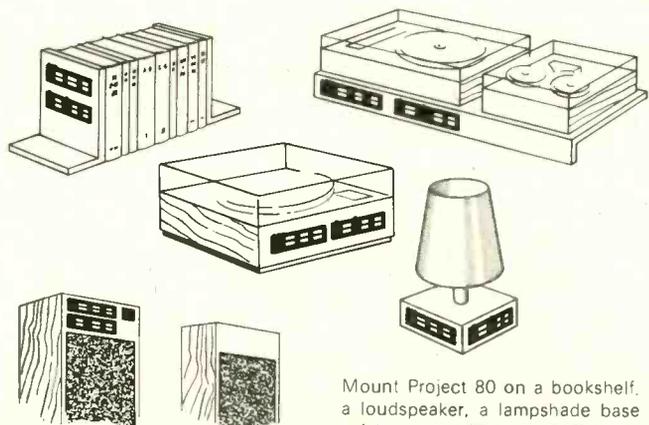
Living with hi-fi takes on new meaning with Sinclair Project 80. The electronics of these revolutionary new modules are all contained within elegantly designed matching cases no more than three-quarters of an inch deep. They are designed for mounting on any appropriate flat surface by means of 6BA bolts extending from the rear of each module and which pass through suitably drilled holes. Connections are taken away out of sight in a similar manner. The possibilities opened up by Project 80 are endless – superb hi-fi systems can be installed in ways hitherto only dreamed about and never before made practical. No more cutting out and shaping to put modules in position. A few holes drilled with the aid of templates supplied and the job is done. Now you need never again be faced with problems of keeping the hi-fi from clashing with carefully thought-out furnishing schemes. (That will surely please wives!) Slider controls have been introduced in place of knobs and all modules in the range incorporate new up-dated circuitry with emphasis on performance standards and built-in protection against overload and shorting. The aim was to re-think modular construction completely – to make it infinitely more versatile, even simpler and more reliable – the result – Project 80 – another triumph for Sinclair, and the most exciting construction modules ever.

the slimmest, most elegant hi-fi modules ever made

Typical Project 80 applications

System	The Units to use	Units cost
Simple battery record player	Z.40	£5 45 –54p V.A.T.
Mains powered record player	Z.40, PZ.5	£10 43 –£1.04 V.A.T.
30W. RMS continuous sine wave stereo amp.	2 x Z.40s, Stereo 80; PZ.6	£30 83 –£3.08 V.A.T.
50W (8 Ω) RMS continuous sine wave de luxe stereo amp.	2 x Z.60s, Stereo 80; PZ.8	£33 83 –£3.38 V.A.T.
Indoor P.A.	Z.60, PZ.8	£14 93 £1.49 V.A.T.

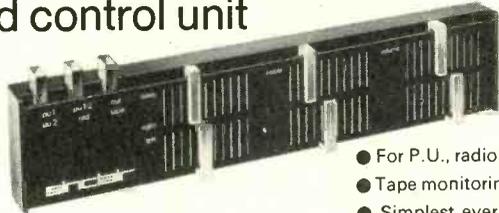
Project 80 FM tuner, decoder, and A.F.U. may be added as required



Mount Project 80 on a bookshelf, a loudspeaker, a lampshade base, a false wall with two Q.16 loudspeakers... almost anywhere.

new thinking in modular hi-fi

Stereo 80 pre-amplifier and control unit



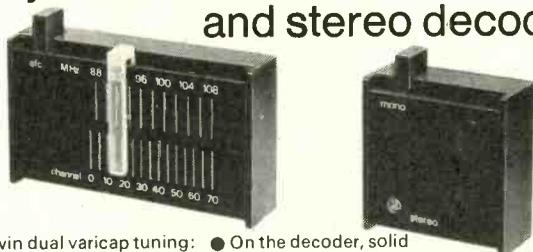
- For P.U., radio and tape
- Tape monitoring switch
- Simplest ever fixing

Each channel has its own separate tone and volume controls operated by sliders, enabling ideal environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry that ensures the finest possible quality from all signal sources! Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

TECHNICAL SPECIFICATIONS

Size - 260 x 50 x 20mm (10 1/2 x 2 x 3/4 ins)
 Finish - Black with white indicators and transparent sliders
 Inputs - Magnetic pick-up 3mV RIAA corrected; Ceramic pick-up 300mV
 Radio 300mV; Tape 30mV
 Signal/noise ratio - 60dB
 Frequency range - 20Hz to 15KHz ± 1dB; 10Hz to 25KHz ± 3dB
 Power requirements - 20 to 35 volts
 Outputs - 100mV + AB monitoring for tape
 Controls - Press button for tape, radio and P.U. Sliders for volume, bass (+ 12dB to - 14dB at 100Hz) treble (+ 11dB to - 12dB at 10KHz)

Project 80 FM tuner and stereo decoder



- Twin dual varicap tuning: 4 pole ceramic filter: switchable A.F.C.
- On the decoder, solid state stereo indicating beacon.

Making the Project 80 F.M. tuner and decoder available separately gives a wider choice of systems and saves money where stereo reception may not be required. The tuner is a triumph of electronic design and assures excellent performance. The decoder gives a 40dB channel separation with 150mV output per channel. Both units may be used with other than Project 80 systems.

TECHNICAL SPECIFICATIONS OF TUNER

Size - 85 x 50 x 20mm (3 1/2 x 2 x 3/4 ins)
 Tuning range - 87.5 to 108 MHz
 Detector - I.C. balanced coincidence for good A.M. rejection
 One I.C. equal to 26 transistors
 Distortion - 0.2% at 1 KHz for 30% modulation
 4 pole ceramic filter in I.F. section
 Aerial impedance - 75 Ω or 240-300 Ω
 Sensitivity - 4 microvolts for 30dB quieting
 Output - 300 mV for 30% modulation
 Power requirements - 23 to 33 volts

DECODER

Size - 47 x 50 x 20mm (1 7/8 x 2 x 3/4 ins)
 One 19 transistor I.C.

R.R.P. **£11.95** +£1.19 V.A.T.
 R.R.P. **£7.45** +0.74 V.A.T.

Guarantee

If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair appointed stockists also offer this guarantee. Should any defect arise in normal use, we will service it without charge. For damage arising from mis-use a charge (typically £1.00) will be made.

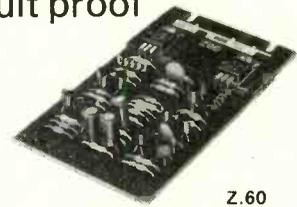


Sinclair Radionics Ltd, London Road, St. Ives, Huntingdon PE17 4HJ
 Telephone St. Ives (0480) 64646

Z.40 & Z.60 power amplifiers totally short-circuit proof



Z.40



Z.60

Intended for use in Project 80 installations, these modules readily adapt to an even wider range of applications. Both incorporate built-in protection against short circuiting and risk of damage from mis-use is greatly reduced.

Z.40 TECHNICAL SPECIFICATIONS

Size - 55 x 80 x 20mm (2 1/4 x 3 1/8 x 3/4 ins) 9 transistors
 Input sensitivity - 100mV
 Output - 15 watts RMS continuous into 8 Ω (35V)
 Frequency response - 10Hz - 100KHz ± 1dB
 Signal/noise ratio - 64dB
 Distortion - at 10 watts into 8 Ω less than 0.1%
 Power requirements - 12 to 35 volts

Z.60 TECHNICAL SPECIFICATIONS

Size - 55 x 98 x 15mm (2 1/4 x 3 7/8 x 3/4 ins) 12 transistors
 Input sensitivity - 100-250mV
 Output - 25 watts RMS continuous into 8 Ω (45V)
 Distortion - typically 0.03%
 Frequency response - 10Hz to more than 200KHz ± 1dB
 Signal/noise ratio - better than 70dB
 Built-in protection against transient overload and short circuiting
 Load impedance - 4 Ω min; max. safe on open circuit

Z.40 R.R.P. **£5.45** + 0.54 V.A.T. Z.60 R.R.P. **£6.95** + 0.69p V.A.T.

Project 80 active filter unit

Makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape. As with Stereo 80, separate controls applied to each channel make it easier to obtain ideal stereo balance.



TECHNICAL SPECIFICATIONS

Size - 108 x 50 x 20mm (4 1/4 x 2 x 3/4 ins)
 Voltage gain - minus 0.2dB
 Frequency response - 36Hz to 22KHz controls minimum
 Distortion - at 1 KHz - 0.03% using 30V supply
 HF cut off (scratch) - 22KHz to 5.5KHz, 12dB/oct. slope
 L.F. cut off (rumble) - 28dB at 20Hz, 9dB/oct. slope

- For scratch and rumble control
- Transistorised active circuitry

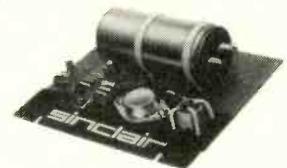
R.R.P. **£6.95** +0.69 V.A.T.

Power supply units

PZ.8

Stabilised. Re-entrant current limiting makes damage from overload or even direct shorting impossible. Normal working voltage (adjustable) 45V.

R.R.P. **£7.98** + 0.79p V.A.T.
 Without mains transformer



PZ.5 30V un stabilised
 R.R.P. **£4.98** + 0.49p V.A.T.

PZ.6 35V. stabilised
 R.R.P. **£7.98** + 0.79p V.A.T.

To **SINCLAIR RADIONICS LTD. ST. IVES, HUNTINGDON PE17 4HJ**

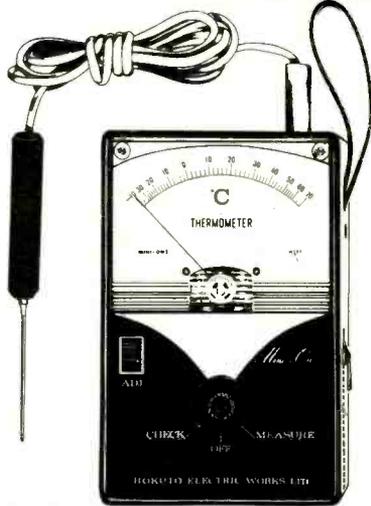
Please send post paid _____

for which I enclose Cash/Cheque for £ _____ including V.A.T.

Name _____

Address _____

ELECTRONIC INDUSTRIAL THERMOMETER



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 in zippered vinyl case with transparent front and carrying loop, Probe, and internal 1½ volt standard size battery.

Model "Mini-On 1" measures from - 40°C to + 70°C, price £17.50

Model "Mini-On Hi" measures from + 100°C to + 500°C, price £20.00 (V.A.T. EXTRA)

Write for further details to

HARRIS ELECTRONICS (LONDON),
138 GRAY'S INN ROAD, LONDON. WC1X 8AX
(*Phone 01-837 7937)

WW-122 FOR FURTHER DETAILS

Newnes Radio Engineer's Pocket Book 14th Edition

Revised by
H. W. Moorshead

A ready reference source for formulae, tables and definitions of electrical and electronic terms, including many mathematical tables. The book is very carefully indexed for quick and accurate selection of material.

1972 188 pp illustrated 0 408 00074 0 £1.20

Sound with Vision

Sound Techniques for Television and Film

E. G. M. Alkin

For the first time the methods developed by the BBC are here made available in book form for the benefit of television sound operators and production staff. The book discusses the problems of simultaneous production of sound and picture, giving practical instruction in methods of overcoming them. There are detailed discussions of operation equipment and trends which will be useful to designers and manufacturers of sound equipment.

1974 294 pp illustrated 0 408 70236 2 £6.00

Video Recording

Record and Replay Systems

Gordon White

This book describes the principles of video recording and discusses the various systems which are on the market or will soon make an appearance. Inevitably the book is technical, but it is designed so that people who have an interest in the subject should find no difficulty in understanding the principles, advantages and disadvantages of the various systems.

1972 216 pp illustrated 0 408 00085 6 £3.25

Obtainable through any bookseller or from

The Butterworth Group
88 Kingsway, London WC2B 6AB.
Trade counter: 4-5 Bell Yard, WC2.



NEW! FOR RTTY ENTHUSIASTS

THE TELEPRINTER HANDBOOK

by D. J. Goacher, G3LLZ, and J. G. Denny, G3NTT

The new RSGB *Teleprinter Handbook* covers all aspects of radioteleprinter (rtty) operation, equipment and techniques with particular reference to the interests of amateurs. For the experienced operator it provides, in one volume, all the accumulated information acquired during the past decade, and covers machines of both European and USA origins; for the intending enthusiast it includes all the basic information necessary to master the techniques of rtty operation.

The contents include: theory, practice and standards; teleprinters; associated rtty machines; power supplies; terminal units; auxiliary equipment; frequency shift keying; filters; test equipment; interconnection and control of rtty equipment; operating procedures; glossary; bibliography.

376 pages and hundreds of illustrations and diagrams.

The **TELEPRINTER HANDBOOK** is available, price £5.35 post free, direct from:

RADIO SOCIETY OF GREAT BRITAIN
35 Doughty Street, London WC1N 2AE

JUST ONE OF A RANGE



TYPE 301

32 MHz, 50mV Sensitivity, STABILITY 3 parts in 10⁶ **£75**

DELIVERY... EX-STOCK TO 10 DAYS

THE HIGHEST PERFORMANCE DIGITAL FREQUENCY COUNTERS
AT THE PRICE IN THE WORLD EVERYBODY BUYS THEM

OTHERS IN THE RANGE:—

401 6 DIGIT, 32 MHz,
STABILITY 1 part in 10⁶
SENSITIVITY 10mV

£110

701 8 DIGIT, 50 MHz
STABILITY 3 parts in 10⁸
SENSITIVITY 10mV

£170

501 8 DIGIT, 32 MHz
STABILITY 3 parts in 10⁸
(crystal oven)
SENSITIVITY 10mV

£160

801A 8 DIGIT, 300 MHz
STABILITY 3 parts in 10⁸
SENSITIVITY 10mV
MEMORY VERSIONS ONLY

£285

PRICES EXCLUSIVE OF VAT

ELECTRONIC START STOP version PLUS £10

MEMORY version PLUS £25

DIRECTLY COUPLED INPUT AND SPECIALS AS REQUIRED

Write for illustrated leaflet

Supplied to and acclaimed by professional engineers everywhere
who have purchased our electronic instruments for the past 10 years



R. C. S. ELECTRONICS
NATIONAL WORKS, BATH ROAD,
HOUNSLOW, MIDDX. TW4 7EE
Telephone: 01-572 0933/4

WW-125 FOR FURTHER DETAILS

TELEPRINTER EQUIPMENT LIMITED

Sales . . . Rentals . . . New . . . Refurbished . . . Installation . . .
Maintenance . . . Overhauls . . . Spare Parts . . . Prompt Deliveries

CREED EQUIPMENT

TELEPRINTERS Models 7B, 54, 75, 444
PERFORATORS 7PN, 85/86, PR75, 25
TAPE READERS 6S4, 6S5, 6S6, 6S6M, 92, 35, 71, 72, 74
HIGH-SPEED TAPE WINDERS 80-0-80V POWER SUPPLY UNITS, etc.

TELETYPE CORP. EQUIPMENT

TELEPRINTERS 15, 19, 20, 28, 32, 33, 35
all configurations
PERFORATORS 14, 19, 28 LPR, RECEIVE & MONITOR GROUP CABINETS
TAPE TRANSMITTERS 14, 20, 28 LBXD & LXD TRANSMIT GROUPS, etc.

SIEMENS EQUIPMENT

TELEPRINTERS T100 and T-68 in various configurations
PERFORATORS T-LOCH 12, T-LOCH 15, A, B, D & F, etc.

OTHER EQUIPMENT

KLEINSCHMIDT, OLIVETTI, LORENZ, COCQUELET, BRITISH, AMERICAN,
CONTINENTAL, ARABIC and other layouts, 5-8 track.

SPECIAL EQUIPMENT

SOLID STATE MOTOR CONTROLS, MODEM INTERFACE UNITS, TARRIFF J
INTERFACE UNITS, TEST EQUIPMENT, COMPUTER INTERFACE UNITS, DEC.
PDP8 and others. SILENCE COVERS AND CABINETS, TELEPRINTER TABLES,
SIGNALLING RECTIFIERS AND CONVERTORS, TAPE HOLDERS.

WW-126 FOR FURTHER DETAILS

COMMUNICATION ACCESSORIES & EQUIPMENT LIMITED

G.P.O. TYPE COMPONENTS FOR PROMPT DELIVERY

JACK PLUGS—201, 310, 316, 309, 404, 420, 609, 610, 1603 — 3201
JACK STRIPS—310, 320, 510, 520, 810
JACK SOCKETS—300, 500, 800, B3 and B6 mountings, 19, 84A and 95A
PATCH PANELS & RACKS—made to specifications
LAMPS, SWITCHBOARD NO. 2, BALLAST PO 11, LAMP STRIPS, 10-way PO 19, 20-way PO 17, Lamp Caps,
Holder No. 12
CORDS (PATCHING & SWITCHBOARD)—made to specifications
TERMINAL BLOCKS (DISTRIBUTION)—20-way up to 250-way
LOW PASS FILTERS—type 4B and PANELS, TELEGRAPH 71 (15 x 4B)
POLARISED TELEGRAPH RELAYS AND UNISELECTORS—various types and manufactures both P.O. and
miniature
LINE TRANSFORMERS/RETARDATION COILS—type 48A, 48H, 49H, 149H, 3/16, 3/216, 3/48A, 3/43A, 48J, etc.
FUSE & PROTECTOR MOUNTINGS—8064 A/B 4028, H15B, H40 and individual 1/2
COILS—39A, 40A, 40E, etc.
P.O.-TYPE KEYS—1000 and PLUNGER TYPES 228, 279, etc.
EQUIPMENT RACKS AND CONSOLES—made to specifications
RELAY ADJUSTING TOOLS, TOOL BAGS FOR MECHANICS, TENSION GAUGES, ARMATURE ADJUSTERS,
SPRING BENDERS ETC. VARIOUS SWITCHBOARD EQUIPMENT.

WW-127 FOR FURTHER DETAILS

MORSE EQUIPMENT LIMITED

The GNT Range of Automatic Morse Equipment is now manufactured in the U.K. and comprises complete equipment for Morse Training Schools and for Automatic Morse Transmission. Models available include:

KEYBOARD PERFORATORS for offline tape preparation
AUTOMATIC TAPE TRANSMITTERS with speeds up to 250 w.p.m.
MORSEINKERS specially designed for training, producing dots and dashes on tape
HEAVY DUTY MORSE KEYS
UNDULATORS for automatic record and W/T signals up to 300 w.p.m.
CODE CONVERTERS converting from 5-unit tape to Morse and vice versa
MORSE REPERFORATORS operating up to 200 w.p.m.
TONE GENERATORS and all Students' requirements
CREED, MORSE EQUIPMENT, PERFORATORS, REPERFORATORS, TRANS-
MITTERS, PRINTERS, MARCONI UG6 UNDULATORS, BUZZERS, ALDIS
LAMPS, etc.

WW-128 FOR FURTHER DETAILS

77 AKEMAN STREET, TRING, HERTS., U.K.

Telephone: Tring 4011, STD: 0442-82 Telex 82362, Answerback: Batelcom Tring

NEW PRACTICAL PAPERBACKS FROM FOULSHAM-TAB

Handbook of Semiconductor Circuits £1.95	Selecting and Improving your Hi-Fi System £1.40 <i>By H. Swearer</i>
All-In-One T.V. Alignment £1.75 <i>By J. Shane</i>	4-Channel Stereo From Source to Sound £1.35 <i>By K. Sessions</i>
Basic Electronic Circuits Simplified £1.85 <i>By N. Hibbs</i>	Japanese Radio, Record and Tape Player Schematic/ Servicing Manual £1.90 <i>By Homer L. Davidson</i>
Basic Electronic Course £1.85 <i>By N. Crowhurst</i>	101 T.V. Troubles From Symptom To Repair £1.40 <i>By A. Margolis</i>
FET Applications Handbook £1.85 <i>By J. Eimbinder</i>	Stereo/Quad Hi-Fi Principles and Projects £1.35 <i>By K. Sessions</i>
Basic Electronic Test Procedures £1.95 <i>By I. M. Gottlieb</i>	How to Repair Musical Instrument Amplifiers £1.50 <i>By B. Wels</i>
Basic Electricity and Beginning Electronics £1.40 <i>By M. Clifford</i>	Installing Hi-Fi Systems £1.40 <i>By J. Markell and J. Stanton</i>
Handbook of IC Circuit Projects £1.40 <i>By J. Ashe</i>	New Ways to Diagnose Electronic Troubles £1.50 <i>By Jack Darr</i>
Pictorial Guide to Tape Recorder Repairs £1.40 <i>By F. H. Belt</i>	Servicing The Solid-State Chassis £1.40 <i>By H. Davidson</i>
Simplified T.V. Trouble Diagnosis £1.85 <i>By Robert L. Goodman</i>	Model Car Racing By Radio Control £1.40 <i>By G. Siposs</i>
Marine Electronic Handbook £1.35 <i>By L. G. Sands</i>	

FOULSHAM-TAB LTD.
YEovil ROAD. SLOUGH. BUCKS.

WW-129 FOR FURTHER DETAILS

STEREO IC DECODER

HIGH PERFORMANCE PHASE LOCKED LOOP
(as in 'W.W.' July '72)
MOTOROLA MC1310P EX STOCK DELIVERY SPECIFICATION

Separation: 40dB 50Hz-15kHz. I/P level: 560mV rms. Input impedance: 50kΩ. Distortion: 0.3% O/P level: 485mV rms per channel. Power requirements: 8-16V at 16mA. Will drive up to 75mA stereo 'on' lamp or LED.

KIT COMPRISES FIBREGLASS PCB (Roller tinned), Resistors, I.C., Capacitors, Preset Potm. & Comprehensive Instructions **£3-98** **WHY PAY MORE? post free.**
RED 29p
GREEN 59p

MC1310P only £3.15 plus p.p. 6p

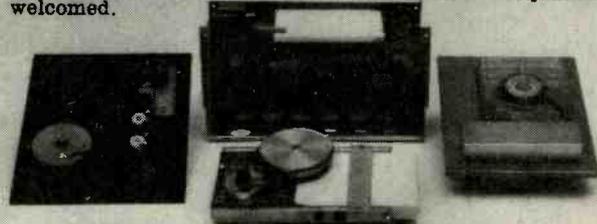
NOTE
As the supplier of the first MC1310P decoder kit, of which we have sold literally thousands, our customers can benefit from our wide experience.

V.A.T.
Please add V.A.T. at 10% to all prices
FI-COMP ELECTRONICS
BURTON ROAD, EGGINGTON, DERBY, DE6 6GY

WW-130 FOR FURTHER DETAILS

Endless Loop Cartridge Units
- Designed, Developed, Manufactured.

As used in industrial monitoring alarm and public address systems etc., - by manual or remote control. All enquiries welcomed.



FITCH TAPE MECHANISMS

Write or phone:
7a Balham Grove, London, SW12. 01-673 1362.

WW-131 FOR FURTHER DETAILS

SPARKRITE MK II

ELECTRONIC IGNITION KIT



COMPRISES

Everything:- Ready-drilled Case and Metalwork, Cables, Coil Connectors, Silicon Grease, Printed Circuit Board, 5-year guaranteed components and a full 8-page instruction leaflet.

WHEN COMPLETE THE UNIT CAN BE FITTED TO YOUR CAR IN ONLY 15 MINUTES USING THE STANDARD COIL AND CONTACT BREAKER POINTS: TO GIVE YOU:

Instant all-weather starting. Up to 20% fuel saving. Longer battery life. Higher top speed. Faster acceleration. Spark plugs last about five times longer. Misfire due to contact breaker, bounce electronically eliminated. Purer exhaust emission resulting in less air pollution. Contact breaker burn *eliminated*.

Suitable for all petrol engines up to 8 cylinders

PRICE ONLY £11.62

Ready-built Unit **£14.85**

Unit for Motor Cycles with twin coils and twin C.B. Points **£23.24** (prices include VAT and post & packing).
(NOT AVAILABLE IN KIT FORM)

Please state whether Positive or negative earth units are required when ordering.

SEND FOR YOUR UNIT OR FULL BROCHURE NOW

FROM ICE ELECTRONIC SYSTEMS DEPT W.W.
114 PARK FARM ROAD
BIRMINGHAM B43 7QH

WW-132 FOR FURTHER DETAILS

BEDFORD ELECTRONICS 7, PRIORY STREET, BEDFORD
TELEPHONE 0234 51961

BRAND NEW 17 INCH TELEVISION MONITORS

- ALL SOLID STATE
- PLUG IN MODULES
- PRECISION TUBE
- PROFESSIONAL QUALITY

PRICE £70 EACH

All circuit boards and most components including metal cabinets and tubes available separately. Send 25p for full circuit diagram, specifications and prices.

OTHER CHEAPER MONITORS AVAILABLE
CAMERAS AVAILABLE SHORTLY

CARD READER

Data Products SPEEDREADER 300 Mechanism and Electronics P.O.A.

POWER SUPPLIES

A.E.I. R2240 2.5V to 30V @ 2A Regulated, fully adjustable, supply voltage and current meters £7. Callers only. Many other L.T. & H.T. power supplies available, please inform us of your requirements.

CCTV CAMERA

A.E.I. Camera Heads comprising scan coils, focus coil and alignment magnet assembly, optical focus mechanism, video amplifier, 'C' lens mount, all mounted in small hammer finish case. 1 Inch Vidicon and lens **NOT** supplied.
PRICE £6 EACH

P.T.F.E.

7/0075 equipment wire to EL1930 Type A £2 per 100 yards. Please check colour and reel size availability before ordering.

Colvern **TEN TURN POTS**. 500R. 5% Lin. 0-1%. £1.25 each.

MULTICORE CABLE, miniature 25 Cores of PVC 7/0076 screened overall and PVC sheathed. £2.50 for 10 yds.

RECTIFIER. Texas 1S103 750 mA 400 P.I.V. 10 for 45p.

4MM SOCKETS. Round, yellow only. 10 for 30p.

SCR. Texas, plastic TIC45 600 mA 60 Vdrn, 20p. each.

CARPENTERS polarised relay SPCO 2 x 1000R, complete with base and retainer as new. 45p each.

POT CORES LA3. 40p each.

BLL RACES Type RCL 1/2 F. Flanged 1/2 in. bore 5/16 in. dia. Sealed packs, 25p each.

DELIVERY

Almost all small orders are now dispatched by return of post.

OPENING HOURS

MONDAY CLOSED.
TUESDAY to FRIDAY 9am-5.30pm.
SATURDAY 10am-4pm.

V.A.T.

PLEASE ADD 10% V.A.T. TO ALL PRICES.

THE NEW NELSON-JONES FM TUNER



PUSH-BUTTON VARICAP DIODE TUNING
(6 Position) ('WW' JUNE '73)

Exclusive Designer Approved Kits

What are the important features to look for in an FM tuner kit? Naturally it must have an attractive appearance when built, but it must also embody the latest and best in circuit design such as:—

- MOSFET** Front end for excellent cross modulation performance and low noise.
- 3 GANG VARICAP** Tuning for high selectivity tuning diodes in back to back configuration for low distortion.
- CERAMIC** IF filters for defined IF response.
- INTEGRATED** circuit IF amplifiers for reliability and excellent limiting/AM rejection.

- PHASE LOCKED** Stereo decoder with Stereo mute, see below.
- LED** fine tuning indicators.
- PUSH BUTTON** tuning (with AFC disable) over the whole FM band.
- IC STABILISED** and S/C protected power supply.
- CABINET** veneered inside and out.

The Nelson-Jones Tuner has all of these features and many more, and more importantly the design is fully proven not just with a few prototypes but with many thousands of working tuners spread across the world.

Basic tuner module prices start as low as £10.79, with complete kits starting at £23.95 (mono) + PP 50p. and of course all components are available separately.

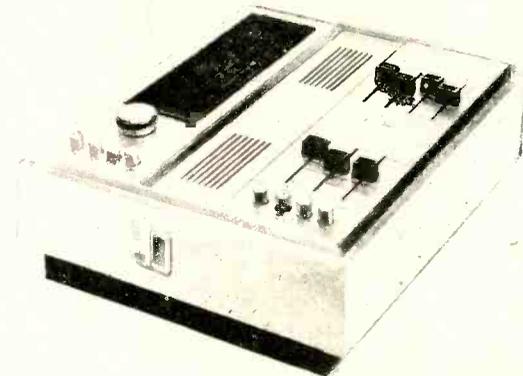
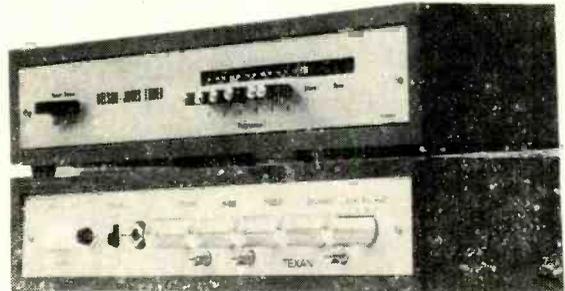
Our low cost alignment service is available to customers without access to a signal generator. Please send large SAE for our latest price lists which detail all of the many options and special low prices for complete kits. All our other products remain available.

PORTUS AND HAYWOOD PHASE LOCKED DECODER (W.W. Sept. '70). Still the lowest distortion P.L. decoder available. THD typically 0.05% (at Nelson-Jones Tuner O/P level)! Supplied complete with Red LED.

Price £5.50 when bought with a complete N-J tuner kit or £7.68 if bought separately (P.P. 19p.)

PLEASE NOTE. Existing tuners are readily convertible and kits/parts are available for this purpose.

TEXAN AMPLIFIER. We have designed the tuner case and metalwork to match the Texan amplifier (see photograph). Complete designer approved Texan kits are available at £28.50 plus p.p 50p including Teak Sleeve.



THE RONDO QUADRAPHONIC SYSTEM (20 WATTS/CHANNEL)

Complete designer approved kits for this outstanding Quadraphonic Sound System ('P.E.' Sep. '73, etc.) with the following features:—

- ★ SWITCHING FACILITIES AND MODULES FOR SQ, QS AND CD4.
 - ★ COMPLETE LOUDSPEAKER ENCLOSURE DESIGN.
 - ★ MODULAR BUILT IN-AM/FM RADIO.
 - ★ INDIVIDUAL KITS MAY BE INCORPORATED IN EXISTING EQUIPMENT.
 - ★ LOW COST, FULLY ENGINEERED, INTEGRAL DESIGN.
 - ★ KITS AVAILABLE AS PUBLISHED—SEE BELOW.
- ★ COMPLETE LOUDSPEAKER SYSTEMS AVAILABLE

CBS SQ* MATRIX DECODER <small>*TM CBS INC.</small>	Complete Kit	£8.00	Post Free <small>Incl. CBS Licence Fee</small>	VAT Extra
PREAMPLIFIER BOARD	Complete Kit	£3.00	Post Free	VAT Extra
MASTER VOL./TONE/BALANCE BOARD	Complete Kit	£8.50	Post Free	VAT Extra
POWER AMP. BOARD AND HEATSINK <small>STEREO PAIR</small>	Complete Kit <small>per Board</small>	£7.50	Post Free	VAT Extra
POWER SUPPLY BOARD	Complete	£5.00	Post Free	VAT Extra
MAIN SMOOTHING CAPACITORS (TWO REQD)	Per Pair	£1.50	Post Free	VAT Extra
MAINS TRANSFORMER	Complete Kit	£6.25	Post Free	VAT Extra
CHASSIS—PUNCHED and DRILLED WITH SCREENS	Complete Kit	£3.25	Post Free	VAT Extra
QUAD SELECTOR SWITCH		£1.30	Post Free	VAT Extra
WOODEN CASE		£1.75	Post Free	VAT Extra
HARDWARE PACK		£2.00	Post Free	VAT Extra
CONTROL SECTION FACIA		£3.50	Post Free	VAT Extra

THE COMPLETE P.E. RONDO SYSTEM IS AVAILABLE AS PUBLISHED.

PLEASE PHONE OR WRITE FOR FULL DETAILS

ACCESS

You can order these goods by Telephone on Access. Simply quote your Access Number.

OPTO-DEVICES

Panel mounting LED's.		7 Seg LED's	
RED	1-9 29p	10-24	23p
GREEN	1-9 59p	10-24	49p

0.325" RH Dec Point.
Common Anode 1-4 £2.00; 5-24 £1.80.
Common Cathode 1-4 £2.00; 5-24 £1.80.
7447 Dec Driver £1.30 (C.A.)

V.A.T. Please add V.A.T. at 10% to all prices for U.K. orders.

INTEGREX LIMITED, P.O. Box 45, Derby, DE1 1TW

Phone Repton (028389) 3580

New Branches BOLTON COVENTRY SUNDERLAND STOCKPORT DONCASTER & PRESTON

- BIRMINGHAM 30-31 Gt. Western Arcade (Closed Wed.) Tel.: 236 1279
BOLTON 23 Deansgate (Closed Wed.) Tel.: 33512
BRADFORD 10 North Parade (Closed Wed.)
COVENTRY 17 Shelton Square, The Precinct (Closed Thurs.) Tel.: 25992
DARLINGTON 19 Northgate (Closed Wed.)
DERBY 97 St. Peter's Street (Closed Wed.) Tel.: 41361
DONCASTER 3 Queensgate, Waterdale Centre. (Closed Thurs.)
EDINBURGH 101 Lothian Road (Closed Wed.)
GLASGOW 326 Argyle St. (Closed Tues.)
LEEDS 7 Whitefriargate (Closed Thurs.)
LEEDS 5-7 County (Mecca) Arcade, Briggate (Closed Wed.) Tel.: 28252
LEICESTER 32 High St. (Closed Thurs.)
LIVERPOOL 73 Dale St. (Closed Wed.)
LONDON 238 Edgware Rd., (Closed Thurs.)
MANCHESTER 60a Oldham St. (Closed Wed.)
MIDDLESBRO 106 Newport Rd (Closed Wed.)



HI-FI CENTRES LTD
MAIL ORDERS TO: 106 HENCONNER LANE, LEEDS 13.
Terms C.W.O. or C.O.D. Postage 28p extra under £2. 33p extra over £2, or as stated. Trade supplied. S.A.E. with enquiries.
EXPORT ENQUIRIES WELCOMED BRANCHES OPEN ALL DAY SATURDAYS AND OPERATE A 5-DAY WEEK
MAIL ORDERS NOT TO BE SENT TO SHOP.
NEWCASTLE-ON-TYNE 24 Newgate Shopping Centre Grainger St. (Closed Wed.)
NOTTINGHAM 19 Market St. (Closed Thurs.)
PRESTON 41 Filargate Walk, St. George's Shopping Precinct (Closed Thurs.)
SHEFFIELD 13 Exchange St. (Closed Thurs.)
STOCKPORT 8 Little Underbank Tel. 480 0777 (Closed Thurs.)
SUNDERLAND 5 Market Square (Closed Wed.)

ALL PRICES INCLUDE VAT AND FULL LABOUR AND MATERIAL GUARANTEES 1yr. ALL ITEMS SUBJECT TO AVAILABILITY. PRICES CORRECT AT 6-2-74 E. & O.E.

HUGE DISCOUNTS ON LEADING BRAND HI-FI

- AKAI GXC 36D Tape Unit £76.95 (List Price £109.50) Carr. £1 Credit
AKAI 4000DS Tape Unit £76.95 (List Price £109.50) Carr. £1 Terms
AKAI 1721L Tape Unit £79.95 (List Price £114.50) Carr. £1 Available
AKAI GYC46D Tape Unit £104.75 (List Price £149.50) Carr. £1
GOLDRING GL72 T/Table & P.U. £29.95 Carr. 75p
with FREE G800 cartridge worth over £10
GOLDRING GL75 T/Table & P.U. £34.45 Carr. 85p
with FREE G800 cartridge worth over £10

B.S.R. MACDONALD MP60 T/Table & P.U. £10.95 (List Price £14.95)

- TURNABLES with MAGNETIC CARTRIDGE, PLINTH & COVER
GARRARD SP25 with G800 SPECIAL PRICE £16.95 Carr. £1
B.S.R. MP60 with G800 SPECIAL PRICE £17.95 Carr. £1
B.S.R. HT70 with G8007 SPECIAL PRICE £23.95 Carr. £1
GARRARD AP76 with G800 SPECIAL PRICE £28.95 Carr. £1
LINEAR 202 10+10 Watt AMPLIFIER £29.95 (List Price £39.93) Carr. 45p

FANE ULTRA HIGH POWER LOUDSPEAKERS

- Power Rating R.M.S. continuous. 2 years guarantee. Carr. free
12" 'POP' 50 50 Watts £12.75
15" 'POP' 60 60 Watts £15.75
18" 'POP' 100 100 Watts £27.50

Or Dep. £1.71 and 8 monthly payments £1.71 (Total £18.39) Pair suitable for all purposes
Or Dep. £2 and 8 monthly payments £2 (Total £18.00)
Or Dep. £3.50 and 8 monthly payments £3.50 (Total £31.50)
SUITABLE FOR BASS GUITAR, ELECTRONIC ORGAN, etc.

R.S.C. G66 MkII 6+6 WATT STEREO AMPLIFIER

High Quality Output. Rating I.H.F.M. Ind. Ganged Controls Bass, Treble, Vol and Balance. Solid state const. employing 10 Trans. Plus diodes. Range 20-20,000Hz. Bass control ± 12 dB. Treble ± 13 dB. Selector switch P.U. or Tape/Radio. Output for 3-15 ohm speakers. Standard 200-250v. 60 Hz mains operation. Attractive Black/Silver metal face plate and matching knobs.

FACTORY BUILT IN Teak Veneered Cabinet. £16.50
Dep. £2.12 & 8 mthly pymts. £2.12 (Total £19.88)

FANE SPEAKERS 'POP' 25/2

12" 25 WATT Dual Cone 15 ohms NOT for Bass Guitar. £8.75
Or Dep. £1.15 and 8 monthly payments £1.15 (Total £10.30)

R.S.C. MAINS TRANSFORMERS

- FULLY GUARANTEED. Interleaved and Impregnated where necessary. Primaries 200-250v. Hz 50.
BETWEEN MIDGET CLAMPED TYPE 2 1/2 x 2 1/2 x 2 1/2 in.
250v., 60mA, 6.3v. 2a, 0.5-6.3v. 3a, £1.10
250-0-250v., 60mA, 6.3v. 2a, £1.16
FULLY SHROUDED UPRIGHT MOUNTING
200-0-250v. 60mA, 6.3v. 2a., 0.5-6.3v. 2a., £1.55
250-0-250v. 100mA, 6.3v. 4a., 0.5-6.3v. 3a., £2.45
300-0-300v. 100mA, 6.3v. 4a., 0.5-6.3v. 3a., £2.45
300-0-300v. 130mA, 6.3v. 4a., c.t., 6.3v. 1a., £2.95
For Mullard 510 Amplifier.
350-0-350v. 100mA, 6.3v. 4a., 0.5-6.3v. 3a., £2.45
350-0-350v. 150mA, 6.3v. 4a., 0.5-6.3v. 3a., £2.95
425-0-425v. 200mA, 6.3v. 4a., c.t., 5v. 3a., £5.45
425-0-425v. 200mA, 6.3v. 4a., 6.3v. 3a., 5v. 3a., £6.00
450-0-450v. 250mA, 6.3v. 4a., c.t., 5v. 3a., £6.00
TOP SHROUDED DROP-THROUGH TYPE
250-0-250v 70mA, 6.3v. 2a., 0.5-6.3v. 2a., £1.49
250-0-250v. 100mA, 6.3v. 2a., 0.5-6.3v. 2a., £1.71
250-0-250v. 100mA, 6.3v. 2a., 6.3v. 1a., £1.75
300-0-300v. 80mA, 6.3v. 2a., 0.5-6.3v. 2a., £1.81
250-0-250v. 100mA, 6.3v. 4a., 0.5-6.3v. 3a., £2.45
300-0-300v. 100mA, 6.3v. 4a., 0.5-6.3v. 3a., £2.45
300-0-300v. 130mA, 6.3v. 4a., c.t., 6.3v. 1a., £2.85
Suitable for Mullard 510 Amplifier
350-0-350v. 100mA, 6.3v. 4a., 0.5-6.3v. 3a., £2.45
350-0-350v. 150mA, 6.3v. 4a., 0.5-6.3v. 3a., £2.85
FILAMENT or TRANSISTOR POWER PACK TYPES
6.3v. 1.5a. 55p; 6.3v. 3a. 60p; 6.3v. 3a. 85p;
6.3v. 6a. £1.45; 12v. 1a. 61p; 0.9-18v. 1a. £1.25;
0.12-25-42v. 2a. £1.95; 12v. 3a. or 24v. 1.5a. £1.50;
CHARGER TRANSFORMERS 0.9-15v. 1a. £1.10;
2a. £1.25; 3a., £1.40; 5a., £1.60; 6a., £1.85;
8a., £2.20.
AUTO (Step UP/Step DOWN) Transformers
0-10/120v., 200-230-250v. 50-80 watts £1.25;
150w., £2.10; 250w., £3.00; 500w., £6.40
OUTPUT TRANSFORMERS
Standard Pentode 5,000Ω to 7,000Ω to 3Ω 55p
Push-Pull 8 watts EL84 to 3Ω or 15Ω 95p
Push-Pull 10 watts 6V6 ECL86 to 3, 5, 8 or 15Ω £1.55
Push-Pull EL84 to 3Ω or 15Ω 12 watts £1.50
Push-Pull Ultra Linear for Mullard 510, etc. £2.45
Push-Pull 15-18 watts, sectionally wound 6L6 KT66, etc., for 3 or 15Ω £2.20
Push-Pull 50 watt high quality sectionally wound EL84, 6L6, KT66, etc. to 3 or 15Ω £3.85

BATTERY/MAINS CONVERSION UNITS

R.S.C. BM1 battery eliminator completely replaces 1.5v. and 50v. Radio batteries where normal 200-250v. AC mains is available. £4.15
Ready for use Post 30p



HI-FI SPEAKER SYSTEMS
Autodrine 121K. 12 in. 15 watt, 11,000 Gauss bass unit. Cross-over unit and Tweeter. Smooth response and wide frequency range ensure realistic sound reproduction. Carr. 33p £6.50
with extra sensitive 15,000 Gauss 12 in. speaker. Carr. 30p £7.65

DIGITAL MAGNETIC HEADS P.O.A.

- 210028 RCA 9 TRACK 303462 RCA 7 TRACK
219019 RCA 7 TRACK 1215872 TYPE1301 7 TRACK
257124 RCA 8 TRACK 500321 POTTER 7 TRACK
282812 RCA 8 TRACK 19467 EPYLON 8 TRACK
303489 RCA 7 TRACK 7681 5/848 BURROUGHS 9 TRACK
73927 RCA 7 TRACK 652623 DRI 12/101 12 TRACK
303464 RCA 7 TRACK L651922 DRI FR3000 16 TRACK

TRANSISTORS & DIODES

- 2N1547 75p AC128 20p
2N1545 50p AF115 25p
2N1542 50p AF116 25p
2N1557 50p AF117 25p
2N1908 £6.00 OC35 40p
2N3054 40p OC42 40p
2N3055 45p OC71 12p
2N985 £1.05 CV7006/OC72 20p
2N1046 £4.50 OC75 25p
2N5322 50p OC77 45p
2N4427 52p OC83 25p
2N3375 £3.46 2N356/OC139 25p
AC126 20p Get110 20p
AC127 25p 2G106/2N711B 43p

RCA PHOTOMULTIPLIER C31005B BRIDGE RECTIFIERS

Checked and tested. £37.50 1B40K05 50v 4a. .95p
RECTIFIER STACKS SWITCHES
GEX541B1P2 £6.88 Edwards High Vacuum "Speedivac" model
GEX541B1P1 £3.50 VSK1B range 25-760 torr contact ratings
GEX541D2P1 £3.50 250v. 5a. volume 4.2 cu. cm. max. working
GEX541N81P1F £6.00 pressure 15lb/sq. in. gauge net weight
GEX541HP3F £6.00 17 ozs. £6.20
SX751N1B1P1F £6.00 Belling Delay hand reset L415 £1.10
Stackpole min. rocker 125v. 10a. 250v. 5a. 20p
Tippalite Rocker 12v. 60p
Securex 5000 press button 250v. ac. £1.20

INTEGRATED CIRCUITS

- MC3544 £1.10
MC353G £2.00
MC358AG £5.00
MC365G £5.00
CA3020 .93p
CA3021 £1.15
CA3028A .97p
CA3038A £2.14
CA3055 £1.24
CA3085 .78p
CD4035AE £1.91
CD4017AE £3.86
CD4047AD £3.86

THYRISTORS

- GE2N1774 200v. 5a. £1.20
CR1-021C 20v. 1a. .25p
CR10-101B 100v. 10a. £1.00
CR10-021 10a. £1.00
CR10-40B 10a. £1.00
CR10-051 10a. £1.00
CR10-017 10a. £1.00
BTX 92 1200r 16a 1200v. £2.85
STC 3/40 400v. 3a. .50p

KEYBOARDS

- ICT Numerical £3.50
ICL Alpha Verifier (PN7035130) carr. 35p £27.50
carr. £1.00

ELECTROACOUSTIC UNIT

6 watt (peak) Amplifier 240v. AC, with inputs for Radio, Tape Recorder, freq. response 80-12,500Hz, bass and treble controls. 2 speakers. Dimensions 265 x 235 x 580 mm. Net weight 10kg. Ideal for education seminars etc. £12.00 incl. carr.

CONNECTORS

- McMurdo Red Range. Plug RP24 .56p
McMurdo Red Range. SKT RS32 .90p
Eng. Elect. Edge. 36 way 0.2 inch £1.00
Sylvania Edge. 48 way 0.2 inch pair £1.40
Ultra Gold-plated Contacts. 0.1 inch Type 10M 54631263C 38 way pair £2.00
20 way pair £1.60

CAPACITORS

Daly Electrolytic 9000 of 40v. 50p; Wego paper 4µf 400v 60p; Dubilier Metallised Paper Type 426 100uf 150v. DC 50p; R.I.C. type 1297 1.8uf 440v. AC 35p. TCC Visconol 0.1uf 1500v. DC 50p.

MOTORS

GEC fractional 1/12 hp 230/250v 1ph 50c 2850rpm £3.50 carr. 67p
E.E. 1hp 230v. 50c 1ph 50c. 1443rpm complete with cap 83/103uf 275v. £13.00
carr. £1.00
3 phase 2HP motor 60/50c., 1800/1500 RPM, 208/220/440v. £21.50
Incl. Carriage

FANS, CENTRIFUGAL BLOWERS

Alrmax Type M1/Y3954 (3 blades) Cast Aluminium alloy impeller & casing (corrosion proof) to current type 3965 7 1/2" 230v. 1ph 50c 2900rpm Class "A" insulation 425cfm free air weight 9 1/2lbs. incl. p.p. £21.00.

Woods Aerofoil short casing type "S" 2700rpm 220/250v 1ph 50c 6" plastic impeller incl. p.p. £11.50.

Woods Aerofoil Code 7.5 280K 200/250v. 1-0a 1ph 50c 2700rpm 7 1/2" impeller 14 blades incl. p.p. £13.50.

Service Electric Hi-Velocity Fans, suitable for Gas combustion Systems. Steam exhausting, Pneumatic conveying, Cooling Electronic equipment, Air blast for Oil burners. Secomak Model 365 (corresponds to 575) Airblast Fan, 440v 3ph 50c 0.75hp 2850rpm, continuous 160cfm 12 in w.g. nett weight 44lb, price incl. carr. £41.00. Secomak model 350 250v 1ph 50c 0.166hp, 2800 rpm continuous 50cfm 2 in. w.g. net weight 34lbs, price incl. carr. £26.00.

Air Controls type VBL4 200/250v 1ph 50c. 11cfm free air weight 7 1/2lbs price incl. p.p. £14.50.

Type VBL5 200/250v 1ph 50c. 172 cfm free air. Weight 10 1/2lbs. price incl. p.p. £18.50.

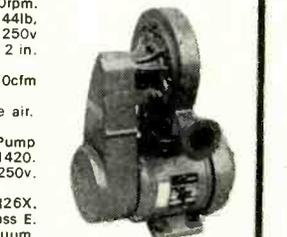
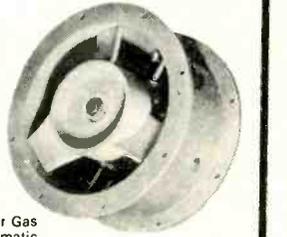
William Ailday Alcosa Two Stage Vacuum Pump Model HSPOB 8hg up to 29 in. mercury rpm 1420. E.E. 3 phase induction, motor 1/2hp cont. 220/250v. 380/440v. £21.00 incl. carr.

Gast MFG Vacuum pump 0522-P702-R26X. Motor 110/120v. A.C. 1 ph. 60c 1725 rpm. Class E. 10cuft to 10in Mercury in 2 mins maintains vacuum. 635mm Mercury. Or as compressor 10psi int. or 15psi cont. £25.00 incl. carr.

Where p.p. not advised add 10p per £ handling and post. (in UK). Cash with order. Personal callers welcome. Open Mon.-Wed. 9.30-5.00 Fri.-Sat. 9.30-5.00. Free Car Park adj. PRICES SHOWN ARE EXCLUSIVE OF V.A.T.

W. & B. MACFARLANE

126 UXBRIDGE ROAD, HANWELL, LONDON W7 3SL
WW-134 FOR FURTHER DETAILS



YATES ELECTRONICS

(FLITWICK) LTD.
DEPT. WW ELSTOW STORAGE DEPOT
KEMPSTON HARDWICK
BEDFORD

C.W.O PLEASE. POST AND PACKING
PLEASE ADD 10p TO ORDERS UNDER £2.

Catalogue which contains data sheets for most of the
components listed will be sent free on request.
10p stamp appreciated.

CALLERS WELCOME
MON.-SAT, 9 a.m.-5 p.m.
PLEASE ADD 10% V.A.T.

RESISTORS

1/4W Iskra high stability carbon film—very low noise—capless construction. 1/4W Mullard CR25 carbon film—very small body size 7.5 x 2.5 mm. 1/4W 2% ELECTROSIL TR5.

Power watts	Tolerance	Range	Values available	1-99	100+
1/4	5%	4.7Ω-2.2MΩ	E24	1p	0-8p
1/4	10%	3.3MΩ-10MΩ	E12	1p	0-8p
1/4	2%	10Ω-1MΩ	E24	3-5p	3p
1/4	10%	1Ω-3.9Ω	E12	1p	0-8p
1/4	5%	4.7Ω-1MΩ	E12	1p	0-8p
4	10%	1Ω-10Ω	E12	6p	5-5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK

0.5 watt 5% Iskra resistors 5 off each value 4.7Ω to 1MΩ.
E12 pack 325 resistors £2.40. E24 pack 650 resistors £4.70.

POTENTIOMETERS

Carbon track 5kΩ to 2MΩ, log or linear (log 1/2W, lin 1/4W).
Single, 12p. Dual gang (stereo), 40p. Single D.P. switch, 24p.

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0-1 matrix).
Sub-miniature 0-1W, 5p each. Miniature 0-25W, 7p each.

TRANSISTORS

AC107	15p	AF126	20p	BF115	25p	OC42	12p	2N3707	12p
AC126	12p	AF139	32p	BF173	20p	OC44	12p	2N3708	10p
AC127	15p	AF178	32p	BF177	28p	OC45	12p	2N3709	11p
AC128	15p	AF180	40p	BF178	32p	OC70	12p	2N3710	11p
AC131	12p	AF181	40p	BF179	32p	OC71	12p	2N3711	11p
AC132	12p	BC107	12p	BF180	32p	OC72	12p	2N3819	32p
AC176	15p	BC108	12p	BF181	32p	OC81	12p	2N4062	12p
AC187	22p	BC109	12p	BF194	14p	OC82D	12p	2N4286	20p
AC188	22p	BC147	12p	BF195	14p	2N2646	60p	2N4289	20p
AD140	50p	BC148	12p	BF197	15p	2N2904	20p	40360	35p
AD149	45p	BC149	12p	BF200	32p	2N2926	10p	40361	35p
AD161	33p	BC157	14p	BF750	20p	2N3054	58p	40362	40p
AD162	36p	BC158	14p	BF751	20p	2N3055	60p	40408	40p
AF114	20p	BC159	14p	BF752	20p	2N3702	13p	ZTX108	15p
AF115	20p	BC187	22p	BU7105	225p	2N3703	12p	ZTX300	15p
AF116	20p	BD131	75p	OC26	45p	2N3704	13p	ZTX302	20p
AF117	20p	BD132	75p	OC28	50p	2N3705	12p	ZTX500	15p
AF118	38p	BD133	75p	OC35	50p	2N3706	11p	ZTX503	20p

ZENER DIODES

400mW 5% 3-3V to 30V, 12p.

WIRE WOUND POTS

3W, 10, 25, 50Ω and decades to 100kΩ, 35p.

DIODES

RECTIFIER

BY127	1250V	1A	12p
IN4001	50V	1A	7p
IN4002	100V	1A	8p
IN4004	400V	1A	8p
IN4006	800V	1A	10p
IN4007	1000V	1A	12p

SIGNAL

OA85	7p
OA90	5p
OA91	5p
OA202	7p
IN4148	5p
BA114	8p

BRUSHED ALUMINIUM PANELS

12in x 6in, 25p; 12in x 2 1/2in, 10p; 9in x 2in, 7p

SLIDER POTENTIOMETERS

86mm x 9mm x 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log. or lin. 40p.
DUAL GANG, 10K + 10K etc. log. or lin. 60p.
KNOB FOR ABOVE, 12p.
FRONT PANEL, 65p.
18 Gauge panel 12in x 4in with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

THYRISTORS

2N5060	50V	0-8A	30p
2N5064	200V	0-8A	47p
106F	50V	4A	40p
106D	400V	4A	65p

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0-001μF, 0-0015μF, 0-0022μF, 0-0033μF, 0-0047μF, 2 1/2p, 0-0068μF, 0-01μF, 0-015μF, 0-022μF, 0-033μF, 3p, 0-047μF, 0-068μF, 0-1μF, 4p, 0-15μF, 6p, 0-22μF, 7 1/2p, 0-33μF, 11p, 0-47μF, 13p.
160V: 0-01μF, 0-015μF, 0-022μF, 0-033μF, 0-047μF, 0-068μF, 3p, 0-1μF, 3 1/2p, 0-15μF, 4 1/2p, 0-22μF, 5p, 0-33μF, 6p, 0-47μF, 7 1/2p, 0-68μF, 11p, 1-0μF, 13p.

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0-01μF, 0-015μF, 0-022μF, 3p, 0-033μF, 0-047μF, 0-068μF, 3 1/2p, 0-1μF, 4p, 0-15μF, 0-22μF, 5p, 0-33μF, 6 1/2p, 0-47μF, 8 1/2p, 0-68μF, 11p, 1-0μF, 13p, 1-5μF, 20p, 2-2μF, 24p.

MYLAR FILM CAPACITORS 100V

0-001μF, 0-002μF, 0-005μF, 0-01μF, 0-02μF, 2 1/2p, 0-04μF, 0-05μF, 0-068μF, 0-1μF, 3 1/2p.

CERAMIC DISC CAPACITORS

100pF to 10,000pF, 2p each.

ELECTROLYTIC CAPACITORS—MULLARD O15/6/7

(μF/V) 1/63, 1-5/63, 2-2/63, 3-3/63, 4-7/63, 6-8/40, 6-8/63, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6-3, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6-3, 68/16, 100/4, 100/10, 100/25, 150/6-3, 150/16, 220/4, 220/6-3, 220/16, 330/4, 6p, 47/63, 100/40, 150/25, 220/25, 330/10, 470/6-3, 7p, 68/63, 150/40, 220/40, 330/16, 1000/4, 10p, 470/10, 680/6-3, 11p, 100/63, 150/63, 220/63, 1000/10, 12p, 470/25, 680/16, 1500/6-3, 13p, 470/40, 680/25, 1000/16, 1500/10, 2200/6-3, 18p, 330/63, 680/40, 1000/25, 1500/16, 2200/10, 3300/6-3, 4700/4, 21p.

SOLID TANTALUM BEAD CAPACITORS

0-1μF	35V	2-2μF	35V	22μF	16V
0-22μF	35V	4-7μF	35V	33μF	10V
0-47μF	35V	6-8μF	25V	47μF	6-3V
1-0μF	35V	10μF	25V	100μF	3V

VEROBOARD

0-1	0-15
2 1/2 x 3 1/2	22p 16p
2 1/2 x 5	24p 24p
3 1/2 x 3 1/2	24p 24p
3 1/2 x 5	27p 27p
17 x 2 1/2	75p 57 1/2p
17 x 3 1/2	100p 78p
17 x 5 (plain)	82p
17 x 3 1/2 (plain)	60p
17 x 2 1/2 (plain)	42p
2 1/2 x 5 (plain)	12p
2 1/2 x 3 1/2 (plain)	11p
Pin insertion tool	52p 52p
Spot face cutter	42p 42p
Pkt. 50 pins	20p 20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2-5mm insulated	8p
Standard insulated	12p	3-5mm insulated	8p
Stereo screened	35p	3-5mm screened	13p
Standard socket	15p	2-5mm socket	8p
Stereo socket	18p	3-5mm socket	8p

D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable, 15p/metre.
6 way screened cable, 22p/metre.

BATTERY ELIMINATOR £1-50

9V mains power supply. Same size as PP9 battery.

LARGE (CAN) ELECTROLYTICS

1600μF	64V	74p	2500μF	64V	80p	4500μF	16V	50p
2500μF	40V	74p	2800μF	100V	£2-60	4500μF	25V	£1-68
2500μF	50V	58p	3200μF	16V	50p	5000μF	50V	£1-10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLTS

0-01μF	10p	0-047μF	13p	0-22μF	20p
0-022μF	12p	0-1μF	13p	0-47μF	22p

POLYSTYRENE CAPACITORS 160V 2 1/2%

10pF to 1,000pF E12 Series Values, 4p each.

SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI

The GDI is the world's first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector.
Kit of parts for detectors including GDI and P.C. board but excluding case. Mains operated detector £5-20. 12 or 24V battery operated audible alarm £7-30. As above for PP9 battery, £6-40.

PRINTED BOARD MARKER

97p
Draw the planned circuit on to a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

TRANSFORMERS

All have 240V Primary

MT 30/2	0-12-15-20-24-30V	2A	£2-85
MT 50 1/2	0-19-25-33-40-50V	1A	£1-90
MT 50/1	0-19-25-33-40-50V	1A	£2-55
MT 50/2	0-19-25-33-40-50V	2A	£3-50
MT 60 1/2	0-24-30-40-48-60V	1A	£2-10
MT 60/1	0-24-30-40-48-60V	1A	£2-80
MT 60/2	0-24-30-40-48-60V	2A	£3-80

HEAT SINKS—REDPOINT

2W 24p 4W 45p TOS Clip 5p TO1 Single 5p
3W 36p 6W 60p TO18 Clip 5p TO1 Double 8p

METERS £1-90

1 1/2" Scale 500uA, 1mA, 10mA, 100mA.

WAVECHANGE SWITCH 23p

1p-12W, 3p-4W, 2p-6W, 4p-3W.

ROTARY MAINS SWITCH 32p

DP, 2A.

THERMISTORS

VA 1005	15p	709	14 pin DIL	40p
VA 1026	15p	741	8 pin DIL	40p
VA 1033	15p	741	14 pin DIL	38p
VA 1055S	15p	723	14 pin DIL	95p
VA 1066S	15p	747	14 pin DIL	85p
VA 1077	15p	748	8 pin DIL	45p
R53	£1-35	DIL Sockets	14 pin and 16 pin	16p

ALUMINIUM BOXES

AB7	2 1/2" x 5 1/2" x 1 1/2"	50p	AB14	7" x 5" x 2 1/2"	84p
AB8	4" x 4" x 1 1/2"	50p	AB15	8" x 6" x 3"	108p
AB9	4" x 2 1/2" x 1 1/2"	50p	AB16	10" x 7" x 3"	122p
AB10	4" x 5 1/2" x 1 1/2"	50p	AB17	10" x 4 1/2" x 3"	108p
AB11	4" x 2 1/2" x 2"	60p	AB18	12" x 5" x 3"	120p
AB12	3" x 2" x 1"	44p	AB19	12" x 8" x 3"	160p

BULGIN MAINS CONNECTORS

3 PIN 1 1/2A	CHASSIS PLUG	10p	3 PIN 1 1/2A	CHASSIS SOCKET	18p
	LINE SOCKET	13p		LINE PLUG	13p
3 PIN 3A	CHASSIS PLUG	10p	3 PIN 3A	CHASSIS SOCKET	21p
	LINE SOCKET	14p		LINE PLUG	23p
3 PIN 5A	CHASSIS PLUG	16p	2 PIN 5A	LINE PLUG	20p
	LINE SOCKET	18p			

The largest selection

EX COMPUTER BOARDS

Packed with transistors, diodes, capacitors and resistors—COMPONENT VALUE £1.50, 3 for ONLY 55p — p & p 30p
SPECIAL, As above PLUS Power Transistors ONLY 55p each — p & p 15p
STABILISED POWER MODULES Complete with circuit diagrams, etc. 99p each — p & p 15p
PAXOLINE BOARDS 7 1/2 x 9" approx. 4 for 30p — p & p 20p.

FIBRE-GLASS PRINTED CIRCUIT BOARDS

16 1/2 x 4" approx. 2 for 55p

DECON-DALO 33pC Marker

Etch resistant printed circuit marker pen 90p each

VEROBOARDS

Packs containing approx. 300g. ins. various sizes, all 0-1 metric 55p

REPANCO CHOKES & COILS

RF Chokes
 CH1, 2.5mH 85p CH2, 5.0mH 25p
 CH3, 7.5mH 25p CH4, 10mH 25p
 CH5, 1.5mH 25p

COILS

DRX1 Crystal set 50p DRX2 Dual range 45p

COIL FORMERS & CORES

NORMAN 1" Cores & Formers 7p
 1" Cores & Formers 8p

SWITCHES

DPDT Toggle 25p SPST Toggle 15p

FUSES

1 1/2" and 20mm, 100mA, 200mA, 250mA, 500mA, 1A, 1.5A, 2A
 QUICN-BLOW 4p ea. ANTI-SURGE 5p ea.

EARPHONES

Crystal 2.5mm plug 33p
 Crystal 3.5mm plug 25p
 8 ohm 2.5mm plug 25p
 8 ohm 3.5mm plug 25p

DYNAMIC MICROPHONES

B1223, 200 ohms plus on/off switch and 2.5mm and 3.5mm plugs £1.60

3-WAY STEREO HEADPHONE JUNCTION BOX

H1012 £1.87

2-WAY CROSSOVER NETWORK

K1007, 80 ohm 1mm. Insertion loss 3dB £1.27

TRANSISTOR EQUIVALENT BOOK 8th EDITION

250 pages of cross references and equivalents for European, American and Japanese transistors. Approximately 9,000 types with more than 50,000 substitutes have been included. The tables were compiled with the utmost care from manufacturers own specifications. The most comprehensive Equivalents Book on the market today!
ONLY £1.85

INSTRUMENT CASES



(Black Vinyl covered)

No.	Length	Width	Height	Price
BY1	8"	3 1/2"	2"	90p
BY2	11"	6"	3"	£1.20

ALUMINIUM BOXES

BA1	5 1/2"	4"	1 1/2"	42p
BA2	4"	4"	1 1/2"	41p
BA3	4"	4"	1 1/2"	41p
BA4	5 1/2"	4"	1 1/2"	47p
BA5	4"	2 1/2"	1"	41p
BA6	3"	2 1/2"	1"	84p
BA7	7"	5"	2 1/2"	66p
BA8	8"	6"	3"	84p
BA9	6"	4"	2 1/2"	54p

PLEASE NOTE: ALL OUR PRICES INCLUDE V.A.T. MODEL AMTRON KITS

Model No.	Description	Price
UK65	Simple transistor tester	£ 1.88
UK145	Amplifier 1.5W	£ 4.37
UK220	Signal Injector	£ 3.13
UK230	AM/FM Antenna Amplifier	£ 3.88
UK275	Mike Pre-amplifier	£ 2.93
UK300	4-channel Radio Control Transmitter	£ 7.95
UK310	Radio Control Receiver	£ 2.98
UK325	4CX2 Channel Splitting unit 1,000 & 2,500 Hz	£ 9.44
UK330	4CX2 Channel Splitting unit 1,500 & 2,500 Hz	£ 9.44
UK705	Superhetrodyne Radio Control Receiver	£ 7.95
UK525	VHF Tuner 120 to 160 MHz	£14.93
UK555	Radio Control Field Strength Meter	£12.74
UK705	Wenderson Wiper timer	£ 8.98
UK710	4-Channel AF mixer	£14.93
UK780	Electronics Unit for Metal Detector	£12.74
UK835	Guitar pre-amplifier	£ 5.87
UK875	Capacitive Discharge Electronic Ignition for Internal Combustion Engines	£17.41

VISIT OUR COMPONENT SHOP

18 BALDOCK ST., WARE, HERTS. (A10)

Open Mon.-Thurs. 9.15-6 p.m. Sat. 9.15-5.30. Late Night Shopping until 7 Fri. Tel. 61353

BIB HI-FI ACCESSORIES

De Luxe Groov-Kleen
 Model 42 £1.84
 Chrome Finish Model 60 £1.50



Ref. 56A. Record/Styleus Cleaning Kit 28p
 Ref. 43. Record Care Kit £2.35
 Ref. 31. Cassette Head Cleaner 54p
 Ref. 32. Tape editing Kit £1.54
 Model 9. Wire Stripper/Cutter 83p
 Ref. P. Hi-Fi Cleaner 31p
 Ref. 32A. Styleus Balance £1.38
 Ref. J. Tape Head Cleaning Kit 51p
 Ref. 34. Cassette Case £1.27
 Ref. 56. Hi-Fi Stereo Hints & Tips 32p

ANTEX SOLDERING IRONS

X25, 25 watt £1.93
 CCN 240, 15 watt £2.15
 Model G, 18 watt £2.15
 SK2. Soldering Kit £2.88
 STANDS: ST1 £1.21, ST2 77p
 SOLDER: J8SWG Multicores Tox 82p
 28SWG Tox 82p, 18SWG 22ft 28p
 28SWG Tube 22p

ANTEX BITS and ELEMENTS

102 For model CCN240 3/4" 38p
 104 For model CCN240 3/4" 38p
 1100 For model CCN240 3/4" 38p
 1101 For model CCN240 1" 38p
 1102 For model CCN240 1" 38p
 1020 For model G240 1" 28p
 1021 For model G240 1" 28p
 1022 For model G240 1" 38p
 5) For model X25 1" 38p
 51 For model X25 1" 38p
 52 For model X25 1/4" 38p
 ELEMENTS
 CCN 240 £1.16 EOCN 240 £1.32
 EG 240 £1.16 EX 25 £1.18

ANTEX HEAT SINKS 10p

V.A.T. included in all prices. Please add 10p P. & P. (U.K. only). Overseas orders—please add extra for postage.

NEW COMPONENT PAK BARGAINS

Pack No. Qty.	Description	Price
C1 250	Resistors mixed values approx. count by weight	0.55
C2 200	Capacitors mixed values approx. count by weight	0.55
C3 50	Precision Resistors mixed values 1-2%	0.55
C4 75	1/4W Resistors mixed preferred values	0.55
C5 5	Pieces assorted Ferrite Rods	0.55
C6 2	Tuning Gaugs, MW/LW VHF	0.55
C7 7	Pack Wire 50 metres assorted colours	0.55
C8 10	Reed Switches	0.55
C9 3	Micro switches	0.55
C10 15	Assorted Pots & Pre-Sets	0.55
C11 3	Jack Sockets 3 x 3.5m 2 x Standard Switch Type	0.55
C12 40	Paper Condensers preferred types mixed valued	0.55
C13 20	Electrolytics Trans. types	0.55
C14 1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0.55
C15 4	Mains Slide Switches, 2 Amp	0.55
C16 20	Assorted Tag Strips & Panels	0.55
C17 10	Assorted Control Knobs	0.55
C18 4	Rotary Wave Change Switches	0.55
C19 3	Relays 6-24V Operating	0.55
C20 4	Sheets Copper Laminate approx. 10" x 7"	0.55

PLUGS AND SOCKETS

SOCKETS
 PS 35 DIN 2 Pin (Speaker) 0.06
 PS 36 DIN 3 Pin 0.10
 PS 37 DIN 5 Pin 180° 0.10
 PS 38 DIN 5 Pin 210° 0.10
 PS 39 Jack 2.5mm Switched 0.09
 PS 40 Jack 3.5mm Switched 0.10
 PS 41 Jack 1" Switched 0.17
 PS 42 Jack Stereo Switched 0.26
 PS 43 Phono Single 0.06
 PS 44 Phono Double 0.06
 PS 45 Car Aerial 0.09
 PS 46 Co-Axial Surface 0.09
 PS 47 Co-Axial Flush 0.14

INLINE SOCKETS

PS 21 D.I.N. 2 Pin (Speaker) 0.13
 PS 22 D.I.N. 3 Pin 0.17
 PS 23 D.I.N. 5 Pin 180° 0.17
 PS 24 D.I.N. 5 Pin 210° 0.17
 PS 25 Jack 2.5mm Plastic 0.10
 PS 26 Jack 3.5mm Plastic 0.12
 PS 27 Jack 1" Plastic 0.24
 PS 28 Jack 1" Screened 0.28
 PS 29 Jack Stereo Plastic 0.22
 PS 30 Jack Stereo Screened 0.32
 PS 31 Phono Screened 0.14
 PS 32 Car Aerial 0.15
 PS 33 Co-Axial 0.17

PLUGS

PS 1 D.I.N. 2 Pin (Speaker) 0.11
 PS 2 D.I.N. 3 Pin 0.12
 PS 3 D.I.N. 4 Pin 0.15
 PS 4 D.I.N. 5 Pin 180° 0.14
 PS 5 D.I.N. 5 Pin 210° 0.15
 PS 6 D.I.N. 6 Pin 0.15
 PS 7 D.I.N. 7 Pin 0.15
 PS 8 Jack 2.5mm Screened 0.10
 PS 9 Jack 3.5mm Plastic 0.09
 PS 10 Jack 3.5mm Screened 0.12
 PS 11 Jack 1" Plastic 0.13
 PS 12 Jack 1" Screened 0.18
 PS 13 Jack Stereo Screened 0.29
 PS 14 Phono 0.06
 PS 15 Car Aerial 0.15
 PS 16 Co-Axial 0.10

CABLES

CP 1 Single Lapped Screen 0.08
 CP 2 Twin Common Screen 0.08
 CP 3 Stereo Screened 0.08
 CP 4 Four Core Common Screen 0.23
 CP 5 Four Core Individually Screened 0.30
 CP 6 Microphone Pully Braided Cable 0.10
 CP 7 Three Core Mains Cable 0.07
 CP 8 Twin Oval Mains Cable 0.06
 CP 9 Speaker Cable 0.04
 CP 10 Low Loss Co-Axial 0.10

CARBON POTENTIOMETERS

Low and Lin
 47K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M
 VC 1 Single Less Switch 0.14
 VC 2 Single D.P. Switch 0.28
 VC 3 Tandem Less Switch 0.44
 VC 4 1K Lin Less Switch 0.14
 VC 5 100K Log anti-Log 0.14

HORIZONTAL CARBON PRESETS

0.1 watt 0.08 each
 100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4.7M

SELENITE BRIDGE RECTIFIERS

18V, 2A. Ideal for those building battery, chargers. 15p each. 10 for 55p

REPANCO TRANSFORMERS

340V. Primary. Secondary voltages available from selected tappings 4V, 7V, 8V, 10V, 14V, 15V, 17V, 19V, 21V, 25V, 31V, 33V 40V, 50V, and 25V-0-25V.

Type	Amps	Price	P * P
MT50/1	1	£1.93	30p
MT50/1	1	£2.42	35p
MT50/2	2	£3.30	40p

WORLD SCOOP! JUMBO SEMICONDUCTOR PACK

Transistors-Germ and Silicon
 Rectifiers-Diodes-Triacs-Thyristors
 I,C's and Zenners ALL NEW AND CODED
APPROX 100 PIECES!

Offering the amateur a fantastic bargain Pak and an enormous saving—identification and data sheet in every Pak
ONLY £2 p & p 20p

EX-COMPUTOR BOARDS—BY THE BOXFULL!

20 Boards packed with Semiconductors and other Electronic Components. Each board approx. size 8" x 7". All known type no. and easily recognisable
FANTASTIC VALUE AT £2.20 per BOX p & p 52p.

SPECIAL PURCHASE by BI-PAK 2N3055.

Silicon Power Transistors NPN
 Famous manufacturers out-of-spec devices free from open and short defects—every one able to 115 watts TO3. Metal Case.
OUR SPECIAL PRICE 8 for £1.

LOW COST CAPACITORS

101 pF 400V 3p each
 500 pF 50V Elect. 10p each

RECORD STORAGE/CARRY-CASES

7" EP, 18 1/2" x 7" x 8", (50 records) £2.10
 12" LP, 18 1/2" x 7 1/2" x 12 1/2", (50 records) £2.95

CASSETTE CASES

Holds 12, 10" x 4 1/2" x 5". Lock & Handle £1.30

8-TRACK CARTRIDGE CASES

Holds 14, 13 1/2" x 5" x 6". Lock & Handle. £1.95
 Holds 24, 13 1/2" x 8" x 5 1/2". Lock & Handle. £2.70
 COLOURS: Red, Black and Tan—Please state preference.

ALL PRICES INCLUDE VAT

CARTRIDGES

ACOS GP91-18C-200mV at 1.2cm/sec £1.16
 ACOS GP93-1, 280mV at 1cm/sec £1.65
 ACOS GP96-1, 100mV at 1cm/sec £2.65
 TTC J-2005, Crystal HI Output 95p
 TTC J-200, 10C Crystal HI Output Compatible £1.10
 TTC J-200 CS Stereo/HI Output £1.60
 TTC J-2105 Ceramic/Med. Output £1.64

CARBON FILM RESISTORS

The E12 Range of Carbon Film Resistors. 1 watt available in PAKS of 50 pieces, assorted into the following groups:—
 R1 50 Mixed 100 ohms-820 ohms 40p
 R2 50 Mixed 1K ohms-8.2K ohms 40p
 R3 50 Mixed 10K ohms-82K ohms 40p
 R4 50 Mixed 100K ohms-1 Meg. ohms 40p
THESE ARE UNBEATABLE PRICES—LESS THAN 1p EACH INCL. V.A.T.

BI-PAK SUPERIOR QUALITY LOW-NOISE CASSETTES

C60, 32p C90, 41p C120, 52p

SEE OUR COMPLETE RANGE IN PRACTICAL ELECTRONICS, PRACTICAL WIRELESS, RADIO CONSTRUCTOR, EVERYDAY ELECTRONICS, ELECTRONICS TODAY INTERNATIONAL

OR SEND 5p. FOR THE FULL LIST OF ALL BI-PAK PRODUCTS

BOOK BARGAIN BUNDLE

8 Books comprising:
 2 Transistor Equivalent books
 1 Radio & Electronic colour code and data chart
 1 Radio valve guide PLUS
 3 Other constructional books on Receivers, FM Tuners, etc.
 A150 1 General construction book
VALUE £3. OUR PRICE £2 p & p 10p.

BP1	Handbook of Transistor Equivalents & Substitutes	40p
BP2	Handbook of Radio, T.V. & Industrial Tube & Valve Equiv.	40p
BP3	Handbook of Tested Transistor Circuits	40p
BP4	International Handbook of the World's Short Wave Radio Stations and FM/T.V. Listings	35p
BP5	Handbook of Simple Transistor Circuits	35p
BP7	Radio and Electronics colour codes and Data Charts	15p
BP8	Sound and Loudspeaker Manual	50p
BP9	38 Practical Tested Diode Circuits for the Home constructor	35p
BP10	Modern Crystal and Transistor Set Circuits for Beginners	35p
BP11	Practical Transistor Novelty Circuits	40p
BP13	Electronic Novelties for the Hobbyist	50p
BP14	Second book of Transistor Equivalents	95p
BP15	Constructors Manual of Electronic Circuits for the home	50p
129	Universal Grant Motor Speed Indicator	8p
138	How to make FM and T.V. aerials Bands 1/2/3	18p
141	Radio Servicing for Amateurs	20p
146	High Fidelity Loudspeaker enclosures	40p
156	Transistor Circuits Manual No. 1	15p
157	Call Design and Construction Manual	30p
161	Radio T.V. and Electronic Data book	25p
174	Transistor sub-miniature receivers	35p
175	Transistor Test Equipment & Service Manual	25p
176	Manual of Transistor Audio Amplifiers	40p
178	A comprehensive Radio Valve Guide—Book 3	30p
183	How to receive foreign T.V. programmes on your set by simple modifications	35p
196	A.R.F. Reactance-Frequency chart for Constructors	15p
200	Handbook of Practical Electronic Musical Novelties 50p	50p
201	Practical Transistorised Novelties for Hi-Fi Enthusiasts	35p
202	Handbook of Integrated Circuits Equivalents and Substitutes	75p
RCC	Resistor Colour Code Disc Calculator	10p

the lowest prices!

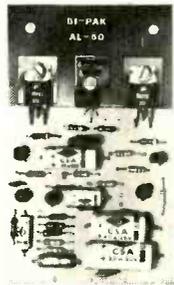
74 Series T.T.L. I.C.'S

BI-PAK STILL LOWEST IN PRICE FULL SPECIFICATION
GUARANTEED. ALL FAMOUS MANUFACTURERS



1		25		100		1000	
SN7400	0.18	0.17	0.16	SN7401	0.18	0.17	0.16
SN7401	0.18	0.17	0.16	SN7402	0.18	0.17	0.16
SN7402	0.18	0.17	0.16	SN7403	0.18	0.17	0.16
SN7403	0.18	0.17	0.16	SN7404	0.18	0.17	0.16
SN7404	0.18	0.17	0.16	SN7405	0.18	0.17	0.16
SN7405	0.18	0.17	0.16	SN7406	0.30	0.34	0.31
SN7406	0.30	0.34	0.31	SN7407	0.30	0.34	0.31
SN7407	0.30	0.34	0.31	SN7408	0.20	0.19	0.18
SN7408	0.20	0.19	0.18	SN7409	0.20	0.19	0.18
SN7409	0.20	0.19	0.18	SN7410	0.18	0.17	0.16
SN7410	0.18	0.17	0.16	SN7411	0.28	0.27	0.26
SN7411	0.28	0.27	0.26	SN7412	0.38	0.34	0.31
SN7412	0.38	0.34	0.31	SN7413	0.32	0.31	0.30
SN7413	0.32	0.31	0.30	SN7414	0.48	0.44	0.42
SN7414	0.48	0.44	0.42	SN7415	0.48	0.44	0.42
SN7415	0.48	0.44	0.42	SN7416	0.48	0.44	0.42
SN7416	0.48	0.44	0.42	SN7417	0.55	0.53	0.50
SN7417	0.55	0.53	0.50	SN7418	0.55	0.53	0.50
SN7418	0.55	0.53	0.50	SN7419	0.55	0.53	0.50
SN7419	0.55	0.53	0.50	SN7420	0.55	0.53	0.50
SN7420	0.55	0.53	0.50	SN7421	0.55	0.53	0.50
SN7421	0.55	0.53	0.50	SN7422	0.55	0.53	0.50
SN7422	0.55	0.53	0.50	SN7423	0.55	0.53	0.50
SN7423	0.55	0.53	0.50	SN7424	0.50	0.46	0.44
SN7424	0.50	0.46	0.44	SN7425	0.50	0.46	0.44
SN7425	0.50	0.46	0.44	SN7426	0.50	0.46	0.44
SN7426	0.50	0.46	0.44	SN7427	0.50	0.46	0.44
SN7427	0.50	0.46	0.44	SN7428	0.55	0.53	0.50
SN7428	0.55	0.53	0.50	SN7429	0.18	0.17	0.16
SN7429	0.18	0.17	0.16	SN7430	0.50	0.46	0.44
SN7430	0.50	0.46	0.44	SN7431	0.75	0.73	0.70
SN7431	0.75	0.73	0.70	SN7432	0.70	0.68	0.65
SN7432	0.70	0.68	0.65	SN7433	0.70	0.68	0.65
SN7433	0.70	0.68	0.65	SN7434	0.18	0.17	0.16
SN7434	0.18	0.17	0.16	SN7435	0.71	0.64	0.64
SN7435	0.71	0.64	0.64	SN7436	0.64	0.71	0.64
SN7436	0.64	0.71	0.64	SN7437	0.64	0.71	0.64
SN7437	0.64	0.71	0.64	SN7438	0.60	0.55	0.50
SN7438	0.60	0.55	0.50	SN7439	0.60	0.55	0.50
SN7439	0.60	0.55	0.50	SN7440	0.60	0.55	0.50
SN7440	0.60	0.55	0.50	SN7441	0.60	0.55	0.50
SN7441	0.60	0.55	0.50	SN7442	0.60	0.55	0.50
SN7442	0.60	0.55	0.50	SN7443	0.60	0.55	0.50
SN7443	0.60	0.55	0.50	SN7444	0.60	0.55	0.50
SN7444	0.60	0.55	0.50	SN7445	0.60	0.55	0.50
SN7445	0.60	0.55	0.50	SN7446	0.60	0.55	0.50
SN7446	0.60	0.55	0.50	SN7447	0.60	0.55	0.50
SN7447	0.60	0.55	0.50	SN7448	0.60	0.55	0.50
SN7448	0.60	0.55	0.50	SN7449	0.60	0.55	0.50
SN7449	0.60	0.55	0.50	SN7450	0.60	0.55	0.50
SN7450	0.60	0.55	0.50				

NOW WE GIVE YOU 50w PEAK (25w R.M.S.) PLUS THERMAL PROTECTION! The NEW AL60 Hi-Fi Audio Amplifier FOR ONLY £3.95



- Max Heat Sink temp. 90°C
- Frequency Response 20Hz to 100KHz
- 0.1% Distortion
- Distortion better than 1% at 1KHz
- Thermal Feedback
- Latest Design Improvements
- Load—3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm x 105mm x 13mm
- Supply voltage 10-35 volts

Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

FULLY BUILT—TESTED and GUARANTEED



STABILISED POWER MODULE SPM80

£3.25

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the mains transformer MT90, the unit will provide outputs of up to 1.5 amps at 35 volts. Size: 63 mm x 105 mm x 20 mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Address, Intercom, Units, etc. Handhook available, 10p.

TRANSFORMER BMT80 £2.15 p. & p. 25p

INTEGRATED CIRCUIT PAKS

Manufacturers' "Full Outs" which include Functional and Part-Functional Units. These are classed as "out-of-spec" from the maker's very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00	12 x 7400	0.55	UIC90	5 x 7490	0.55
UIC01	12 x 7401	0.55	UIC91	5 x 7491	0.55
UIC02	12 x 7402	0.55	UIC92	5 x 7492	0.55
UIC03	12 x 7403	0.55	UIC93	5 x 7493	0.55
UIC04	12 x 7404	0.55	UIC94	5 x 7494	0.55
UIC05	12 x 7405	0.55	UIC95	5 x 7495	0.55
UIC06	8 x 7406	0.55	UIC100	5 x 74100	0.55
UIC07	8 x 7407	0.55	UIC101	5 x 74101	0.55
UIC10	12 x 7410	0.55	UIC102	5 x 74102	0.55
UIC20	12 x 7420	0.55	UIC103	5 x 74103	0.55
UIC30	12 x 7430	0.55	UIC104	5 x 74104	0.55
UIC40	12 x 7440	0.55	UIC105	5 x 74105	0.55
UIC41	5 x 7441	0.55	UIC106	5 x 74106	0.55
UIC42	5 x 7442	0.55	UIC107	5 x 74107	0.55
UIC43	5 x 7443	0.55	UIC108	5 x 74108	0.55
UIC44	5 x 7444	0.55	UIC109	5 x 74109	0.55
UIC45	5 x 7445	0.55	UICX1	20 Assorted 74's 1.55	

Packs cannot be split, but 25 assorted pieces (our mix) is available as PAK UIC X1.

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market. The PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise S.P.N. devices for use in the input stages. The PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

- SPECIFICATION:**
- Frequency response: 20Hz—20KHz ±1dB
 - Harmonic distortion: better than 0.1%
 - Inputs: 1. Tape head 1.25mV into 50KΩ
 - 2. Radio, Tuner 35mV into 30KΩ
 - 3. Magnetic P.U. 1.5mV into 50KΩ
 - Tape and P.U. inputs equalized to RIAA curve within ±1dB from 20Hz to 20KHz.
 - Bass control: ±15dB at 20Hz
 - Treble control: ±15dB at 20KHz
 - Filters: Rumble (high pass) 100 Hz
 - Scratch (low pass) 8KHz
 - Signal/noise ratio: better than +65dB ±26dB
 - Input overload: 4-5 volts at 20mA
 - Supply: 292 x 82 x 35 mm
 - Dimensions: 292 x 82 x 35 mm

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £25.30 FREE p.&p.

only £13.15

LINEAR I.C.'S—FULL SPEC.

Type No.	Use	1	25	100	
72700	DH1	14	0.50	0.48	0.45
72708	DH1	14	0.35	0.33	0.30
72710	DH1	14	0.45	0.43	0.40
72714	DH1	14	0.40	0.38	0.40
72716	DH1	8	0.38	0.38	0.34
72718	DH1	8	0.38	0.38	0.34
72720	TO-5	8	0.50	0.45	0.40
81701C	TO-3	8	0.50	0.45	0.40
81702C	TO-3	8	0.50	0.45	0.40
TAA263	TO-72	4	0.90	0.70	0.60
TAA264	TO-74	10	1.60	0.95	0.90
TAA50A	TO-65	10	1.85	1.10	1.00
B4700C	TO-3	6	0.28	0.28	0.24
B4700C	TO-5	8	0.35	0.33	0.30
B4711	TO-5	10	0.45	0.43	0.40
ZN414	TO-18	4	1.20		

DTL 930 SERIES LOGIC I.C.'S

Type No.	1	25	100
BP930	0.15	0.14	0.13
BP932	0.16	0.15	0.14
BP933	0.18	0.15	0.14
BP935	0.16	0.15	0.14
BP936	0.16	0.15	0.14
BP944	0.18	0.15	0.14
BP945	0.30	0.28	0.25
BP946	0.15	0.14	0.13
BP948	0.30	0.28	0.25
BP951	0.70	0.65	0.60
BP962	0.15	0.14	0.13
BP963	0.45	0.43	0.40
BP994	0.45	0.43	0.40
BP997	0.45	0.43	0.40
BP999	0.45	0.43	0.40

DUAL-IN-LINE SOCKETS

Type	Description	Price
MAN 3M	L.E.D. 7 Segment Display 0.127" High Characters	£1.90
CR 60	Side Viewing 'Nixie' Type Tube 16 mm.	£1.87
GR 116	Side Viewing 'Nixie' Type Tube 13 mm.	£1.70

3 TERMINAL POSITIVE VOLTAGE REGULATORS

µA7805	5V (Equivalent to MV85V)	£1.76
µA7812	12V (Equivalent to MV12V)	£1.76

BI-PAK CATALOGUE & LISTS

Send S.A.E. and 10p

TEAK VENEERED CABINETS for:

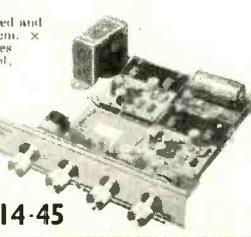
- STEREO 20
- TC 20. £3.95 p&p 30p
- MK 50 KIT
- TC 100. £6.50 p&p 30p

E.M.I. LEK 350 Loudspeaker System Enclosure kit in teak veneer, including speakers.

Rec. retail price £45.50 per pr. OUR SPECIAL PRICE £35.50 per pair P. & P. £1. ONLY WHILE STOCKS LAST!

The STEREO 20

The Stereo 20 amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm. x 14 cm. x 5.5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The Stereo 20 has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 30mV into 1M. Prep. res. 25Hz-25kHz. Input 2 (AUX.) 4mV into 30K. Harmonic distortion. Bass control ±12dB at 30Hz. Typically ±2.5% at 1 watt. Treble control ±14dB at 14KHz.



£14.45

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with ceramic cartridge while the auxiliary input will suit most magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm x 84mm x 35mm

- PRICE £4.35**
- Frequency response—20Hz—50KHz (±5dB)
- Bass control—±12dB at 60Hz
- Treble control—±14dB at 14KHz
- Input 1 Impedance—1 Meg. ohm
- Sensitivity—300mV
- Input 2 Impedance—30 K ohms
- Sensitivity—4mV

FRONT PANELS FP12 with knobs £1.20

POWER SUPPLIES

PS 12	(Use with AL10 & AL20)	88p
SPM 80	(Use with also AL30 & AL50)	£3.25

All prices inclusive of V.A.T. Gira No. 388 - 7006

Please send all orders direct to warehouse and despatch department

BI-PAK

P.O. BOX 5, WARE · HERTS

Postage and packing add 11p. Overseas add extra for airmail. Minimum order 55p. Cash with order please.

Guaranteed Satisfaction or Money Back

HART ELECTRONICS

AUDIO KITS

F.M. TUNER

This latest addition to our range will be in production late March '74. It is designed to offer the best possible performance allied to the ease of operation given by push button varicap tuning. We have taken great care to look after the constructors' point of view and there are no coils to wind, no RF circuits to wire and no alignment is required, in fact the whole unit can be easily completed and working in an evening as there are only 3 transistors, one IC and two ready built and aligned modules comprising the active components. We have abandoned the concept of having a tuner as large as the amplifier and this new unit has a frontal size of only 1½ in. x 4 in. It can be mounted on the side of our Bailey amplifier metalwork thus turning it into a tuner/amplifier whilst only increasing its width by 1½ in. Cost of tuner chassis (no case) is £22 for mono, £25 45 for stereo. Metal case £2 55. An extended wooden case to fit tuner and amplifier will be offered shortly.

BAILEY/BURROWS/QUILTER PRE AMP.

The best engineered kit available of the combined best of three pre-amp designs. This is the kit with no wiring to the controls, switches or inputs. A complete and sophisticated 5 input signal processing stage for any power amplifier requiring up to 1½V input for only £20 50. Front end only £10 44. Tone control only £11 41.

BAILEY 30 WATT POWER AMPS.

Our best selling power amplifier, you can't better its performance or the quality of the kit and at only £9 88 per channel, it's amazing value for money.

METALWORK, FRONT PLATES, WOODEN CASES

These are the things that convert your hobby into a cost saving professional equipment. Remember if the finished job looks decent the wife won't worry about the money you spend. Complete metalwork for Stereo Bailey 30's, preamp and power supply £5 40. Metal cover £1 60. Wooden case £4 85. Front plate £1 37.

DIGITAL MULTIMETER

Our first venture into instruments and by the way it's selling it won't be long before we're offering others. It is of course unique as it measures DC and AC volts, resistance, capacitance, period, time and frequency. Not bad for £65's worth of parts.

STUART TAPE CIRCUITS

Our printed circuits and components offer the easy way to convert any suitable quality deck into a very high quality Stereo Tape unit. Input and output levels suit Bailey pre amp. Total cost varies but around £35 is all you need. We can offer tape heads as well if you want new ones.

All above kits have fibreglass PCB's. Prices exclude VAT but P&P is included. Further information is in our lists FREE if you send us a 9 in. x 4 in. S.A.E.

REPRINTS

Post free, no VAT.
BAILEY 30W. 18p.

STUART TAPE RECORDER

3 articles under one cover 30p.
PRE AMP circuit and assembly notes 15p.

SPRING BARGAIN SALE

Of brand new components at trade prices.

Unit prices are shown, quantity prices by negotiation.	
50. BYX38,300. Mullard	26p
200. 2N3708. Texas	8p
860. 2N4058. Texas	13p
390. 2N3704. Texas	12p
780. 2N3702. Texas	12p
290. 2N3710. Texas	10p
19. CA3090Q. RCA (stereo decoder)	£4 50
30. 2N687. Texas and Hughes	16p
50. 20C6. IR	70p
30. BC182L	11p
20. OC81D. Mullard	10p
20. ACY 18. Mullard	24p
90. OAZ 235. Mullard	45p
30. 2N1613. Texas	18p
100. BC212L. Texas	13p
400. 2N377. Sylvania	15p
10. 2N696. Texas	15p
60. VS248. Varo (200piv 2A Bridge)	50p
30. 2N2906. Motorola	35p
25. MJ480. Motorola	86p
30. 2N388. SESCO	25p
Resistors	
25. CLR 1106/115. 1000Ω. WW Preset Colvern	30p
800. 1W WJW 22Ω. Plessey	08p
28. Trimpot 1k. MEC	60p
Capacitors	
50. C437A/IA4000. 4000/25. Mullard	20p
400. C428A/RF80. 80/25. Mullard	22p
20. 2500uf 70v. CCL	80p
25. C431 BR H1800. 1600/64. Mullard	77p
30. 2500uf 25v. Plessey	35p
40. C42 FRIH2000. 2000/64. Mullard	£1 80
Miscellaneous	
90. 50DN 0400 A100 Heatsink. Marston	60p
100. 10DN 0400 C1 SX Heatsink. Black anod.	48p
1. CRT DPM9-11. Mullard	£15 00
1. CRT 3A2P 31. El-el	£15 00
1. CRT 10W4A. RCA	£5 00
1. CRT 10FP4A. RCA	£5 00
2. CRT SE1470. EMI	£12 00
2. Monitor. BD851. Marconi	£5 00
20. T 502. Eagle 2 in. Vernier Dial	£1 12
300. 79/840. 3way Phono soc. Carr	05p
350. 79/844. 5way Phono soc. Carr	06p
100. SW 1587. 3 x 3PCO. Push button sw.	15p
200. 4P 3W. Rotary switch	10p
200. 6P 5W. Rotary switch	30p
1. PE Gemini FM Turner. AMC	£12 00
2. FM Turner Front end. Guest	£4 00
1. Deram loudspeaker. Decca	£12 00

Also others too numerous to mention, please send for full list.

Penylan Mill, Oswestry, Salop

Personal callers are always welcome, but please note we are closed all day Saturday

MARCONI SIGNAL GENERATOR TYPE TF-144G: Freq. 85 Kc/s-25 Mc/s in 8 ranges. Incremental: $\pm 1\%$ at 1 Mc/s. Output: continuously variable 1 microvolt to 1 volt. Output Impedance: 1 microvolt to 100 millivolts, 10 ohms 100mV - 1 volt - 52.5 ohms. Internal Modulation: 400 c/s sine wave 75% depth. External Modulation: Direct or via internal amplifier. A.C. mains 200/250V, 40-100 c/s. Consumption approx. 40 watts. Measurements 29 x 12½ x 10 in. Secondhand condition. £27 50 each, Carr. £1 50.

CT.52 MINIATURE OSCILLOSCOPE: Portable. Operates from 115V or 250V 50-60c/s; or 180V 500c/s. A small compact tropicalised instrument designed to meet requirements of radar and communication engineers and general electronic service. Measures 9 in. x 8 in. x 6½ in. Time base 10c/s-40Kc/s. Y plate sensitivity 40V per cm. Tube 2½ in. Frequency compensated amplifier up to 38dB gain. Bandwidth up to 1 Mc/s. Single sweep facilities. Complete with test leads, metal transit case. As new £27 50 each. Carr. £1.

MODULATOR UNIT: 50 watt, part of BC-640, complete with 2 x 811 valves, microphone and modulator transformers etc. £7 50 each, 75p carr.

CATHODE RAY TUBE UNIT: With 3in. tube, Type 3EG1 (CV1526) colour green, medium persistence complete with nu-metal screen, £3 50 each, post 50p.

APN-1 INDICATOR METER, 270° Movement. Ideal for making rev. counter. £1 25, post 30p.

AIRCRAFT SOLENOID UNIT S.P.S.T.: 24V, 200 Amps, £2 each, 30p post.

VARIAC TRANSFORMERS: Input 115V, output 0-135V at 2 Amps. £3 each 75p post.

RACK CABINETS: (totally enclosed) for Std. 19 in. Panels. Size 6 ft. high x 21 in. wide x 16 in. deep, with rear door. £12 each, £2 50 Carr. OR 4 ft. high x 23 in. wide x 19 in. deep, with rear door. £8 50, each, £2 Carr.

INSTRUMENT CABINETS: 19"W. x 16"H. x 16"D. £5 00 + £1 25 carr. 19"W. x 10"D. x 5"H. £2 50 + £1 00 carr.

CLASS "D" WAVEMETER NO. 1 MK. II: Crystal controlled heterodyne frequency meter covering 2-8MHz. Power supply 6V d.c. Good secondhand cond. £7 50 each. Post 60p.

ROTARY INVERTERS: TYPE PE.218E—input 24-28V d.c., 80 Amps, 4,800 rpm. Output 115V a.c. 13 Amp 400 c/s. 1 Ph. P.F.9. £17 50 each. Carr. £1 50.

REDIFON TELEPRINTER RELAY UNIT NO. 12: ZA-41196 and power supply 200-250V a.c. Polarised relay type 3SEITR. 80-0-80V 25mA. Two stabilised valves CV 286. Centre Zero Meter 10-0-10. Size 8in. x 8in. x 8in. New condition £7 50, Carr. 75p.

WESTON INDUSTRIAL THERMOMETER MODEL 221: 0-100°C. 3in. dia. scale. Accuracy 1%. Precision made coil within-coil structure. Changes in temperature cause a rotary action of the Helix turning the shaft to which the pointer is mounted. £2 80 each 30p post. Unused condition.

TS 15C/AP FLUXMETER: Used to provide qualitative measurements of flux densities between pole faces of magnets. Range 1200-9600 gauss. $\pm 2\%$. S/hand good cond. £25 + 60p post.

ALL U.K. ORDERS SUBJECT TO 10% VALUE ADDED TAX. THIS MUST BE ADDED TO THE TOTAL PRICE (including post or carriage).

If wishing to call at stores, please telephone for appointment.

W. MILLS

3-B TRULOCK ROAD, LONDON, N17 0PG
Phone: 01-808 9213 and Bedford 740605 (STD 0234).

TELEPRINTER TYPE 7B: Pageprinter 24V d.c. power supply, speed 50 bauds per min. 'as new' cond. in original packing case, £25 each; or second hand cond. (excellent order) no parts broken, £15 each. Carriage either type £2.

INSULATION TEST SET: 0-10 kV negative, earth with amplifier provision for checking ionisation. 110/230V a.c. input. S/hand good cond. £30 + £1 carr.

APN-1 ALTIMETER TX/RX: Freq. approx. 410MHz. Complete with 28V dynamotor, 3 relays, precision resistors, 11 valves. Useful breakdown for parts. £4 each + 75p carr.

ANTENNA MAST 12 ft. 3 sections with suitable base to mount on the above Mast, to extend to 42 ft. £1 50 each + 50p carr.

T.1509 TRANSMITTERS (FOR EXPORT ONLY): General-purpose HF communications transmitter for use in fixed or mobile ground stations. Hand or high speed keying. Crystal or MO control, with temperature compensated MO circuit. CW, MCW and R/T. Frequency: 1.5 to 20 Mc/s. Modulation: 100% O/p output impedance: 50 ohms. Audio input: 600 ohms. Valves: Power Amplifier 2 x 813 and Modulator 2 x 813. Power requirements 200-250 volts a.c., 50 cycles. Power out put 300 watts. Dimensions 24" x 6in. W. x 2ft. D. x 5ft. H. Weight: 800 lbs. Excellent condition, price £225 00 each.

AN/ARC-27 TRANSMITTER/RECEIVER (FOR EXPORT ONLY): Frequency 225-400 mc. 1750 channels 100 Kc apart with 18 preset channels. Modulation: am. Power output 9 watts. Receiver is superheterodyne. Max. output 2 watts. Antenna: 50 ohm impedance. Power requirements 24v d.c. Complete transmitter with operating cables, control box, headphones, microphone. Price £250 00 each secondhand, excellent condition.

POWER SUPPLY suitable for AN/ARC-27: 100 volts to 250 volts a.c. input. 24v d.c. output @ 41 amps fully smoothed. £45 00 each.

FREQUENCY COMB GENERATOR HEWLETT PACKARD TYPE 8406A: 1MHz; 10MHz; 100MHz. External Trigger. £65. Carr. £1.

CRYSTAL TEST SET TYPE 193: used for checking crystals in freq. range 3000-10,000KHz. Mains 230V 50Hz. Measures crystal current under oscillatory conditions and the equivalent resistance. Crystal freq. can be tested in conjunction with a freq. meter. £15. Carr. £1 50.

CRYSTAL TEST SET TYPE CT.554: Later version of the above model. £30. Carr. £1 50.

DELPENA RF GENERATOR TYPE E.15: 15kW at 500Hz; input 440V 3 ph. 50Hz. £275. Carr. at cost.

H.V. TRANSMITTER: 8000/8000. Output 300mA. rms. Size: 12" x 12" x 36". 230V input. £35. Carr. £3.

COPPER WIRE AERIAL: with insulators, 100ft. long. £1 50. Post 40p.

TELEPHONE CABLE: (Twin) PVC covered suitable for extension speakers, burglar alarms etc. 200 yds. per roll. £2 50 a roll. Post 50p.

DON10 CABLEWIRE: (Twin) 1,350ft. on metal reel. £5 per reel. Carr. £1.

LISTS OF EQUIPMENT AVAILABLE: MOTORS; TELEPRINTERS; AR88 SPARES; TEST EQUIPMENT ETC. Send 10p for above lists.

C. T. ELECTRONICS

semiconductors

267 ACTON LANE, LONDON W4 5DG 01-994 6275

MAIL ORDER DEPT./REGISTERED OFFICE/COMPONENT COUNTER

AC107 35p	BCY33 45p	MJE370 75p	OC77 40p	ZTX504 50p	2N2907 30p
AC125 25p	BCY34 45p	MJE371 80p	OC81 25p	ZTX531 30p	2N2926G 15p
AC126 25p	BCY38 60p	MJE520 60p	OC83 25p	ZTX550 30p	2N3053 25p
AC127 25p	BCY39 85p	MJE521 75p	OC84 25p	1N984 8p	2N3054 60p
AC128 25p	BCY55 £1.20	MJE2955 £1.95	OC139 40p	1N816 6p	2N3055 65p
AC176 25p	BCY70 22p	MJE3055 85p	OC140 25p	1N4001 7p	2N3056 60p
AC187 25p	BCY71 20p	MM1613 45p	OC170 25p	1N4002 8p	2N3232 70p
AC188 30p	BCY72 20p	MM1712 60p	OC171 25p	1N4003 9p	2N3440 40p
AD140 55p	BD121 75p	MPP102 45p	OC200 50p	1N4004 10p	2N3702 14p
AD149 65p	BD123 75p	MPP103 40p	OC201 60p	1N4005 12p	2N3703 12p
AD161 44p	BD124 75p	(2N5457) 35p	OC202 75p	1N4006 13p	2N3704 12p
AF114 25p	BD132 75p	(2N5458) 40p	OC205 80p	1N4007 14p	2N3705 12p
AF115 25p	BD153 75p	MPP105 40p	TIP29A 50p	1N4018 7p	2N3707 12p
AF116 25p	BD156 75p	(2N5459) 40p	TIP30A 60p	2N696 30p	2N3708 12p
AF117 25p	BDY11 £1.40	NKT135 35p	TIP31A 65p	2N697 25p	2N3709 14p
AF118 50p	BF152 20p	NKT222 25p	TIP32A 75p	2N698 25p	2N3771 £2.80
AF172 30p	BF194 14p	NKT401 75p	TIP33A £1.05	2N706 12p	2N3772 £3.00
BA102 30p	BF195 15p	NKT404 80p	TIP34A £1.55	2N706A 15p	2N3773 £3.40
BA112 60p	BF196 15p	NKT773 25p	TIP35A £3.35	2N708 15p	2N3819 35p
BA114 18p	BFX29 30p	NKT774 25p	TIP36A £3.65	2N930 20p	2N3820 55p
BC107 14p	BFX84 30p	OA5 25p	TIP41A 75p	2N1132 25p	2N3866 85p
BC108 14p	BFX85 30p	OA10 50p	TIP42A 95p	2N1302 20p	2N3904 22p
BC109 14p	BFX86 30p	OA47 10p	TIP29B 60p	2N1303 20p	2N3905 22p
BC109C 16p	BFX87 30p	OA70 12p	TIP31B 75p	2N1304 25p	2N4058 12p
BC147 12p	BFX88 30p	OA81 10p	TIP32B 85p	2N1305 25p	2N4059 12p
BC148 12p	BFY44 50p	OA90 10p	TIP33B £1.20	2N1306 35p	2N4060 12p
BC149 12p	BFY50 10p	OA90 10p	TIP34B £1.75	2N1307 25p	2N4061 14p
BC157 14p	BFY51 25p	OA200 10p	TIP35B £2.90	2N1309 35p	2N4126 17p
BC158 14p	BFY52 25p	OA202 10p	TIP36B £3.80	2N1613 25p	2N4286 15p
BC159 14p	BFY53 25p	OA210 35p	TIP29C 75p	2N1711 25p	2N4287 15p
BC169C 15p	BFY90 60p	OA211 35p	TIP30C 85p	2N2160 65p	2N4288 15p
BC182 13p	BSW63 60p	OC18 90p	TIP31C 90p	2N2217 25p	2N4289 15p
BC183 13p	BSW68 75p	OC19 85p	TIP32C £1.10	2N2218 30p	2N4290 15p
BC184 13p	BSY95A 12p	OC22 55p	TIP33C £1.35	2N2219 35p	2N4444 £1.90
BC212 15p	BY127 20p	OC26 63p	TIP34C £2.00	2N2222 25p	2N4871 35p
BC213 15p	BY164 60p	OC28 63p	TIP35C £3.25	2N2222A 25p	2N4871 35p
BC214 15p	IS103 15p	OC35 60p	TIP36C £4.25	2N2938 50p	2N5191 96p
BC238 14p	MJ340 50p	OC44 20p	TIS50 40p	2N2646 £1.50	2N5194 £1.10
BC239 14p	MJ481 95p	OC45 20p	ZTX107 15p	2N2846 £1.50	40360 50p
BCY30 40p	MJ2801 £1.20	OC71 17p	ZTX300 15p	2N2904 30p	40361 50p
BCY31 55p	MJ2901 £2.20	OC75 25p	ZTX500 16p	2N2905 45p	40362 55p
BCY32 95p	MJE340 50p	OC76 25p	ZTX501 20p	2N2906 25p	

DIGITAL		INTEGRATED CIRCUITS	
SN7400 28p	SN7412 42p	SN7433 70p	SN74104 £1.45
SN7401 38p	SN7413 60p	SN7437 70p	SN74105 £1.45
SN7402 28p	SN7416 40p	SN7438 65p	SN74110 50p
SN7403 28p	SN7417 40p	SN7440 35p	SN74111 80p
SN7404 40p	SN7420 20p	SN7441 75p	SN74118 £1.00
SN7405 40p	SN7422 48p	SN7442 75p	SN74119 £1.90
SN7406 40p	SN7423 52p	SN7443 £1.05	SN74121 65p
SN7407 40p	SN7425 48p	SN7445 £2.00	SN74122 £1.35
SN7408 55p	SN7427 48p	SN7446 £2.00	SN74123 £2.70
SN7409 45p	SN7428 50p	SN7447 £1.75	SN74124 £1.00
SN7410 28p	SN7430 30p	SN7448 £2.00	SN74125 £2.70
SN7411 24p	SN7432 48p	SN7450 25p	SN74126 £2.50
			SN74166 £4.00
			SN74167 £2.25
			SN74170 £4.10
			SN74174 £2.00
			SN74175 £1.35
			SN74176 £1.60
			SN74177 £1.00
			SN74180 £1.55
			SN74181 £7.00
			SN74182 £2.00
			SN74184 £2.45
			SN74185 £2.40
			SN74191 £1.95
			SN74192 £2.00
			SN74193 £2.00
			SN74194 £2.50
			SN74195 £1.85
			SN74196 £1.50
			SN74197 £1.50
			SN74198 £4.60
			SN74199 £4.60

S.C.R.	
CRS1105 40p	
CRS1110 56p	
CRS1120 60p	
CRS1140 65p	
CRS1160 90p	
CRS1110 62p	
CRS3120 62p	
CRS340 90p	
CRS7400 1.00	
CRS16/100 85p	
CRS16/200 90p	
CRS16/600 £1.60	
C106B 45p	
C106D 70p	
40669 90p	
TIC44 25p	
2N4444 90p	

TRIACS	
TXL228B 8A 400V 90p	
SC400 £1.40	
SC40E £1.65	
SC45D £1.70	
SC45E £2.42	
SC50E £2.70	
DIAC 25p	
3A 200V Rec. Diode 25p	

LOW COST OSCILLOSCOPES	
Cossor 1035. D.B.	Solartron CD643.1
1049 Mk. 3A. D.B.	CD715.2.
1049 Mk. 4. D.B.	EMI WM2.
Solartron AD557.	WM3B.
CD513.2.	WM7.
CD523 S.2.	WM8.
CD643.	WM16.
	WM18.
	WM26.

LINEAR OP. AMPS	
LM309K 5V. 1A. Voltage Reg. £2.10	
LM723C 2-37V. 150mA Voltage Reg. £1.05	
MFC4000 250mW Audio 60p	
TBA800 5 Watt Audio £1.50	
709C OP. Amp D.I.L./T099 45p	
741C Op. Amp 8/14 D.I.L./T099 55p	
748C Op. Amp D.I.L. 75p	
747C Dual Op. Amp. £1.20	
ZN414 Radio I.C. £1.25	
TAD100 Radio I.C. Inc. Filter £1.90	
CA3014 £1.55	
CA3018 £1.00	
CA3028 £1.20	
CA3036 £1.00	
CA3046 95p	
CA3048 £2.35	
CA3075 £1.60	
CA3090Q £4.85	
MC1303L £2.20	

BRIDGE RECTIFIERS	
W02 1A. 200V 38p	
BY164 1.4A. 200V 57p	
MDA352/2 6A. 100V. 80p	
ZENER DIODES	
BZY88 series 400mW. 3.3-33V. 5% 15p	
1.5 Watt range 25p	
10 Watt range 4p	
L.E.D.	
TIL209 28p	
HP5082 28p	
MA2082R 25p	
L.D.R.	
ORP 12 60p	

WAREHOUSE

20-24 BEAUMONT ROAD, W.4. SURPLUS COMPONENTS, TEST EQUIPMENT, etc., etc.

THOUSANDS OF BARGAINS

Test Equipment ★ Oscilloscopes ★ Signal Generators ★ Counters
Cabinets ★ Bridges ★ Meters ★ Transmitters ★ Receivers ★ Power Supplies ★ Laboratory Equipment ★ Galvanometers ★ Audio Equipment ★ Video Equipment ★ Meters ★ Battery Chargers
Motors ★ Etc. ★ Etc.

20 TONS OF ELECTRONIC EQUIPMENT

Resistors ★ Relays ★ Capacitors ★ Switches ★ Transformers
Meters ★ Potentiometers ★ Component Panels ★ Semiconductors
Cable ★ Values ★ Etc. ★ Etc. ★ Etc.

Regret no lists available. Personal callers only. Cash and Carry only.

AUDIO ACCESSORY SHOP

17 TURNHAM GREEN TERRACE, CHISWICK, W.4

VALVE AMPLIFIERS

5 Watt..... £12.50	50 Watt..... £36.25
15 Watt..... £24.50	150 Watt..... £75.90
30 Watt..... £29.50	500 Watt..... £124.50

TRANSISTOR AMPLIFIERS

FAL Phase 50W..... £39.93	FAL Phase 100W..... £69.95
---------------------------	----------------------------

DISCO CONSOLES

FAL Disco Mk. 2..... £82.99	FAL Power Disco..... £123.75
-----------------------------	------------------------------

HEAVY DUTY LOUDSPEAKERS

8in. + Tweeter..... £1.10	12in. x 8in. + Tweeter..... £9.00
13x8in. + Tweeter..... £7.50	15x18x8in. + Tweeter..... £7.50
12in. x Tweeter..... £9.00	

★ SPECIAL OFFER PRICE ★
Decca 8in 10 watt Hi-Fi speaker, plus matching tweeter £7.50 complete
Suitable 2 way Xover..... £1.21

DISCO LIGHTING

Sound-Light Module..... £7.90	3 Channel Sound-Light..... £22.50
Oil Wheel 6in. dia..... £5.25	Suitable 1rpm Motor..... £1.03
Strobe 4 Joule..... £25.00	Single Flash Box..... £7.50
(100W Red, Blue, Gnl., Yel.)	Triple Flash Box..... £16.25
	150W Projector plus Wheel..... £25

TEAK VENEERED SPEAKER CABINETS	
For 8x5in. Speaker Size 7 1/2 x 11 1/2 x 5 1/2..... £3.50	
8in. + Tweeter 9 1/2 x 13 1/2 x 5 1/2..... £5.00	
13x8in. 10 1/2 x 17 x 6..... £5.75	
13x8in. + Tweeter 12 x 18 1/2 x 8..... £7.50	
12in. x Tweeter 15 1/2 x 18 x 8..... £9.00	

ALSO: Audio Connecting Leads, Tape, Cassettes, Stereo Systems, Mixers, Mic. Stands, Speaker Cloth, Turntables, Plinths, Covers, etc., etc.

REXINE COVERED SPEAKER CABINETS	
Suitable for P.A. or DISCO use, takes 12in. speaker unit. Size approx. 18x18x8in. £9.00.	

SPEAKER CLOTH
Available in Black or Green; Approx. width 54in. £1.75 yd.

HEADPHONES
Type H-202 Features Mono/stereo switch, Volume controls on each channel. Freq. response 20-20,000Hz. Impedance 4-16 ohms. £4.50.

ELECTRONIC COMPONENTS BARGAIN COMPONENT PACKS

SGS EA1000 3W AMPLIFIER MODULE £2.45. Handbook 10p	Pack No. 1 500 Carbon resistors, 1/4, 1/2, 1, 2 watt.
Solidev 15W Class B Audio Amp Thick film Circuit £3.65. Handbook 15p.	2 100 Electrolytic Condensers.
TBA 8005W Audio I.C. £1.50. Data 10p.	3 250 Ceramic, Polystyrene, Silver Mica, etc., Condensers.
UA041 5W Amplifier Module £3.75	4 250 Polyester, Polycarbonate, Paper, etc., Condensers.
	5 25 Potentiometers, assorted.
	6 250 High-stab. 1%, 2%, 5% resistors.
	7 50 Assorted Tagstrips.
	8 1lb Assorted nuts, bolts, washers, spacers, etc.
	9 25 Assorted switches, rotary, lever, micro, toggle, etc.
	10 50 Preset Potentiometers.
	13 30 Unmarked OC71 Transistors.
	14 25 Unmarked 250mW, Zener Diode. 4-7V, 5-1V, 6-2V, 7-5V, 9-1V, 10V. Measured and tested. Please state voltages required.
	15 50 C.E. Diode QA47 Equiv.

★★SPECIAL OFFERS★★

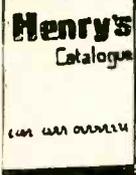
MINIATURE MAINS TRANSFORMER. PRI. 240V. SEC. 12V. 100mA. Manuf.: Hinchley Size: 36 x 45 x 40mm. F.C. 53mm. Price: 1-65p. 100-60p. ea. 1000-50p. ea. 10,000-40p. ea.	GREY ML6650. 3 x 7/0 2mm. Price: 100m.-£4.50 1000m.-£35 10,000m.-£330
3 CORE PVC INSULATED MAINS CAPACITOR 0.47mfd. 50V. MYLAR FILM CAPACITOR Size: 1in x 0.35in x 0.65in P.C. Mount. Price: 100-6.8p. ea. 1,000-5p. ea. 10,000-4.3p. ea.	
POWER SUPPLY. 12V. 6.5A. Stabilised Power Supply. Contains 18 5V, 8.5A. sec. Transformer, 4x4000µF 25V. Mullard capacitors, 2x2N3055 on 2 Redpoint heatsinks, 12A, 120V. Bridge rectifier stabilised p.c.b. circuit diagram. The parts alone are worth the asking price of £13 each inc. carriage.	
240V. A.C. SOLENOID. Reversible operation; twin coil. Size: approx. 2 1/2 x 1 1/2 x 1 1/2in. 90p each.	

All prices and details on application, phone 01-994 6275. Inspection welcome—call at warehouse.

V.A.T.
Unless otherwise stated all prices are EXCLUSIVE of V.A.T. Please add 10% to all orders. Carriage: orders under £5 + 20p. Over £5 post free.

Henry's

U.K.'s LARGEST RANGE OF ELECTRONIC COMPONENTS AND EQUIPMENT AT BARGAIN PRICES
 Latest Catalogue price 55p post paid. Complete with Discount Vouchers



Now built and used by thousands of satisfied customers. Features slim design overall size in cabinet 15 1/2" x 2 1/2" x 6-IC's, 10 transistors, stabilisers, Gardners low field transformer. Fibre Glass PC Panel, complete chassis work. Now available built and tested as well as in kit form. HIGH QUALITY AND STABILITY ARE PRE- DOMINATE FEATURES — DEVELOPED BY TEXAS ENGINEERS FOR PERFORMANCE, RELIABILITY AND EASE OF CONSTRUCTION. FACILITIES.

On/off switch indicator, headphones socket, separate treble, bass, volume and balance controls, scratch and rumble filters, mono/stereo switch, input selector; Mag. P.U., Radio Tuner, Aux. Can be altered for Mic., Tape, Tape-head, etc. Constructional details Ref. No. 21 30p. Distributed by Henry's throughout UK.

FREE — Teak cabinet with complete kit.
Kit Price £28.50 (+VAT+50p carr/ packing) or built and tested £35.00 (+VAT+50p carr/packing), as illustrated.

BUILD THE TEXAN

20 + 20WATT IC STEREO AMPLIFIER

As featured by Practical Wireless 1972

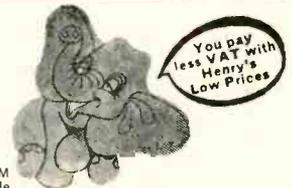


Carlsbro Reverberation Unit £44.00
 Disco anti-feedback microphone £11.95
 Colt 150 watt liquid wheel projector £23.50
 150 watt QI liquid wheel projector £50.00
 150 watt QI cassette wheel projector £50.00
 Spare Effects and Liquid cassettes large range of patterns £6.00
 6in. Liquid wheels £5.50. Various Cassettes £6.00
 Mini spot bank fitted 3 lamps £12.95
 Auto Trillite (mini with flashers) £17.00
 Bubblemaker with 1 gall. Liquid £41.15
 Mixer/Misc/Speakers/Lighting UK's largest range. FREE stock list ref. No. 18 on request.
 AKG/RESLO/DJ/CARLSBRO/EAGLE Mics, Stands, Mixers, Cabinets, Chassis and complete Speaker Systems, Megaphones, Turntables, Public Address Components.

BUILD THE NEW HENELEC

STEREO FM TUNER

A completely new high stability stereo FM tuner. Features variable capacity diode tuning, stabiliser power supply, IC Decoder, high gain low noise. IF stages, LED indicators. Tuning meter, AFC, eas to construct and use. Mains operated. Slim modern design with fibre glass PC, teak cabinet etc. Available as a kit to build or ready built. Overall size 8" x 2 1/2" x 6 1/2". Produced to give high performance with a realistic price. (Parts list and constructional details Ref. No. 5 30p.) Henry's are sole distributors UK and Europe.



Kit price
£21.00 (+VAT)
 OR BUILT AND TESTED £24.95 (+VAT)

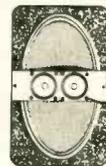
EARN YOURSELF EASY MONEY, WITH PORTABLE DISCO EQUIPMENT

DISCO MINI A complete portable disco, fitted mixer/preamp, 2 decks all facilities As above but with Slider Controls £98.50
 £118.50
 100 watt amplifier for above £49.50
SDLS100 100 watt mixer/amplifier with slider controls £69.00
R50 50 watt mixer/amplifier £49.50
R100 100 watt mixer/amplifier £57.50
DISCO AMP 100 watt mixer/amplifier £73.00
NORTH COURT
 400, 40 watt Mixer Amplifier £37.50
 800, 80 watt Mixer Amplifier £43.00
DISCO MIXER/PREAMPLIFIERS
 (OP for up to 6-100 watt amplifiers)
SDLI (rotary controls) £49.50
SDLI (slider controls) £58.50
OISOX VOX (slider controls) the complete disco preamp £72.00
DJ100 100 watt power amplifier for above £49.50
DJ300 Mk II 3 channel 3kw sound to light £36.00
DJ30L Mk III Slider Controls £45.50
DJ DISCLITE As 30L/III + Variable speed flashes £54.00
DIMAMATIC 1 kW adjustable speed auto dimmer £25.00

LOW COST HI-FI SPEAKERS

SPECIAL OFFER

EMI 13" x 8" (ull) range speakers (post 20p each or 30p pair)
 *150TC—8 ohms Twin Cone 10 watt £2.20 each or £4.00 pair.
 *450 10 watt C/o Twin Tweeters 3, 8 or 15 ohms £3.85 each.
 EW 15 watt 8 ohms C/o Tweeter £5.25 each.
 350 20 watt C/o Tweeters 8 or 15 ohms £7.80 ea.
 * Polished wood cabinet £4.60 post 35p.
SPEAKER KITS (carr. etc. 35p)
 20-2 8" 30 watt £24.50 pair
 20-3 40 watt £35.95 pair
 LINTON 2 20 watt £18.30 pair
 GLENDALE 3 30 watt £32.95 pair
 DOVEDALE 3 30 watt £51.50 pair
 KEF KK2 £20.40 each
 KEF KK3 £32.00 each



MINIATURE AMPLIFIERS

AMPLIFIERS (carr. etc. 20p).

4-300, 0.3 watt 9 volt £1.75
 104, 1 watt 9 volt £3.10
 304, 3 watt 9 volt £2.95
 555, 3 watt 12 volt £4.10
 E1208, 5 watt 12 volt £5.10
 608, 10 watt 24 volt £4.95
 410, 10 watt 28 volt £4.95
 E1206, 30 watt 45 volt £9.75
 E1210, 2 1/2 + 2 1/2 watts 12 volt £7.75
 RE500, 5 watt IC mains operated Amplifier with controls £6.30
 SAC14, 7 + 7 watt Stereo with controls £11.75
 SAC13, 15 + 15 watt Stereo with controls £14.95
PROJECT 805 KIT £19.95
PROJECT 805 £26.95
 SP40-5 2Z40/Stereo 80/P25 £25.00
 SP40-6 2Z40/Stereo 80/P25 £27.75
 SP60 2Z60/Stereo 80/P28 £30.45



POWER SUPPLIES FOR EVERY PURPOSE

PURPOSE

(All cased unless stated chassis)

470C 6 7/8/9 volt 300 MA (includes Multi-Adaptor for Tape Recorders, etc.) £2.15 post 20p
 Car Lighter Voltage Adaptors 300mA (State voltage 6v, 7iv, 9v) £1.95 ea. post 25p
 SC202 3/6/7 1/2 volt 400mA £3.65 carr. 30p
 HC244R Stabilised version £4.90 carr. 30p
 P500 9 volt 500mA £3.20 post 20p
 P11 24 volt 500mA (chassis) £2.90 post 20p
 P15 26/28 volt 1 amp (chassis) £2.90 post 20p
 P1060 12v 1 amp (chassis) £4.50 post 20p
 P1081 45v 0.9 amp (chassis) £7.50 post 20p
 P12 4 1/2 volt 0.4-1 amp £7.15 post 30p
 SE101A 3 1/2/3/12 volt 1 amp (Stab.) £12.50 post 25p
 RP164 6 7/8/9/12 1 amp (Stab.) £12.95 post 30p



TEST EQUIPMENT MULTIMETERS

(carr. etc. 30p)

111-2 20K/Volt Simline £5.95
 20K/Volt Simline deluxe with case £6.75
 TLH33D 2K/Volt Robust with case £7.50
 U437 10K/Volt Steel case, AC up to 40KHz £4.95
 U4324 20K/Volt with AC current ranges £8.00
 AF105 50K/Volt £11.95
 U4313 20K/Volt AC current, Steel case £10.50
 U4341 Plus Built in transistor tester £10.50
 Model 500 30K/Volt £9.95



OTHER EQUIPMENT

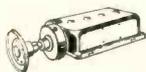
SE250B Pocket Signal Injector 2.10 carr. 15p
 SE500 Pocket Signal Tracer 1.70 carr. 15p
 TE15 Grid Dip meter 440kHz-280MHz 15-00 carr. 30p
 AC Millivoltmeter £18.30 pair
 TE40 1-2MHz 18.95 carr. 35p
 TE65 28 Range valve voltmeter 19.95 carr. 40p
 TE20D 120kHz-500Hz RF Generator 17.95 carr. 40p
 TE22D 20Hz-200KHz Audio Generator 18.95 carr. 40p
 SE350A Deluxe Signal Tracer 12.50 carr. 20p
 SE400 Volts/ohms/R-C sub./RF field/RF gen. 14.75 carr. 20p

NEW SINCLAIR PROJECT 80

Stereo Pre-Amplifier £11.95
 Audio Filter Unit £6.95
 Z40-15 watt Amplifier £5.45
 Z60-25 watt Amplifier £6.95
 P25 Mod. for 1 on 2 Z40 £4.98
 P25 Mod. (S Tab) 1 on 2 Z40 £7.98
 P25 Mod. (S Tab) 1 on 2 Z60 £7.98
 TRANSFORMER FOR P28 £3.95
 NEW FM TUNER £11.95
STEREO DECODER £7.45
 All items post paid.

SPECIAL PURCHASES

UHF TV TUNERS CHANNELS 21 TO 64
 Brand new transistorised geared tuners for 625 line Receiver IF output. £2.50 post 20p.



FIBRE OPTICS

0-01 diam. Mono Filament £1.50 per 25 metre reel.
 0-13 diam. 64 Fibres Sheathed. £1.00 per metre.
 SPRAY-15mm diam. Mares Tails. £9.50

All types offered subject to availability. Price correct at time of proof. E & O.E. Subject to change without notice. 10% VAT to be added to all orders. Export Supplied.

GARRARD BATTERY TAPE DECK

GARRARD 2 speed 9 volt tape decks. Fitted record/play and oscillator/erase heads. Wind and rewind controls. Takes up to 4" spools. Brand new complete with head circuits. £9.50 carr. 30p.



TOP QUALITY SLIDER CONTROLS

60mm stroke high quality controls complete with knobs (post, etc., 15p any quantity).
Singles Log and Lin 5K, 10K, 22K, 50K, 100K, 250K, 500K, 1 Meg, 45p each.
Ganged Log and Lin 10K, 22K, 50K, 100K, 250K, 50p each. (Quantity discounts available). Complete with knobs.

MARRIOT TAPE HEADS

4 TRACK MONO or 2 TRACK STEREO. '17' High Impedance £2.00. '18' Medium Impedance £2.00. R730/E73 2 track mono Record/Erase, low imp. 75p pair. Erase Heads for '17' and '18' 75p. '63' 2 track mono, Hi imp. £1.75. '43' Erase Head for '63' 75p. (Post etc., 15p any quantity.)

NEW REVOLUTIONARY SUPER TESTER 680R

The complete testing system

Volts AC=11 ranges from 2V to 2500V
 Volts DC=13 ranges from 100mV to 2KV
 Amp DC=12 ranges from 500A to 10A
 Amp AC=10 ranges from 200uA to 5A
 Ohms=6 ranges from one tenth of Ohm to 100MQ
 Reactance=1 range from 0 to 10MQ
 Capacity=6 ranges from 0 to 500pF and from 0 to 0.5uF and from 0 to 50.000pF
 Frequency=2 ranges from 0 to 500Hz and from 0 to 5000Hz
 Output Voltage=9 ranges 10V to 2500V
 Decibels=10 ranges from -24 to +70dB



PRICE
£18.50

ACCESSORIES

Transistor tester 11.00
 Electronic voltmeter 18.00
 Amclamp 11.95
 Temperature probe 11.95
 Guess meter 11.95
 Signal injector 5.95
 Phase Sequence 5.95
 EHT Probe 5.95
 Shunts 25/50/100A 4.50 each

EXCLUSIVE DECCA KELLY SPEAKERS

12 watt speaker Tweeter systems, Bin Bass/Midrobe and Melnex Domed HF radiator plus crossover £12.50 per pair of systems (carr. pkg. 40p) or built into veneered cabinets, size 18x12x6 1/2in. £19.50 pair (carr. 21).

Electronics Supplies

Specialists in electronics for more than 30 years. Trade and industry supplies—every type of component and equipment.

TRANSISTORS/ SEMICONDUCTORS

U.K.'s largest range for every application. Small quantity discounts. Also Trade, Export and Industrial enquiries invited. Latest stock list (Ref. No. 36) includes valves on request.

HI-FI TAPE EQUIPMENT



U.K.'s largest range with discount and demonstrations for callers. Latest stock lists on request (Ref. No. 17) Phone 01-402-4736 for Barclay/Access Card Direct orders and latest prices.

Henry's RADIO LIMITED

EDGWARE ROAD, LONDON W2

404-406 Electronic Components and Equipment 01-402 8381
 309 PA - Disco - Lighting High Power Sound 01-723 6963
 303 Bargains Store (Callers only)
 Home and Car Entertainment Centres. London and branches now open.
 120 Shaftesbury Avenue, London W1 01-437 9692
 104 Burnt Oak Broadway, Burnt Oak, Edgware 01-952 7402
 190-194 Station Road, Harrow, Middlesex 01-663 7788/9
 354-356 Edgware Road, London W2 01-402 5854/4736

All mail to
 303 Edgware Road,
 London W2 1BW
 All stores open 9 am to
 6 pm six days a week
 Hi-Fi - Tape Equipment
 Discount Stock List
 Free at all stores

Henry's U.K.'s LARGEST RANGE OF BRANDED AND GUARANTEED DEVICES. (Quantity Discounts 10% 12+, 15% 25+, 20% 100+) (Any one type except where quantity discounts show) Min. Order £1.00 please, Post10p.

INTEGRATED CIRCUITS

VERY IMPORTANT. ONLY branded I.C.'s are to the FULL manufacturers specifications. ALL others are not. Henry's sell only branded Integrated Circuits... From TEXAS... I.T.T... FAIRCHILD... SIGNETICS... So why buy alternatives or under spec. devices when you can purchase the genuine article from us—ex stock... need we say more!



Type	1/11	12/29	30/99	Type	1/11	12/29	30/99	Type	1/11	12/29	30/99
	£p	£p	£p		£p	£p	£p		£p	£p	£p
SN7400N	0.20	0.18	0.16	SN7448N	1.50	1.27	1.13	SN74141N	1.00	0.90	0.80
SN7401N	0.20	0.18	0.16	SN7450N	0.20	0.18	0.16	SN74142N	2.88	2.88	2.52
SN7402N	0.20	0.18	0.16	SN7461N	0.20	0.18	0.16	SN74143N	1.44	1.44	1.26
SN7403N	0.20	0.18	0.16	SN7453N	0.20	0.18	0.16	SN74147N	2.30	2.30	1.83
SN7403AN	0.38	0.38	0.33	SN7454N	0.20	0.18	0.16	SN74148N	2.01	2.01	1.63
SN7404N	0.24	0.21	0.18	SN7460N	0.20	0.18	0.16	SN74150N	2.30	2.30	2.01
SN7405N	0.38	0.33	0.28	SN7470N	0.33	0.30	0.27	SN74151N	1.15	1.15	1.00
SN7406N	0.44	0.44	0.38	SN7472N	0.50	0.38	0.34	SN74153N	1.09	1.09	0.95
SN7406AN	0.40	0.38	0.35	SN7473N	0.44	0.41	0.37	SN74154N	2.30	2.30	2.01
SN7407N	0.40	0.38	0.35	SN7474N	0.48	0.48	0.42	SN74155N	1.15	1.15	1.00
SN7408N	0.25	0.22	0.19	SN7475N	0.58	0.55	0.51	SN74156N	1.09	1.09	1.00
SN7409N	0.20	0.18	0.16	SN7476N	0.45	0.38	0.32	SN74157N	1.09	1.09	0.95
SN7409AN	0.30	0.27	0.25	SN7478N	0.50	0.50	0.44	SN74164N	2.01	2.01	1.78
SN7410N	0.20	0.18	0.16	SN7481N	1.25	1.10	0.95	SN74165N	1.58	1.58	1.38
SN7411N	0.25	0.23	0.21	SN7482N	0.87	0.80	0.72	SN74161N	1.58	1.58	1.38
SN7412N	0.28	0.28	0.25	SN7483N	1.20	1.10	1.00	SN74162N	1.58	1.58	1.38
SN7412AN	0.30	0.27	0.25	SN7485N	1.87	1.87	1.63	SN74163N	1.58	1.58	1.38
SN7414N	0.72	0.72	0.63	SN7486N	4.32	4.32	3.78	SN74166N	2.01	2.01	1.76
SN7416N	0.20	0.27	0.25	SN7490N	0.75	0.70	0.63	SN74167N	2.16	2.16	1.89
SN7417N	0.30	0.27	0.25	SN7491AN	1.10	1.00	0.90	SN74167N	4.10	4.10	3.59
SN7420N	0.20	0.18	0.16	SN7492N	0.75	0.70	0.63	SN74170N	2.88	2.88	2.52
SN7422N	0.28	0.28	0.25	SN7493N	0.75	0.70	0.63	SN74172N	5.76	5.76	5.84
SN7422AN	0.38	0.38	0.33	SN7494N	0.85	0.80	0.75	SN74173N	6.66	6.66	6.45
SN7423N	0.37	0.34	0.32	SN7495N	0.85	0.80	0.75	SN74174N	1.80	1.80	1.57
SN7425N	0.37	0.37	0.32	SN7496N	1.00	0.90	0.83	SN74175N	1.29	1.29	1.13
SN7426N	0.37	0.37	0.32	SN74100N	2.16	1.89	1.89	SN74176N	1.44	1.44	1.26
SN7428N	0.43	0.43	0.37	SN74104N	0.80	0.73	0.65	SN74177N	1.44	1.44	1.26
SN7430N	0.20	0.18	0.16	SN74105N	0.51	0.51	0.45	SN74181N	5.18	5.18	4.53
SN7432N	0.37	0.37	0.32	SN74107N	0.51	0.51	0.45	SN74182N	1.44	1.44	1.26
SN7433N	0.43	0.43	0.38	SN74111N	0.86	0.86	0.75	SN74184N	2.16	2.16	1.89
SN7433AN	0.57	0.57	0.50	SN74116N	2.16	2.16	1.89	SN74185AN	2.16	2.16	1.89
SN7437N	0.43	0.43	0.37	SN74181N	1.00	0.90	0.83	SN74189N	4.48	4.48	3.97
SN7438N	0.43	0.43	0.37	SN74191N	1.92	1.92	1.68	SN74190N	2.30	2.30	2.01
SN7438AN	0.57	0.57	0.50	SN74192N	1.05	1.05	0.92	SN74191N	2.30	2.30	2.01
SN7440N	0.20	0.18	0.16	SN74121N	0.57	0.57	0.50	SN74192N	2.30	2.30	2.01
SN7441N	0.85	0.79	0.73	SN74122N	0.80	0.80	0.70	SN74193N	2.30	2.30	2.01
SN7442N	1.50	1.27	1.13	SN74123N	1.44	1.44	1.26	SN74194N	1.72	1.72	1.51
SN7444N	1.10	1.27	1.13	SN74125N	0.89	0.89	0.60	SN74195N	1.44	1.44	1.26
SN7445N	2.16	2.16	1.89	SN74126N	0.69	0.69	0.60	SN74196N	1.58	1.58	1.38
SN7446N	2.16	2.16	1.89	SN74128N	0.72	0.72	0.63	SN74197N	1.58	1.58	1.38
SN7447AN	1.80	1.80	1.57	SN74136N	0.63	0.63	0.55	SN74198N	3.18	3.18	2.77
								SN74199N	2.88	2.88	2.52

LARGER QUANTITY AND O.E.M. PRICES PHONE (01) 723 3646. PRICING OF SN7400 SERIES I CALCULATED ON THE TOTAL NUMBER ORDERED REGARDLESS OF MIX. SN74... HIGH POWER... SN74... LOW POWER SERIES IN STOCK... SEND FOR LIST 35, FREE ON REQUEST. LOW PROFILE SOCKETS 14 PIN... 15p. 16 PIN... 17p. 8 PIN... 14p.

TRANSISTORS

A SELECTION FOR FULL LIST SEND FOR BOOKLET 36 TODAY.

AAZ13 10p	BC182 12p	BYZ13 35p	OC36 65p	ZTX108 10p	2N3714 1.60
AC107 35p	BC178 18p	OC164 18p	OC44 18p	ZTX300 14p	2N3771 1.75
AC128 20p	BCY39 30p	OC45 18p	OC45 18p	ZTX302 18p	2N3773 2.25
AC187 20p	BCY55 2.50	OC71 15p	OC71 15p	ZTX500 15p	2N3790 2.25
ACY17 35p	BCY70 15p	OC72 25p	OC72 25p	2G201 40p	2N3919 35p
ACY39 85p	BCV71 20p	OC77 55p	OC77 55p	2N697 15p	2N3866 75p
AD149 50p	BCV101 13p	LM3080 1.87	OC81 25p	2N935 15p	2N3903 15p
AD161 39p	BD124 80p	MAT121	OC83 25p	2N930 20p	2N4002 14p
AD192 39p	BD131 45p		OC140 65p	2N987 45p	2N4126 15p
AF117 20p	BF115 22p		OC170 25p	2N1132 25p	2N4871 35p
AF118 50p	BF180 22p	MJE340 50p	OC200 55p	2N1304 22p	2N5457 38p
AF239 44p	BFX34 25p	MJE320 65p	OC21 25p	2N1613 20p	2S001 3.00
AS27 30p	BFX88 22p		OC27 1.00	2N1671 1.00	2S026 8.90
BA115 19p	BFY20 20p	MPF105 46p	ORP12 55p	2N2147 75p	2S030 7.00
BAX13 5p	BFY51 20p	NKT217 45p	ORP60 45p	2N2160 69p	40250 45p
BC107 15p	BFY64 45p	NKT404 60p	P346A 20p	2N2926 10p	40361 40p
BC108 15p	BFY90 75p	OAS 60p	TIL209 25p	2N3053 20p	40362 40p
BC109 15p	BLV36 6.25	OA81 10p	TIP29A 49p	2N3054 45p	40408 50p
BC109 14p	BSX20 15p	OA200 8p	TIP30A 58p	2N3055 45p	40486 75p
BC113 16p	BU105 2.20	OA202 10p	TIP31A 61p	2N3440 50p	40636 1.00
BC147 12p	BY100 15p	OC26 85p	OC22 90p	2N3442 1.00	40430 85p
BC169C 14p	BY127 15p	OC28 65p	TIP42A 90p	2N3525 80p	
		OC35 55p	TI543 28p	2N3614 59p	
			V405A 25p	2N3702 11p	

TRIACS

Std. mounting with accessories

3 AMP RANGE	SC45B 200v £1.15
	SC45D 400v £1.45
	SC45E 500v £1.85
Type P.I.V. Each	15 AMP RANGE
SC35A 100v 80p	SC50A 100v £1.45
SC35B 200v 85p	SC50B 200v £1.65
SC35D 400v 90p	SC50D 400v £1.95
SC35E 500v £1.20	SC50E 500v £2.25
6 AMP RANGE	TRIACS Additional Types
SC40A 100v 90p	40430 TRIAC (T06E) 85p
SC40B 200v 95p	40669 TRIAC (Plastic) 90p
SC40D 400v £1.20	
SC40E 500v £1.50	
10 AMP RANGE	40486 TRIAC (T05) 75p
SC45A 100v £1.05	
3 Amp T043	15 Amp T048

SILICON CONTROLLED RECTIFIERS

Type	ONE AMP (T05) P.I.V.	1-11
CRS 1/105AF	50v	30p
CRS 1/10AF	100v	30p
CRS 1/120AF	200v	35p
CRS 1/140AF	400v	45p
CRS 1/160AF	600v	55p
THREE AMP (T048)		
CRS 3/105AF	50v	40p
CRS 3/10AF	100v	40p
CRS 3/20AF	200v	45p
CRS 3/40AF	400v	55p
CRS 3/60AF	600v	65p
FIVE AMP		
CRS 5/400	400v	60p
SEVEN AMP (T048)		
CRS 7/100	100v	60p
CRS 7/200	200v	67p
CRS 7/400	400v	80p
CRS 7/600	600v	95p
SIXTEEN AMP (T043)		
CRS 16/100	100v	70p
CRS 16/200	200v	75p
CRS 16/400	400v	85p
CRS 16/600	600v	£1.10

EASY TO BUILD KITS BY AMTRON - EVERYTHING SUPPLIED

Model No.		
310	Radio control receiver	2.98
303	4-channel R/C transmitter	3.95
345	Superhet R/C receiver	5.95
450	TV sweep generator	12.33
65	Simple transistor tester	1.40
115	8 watt Amplifier	3.90
120	12 watt amplifier	4.70
125	Stereo control unit	5.70
130	Mono control unit	3.60
605	Power supply for 115	4.55
610	Power supply for 120	4.55
615	Power supply for 2 x 120	5.73
230	AM/FM aerial amplifier	2.98
240	Auto parking light	5.90
275	Mic. preamplifier	6.08
570	LF generator 10Hz-1mHz	15.83
575	Sq. wave generator 20Hz-20KHz	14.63
590	SWR meter	12.83
610	Photo cell charger 1-2-12v	8.00
630	STAB Power supply 6-12v 0.25-0.1A	8.15
690	DC motor speed Gov.	2.87
700	Electronic Chaffinch	7.00
705	Windscreen wiper timer	8.80
710	Photo cell switch	10.15
780	Metal Detector (electronics only)	9.65
790	Capacitive Burglar alarm	6.85
835	Guitar preamp.	4.25
840	Delay car alarm	6.15
875	CAP. Discharge ignition for car engine (-V-Earth)	13.15
80	Scope Calibrator	2.25
255	Level indicator	6.15
255	120-160mHz VHF timer	7.70
715	Photo cell switch	7.70
795	Electronic continuity tester	4.30
860	Photo timer	13.25
371	Slide projector auto. feed control	7.15
235	Acoustic Alarm for driver	7.60
465	Quartz XTAL checker	8.75



ALL KITS OFFERED SUBJECT TO STOCK AVAILABILITY

Prices correct at time of preparation. Subject to change without notice.

EXCLUSIVE-SPECIAL OFFERS!

- MW/LW CAR RADIO - or - Earth with speakers and fixings. £6.50 carr/pack 30p.
- 8 TRACK CAR STEREO (- Earth) with speakers, in pods and fixings £12.50 carr/pack 40p.
- PORTABLE BATTERY CASSETTE TAPE PLAYER £7.25
- CAR LIGHTER PLUG AND ADAPTOR for all cassette and radio 6/7/9 volt output (state width) £1.95 each.
- ROTEL STEREOPHONES RH630 £4.50; RH700 £6.75; RH430 £3.30. ROTAL RA310 15+15watt Stereo Amplifier (LX) £52.00/£34.52
- AKAI GXC40 Stereo cassette recorder £59.95 carr/pack 50p.
- Pair Akai ADM microphones £6.95 carr/pack 20p
- WEIN W500 BATTERY/MAINS CASSETTE RECORDER £12.75
- PORTABLE CASSETTE TAPE Player - for car or carry around. £7.25 carr/pack 20p.
- HANIMAX POCKET CALCULATOR WITH KEY £33.50
- HANIMAX BC811M Memory Version £37.50
- MAINS UNIT for BC806, BC811M £2.85 (state model)
- Hanimax H101 STEREO COMPACT RECORD PLAYER 2x7 watts. Complete with speakers (List £54.50) Price £39.95 Plus free pair of stereo phones.

NEW RANGES BRIDGE RECTIFIERS

FEATURES SMALL SIZE AND LOW COST. Sizes are approximate.

250M/A QUARTER AMP	B2/05 50v	16p
	B2/10 100v	16p
	B2/20 200v	18p
	B2/40 400v	25p
	B2/60 600v	27p
	1/2 x 1/2 dia.	
1 AMP P.I.V. Pricing	Type	P.I.V. Price ea.
	B05/05 50v	20p
	B05/10 100v	22p
	B05/20 200v	23p
	B05/40 400v	25p
	B05/60 600v	27p
	1/2 x 1/2 x 1/2 dia.	
1 AMP P.I.V.	B1/05 50v	25p
	B1/10 100v	25p
	B1/20 200v	28p
	B1/50 500v	30p
	1/2 x 1/2 x 1/2 dia.	
1 AMP P.I.V.	W005 50v	29p
	W01 100v	30p
	W02 200v	32p
	W06 600v	35p

VALVES

B12H	£	FP96	£	0-80
CV31	0-45	FP77A	1-00	1-00
DAP96	0-50	EF40	0-62	PC888
DP96	0-45	EF41	0-65	PC889
DK96	0-80	EF90	0-25	PC8189
DL92	0-35	EF93	1-00	PC890
DL94	0-45	EF95	0-21	PC892
DL96	0-55	EF96	0-27	PC894
DM70	0-60	EF99	0-25	PC896
DV86	0-35	FP97	0-31	PCF200
DV87	0-30	FP92	0-40	PCF201
DV902	0-30	FP95	0-55	PCF801
ES80C701	1-08	FP183	0-38	PCF802
EL800C	0-65	FP184	0-81	PCF805
EL820C	1-15	FP1200	0-60	PCF806
EA00	0-18	FL34	0-50	PCF808
EABCS0	0-35	FL36	0-47	PCF1200
EAP42	0-55	FL41	0-55	PCF802
EB91	0-20	EL41	0-52	PCL82
EB93	0-60	EL42	0-52	PCL83
EB94	0-65	EL44	0-21	PCL84
EB99	0-40	EL85	0-44	PCL86
EBF83	0-40	EL86	0-28	PC1805
EBF99	0-27	EL90	0-31	PC1500
ECC81	0-35	EL95	0-38	PFL200
ECC82	0-25	EL90	0-70	PL36
ECC83	0-33	FL504	0-70	PL38
ECC84	0-27	EM1	0-62	PL81
ECC85	0-36	EM80	0-45	PL82
ECC86	0-80	EM84	0-35	PL83
ECC88	0-38	EM87	0-70	PL84
ECC189	0-85	EY51	0-40	PL84
ECP80	0-31	EY81	0-47	PL500
ECP82	0-35	EY86	0-40	PL504
ECP83	0-67	EY88	0-40	PL508
ECH91	0-56	EZ40	0-50	PL509
ECH42	0-70	EZ41	0-75	PL509
ECH91	0-30	EZ80	0-38	PL802
ECH83	0-40	EZ81	0-27	PY33
ECH84	0-40	GY501	0-70	PY80
ECL40	0-40	GZ34	0-80	PY81
ECL82	0-31	GZ37	0-63	PY82
ECL83	0-70	KP66	2-30	PY82
ECL86	0-40	KT88	2-90	PY83

N78	£	2-75	PY88	£	0-38	Z800U	£	2-00	6AL5W	£	0-50	6Y7M	£	0-45	J2AX7	£	0-30	35W4	£	0-40
OA2	0-40	PY500	1-00	Z801U	1-20	6AM6	0-35	6K6GT	0-70	12BA6	0-40	35Z4GT	0-55	0-45	12BE6	0-50	50C5	0-55	0-70	
OB2	0-40	PY600	0-45	Z803U	2-25	6AN8	0-60	6K7	0-40	12BH7	0-25	50C16G	1-10	0-70	12CH7	0-50	50C16G	1-10	0-70	
PAC80	0-35	PY901	0-45	Z807U	1-10	6AQ5	0-42	6K7G	0-25	12X4	0-45	75	0-45	0-75	12C8	0-45	75	0-45	0-75	
PC97	0-41	QQV03-10	1-20	1L4	0-20	6AQ5W	0-45	6K8GT	0-70	12E1	0-25	76	0-55	0-76	12E1	0-25	76	0-55	0-76	
PC900	0-48	R19	0-35	1R5	0-45	6AS6	0-50	6K25	0-70	12E1	0-25	76	0-55	0-76	12E1	0-25	76	0-55	0-76	
PC824	0-38	TT21	4-20	1R4	0-30	6AT6	0-38	6L8M	1-35	12K5	0-85	78	0-50	0-50	12K7	0-45	80	0-55	0-70	
PC825	0-40	UT5	0-85	1R5	0-45	6AU6	0-30	68A7	0-40	12K7GT	0-45	80	0-55	0-70	12K8GT	0-60	729A/B	7-00	0-70	
PC828	0-55	UT6	0-85	1T4	0-20	6AQ5	0-42	68A7GT	0-25	12K8GT	0-60	729A/B	7-00	0-70	12Q7	0-40	803	5-50	0-70	
PC889	0-45	U191	0-68	1X2A	0-60	6B7	0-55	68G7	0-40	12S7	0-40	803	5-50	0-70	12S7	0-40	803	5-50	0-70	
PC890	0-40	U191	0-68	1X2B	0-60	6B6A	0-25	68I7	0-40	1487	0-80	807	5-50	0-70	1487	0-80	807	5-50	0-70	
PC892	0-45	UAF32	0-55	3A4	0-50	6BE6	0-32	68J7GT	0-28	18A95	0-50	813	4-75	0-70	18A95	0-50	813	4-75	0-70	
PC894	0-34	UBC41	0-48	3DE	0-40	6BG6	0-70	68K7	0-45	19G3	7-00	869A	1-00	0-70	19G3	7-00	869A	1-00	0-70	
PC896	0-55	UBF89	0-35	3Q4	0-60	6B6	0-55	68L7GT	0-28	19G6	5-75	921A	4-75	0-70	19G6	5-75	921A	4-75	0-70	
PCF200	0-75	UBF89	0-40	384	0-35	6B7Q2A	0-55	68N7GT	0-45	19H4	6-25	954	0-50	0-70	19H4	6-25	954	0-50	0-70	
PCF201	0-75	UB11	0-70	3V4	0-45	6BR7	1-00	68Q7	0-45	20P4	1-00	955	0-40	0-70	20P4	1-00	955	0-40	0-70	
PCF801	0-50	UB121	0-70	5H/254M	3-00	6BW6	0-90	68V6	0-45	25L6GT	0-60	956	0-30	0-70	25L6GT	0-60	956	0-30	0-70	
PCF802	0-45	UC085	0-45	5H/255M	3-00	6B7W	0-90	68V6GT	0-45	30C15	0-90	957	0-40	0-70	30C15	0-90	957	0-40	0-70	
PCF805	0-90	UC080	0-60	6E40Y	0-75	6C4	0-30	6X4	0-40	30C16	0-90	933	0-60	0-70	6C4	0-30	6X4	0-30	0-70	
PCF806	0-65	UC142	0-70	5U4G	0-35	6C6	0-40	6X5G	0-40	30C18	0-90	933	0-60	0-70	5U4G	0-35	6C6	0-40	0-70	
PCF808	0-85	UC181	0-35	5V4G	0-45	6CH6	0-55	6X5GT	0-45	30F5	1-00	6057	0-60	0-70	UC181	0-35	5V4G	0-45	0-70	
PC1200	0-70	UCL82	0-35	5Y3GT	0-45	6CL6	0-50	6Y6G	0-75	30FL1	0-75	6060	0-60	0-70	UCL82	0-35	5Y3GT	0-45	0-70	
PC802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF805	0-90	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF806	0-65	UC142	0-70	5U4G	0-35	6C6	0-40	6X5G	0-40	30C18	0-90	933	0-60	0-70	UC142	0-70	5U4G	0-35	0-70	
PCF808	0-85	UC181	0-35	5V4G	0-45	6CH6	0-55	6X5GT	0-45	30F5	1-00	6057	0-60	0-70	UC181	0-35	5V4G	0-45	0-70	
PC1200	0-70	UCL82	0-35	5Y3GT	0-45	6CL6	0-50	6Y6G	0-75	30FL1	0-75	6060	0-60	0-70	UCL82	0-35	5Y3GT	0-45	0-70	
PC802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF805	0-90	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF806	0-65	UC142	0-70	5U4G	0-35	6C6	0-40	6X5G	0-40	30C18	0-90	933	0-60	0-70	UC142	0-70	5U4G	0-35	0-70	
PCF808	0-85	UC181	0-35	5V4G	0-45	6CH6	0-55	6X5GT	0-45	30F5	1-00	6057	0-60	0-70	UC181	0-35	5V4G	0-45	0-70	
PC1200	0-70	UCL82	0-35	5Y3GT	0-45	6CL6	0-50	6Y6G	0-75	30FL1	0-75	6060	0-60	0-70	UCL82	0-35	5Y3GT	0-45	0-70	
PC802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF805	0-90	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF806	0-65	UC142	0-70	5U4G	0-35	6C6	0-40	6X5G	0-40	30C18	0-90	933	0-60	0-70	UC142	0-70	5U4G	0-35	0-70	
PCF808	0-85	UC181	0-35	5V4G	0-45	6CH6	0-55	6X5GT	0-45	30F5	1-00	6057	0-60	0-70	UC181	0-35	5V4G	0-45	0-70	
PC1200	0-70	UCL82	0-35	5Y3GT	0-45	6CL6	0-50	6Y6G	0-75	30FL1	0-75	6060	0-60	0-70	UCL82	0-35	5Y3GT	0-45	0-70	
PC802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF805	0-90	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF806	0-65	UC142	0-70	5U4G	0-35	6C6	0-40	6X5G	0-40	30C18	0-90	933	0-60	0-70	UC142	0-70	5U4G	0-35	0-70	
PCF808	0-85	UC181	0-35	5V4G	0-45	6CH6	0-55	6X5GT	0-45	30F5	1-00	6057	0-60	0-70	UC181	0-35	5V4G	0-45	0-70	
PC1200	0-70	UCL82	0-35	5Y3GT	0-45	6CL6	0-50	6Y6G	0-75	30FL1	0-75	6060	0-60	0-70	UCL82	0-35	5Y3GT	0-45	0-70	
PC802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF805	0-90	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF806	0-65	UC142	0-70	5U4G	0-35	6C6	0-40	6X5G	0-40	30C18	0-90	933	0-60	0-70	UC142	0-70	5U4G	0-35	0-70	
PCF808	0-85	UC181	0-35	5V4G	0-45	6CH6	0-55	6X5GT	0-45	30F5	1-00	6057	0-60	0-70	UC181	0-35	5V4G	0-45	0-70	
PC1200	0-70	UCL82	0-35	5Y3GT	0-45	6CL6	0-50	6Y6G	0-75	30FL1	0-75	6060	0-60	0-70	UCL82	0-35	5Y3GT	0-45	0-70	
PC802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF802	0-45	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183	0-65	5Y4G	0-35	0-70	
PCF805	0-90	UC183	0-65	5Y4G	0-35	6D6	0-65	6Z2	0-35	30PL12	0-95	6064	0-45	0-70	UC183					

ELECTROVALUE CATALOGUE 7



NOW READY

An **A** to **Z** guide to component buying

Perhaps you have not yet had a chance to know about the latest EV Catalogue (No. 7). It is our best yet. On the index page, between "Aluminium Boxes" and "Zener Diodes", are over 200 references to contents amounting in all to thousands of items, classified, described, often illustrated, and priced. There are technical diagrams and data. At 25p, Catalogue 7 is excellent value by any standard. With the 25p Refund Voucher it costs you virtually nothing when you order £5-worth or more. Get your copy and cut out "component hunting" from now on.

25p INCLUDING 25p REFUND VOUCHER ALLOWABLE ON ORDERS £5 OR MORE LIST VALUE

★ A SELECTION FROM EV CATALOGUE 7

TRANSISTORS

Very wide range of types is shown together with grouped and tabulated specifications for each one. Outlines are illustrated, and there is a full range of supporting hardware. Also near-equivalent tables are given.

I.C.s

Here too a wide range of TTL types are shown, together with linear and special-purpose types such as touch switches, etc. Over 60 circuit and connection diagrams as well as much other useful information is included.

MINITRON DIGITAL INDICATORS

3015F Seven segment filament, compatible with standard logic modules. 0-9 and decimal point; 9mm characters in 16 lead DIL. **£1.20**
Suitable 8CD decoder driver **£1.15**
3015G showing + or - & 1 & dec. pt. **£1.20**

POLYESTER CAPACITORS C.280

Radial leads for P.C.B. mounting. Working voltage 250V d.c.
0.01, 0.015, 0.022, 0.033, 0.047 ea. **3p**
0.068, 0.1, 0.15 ea. **4p**
0.22, 5p; 0.33, 7p; 0.47, 8p; 0.68, 11p; 1.0, 14p; 1.5, 21p; 2.2, 24p

SILVERED MICA CAPACITORS

Working voltage 500V d.c.
Values in pF—2.2 to 820 in 32 stages ea. **6p**
1000, 1500 7p; 1800 8p; 2200 10p; 2700, 3600 12p;
4700, 5000 15p; 6800 20p; 8200, 10,000 28p

CERAMIC DISC

1000pF/500, 2000/500, 5000/500, 0.01mF/50, 0.02mF/50, 0.1mF/3—each 2p; 0.05mF/50V—3p

CERAMIC PLAIN

In a range of 26 values from 22 to 6800pF/50V d.c., each 2p

POTENTIOMETERS

ROTARY, CARBON TRACK. Double wipers for good contact and long working life

P.20 SINGLE linear 100ohms to 2.2megohms ea. **14p**
P.20 SINGLE log. 4.7Kohms to 2.2megohms ea. **14p**
JP.20 DUAL GANG lin. 4.7Kohms to 2.2megohms ea. **48p**
JP.20 DUAL GANG log. 4.7Kohms to 2.2megohms ea. **48p**
JP.20 DUAL GANG Log/antilog 10K, 22K, 47K, 1 megohm only ea. **48p**
JP.20 DUAL GANG antilog 10K only ea. **48p**
2A DP mains switch for any of above **14p** extra.
Decades of 10, 22 and 47 only available in ranges above.
Skeleton Carbon Presets Type PR, horizontal or vertical 6p each.

SLIDER POTENTIOMETERS

Linear or log. 10K to 1 meg. in all popular values ea. **30p**
Escutcheon plates, black, white or light grey ea. **10p**
Control knobs, blk/wht/red/yel/gln/blu/dk. grey/lt grey ea. **7p**

RESISTORS

Code	Watts	Ohms	1 to 9	10 to 99	100 up
C	1/20	82-220K	9	8	7.5
C	1/3	4.7-470K	3	1.1	0.9 nett
C	1/2	4.7-10M	1.3	1.1	0.9 nett
C	3/4	4.7-10M	1.8	1.2	0.9 nett
C	1	4.7-10M	3.2	2.5	1.9 Nett
MO	1/2	10-1M	4	3.3	2.3 nett
WW	1	0.22-9	9	9	8
WW	3	1-10K	7	7	8
WW	7	1-10K	9	9	8 nett

Codes:

C = carbon film, high stability, low noise.
MO = metal oxide, Electrofil TR5, ultra low noise.
WW = wire wound, Plessey.
Values: All E12 except C 1/2W, C 3/4W, and MO 1/2W, E12: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

Tolerances:

5% except WW 10% ± 0.05Ω and MO 1/2W 2%.
Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions of one penny on total value of resistor order.) Prices for 100 up in units of 100 only.

ZENER DIODES

Full range E24 values: 400mW: 2.7V to 36V, 14p each; 1W: 6.8V to 82V, 21p each; 1.5W: 4.7V to 75V, 48p each. Clip to increase 1.5W rating to 3 watts (type 266F), 5p.

VEROBOARD

Copper clad 0.1 matrix—2.5 x 3.75 ins. 24p; 3.75 x 3.75 ins.—27p; 2.5 x 5 ins.—27p; 3.75 x 5 ins.—30p.
Copper clad 0.15 in. matrix 2.5 x 3.75 ins.—16p; 3.75 x 3.75 ins.—27p; 2.5 x 5 ins.—27p; 3.75 x 5 ins.—33p.
Vero spot face cutter (any matrix) 43p.
0.040 pins (for 0.1 matrix) per 100—30p.
0.052 pins (for 0.15 matrix) per 100—30p.

ELECTROVALUE LTD

28, ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY TW20 0HB

Telephone Egham 3603, Telex 264475

Shop hours: 9-5.30 daily, 9-1 pm Sats.

NORTHERN BRANCH: 680, Burnage Lane, Burnage, Manchester M19 1NA

Telephone (061) 432 4945

Shop hours: Daily 9-1 and 2-5.30pm; 9-1pm Sats.

U.S.A. CUSTOMERS are invited to contact ELECTROVALUE AMERICA, P.O. Box 27, Swarthmore PA 19081.

ELECTROLYTIC CAPACITORS

Axial Lead	3V	6.3V	10V	16V	25V	40V	63V	100V
0.47	—	—	—	—	—	—	11p	8p
1.0	—	—	—	—	—	—	11p	8p
2.2	—	—	—	—	11p	—	8p	8p
4.7	—	—	—	—	11p	—	8p	8p
10	—	—	—	—	—	8p	8p	8p
22	—	—	—	—	—	8p	8p	8p
47	8p	—	8p	8p	8p	8p	10p	13p
100	9p	8p	8p	8p	8p	8p	10p	12p
220	8p	8p	8p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	18p	18p	23p	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
10,000	42p	46p	—	—	—	—	—	—

This is EV Service

DISCOUNTS

Available on all items except those shown with NETT PRICES. 10% on orders from £5 to £14.99. 15% on orders £15 and over.

FREE PACKING AND POSTAGE

in U.K. For mail orders for £2 list value and under there is an additional handling charge of 10p.

GUARANTEE OF QUALITY

All goods are sold on the understanding that they conform to manufacturers' specifications and satisfaction is guaranteed as such—no rejects, 'seconds' or sub-standard merchandise is offered for sale.
Prices quoted do not include V.A.T. for which 10% must be added to total nett value of order. Every effort is made to ensure the correctness of information and prices in this advertisement at time of going to press. Prices subject to alteration without notice.

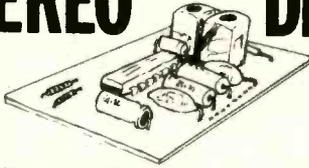
GIRO ACCOUNT No. 38/671/4002

Every effort is made to ensure the correctness of information and prices in this advertisement at time of going to press. All postal communications, mail orders, etc., to Head Office at Egham address. S.A.E. with enquiries requiring answers.

BI-PRE-PAK

AUDIO BARGAINS

STEREO DECODER £4.95



incl. P. & P. and VAT

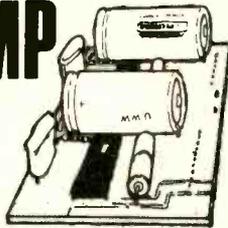
A ready built unit ready for connection to the I.F. stages of existing F.M. Radio or Tuner. A tell-tale light can be connected. The unit is a small printed circuit, no further adjustment necessary. A L.E.D. is recommended as the indicating light, suitable device available from us at 36p. Instructions included.

3 W R.M.S. I.C. AMP

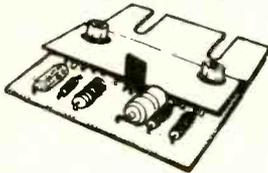
only £1.65 incl. P. & P. and VAT

Order Code I.C.A. 1

On P.C. Board with all components or 2 on one board for £2.86. Order Code I.C.A. 1/5. These amps. are supplied with a free booklet on connecting up, specifications and easy to build projects using the J.C.A. 1.



5W & 10W AMPS



5W ONLY £1.98
10W ONLY £2.49

incl. P. & P. and VAT.

These matchbox size amplifiers have an exceptionally good tone and quality for the price. They are only 2 1/2" x 1 1/2". The 5W amp will run from a 12V car battery making it very suitable for portable voice reinforcement such as public functions. Two amplifiers are ideal for stereo. Complete connection details and treble, bass, volume and balance control circuit diagrams are supplied with each unit. Discounts are available for quantity orders. More details on request. **Cheapest in the U.K. Built and tested.**

Now available for 5 & 10W AMPS

Pre-assembled printed circuit boards 2" x 3" available in stereo only, will fit .15 edge connector.
Stereo Pre-Amp 1 (Pre 1). This unit is for use with low gain crystal or ceramic pick up cartridges. £1.21.
Stereo Pre-Amp 2 (Pre 2). This unit is for use with magnetic pick-up cartridges. £1.69.
Stereo Tone Control (STC). This unit is an active tone control board and when used with the right potentiometers will give bass and treble boost and cut. £1.21.
Instruction leaflet supplied with all units. Post and Packing and VAT included in Prices.

I enclose £ for

..... 8 Tracks/..... 3W Amps/..... 5W Amps

..... 10W Amps/..... Stereo Pre-Amps 1

..... Stereo Pre-Amps 2 Stereo Tone Controls

(Please insert quantities and delete those not applicable)

Name

Address

BI-PRE-PAK Dept B 222/224 WEST ROAD,
WESTCLIFF ON SEA, ESSEX S50 9DF.
Co. Regn. No. 820919 TELEPHONE: SOUTHEND (0702) 46344.

Trannies

4 Bush House
Bush Fair, Harlow
Essex

- * PRICES INCLUSIVE OF V.A.T.
- * Retail Shop open 9 to 5.30 Mon to Sat.
- * Post & Package 10p.
- * 1974 Catalogue 12p.
- * Tel. Harlow 37739.

74 Series TTL (National Semiconductors and I.T.T.)

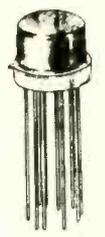
LOW PRICES, HIGH QUALITY

No's	1+	25+	100 plus	No's	1+	25+	100 plus
7400	20p	18p	14p	7447	£1.48	£1.37	£1.28
7401	20p	18p	14p	7448	£1.98	£1.81	£1.70
7402	20p	18p	14p	7450	20p	16p	12p
7403	20p	18p	14p	7451	20p	19p	14p
7404	21p	19p	14p	7452	20p	19p	14p
7405	21p	19p	14p	7454	20p	18p	14p
7406	54p	49p	33p	7460	20p	18p	14p
7407	54p	49p	33p	7472	33p	30p	22p
7408	29p	24p	17p	7473	46p	42p	30p
7409	29p	24p	17p	7474	44p	40p	30p
7410	20p	18p	14p	7475	63p	57p	42p
7411	23p	21p	16p	7476	55p	51p	36p
7412	40p	33p	24p	7480	£1.10	99p	70p
7413	31p	29p	21p	7481	£1.37	£1.26	£1.15
7416	49p	47p	33p	7482	£1.10	99p	70p
7417	57p	53p	38p	7484	£1.32	£1.29	£1.18
7420	20p	18p	14p	7485	£2.75	£2.64	£2.50
7422	60p	58p	42p	7486	49p	42p	30p
7423	60p	58p	42p	7489	£4.95	£4.29	£3.94
7425	60p	53p	39p	7490	82p	71p	50p
7426	35p	31p	22p	7492	84p	65p	45p
7427	55p	51p	36p	7493	82p	66p	45p
7428	85p	79p	58p	7494	£1.04	93p	70p
7430	20p	18p	14p	7495	£1.14	£1.03	£0.92
7432	42p	33p	24p	7496	£1.25	£1.15	£1.04
7433	97p	91p	65p	74100	£2.75	£2.58	£2.30
7437	77p	74p	54p	74104	£1.18	£1.14	£1.03
7438	77p	74p	54p	74105	£1.18	£1.14	£1.03
7440	20p	18p	14p	74107	48p	45p	30p
7441	81p	78p	57p	74110	67p	65p	45p
7442	80p	78p	57p	74111	£1.52	£1.40	£1.26
7443	£1.40	£1.32	£1.10	74118	£1.10	80p	60p
7444	£1.57	£1.52	£1.41	74119	£1.64	£1.54	£1.40
7445	£2.31	£2.18	£1.71	74121	47p	42p	30p
7446	£2.31	£2.18	£1.70	74122	£1.70	£1.53	£1.38



Linear Integrated Circuits

301 DIL	50p
301 TO99	55p
301 8 Pin DIL	46p
301A DIL	69p
301A TO99	69p
301A 8 Pin DIL	69p
308 TO99	£6.55
308A TO99	£6.40
709C DIL	38p
709C TO99	36p
723A DIL	89p
723P TO99	89p
741C 8 Pin DIL	36p
741C 14 Pin DIL	38p
741C TO99	38p
747C DIL	46p
748C DIL	39p
748C TO99	41p



Electrolytic Capacitors

4 VOLT	16 VOLT	40 VOLT
47µF 6p	15µF 6p	100µF 6p
100µF 6p	33µF 6p	100µF 9p
220µF 6p	150µF 6p	68µF 10p
330µF 6p	150µF 8p	220µF 11p
1000µF 13p	220µF 9p	470µF 19p
4700µF 29p	680µF 17p	680µF 25p
	1000µF 17p	1000µF 25p
	1500µF 25p	2200µF 44p
	2000µF 43p	

Resistors

1/2 watt 5%	100 plus
carbon	1p 0-7p
1/2 watt 5%	1p 0-7p
carbon	1p 0-7p
1 watt 10%	2p 2p
carbon	2p 2p
Range	10
ohms to 4.7	
megohms.	
1 watt m/o	
carbon	3p 2-4p
Range	10
ohms to 1	
megohms.	

Vereoboard

0-15	0-1
mat-	mat-
17p	17p
22p	22p
22p	24p
22p	24p
28p	28p
28p	28p
60p	79p
81p	£1.05
Pin insertion	
tool	82p
Spot	
face	
cutter	52p 52p
Pin	36p
pins	42p 42p
20p	20p

VOLUME CONTROLS

Potentiometers	
Carbon track 500Ω to	
22MΩ. Log or Linear.	
Single 13p. Dual gang	
(stereo) 44p. Single	
type with D.P. switch	
13p extra.	

Transistor/ Diodes/ Thyristors

AC126	15p	DIODES	
AC127	15p	1N4001	5p
AC128	15p	1N4002	5p
AC187	26p	1N4003	6p
AC187	16p	1N4148	4p
AC188	25p	OA90	8p
AC188	16p	OA91	8p
AD140	49p		
AD149	49p		
AD161	42p		
AD162	42p		
AF114	16p		
AF115	16p		
AF116	16p		
AF117	16p		
BC107	12p		
BC108	12p		
BC109	13p		
BC147	12p		
BC148	12p		
BC149	13p		
BF194	16p		
BF195	18p		
BFY50	19p		
BFY51	20p		
BFY52	20p		
OC25	40p	THY-	
OC28	55p	RISTORS	
OC35	49p	1 amp	
OC36	54p	50v	28p
OC37	15p	100v	30p
2N3053	26p	400v	38p
2N3054	55p	3 amp	
2N3055	49p	50v	44p
2N3819	28p	100v	50p
40636	86p	400v	66p

Mullard Polyester Capacitors

C280 SERIES
250V P.C. mounting: 0-01µF, 0-015, 0-022 3ip, 0-033, 0-047, 0-068 4p, 0-1 4ip, 0-15, 0-22 5ip, 0-33 7p, 0-47 9ip, 0-68 12p, 1µF 14p, 1.5µF 22p, 2.2µF 27p.

C296 SERIES
400V: 0-001µF, 0-0015, 0-0022, 0-0033, 0-0047 3p, 0-0068, 0-01, 0-015, 0-022, 0-033 3ip, 0-047, 0-068, 0-1 4ip, 0-15 6ip, 0-22 8ip, 0-33 12p, 0-47 14ip, 0-68 16p, 1µF 18p, 1.5µF 22p, 2.2µF 27p, 0-1 4p, 0-15 4p, 0-1 4ip, 0-15, 0-22 5ip, 0-33 7p, 0-47 9ip, 0-68 12p, 1µF 14ip, 1.5µF 22p, 2.2µF 24p.

£1 BARGAIN PACKS

- £1 10 Silicon NPN Power transistors (2N3055) tested/unmarked.
- £1 30 Plastic FET's unmarked/untested, similar to 2N3819.
- £1 20 TO5 transistors NPN or PNP, state which, 2 to 5 amp untested/unmarked.
- £1 20 TO18 transistors PNP like BC178, BC179 etc. untested/unmarked.
- £1 30 Plastic 2N3055 unmarked/untested TO220 case.
- £1 10 General Purpose, fully tested FET's. 500 carbon resistors 1, 1/2, 2 watt.
- £1 100 Electrolytic condensers.
- £1 250 Ceramic Polystyrene, Silver Mica etc. Condensers.
- £1 Polyester, Polycarbonate, Paper, etc. condensers.
- £1 25 Potentiometers assorted.
- £1 250 High Stab 1%, 2%, 5% resistors.
- £1 1lb Assorted nuts, bolts, washers, spacers, etc.
- £1 25 Assorted Switches, rotary, lever, micro, toggle, etc.
- £1 50 Preset Potentiometers.



We have been appointed stockist of Amtron high quality construction kits.

- UK65 Transistor tester £1.89
- UK92 Telephone Amplifier £7.91
- UK110 Stereo Amp £11.07
- UK220 Signal Injector £2.57
- UK230 AM/FM Antenna Amplifier £3.23
- UK300 Four channel Radio Control Transmitter £6.55
- UK310 Radio control Receiver £3.28
- UK325 "GCX2" channel splitting unit 1000 and 2000 Hz £7.86
- UK330 "GCX2" channel splitting unit 1500 and 2500 Hz £7.86
- UK345 Superheterodyne radio control receiver £6.55
- UK415 Resistor Box £8.39
- UK425 Capacitor Box £8.39
- UK525 VHF tuner 120 to 160MHz £12.44
- UK540 LW/MW/FM tuner £27.54
- UK790 Capacitive Burglar Alarm £7.57
- UK835 Guitar pre-amplifier £4.72

★ any 5 packs £4 ★
P/P 10p for each Pack.



INCORPORATING LASKYS RADIO AND G. W. SMITH & CO. (RADIO).

AUDIOTRONIC Model ATM1

Top value 1,000 opv pocket multi-meter. Ranges: 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance: 0/150k ohms/300A. Decibels: 10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.



OUR PRICE £2.95 P&P 15p

AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgewise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC. (2500 opv). 0-6/30/300/600V DC. (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. -10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.



OUR PRICE £3.50 P&P 15p

MODEL C1092 MULTIMETER

Features 5,000 opv jewel movement and a good selection of range functions. Edgewise ohms adjustment. Ranges: -0-3/15/150/300/1,200V AC (2,500 opv). 0-6/30/300/600V DC (5,000 opv). DC current: 0-300mA. Resistance: R x 10, R x 1,000. -10 to +16dB. Complete with battery, test leads and data booklet. Size: 120 x 73 x 28mm.



OUR PRICE £3.75 P&P 35p

MODEL U437 MULTIMETER

10,000opv. A first class instrument manufactured in USSR to the highest standards. Ranges: 2.5/10/50/250/500/1000V DC. 2.5/10/50/250/500/1000V AC. DC current 100uA/1/10/100mA/1A. Resistance 300 ohms/3/300k/3 Meg. ohms. Complete with batteries, test leads, instructions and a sturdy steel carrying case.



OUR PRICE £4.95 P&P 25p

MODEL TH12

20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. DC current 100uA/0.5/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. -20 to +50dB.



OUR PRICE £5.95 P&P 15p

U4323 MULTIMETER

20,000opv. Simple unit with audio oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/25/50/100/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: 5/50/500 ohms/5/10/100k ohms/1Meg. Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.



OUR PRICE £7.00 P&P 20p

MODEL TE300

30,000opv. Mirror scale. Overload protection. 0/0.6/3/11/60/300/1200V DC. 0/6/30/120/600/1200V AC. 0/30uA/6mA/60mA/300mA/600mA. 0/8k/80k/800k/8 Meg ohms. -20 to +63dB.



OUR PRICE £7.50 P&P 15p

ALL PRICES EXCLUDE VAT

Also see following pages

HIOKI Model 720X VOM

A versatile, accurate measuring instrument. 20,000 opv/0.5/25/100/500/1000V DC. 0/10.50/250/1000V AC. 0-50uA/250mA. 0-20k/2 Megohms.



OUR PRICE £9.97 P&P 20p

U4324 MULTIMETER

High sensitivity, overload protected. 20,000Opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistance: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: -10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.



OUR PRICE £8.00 P&P 20p

TMK MODEL TW50K

46 ranges, mirror scale. 50kV/DC 50kV/AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/15/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistance: 10k/100k/1 Meg/10 Meg ohms. -20 to +81.5dB



OUR PRICE £8.50 P&P 17p

U435 MULTIMETER

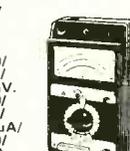
20,000opv. Overload protected. Ranges: 15mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.



OUR PRICE £8.75 P&P 20p

U4312 MULTIMETER

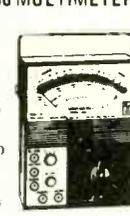
extremely sturdy instrument for general electrical use. 6670pv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC. 0/10/50/250/1000V AC. DC current: 1/5/6/60mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.



OUR PRICE £9.75 P&P 25p

KAMODEN 360 MULTIMETER

High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale. 5" overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. DC current: 0.01/0.1/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100k ohms. Decibels -20 to +62dB. Battery operated. Size 180 x 140 x 80mm. Supplied complete with test leads etc.



OUR PRICE £13.95 P&P 25p

U91 Clamp VOLT AMMETER

For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500mA. Accuracy 4%. Size 253 x 94 x 36mm. Complete with carrying case, leads and fuses.



OUR PRICE £10.50 P&P 20p

MODEL 500

30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/0.5/500mA. 12A DC. 0/6k/6 Meg/60 Megohms.



OUR PRICE £10.95 Carr. paid

HIOKI 750X VOLT-OHM MILLIAMETER

43 ranges: 0-0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0-0.3/6/15/30/60/120/300/600/1,200V AC. Current: 0-30/60uA/1.5/3/15/30/150/300 mA/6/12A. Resistance 0-3/300k/3/30Mohms. Decibels: -10 to +17dB. Output -0-3/6/15/30/60/120/300V. Accuracy +/- 3% DC, +/- 4% AC. Sensitivity: 50,000 opv/DC. 5,000 opv AC. 4 inch meter. Built in protection. Size: 57 x 102 x 153mm.



OUR PRICE £11.95 P&P 40p

KAMODEN HM7208 FET VOM

Input impedance 10 Megohms. Ranges: 0/25/1/2.5/10/50/100V DC. 0/2.5/10/50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms



OUR PRICE £14.95 P&P 30p

370WTR MULTIMETER

Features AC current ranges. 20,000opv. 0/0.25/1/5/10/50/100V DC. 0/2.5/10/50/250/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: -20 to +62dB



OUR PRICE £17.50 P&P 25p

TE40 HIGH SENSITIVITY AC VOLT METER

10 Meg input. 10 ranges: 0.001/0.03/0.1/0.3/1/3/10/30/100/300V RMS. Scps -1.2MHz. -40 to +50dB supplied complete with leads and instructions.



OUR PRICE £17.50 P&P 25p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750V AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75V DC. 0/750mV/1.5/3/7.5/15/30/75V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.



OUR PRICE £49.00 P&P 50p

U4317 MULTIMETER

High sensitivity instrument for field and laboratory work. Knife edge pointer, 36mm. mirror scale. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: -5 to +10dB. Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.



OUR PRICE £15.00 P&P 20p

Model HT100B4 MULTIMETER

Overload protected, shock proof circuits. 9.5uA Meter with high sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1.5/50/250/500/1,000 Volts DC. 2.5/10/50/250/1,000 Volts AC. DC resistance: 0-20/200k/2/20 Meg. ohms. DC current: -10/250uA/2.5/25/250 mA/10A. AC current: -0-10A. -20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.



OUR PRICE £15.00 P&P 40p

TE65 VALVE VOLTMETER

28 ranges. DC volts 1.5-1000V. AC volts 1.5-1500V. Resistance up to 1000 Megohms, 200/240V AC operation. Complete with probe and instructions.



OUR PRICE £17.50 P&P 30p

C15 PULSE OSCILLOSCOPE

For display of pulsed and periodic wave-forms in electronic circuits. VERT. AMP Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1-25 HOR. AMP. Bandwidth: 500kHz. Sensitivity at 100kHz VRMS/mm: 0.3-25 Preset triggered sweep 1-3000usec. Free running 20-200 kHz in nine ranges. Calibrator pips. 220 x 260 x 430mm. 115-230V AC



OUR PRICE £39.00 Carr. paid

RUSSIAN C116 Double Beam OSCILLOSCOPE

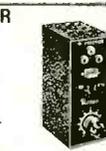
5MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec to 100 milli-sec/cm. Free running time base, 50Hz-1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.



OUR PRICE £87.00 Carr. paid

L84 TRANSISTOR TESTER

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.



OUR PRICE £4.50 P&P 20p

U4341 Multimeter & Transistor Tester

27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.2/3/30/300mA AC. Resistance: 0.06/0.2/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.



OUR PRICE £10.50 P&P 20p

L83 TRANSISTOR TESTER

Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied



OUR PRICE £3.95 P&P 20p

KAMODEN HM350 TRANSISTOR TESTER

High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.



OUR PRICE £12.50 P&P 30p

STOOTH MULTIMETER TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600/600V AC. Decibels: -5 to +10dB. 0/12/600uA/2/300mA/6/12A DC. 0/10k/1 Meg/100 Meg. -20 to +50dB. 0.01-0.2 MFD



OUR PRICE £15.95 P&P 25p

TE16A TRANSISTORISED SIGNAL GENERATOR

5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 145 x 149 x 92mm. Complete with instructions and leads



OUR PRICE £8.97 P&P 25p

MODEL TE20 RF SIGNAL GENERATOR

Six bands. 120kHz-260MHz. Dual output RF terminals. Separate variable audio output. Accuracy +/- 2%. Audio output to 8V. Power requirements: 105-25V. 220-240V AC. Size: 193 x 265 x 150mm. Complete with test leads etc.



OUR PRICE £17.50 P&P 40p

ARF 300 AF/RF SIGNAL GENERATOR

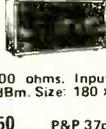
All transistorised compact fully portable. AF sine wave 18Hz to 220 kHz. Square wave 18Hz to 100kHz. Output Square/Sine wave 10V. P.P. RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads



OUR PRICE £29.95 P&P 50p

AT201 Decade ATTENUATOR

Frequency range 0-200kHz. Attenuator 0-111dB, 0.1dB steps. Impedance 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 55mm.



OUR PRICE £12.50 P&P 37p

MCA220 Automatic Voltage Stabiliser

Input 88-125V AC or 176-250V AC. Output 120V AC or 240V AC. 200V/A rating. P&P 50p.



OUR PRICE £11.97

PS100B Regulated POWER SUPPLY UNIT

Solid state. Output 6, 9 or 12V DC up to 3 Amp. Meter to monitor current. Input 220/240V AC. Size: 100 x 82 x 159mm.



OUR PRICE £11.97 P&P 25p

PS200 Regulated POWER SUPPLY UNIT

Solid state. Variable output 5-20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.



OUR PRICE £19.95 P&P 25p

SEW CLEAR PLASTIC PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES ETC.
Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

CLEAR PLASTIC MODEL SD640

Size: 85 x 64mm

50uA	£3.35
100uA	£3.30
200uA	£3.30
500uA	£3.25
50-0-500uA	£3.35
100-0-1000uA	£3.30
1mA	£3.20
5mA	£3.20
10mA	£3.20
50mA	£3.20
100mA	£3.20
500mA	£3.20
1A DC	£3.20
5A DC	£3.20
10A DC	£3.20
5V DC	£3.20
20V DC	£3.20
300V DC	£3.20
15V AC	£3.30
300V AC	£3.30
VU Meter	£3.45



*Items with asterisk are Moving Iron type, all others are Moving Coil

CLEAR PLASTIC MODEL SD830

Size: 110 x 83mm

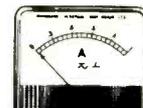
50uA	£3.75
100uA	£3.70
200uA	£3.65
500uA	£3.46
50-0-500uA	£3.75
100-0-1000uA	£3.70
1mA	£3.40
5mA	£3.40
10mA	£3.40
50mA	£3.40
100mA	£3.40
500mA	£3.40
1A DC	£3.40
5A DC	£3.40
10A DC	£3.40
5V DC	£3.40
20V DC	£3.40
300V DC	£3.40
15V AC	£3.66
300V AC	£3.66
VU Meter	£3.85



CLEAR PLASTIC MODEL 65P

Size: 86 x 78mm

50uA	£4.10
100uA	£3.75
200uA	£3.35
500uA	£3.05
50-0-500uA	£3.45
100-0-1000uA	£3.40
500-0-5000uA	£2.85
1mA	£2.85
5mA	£2.85
10mA	£2.85
50mA	£2.85
100mA	£2.85
500mA	£2.85
1A DC	£2.85
5A DC	£2.85
10A DC	£2.85
15A DC	£2.85
20A DC	£2.85
30A DC	£2.85
50A DC	£2.85
5V DC	£2.85
10V DC	£2.85
20V DC	£2.85
50V DC	£2.85
150V DC	£2.85
300V DC	£2.85
15V AC	£3.10
50V AC	£3.10
150V AC	£3.10
300V AC	£3.10
500V AC	£3.10
S Meter 1mA	£3.15
VU Meter	£4.10
1A AC	£2.85
5A AC	£2.85
10A AC	£2.85
30A AC	£2.85
50A AC	£2.85
100mA AC	£2.85
200mA AC	£2.85
500mA AC	£2.85



CLEAR PLASTIC MODEL SW100

Size: 100 x 80mm

50uA	£4.55
100uA	£4.36
500uA	£4.10
50-0-500uA	£4.35
100-0-1000uA	£4.30
1mA	£3.95
1A DC	£3.95
5A DC	£3.95
20V DC	£3.95
50V DC	£3.95
300V DC	£3.95
300V AC	£4.00
VU Meter	£4.75



CLEAR PLASTIC MODEL 45P

Size: 50 x 50mm

50uA	£3.00
100uA	£2.85
200uA	£2.75
500uA	£2.70
50-0-500uA	£2.90
100-0-1000uA	£2.75
500-0-5000uA	£2.65
1mA	£2.65
5mA	£2.65
10mA	£2.65
50mA	£2.65
100mA	£2.65
500mA	£2.65
1A DC	£2.65
5A DC	£2.65
10V DC	£2.65
20V DC	£2.65
50V DC	£2.65
300V DC	£2.65
15V AC	£2.70
30V AC	£2.65
300V AC	£2.70
S Meter 1mA	£2.75
VU Meter	£3.00
5A AC	£2.65
10A AC	£2.65
20A AC	£2.65
30A AC	£2.65



BAKELITE MODEL S80 Enlarged Window

Size: 80 x 80mm

50uA	£3.85
100uA	£3.75
200uA	£3.36
500uA	£3.05
50-0-500uA	£3.75
100-0-1000uA	£3.65
1mA	£3.00
5mA	£3.30
10mA	£3.30
50mA	£3.30
100mA	£3.30
500mA	£3.30
1A DC	£3.30
5A DC	£3.30
10V DC	£3.30
20V DC	£3.30
50V DC	£3.30
150V DC	£3.30
300V DC	£3.30
15V AC	£4.05
50V AC	£4.05
150V AC	£4.05
300V AC	£4.05
S Meter 1mA	£2.85
VU Meter	£4.05



EDGWISE MODEL PE70

Size: 90 x 34mm

50uA	£4.15
100uA	£3.95
200uA	£3.75
500uA	£3.60
50-0-500uA	£3.95
100-0-1000uA	£3.85
1mA	£3.50
300V AC	£3.50
VU Meter	£4.25



MODEL ED107 EDUCATIONAL METER

Size: 100 x 90 x 150mm including terminals

A range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working.



50uA	£7.60
100uA	£7.05
50-0-500uA	£7.05
1A DC	£6.55
5A DC	£6.55
5V DC	£6.55
10V DC	£6.55
15V DC	£6.55
20V DC	£6.55
50V DC	£6.55
300V DC	£6.55
500mA/5A DC	£6.55
5V/50V DC	£7.70
5V/15V DC	£7.70
1A/15A DC	£7.70

CLEAR PLASTIC MODEL 85P

Size: 120 x 110mm

50uA	£4.85
100uA	£4.70
200uA	£4.45
500uA	£4.40
50-0-500uA	£4.70
100-0-1000uA	£4.45
500-0-5000uA	£4.30
1mA	£4.30
1-0-1mA	£4.30
5mA	£4.30
10mA	£4.30
50mA	£4.30
100mA	£4.30
500mA	£4.30
1A DC	£4.30
5A DC	£4.30
15A DC	£4.30
30A DC	£4.30
10V DC	£4.30
20V DC	£4.30
50V DC	£4.30
150V DC	£4.30
300V DC	£4.30
15V AC	£4.35
300V AC	£4.35
S Meter 1mA	£4.30
VU Meter	£6.00
1A AC	£4.30
5A AC	£4.30
10A AC	£4.30
20A AC	£4.30
30A AC	£4.30



CLEAR PLASTIC MODEL 38P

Size: 42 x 42mm

50uA	£2.80
100uA	£2.70
200uA	£2.65
500uA	£2.50
50-0-500uA	£2.75
100-0-1000uA	£2.65
500-0-5000uA	£2.50
1mA	£2.50
1-0-1mA	£2.50
2mA	£2.50
5mA	£2.50
10mA	£2.50
20mA	£2.50
50mA	£2.50
100mA	£2.50
150mA	£2.50
200mA	£2.50
300mA	£2.50
500mA	£2.50
750mA	£2.50
1A DC	£2.50
5A DC	£2.50
10A DC	£2.50
15A DC	£2.50
20A DC	£2.50
3V DC	£2.50
10V DC	£2.50
15V DC	£2.50
20V DC	£2.50
50V DC	£2.50
100V DC	£2.50
150V DC	£2.50
20V DC	£2.50
50V DC	£2.50
100V DC	£2.50
150V DC	£2.50
300V DC	£2.50
500V DC	£2.50
S Meter 1mA	£2.65
VU Meter	£2.80



CLEAR PLASTIC MODEL 52P

Size: 60 x 60mm

50uA	£3.85
100uA	£3.30
200uA	£2.90
500uA	£2.90
50-0-500uA	£3.35
100-0-1000uA	£3.25
1mA	£2.75
5mA	£2.75
10mA	£2.75
50mA	£2.75
100mA	£2.75
500mA	£2.75
1A DC	£2.75
5A DC	£2.75
10V DC	£2.75
20V DC	£2.75
50V DC	£2.75
100V DC	£2.75
15V AC	£2.85
300V AC	£2.85
S Meter 1mA	£2.85
VU Meter	£2.85



BAKELITE MODEL 65

Size: 80 x 80mm

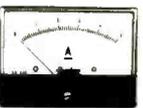
25uA	£5.05
50uA	£3.90
100uA	£3.30
500uA	£3.00
50-0-500uA	£3.35
100-0-1000uA	£3.20
500-0-5000uA	£2.85
1mA	£2.85
1-0-1mA	£2.85
10mA	£2.85
50mA	£2.85
100mA	£2.85
500mA	£2.85
1A DC	£2.85
2A DC	£2.85
5A DC	£2.85
15A DC	£2.85
30A DC	£2.85
50A DC	£2.85
10V DC	£2.85
20V DC	£2.85
50V DC	£2.85
100V DC	£2.85
150V DC	£2.85
300V DC	£2.85
30V AC	£2.85
50V AC	£2.85
150V AC	£2.85
300V AC	£2.85
500V AC	£2.85
VU Meter	£4.00
S Meter 1mA	£2.85
1A AC	£2.85
5A AC	£2.85
10A AC	£2.85
20A AC	£2.85
30A AC	£2.85
50A AC	£2.85
100mA AC	£2.85
500mA AC	£2.85
50mV DC	£3.20
100mV DC	£3.20



CLEAR PLASTIC MODEL SD460

Size: 59 x 46mm

50uA	£3.10
100uA	£3.05
200uA	£3.00
500uA	£2.80
50-0-500uA	£3.10
100-0-1000uA	£3.05
1mA	£2.85
6mA	£2.85
10mA	£2.85
50mA	£2.85
100mA	£2.85
500mA	£2.85
1A DC	£2.85
5A DC	£2.85
10A DC	£2.85
15A DC	£2.85
20A DC	£2.85
3V DC	£2.85
10V DC	£2.85
15V DC	£2.85
20V DC	£2.85
50V DC	£2.85
100V DC	£2.85
150V DC	£2.85
300V DC	£2.85
500V DC	£2.85
S Meter 1mA	£3.00
VU Meter	£3.20



POSTAGE & PACKING 15p

SUPER VALUE TOP QUALITY TRIO equipment

TRIO JR599 RECEIVER



Nine wave-bands covering 1.8-29.7 MHz, 144-146MHz and 10MHz WWV SSB, CW, AM and FM. AF output is more than 1 watt. S Meter. Squelch control. BFO. 7 variable AF and RF controls. 4-16 ohm phone jack. SSB-CW, ANL, variable BFO. S Meter and separate band spread dial. IF frequency 445kHz, audio output 1 1/2 watt. Variable RF and AF gain controls. 115/250V AC, with instructions.

Our Price £132.50 CARR. PAID

TRIO 9R59DS RECEIVER



Four bands covering 550kHz to 30 MHz continuous and electrical bandspread on 10, 15, 20, 40, and 80 mtrs. 8 valve plus 7 diode circuit. 4 to 8 ohm output and phone jack. SSB-CW, ANL, variable BFO. S Meter and separate band spread dial. IF frequency 445kHz, audio output 1 1/2 watt. Variable RF and AF gain controls. 115/250V AC, with instructions.

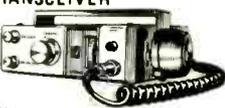
Our Price £42.50 CARR. PAID

TRIO TR2200 TRANSCEIVER

Fully transistorized portable VHF transceiver. Will transmit and receive on six channels between 144-146MHz. 1 watt transmitter. 12V DC internal or external supply. Built-in charger for Ni-Cad cells. Power/volume switch, squelch control, channel selector, mic. socket, earphone/external speaker socket. Complete with microphones and 144.48, 144.72 & 145.30 crystals. Size: 134 x 58 x 180mm.

OUR PRICE £79.50 Carr.paid

BELTEK W5400 CAR TRANSCEIVER



Solid state mobile transceiver for 12 volt DC neg. Transmits and receives on any 12 of 28 channels between 144 and 146MHz. Power output 10W and 1W switchable. Controls: On/off/volume, squelch and channel selector. Internal 3" speaker. Complete with dynamic mic. PTT switch, three sets of crystals for 144.48, 144.6 and 145MHz, mounting bracket and instructions. Size: 150 x 70 x 220mm.

OUR PRICE £75.00 P&P 50p

W



INCORPORATING LASKYS RADIO AND G. W. SMITH & CO. (RADIO).

CALL INTO YOUR NEAREST BRANCH OR ORDER WITH CONFIDENCE BY MAIL ORDER

CENTRAL LONDON

- 10 TOTTENHAM CT. RD. 01-637 2332
- 27 TOTTENHAM CT. RD. 01-636 2715
- 33 TOTTENHAM CT. RD. 01-636 2605
- 42/45 TOTTENHAM CT. RD. 01-636 0845
- 87 TOTTENHAM CT. RD. 01-580 3739
- 257/8 TOTTENHAM CT. RD. 01-580 0670
- 21 OLD COMPTON ST. 01-437 9369
- 3 LISLE ST. WC2 01-437 8204
- 34 LISLE ST. WC2 01-437 9155
- 118 EDGWARE RD. W2 01-723 9789
- 193 EDGWARE RD. W2 01-723 6211
- 207 EDGWARE RD. W2 01-723 3271
- 311 EDGWARE RD. W2 01-262 0387
- 346 EDGWARE RD. W2 01-723 4453
- 382 EDGWARE RD. W2 01-723 4194
- 109 FLEET ST. EC4 01-353 5812
- 152/3 FLEET ST. EC4 01-353 2833
- 378 HARROW RD. W9 01-286 9530

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20-20,000Hz. Complete with 6' lead and plug. **OUR PRICE £1.97**



P&P 30p

TE1018 Deluxe Mono High Impedance Headset.

Sensitive magnetic headset with soft ear pads. Impedance 2,600 ohms (600 ohms DC). Frequency response: 200-4,000Hz. **OUR PRICE £2.25**



P&P 30p

DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedance 8 ohms. 20-12,000Hz. Complete with lead and plug. **OUR PRICE £2.25**



P&P 30p

TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedance. Frequency response 25Hz-18KHz. Complete with cable and stereo jack plug. **OUR PRICE £2.60**



P&P 30p

SH80V MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedance. Frequency response 20Hz-18KHz. Complete with 10ft. coiled lead and jack plug. **OUR PRICE £4.97**



P&P 30p

BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching, communications etc. Headset impedance 16 ohms. Microphone impedance 200 ohms. **OUR PRICE £5.95**



P&P 30p

SPECIAL BARGAIN!! PHONIC 10 Two Way Speakers

Matched pair of compact bookshelf speakers of unique design. Incorporating a 2" high frequency unit & 6" woofer. 8 ohms impedance. Size: 348 x 228 x 110mm. **OUR PRICE £8.85 Pair**



P&P 50p

SPECIAL BARGAIN !! STEREOSOUND SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead. **OUR PRICE £12.95**



P&P 50p

AUDIOTRONIC CRITERION SPEAKERS

High quality three way speaker system offering a performance better than more expensive units. Teak finished with dark fronts. Frequency response: 40Hz-20KHz. 8 ohms impedance. Maximum power 20 watts. Size: 476 x 232 x 232mm. **OUR PRICE £27.50 Pr.**



P&P £1

HIGH QUALITY CONSTRUCTION KITS

WE ARE APPOINTED STOCKISTS AT ALL BRANCHES. All kits are complete with comprehensive easy to follow instructions and covered by full guarantee. Post and Packing 15p per kit.

- AE1 100mW output stage..... £1.65
- AE2 Pre-amplifier..... £1.25
- AE3 Diode receiver..... £2.00
- AE4 Flasher..... £1.09
- AE5-Astable multi-vibrator..... £1.05
- AE6 Monostable multi-vibrator..... £1.02
- AE7 RC generator..... £1.06
- AE8 Bass filter..... 99p
- AE9 Treble filter..... 99p
- AE10 CCRB filter..... 99p
- AF20 Mono amplifier..... £4.80
- AF25 Mixer..... £3.60
- AF30 Mono pre-amplifier..... £2.61
- AF35 Emitter amplifier..... £2.27
- AF80 0.5W mic. amplifier..... £4.22
- AF305 Intercom..... £9.52
- AF310 Mono amplifier..... £5.91
- AT5 Automatic light control..... £2.58
- AT25 Window wiper robot..... £5.82
- AT30 Photo cell switch unit..... £5.70
- AT50 400W triac light dimmer/speed control..... £4.80
- AT56 2,200W triac light dimmer/speed control..... £6.90
- AT69 1 channel light control..... £7.80
- AT65 3 channel light control..... £14.55
- GP304 Circuit board..... £4.94
- GP310 Stereo pre-amplifier for use with 2 x AF310..... £21.27
- GP12 Circuit board..... £11.45
- GU330 Tremolo unit..... £7.50
- HU61 Diode detector..... £3.32
- HF65 FM transmitter..... £2.70
- HF75 FM receiver..... £2.87
- HF310 FM tuner..... £15.81
- M191 VU Meter..... £24.12
- HF330 Decoder (HF310/325)..... £9.96
- HF380 lw/hf aerial amplifier..... £4.94
- HF395 broadband aerial amp..... £1.77
- LF380 Quadraphonic device..... £11.36
- M160 Multi-vibrator..... £1.71
- M170 Transistor tester..... £4.55
- M192 Stereo balance meter..... £4.97
- M1302 Transistor tester..... £8.45
- NT10 Stabilised power supply 100mA, 9V..... £6.15
- NT100 Stabilised p. supply..... £12.51
- NT305 Voltage converter..... £4.50
- NT315 Power supply 240V AC to 4.5/15V DC, 500mA..... £9.57

Amateur Electronics by Josty-Kit, the professional book for the amateur - covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for A3 to A10 above. **OUR PRICE £3.30 (No VAT)** P&P 25p plus VAT.

DT55G DIGITAL CLOCK MECHANISM

Features 24 hour alarm setting, on/off, alarm and auto alarm 'sleep' switch. Illuminated rotary dial with hours, minutes and seconds. Automatically turns off radio, TV, light etc. and with auto-switching will turn on again when required. 240V AC operation. Switch rating 250V-3 Amp. **OUR PRICE £5.95**



P&P 30p

SPECIAL BARGAIN! FERGUSON 3406 HI-FI SPEAKERS

High quality 2 way speaker systems. 25 Watts. 4-8 ohms. 40Hz-18KHz. Size: 560 x 340 x 255mm. approx. Wood grain finish with black fronts. **OUR PRICE £26.95 PR. P&P £1**



P&P £1

RUH6 Reflex Horn Speaker

Built-in driver unit. Impedance 16 ohms. Power rating 10W. Response 380-7000Hz. Size approx. 6" x 6". Weather and shock protected. **OUR PRICE £4.97**



P&P 30p

RECORD DECKS

- BSR McDONALD P&P 50p
- C114 Mini..... £3.95
- C129 Mono..... £5.50
- C137..... £7.00
- 510/TPD..... £12.55
- 610..... £11.35
- 610/TPD..... £16.65
- 710..... £22.70
- 810..... £28.30
- MP60..... £8.90
- MP60/ADC K8..... £11.50
- MP60/TPD..... £14.20
- HT70/ADC K7E..... £12.50
- HT70..... £15.95
- HT70/TPD..... £17.80
- CONNOISSEUR
- BD1 Kit..... £10.20
- BD1 Chassis..... £12.50
- BD2/SAU2/Chassis..... £25.50
- BD2/SAU2/Printh/Cover..... £32.25
- GARRARD
- 1025T Stereo..... £4.95
- 2025TC Less cartridge..... £6.35
- 2025TC/KS40A..... £6.95
- SP25 Mk3..... £9.25
- SP25 Mk3/G800..... £17.55
- SP25 Mk4..... £10.90
- SP25 Mk4/M75-6..... £13.90
- 865B..... £20.00
- SL65B..... £11.15
- SL72B..... £17.75
- SL95B..... £28.00
- GOLDRING
- G101 Mk2/P/C..... £22.50
- GL72..... £25.45
- GL72P..... £33.75
- GL75..... £32.20
- GL75P..... £41.65
- GL75..... £34.60
- GL78/P/C..... £56.25
- GL85/P/C..... £72.00

RECORD DECK PACKAGES

- BSR McDONALD P&P 75p
- 210/SC7M..... £7.95
- C129..... £9.50
- MP60/G800..... £19.50
- MP60/TPD/ADC K8..... £16.80
- MP60/M44/7..... £18.25
- HT70/TPD/ADC K7E..... £21.25
- 1010/TPD/ADC K8..... £19.25
- GARRARD
- 2025TC/9TA-HC/D..... £11.35
- SP25 Mk3/G800..... £18.15
- SP25 Mk3/M44E..... £18.25
- SP25 Mk3/M44E..... £17.80
- SP25 Mk3/M55E..... £18.80
- SP25 Mk3 Module/M75-6..... £19.45
- SP25 Mk4/G800..... £19.95
- SP25 Mk4/AMC50E (M55E)..... £21.30
- AP76/G800..... £26.75
- AP76/M44-7..... £27.50
- AP76/M44E..... £28.00
- AP76/M55E..... £28.60
- AP76/M75E..... £35.20
- AP76/M75E..... £31.20
- GOLDRING
- GL72/G800..... £35.65
- GL75/G800..... £40.90
- GL75/G800E..... £43.35
- GL78/G800..... £45.55
- GL78/G800..... £48.15
- G101/P/C/G800..... £23.70
- RANK DOMUS
- BD2000..... £43.80
- BA4000..... £53.95
- BD6000..... £67.50
- WHARFEDALE
- Linton W30 Tack..... £23.90
- Linton W30 White..... £25.10

AUDIOTRONIC LOW NOISE CASSETTES

- TYPE 10 25
- C90 £1.27 £3.00 £7.08
- C60 £2.24 £4.25 £10.00
- C120 £2.73 £5.17 £12.24

AUDIOTRONIC CRO2 CASSETTES

- TYPE 5 10 25
- CR60 £3.92 £7.72 £19.12
- CR90 £5.32 £10.46 £25.22

AUDIOTRONIC 8 TRACK CARTRIDGES

- TYPE Each 5 10 25
- 40M 85p £4.00 £7.50
- 80M £1.15 £5.40 £10.25

P&P Cassettes 3p, Cartridges 5p each OVER 10 of either POST FREE!

EMI LOUSPEAKERS

Model 350 13 x 8" with single tweeter/crossover 20-20,000Hz. 15 watts RMS. Available 8 or 15 ohms. **OUR PRICE £7.25 each** P&P 37p



P&P 30p

SINCLAIR CAMBRIDGE CALCULATOR

To build yourself. Complete kit of parts with step by step instructions to build a full specification pocket sized calculator. **OUR PRICE £24.95** P&P free



ALSO AVAILABLE READY BUILT Recommended Price £29.95

OUR PRICE £27.20 P&P 25p

Also available - **SINCLAIR EXECUTIVE** Recommended Price £39.00

OUR PRICE £35.45 P&P 25p

SINCLAIR EXECUTIVE WITH MEMORY Recommended Price £49.00

OUR PRICE £44.50 P&P 25p

SINCLAIR Project 80 Modules

- Z40 Power Amplifier..... £5.45
- Z60 Power Amplifier..... £6.95
- Stereo 80 Pre-Amplifier..... £11.95
- Active Filter Unit..... £6.95
- P25 Power Supply..... £4.98
- P26 Power Supply..... £7.98
- P28 Power Supply..... £7.98
- Transformer for P28..... £4.05

SINCLAIR Project 80 Packages

- 2 x Z40/Stereo 80/P25..... £25.00
- 2 x Z40/Stereo 80/P26..... £27.75
- 2 x Z60/Stereo 80/P28..... £30.45

POST & PACKING 35p each.

AUDIOTRONIC AHAT10 Stereo Headphone Amplifier

All silicon, transistor amplifier operates from magnetic, ceramic core transformer. Inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. INPUTS: 5mV and 100mV. OUTPUT: 50mV per channel. **OUR PRICE £8.50** P&P 20p



1021 Stereo Listening Station

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on-off side switch, stereo headphone socket. **OUR PRICE £2.25** P&P 15p



MP7 MIXER-PREAMPLIFIER

5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k. **OUR PRICE £8.97** P&P 20p



EA41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated Simply plug in microphone, guitar etc. and output to your amplifier. Volume control and depth of reverberation control. Beawalnut cabinet. 184 x 77 x 108mm. **OUR PRICE £7.50** P&P 20p



Model A1018 FM TUNER

6 transistor high quality unit - 3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88-108MHz. Powered by 9V battery. **OUR PRICE £9.65** P&P 30p



Stereo multiplex adapter £4.97 extra.

ALL PRICES EXCLUDE VAT

ESSEX

- 86 SOUTH ST. ROMFORD 70-20218

SURREY

- 1046 WHITGIFT CENTRE, CROYDON 01-681 3027
- 27 EDEN ST. KINGSTON 01-546 7845
- 33 HILL ST. RICHMOND 01-948 1441

KENT

- 53/57 CAMDEN RD., TUNBRIDGE WELLS 0892-23242

LEICESTERSHIRE

- 45 MARKET PLACE, LEICESTER 0533-537678

ALL BRANCHES OPEN FROM 9am to 6pm MON. TO SAT.

HEAD OFFICE AND MAIL ORDER DEPARTMENT

AUDIOTRONIC HOUSE, THE HYDE INDUSTRIAL ESTATE, THE HYDE, LONDON NW9 6JJ. TELEPHONE: 01-205 3735 & 5651.

MAIL ORDER SPECIALISTS

We offer a speedy and efficient service by mail order. Remember to add 10% VAT to total value of goods including carriage and packing and send cash with order to head office. TO AVOID DELAYS PLEASE PRINT NAME AND ADDRESS CLEARLY IN CAPITALS.

BARCLAYCARD & ACCESS

Holders welcome call into any branch or telephone your order to head office. CREDIT TERMS available for Personal Shoppers on sales of £50 and over

BARGAIN CENTRE

Many special clearance offers and end of stock lines at 87 TOTTENHAM COURT RD. FOR PERSONAL SHOPPERS.

EXPRT Personal exports

arranged for overseas visitors at all our branches. Goods despatched to all parts of the world through our Export Mail Order Department. Immediate attention given to orders.

CHEQUES ACCEPTED FROM PERSONAL SHOPPERS ONLY WITH BANKERS CARD.

All prices correct at 12-2-74 but subject to change.



G. F. MILWARD

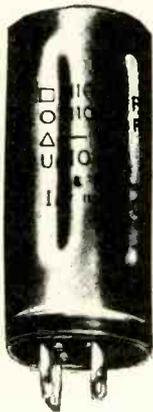
ELECTRONIC COMPONENTS

Wholesale/Retail: **369 Alum Rock Road, Birmingham B8 3DR. Tel. 021-327 2339**

Special Offer!!!—From Stock—New—Boxed—AND 60% Discount!

MULLARD ELECTROLYTIC CAPACITORS

071 and 072 Series



Type No.	Working Voltage Vdc.	Capacitance μ F	Max. Ripple Current at 50°C	Weight	Price
071 14472	10	4700	2.5 amps	1oz	15p
071 14682	10	6800	4 amps	1oz	17p
071 15332	16	3300	2.4 amps	1oz	15p
071 15472	16	4700	3.9 amps	1oz	17p
071 15682	16	6800	5.8 amps	1oz	22p
071 14113	10	11000 + 11000	10.6 amps	3oz	37p
072 14173	10	16500 + 16500	13.4 amps	4oz	49p
072 15752	16	7500 + 7500	10.5 amps	3oz	37p
072 15113	16	11000 + 11000	13.8 amps	4oz	49p
072 16502	25	5000 + 5000	9.6 amps	3oz	37p
072 16752	25	7500 + 7500	12.6 amps	4oz	49p
071 18681	63	680	2.1 amps	1oz	15p

106 and 107 Series

Type No.	Working Voltage Vdc.	Capacitance μ F	Max. Ripple Current at 50°C	Weight	Price
106 14153	10	15000	7 amps	4oz	57p
106 17103	40	10000	12 amps	7oz	94p
107 10222	100	2200	10 amps	5oz	74p

Type No.	Voltage	Capacitance	Weight	Price
102 15183	16	16000	8oz	25p
104 90063	20	39000	16oz	39p
102 16802	25	3000	7oz	25p
104 90001	45	20000	16oz	50p

A discount of 10% may be deducted from above prices on lots of 100 of any one type.

Please calculate the weight of your order and include appropriate postage.

Not over	Ordinary Parcels
1 1/2lb	20p
2lb	22p
3lb	27p
5lb	32p
8lb	37p
10lb	42p
14lb	52p
18lb	62p
22lb	72p



SMALL ELECTROLYTICS

Ref. No.	Capacity	Voltage	Price
H8/2	2-3 μ f	25v	4p
H8/2A	3-3 μ f	25v	4p
H8/3	3 μ f	50v	4p
H8/3A	4 μ f	50v	4p
H8/4	4-7 μ f	25v	4p
H8/4A	5 μ f	64v	4p
H8/5	5 μ f	10v	4p
H8/5A	5 μ f	150v	4p
H8/6A	10 μ f	10v	4p
H8/7	10 μ f	70v	4p
H8/8	16 μ f	35v	4p
H8/8A	16 μ f	16v	4p
H8/9	20 μ f	6v	2p
H8/9A	20 μ f	70v	4p
H8/10	22 μ f	50v	4p
H8/10A	22 μ f	100v	4p
H8/11	25 μ f	12v	4p
H8/12	32 μ f	15v	4p
H8/12A	30 μ f	10v	4p
H8/13A	32 μ f	50v	4p
H8/14	40 μ f	25v	5p
H8/14A	40 μ f	16v	4p
H8/15	47 μ f	50v	4p
H8/15A	40 μ f	35v	4p
H7/1	50 μ f	6v	3p
H7/1A	50 μ f	10v	4p
H7/2A	64 μ f	2.5v	2p

Ref. No.	Capacity	Voltage	Price
H7/3A	64 μ f	25v	4p
H7/4	84 μ f	15v	4p
H7/4A	64 μ f	35v	5p
H7/5	80 μ f	16v	4p
H7/7	100 μ f	25v	4p
H7/8	125 μ f	16v	5p
H7/8A	100 μ f	35v	6p
H7/9	100 μ f	63v	6p
H7/9A	125 μ f	4v	4p
H7/10	125 μ f	25v	6p
H7/10A	160 μ f	2.5v	3p
H7/11	160 μ f	25v	6p
H7/11A	150 μ f	16v	5p
H7/13A	200 μ f	25v	8p
H7/14	220 μ f	50v	10p
H7/15	220 μ f	25v	5p
H7/15A	220 μ f	35v	10p
H6/1A	250 μ f	4v	3p
H6/3A	320 μ f	2.5v	3p
H6/4	320 μ f	10v	4p
H6/4A	330 μ f	16v	5p
H6/5	330 μ f	25v	10p
H6/5A	330 μ f	35v	15p
H6/8	470 μ f	25v	10p
H6/8A	470 μ f	35v	20p
H6/9A	400 μ f	40v	20p
H6/13A	1000 μ f	25v	16p

RECTIFIERS 1N4007 1200 peak volts, 30 amps peak current, 1 amp mean current. 100 for £7.50, 1,000 £50.

UNREPEATABLE BARGAIN **BD112**

TO3-NPN DIFFUSED SILICON PLANAR EPITAXIAL. VCBO COLLECTOR TO BASE—80 VOLTS. VCEO COLLECTOR TO EMITTER—60 VOLTS. VEB0 EMITTER TO BASE—5 VOLTS. 20 WATTS—2 AMPS—30 MHz. FEATURES HIGH CURRENT GAIN OVER WIDE RANGE OF COLLECTOR CURRENT

25p!
ONLY

REMEMBER! ALL GOODS PLUS 10% V.A.T.

G. F. MILWARD, Drayton Bassett, Tamworth, Staffs. Postage (minimum) per order 15p.

NEW! NEW! NEW! NEW!

An aerosol spray providing a convenient means of producing any number of copies of a printed circuit both simply and quickly. Method: Spray copper laminate board with light sensitive spray. Cover with transparent film upon which circuit has been drawn. Expose to light. (No need to use ultra-violet.) Spray with developer, rinse and etch in normal manner. Light sensitive aerosol spray Developer and Etchant £1.00 plus postage 50p

Copper-clad Fibre-glass Board—50p sq. ft. (max. 3' X 4')

NEWER THAN NEW!!!

Fibre Glass Board pre-treated with light-sensitive lacquer enabling you to produce prototype printed circuits within five minutes.

Type	Voltage	Frequency	Price
SILICON P.N.P.			
BCY 71	45	200 MHz	12p
BFS 92	100	70 MHz	20p
BFS 95	40	70 MHz	17p
BFX 12	25	210 MHz	10p
2N 2305	60	200 MHz	15p
2N 3702	40	100 MHz	11p
2N 3703	50	100 MHz	12p

Type	Voltage	Frequency	Price
SILICON N.P.N.			
BC 108	30	150 MHz	10p
BC 109	30	150 MHz	10p
BF 179	225	125 MHz	40p
BF 180	30	625 MHz	25p
BFW 58	80	80 MHz	15p
BFX 43	30	500 MHz	20p
BFX 86	40	50 MHz	17p
BFY 53	30	50 MHz	10p
2N 697	60	40 MHz	12p
2N 709	15	900 MHz	30p
2N 718	60	60 MHz	12p
2N 753	25	250 MHz	12p
2N 744	20	300 MHz	12p
2N 1613	75	60 MHz	17p
2N 2220	60	250 MHz	15p

Type	Voltage	Frequency	Price
SILICON N.P.N.			
2N 3053	60	100 MHz	17p
2N 3707	30	200 MHz	12p
2N 5179	20	900 MHz	40p
GERMANIUM P.N.P.			
ADY 26	80	75 watts	£1
AF 124	20	75 MHz	20p
AFY 19	32	350 MHz	20p
ASZ 21	15	450 MHz	20p
GET 113	32	2 watts	10p
GET 120	32	2 watts	10p
OC 123	50	1 MHz	10p
OCF 70	Light-sensitive		20p
2N 1307	30	10 MHz	15p
2N 1309	30	15 MHz	45p
2N 443	60	150 watts	£1
HIGH FREQUENCY, POWER			
BFR 64	40	1,200 MHz	£1
BLY 89A	35	650 MHz	£5
BLY 93A	60	500 MHz	£5
BLY 218	36	1,200 MHz	£2
2N 709	15	800 MHz	15p
2N 3926	36	250 MHz	£1

Type	Voltage	Frequency	Price
MICROWAVE DEVICES			
CL 8300		Gunn effect oscillator	9.4 GHz £40
CL 8370		ditto	9.5 GHz £10
CL 8380		ditto	10.5 GHz £10
CL 8390		ditto	11.5 GHz £10
CL 8430		ditto	9.35 GHz £40
CL 8450		ditto	9.35 GHz £40
CL 8470		ditto	9.35 GHz £40
BXY 27		Varactor Diode, "S" Band, Cut-off	70 GHz £1
BXY 28		Varactor Diode, Cut-off	100 GHz £1
BXY 32		Frequency Multiplier, "X" Band	150 GHz £1
BXY 35A/C		ditto	25 GHz £1
BXY 35C/D		ditto	75 GHz £1
BXY 38C/E		ditto	100 GHz £1
BXY 39C/D		ditto	120 GHz £1
BXY 40D/E		ditto	150 GHz £1
BXY 41C/D/E		ditto	180 GHz £1
		ditto	200 GHz £1

Marshall's

42 Cricklewood Broadway, London NW2 3ET
Tel: 01-452 0161 Telex: 21492

Take advantage of our offer of Nitsuko electrolytic capacitors (before we sell them all)

Voltage	Capacitance	Dimensions DxL (MM)	Quantity	Price £ each
6v	2200MF	18.0 x 31.5	10,000	0.076
	3300MF	18.0 x 40.0	10,200	0.090
	4700MF	22.4 x 40.0	9,900	0.105
10v	33MF	6.3 x 16.0	20,000	0.020
	330MF	10.0 x 31.5	4,000	0.023
	470MF	12.5 x 31.5	5,000	0.040
	1000MF	12.5 x 31.5	37,500	0.045
	2200MF	18.0 x 40.0	18,000	0.080
	3300MF	22.4 x 40.0	20,460	0.100
16v	220MF	10.0 x 31.5	1,000	0.030
	330MF	12.5 x 31.5	2,500	0.045
	470MF	12.5 x 31.5	2,500	0.050
	2200MF	22.4 x 40.0	27,750	0.115
25v	220MF	12.5 x 31.5	2,500	0.0475
	330MF	12.5 x 31.5	47,500	0.045
	470MF	18.0 x 31.5	13,200	0.0571
	1000MF	18.0 x 40.0	7,000	0.090
35v	100MF	12.5 x 31.5	7,500	0.030
	330MF	18.0 x 31.5	5,500	0.080
	470MF	18.0 x 40.0	9,000	0.085
	1000MF	22.4 x 40.0	3,000	0.100
50v	220MF	18.0 x 31.5	2,200	0.085

1000.off prices are shown

TRAMPUS

MONEY BACK IF NOT SATISFIED

all brand new, full spec. Top grade.

Free fabulous NEW catalogue. Send SAE.

red+lg pin data source **LED's 17p!** Til209 & clip 22p
BIG 1/4 panel clip & RED LED 28p. GREEN & clip 59p
INFRA RED LED £1. ICphoto amp 44p & amp/switch 85p

Digital Display LED 1/3 0-9p.DIL. £1-69
Minitron type 0-9pDIL £1-19. SOCKETS 13p.

IC DIGITAL CLOCK CHIPS.
Texas etc with 4 displays £12. 6 displays & chip £14. pcb £1-49
Mostek date & alarm chips with 6 displays £19.

hit: All parts & case. National chip. 4 digit £20. 6x £23.

with data **integrated circuits** GAS sensor TGS308 £2
KIT £4-69 fully £8 built

741: 8pin 29p, to99 & 14pin 27p 748 33p 709 21p
710 35p 723 59p. 555 timer 79p ZN414 rx. £1-10

703 rf if 28p mc1310 & led £2-76 mc1339 £1-20 TAD100 & if £2
IAMP + REGULATOR 7805, 5 (& 7-20)V. also 12 & 15V £1-49
AUDIO AMPS: mfc4000 50p; 1 & 2W £1-19; 3W £1-29; 6W...

gates 7400 etc 16P 7413 32P 7447 £1-25
7470/72 32P 7474/76 39P 7490 63P
7492 69P 74121 49P & all others in cat. low prices.

NEW 16pin counter/driver 90/47 £2-25 DALO pcb. PEN 69p.
DIL. SOCKETS: Professional / gold P.Pins hi or lo Profile 8, 14, 16 Pin 13P

2N3055 33p. four £1. BC107, BC108, BC109 all 7p ea
IN914 3p ZENERS BZY88 8p. 1A RECTS 50v 3 1/2p 400v 5p. BRIDGE 20p
FETS: 2N3819 19p 2N3823E 20p 4416E 25p BC182/3/4 10p
BC212/3/4 11p BCY70 13p BD131/2 35p ea. BFY5123 15p TIS43 25p
2N2926 0y 7p 2N3053 15p 2N3702/3/4/5/6/7/8/9/10/11 all 9p ea
2N3904/6 14p HEATSINKS 5f/205 18f/2018 5p. TO3: 4YL 29p TV3 14p

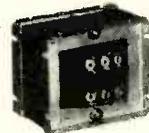
CAPACITORS 25V10, 50, 100uf 5p. DISCS 4p. PRESETS 5p. CARBON-
POTS 11P. Switch 1P. Dual 5 1/2P. ULTRASONIC TRANSDUERS £2 ea
FLUORESCENT LIGHTS, 8W, 13" 12V £2-59

Trampus electronics ADD 10% VAT TO PRICES. P & P 10P CWO.
P.O. BOX 29, BRACKNELL, BERKS.

TRANSFORMERS

SAFETY MAINS ISOLATING TRANSFORMERS Pri 120/240V Sec 120/240V Centre Tapped & Screened

Ref. No.	VA (Watts)	Weight lb oz	Size cm.	P & P
07	20	1 8	7.0 x 7.0 x 6.0	£2 30
149	60	3 12	9.9 x 7.7 x 8.6	3 45
150	100	5 8	9.9 x 8.9 x 8.6	3 79
151	200	8 0	12.1 x 9.3 x 10.2	6 45
152	250	13 12	12.1 x 11.8 x 10.2	8 41
153	350	15 0	14.0 x 10.8 x 11.8	11 20
154	500	19 8	14.0 x 13.4 x 11.8	16 25
155	750	29 0	17.2 x 14.0 x 14.0	22 10
156	1000	38 0	17.2 x 16.6 x 14.0	29 87
158	2000	60 0	21.6 x 15.3 x 18.1	49 25
159	3000	85 0	23.5 x 17.8 x 19.7	76 53
160	6000	78 0	35.0 x 20.4 x 29.3	125 89



AUTO TRANSFORMERS

Ref. No.	VA (Watts)	Weight lb oz	Size cm.	Auto Taps	P & P
113	20	0	5.8 x 5.1 x 4.5	0-115-210-240	£2 22
64	75	2 4	7.0 x 6.7 x 6.1	0-115-210-240	2 40 36
4	150	3 4	8.9 x 7.7 x 7.7	0-115-200-220-240	2 89 36
66	300	5 4	9.9 x 9.6 x 8.6	" " "	5 63 52
87	500	12 8	12.1 x 11.2 x 10.2	" " "	8 36 67
84	1000	19 8	14.0 x 13.4 x 14.3	" " "	15 19 82
93	1500	30 4	14.0 x 15.9 x 14.3	" " "	21 99 *
95	2000	32 0	17.2 x 16.6 x 14.0	" " "	28 70 *
73	3000	40 0	21.6 x 13.4 x 18.1	" " "	39 17 *

CASED AUTO TRANSFORMERS

115V 500VA cased transformer, with mains lead and two 115V outlet sockets, £9.49. P & P 67p. A 20 Watt version. £2.02. P & P 22p.

LOW VOLTAGE TRANSFORMERS

PRIMARY 200-250 VOLTS 12 ANO/OR 24 VOLT RANGE

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Windings	P & P
111	0.5 0-25	1 4	4.8 x 2.9 x 3.5	0-12V at 0-25A x 2	£2 22
213	1.0 0-5	1 4	6.1 x 5.8 x 4.8	0-12V at 0-5A x 2	1 44 22
71	2 1	1 12	7.0 x 6.4 x 6.1	0-12V at 1A x 2	1 90 22
18	4 2	2 12	8.3 x 7.7 x 7.0	0-12V at 2A x 2	2 68 36
70	6 3	3 8	8.9 x 8.0 x 7.7	0-12V at 3A x 2	3 20 42
109	8 4	5 8	9.9 x 8.9 x 8.6	0-12V at 4A x 2	3 60 52
72	10 5	6 4	9.9 x 9.6 x 8.6	0-12V at 5A x 2	4 25 52
116	12 6	6 12	9.9 x 10.2 x 8.6	0-12V at 5A x 2	5 10 52
17	16 8	8 12	12.1 x 9.9 x 10.2	0-12V at 8A x 2	6 56 52
115	20 10	18 8	14.0 x 9.6 x 11.8	0-12V at 10A x 2	8 36 52
187	30 15	15 8	14.0 x 12.1 x 11.8	0-12V at 15A x 2	15 40 82
226	60 30	32 0	17.2 x 15.3 x 14.0	0-12V at 30A x 2	28 44 *

30 VOLT RANGE

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P
112	0.5	1 4	6.1 x 5.8 x 4.8	0-12-15-20-24-30V	£1 42 22
79	1 0	2 4	7.0 x 6.7 x 6.1	" " "	1 92 36
3	2 0	3 4	8.9 x 7.7 x 7.7	" " "	2 90 36
20	3 0	4 8	9.9 x 8.3 x 8.6	" " "	3 58 42
21	4 0	6 4	9.9 x 9.6 x 8.6	" " "	4 25 52
51	5 0	6 12	12.1 x 10.2 x 11.8	" " "	5 30 52
117	6 0	8 0	12.1 x 9.3 x 10.2	" " "	6 31 52
88	8 0	12 0	12.1 x 11.8 x 10.2	" " "	8 18 67
89	10 0	13 12	14.0 x 10.2 x 11.8	" " "	10 33 67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P
102	0.5	1 12	7.0 x 6.4 x 6.1	0-19-25-33-40-50V	£1 90 30
103	1 0	2 12	8.3 x 7.4 x 7.0	" " "	2 80 36
104	2 0	5 8	9.9 x 8.9 x 8.6	" " "	3 87 42
105	3 0	6 12	9.9 x 10.2 x 8.6	" " "	5 26 52
106	4 0	10 0	12.1 x 10.5 x 10.2	" " "	6 99 52
107	6 0	12 8	14.0 x 10.2 x 11.8	" " "	10 35 67
118	8 0	18 0	14.0 x 12.7 x 11.8	" " "	13 51 97
119	10 0	25 0	17.2 x 12.7 x 14.0	" " "	16 93 *

60 VOLT RANGE

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P
124	0.5	2 4	7.0 x 6.7 x 6.1	0-24-30-40-48-60V	£1 93 36
126	1 0	3 4	8.9 x 7.7 x 7.7	" " "	2 70 36
127	2 0	6 4	9.9 x 9.6 x 8.6	" " "	4 25 42
125	3 0	8 12	12.1 x 9.9 x 10.2	" " "	6 46 52
123	4 0	13 12	12.1 x 11.8 x 10.2	" " "	8 36 67
120	6 0	18 0	14.0 x 10.2 x 11.8	" " "	9 85 67
121	8 0	25 0	14.0 x 14.7 x 11.8	" " "	12 41 82
122	10 0	25 0	17.2 x 12.7 x 14.0	" " "	13 65 **
189	12 0	29 00	17.2 x 14.0 x 14.0	" " "	20 09 **
					22 49 *

MINIATURE TRANSFORMERS WITH SCREENS

Ref. No.	MA	Weight lb oz	Size cm.	VOLTS	P & P
238	200	2 2	2.8 x 2.6 x 2.0	3-0-3	£1 31 10
212	1A 1A	1 4	6.1 x 5.8 x 4.8	0-6-0-6	1 52 22
113	100	4	3.9 x 2.6 x 2.9	0-9-0-9	1 12 10
235	330, 330	4	4.2 x 2.9 x 3.5	0-9-0-9	1 52 10
207	500, 500	1 00	6.1 x 5.4 x 4.8	0-8-9, 0-8-9	2 03 22
208	1A, 1A	1 12	7.0 x 6.4 x 6.1	0-8-9, 0-8-9	2 73 30
236	200, 200	4	4.8 x 2.9 x 3.5	0-15, 0-15	1 52 10
214	300, 300	1 4	6.1 x 5.8 x 4.8	0-20, 0-20	1 60 22
221	700 (D.C.)	1 8	7.0 x 6.1 x 6.1	20-12-0-12-20	1 41 30
206	1A, 1A	2 12	8.3 x 7.7 x 7.0	0-15-20, 0-15-20	3 08 38
203	500, 500	2 4	8.3 x 7.0 x 7.0	0-15-27, 0-15-27	2 82 38
204	1A, 1A	3 4	8.9 x 7.7 x 7.7	0-15-27, 0-15-27	2 86 38

BATTERY CHARGER TYPES

Ref. No.	PRIMARY 200-250 VOLT (Secondary 2V, 6V, 12V)	Weight lb oz	Size cm.	P & P
45	1.5	1 8	7.0 x 6.1 x 6.1	£1 30
86	4.0	3 4	8.9 x 7.7 x 7.7	2 93 42
96	6.0	6 4	9.9 x 9.6 x 8.6	4 40 52
148	6.0	12	9.9 x 10.2 x 8.6	5 02 52
50	12.5	12 0	14.0 x 10.2 x 11.8	7 53 67

*Carriage via B.R.S.

Also stocked: SEMICONDUCTORS • VALVES
AVOMETERS • ELECTROSIL RESISTORS

PLEASE ADD 10% FOR V.A.T. including P. & P.

BARRIE electronics
3, THE MINORIES, LONDON EC3N 1BJ
TELEPHONE: 01-488 3316/8
NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST.

R.S.T. VALVE MAIL ORDER CO. Blackwood Hall, 16A Wellfield Road, London, SW16 2BS Tel: 01-677 2424 Telex: 946708 R.S.T.

VALVES

AZ31 0-55	DV803 0-37	ECF82 0-40	EF98 0-75	EZ80 0-28	OA2 0-40	PD500 1-30	PY82 0-35	UCH42 0-75	3B4 0-40	6B7 0-90	6V76GT 0-50	80C15 1-05	80T 0-45
AZ41 0-60	EAB080	ECF83 0-50	EF184 0-35	EZ61 0-29	OB2 0-40	PEN45DD	PY83 0-38	UCH81 0-40	3C4 0-70	6C4 0-35	6X4 0-70	80C17 1-10	80T 2-25
CB131 1-00	0-38	ECH83 0-45	EF300 0-55	EZ90 0-40	OC8 0-60	PFL2000-65	PY801 0-50	UFL82 0-35	5R4GY 0-80	6CD9G 1-30	6X5GT 0-45	80C18 0-90	80T 2-00
CL33 1-50	EAF42 0-75	ECH84 0-45	EL33 1-75	GV501 0-80	PC88 0-60	PC88 0-60	SP41 3-00	UFL83 0-35	5R4GY 0-80	6CE6 1-40	6E6 0-75	80C19 1-10	TUBES
CY31 0-50	EAF5010-50	ECL80 0-55	EL34 0-45	GZ30 0-45	PC90 0-48	PC90 0-48	SP41 3-00	UFL84 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C20 1-10	2AF1 4-00
DAF91 0-50	EAF91 1-20	ECL82 0-55	EL35 1-41	GZ32 0-50	PC98 0-40	PC98 0-40	SP41 3-00	UFL85 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C21 1-10	3BF1 4-50
DAF96 0-50	BH41 0-75	ECL86 0-40	EL42 0-90	GZ34 0-65	PC189 0-60	PC189 0-60	SP41 3-00	UFL86 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C22 1-10	3BF1 4-50
DC90 1-35	EBC81 0-33	ECL80 0-40	EL44 0-28	H3 0-90	PC189 0-60	PC189 0-60	SP41 3-00	UFL87 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C23 1-10	3BF1 4-50
DF91 0-30	EBF80 0-40	EL30 0-20	EL41 0-50	HL41DD	PC189 0-60	PC189 0-60	SP41 3-00	UFL88 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C24 1-10	3BF1 4-50
DF96 0-60	EBF83 0-40	EF37A 1-50	EL36 0-40	HN309 1-50	PCF8010-50	PCF8010-50	SP41 3-00	UFL89 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C25 1-10	3BF1 4-50
DE91 0-45	EBF89 0-32	EF39 1-20	EL360 1-25	HN309 1-50	PCF802 0-50	PCF802 0-50	SP41 3-00	UFL90 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C26 1-10	3BF1 4-50
DE92 0-70	EBL31 1-50	EF41 0-65	EL360 1-25	HN309 1-50	PCF805 0-90	PCF805 0-90	SP41 3-00	UFL91 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C27 1-10	3BF1 4-50
DE96 0-60	ECC40 1-00	EF52 1-25	EM80 0-45	KT66 2-50	PCF806 0-75	PCF806 0-75	SP41 3-00	UFL92 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C28 1-10	3BF1 4-50
DL92 0-40	ECC41 0-40	EF80 0-25	EM81 0-60	KT81 (7C5)	PCF808 0-90	PCF808 0-90	SP41 3-00	UFL93 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C29 1-10	3BF1 4-50
DL94 0-48	ECC82 0-43	EF85 0-35	EM84 0-35	KT88 2-90	PCF809 0-75	PCF809 0-75	SP41 3-00	UFL94 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C30 1-10	3BF1 4-50
DL96 0-55	ECC85 0-40	EF89 0-28	EM86 0-40	KTW611-00	PCF810 0-75	PCF810 0-75	SP41 3-00	UFL95 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C31 1-10	3BF1 4-50
DM70 0-80	ECC88 0-40	EF91 0-37	EZ10 0-75	KTW621-00	PL85 0-50	PL85 0-50	SP41 3-00	UFL96 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C32 1-10	3BF1 4-50
DR67 0-38	ECC89 0-35	EF92 0-50	EZ11 0-75	N78 2-75	PL86 0-45	PL86 0-45	SP41 3-00	UFL97 0-35	5R4GY 0-80	6E6 1-00	6E5 1-00	80C33 1-10	3BF1 4-50

TRANSISTORS

1N21 0-17	2N708 0-15	2N3709 0-10	AF116 0-25	BF195 0-15	CR83-40	GJ7M 0-50	NKT128 0-45	OA95 0-07	OC26 0-40	OC71 0-15	OC84 0-30	ORP60 0-45
1N23 0-35	2N1302 0-18	2N3710 0-11	AF139 0-33	BF196 0-15	CR83-40	K8100A-20	NKT211 0-25	OA202 0-10	OC29 0-65	OC72 0-25	OC83 1-10	ORP61 0-48
1N4001 0-06	2N1303 0-18	2N3711 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT101 0-20	NKT212 0-25	OA210 0-10	OC30 0-40	OC73 0-50	OC83 1-10	ORP62 0-75
1N4002 0-07	2N1304 0-22	2N3712 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT120 1-25	NKT213 0-25	OA211 0-30	OC35 0-55	OC74 0-30	OC83 1-10	ORP63 0-75
1N4003 0-08	2N1305 0-22	2N3713 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT121 0-25	NKT214 0-25	OA212 0-30	OC35 0-55	OC75 0-30	OC83 1-10	ORP64 0-75
1N4004 0-08	2N1306 0-28	2N3714 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT122 0-25	NKT215 0-25	OA213 0-30	OC35 0-55	OC76 0-30	OC83 1-10	ORP65 0-75
1N4006 0-12	2N1307 0-28	2N3715 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT123 0-25	NKT216 0-25	OA214 0-30	OC35 0-55	OC77 0-30	OC83 1-10	ORP66 0-75
18111 0-13	2N1308 0-28	2N3716 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT124 0-25	NKT217 0-25	OA215 0-30	OC35 0-55	OC78 0-25	OC83 1-10	ORP67 0-75
18132 0-13	2N1309 0-28	2N3717 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT125 0-25	NKT218 0-25	OA216 0-30	OC35 0-55	OC79 0-25	OC83 1-10	ORP68 0-75
20220 0-63	2N1310 0-28	2N3718 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT126 0-25	NKT219 0-25	OA217 0-30	OC35 0-55	OC80 0-25	OC83 1-10	ORP69 0-75
20301 0-40	2N1311 0-28	2N3719 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT127 0-25	NKT220 0-25	OA218 0-30	OC35 0-55	OC81 0-25	OC83 1-10	ORP70 0-75
20302 0-40	2N1312 0-28	2N3720 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT128 0-25	NKT221 0-25	OA219 0-30	OC35 0-55	OC82 0-25	OC83 1-10	ORP71 0-75
20696 0-16	2N1313 0-28	2N3721 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT129 0-25	NKT222 0-25	OA220 0-30	OC35 0-55	OC83 1-10	OC83 1-10	ORP72 0-75
2N697 0-15	2N1314 0-28	2N3722 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT130 0-25	NKT223 0-25	OA221 0-30	OC35 0-55	OC83 1-10	OC83 1-10	ORP73 0-75
2N706 0-10	2N1315 0-28	2N3723 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT131 0-25	NKT224 0-25	OA222 0-30	OC35 0-55	OC83 1-10	OC83 1-10	ORP74 0-75
2N706A-012	2N1316 0-28	2N3724 0-11	AF139 0-33	BF196 0-15	CR83-40	MAT132 0-25	NKT225 0-25	OA223 0-30	OC35 0-55	OC83 1-10	OC83 1-10	ORP75 0-75

Industrial Valves

1B3GT	3B28	5Z3	12E14	815	6923	CV28	CV404	CV2325	E180F	GXU2	ME104	Q810/45
1B24	3B29	6AF4A	13D1	828	5727	CV31	CV415	CV2361	E181CC	GXU3	ME1500	Q810/50
1B36A	3C22	6AK5	28D7	830B	5745	CV33	CV416	CV2466	E182CC	GXU4	ME1501	Q810/60
1B38A	3C23	6AM5	29D7	866	5750	CV35	CV417	CV2516	E185F	GXU5		Q810/66
1N21	3C24/24G	6AM6	53KU	866A	5751	CV38	CV418	CV2522	EA50	KT66	OA2	Q810/45
1N21B	3C46	6AN5	75C1	866E	5802	CV39	CV419	CV2721	EA76	KT77	OA3	Q810/45
1N23B	3CX100A5	6AR6	85A1	881R	5823	CV41	CV420	CV2901	ECF35	KT88	OA4G	Q81200
1N23CR	3E29	6AS6	85A1	891R	5841	CV128	CV421	CV2902	ECF36			Q81200
1X2A	3J121E	6AU4GT	85A2	5963	9001	CV131	CV422	CV2903	ECF37			Q81200
1X2B	3J180E	6AUBGT	90AG	5965	9002	CV132	CV423	CV2904	ECF38			Q81200
2A3	3J170E	6AV5	90AV	956	9003	CV133	CV424	CV2905	ECF39			Q81200
2A315	3Q195E	6AV5GT	90C1	956	9004	CV136	CV425	CV2906	ECF40			Q81200
2C26A	384	6AW8A	90CG	957	9005	CV137	CV426	CV2907	ECF41			Q81200
2C34	3V/340B	6AX5GT	90CV	9021	9006	CV138	CV427	CV2908	ECF42			Q81200
2C39A	3V/390B	6B1A	95A1	1625	9007	CV140	CV428	CV2909	ECF43			Q81200
2D21		6BA8A	100TH	1625A	9008	CV141	CV429	CV2910	ECF44			Q81200
2D21W	4-125A	6BK4	150B2	2050	9009	CV142	CV430	CV2911	ECF45			Q81200
2E26	4-260A	6BK7GTA	150C1	2051	9010	CV143	CV431	CV2912	ECF46			Q81200
2J31	4-400A	6BL7GTA	150C2	2052	9011	CV144	CV432	CV2913	ECF47			Q81200
2J33	4B32	6BR7	150C3	4003A	9012	CV145	CV433	CV2914	ECF48			Q81200
2J50	4C35	6BS7	150C4	4003B	9013	CV146	CV434	CV2915	ECF49			Q81200
2J54	4CX250B	6BTXTGT	150TH	4242A	9014	CV147	CV435	CV2916	ECF50			Q81200
2J56A	4E27	6B2E	328	4313C	9015	CV148	CV436	CV2917	ECF51			Q81200
2K25	4F50	6C6E	329	4328A	9016	CV149	CV437	CV2918	ECF52			Q81200
2K26	4F52	6CH6	328	4328B	9017	CV150	CV438	CV2919	ECF53			Q81200
2K28	4F52A	6CL6	329	4328C	9018	CV151	CV439	CV2920	ECF54			Q81200
2K45	4J53	6CW4	705A	5544	9019	CV152	CV440	CV2921	ECF55			Q81200
2X2A	4X150A	6DK6	715A	5545	9020	CV153	CV441	CV2922	ECF56			Q81200
	4X150B	6DQ6R	715B	5642	9021	CV154	CV442	CV2923	ECF57			Q81200
3A/107A	4X250B	6EA8	723A/B	5644	9022	CV155	CV443	CV2924	ECF58			Q81200
3A/108A		6F33	725A	5651	9023	CV156	CV444	CV2925	ECF59			Q81200
3A/108B	5B/251M	6H6(metal)	801	5670	9024	CV157	CV445	CV2926	ECF60			Q81200
3A/108C	5B/252M	6K7GT	801	5672	9025	CV158	CV446	CV2927	ECF61			Q81200
3A/110A	5B/254M	6R6A	803	5676	9026	CV159	CV447	CV2928	ECF62			Q81200
3A/110B	5B/255M	6V6GT	805	5687	9027	CV160	CV448	CV2929	ECF63			Q81200
3A/146J	5B/256M		807	5696	9028	CV161	CV449	CV2930	ECF64			Q81200
3A/167M	5B/257M	11E3	808	5702	9029	CV162	CV450	CV2931	ECF65			Q81200
3A/5	6C22	11F13	811	5718	9030	CV163	CV451	CV2932	ECF66			Q81200
3B/240M	5B21	12AY7	811A	5719	9031	CV164	CV452	CV2933	ECF67			Q81200
3B/241M	5B4GY	12B4A	812A	5725	9032	CV165	CV453	CV2934	ECF68			Q81200
3B24	5U4GB	12B7YA	813	5725	9033	CV166	CV454	CV2935	ECF69			Q81200

7410 0-20	7411 0-20	7412 0-20	7413 0-20	7414 0-20	7415 0-20	7416 0-20	7417 0-20	7418 0-20	7419 0-20	7420 0-20	7421 0-20	7422 0-20	7423 0-20	7424 0-20	7425 0-20	7426 0-20	7427 0-20	7428 0-20	7429 0-20	7430 0-20	7431 0-20	7432 0-20	7433 0-20	7434 0-20	7435 0-20	7436 0-20	7437 0-20	7438 0-20	7439 0-20	7440 0-20	7441 0-20	7442
-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	------

P. F. RALFE

10 Chapel St London N.W.1

Phone 01-723 8753

ADVANCE CROSS HATCH & DOT GENERATORS

Suitable for 625, 405 & Video. Switchable sound carrier generator. Offered brand new in original makers cartons. Price each £28.00 postage inc.

AERIAL CHANGE/OVER RELAYS
of current manufacture designed especially for mobile equipments, coil voltage 12v., frequency up to 250 MHz at 50 watts. Small size only, 2 in. x 1/4 in. Offered brand new, boxed. Price £1.50, inc. P.&P.

'ALCAD' Sealed rechargeable Nickel-cadmium batteries.
Type W3.5, 1.2V at 3.5 Ah. Size as 'U2'. Offered new in packs supplying 12V, £15. Or separately at £1.25 + pp. 5p. each

Automatic Constant current electronic battery chargers specially designed for nickel cadmium cells. Metered and fused. Up to twelve cells can be charged up to 750mA, variable 0-750mA. Size 7x6x5ins. Brand new units. Price each £17.

Smiths Ltd Weight indicators, self powered, measures 0 to 20 cwt in 1 cwt divisions on a 4" circular meter indicator, 30 feet of cable and heavy duty load cell use with bell crank or actual reading is 5 cwt for F.S.D. Brand new units special price £7.50 post 50p.

Cosor Electronic Inverters type CRA 200. A high quality device for producing a 115v 400HZ single phase output. Incorporating the following features: Input 23-28V D.C.
* Full overload protection.
* Sine wave output.
* Remote control facilities.
* Completely Solid State (Silicon transistors).
* Built to Aircraft specifications.
* 180VA of output continuous.
May be run in series operation for 3 phase requirements. Offered brand new boxed units. Price £17.50 Carriage 50p.

AUDIO OSCILLATORS AMERICAN TS-382/U

Covers 20 c/s-200 Kc/s in four ranges. Output voltage 1 micro volt to 10 v. in seven ranges. Built in calibrator. Sine wave O.P. is excellent over complete range. Supplied with transmit case, adaptors and circuits and transformer for 240 A.C. £20.

MINIATURE AEI UNISELECTORS
12 position x 3 bank 250 ohm coils, 1 bridging and 2 non-bridging wipers available now—Type 2200A complete with bases. Price £4.

BRAND NEW DIGITAL PANEL VOLT METERS
10MV-1.99VV. 199 Measuring points. Input impedance 100Mohm. Automatic zeroing. Measurements: 155mm x 72mm x 72mm. List price was £52.00. OUR PRICE £24.50.

DIGITAL MEASUREMENT Type 2003 Digital Voltmeter. 3 1/2 Digit display. Measuring up to 1000 Volts. AS NEW £65.

'MUIRHEAD DECADE OSCILLATOR'
—type DB90A. 4 dial type. Frequency up to Khz in 1 Hz steps. Incorporates a 'scope tube for very accurate frequency setting. Condition as new. Price £105.

500 MHz FREQUENCY DIVIDER TCD 500. Sensitivity 10mV (1-300MHz), 50mV (300-500MHz). The TCD500 is designed to extend the range of existing frequency counter by 10 or 100 times to a maximum of 500MHz. Completely self-contained, no external standards required. The TCD500 is suitable for any type frequency counter over 1MHz. Solid-state, small size. Brand new. Price only £100.

MUFFIN INSTRUMENT FANS

Dimensions 4.5 x 4.5 x 1.5 ins. Very quiet running, precision fan specially designed for cooling electronic equipment, amplifiers etc. For 110V. AC operation—(practise is to run from split primary of mains transformer or use suitable mains dropper). CC only 11 Watts. List price over £10 each. Our price, in brand new condition, is £3.50.

DIGITAL FREQUENCY METER type 'FT300'—reads as frequency meter up to 99.99KHz in three ranges or as tachometer, 99,990 RPM. Solid-state instrument. Clear read-out. Size only 8in. by 5in. by 2 1/2in. Weight 4 1/2 lbs. BCD outputs. Operating voltage 110/240 V. AC. Made by famous manufacturer. These units are brand new in original makers cartons. Our price: £55.

POLARAD Model S884WA SPECTRUM ANALYSER
10MHz-63GHz. I.F. Markers. Spectrum calibrator. Log/Lin scale. NB. This is not the instrument with the expensive TWT to replace. Supplied in full working, excellent condition. Guarantee.

AVO TYPE 1 L.C.R. BRIDGE.
Slide-rule scale Price £75.00.

DERRITRON DIGITAL WHEATSTONE BRIDGE. Model 11075. Reads from 1 mill-ohm to 9.999M ohms.

ADVANCE LF SIGNAL GENERATOR TYPE SG70. Range 5Hz to 125KHz. Sine and square wave. Direct floating output of 4 Watts into 600 ohms. (49 V.R.M.S. indicated on calibrated meter). Distortion better than 1%, at two Watts. Attenuated metered output with 50 db decade attenuator. BRAND NEW. Price £145.00.

SCHOMANDL PRECISION FREQUENCY METER TYPE FDI WITH FDMI ADAPTOR
GPO approved equipment for Radio Telephone Marine servicing etc., offered in as new condition with calibration certificate.

G.E.C. Uniselectors, 8-banks, 25 position full wipe. 75 ohm coil. Not new but excellent working condition. Each £2.

Brand new GEC 3 banks of 25 position uniselectors with fitted suppressor. £2.50 each.

SIX Level A.E.I. Uniselectors miniature plug in type 2216A coil 125 ohms. non-bridging wipers with index. 12 position 6 bank. Absolutely brand new in makers cartons sold complete with base. £6.50

INSTRUMENT CASES

Dimensions: 10 x 6 1/2 x 6 1/2 ins. Incorporates large scale 50A meter. Ideal for electronic multi-meter construction etc. Brand new with tilt stand. Finished in blue hammer. A very good buy, only £4. PP. 30p each.

TINSLEY type 4363D Vernier potentiometer. Good condition. Price £75.

FRIGIDAIRE, AIR-CONDITIONING UNIT. Table-top model. 4 inch diameter pipe outlet. Complete and ready for use. Price £125.

WAYNE KERR type B521 Component bridge. Accurate measurement of LC & R. £55. Excellent order throughout.

TEKTRONIX OSCILLOSCOPES

Type 545A with 'CA' plug-in. (Or 'L'). DC—30MHz.
Type 561A with 3A1 and 3B3 units. DC—10MHz.
Type 535 with CA plug-in unit. DC—15MHz.
Type 551. Double-beam with L&G units. DC—27MHz.



Also available:
Dynamco D7100 with 1Y2 and 1X2 plug-ins. Portable, DC—30MHz.
Hewlett-Packard 175A, 1781 and 1755A plug-ins. DC—30MHz.

TEKTRONIX type 545A OSCILLOSCOPE. Complete with 'CA' plug-in unit. As new. Perfect condition, calibrated to manufacturers standards. Bandwidth to 30MHz. This offer is too good to miss. Price only £295 (plus V.A.T.)

Solartron digital voltmeter CT469 with AC plug-in. DC, 1000V. AC, 500V. Many facilities are incorporated in this instrument, c/w handbook. Sold as new condition. Price £275.

Rohde & Schwarz URV. 1KHz—1600MHz. UHF milli-voltmeter. Range 1mV-20V with probe insertion unit. £75.

SIGNAL GENERATORS

Marconi type TF801D. 10-485MHz. Excellent.

P.U.R.

Marconi type TF867. 15KHz-30MHz. £100.

Rohde & Schwarz UHF Signal Generator. 1000MHz—1900MHz. In four ranges. Output 0.7—7V into 52 ohms. Piston type attenuator. Price £125.

Rohde & Schwarz SMCK SHF Signal Generator. 1.7-5GHz. Price £75.

Hewlett-Packard 202A LF Function Generator. Range .008Hz to 1.2KHz. Sine, square and triangular O.P. waveforms. As new condition. Price £45.



MARCONI TEST EQUIPMENT. All items have been calibrated, reconditioned and guaranteed.

Wave Analyser TF455E. Frequency range 20Hz. £105.

TF893 Audio Wattmeter. Range 20Hz-35KHz. Power range 20uW-10W. Impedance 2.5 Ω to 20K Ω in 48 steps. Direct calibration in Watts and dbm. Price £30.

MARCONI TF340 AF power meters. As above but limited to 6 Watts. £25 each.

MARCONI Sensitive Voltmeter type TF2600. As new. 1mV—300 Volt. Full-scale deflection. 12 ranges, with dbm markings. A modern instrument. Only £50.

TF2162 MF attenuator. DC-1MHz. 0-111db attenuation in -1db steps. Impedance 600 ohms unbalanced. Price £50.

TF2163 U.H.F. Attenuator. DC-1 GHz. 0-142db in 1db steps. Z, 50 ohms. Max. power input 0.5W. As new Price £75.

TF801D/I A.M. Signal Generator up to 470MHz.

TF1041B Voltmeter. 300mV-300V. 20Hz-1500MHz. £45.

MARCONI DOUBLE PULSE GENERATOR TF1400/S. With secondary P.G. Type 6600/1. As new condition. £105.

OAI094AHF Spectrum Analyser 100KHz-30MHz. As new.

TF1417 Counter, Frequency Meter 7 digits. Plus range extension unit TF1434/2 to 220MHz. As new.

ADVANCE DVM4 Digital voltmeter. AC/DC. Brand new £65.

PO type, 316, Jack Plugs. Complete with leads. Good condition. Price £2 for ten.

DIGITAL MEASUREMENTS DM2003 Digital voltmeter. AC/DC to 1KV. Direct readout. New price over £350 each. Our price, in full working condition is £75.00.

ADVANCE type TCIA Timer-counter. Solid-state. 6 digit readout. Manual or auto. (electronic) stop/start. As frequency meter —1Hz—1MHz, or timer with all facilities. Brand new with handbook, leads, etc. Special offer £65.

R216 V.H.F. AM/FM Communications receivers. Coverage 19-157MHz. Film scale dial 2 frequency crystal calibrator. Plus all other facilities. Complete with A.C. power supply connecting lead. Supplied in full working order in excellent secondhand condition.

PLEASE ADD 10% V.A.T. TO THE TOTAL AMOUNT WHEN ORDERING. INCORRECT AMOUNTS WILL CAUSE DELAY IN DESPATCH. THANK YOU.

LEMANIA AIRCREW CHRONOGRAPHS. Stainless Steel case with screw back; luminous hands and markings. One fifth sec. sweep hand controlled independently of main movement by press to start, stop and return to zero button. 15 jewel movement. Many of these watches are as new but all have been cleaned and checked. Fitted strap. White face £18-55, Black face £19-50 inc. P.&P. Inspection against remittance



GS WATCHES all with brushed stainless steel case with screw back and black faces. Manufactured by CYMA, VERTEX, TIMOR, GRANA, IWC, RECORD, SMITHS etc. to a common specification. We will try to meet your requirements for specific manufacturer and quantity orders will be of one manufacturer's production. All cleaned and checked. Fitted Strap. £8-95 inc. P.&P. We also have limited quantities of these watches by OMEGA, LONGINES, BUREN, JAEGER LE COULTRE at £15-50 inc. P.&P.

GAS CHROMATOGRAPHY RESEARCH OVEN PV4051/4056

A large capacity oven of low thermal mass for use between 35 and 350°C. Provides a forced air circulating system yielding 1000 changes of air per min. The oven has forced air cooled outer surfaces when the internal temperature is high. 210-250V, 50Hz, 2-6KW, £28.60. (C.Pd. England and Wales).

GAS CHROMATOGRAPHY OVEN/ANALYSER UNIT PV4050/4055

A somewhat smaller unit than the previous item for use between 35 and 500°C. 600 changes per min. with cooled outer surface. Internal dimensions 20cm x 18cm high x 20cm deep. Max. heating rate 30-400°C in 6 mins. Max. cooling rate 400°C to 100°C in 4 mins. 210-250V, 50Hz, 2-6KW, £22.00. (C.Pd. England and Wales).

IONISATION AMPLIFIER PV4075

A modern high grade low noise solid state amplifier to feed a potentiometer recorder. 18 input ranges from 10⁻¹² to 5x10⁻⁷ A with 5 outputs of 1mV to 100mV. Linearity 0.1%. Noise less than 0.5% f.s. at max. sensitivity. Back off facility. Dimensions 28 x 10 x 43 cm deep. With operating information £27-50. (C.Pd. U.K.)

Details of these three and other gas chromatography items are available—price 25p (C.W.O. only) Handbooks (complete) Available.

ALL PRICES INCLUDE 10% V.A.T.

SPECIALIST STOCKISTS OF SERVOMOTORS, SYNCHROS, MAGSLIPS & CONNECTORS

Servo and Electronic Sales Ltd

Post Orders and Technical enquiries to: "BAYS", HIGH ST., LYDD, KENT. Lydd 20252 (STD 0679) TELEX 965265 V.A.T. Reg. No. 201-1296-23 TELEX 965265

WE ARE ANXIOUS TO BUY Synchro Test Equipment manufactured by Muirhead, Singer-Gertsch etc. Test Dials, Dividing Heads, Bridges, Standards etc. to expand our testing facilities.

RADAR CABLEFORM INSULATION TESTER for checking insulation between individual conductors and each other and ground at preselected voltages up to 10Kv. Full details on application.

PLESSEY GROUND BASED U.H.F. GROUND/AIR TX/RX FOR EXPORT ONLY OR SALE TO LICENSED USERS.

This equipment comprises: Single Channel Receiver 5820-99-932-5694. Single Channel Transmitter 5820-99-932-5698. Single Channel Amplifier 5820-99-932-5701. Power Unit for Amplifier 5820-99-932-5700. Cooler Unit 5820-99-932-3995.

These assemble into a free standing rack unit providing U.H.F. communications over 225 0 to 399-9MHz, the TX/Amplifier unit giving 100 Watts R.F. output into 50 Ohms. We have sufficient of these units to form 12 complete installations with a number of spare sub-units. All are guaranteed new and unused. Full details on request.

MANUFACTURERS!!

Metal Oxide Resistors (ELECTROSIL & WELWYN)

Tantalum Capacitors (KEMET, ITT, PLESSEY, ETC.)

Scientific Instruments

Electronic Test Instruments

Synchros and Servomotors

ALL AVAILABLE EX STOCK!

WE HAVE ONE OF THE LARGEST STOCKS IN THE COUNTRY OF INSTRUMENTS AND COMPONENTS MANUFACTURERS. TELEX 965265. RE AVAILABILITY.

OVER 300,000 IN STOCK! Multiway and R.F. Connectors by twenty different companies! Send us your detailed requirements quoting Nato numbers if known. We are now on TELEX.

MIL SYNCHROS AVAILABLE EX-STOCK

In sizes 08, 11, 15, 16, 18 and 23 for 50, 60 and 400 Hz operation. Synchro Control Transformers, Synchro Control Transmitters, Synchro Torque Transmitters and Receivers, Synchro Resolvers

TAPE STORAGE CANS. Brand new finished steel cans originally intended for 16mm film but ideal for storing 7 in. reels of tape. Our last supply of these items was quickly exhausted at 30p each but as a result of a massive new purchase we can now offer a case of 55 (Minimum order) at £7.30 inc. P. & P. and V.A.T. Sample can available at 38p inc. P. & P. and V.A.T. **FLOODLAMPS (WEATHERPROOF)** 12 in. x 12 in. on swivelling mount—full details and illustration on application. £18-25 inc. P. & P. (U.K. Mainland only) and V.A.T.

POLARAD WIDE RANGE DISPERSION SPECTRUM ANALYSER covering 10MHz to 40.88KMHZ. Model SA 84W with handbook £125 plus V.A.T. Send S.A.E. (Foolsap) for information.

ETHER ELECTROMETHODS LOW INERTIA INTEGRATING MOTORS. Available ex-stock at extremely low prices. For 6, 12 and 24v. operation in stock. **VATRIC SIZE 23 PULSE GENERATORS** (Shaft Digitizers). Full details and price on application.

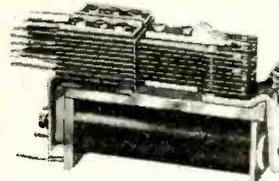
PLANAIR. Axial Flow Fans (with mounting) Type 6PL-122-331. Mx 2 dia. 2,800 r.p.m. 400v. 3ph 50Hz. New and boxed £16-50 (C.Pd. U.K.). Also available tested but not new in 220/240v. 50Hz version at £6-50 (C.Pd. U.K.).

DRY REED INSERTS



Overall length 1.85in. (Body length 1.1in.) Diameter 0.14in. to switch up to 500mA at up to 250V. D.C. Gold clad contacts 69p per doz.; £4.12 per 100; £30-25 per 1,000; £275 per 10,000. All carriage paid U.K. Heavy duty type (body length 2in.) diameter 0.22in. to switch up to 1A. at up to 250V. A.C. Gold clad contacts, £1.37 per doz.; £6-88 per 100; £52-25 per 1,000; Changeover type £2.75 per doz. All carriage paid U.K. Operating Moments 6tp per doz.; £4.40 per 100; £38-50 per 1000. All carriage paid.

Wilkinsons



RELAYS P.O. TYPE 3000 AND 600

BUILT TO YOUR SPECIFICATION. HIGHEST QUALITY AT COMPETITIVE PRICES WITH A QUICK DELIVERY SERVICE. QUOTATIONS BY RETURN HOME AND OVERSEAS.

P.O. TYPE UNISELECTORS

8 Level all non bridging 300 ohms £14.08 ea. 11 Level 1 bridging 10 non bridging 65 ohms £17.38 ea. 4 pole 50 way all non bridging 75 ohms £11.33 ea.

LARGE STOCKS HELD OF G.E.C. MINIATURE SEALED AND ERICSON CYLINDRICAL TYPE RELAYS.

METERS 2 in. flush round AC/DC with fixing clip 0-20 or 0-40 volts, 0-5 amps, all £2.31 ea.

BRIDGE MEGGERS 1000 Volts 0/100 Megohms with Resistance Box 0/999 Ohms, £84.70 ea. **CALVAND METERS.** Mirror type BB 3,000 cycles, focal length 20 cm, £19.90 ea., and Cambridge Insts. UNIPIVOT type 50-0-50 microamps, scaled 35-0-35, knife pointer, mirror scale, 4 in. dia., in leather case, £11.33 ea.

BULKHEAD FITTINGS. 9 inch diameter, flat tripod type. Push Bar Switch Lampholder, suitable for lamps up to 100 watts, £300 for 400 delivered.

RECTIFIERS. Selenium. Full wave Bridge, 24 volts 8 amp, £500 for 500 delivered.

CROUZEY SYNCHRONOUS GEARED MOTORS, operating at 3 rpm from 24 volts AC 50 cycles 4 watts, spindle 1/8" x 1/8", £3.35 ea. 24 volt Transformer with 240 volt AC input available, £1.73 ea.

F.H.P. MOTORS. 1/2 h.p. capacitor start 200/210 V single phase 50 cycles 1425 r.p.m. spindle 1/8" x 2", resilient base, £12.65 ea.

1/2 h.p. 200/210 volts Capacitor start single-phase 50 cycles 1425 rpm, spindle 1/8" x 1 1/2", solid base, £12.65 ea.

1/2 h.p. 230/250-400/440 volts three-phase, 960 rpm, spindle 1/8" x 2", solid base, £12.65.

1/2 h.p. 200/220-346/380 volts three-phase 50 cycles 1425 rpm, spindle 1/8" x 1 1/2", solid base, £12.65 ea.

1/2 h.p. Capacitor start 230 volts single-phase 50 cycles 2850 rpm, spindle 1/8" x 2 1/2", solid base, £17.87 ea.

IMHOFF BLOWER UNITS in a standard 19" rack mounting assembly with Glass Fibre Air Filter and directional duct capacitor fan. Motor 1/50 h.p. 200/250 volts or 100/125 volts AC 50 cycles 2800 rpm, £2.90 ea.

HIGH SPEED COUNTERS £2.03 each

3 1/2 in. x 1 in. 10 counts per second with 4 figures. The following DC voltages are available 6 v., 12 v., 24 v., 50 v., or 100 v. Auxiliary contacts, normally open, 40p extra.

MINIATURE BUZZERS, 12 volts, with tone adjuster 25p ea., lots of 50 only, as illustrated

RECTIFIER UNITS WESTALITE TYPE BC 3-3/15. Input 200/250 volts AC. Output up to 6 volts DC. Heavily damped 0/20 ammeter Moving Coil 2 1/2 in. reads true charging current, which is regulated by a four position rotary switch and sliding resistance. A ballast is fitted to smooth out mains variations. AC and DC fuses fitted. Size 1 1/2 in. x 1 3/4 in. x 1 1/2 in., designed to stand on bench or fit to a wall, £12.50 ea.

MINIATURE DIGITAL INDICATOR. Size of digits 1/8 in., illuminated by 28 volt lamps. reading 0 to 9 with decimal points, quick disconnect at rear of unit for easy lamp replacement. This miniaturized digital display operates on a rear-projection principle, when one of the twelve lamps at the rear of the unit is lighted, the lamp projects the corresponding digit on the condensing lens through a projection lens on to the viewing screen at the front of the unit, £24.40 ea. Illustrated details available

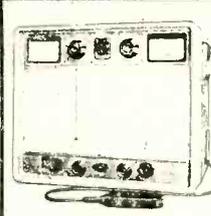
EQUIPMENT WIRE 7/0076 single sheath PVC. Blue only, £7.17 per 1,000 yds. 14/0076 Type 11, £9.37 1,000 yds.

HEADLAMP BULBS S.B.C. 6 volt 36 watt Double contact, £250 for 5,000 delivered.

RESISTORS EX STOCK IN QUANTITY WIRE WOUND, HIGH STABILITY CARBON, ETC., BEST MAKES AT LOWEST POSSIBLE PRICES.

ALL PRICES SHOWN INCLUDE CARRIAGE U.K. ONLY AND 10% VAT

L. WILKINSON (CROYDON) LTD, LONGLEY HOUSE, LONGLEY RD., CROYDON, CR0 3LH. Phone 01-684 0236. Grams: WILCO CROYDON



MARCONI TF 80 SIGNAL GENERATOR

Range: 15KHz to 30MHz. Output 0.4uV to 4V at 13 or 75 ohms. Impedance with termination (supplied). Built in crystal check facility with handbook. £138 including carr.

T.F.995A/1 F.M./A.M. SIGNAL GENERATOR

Freq. range: 2 MHz to 216 MHz. Built-in crystal calibrator. Output range: 200 mV to 0.1uV. F.M. or A.M. also simultaneous f.m. and a.m. £235.

TF.801D/1/S A.M. SIGNAL GENERATOR

Freq. range: 10 MHz to 485 MHz. Built-in crystal calibrator. Internal and external sine a.m. External pulse modulation. Calibration Accuracy: Using crystal calibrator, within ±0.2% over entire frequency range. R.F. output level 0.1uV to 1V source e.m.f. £249.

OA.1094A/3 H.F. SPECTRUM ANALYSER

Freq. range: 100 Hz to 30 MHz. Measures relative amplitudes up to 60 dB. Spectrum width 0-30 KHz. Sweep duration: 0.1, 0.3, 1, 3, 10, 30 sec. and manual. Full spec. on request. £695.

TF.801B/3/S A.M. SIGNAL GENERATOR

Freq. range: 12 MHz to 485 MHz in five bands. Built-in crystal calibrator. Full spec. on request. £220.

TF.937 F.M./A.M. SIGNAL GENERATOR

Freq. range 85 KHz to 30 MHz. The carrier freq. can be standardized against a built-in dual freq. crystal calibrator, which is complete with miniature loudspeaker as an aural beat detector. £87.

OA.1094A/S H.F. SPECTRUM ANALYSER

Freq. range: 3 MHz to 30 MHz in nine steps. spectrum width 0 to 30 KHz. Sweep distortion: 0.1, 0.3, 1, 3, 10, 30 sec. and manual. Full spec. on request. £445.

TF.114H/S SIGNAL GENERATOR

Frequency range: 10 kHz-72 MHz. Stability: ±0.002%. High discrimination, plus crystal calibrator. Good r.f. waveform at all frequencies. Protected thermocouple level monitor. Full spec. on request. £220.

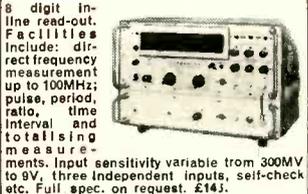
TF.2343 QUANTIZATION DISTORTION TESTER

Checks a.f. to a.f. distortion of p.c.m. systems. Utilises system power supply. Output level: Variable in 1 dB steps, from -50 to +2 dBm. Accuracy: 0.2 dB at +2 dBm ±0.5 dB incremental. Quantization distortion: 0 to -40 dB in 0.5 dB steps. Meter indication: True r.m.s. Input impedance: 600S2 ±10% balanced. £245.

T.111 ROBAND TRANSISTORISED SUPPLY

Mains input 110V or 230V, output ±50V at 5 Amperes cont. variable, overload cut-out. £67.

RACAL UNIVERSAL COUNTER/TIMER SA550 (CT488)



8 digit in-line read-out. Facilities include: direct frequency measurement up to 100MHz; pulse, period, ratio, time interval and tallying measurements. Input sensitivity variable from 300mV to 9V, three independent inputs, self-check etc. Full spec. on request. £143.

JOHN CRICHTON

Electronic Equipment
558, Kingston Road, Raynes Park, London, S.W.20

Inland V.A.T add 10%
Prices include P. & P.
Carriage extra for overseas orders.
Please phone 01-540 9534

BI-PRE-PAK

SUPPLIERS OF SEMI-CONDUCTORS TO THE WORLD



Telephone Corner

COMPLETE TELEPHONES
NORMAL HOUSEHOLD TYPE AS
SUPPLIED TO THE POST OFFICE EX. G.P.O.

Only **£1-05**
P & P 45p EACH

TELEPHONE DIALS

Standard Post Office type. Guaranteed in working order.

Only **27 1/2p** P & P 16p EACH

Tested and Guaranteed Paks



B79	4	1N4007 Sil. Rec. diodes, 1,000 PIV lamp plastic	55p
B81	10	Reed Switches 1" long 1/2" dia. High speed P.O. type	55p
B99	200	Mixed Capacitors. Approx. quantity, counted by weight. P & P 15p.	55p
H4	250	Mixed Resistors. Approx. quantity, counted by weight P & P 15p.	55p
H35	100	Mixed Diodes, Germ. Gold bonded etc. Marked and Unmarked	55p
H38	30	Short lead Transistors. NPN Silicon Planar types	55p
H39	6	Integrated circuits. 4 Gates BMC 962. 2 Flip Flops BMC 945	55p
H41	2	Power Transistors Comp. Pair BD 131/132	55p
H63	4	2N3055 Type NPN Sil. power transistors. Below spec. devices	55p



Unmarked Untested Paks

B1	50	Germanium Transistors PNP, AF and RF.	55p
B66	150	Germanium Diodes Min. glass type	55p
B84	100	Silicon Diodes DO-7 glass Equiv. to OA200, OA202	55p
B86	100	Sil. Diodes sub. min. IN914 and IN916 types	55p
H16	15	Experimenters Pak of Integrated Circuits, Data supplied	55p
H46	40	NPN Silicon Trans. 2N3707-11 range, low noise amp.	55p
H34	15	Power Transistors. PNP, Germ. NPN Silicon TO-3 Can. P & P 5p extra.	55p

Make a rev counter for your car

The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter for any car with normal coil ignition system.

£1-10 each

Ex GPO Push-button Intercom Telephones

Exactly as internal telephone systems still in everyday use where automatic internal exchanges have not yet taken over. Available in 5, 10 or 15 ways. Complete with circuits and instructions. Necessary 24 pair cable 22p per yard. Price of each instrument is independent of the number of ways.

£2.75 P & P 38p per instrument
Cable can be sent by Parcel Post. Post and Packing per 50 yds: 73p

EXTENSION TELEPHONES
71p each p.p. 27p. £1.37 for 2 p.p. 55p. These phones are extensions and do not contain bells.

A Cross Hatch Generator £3-85 post paid

A complete kit of parts including Printed Circuit Board. A four position switch gives X-hatch. Dots. Vertical or Horizontal lines. Integrated Circuit design for easy construction and reliability. A project in the Sept. '72 edition of Television.

New Paks

Tested, Guaranteed

H64	4	3819 N Channel FET's ZN3819 in plastic case	55p
H65	4	40361 Type NPN Sil. transistors TO-5 can comp. to H66	55p
H66	4	40362 Type PNP Sil. transistors TO-5 can comp. to H65	55p

Untested, Unmarked

H67	10	3819 N Channel FET's plastic case type	55p
-----	----	--	-----

Over 1,000,000 Transistors in stock



We hold a very large range of fully marked, tested and guaranteed Transistors. Diodes and Rectifiers at very competitive prices. Please send for Free Catalogue.

Our very popular 4p Transistors

FULLY TESTED & GUARANTEED
TYPE "A" PNP Silicon alloy, TO-5 can.
TYPE "B" PNP Silicon, plastic encapsulation.
TYPE "E" PNP Germanium AF or RF.
TYPE "F" NPN Silicon plastic encapsulation.
TYPE "G" NPN Silicon, similar ZTX300 range.
TYPE "H" PNP Silicon, similar ZTX500 range.

Various Types
8 RELAYS FOR £1-10

Post & Packing 27p

High-speed magnetic counters



4 digit (non reset) 24v or 48v (state which)
4 X 1 X 1". 33p p.p. 5p.

Plastic Power Transistors



NOW IN TWO RANGES

These are 40W and 90W Silicon Plastic Power Transistors of the very latest design, available in NPN or PNP at the most shatteringly low prices of all time. We have been selling these successfully in quantity to all parts of the world and we are proud to offer them under our Tested and Guaranteed terms.

RANGE 1 VCE. Min. 15 1-12 13-25 26-50
HFE. Min. 15

40 Watt 22p 20p 18p
90 Watt 26p 24p 22p

RANGE 2VCE. Min. 40

RANGE 2VCE. Min. 40
HFE. Min. 40

40 Watt 33p 31p 29p
90 Watt 38p 36p 33p

Complementary pairs matched for gain at 3 amps, 11p extra per pair. Please state NPN or PNP on order.

LM380 AUDIO I.C.

as featured in *Practical Wireless*, December issue, complete with application data £1.10.

INTEGRATED CIRCUITS

We stock a large range of I.C.s at very competitive prices (from 11p each). These are all listed in our FREE Catalogue, see coupon below.

METRICATION CHARTS now available

This fantastically detailed conversion calculator carries thousands of classified references between metric and British (and U.S.A.) measurements of length, area, volume, liquid measure, weights etc. Wall Chart 18p. Pocket Size 15p.

LOW COST DUAL IN LINE I.C. SOCKETS

14 pin type at 16p each }
16 pin type at 18p each } Now new low profile type.

BOOKS

We have a large selection of Reference and Technical Books in stock.

BUMPER BUNDLES

These parcels contain all types of surplus electronic components, printed panels, switches, potentiometers, transistors and diodes, etc.

2 LBS in weight for £1-10

Post and Packing 27p.

Our famous P1 Pak is still leading in value

Full of Short Lead Semiconductors & Electronic Components, approx. 170. We guarantee at least 30 really high quality factory marked Transistors PNP & NPN and a host of Diodes & Rectifiers mounted on Printed Circuit Panels. Identification Chart supplied to give some information on the Transistors. 11p P & P on this Pak.

Please ask for Pak P.1. only **55p**

Please send me the FREE Bi-Pre-Pak Catalogue.

ALL PRICES INCLUDE 10% VAT

NAME

ADDRESS

MINIMUM ORDER 50p CASH WITH ORDER PLEASE. Add 11p post and packing per order. OVERSEAS ADD EXTRA FOR POSTAGE.

Buy these goods with Access.

Marshall's

A. Marshall & Son (London) Limited
42 Cricklewood Broadway London NW2 3HD Telephone 01-452 0161
& 65 Bath Street Glasgow G2 2BX Telephone 041-332 4133

months best buy ex-stock
All British made 'Calcate' calculator
One of the first electronic calculators in the world with no mechanical switches or moving parts. Touch button operation using latest MOS integrated circuitry. Complete with charger and case. 1 year's guarantee. 140mm x 80mm.
Our price £29.00 excluding VAT
Recommended price £42.50. Post & packing 30 pence UK

Transistors

2G301	0.15	2N3709	0.09
2G302	0.15	2N3710	0.12
2G303	0.25	2N3711	0.09
2G306	0.30	2N3712	0.05
2G309	0.30	2N3713	1.15
2G345B	0.25	2N3710	2.29
2G371	0.15	2N3715	2.16
2G374	0.15	2N3716	3.00
2N174	1.40	2N3773	3.96
2N407	0.40	2N3779	3.25
2N456	0.75	2N3790	4.21
2N456A	0.75	2N3791	4.20
2N457A	0.80	2N3792	5.04
2N491	3.25	2N3794	0.10
2N695	0.15	2N3819	0.32
2N697	0.15	2N3820	0.47
2N698	0.25	2N3823	1.42
2N699	0.29	2N3824	1.33
2N706	0.12	2N3826	0.23
2N705A	0.12	2N3854	0.16
2N708	0.13	2N3854A	0.16
2N709	0.40	2N3855	0.16
2N711	0.30	2N3855A	0.16
2N718	0.21	2N3856	0.16
2N718A	0.43	2N3856A	0.16
1N120	0.50	2N3858	0.16
2N721	0.55	2N3858A	0.16
2N914	0.15	2N3859	0.16
2N916	0.17	2N3859A	0.16
2N918	0.15	2N3860	0.16
2N929	0.14	2N3866	0.16
2N930	0.14	2N3877	0.25
2N1090	0.23	2N3877A	0.26
2N1091	0.24	2N3900	0.20
2N1131	0.20	2N3900A	0.20
2N1132	0.20	2N3901	0.32
2N1302	0.16	2N3903	0.24
2N1303	0.16	2N3904	0.27
2N1304	0.20	2N3905	0.24
2N1305	0.22	2N3906	0.27
2N1306	0.22	2N4036	0.46
2N1307	0.22	2N4037	0.40
2N1308	0.25	2N4058	0.16
2N1309	0.25	2N4059	0.09
2N1483	0.90	2N4060	0.11
2N1507	0.24	2N4061	0.11
2N1613	0.20	2N4062	0.11
2N1631	0.35	2N4302	0.25
2N1637	0.30	2N4303	0.47
2N1638	0.32	2N4916	0.20
2N1701	1.10	2N4917	0.17
2N1702	2.15	2N4918	0.50
2N1711	0.22	2N4919	0.63
2N1893	0.30	2N4920	0.71
2N2102	0.30	2N4921	0.50
2N2147	0.70	2N4922	0.55
2N2148	0.94	2N4923	0.60
2N2192	0.40	2N5172	0.12
2N2192A	0.40	2N5170	0.22
2N2193	0.40	2N5175	0.26
2N2193A	0.61	2N5176	0.32
2N2194	0.27	2N5190	0.92
2N2194A	0.30	2N5191	0.96
2N2195	0.37	2N5192	1.24
2N2195A	0.18	2N5193	1.01
2N2196	0.30	2N5194	1.10
2N2218A	0.30	2N5194	1.10
2N2219	0.37	2N5195	1.46
2N2219A	0.30	2N5245	0.35
2N2220	0.20	2N5457	0.35
2N2221	0.20	2N5458	0.33
2N2221A	0.33	2N5459	0.33
2N2222	0.31	3N128	0.73
2N2222A	0.10	3N138	1.65
2N2368	0.11	3N139	1.42
2N2369	0.15	3N140	0.92
2N2369A	0.17	3N141	0.81
2N2646	0.70	3N142	0.58
2N2647	1.20	3N143	0.75
2N2711	0.12	3N152	0.92
2N2712	0.12	3N153	0.81
2N2713	0.17	3N154	0.84
2N2714	0.10	3N159	1.17
2N2904	0.28	3N187	1.55
2N2904A	0.25	3N200	2.49
2N2905	0.71	3N201	1.05
2N2905A	0.88	4050	0.78
2N2906	0.24	4051	0.61
2N2906A	0.30	40309	0.30
2N2907	0.32	40310	0.50
2N2907A	0.33	40313	0.92
2N2923	0.12	40316	0.46
2N2924	0.12	40489	0.46
2N2925	0.15	4060	0.50
2N2926	0.40	40361	0.43
Green	0.12	40362	0.45
Yellow	0.10	40363	0.88
2N3053	0.31	40369	0.22
2N3054	0.60	40395	0.65
2N3055	0.75	40405	0.44
2N3390	0.20	40407	0.33
2N3391	0.20	40487	0.50
2N3391A	0.22	40409	0.52
2N3392	0.13	40410	0.50
2N3393	0.12	40411	0.53
2N3394	0.17	40414	3.55
2N3402	0.12	40487	0.69
2N3403	0.19	40468A	0.44
2N3404	0.24	40600	0.69
2N3405	0.27	40601	0.67
2N3414	0.10	40602	0.46
2N3415	0.10	40603	0.38
2N3416	0.13	40604	0.58
2N3417	0.21	40636	1.10
2N3570	1.23	40673	0.70
2N3571	1.12	40674	0.93
2N3572	0.97	40675	0.16
2N3702	0.11	40676	0.16
2N3703	0.10	40677	0.16
2N3704	0.14	40678	0.16
2N3705	0.10	40679	0.16
2N3706	0.09	40680	0.16
2N3707	0.10	40681	0.16
2N3708	0.70	40682	0.16

AC142K	0.23	BC259	0.13	BFX63	2.48
AC151V	0.14	BC261	0.20	BFX68	0.68
AC152V	0.17	BC262	0.18	BFX84	0.24
AC153	0.22	BC263	0.23	BFX85	0.29
AC153K	0.25	BC290	0.42	BFX86	0.24
AC154	0.20	BC301	0.30	BFY70	0.28
AC176	0.18	BC302	0.27	BFX88	0.25
AC176K	0.20	BC303	0.54	BFX89	0.45
AC187K	0.20	BC307	0.10	BFY10	0.35
AC188K	0.28	BC307A	0.10	BFY11	0.45
AC17	0.35	BC308	0.09	BFY11	0.90
AC18	0.24	BC308A	0.09	BFY18	0.35
AC19	0.27	BC308B	0.09	BFY19	0.35
AC20	0.22	BC309	0.10	BFY20	0.50
AC21	0.26	BC309A	0.10	BFY29	0.40
AC22	0.16	BC309B	0.10	BFY30	0.20
AC28	0.20	BC327	0.24	BFY41	0.43
AC30	0.42	BC328	0.22	BFY43	0.65
AC39	0.65	BC337	0.19	BFY50	0.22
AC40	0.17	BC338	0.17	BFY51	0.15
AC41	0.17	BCY30	0.43	BFY52	0.20
AC44	0.31	BCY31	0.40	BFY53	0.15
AD136V	0.96	BCY32	1.15	BFY56	0.34
AD142	0.54	BCY33	0.34	BFY64	0.41
AD143	0.28	BCY34	0.35	BFY75	0.40
AD149V	0.66	BCY38	0.77	BFY76	0.22
AD150	0.63	BCY39	1.05	BFY77	0.24
AD161	0.45	BCY40	0.50	BFY78	0.36
AD162	0.45	BCY42	0.15	BFY90	0.60
AD163	0.45	BCY43	0.15	BFY99	0.60
AD169	1.05	BCY58	0.22	BSX21	0.12
AF109R	0.40	BCY59	0.22	BSX20	0.14
AF114	0.25	BCY70	0.17	BSX21	0.20
AF115	0.24	BCY71	0.22	BSX26	0.49
AF116	0.24	BCY72	0.13	BSX27	0.34
AF117	0.20	BCY87	0.47	BSX27	0.25
AF118	0.50	BCY88	2.40	BSX29	0.47
AF121	0.22	BCY89	0.97	BSX30	0.68
AF124	0.34	BCZ10	0.35	BSX59	0.78
AF125	0.20	BCZ11	0.20	BSX61	0.42
AF126	0.19	BD115	0.75	BSX61	0.42
AF127	0.20	BD116	0.50	BSX76	0.15
AF139	0.38	BD121	0.75	BSX77	0.20
AF170	0.27	BD123	0.82	BSX78	0.25
AF172	0.25	BD124	0.70	BSY24	0.20
AF178	0.55	BD130	0.57	BSY25	0.15
AF179	0.65	BD131	0.40	BSY26	0.20
AF180	0.50	BD132	0.50	BSY27	0.15
AF186	0.40	BD135	0.40	BSY28	0.15
AF200	0.35	BD136	0.49	BSY28	0.15
AF211	0.55	BD137	0.55	BSY38	0.20
AF229	0.41	BD138	0.63	BSY39	0.20
AF240	0.72	BD139	0.71	BSY51	0.25
F279	0.20	BDY103	0.30	BSY52	0.25
AF280	0.54	BDY10	1.25	BSY53	0.25
AFY42	0.74	BDY11	1.50	BSY54	0.30
AL102	0.75	BDY17	1.50	BSY56	0.79
AL103	0.71	BDY18	1.75	BSY65	0.15
ASV26	0.30	BDY19	0.97	BSY70	0.40
ASV27	0.36	BDY20	0.05	BSY79	0.40
ASV28	0.28	BDY38	1.65	BSY790	0.45
ASV29	0.38	BDY60	0.90	BSY95A	0.09
ASV55	0.35	BDY61	1.25	BU10A	1.42
BC107	0.15	BDY62	2.00	BU105	2.25
BC108	0.15	BF115	0.23	C111	0.53
BC109	0.19	BF117	0.43	GET111	0.45
BC113	0.12	BF119	0.53	GET113	0.20
BC114	0.12	BF121	0.23	GET114	0.20
BC115	0.15	BF123	0.27	GET115	0.50
BC116	0.15	BF125	0.25	GET119	0.35
BC117	0.15	BF152	0.20	GET120	0.25
BC118	0.21	BF153	0.20	GET135	0.20
BC119	0.11	BF154	0.16	GET136	0.20
BC121	0.27	BF158	0.23	GET138	0.20
BC122	0.23	BF159	0.27	GET173	0.12
BC126	0.20	BF160	0.23	GET173	0.12
BC127	0.50	BF161	0.20	GET180	0.20
BC134	0.11	BF166	0.35	GET187	0.20
BC135	0.11	BF167	0.21	GET189	0.22
BC136	0.11	BF173	0.31	GET189	0.22
BC138	0.15	BF178	0.25	GET199	0.49
BC140	0.39	BF179	0.43	TIP31A	0.74
BC141	0.34	BF180	0.35	TIP32A	0.74
BC142	0.24	BF181	0.32	TIP33A	1.01
BC143	0.21	BF182	0.40	TIP34A	1.51
BC144	0.24	BF183	0.40	TIP35A	2.90
BC145	0.21	BF184	0.17	TIP36A	3.70
BC147	0.12	BF185	0.17	TIP41A	0.79
BC148	0.10	BF194	0.14	TIP42A	0.50
BC149	0.12	BF195	0.17	TIP295S	0.98
BC153	0.18	BF196	0.15	TIP305S	0.60
BC154	0.18	BF197	0.15	ME0401	0.18
BC157	0.14	BF198	0.15	ME0402	0.20
BC158	0.13	BF199	0.18	ME0404	0.13
BC159	0.14	BF200	0.40	ME0411	0.17
BC160	0.37	BF224J	0.14	ME0412	0.18
BC167B	0.11	BF225J	0.19	ME0413	0.14
BC168B	0.13	BF237	0.20	ME1120	0.25
BC168C	0.11	BF238	0.25	ME2000	0.09
BC169B	0.13	BF244	0.16	ME4002	0.11
BC169C	0.11	BF245	0.33	ME4003	0.14
BC170	0.11	BF246	0.43	ME4010	0.10
BC171	0.13	BF247	0.49	ME4012	0.11
BC172	0.11	BF254	0.16	ME4013	0.14
BC182	0.10	BF255	0.17	ME4014	0.11
BC182L	0.12	BF257	0.41	ME6010	0.14
BC183	0.09	BF258	0.46	ME6012	0.16
BC183L	0.12	BF259	0.45	ME60	

UNIQUE OPPORTUNITIES

GENERATORS

MARCONI TF867 STANDARD SIGNAL GENERATOR



Carrier Frequency. Range: 15Kc/s-30Mc/s in 11 bands. Calibration Accuracy: $\pm 1\%$. Stability: After warm up the drift in a 10-minute period is, typically, less than 0.005% for carrier frequencies up to 3.2Mc/s and less than 0.01% from 3.2-30Mc/s. Output Voltage: 0.4 μ V-4V. Impedance: 75 ohms nominal for outputs from 2-4 v. 75 ohms for outputs from 4 μ V-2V. 13 ohms for outputs from 0.4 μ V-0.4V.

Accuracy: below 3Mc/s ± 0.25 dB of $\pm 0.1\mu$ V. 3-10Mc/s ± 0.5 dB or 0.02 μ V. 10-30Mc/s ± 1 dB or $\pm 0.5\mu$ V. Power Supply: 100-125V, 200-250V 40-100c/s. Dimensions: 18 in. high X 21 in. wide X 14 in. deep. Price £145

DOUBLE PULSE GENERATOR TYPE TF 1400/S
10 c/s-100 Kc/s. Complete with TM 6600. Pulse adjustable between 1.5 μ sec. before and up to 3,000 μ sec. PRICE £145-00

MARCONI A.M. SIGNAL GENERATOR TYPE TF801D
10-485Mc/s in five ranges. Output 0.1 μ V-1 Volt E.M.F. External Sine A.D. Frequency 30c/s-50Kc/s. P.O.A.

PHILIPS SQUARE WAVE GENERATOR MODEL GM2314 Range 15 c/s-200 Kc/s. Duration of square wave pulses between 0.75 μ sec and 40 m/sec. Square wave voltage 10V PRICE £75-00

AMPLITUDE MODULATOR TF1102
100Kc/s-300Mc/s Sine-wave from 20 c/s-15 Kc/s and 20 x/s-500Mc/s £35-00

MARCONI Type TF987/1 NOISE GENERATOR
1-200 Mc/s ± 0.5 DB £20-00

MARCONI TF2092 NOISE GENERATOR £295-00

MARCONI VHF SIGNAL GENERATOR TF 1145
450-1900 Mc/s £295-00

PHILIPS VIDEO GENERATOR GM2887 £95-00

HEWLETT PACKARD SIGNAL GENERATOR 6088B
10-400 mc in five bands. Output voltage 0.1 mV-0.8 Volt 50 ohm. £165.

MARCONI H.F. CIRCUIT MAGNIFICATION METER TF886A
A direct reading Q Meter 15-170 Mc/s Magnification 60-7200 Q £45-00

MARCONI DISTORTION FACTOR METER TF142F
100 c/s-8 Kc/s 0.05%-50% Measures all spurious components up to 30Kc/s £35-00

MARCONI PULSE GENERATOR TF675E
Repetition Frequency 50c/s-50Kc/s 0.15-40 μ Sec £35-00

MARCONI WIDE RANGE R.C. OSCILLATOR TF1370
Sine-waves 10c/s-Mc/s, square waves 10c/s-100Kc/s Direct outputs up to 31.6V. Attenuator with three impedances. £120-00

HETERODYNE UNIT TF1221
2Kc/s-100Mc/s £45-00

WAYNE-KERR NOISE GENERATOR
A portable instrument for measuring the noise factor of radio receiving equipment, metric radar receivers, and radar wide-band i.f. amplifiers in the band 15KHz-160MHz. £115

MARCONI Type TF144H STANDARD SIGNAL GENERATOR



Frequency range: 10KHz-72MHz. Crystal Check: 400KHz and 2MHz crystals. Stability: 0.002% in 10 minute interval. FULL SPECIFICATION AVAILABLE ON REQUEST £225

MARCONI TYPE TF801A SIGNAL GENERATOR
Frequency range: 10MHz to 310MHz. O/P voltage: 0-100 db relative to 200 mV into 75ohm IV CW O/P available. Internal modulation: 400Hz, 1kHz and 5kHz to 80% sine or square. £45-00

ADVANCE TYPE D1/D SIGNAL GENERATOR
Frequency range: 10MHz-300MHz. O/P voltage: 1V-10mV. £25-00

ROHDE & SCHWARZ SIGNAL GENERATOR
BN4105 30-300 Mc $\pm 1\%$ Output 3 Volt. £350-00.

HEWLETT PACKARD 8690 SWEEP GENERATOR
plus 8693B Plug-in. 3.7-8.3 GHz. £1,695-00.

MARCONI TF995A/2M
AM/FM Generator. £325-00.

FANTASTIC VALUE IN OSCILLOSCOPES

TEKTRONIX

524AD £125
535A DC-30 Meg £205

Main Frame £225
545 " With CA time base £295

545A " £295

HEWLETT PACKARD 185B
Sampling Oscilloscope DC-1000 Meg complete with 187C Dual Trace AMP has 350 microsec. Rise time (1000 MC). £395

COSSOR CDU 110

Dual Channel Transistorised DC-25 MHz at 5mV/cm. 0.2 microsec. $-0.5 \pm 3\%$ 5X Magnification extends sweep speed to 40 nanosec./cm. Sweep delay 180 nanosec. £249-50



COSSOR CDU 120

Dual Channel fully transistorised 50 mV/cm to 10V DC-60 MHz. Rise time 6 nanosec. 1 mV/cm at 25 MHz. 0.1 microsec. £349-50

COSSOR CDU 150

Rugged Transistorised fully portable Dual Channel DC-35 MHz at 5mV/cm. As used by numerous government departments (c/f CT531) £375
COSSOR. The very latest COSSOR 4000 Dual beam. 55 MHz at 50mV/cm Trigger. SCOOP—ONE ONLY £395

TEKTRONIX 526 COLOUR TV VECTORSCOPE
M00158M PAL £495.

FAIRCHILD 766H/F Dual Trace & Delay Sweep P.O.A.
MARCONI BATTERY/MAINS TF 2203 TRANSISTORISED, FULLY PORTABLE FAST RISE-TIME DE-20MEG RISE-TIME 23 n. sec. 50mV/cm. £135.

TEKTRONIX STORAGE OSCILLOSCOPE TYPE 564 including 3A6 and 3B1 plug-ins. £475

SYNCHROVERTER SWITCH TYPE G1280 BY ELLIOTT PRICE £3.

DC AMPLIFIER BY ASTRODATA 885-235 £49.
SAUNDERS OSCILLATOR CLC 7-12K/mc/s £25.
MUIRHEAD D880A 2 Phase Decade Oscillator £75.

ALPHANUMERIC NIXIE TUBES B7971
Has the ability to display all letters of the alphabet and numerals 0 thru 9 in a single tube. Readability in high ambient light 200 footlamberts brightness. Supply voltage 170 VDC, numeral height 2.5 inches. PRICE 99p P & P 16p.



MINITRON

K.G.M. Type 3015F 7 Segment display showing figures 0-9 plus decimal point. Character of 9mm height. In 16 DIL case.

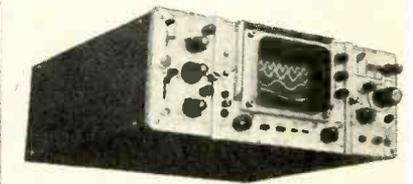
NEW LOW PRICE £1-25
SN7447N BCD Decoder Driver £1-00

Sensational Offer due to frustrated export orders

DYNAMCO 71 OSCILLOSCOPE

1/2 PRICE

* Fully Transistorised * Dual Channel * Sweep Delay * Range DC-30 MHz * Sensitivity 1mV



The 71 Display Unit contains the cathode ray tube an controls, power supplies, calibrator, vertical and horizontal main deflection amplifiers and unblanking amplifier for the 71 series of oscilloscopes.

On either side of the Display Unit may be plugged the vertical and horizontal deflection units.

The design of the 71 display unit allows its use as a self contained oscilloscope with or without plug-in units.

Waveform: Approximately Squarewave. Amplitudes 50mV, 500mV and 5V. Accuracy: $\pm 2\%$. Repetition Rate 1KHz $\pm 2\%$. Rise Time: $<1\mu$ s. Fall Times: $<5\mu$ s. Output Impedance: 50mV, 500mV : 50 Ω . 5V : 500 Ω . Current Output: 10mA 1KHz squarewave available at loop on front panel $\pm 2\%$.

1X2 DELAYED SWEEP TIMEBASE
The type 1X2 is a timebase module used to provide normal and delayed sweeps. The module contains two timebases, one of which 'A', is intended for a main sweep, the other 'B', for delaying the start of timebase 'A'. Fine delay is achieved by using a comparator circuit controlled by a calibrated 10 turn knob.

During delayed operation, pulse location is simplified by the use of a Bright-up Strobe ('B' Intensified by 'A'). To vary the 'hold off' period for maximum repetition rates, the 'B' timebase has a variable velocity control with two calibrated positions (X1 and X5).

CALIBRATED SWEEP RATES
0.2 μ s in 19 calibrated steps. Uncalibrated variations between steps 0.5secs (5 second sweep).

SWEEP RATES
10 μ s/division to 10ms. Fine control extends the sweep rate to 50ms (0.5 second sweep). Accuracy: 5% on all calibrated ranges.

MAGNIFIER
X1 and X10 extends the fastest sweep rate to 20 μ s.

1Y2 DUAL CHANNEL AMPLIFIER
The 1Y2 is a wide band, dual channel amplifier. It features two identical wide-band preamplifiers, each with its own input selector and attenuator, which may be electronically switched to provide single or dual trace displays. In addition the two channels may be combined algebraically.

A balanced helical wound delay line provides 160ns of signal delay

Unrepeatable offer—limited quantity only!

Listed at over £500 **£249.50**

ADD 10% VAT TO ALL PRICES



ELECTRONIC BROKERS LIMITED

49/53 PANCRAS ROAD : LONDON NW1 2QB. Tel: 01-837 7781

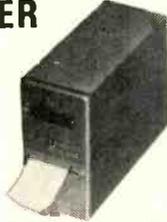
to purchase some of the World's finest calibration instruments at savings of

33 1/3% AND MORE!

SODECO IMPULSE PRINTING COUNTER

4 Digit Decimal Counter
10c/second Electrical
Reset & Print-out 24 Volts
Type PN117.
Brand New.

PRICE £42



PHILIPS VALVE VOLTMETER

MODEL GM6014 Max. 300mV, 1000Hz-30MHz. £30.00
WIDE RANGE OSCILLATOR TYPE 400C by DAWE
1 c/s-1,000 c/s. PRICE £35.00

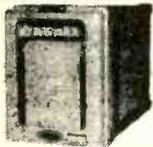
FANS BY PLANNAIR

115V-3 Phase 400 c/s-11,000 rpm. Type 1PL41-234 PRICE £4.00

R.C. OSCILLATOR TYPE G432 by FURZEHILL
Square and sine wave. 250 Kc/s. PRICE £25.00

LAMBDA REGULATED POWER SUPPLIES
New Range just arrived! Phone for details.

PEN RECORDERS



SINGLE PEN RECORDER

by Record Electrical. 3" chart, sensitivity 1 milliamper, chart speed 1" and 6" per hour. Size 8" x 11" x 6". Offered complete with pen assembly and spare chart. Listed at over £100—this month's special price due to bulk purchase... £39.50 plus £5.00 packing and carriage. 500uA AVAILABLE £45

LEEDS & NORTHRUP STRIP CHART RECORDER
This well-known instrument is fitted with a Series 60 control unit servo amplifier 101041 BR EQ. Range: 5-571 to 18-855. Ref. junction 320F. Primary element: P1, P1, 13% RH JMC. Response time: 5 secs. for f.s.d. Chart width: 7 in. Chart speed: 1 in. per hour. Power supply: 120V 50 Hz. (auto-transformer available). Dimensions: Ht. 18", width 11", depth 12 1/2". Weight 51 lbs. PRICE £80.00

POTENTIOMETERS

TEN TURN 3600° ROTATION

Res Ohms	Linearity	Per cent	Manufacturers	Model	Price
100	0.5	.....	Beckman	A.S.	£2.00
200	0.5	.....	Beckman	A.S.	£2.00
500	0.1	.....	Beckman	S.	£2.50
1000	1.0	.....	Relcon	HEL107-10	£2.25
1K	0.5	.....	Relcon	HEL0710	£2.25
2K	0.25	.....	Beckman	SA1101	£3.00
2K	0.25	.....	Beckman	7216	£3.00
2K	0.25	.....	Reliance	GPM15	£2.00
2K	0.25	.....	General Controls	GPA15/4	£2.00
5K	0.25	.....	Relcon	07-10	£2.25
5K	0.25	.....	Colvern	CLR2503	£3.00
10K	0.1	.....	Beckman X	A.	£3.50
15K	0.1	.....	Colvern	CLR2402	£3.00
25K	0.5	.....	Helipot	SAJ337	£3.00
25K	0.05	.....	Beckman	SA1244	£4.50
30K	0.1	.....	Beckman	A.88	£3.50
30K	0.5	.....	Beckman	SA1692	£3.00
50K	0.5	.....	Reliance	07-10	£2.25
50K	0.5	.....	Beckman	A.	£2.25
50K	0.5	.....	Beckman	A.	£3.00
100K	0.1	.....	Colvern	2501	£2.25
298K	0.1	.....	Beckman	8A3902	£3.50
300K	0.1	.....	Beckman	A.	£3.50

THREE TURN 780° ROTATION

25K	.....	Beckman	Type C	£2.25
100/100	.....	Beckman	Type C	£3.00
300	.....	Beckman	9303	£2.25
1K	.....	Fox	PX2/H3	£2.25
10K	0.5	Beckman	C.ss	£2.25
20K/20K	0.1	Beckman	C.S.	£3.00
10K/10K	0.1	Beckman	C.S.	£3.00
50K	0.5	Beckman	C.S.	£1.75

FIFTEEN TURN 5400° ROTATION

25K/25K	.....	Beckman B.	10 watts	£6.50
46K/46K	.....	Beckman B.	10 watts	£6.50

SINE COSINE POTENTIOMETER 47K

Precision component by Pye. Model 2002. Manufactured to rigid Ministry specification. The assembly consists of three units mounted in one frame. Each unit contains two sine and two cosine potentiometer sections, the sliders being ganged together. Electrical connections, 2 end taps, slider and centre tap. Mechanical IP: 30 r.p.m. Max. torque: 3 1/2 oz./in. Dimensions: W. 6 1/2 in. H. 5 in. D. 7 1/2 in. Wt. 7 1/2 lbs. Ex equipment. Good condition. Price £5. Carriage extra.



COMPUTER ACCESSORIES

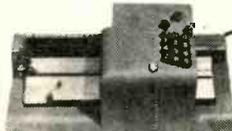
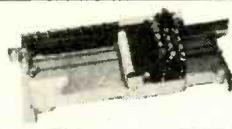
80 COLUMN HAND PUNCHES



Ideal for stock control, sales analysis, back-up in existing computer installations, DP training centres, schools, etc. New low cost model £59.50 plus carriage.

DE LUXE MODEL

Incorporating tabulating mechanism. £79.50 plus carriage.



ELECTRIC HAND VERIFIER
£89.50 plus carriage.

All machines supplied with numeric keytops and dust-cover and covered by our three month guarantee. Delivery ex-stock. Optional extra alpha keytops and chip tray. Send for free descriptive leaflet NOW!

THIS MONTH'S SPECIAL MINI COMPUTER OFFER

SAVE 75% OF LIST PRICE ON THIS DEC PDP SYSTEM



DEC PDP8 4K 1.5 microsecond £1250. ASR33 Printer available £200. PDP8S 8K CPU plus Teletype £1395. PDP8 4K CPU plus VDU P.O.A.

ATTENTION: PDP 11 USERS. MEMORY UPGRADES 4K, 8K, 12K, 16K SAVE MONEY NOW.

WIDE RANGE OF SPARES FOR THE FOLLOWING COMPUTERS ICL 1500, ICL 1900, SYSTEM 4, 4100, 803, AMPEX, etc.

COSSOR VISUAL DISPLAY DID400. Consisting of Keyboard & Display 402 stand alone capability for alphanumeric data entry. Available from £500. Please phone for details.

TELETYPE PUNCH

BRPE High-speed punch. Self-contained, consists of punch unit, base, motor unit. For use in many data communication systems. Operating speeds up to 100 characters per second. (1100 words per minute). Available for punching 5, 6, 7, or 8, level codes, into 1/4" tape. Synchronous, parallel-wire input. £145



Models S110 and R82C, 17 char. per sec. Rebuilt, available from stock. £45.

ICT KEYBOARDS

In original packing—Numerical from £4.50

ICT KEYBOARDS

In original packing—Alpha-numeric Prices from £15.00

Magnetic Tape Transmitters AMPEX TM4, TM2, TM7, FR300, IBM 7330, POTTER, ICL Magnetic Drums. From £75.

IBM PUNCH CARD EQUIPMENT FULLY GUARANTEED

Prices from
024 Automatic alphanumeric keypunch..... £340.00
026 Automatic alphanumeric printing keypunch..... £820.00
056 Verifier features and operation same as 024, 026. £380.00
082 Sorter 500 cards per minute are sorted..... £740.00
Carriage extra.

FREQUENCY CONVERTER MODEL B.40

50 KVA to 60 Hz power frequency converter. Fully overhauled. Specification: Prime Mover: Electric Motor
Input: 220/380V 50Hz 3ph Output: 220V 60Hz 3ph
at 50 KVA with PF of 0.8. PRICE £450.00

HEWLETT PACKARD DIGITAL RECORDER

MODEL 565A Data Entry, parallel to 11 columns. Print speed 5 lines per second. PRICE £85.00.

HEWLETT PACKARD 200 CD Sine wave Oscillator

5Hz-600KHz 10 Volts. £59.00.

PYE HIGH RESISTANCE OHMMETER MODEL 10B

Range from 0.3-20,000 Megohms in 4 ranges at 500V. Used for the measurement of components or circuits having high parallel capacitance. PRICE £20.00



MULLARD VALVE VOLTMETER MODEL E7555/2

PRICE £20.00

WEE MEGGERS BY EVERSHERD & VIGNOLE

100 volt 0.025Ω-20MΩ Series 3 Mk III £25
250 volt 0.015Ω-10MΩ Series 3 only £16
250 volt 0.015Ω-20MΩ Series 3 only £18
250 volt 0.025Ω-20MΩ Series 3 Mk III £22



VENNER 3334

Digital Frequency Meter 0-1MHz £45.00.



VENNER 3336

Digital Counter Six Digit 0-1MHz £55.00. With 15 Meg Counter extension for above £85.00.



STOP PRESS

We have just taken into stock over 20 tons of RF test equipment by various manufacturers. Please telephone us as by the time this advertisement appears, we will have lists available.

WANDEL & GOLTERMANN

Distortion Measuring Set VZM-1 for colour t.v. 625 lines PAL. £750.
Distortion Measuring Set VZM-2 556KHz-12MHz £250.
Distortion Measuring Set VZM-83 52/304/556KHz comprises a generator and receiver used mainly to measure transmission distortion on FM radio link systems. £245.
Voltage & Level Meter 10KHz-14MHz TFPM 43 measuring range 8v-40uv (+ 20-86dB). £339.
Selective Level Oscillator 10KHz-14MHz TFPS 42 £349.

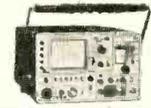


HEWLETT PACKARD Microwave Power Meter Type 430C
Fast readings. Read power directly in mW and dBm. Use 100- or 200-ohm, positive or negative temperature coefficient bolometers. Read CW and modulated power from 0.01 mW to 10 mW or dBm -20 to +10 dBm. £65.00.

693 Sweep Oscillator by HEWLETT PACKARD. £495.
Vzm-83 distortion Generator. Vzm-2 distortion set. LM 6-9 level Meter. P.O.A.

TEKTRONIX Spectrum Analyser

10MHz-40GHz Type 491
One only £1,500.00.



MARCONI TF 2305/8. Sine/Squared Pulse and Bar Generator for T.V. 625 system and colour. £450.00.

TF 2904. Colour gain and delay test set for NTSC and PAL colour T.V. systems. £190.00.

TF 2603 RF Millivoltmeter. 50k-50kHz-(500MHz. Sensitivity from 300 V. £95.00.



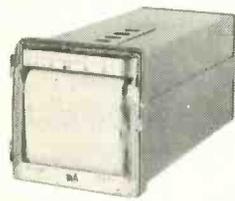
ELECTRONIC BROKERS LIMITED
49/53 PANCRAS ROAD : LONDON NW1 2QB. Tel: 01-837 7781

ADD 10% VAT TO ALL PRICES

ELECTRONIC BROKERS RANGE

PEN RECORDERS

JUST OUT — NEW CATALOGUE ON FULL RANGE OF PEN RECORDERS. SEND READER'S CARD FOR FREE COPY. (WW 130)



MINIATURE PEN RECORDER

Provides permanent record of DC currents up to 1mA. Eminently suitable for use where space is limited. Separate time marker pen provided. Chart width 80mm. Chart length 40ft. Chart speeds: Slow 20-60-180 mm/hour. Fast 600-1800-5400 mm/hour. Dimensions 120x120x285mm. Weight 7.7 lbs. (3.5 Kg). Price complete with accessories

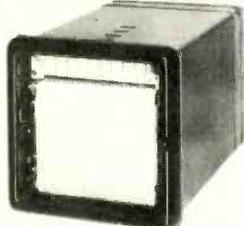
£39.00



NEW HIGH SPEED PEN RECORDERS 3 MODELS AVAILABLE:

SINGLE CHANNEL £180 : THREE CHANNEL £310 : FIVE CHANNEL £385
Frequency range 0C to 100Hz. Recording presented in curvilinear coordinates by means of ink on paper. Built-in solid state amplifier (one per channel) provides 8 calibrated sensitivity steps. Two marker pens are provided; one of these can be connected to internal time marker oscillator providing 1 second pulses. This pen can also be used as a process marker to mark a desired event on the chart. Second marker pen can be used as 'zero' (reference) line marker or as another event marker. Full range of chart speeds is immediately available by means of push button control.

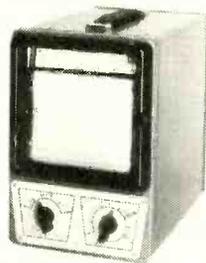
SPECIFICATION. Basic error 4%. Frequency response from 0C to 100Hz, 2 db. Calibrated sensitivity V/cm: 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5. Width of each recording channel 40mm. Chart speeds mm/sec: 1, 2, 5, 10, 25, 50, 125, 250. Internal calibrating voltage: 40mV. Chart length: 50 meters. Voltage: 220/250. **COMPLEMENT OF ACCESSORIES AVAILABLE.**



10 CHANNEL EVENT RECORDER

Designed for recording sequences of up to ten different operations, e.g. sequence of machine tool operation, switching sequences, etc. Record is presented in the form of square "pulses". When energised, pen moves by approximately 4mm, to the right of zero line. Response time 100 milliseconds. Chart width 110mm. Chart length 50ft. Inv. capacity 72 hours. Chart speeds 20-60-180-600-1800-5400 mm/hour. Size 160x160x255mm. Weight 9 lbs. Price complete with accessories

£52.00



PORTABLE AC/DC RECORDING VOLTAMMETER

Fitted with separate zero-marking pen. Accuracy 1.5% DC, 2.5% AC. Measurements ranges — AC and DC: 5-15-150-250-500mA 1.5-5 Amps 5-15-50-150-250-500V. DC only 150mV. Frequency range 45 to 1000 c/s. Chart width 100mm. Chart speeds 20-60-180-600-1800-5400 mm/hour. Weight 22 lbs. Price complete with accessories

£78.00



SINGLE PEN RECORDER

A most versatile pen recorder producing a trace on a curvilinear 3 in. strip chart. Two synchronous speeds: 1 in. and 6 in. per hour.

Fitted with high and low alarm contacts operated by the moving coil. Basic movement 1mA DC coil resistance 400 ohms. Fitted with rectifier to allow operation on AC effective coil impedance at 50Hz 1800 ohms.

TYPE 230

Power supply required: 230V 50Hz. Applications: Ideal for recording relatively slow changing phenomena such as: Temperature; Gas or Liquid Flow Rates, Sound Levels, Speed variations, Power Demand, Rainfall, humidity, etc.

PRICE £25.00

Clockwork version also available £29.50. These two items are newly reconditioned only.



MINIATURISED STRIP CHART RECORDER

Indicates the magnitude of applied currents or voltages by a continuous distortion-free line on pressure sensitive paper. Moving coil movement, scale calibrated 0-1 milliamp d.c. Internal resistance 100 ohms. Chart drive motor 240V 50Hz. Chart speed 1" per hour. Complete with handbook.

Price £25.00

Fabulous TES Equipment

Send reader's card for free catalogue of test equipment. (WW 131)

obtainable only from Electronic Brokers Ltd.



11" OSCILLOSCOPE Type 0271

This oscilloscope has a 11" screen, is fully transistorized, and its dimensions allow mounting on standard rack. It can be equipped with a series of plug-in units which make it highly versatile at a very convenient cost. Dual-trace, time axis logarithmic and differential amplifiers, plug-in units are provided, as well as other plug-in units for interesting and special applications. Since it incorporates the Z-axis modulator, it can be used for display of swept curves, in conjunction with any type of sweep-marker generator, ensuring high stability and deflection linearity.

Vertical amplifier (with plug-in type CV 271-A) Bandwidth: DC to 10kHz within 3 dB DC to 10kHz within 3 dB. Sensitivity: 1mV/pp to 10Vpp in 5 ranges. Input impedance: 0.5 MΩ, with approx. 30 pF.

Horizontal amplifier. Bandwidth: 10Hz to 1kHz Sensitivity: 50 mV/pp max. adjustable. Mains frequency scanning: phase-adjustable, approx. 180°. Z axis: suppression by 25Vp negative.

£120.00

Plug-in Type A, B, C, D, E, F, P.O.A.



OSCILLATOR FM Mod QF 272

Built with modern concepts, this oscillator has been developed to meet all the requirements for the calibration of any FM receiver. It can be used in conjunction with an AM oscillator, for testing on production lines, or for teaching purposes.

It is provided with good frequency resolution and stability, an efficient output attenuator and has particular built-in features which keep the irradiation field at a practically negligible level.

Simplicity of construction and stability of the characteristics are combined in this circuit. Thus an instrument has been developed which, whilst priced as a normal service oscillator, has many of the characteristics of a signal generator. Solid state. RF frequency range: from 85 — 110 MHz. IF frequency range: from 9.5 — 12 MHz. Frequency accuracy: within ± 1%. Max output signal: 0.1V ± 3dB (open circuit). Attenuator: continuous, 0 — 100 dB approx. indication. Output impedance: 75 Ohm constant, FM modulation: frequency 400Hz ± 5% F adjustable until ± 100kHz, about. Sweep frequency: 50Hz (Meius) ± F adjustable until about ± 500kHz.

£139.50



LARGE WAVEBAND OSCILLOSCOPE Mod 0373

A very reliable oscilloscope, with a flat screen tube, developed for all applications where the specific function of the trigger is not of primary importance. Completely solid state (40 semiconductors) except for the input and Y terminal for reasons of security and economy. All power supplies are stabilised, including the voltage to the tube. It has a monumetal screen. Recommended mainly for teaching purposes and for servicing or production lines of televisions.

Vertical Amplifier Bandwidth: DC to 10MHz within 3 dB. Deflection Sensitivity: 20 mVpp/cm for all the range. Input Attenuator: from 20 mVpp/cm to 10 Vpp/cm in 9 ranges. Rise time: about 35 nS. Input impedance: 1 Mohm with about 30 pF. Internal Calibration: for sensitivity control. Y: Horizontal Amplifier Bandwidth from DC to 0.5MHz. Deflection Sensitivity: 100 mVpp/cm — adjustable. X Deflection Line Voltage: phase adjust, within 180° approx. Time Base (uncalibrated): from 1μS/cm to 10mS/cm. Synchronization: automatic. Internal and mains external. minimum 100 mVpp. Z Axis: 20V negative blank the intensity.

Synchronization: automatic ± internal and mains external, minimum 100 mVpp. Z Axis: 20v negative blank the intensity.

£169.50



SWEEP MARKER GENERATOR Mod SM 972

This generator has been specially developed for the design and testing of active and passive network within the frequency range 5-800 MHz; by excluding the sweep, it can be used as a normal non-modulated generator.

It has a good output stability and linearity of amplitude and is particularly suitable for the observation of the curve of passing wavebands from some tenth of KHz up to hundreds of MHz.

Quartz signal markers placed at intervals of 1.5, 10 and 50 MHz (which can be included singly up to their total number) make it possible to locate frequencies with accuracy and ease. It is recommended that the 11" Oscilloscope 271 be coupled with this generator for a better performance.

Appropriate outputs allow remote control and programming of the instrument through a keyboard so as to facilitate its use on production lines. Solid state. Sweep range: 5 — 400MHz and 400 — 800MHz Δ F variable from few KHz until all the range. Sweep frequency: 50 Hz (meius). Output signal: 1 Vpp-75 Ohm. External attenuator: adjustable continuously 0 — 80 dB. Amp/freq linearity: within ± 1 dB for A total Δ F. Markers: quartz, adjustable in amplitude. Markers presentation: Birdy type. Markers interval: 1-5-10-50 MHz as like it.

£525.00

RCL BRIDGE Type P 966

£245

AM-FM GENERATOR Type AF 1065

£259.50

OUTPUT POWER METER Type MU 964

£129

TV SWEEP MARKER GENERATOR Type VU 187

£259.50

WOW AND FLUTTER METER Type WF 971

£295

DISTORTION METER Type D566 B

£319

LF SIGNAL GENERATOR Type G 1185 B

£229

DUAL TRACE OSCILLOSCOPE Type 0371

£369



MODULATED OSCILLATOR Type OM 866

Up-to-date radio receivers possess such a high degree of sensitivity that, even in radio-service shops, a fairly high-performance oscillator is required, so as to permit the output signal to be attenuated also at high frequencies, which is the condition for avoiding saturation of the input stage in transistorized radio receivers.

This oscillator is provided with a buffer-modulator stage to prevent possible spurious modulations. An accurate shielding of the oscillator stage, and an enlarged frequency range for calibration of intermediate-frequency stages, are further features which complete the rational design of this instrument.

Frequency range: from 150KHz to 46MHz in 6 ranges FM expanded range: 430-530 KHz. Frequency accuracy: better than 1%; IF range 0.1%. Internal modulation: 400 Hz; fixed 30%. External modulation: from 20 Hz to 15 KHz. Max RF output: 0.2V ± 3 dB. Attenuator: continuous, linear and in steps. Output impedance: 75 Ohm constant. VF output voltage: 2 V approx.

£85.00



SWEEP MARKER GENERATOR Mod IF 271

Developed exclusively for production use, this instrument allows a rapid and accurate calibration of intermediate TV frequency stages with the possibility of inserting, singly or simultaneously, a total of 8 quartz markers either of standard frequency or frequencies chosen according to the different production systems, including the colour under-carrier.

Its solid state construction makes it extremely reliable, a fundamental requirement of an instrument used on production lines. Frequency control range: 36.15 MHz (or 43 MHz). Width of the sweep: about 12 MHz. Sweep linearity: within 1 dB. Sweep frequency: 50 Hz (meius). Output signal: 0.4 Vp 75 Ohm. Attenuator: adjustable continuously from 0 — 80 dB. Regulation sweep phase: max. 180°, about. Quartz marker: max. no. 8, to be precised. Markers inclusion: single switch. Marker type: best over Y axis oscilloscope. Marker amplitude: adjustable.

£585.00



SOUND GENERATOR Mod GS 1171B

This instrument is of great help in the production of televisions for a rapid and definitive calibration of the sound circuits, rendering superfluous the use of the emitter for a final test. It is a frequency modulated generator with a 1:10,000 stability, more than sufficient for its purpose, with the possibility of frequency tests which bring the short term stability within 50 Hz on 5.5 MHz. It can be supplied, on request, for any other frequency in the 4-12 MHz range. It is completely solid state and offers high reliability.

Central range frequency: 5.5 MHz (other frequencies on request). Frequency deviation: ± 25 KHz. Frequency stability: within ± 250 Hz (with possibility of control). Linearity: with 1 dB. Modulation frequency: 400 Hz. Output signal: 1 Vp, about on 75 Ohm. Attenuator: Continuously adjustable from 0 — 80 dB.

£549.00

OF SELECTED TEST EQUIPMENT

All items are brand new and guaranteed for 12 months

Selected by Electronic Brokers as the finest value for money obtainable today



Sole agents for **I.C.E.**

FREE! NEW CATALOGUE NOW AVAILABLE send reader's card (WW 132)

THE REVOLUTIONARY SUPERTESTER 680R

FOUR INTERNATIONAL PATENTS — SENSITIVITY 20,000 Ohms per Volt
10 FIELDS OF MEASUREMENT
AND 80 RANGES. ACCURACY 1% in D.C. 2% in A.C.
OUTSTANDING FEATURES:
20,000 Ohm per Volt sensitivity • Fully screened against external magnetic fields • Scale width and small case dimensions (128 x 95 x 32mm) • Accuracy and stability (1% in D.C., 2% in A.C.) of indicated reading • Simplicity and ease of use and readability • Full ranges of accessories • 1000 times overload • Printed circuit board is removable without de-soldering • More ranges than any other meter. VOLTS A.C. = 11 ranges: 2-10-50-250-1000-2500 Volts and 4-20-100-500 and 2000 Volts. VOLTS D.C. = 13 ranges: 100mV-2V-10-50-200-500-1000 Volts 200 mV-4V-20-100-400 and 2000 Volts AMP D.C. = 12 ranges: 50 μ A-500 μ A-5 mA-50 mA-500 mA-50 Amp and 100 μ A-1 mA-10 mA-100 mA-1 Amp and 10 Amp. AMP A.C. = 10 ranges: 250 μ A-2.5 mA-25 mA-250 mA-2.5 Amp and 500 μ A-5 mA-50 mA-500 mA-5 Amp. OHMS REACTANCE = 6 ranges: x1-x10-x100-x1000-x0.000 and Low Ohms. DETECTOR = 1 range: from 0 to 10 Megaphms. FREQUENCY = 2 ranges: from 0 to 500 and from 0 to 5000 Hz. V. OUTPUT VOLTAGE = 9 ranges: 10-50-250-1000-2500 V and 20-100-500-2000 Volts. DECIBELS = 10 ranges: from -24 to +70 db. CAPACITY = 6 ranges: from 0 to 50.000 and from 0 to 500.000 pF using the mains and from 0 to 20, from 0 to 200, from 0 to 2,000 and from 0 to 20,000 Micro farad using the incorporated 3 Volts battery. Bold figures indicate depress button.



£18.50
with shockproof case

ALL I.C.E. EQUIPMENT POST FREE

ACCESSORIES TO CONVERT THE SUPERTESTER 680R TO THE FOLLOWING:

Amperclamp

For measuring a.c. currents from 250mA to 500 amps. **£11.95**



Signal Injector

Producing 1KHz and 500 KHz signals for circuit testing. **£5.95**



Transistor Tester

For transistors and diodes. **£11.00**



Gauss Meter

For measuring magnetic field strengths. **£11.95**

Phase Sequence Indicator

To indicate the phase sequence of a 3 phase supply. **£5.95.**



Temperature Probe

Covering the range -50 to +200°C **£11.95**



Electronic Voltmeter

Input resistance of 11Mohms for d.c. and 1.6Mohms shunted by 10pF for a.c. **£18.00**



METERS, PROBES, ETC.



AC/DC MULTIMETER

With taut band suspension movement. Sensitivity 20,000 ohms per volt on DC and 4,000 ohms per volt on AC.
Technical Data:
0.06-0.6-6-60-600mA-3 Amps DC
0.3-3-30-300mA-3 Amps AC 0.6-1-2-3-12-30-60-120-600 DC 1200 Volts
3-6-15-60-150-1300-600-900 Volts AC 45 to 20,000 Hz.
500 Ω 5-50-600 Ω resistance. Decibel range -10 to +12dB. Accuracy (% of F.S.D.)—DC and resistance measurements +2.5. Price with test leads, and storage case **£8.00 POST FREE**



AMPERTEST 690 NEW CLAMP TYPE AMMETER

With unique self-locking meter system retains reading until released, enabling engineer to obtain accurate results after testing inaccessible places etc.

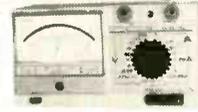
Designed for use in one hand, measures without breaking the circuit. It has six current ranges from 3A to 600A f.s.d. with the first division at 100mA a 10-to-1 current transformer supplied with the instrument provides ranges from 300mA to 60A f.s.d. with the first division at 10mA. Two a.c. voltage ranges of 250V and 600V f.s.d. are provided.

£39.50 POST FREE inc. leather case

MODEL 300 LOGIC PROBE

A compact easy-to-operate logic probe. As a light-emitting diode is used the unit actuates with low power. It does not affect the circuit under test because of high input impedance. Up to as high a frequency as 12 MHz.

£5.50 POST FREE



AC/DC MULTIMETER

With taut suspension movement and full coverage of AC and DC current and voltage ranges.

The instrument incorporates all facilities needed for field and laboratory measurements. Knife edge pointer and 86mm long mirror scale allow the high inherent accuracy of the instrument to be utilized in full. The movements and circuits are fully protected by transistorized triggering circuit.

Scale length: 86mm. D.C. current ranges: 50 μ A, 0.5, 1, 5, 10, 50, 250mA, 1, 5 Amps. A.C. current ranges: 0.25, 0.5, 1, 5, 10, 50, 250mA, 1, 5 Amps. D.C. voltage ranges: 100mV, 0.5, 2.5, 10, 25, 50, 100, 250, 500, 1000V. A.C. voltage ranges: 0.5, 2.5, 10, 25, 50, 100, 250, 500, 1000V. Transmission level: -5 to +10db. Resistance ranges 0.5, 200 Ω ; mid-scale reading 13 10 Ω -3k Ω ; mid-scale reading 200 Ω ; 100 Ω 30k Ω ; mid-scale reading 2000 Ω ; 1k Ω -300k Ω mid-scale reading 20k Ω . Accuracy, % of F.S.D.: D.C. ranges — 1.5 A.C. ranges — 2.5. Sensitivity: D.C. Ranges, 20,000 Ω /V. A.C. ranges, 4,000 Ω /V for all ranges except 2.5V and 10V. 1000 Ω /V for 10V range. 200 Ω /V for 2.5V range. Batteries required: 2 dry cells 1.5V for automatic cut-out 1 dry cell 1.5V for resistance range.

Overall dimensions 210 x 115 x 90mm. in carryin g case, comp late with test leads. **POST FREE £15**

MULTIMETER

0.1-1-10-100-1000mA. 2.5-10-20-250-500-1000V. AC-DC. Sensitivity AC and DC all ranges except 10V-10,000 Ohm/V. Dimensions 211 x 118 x 75mm. Weight 2.9 lbs. Price complete with steel carrying case and test leads. **post free £4.95**



UNIQUE MULTIMETER/SIGNAL GENERATOR

Taut suspension movement. Simple multimeter combined with audio I.F. Test Oscillator providing AC and DC Voltage ranges. D.C.

current ranges and resistance ranges. 1kHz and 485kHz oscillator output makes the instruments suitable for general tuning of receivers etc.

Scale length: 65mm. D.C. voltage ranges: 0.5, 2.5, 10, 50, 250, 500, 1000V. A.C. voltage ranges: 2.5, 10, 15, 250, 500, 1000V. D.C. current ranges: 0.05, 0.5, 5, 50, 500mA

Sensitivity: 20,000 Ω /V. Resistance ranges: 5-100k Ω mid-scale reading 50k Ω 10k Ω ; mid-scale reading 500 Ω 50k Ω -100k Ω ; mid-scale reading 5k Ω 5k Ω -1m Ω mid-scale reading 50k Ω

Accuracy: 5% of F.S.O. Internal battery: 3V dry cell. Oscillator output 1kHz squarewave. 485kHz sinewave modulated by 1kHz squarewave signal. Output voltage: 1V minimum.

Overall dimensions: 160 x 97 x 40mm. in carrying case, complete with test leads. **£7.00 POST FREE**

ELECTRONIC TIME DELAY SWITCH

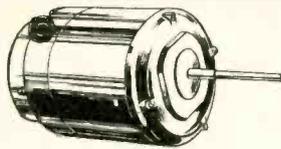
Delay period 1-25 minutes adjustable, load 1000 watts maximum. Operating Voltage 180-250V a.c. 50Hz. Size 3 $\frac{1}{2}$ x 3 $\frac{1}{2}$ x 1 $\frac{1}{2}$ Standard Ivory Surface mounting Box. **Trade Price £5.80 POST FREE**



ADD 10% VAT TO ALL PRICES • PROMPT DESPATCH MAIL ORDER CALLERS WELCOME MON-FRI 9 A.M. to 5.30 P.M.

Add £2 towards the cost of packing and carriage on all items for U.K. delivery (except where packing and carriage are already indicated).

ELECTRONIC BROKERS LTD. 49-53 Pancras Road, London NW1 2QB. Tel 01-837 7781

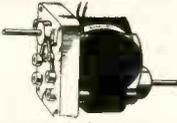


"SLO-SYN" 3-LEAD SYNCHRONOUS STEPPING MOTOR

Type SS15. These fine motors are easily reversed, starting and stopping in less than 5° without electrical or mechanical braking. Simple relay circuit can be applied to give DC., to winding for a maximum holding torque of 300oz/in with 35v at 0.35amps through winding. For A.C. (synchronous) operation at 120v., 50Hz. Speed 60 rpm at 60Hz., 72 rpm. STEPPING. Holding torque at 60 steps per second—100 oz/in. Can be wired to give 100 or 200 steps per revolution with accuracy of 0.1° per step non-cumulative. Torque characteristics can be modified by simple R.C. circuits. Dimensions: dia. 4", body length 4½", spindle length 2½" x 1/8" dia. Weight 1½ lbs. BRAND NEW in maker's packing. Offered at less than ½ maker's price. **£15**

OPEN FRAME shaded pole GEARED MOTORS

(Dural gear case)
240 A.C. 28rpm. 11W
HIGH TORQUE approx.
overall size: 3½" x 3½" x 2½" + spindle 1/8" dia. as illustrated. £3. P. & P. 30p.
Similar to above, 19rpm. £3. P. & P. 30p.
110rpm with pressed steel gear case (similar to above but slightly smaller). £3. P. & P. 30p.



CARTER ELECTRIC

Similar to above with alloy gear case, 60 r.p.m. This item is ex-equipment but perfect. £1.95. P & P 30p.



SMITHS RINGER-TIMER

Reliable 15 minute times, spring wound (concurrent with time setting) 15x1min divisions, approximately 1/2 between divisions. Panel mounting with chrome bezel 3½" dia. £1.40. 15p. P. & P.

FEW ONLY

Fully stabilised "Labgear" Power Supply Unit. Input 90-240v. 50Hz. Outputs 6v, 6a D.C., and 6v+2v, 100mA. Hum and ripple at full load—less than 3mV peak to peak. Stability improvement ratio for 15% mains change—1/1000:1. Output impedance 0.005 ohms. 9½" x 9½" x 12½". Weight 20½lb. £39.50. Carr. & Pkg £1.50. In manufacturer's carton.

"LABGEAR ELIMINATOR"

P.S.U. 200-250v. 40/60Hz. Alternative outputs fully variable (variac incorporated). Output 1. 12v at 5a D.C. fully smoothed. Output 2. 12v at 8a D.C. with ripple content. Output 3. 20v at 10a A.C. 2½" x 2½" flush 0.20v D.C. mic meter. In attractive grey hammer finish case. In maker's carton. £41.50. Carr. & Pkg. £1.50.

SHADED POLE MAINS MOTOR

A quality shaded pole motor. Open frame. 3" high x 2½" x 2". Spindle 1" x 1/8". 1.4 20r.p.m. £1.95 P & P 20p.

SOLENOIDS

by WESTOOL

240AC type MM6. 3lb. pull, 2½" x 1" x 1½". Travel 1". 90p each. P.&P. 10p.

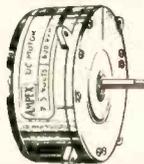


240AC type MM4. 2lb. pull, 1½" x 1½" x 1". Travel ½". 70p each. P. & P. 10p. Quantity discounts; 10-50 10%. 50 upwards 25%



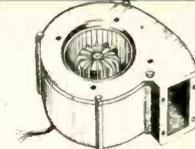
MAINS SOLENOID

This little unit gives vertical lift of approximately 1" through hinged "elbow". Bracket incorporates 2 fixing screws. Length of arm, 2½". 240V A.C. Pull at coil is approximately 1½lb. £1. FREE P. & P. Special quotes for quantities.



AMPEX 7.5v. DC MOTOR

An ultra precision tape motor designed for use in the AG20 portable recorder. Torque 450GM/CM. Stall load at 500ma. Draws 60ma on run. 600rpm ± speed adjustment. Internal AF/RF suppression. 1/2" dia. x 1" spindle, motor 3" dia. x 1½". Original cost £18.50. OUR PRICE £3.33. P. & P. 25p. Large quantities available (special quotations). Mu-metal enclosure available. 75p each. FREE P. & P.



ULTRA PRECISION CENTRIFUGAL BLOWER by Air Control Ltd.

30 segments individually balanced in heavy cast alloy case. 2,300 r.p.m. 240v A.C. Very powerful and silent running. 5½" dia. 3" inlet dia. Outlet flange 3" x 2½". **Limited number only £8.95 P & P 40p.**

SILVANIA MAGNETIC SWITCH

Now complete with reference magnet!

A magnetically activated switch, vacuum sealed in a glass envelope. Silver contacts, normally closed. Rated 3amp at 120v. 1½amp at 240v. Size: (approx.) 1½" long x 1" dia. Ideal for burglar alarms, security systems etc., and wherever non-mechanical switching is required. 10 for £2; P & P 15p. 50 for £8.80; 100 for £16.50. FREE P.&P. over 10.

NORPLEX

The famous American fibre-glass copper-clad laminate. Finest quality with woven glass base of Epoxy-resin. Excellent Mech. and Elec. conductive properties. Heat resistant. Ideal for P.C.'s etc. THIS IS A SPECIAL PURCHASE AND ONLY AVAILABLE WHILE STOCKS LAST! Sizes: 12" x 12"; 24" x 12"; 24" x 24"; FULL SHEET 43" x 37" (11 sq. ft.). Single-sided Copper with thickness of 1/32", 3/64", 3/32". Also double-sided 1/32", 1/16", 3/32". £1 per sq. ft. Cut sizes (1-10 sq. ft.) 25p. P. & P. Full Sheet £8 each. Carr. £1 for 1st sheet plus 25p each additional sheet.

KNOWLE (U.S.A.) MINIATURE MICROPHONE CAPSULES

Impedance approx. 200Ω, output 60 or 80 DB at 1 Kc. As used in deaf aids, bugging devices, etc. Size (60 DB) 7/32" x 5/32" x 1/8"; (80 DB) 1/2" x 5/32" x 1/8". Ex-equipment, all tested. £1.50 each. P. & P. FREE.

ALL PRICES INCLUDE V.A.T.

Whilst we welcome official orders from established companies and Educational Departments, it is no longer practical to invoice goods under £5. Therefore, please remit cash with orders below this amount.

ELECTRO-TECH COMPONENTS LTD.

315/317, EDGWARE ROAD, LONDON, W2.
Tel: 01-723 5667 01-402 5580

ELECTRONIC ORGAN DIVIDER BOARDS built to high industrial/computer spec. 5 octave set £15. Complete with connection data and oscillator details.

COPPER LAMINATE P.C. BOARD

8½ x 5½ x 1/16 in. 12½p sheet, 5 for 50p
11 x 6½ x 1/16 in. 19p sheet, 4 for 50p
11 x 8 x 1/16 in. 20p sheet, 3 for 50p
16½ x 4 x 1/16 in. (Fibreglass), 30p sheet.
Offcut pack (smallest 4 x 2 in.) 50p 30q. in.
P&P single sheet 4p. Bargain packs 20p

TELEPHONE DIALS (New) £1 ea.

RELAYS (G.P.O. '3000'). All types. Brand new from 37½p ea. 10 up quotations only.
EXTENSION TELEPHONES (Type 706) Various Colours £3-50. P.P. 25p. Excellent condition.
RATCHET RELAYS. (310 ohm) Various Types 85p. P.P. 5p.
UNISELECTORS (NEW) 25 way 12 Bank (Non Bridging) 68 ohms. £6. P.P. 30p.



PRECISION A.C. MILLIVOLTMETER (Solatron) 1.5m.v. to 15v; 60db to 20db. 9 ranges. Excellent condition. £22-50. P.P. £1-50.

HIGH CAPACITY ELECTROLYTICS

2,200µf. 100v. (1½ x 4in.) 60p. 3,150µf. 40v. (1½ x 4in.) 60p. 10,000µf. 25v. (1½ x 4½in.) 60p. 10,000µf. 100v. (2½ x 4½in.) £1. 12,000µf. 40v. (2 x 4in.) 75p. 16,000µf. 16v. (2 x 4in.) 60p. 21,000µf. 40v. (2½ x 4in.) £1. Post and packing 5p.

2,800µf. 100v. (4½ x 2 in.). 80p. 15,000µf. 63v. (4½ x 2½ in.). £1.
ROTARY VACUUM PUMPS (GS10) with Motor on Bedplate. £25. P.P. £2.

HIGH VACUUM DIFFUSION PUMPS (Metrovac 093C). New condition. £40. P.P. £2. A.E.I. P10. ION Pump Control Units. £17-50.

OVERLOAD CUT-OUTS. Panel mounting (1½ x 1½ x ½in.) 800 M/A/1-8 amp/10 amp. 35p ea. P.P. 5p.

BULK COMPONENT OFFER. Resistors/Capacitors. All types and values. All new modern components. Over 500 pieces £2. (Trial order 100pcs. 50p.) We are confident you will re-order.

REGULATED POWER SUPPLY. Input 110/240v. Output 9v. DC. 1½ amp. 12v. D.C. 500 m/a. £4. P.P. 30p.

U.K. ORDERS 10% V.A.T. SURCHARGE

TRANSFORMERS

ADVANCE "VOLSTAT" TRANSFORMERS. Input 242v. A.C.

CV50. 38v. at 1 amp; 25v. at 100 m/a. 75v. at 200 m/a. £2 ea. P.P. 40p.

CV75. 25v. at 2½ amp. £2-50. P.P. 50p.

CV100. 50v. at 2 amp; 50v. at 100 m/a. £3. P.P. 50p.

CV250. 25v. at 8 amp; 75v. at ½ amp. £5. P.P. £1.

CV500. 45v. at 3 amp; 35v. at 2 amp; 25v. at 3 amp. £7. P.P. £1.

L.T. TRANSFORMER. Prim. 240v. Sec. 13v. at 1.5 amp. 75p. P.P. 15p.

L.T. TRANSFORMER. Prim. 240v. Sec. 24v. at 1½ amp. £1-20. P.P. 20p.

L.T. TRANSFORMER. Prim. 110/240v. Sec. 0/24/40v. 1½ amp. (Shrouded). £1-50. P.P. 30p.

L.T. TRANSFORMER. Prim. 110/240v. Sec. 28/0/28v. at 2 amp; 10.5v. at 1 amp. (Shrouded). £2-25. P.P. 40p.

L.T. TRANSFORMER. Prim. 200/250v. Sec. 20/40/60v. at 2 amp. (Shrouded). £2-25. P.P. 40p.

L.T. TRANSFORMER (H.O.) Prim. 200/250v. Sec. 18v. at 27 amp; 40v. at 9-8 amp; 40v. at 3-6 amp; 52v. at 1 amp; 25v. at 3-7 amp. £15. P.P. £2.

H.T./L.T. TRANSFORMER. Prim. 200/250v. Sec. 1-500/0/500v. 150 n/a. Sec. 2 31v. at 5 amp. £3. P.P. 75p.

E.H.T. TRANSFORMER. 240v. Sec. 2.5-0-2.5 K.V. at 12 m/a; 7.5v. at 1 amp; 2.5v. at 2 amp. £2-50. P.P. 35p.

E.H.T. TRANSFORMER. 240v. Sec. 1800v. 50 mA. £2-50. P.P. 50p.

250W. ISOLATION TRANSFORMER. 240v. £3-25. P.P. 50p.

1000W. ISOLATION TRANSFORMER. 220/240v.-242v. (c' core type). £12. P.P. £1-50.

2500W. ISOLATION TRANSFORMER (CONSTANT VOLTAGE). Prim. 190-260v. 50 HZ. Sec. 230v. at 10.9 amp. £30. Carr. £2.

500W. STEP-DOWN TRANSFORMER. (Double wound.) 240v.-115v. 50 HZ. £6-50. P.P. £1.

2300W. STEP-DOWN TRANSFORMER. (Double wound.) 240v.-117v. 50 HZ. £22-50. P.P. £2.

HIGH-SPEED MAGNETIC COUNTERS. 4 digit (non reset) 24v. or 48v. (state which) 4 x 1 x 1 in. 40p. P.P. 5p.



5 digit (non-reset) 6-12-24-48v. (state which) 75p. P.P. 5p.

3 digit 12v. (Rotary Reset) 2½ x 1½ x 1½ in. £1 each
3 digit 12v. (Reset) 3½ x 1 x 1 in. £2-25. P.P. 5p.
5 digit (Reset) 12v. £3. P.P. 5p.

MULTICORE CABLE (P.V.C.)

6 core (6 colours) 3 screened, 14/0048. 15p. yd. 100 yds. £12-50.

20 core (2 screened) 17ip yd. 100 yds. £15.

24 core (24 colours) 20p. yd. 100 yds. £17-50.

30 core (15 colours) 22ip. yd. 100 yds. £18-50.

34 core (17 colours) 25p. yd. 100 yds. £20.

Minimum order 10 yds.

REBBIION CABLE (8 colours)

£1-25

10m.

8 cores. 7/ mm. bonded side by side in ribbon form.

SMALL MOTOR (1/50 H.P.) 900 R.P.M. 230/250v. A.C. £1-50. P.P. 30p.

RELAYS

SIEMENS/VARLEY PLUG-IN. Complete with transparent dust covers and bases. 2 pole c/o contacts 35p ea.; 6 make contacts 40p ea.; 4 pole c/o contacts 50p ea. 6-12-24-48v types in stock.

12 VOLT H.O. RELAYS (3x2x1 in.) with 10 amp. silver contacts 2 pole c/o 40p ea.; 2 pole 3 way 40p. P.P. 5p.

24 VOLT H.O. RELAYS (2x2x½ in.) 10 amp. contacts. 4 pole c/o. 40p ea. P.P. 5p.

240v. A.C. RELAYS. (Plug-in type). 3 change-over 10 amp. contacts. 75p (with base). P.P. 5p.

P.A.R. BISTABLE RELAY (Latching) P.P. 5p. 24v. D.C. 4 c/o contacts 65p. P.P. 5p.

SILICON BRIDGES. 100 P.I.V. 1 amp. (½ x 1½ in.) 30p 200 P.I.V. 2 amp. 60p.

24 VOLT A.C. RELAYS (Plug-in).

3 Pole Change-over 60p.

2 Pole Change-over 45p.

PATTRICK & KINNIE

191 LONDON ROAD · ROMFORD · ESSEX
ROMFORD 44473 RM7 9DD

Principles and Calculations for Radio Mechanics Part 1

R. A. Bravery and A. P. Gilbert

Part of the Radio, Television and Electronics Servicing Series, this volume deals with the subject matter for Part 1 of the City and Guilds Radio Mechanics Course 222.

1974 152 pp., illustrated 0 408 00119 4 £1.50

Rapid Servicing of Transistor Equipment 2nd Edition

Gordon J. King

This completely revised second edition takes account of recent developments such as capacitor-diodes, f.e.t.s and integrated circuits.

1973 180pp., illustrated 0 408 00116 X £1.90

Robotics

John F. Young

The object of this book is to present a comprehensive and orderly account of the principles and practice of robotics. It will provide a valuable source of reference for research workers and those in related fields.

1973 304 pp., illustrated 0 408 70522 2 £6.00

Obtainable through any bookseller or from

The Butterworth Group

Borough Green, Sevenoaks, Kent TN15 8PH. Tel. Borough Green 2247.

CAVERN ELECTRONICS

1974 COMPONENTS CATALOGUE

30p plus 11p Post and Packing

HUNDREDS OF COMPONENTS · ILLUSTRATIONS · DATA

Details of our Credit Scheme included.

Send Cheque or P.O. for 41p to:—

CAVERN ELECTRONICS
94 Stratford Road, Wolverton
MILTON KEYNES MK12 5LU

Retail Counter open Tuesday to Saturday

WW—123 FOR FURTHER DETAILS

Audio Connectors

Broadcast pattern jackfields, jackcords, plugs and jacks
Quick disconnect microphone connectors
Amphenol (Tuchel) miniature connectors with coupling nut
Hirschmann Banana plugs and test probes
XLR compatible in-line attenuators and reversers

Low cost slider faders by Ruf

Future Film Developments Ltd.
90 Wardour Street,
London W1V 3LE
01- 437 1892/3

WW—124 FOR FURTHER DETAILS

The new **Oryx 50** is temperature controlled, light, small, easy to handle, rapid heating and high performance. It has a temperature control within $\pm 2C$ and adjusted in seconds whilst running to any value between 200C and 400C. Longlife iron-coated tip as standard (11 sizes available).

Oryx De-Soldering Irons—small model SR3A instantly removes solder from printed circuits, etc., accurate, reliable, simple, PTFE nozzle. Larger instrument SR2 gives more suck, less recoil as only piston moves.

Oryx 50 Iron
1 @ £6.60

De-Soldering Tools
SR3A £5.06
SR2 £6.65

Safety Stand £2.44

Prices include P. & P. and VAT.

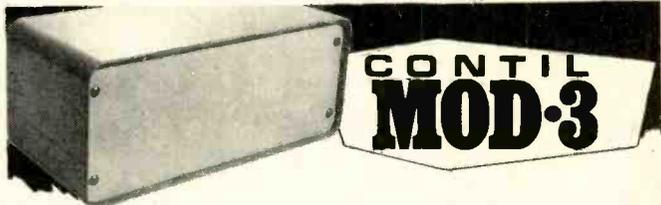
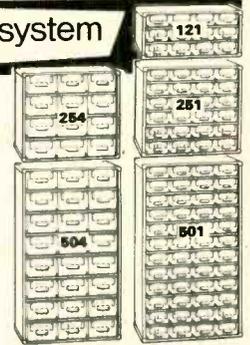


WH·MK spacemiser storage system

Cabinets have stove enamelled steel frames in three heights all of equal width and depth. The frames are strong and rigid, fitted with top and bottom locating pegs and rear slots making stacking, wall or frame mounting positive and simple.

121, 122, 123, 124	£4.07
251, 252, 253	£6.16
501, 502, 503	£10.67
254, 257, 258	£5.83
504, 507, 508	£10.01

All prices include P. & P. and VAT.



Contil Mod-3 cases are in six sizes and offer the manufacturer of small instruments an attractive low cost case available ex-stock. Made in blue PVC-coated steel and complete with front and rear panels and chassis, they are light, strong and rigid. PCB and PSU mounting systems available.

Mod-301	£3.54	Mod-304	£4.20
Mod-302	£3.71	Mod-305	£5.21
Mod-303	£4.20	Mod-306	£5.77

Less for quantities
Prices include P. & P., VAT, feet and screws



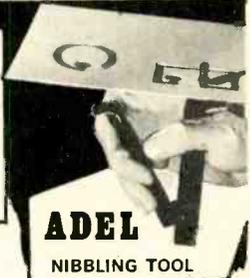
BRADRAD DRILLING & DEBURRING TOOL equals eleven drills. One cut drills and deburrs the normal run of steels, aluminium, brass, copper and all types of plastics, perspex, fibreglass, etc. and hardboard should the need arise it is designed to overcome all the problems associated with drilling thin materials—it drills interlocking holes for instance.

$\frac{1}{4}$ "- $2\frac{1}{2}$ " in $\frac{1}{8}$ " steps or 6-36mm in 3mm steps. Both with $\frac{1}{2}$ " shanks £10.75
Also $1\frac{1}{2}$ "- $2\frac{1}{2}$ " and 36-60mm £27.88



Q-MAX METAL PUNCH

Q-MAX PUNCHES
 $\frac{3}{8}$ " £1.10
 $\frac{1}{2}$ " or $\frac{5}{8}$ " £1.27
 $\frac{3}{4}$ " or $\frac{7}{8}$ " £1.35
1", $1\frac{1}{8}$ ", $1\frac{1}{4}$ " £1.73
 $1\frac{1}{2}$ " £1.84



ADEL NIBBLING TOOL
The Adel cuts holes of virtually any shape and size starting from a $\frac{1}{16}$ " hole, cutting cleanly like a punch and die. Ideal for notching clearances on flanges of cabinets or chassis. £4.81.
All prices include P. & P. and VAT.

Available in a range of six sizes in 21-gauge Zintec with blue Acrylic texture. Front panels white Zintec steel or PVC/Aluminium.



Width	Depth	Height	No.	Case cost	Extra for ali. panel
7"	5"	5"	755	£5.59	23p.
8	6	7	867	£6.12	19p.
9	7	5	975	£6.12	19p.
12	7	7	1277	£6.73	18p.
unpainted					
12	7	7	1277	£5.56	—
16	12	7	16127	£9.55	50p.
19	10	10	191010	£13.17	—

Less for quantities. Prices include steel panel with feet and screws, P. & P. and VAT.

Prices correct March 1974.
WEST HYDE DEVELOPMENTS Ltd., Ryefield Cres., Northwood Hills, Northwood, Middx HA6 1NN.
Tel: Northwood 24941/26732



Write or 'phone for new free catalogue.
WW—139 FOR FURTHER DETAILS

Telex: 923231

TEKTRONIX 536 Oscilloscope with T & CA plug-ins £295.

MAINS STABILISERS

SERVOMEX type AC2—9 amps. £20 ea.
SERVOMEX type AC7—30 amps. £35 ea.
Carriage £1.50

AMERICAN SWEEP GENERATOR type 452. Covers from 5 to 100 MHz. Has built in display and 101 DB Push Button RF Attenuator in one DB steps, plus Calibrated Marker Generator covering 5 to 100 MHz continuous. American Government Contract, so quality is high. Supplied for 240V 50 HZ operation with plugs and leads. Size 13 1/2 x 9 1/2 x 19in. Price £70 each. Carriage £1.50.

AMERICAN SWEEP GENERATOR type TRM 3 15 to 400 MHz. £300.

AMERICAN POWER UNITS STANOARO 230V 50 HZ Input 28V 40 AMP OUTPUT. Size 22 x 16 x 9in. Supplied in original transit case £25.

AMERICAN AM GENERATOR type 497. 4 to 400 MHz. Supplied with leads, etc., for 240V 50 HZ operation £35.

GERTCH Frequency Meters FM3 20 MHz—1000 MHz. £80.00 each. Carriage £1.50.

12" LONG PERSISTENCE TUBES. Type 12DP7A. Connections, voltages, etc. Brand New Boxed £7.50 each including carriage and V.A.T.

MARCONI TF 1026 Frequency Meters 125—250 MHz. £25.00 each. Postage 75p.

SPECIAL 40 MHZ SCOPE SOLARTRON CO1212 ONLY £50. Has to be a snag. There is no plug-in Y amps available. TB-100 nanosecs per cm. to 5 secs. per cm. in 24 calibrated ranges. 20 nanosecs per cm. with times 5 expansion. 5" flat faced tube. Trace locator. 0.2 microsec. signal delay. Built in calibrator. 1 KHZ square wave. 200 micro volts to 100 volts in 18 calibrated ranges. Tube sensitivity 3 V/CM MAIN FRAM Y AMP boosts this to better than 200mV per cm. at 40 MHz. 240V. 50 HZ input. Complete with full manual including plug-in circuits. Come and see one working or Carriage £1.50.

***STILL at £42.50**

Solartron CD 7115.2 Double Beam Oscilloscope DC—9 mcs/s; 3 mV/cm; trigger delay; crystal calibrator; 4" flat faced tube. In good working condition. Carr. £1.50.

SOLARTRON CO 523 Single Beam Oscilloscope 3db at 10 MHz; 1mV max sensitivity. DC coupled down to 1 vol. 4in. flat faced PDA tube. TB from 1 secs. per cm. to 0.1 microsecs. per cm. plus times 5 expansion £50.

MARCONI TF 195M-0/40 KHZ Sine Wave Generator 0/40 Volts output Metered. These must go £7.25.

MARCONI TF 801B. AM SIGNAL GENERATOR. 12 to 470 MHz. In good working condition £90.

MARCONI TF 938 (CT44). Absorption Wattmeter 10mW to 6 Watts. Input impedance 2.5 ohms to 20K ohms. Freq. response flat at 20KHZ. Calibrated in volts and db's. 5in. mirror backed meter £7.50 ea. P. & P. 75p.

MARCONI VVM TF1041A £22.50.

MARCONI TF 428C. Measures AC 100MV to 150V 20HZ to 15 MHz. Measures DC 40MV to 300V. Complete with probe. Standard 240V operation £12.50 each.

MARCONI TF899. Measures 20MV to 2V AC. 50 HZ to 100 MHz. £10 each.

MARCONI VVM TF 1300. Measures AC 50MV to 100V, 20 HZ to 300 MHz. DC 100MV to 300V. Ohms 50 to 5 Meg Ohm. In fine condition £18 each.

AVO TRANSISTOR AND DIODE TESTER TYPE CT 537. In superb condition, in original crates with full instructions, circuit diagram, etc. New price £250 Plus. **OUR PRICE** £40 ea. Carr. £1.25.

RACAL RA17 RECEIVER from £230.

SLOPED CASES size 9 X 7in. with 8in. slope, 15in. long, in Hammer Grey. Brand New boxed £1. Packing and postage 37p.

E.H.T. TRANSFORMERS. e.g. 9.5kV-0—9.5kV 3kVA Single phase. £45 each Carriage at cost. Others available Single and 3 Phase and High Voltage Power Units.

BRAND NEW AMERICAN HIGH VOLTAGE CAPACITORS. 0.15mfd 120KV working. £20 each. Carriage at cost.

MODERN TELEPHONES type 706. Two tone grey. £3.75 ea. Two-tone green £3.75 ea. Black £2.75 ea. P. & P. 25p ea.

Ideal **EXTENSION** Telephones with standard GPO type dial, bell and lead coding. £1.75 ea. P. & P. 25p.

All telephones complete with bell and dial.

POTENTIOMETERS

COLVERN 3 watt. Brand new, 25; 50k all at 13p ea.

MORGANITE Special Brand new, 2.5; 10; 100; 250; 500K; 1 in. sealed, 17p ea.

BERCO 2 1/2 Watt. Brand new, 5; 10; 50; 250; ohms; 1; 2.5; 10; 25; 50K at 15p ea.

STANOARO 2 meg. log pots. Current type 15p ea.

INSTRUMENT 3 in. Colvern 5 ohm 35p ea.; 50k and 100K 50p ea.

BOURNS TRIMPOT POTENTIOMETERS. 20; 50; 100; 200; 500 ohms; 1; 2; 2.5; 5; 10; 25k at 35p ea. ALL BRAND NEW.

RELIANE P.C.B. mounting; 270; 470; 500 ohms; 10K at 35p ea. ALL BRAND NEW.

ALMA precision resistors 200K; 400K; 497K; 998K; 1 meg—0.1% 27p ea.; 3.25k, 5.6k, 13k—0.1% 20p ea.

CAPACITORS. Brand New. 10,000mfd 50V 60p ea. P & P 15p.

RELAYS

Varley VP4 Plastic covers 4 pole c/o 5K—30p ea. 15K—33p ea.

CARPENTERS polarised Single pole c/o 20 and 65 ohm coil as new 37p each. 14 ohm coil 33p each. 45 ohm coil 33p each.

TRANSFORMERS. All standard inputs.

Gard/Parm/Part. 450-400-0-400-450. 180 MA. 2 x 6.3v. £3 ea.

Neptune Series. Multi 6.3 volts to give 48V at 3.5 amps etc. £3.50 incl. P. & P.

Large quantity LT, HT, EHT transformers and chokes.

S.T.C. PUSH BUTTON ATTENUATORS. 0-9; or 0-90 in 1 db steps. State choice £3 ea. P. & P. 37p or £5 a pair P. & P. 57p.

MUIRHEAD Attenuator D239B. 85 db's in 1 db steps. £3 each. P. & P. 37p.

COLVERN TEN TURN POTS, ex eq. 100K at 60p each. Complete with dial £1.50 each. P. & P. 15p.

£1 WORTH OF 'UFS'. Six Brand New capacitors all between 15V and 100V. Total capacitance not less than 7,000mfd. P. & P. 45p.

CAPACITOR PACK 50 Brand new components only 50p. P. & P. 17p.

POTS 10 different values. Brand new. 50p. P. & P. 17p.

COMPONENT PACK consisting of 5 pots various values, 250 resistors 1 and 1 watt etc., many high stabs. All brand new. Fine value at 50p per pack. P. & P. 17p.

DELIVERED TO YOUR DOOR 1 cwt. of Electronic Scrap chassis, boards, etc. No Rubbish. FOR ONLY £3.50. N. Ireland £2 extra.

P.C.B. PACK S & D. Quantity 2 sq. ft.—no tiny pieces. 50p plus P. & P. 20p.

FIBRE GLASS as above £1 plus P. & P. 20p.

5 CRYSTALS 70 to 90kHz. Our choice, 25p. P. & P. 15p.

TRIMMER PACK, 2 Twin 50/200 pf ceramic; 2 Twin 10/60 pf ceramic; 2 min strips with 4 preset 5/20 pf on each; 3 air spaced preset 30/100 pf on ceramic base. ALL BRAND NEW 25p the LOT. P. & P. 10p.

ROTARY SWITCH PACK—6 Brand New switches (1 ceramic; 1-4 pole 2 way etc.), 50p. P. & P. 20p.

FLAT FACED 4" Twin Beam Tube. Type CV2193. (Cossor 893D). Green Trace Brand New. £4 each. P. & P. 37p.

C.R.T.'s 5" type CV1385/ACR13. Brand new with spec. sheet. 69p ea. P. & P. 35p.

TUBE type VCR138 £2 ea. P. & P. 37p. Numetal shields 80p ea.

BASES for CV1385 or VCR138 20p ea. P. & P. 15p.

GRATICULES. 12 cm. by 14 cm. in High Quality plastic. 15p each. P. & P. 5p.

PANEL mounting lamp holders. Red or green. 9p ea. Miniature. **PANEL** mounting lamp with holders—10V 15MA 5p ea.

BECKMAN MODEL A. Ten turn po complete with dial. 100k 3% Tol 0.25%—only £2.13 ea.
Also 450K 0.5% with dial £2.13 ea.

ELECTROSTATIC VOLTMEETERS from 0-500 Volts to 0-10KV. S.A.E. with your requirements.

FIBRE GLASS PRINTED CIRCUIT BOARD. Brand new. Single sided up to 2 1/2" wide x 15" 1p per sq. in. Larger pieces 1p per sq. in. Double sided. Any size 1p per sq. in. Postage 10p per order.

INTEGRATED CIRCUIT test clip by AP inc. Gold Plated clip-on. Brand New individually boxed. £1.00 ea. P. & P. 10p.

DECADE DIAL UP SWITCH—5 DIGIT. Complete with escutcheon. Black with white figures. Size 4in. long x 1in. high x 1 1/2in. deep. Ex-Plessey. £1.40 each. P. & P. 15p.

LIGHT EMITTING DIODES (Red) from Hewlett-Packard. Brand New 38p ea. Information 5p. Holders 1p.

SANGO 50 micro amp meter. 2 1/2" diameter. Ex-brand new radiation equip. £1.25 ea. P. & P. 17p.

FIVE moving coil meters £2 P. & P. 37p.

VISCONOL EHT CAPACITORS

0.05mfd 2.5kv 50p ea. 0.01mfd 5kv 40p ea. 0.05mfd 8kv 50p ea. 0.01mfd 10kv 50p ea. 0.002mfd 15kv 65p ea. 0.1 mfd 4kv 35p ea.

OUILLIER 0.1mfd 5 KV; 0.1mfd 7.5 KV; 0.25mfd 7.5 KV; 0.5mfd 5 KV all at 50p ea. P. & P. 15p.

OTHER BLOCK PAPER CAPACITORS AVAILABLE. S.A.E. with requirements.

PHOTOCELL equivalent OCP 71, 13p ea. Photo resistor type Clare 703 (TO5 case). Two for 50p.

MULLARO OCP70 10p each.

SPECTRUM ANALYSER MODULE

FREQUENCY RANGE 10-850 MHZ

Only requires any general purpose oscilloscope to enable the user to look at any frequency in the above range. Standard mains input. A professional instrument priced at **£68.00.** Plus V.A.T. at 10%. S.A.E. for brochure.

MAKE YOUR SINGLE BEAM SCOPE INTO A DOUBLE WITH OUR NEW LOW PRICED SOLID STATE SWITCH. 2 HZ to 8 MHz. Hook up a 9 volt battery and connect to your scope and have two traces for **ONLY £5.50.** P. & P. 25p.
STILL AVAILABLE our 20 MHz version at **£9.25.** P. & P. 25p.

20HZ to 200KHZ

SINE AND SQUARE WAVE GENERATOR

In four ranges. Wien bridge oscillator thermistor stabilised. Separate independent sine and square wave amplitude controls. 3V max sine, 6V max square outputs. Completely assembled P.C. Board, ready to use. 9 to 12V supply required. **£7.85** each. P & P 25p. Sine Wave only **£5.85** each. P & P 25p.

TRANSISTOR INVERTER

12V to 1.5 KV 2MA. Size 1 1/2 x 2 1/2 x 4in. Multi tapped secondary and output level control makes possible large range of voltage and current output combinations without modification. Very flexible unit at **£2.95** each. P. & P. 25p.

NEW WIDE RANGE WOBBLATOR

5 MHz to 150 MHz (Useful harmonics up to 1.5 GMZ) up to 15 MHz sweep width. Only 3 controls, preset RF level, sweep width and frequency. Ideal for 10.7 or TV IF alignment, filters, receivers. Can be used with any general purpose scope. Full instructions supplied. Connect 6.3V AC and use within minutes of receiving. All this for only **£5.75.** P. & P. 25p.

Unless stated—please add £1.50 carriage to all units.

VALUE ADDED TAX not included in prices—please add 10%

Official Orders Welcomed, Gov./Educational Depts., Authorities, etc., otherwise Cash with Order

Open 9 am to 6.30 pm any day (later by arrangement.)

CHILTMHEAD LTD

7/9 ARTHUR ROAD, READING, BERKS. (rear Tech. College, Kings Road) Tel.: Reading 582605/65916

APPOINTMENTS VACANT

BOX NUMBERS: Replies should be addressed to the Box number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London, SE1.

PHONE: Allan Petters on 01-261 8508 or 01-928 4597.

Classified Advertisement Rates are currently zero rated for the purpose of VAT.

Advertisements accepted up to 12 noon Friday, 5th April, for the April issue, subject to space being available.

Maintenance Engineers

Data Communications Network

We have two interesting new vacancies, due to continuing rapid expansion in services to member firms, for electronics engineers in our Communications Group. The group is responsible for fault-handling on three major networks: one is well-established, with two Argus 400s driving 1700 digi-tv displays in various parts of London; the second, now being commissioned, links 150 Olivetti teleprinters to two DEC PDP 11/40s, to provide a Remote Data Entry (RDE) service for London Members; the third, also being commissioned, extends the Argus system UK-wide via PDP 11s in major centres. Quite exceptionally high service levels are achieved, faults being located and repaired extremely rapidly.

The engineers we require are qualified to at least ONC level, experienced in maintaining data communications systems, and probably aged 25-35. They will work rotating 8 hour shifts between 9 a.m. and 7 p.m.



The Stock Exchange

The Centre Engineer

will record and progress faults, in particular diagnosing their whereabouts and initiating maintenance action. He has a sound knowledge of the principles of tv and data transmission. Starting salary probably £2,250-£2,700.

The Field Engineer

will at first work chiefly on the RDE network. He is skilled in rapid fault location, and preferably has some knowledge of the principles of tv transmission. Starting salary probably £1,750-£2,250.

These are permanent career positions with full fringe benefits. To reply please 'phone or write briefly to Ben Mee, The Stock Exchange, London, EC2N 1HP (01-588 2355 ext. 8064).

3369

ASSISTANT PROJECT ENGINEER FOR COLOUR SORTING MACHINES

A responsible man with drive and initiative is required in our development department to work directly under a project leader. He will require a working knowledge of both electronics and mechanics, and be capable of working with the minimum of supervision.

Why not ring 01-980 6041 for an informal discussion, or write to:

Mr Ken Hurley,
Gunson's Sortex Ltd.,
46-52 Fairfield Road,
Bow, London E3 2QQ.



Sortex

3590

RADIO OPERATORS JOIN THE POST OFFICE FROM AGE 19

A job in the Post Office Maritime Service is the key to an interesting career, whether you have recently qualified and are looking for a shore-based job, or are seagoing and wish to swallow the anchor. A progressive future in the Post Office could be yours if you hold a General Certificate in Radiocommunication, issued by the Ministry of Posts and Telecommunications, or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic.

Starting pay at age 19 is £1,450 a year, including contributions to a compulsory pension scheme, with an additional allowance averaging £300 for shift duties. After two years, satisfactory service your pay becomes £1,840, rising to a maximum of £2,450 at age 26 years. If you are over 19 years of age your salary is dependent upon age at entry.

There are opportunities for further promotion to positions with a basic salary of £3,475 and prospects for advancement into Senior Management.

For further information, write to the Inspector of Wireless Telegraphy (L57.), IMTR/WTS, Room 643, Armour House, St. Martins-le-Grand, London EC1A 1AR.

Post Office
Telecommunications

Looking for a Career ? Not just a job? in Electronics



Our Industrial Applications Department is currently engaged on an extensive research programme covering a wide range of electro-magnetic interference topics, in particular the interference characteristics of electrical, electronic equipment and systems from avionics to computers. The programme includes investigation of new measuring techniques and development of specialised circuit and measuring instruments where necessary. The equipment in our laboratories is fully up to date and highly sophisticated.

We would like to hear from you if you are interested in radio, electronics, communications and related fields. Basically what we are looking for are young people with *potential*, as opposed to experience, in these areas. Whether you are qualified to 'O' Level or 'A' Level standard or whether you have a relevant ONC/HNC qualification (or come to that, a degree in electrical/electronic engineering) we would very much like to discuss with you the career prospects we offer.

Full on-the-job training will be provided and you will be encouraged to obtain further technical qualifications by day-release. Course and examination fees will be paid and one week's revision leave will be provided each year, over and above your normal three weeks holiday entitlement.

Commencing salaries are fully competitive and are reviewed annually to match performance. Wherever possible we like to promote from within the organisation.

ERA offers extremely attractive working conditions in a pleasant part of the Surrey countryside. Amenities include transport, plenty of car park space and a thriving sports and social club.

Phone for an application form or drop a line to —
The Personnel Manager, The Electrical Research Association,
Cleeve Road, Leatherhead, Surrey. Tel: Leatherhead 74151

3562

Glaxo

Start your Career in Electronics

If you have studied to 'A' level standard in science subjects and have an interest or some experience in electronics, this could be just the opportunity for you. We need a Junior Electronics Technician in our Physical Chemistry Department for duties which include construction of new apparatus and maintenance of electronic instruments used in chemical laboratories.

We will give you time off to study for further qualifications.

In addition to an attractive salary, which is regularly reviewed, we offer excellent conditions of employment including a bonus scheme.



Please apply quoting ref. ZH674 to the Personnel Officer (Research), Glaxo Laboratories Ltd., Greenford, Middlesex.

3405

Interested in computers, radio and radar?

Train to become an expert in air traffic control engineering

Vacancies exist for 3-year apprenticeships in the National Air Traffic Services of the Civil Aviation Authority. This is an excellent opportunity for enthusiastic young men and women who want to work with advanced computer, radio and radar systems, navigational and automatic landing aids.

Full Pay During Training: Apprentice Technicians receive starting pay of £883 - £1427 (reviewed periodically) according to age, plus annual increments and a

special £100 award on passing the first year's examinations. Promotion prospects are wide-ranging and opportunities exist for selected candidates based on performance and potential to pursue a course of study for a degree.

Entry Qualifications: If you will be over 16 or under 20 on 1 September 1974 you should or expect to have GCE passes in English Language, Mathematics, and one of the following - Physics, Physics with Chemistry, Mechanics or Mechanical Science. Normally the standard will be at A level for Mathematics and the Science subject, but applicants under 18 will be considered if they have the above subjects at O

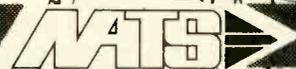
level and not less than five passes in all at this level. Preference will be given to those who already possess these qualifications. Scottish, Northern Ireland and CSE equivalents are acceptable.

For full details post this coupon to:

Mrs P. M. Annesley,
Personnel Branch (P2)
Room 520, Civil
Aviation Authority
129 Kingsway,
London WC2B 6NN
marking your envelope 'Recruitment'

Name.....
Address.....
.....
..... (w w)

(Not applicable to residents outside the United Kingdom)



National Air Traffic Services

There is scope,
variety and
responsibility as a

Radio Technician

Join the National Air Traffic Services of the Civil Aviation Authority as a Radio Technician and you have the prospect of a steadily developing career in a demanding and ever expanding field.

ENTRANCE QUALIFICATIONS

You should be 19 or over, with at least one year's practical experience in telecommunications. Preference will be given to those having ONC or qualifications in Telecommunications.

Once appointed and trained, you will be doing varied and vital work on some of the world's most advanced equipment including computers, radar and data extraction, automatic landing systems, communications and closed circuit television.

Vacancies exist at locations near London (Heathrow), London (Gatwick) and Stansted Airports and for suitably qualified people at the Signals Training Establishment, Milton Keynes, Bucks.

Salary: £1383 (at 19) to £1836 (at 25 or over); scale maximum £2158 (higher rates at Heathrow). Some posts attract shift-duty payments. Promotion prospects are excellent and ample opportunity and assistance is given to study for higher qualifications.

Mr R F Simons,
National Air Traffic Services,
STE (Recruitment), Bletchley Park,
Bletchley, Milton Keynes, Bucks.

Please send me application form for
entry as Radio Technician.

Name _____

Address _____



National Air Traffic Services

ELECTRICITY SUPPLY COMMISSION OF MALAWI

COMMUNICATION ENGINEER

The commission invites applications from suitably qualified persons for the above post.

Candidates should have a full City and Guilds Technological Certificate and at least five years' experience of V.H.F./F.M. radio; Power line carrier or multi-channel single sideband radio and equipment, and supervisory systems using relay logic/solid state digital techniques.

The successful candidate will be required to train a Malawian Engineer who will succeed him at the end of the contract period. Formal training experience will therefore be an advantage.

Salary, inclusive of tax free gratuity of 25%, will be in the scale £2,913 - £3,281, in addition the post carries the following fringe benefits:—

Housing with basic furniture at nominal rent;

Free medical attention for the employee and his family;

Vacational leave at the rate of four working days for every completed month of service plus local leave of twelve working days per annum;

Education allowances;

Removal expenses and air fares from and to the place of engagement.

Please apply to MALAWI BUYING AND TRADE AGENTS, Recruitment Section 32/34 St Johns Wood Road, London NW8 8RA for application form, quoting reference B.173.

[3516]

ELECTRONIC EVALUATION ENGINEER

We are manufacturers of the specialist range of Leak and Wharfedale Hi-Fi products and the demand for our quality products, which are designed, developed and manufactured to precise published specifications, is continually increasing. The company's policies, therefore, include controlled expansion, continuous improvement to current products and the extension of our product range.

A vacancy is available in the Engineering Function for an Electronic Evaluation Engineer to provide a technical support service on product evaluation and the supply of factored products. This will involve him in the assessment of performance, construction, safety and suitability of factored products and others and the preparation of written reports. This position will also demand close liaison with suppliers, quality control departments and product planning for the preparation and assistance with the technical specifications required.

Applicants should be educated to HNC or degree level and have had a minimum period of four years project or product experience in Hi-Fi Electronics or a closely related field.

The company's premises are located at Idle, Bradford, convenient for travelling from both Bradford and Leeds and near to the pleasant rural surroundings of the Aire Valley.

The company can offer competitive employment conditions including free life assurance and contributory pension scheme.

Application forms may be obtained from:



J. R. Murgatroyd,
Personnel Officer,
Rank Radio International,
Bradford Road, Idle,
Bradford BD10 8SF.
Tel: 612552

RANK RADIO INTERNATIONAL

3579

Customer Engineers

As one of the largest and most successful computer manufacturers, we place particular importance on the maintenance of a high level of customer service. Our equipment is among the most advanced in the world today. Highly sophisticated hardware used by top companies and organisations in commerce, industry, science and government.

Our Customer Service organisation is, therefore, immensely important to us if we are to maintain the high standards we have set ourselves over the years, during which we have pioneered much of the advanced technology in use today throughout the industry.

We're looking for Customer Engineers to carry out, to a high professional standard, all electronic and electro-mechanical work concerned with installation, modification, refurbishing, preventive and remedial maintenance on UNIVAC

equipment both in the UK and Europe.

We require men with a knowledge of electronic or mechanical fault-finding techniques. In addition to technical competence, essential requirements are a pleasant personality and the ability to maintain a good relationship with customers. Full product training will be given.

To Engineers looking for the best in salaries, vacancies exist in most parts of the country. Conditions and fringe benefits are what you would expect when you join a company within the international Sperry Rand organisation. Future career prospects in the computer field are excellent.

For vacancies in London or the South write with personal and career details to **Personnel Manager, Ref. WW, Sperry Univac, Univac House, 160 Euston Road, London NW1. Tel: 01-387 0911.**



For vacancies in the Midlands and North write with personal and career details to **Personnel Manager, Ref. WW, Sperry Univac, Lynnfield House, Church Street, Altrincham, Cheshire. Tel: 061-928 7731.**

SPERRY  **UNIVAC**
PROFIT FROM EXPERIENCE

Skilled in T.V. Electronics?

Here's a job to put you to the test

With the coming of colour TV, there has been a tremendous upsurge of opportunities for electronics people. It's an industry which is growing fast and at ITT in Hastings, this growth has been particularly apparent. Production is increasing rapidly to keep pace with the continuing demand for our sets throughout Europe.

Here in Hastings, we're looking for top-notch senior engineers to join our Test Engineering team. It's a job calling for formal electronics training followed by extensive practical experience of TV test as a Service Engineer, in the Forces or in industry.

If you'd like to put your ability to the test with ITT, we'd like to hear from you. It's an opportunity which, if you have the expertise we are looking for, could take you into the training areas of the Company. Generous additional benefits include pension and sickness schemes and assistance with re-location expenses where appropriate.

Write now with full details of your qualifications and experience to David Harris, Personnel Officer, ITT Consumer Products (UK) Ltd, Theaklen Drive, Hastings, Sussex TN34 1YL.



The heart of Hastings **ITT**

3578

Test Engineers

UP TO £2,600

Excellent career development opportunities are open to you at IAL.

Positions are immediately available within our rapidly expanding Electronics Engineering Division which will involve you in Testing, and Trouble Shooting on the most advanced solid state electronic assemblies and a wide range of sophisticated systems.

Interested? We are looking for men of ability with drive and initiative who have good practical experience and a sound technical background particularly in the data field. We would like to hear from you today. Excellent conditions and benefits include membership of a contributory pension and life insurance scheme.

IAL are a member of the British Airways Group and are engaged in aviation services, communications, electronics engineering and printing world wide.

Write or call for interview to:
Mr. R. Radcliffe, Personnel Officer (UK & E)
International Aeradio Ltd.,
Aeradio House, Hayes Road,
Southall, Middlesex.
01-574 2411

IAL INTERNATIONAL AERADIO

SERVICE ENGINEER

A vacancy exists in our Service Department for an experienced SERVICE ENGINEER with suitable qualifications, for servicing HF and VHF SSB and PM equipment.

Salary will be over £1800, dependent upon qualification and experience.

SALES ASSISTANT

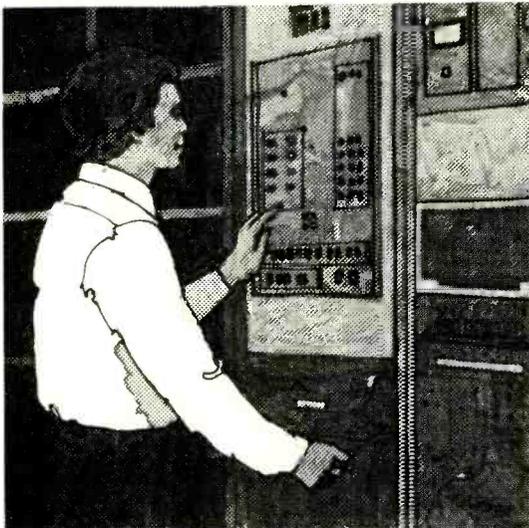
A young, lively person holding a Class A or B Radio Amateurs' licence is required to assist the Sales Manager. If you are interested in joining our team, we would be pleased to hear from you. Further details from the Managing Director, Western Electronics (U.K.) Ltd., Osborne Road, Totton, Southampton. Telephone: Totton 4930.

[3567]

The Flying Squad



We require young Electronics Engineers, with HNC or equivalent, who will learn to operate and maintain our advanced and highly sophisticated electronic equipment at transmitting stations throughout the country, bringing independent television and independent local radio into millions of homes.



Much of our work concerns the maintenance of remote unattended stations. Our mobile teams—the flying squad of the IBA—may be called on to rectify a fault at short notice—it may be during the year's worst thunderstorm or the hottest day of the summer. It could be

a false alarm—something that needs a good temperament to rush to a stormswept hillside when all is well, but more often there is a real job to be done.

You could join us—IBA run a special 18 month training course to give you a comprehensive knowledge of operations and maintenance techniques, plus an additional recognised qualification. To succeed you must be flexible about hours, willing to travel, able to drive and prepared to undertake a demanding training course. We'll pay you a training salary of between £1,461 and £1,851 and on successful completion of your training you will move to £2,253 with progression to £2,880 or more.

Interested? Simply write or 'phone for full details and application forms to:
The Personnel Officer,
Independent Broadcasting Authority,
Crawley Court, Winchester,
Hants. SO21 2QA. Tel: Winchester 822599.



IBA INDEPENDENT BROADCASTING AUTHORITY

SERVICE ENGINEERS

Take on Tomorrow's Technology as an IBM Computer Customer Engineer.

Get to grips with the latest developments in electronics and electro-mechanical design and you can really call yourself a Service Engineer. Let's face it—a lot of today's electronics are derived from computer-technology so it makes sense to get to the heart of it—computer servicing.

We'll train you thoroughly to service and maintain medium and large scale systems, data recording, tele-processing and data entry terminals. In fact, your training will be continuous because there will always be something new to learn. Our technology is continually evolving. So as our systems develop so will your engineering techniques.

You should be educated to 'O' level with a logical mind and a good mechanical aptitude. Knowledge of electronics is necessary for all but those primarily interested in working on Data Recording.

In addition you'll need the ability to communicate with people at all levels, the enthusiasm to work without supervision and be willing and able to accept responsibility.

Starting salaries are substantial. You'll enjoy above-average fringe benefits and prospects for promotion are particularly good in an organisation that promotes from within, on merit.

Right now we have opportunities throughout the UK, so if you're looking for a start with one of the world's top companies, write to Anne Dare, IBM United Kingdom Limited, 389 Chiswick High Road, London W4 4AL quoting ref. WW/91889



[3529]

telesonic marine ltd.

MARINE ELECTRONICS ENGINEER

Are you experienced in installing and servicing marine electronic equipment such as Radar, Navigation Equipment, and radio telephones? We require such a man for a fascinating job travelling to luxury yachts, etc., all round the country. If you live near London and are able to drive, a good salary awaits you working in idyllic friendly atmosphere.

Apply **Telesonic Marine Ltd.**

Tel: 01-387 7467

3391

LONDON BOROUGH OF HILLINGDON

VISUAL AND AURAL AIDS TECHNICIAN

suitably qualified and experienced person required to assist in the day to day maintenance and repair of visual and aural aids equipment in schools.

Salary £1,521-£1,749 p.a. incl. L.W. Current clean driving licence essential.

Ref: E/28/180. Closing date 31 January, 1974.

Application forms available from and returnable to Personnel Officer, Belmont House, 38 Market Square, High Street, Uxbridge, UB8 1TR.

[3421]

UNIVERSITY OF LIVERPOOL SCHOOL OF EDUCATION

TECHNICIAN (AVA and CCTV)

Invitations are invited for the above post to have overall responsibility for the AVA and CCTV provision in the School.

Applicants should be qualified and experienced in the fields of electronics and Audio Visual Aids and be capable of working on their own initiative and supervising other technicians. This is a new post with interesting possibilities for developing new forms of work in the field of Educational Technology. Salary within a range up to £2,382 per annum according to qualifications and experience.

Further particulars and application forms may be obtained from the Registrar, The University, P.O. Box 147, Liverpool, L69 3BX. Quote ref. RV/WW/80663. [3537]



Hamilton College of Education

require a

TELEVISION ENGINEER (COLOUR UNIT)

to join a team engaged in the operation, maintenance and development of the College service. At present the service consists of a two channel colour mobile control room with distribution facilities within the college.

Experience in video tape recorders and/or colour cameras and monitors an advantage.

Normal colour vision and driving licence essential. Annual leave will be 4 weeks.

Salary will be in the range £1530-£2100 (N.J.C. Grade IV, V and VI) depending on qualifications and experience. (Salary scales are at present under review.)

Further information and application forms may be obtained from the College Secretary by telephoning Hamilton 23241, or writing as soon as possible to:

COLLEGE OF EDUCATION,
Bothwell Road, Hamilton,
Lanarkshire, ML3 0BD.

[3401]

**THE BRITISH COUNCIL
QATAR
REGIONAL TRAINING CENTRE, DOHA
AN
INSTRUCTOR IN RADIO
AND TELEVISION SERVICING**

Candidates, men only, preferably between 28 and 35, should normally be citizens of and permanently resident in the United Kingdom and have a British educational background. They must have relevant C & G FTC, have had approved training as an instructor and at least 5 years' trade experience after training. Some training/teaching experience in a technical institute or recognised work training department is also essential.

SALARY: QRials 2400 (£250 approx.) a month, tax free. Free furnished accommodation or allowance in lieu; car allowance QR400 a month; two months' annual leave, passage paid; free medical service; return air fares. Three year contract, renewable, guaranteed by British Council. 73 AM/132.

Write quoting relevant reference number to THE BRITISH COUNCIL (APPOINTMENTS), 29 BRESSENDEN PLACE, LONDON SW1E 5DD for further particulars and application form to be completed as soon as possible.

[3538



has a vacancy for a trainee Sound Maintenance Engineer. Applicants should have a good technical background, preferably to 'A' Level standard, and have a keen interest in the practical aspects of sound engineering. Starting salary £1,662 p.a. 4 weeks holiday. Subsidised staff restaurant.

INDEPENDENT TELEVISION NEWS LIMITED
ITN HOUSE, 48 WELLS ST., LONDON W1P 3FE
TEL: 01-637 2424.

3412

**Broadcast
Television**

The following vacancies exist for enthusiastic young engineers to work in our newly equipped studios:

1. VISION ENGINEER.
2. SOUND ENGINEER.
3. VIDEOTAPE ENGINEER.

Previous experience in television preferred but enthusiasm essential.

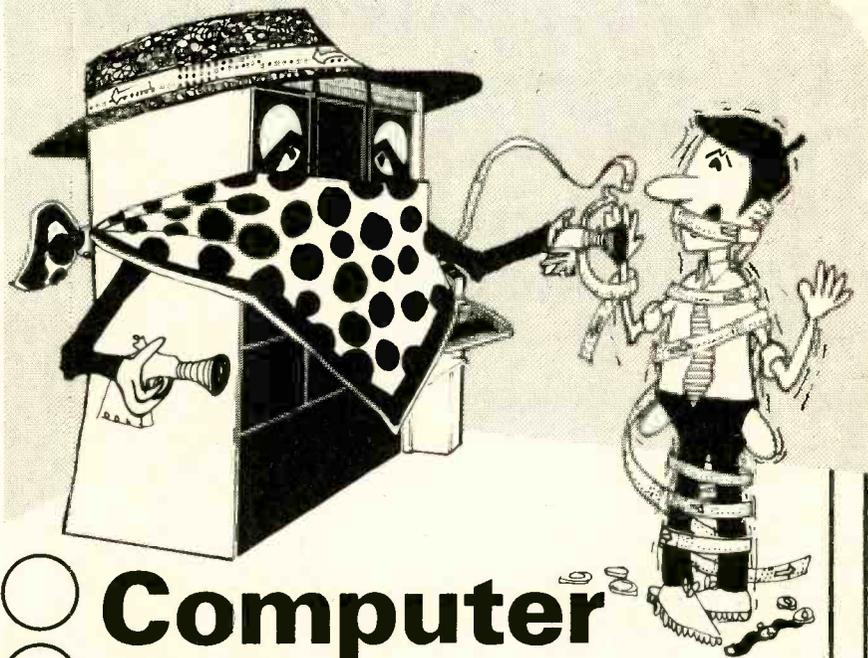
Qualifications: Attending a course leading to HNC or equivalent.

Salary: Commensurate with qualifications and experience. Plus various fringe benefits.

Apply in writing to:

**P. Haines, Ewart & Co. (Studio) Ltd.,
Wandsworth Plain, London, SW18 1ET.**

[3515



**Computer
Field
Engineers
Have you got what
it takes?**

Have you got what it takes to join the world's most successful mini-computer Company?

If you have the ambition to succeed in computer field service and have a good knowledge of digital circuitry, then you may have what it takes. If you also have previous field service experience, particularly on computer products and if you have an H.N.C. or similar qualification, you are more likely to have what it takes.

We are looking for field engineers to work on our world-famous range of PDP mini-computers. We have openings both for site and mobile engineers, located throughout the country but mainly in the South East of England.

The work is varied and challenging, and the rewards are suitably high.

If you are interested, please write or telephone for an application form to our Personnel Department quoting reference WW 122.

DIGITAL EQUIPMENT COMPANY LIMITED
Fountain House, Butts Centre, Reading RG1 7QN. Tel. (0734) 599049



3563

Communications Engineers

Career
Development
Opportunities
- up to £2,800



There are excellent career opportunities within the final inspection department of IAL open to engineers who have a sound theoretical and practical understanding of basic electronics.

These positions of responsibility involve varied and interesting work associated with a wide range of communication equipment including Control and Monitoring Aids for Data Handling Centres, Air Traffic Control Consoles, with associated hardware, and M.F. Nav aids.

Applicants should be able to demonstrate competence in standard electronic test procedures. Benefits include holiday air fares for you and your family at nominal cost.

To find out more, and to arrange an interview please contact: Mr. R. Radcliffe, Personnel Officer (U.K.),

IAL

**Aeradio House,
Hayes Road, Southall,
Middlesex. Tel: 01-574 2411**

3576

Supervisory Project Engineer

Thames Television has a vacancy for a Supervisory Project Engineer, who will be based at their Teddington Studios in Middlesex, to co-ordinate the Company's requirements on building work and to liaise with architects and other building consultants to achieve the required results.

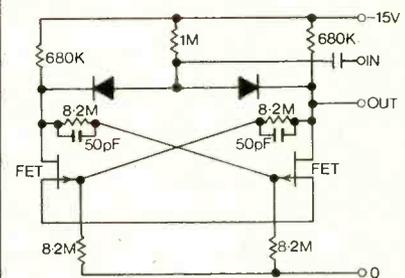
The successful applicant will be responsible to the Head of the Engineering Department and will be part of a team providing a complete service to the Company for all capital projects.

Applicants should preferably be qualified to the requirements of the Professional Engineering Institutions. They must have a wide knowledge of all aspects of Television and a basic knowledge of buildings techniques. An ability to analyse the users' needs and translate these into practical information is also required.

Interested applicants are invited to write, in confidence, giving brief details of age, qualifications and experience to: The Staff Relations Officer, Thames Television Limited, Teddington Lock, Teddington, Middlesex.

THAMES

3544



If you tell us why this circuit does not operate you could be the 20-25 year old technician who after a suitable training period would join our Test Team. Peter Waugh, our Chief Designer, will be pleased to receive your answer—and the reason for reading *Wireless World* advertisements!

Scopex is a rapidly-expanding company offering many opportunities for advancement. Salary is commensurate with the position offered.

Reply to:

**Mr. P. Waugh,
Scopex Instruments Ltd.,
Pixmore Industrial Estate,
Pixmore Avenue, Letchworth,
Herts. SG6 1JJ
Tel: Letchworth 72771**

3557

ENGINEERING OPPORTUNITIES

with Europe's largest TV assembly plant

Yes — we're No. 1 in Europe. And to keep it that way, we need a strong, top class team of engineers. Here is your chance to join them. We need . . .

SENIOR ELECTRONIC DESIGN ENGINEERS

who will work on all aspects of electrical design of television receivers. The successful applicants are likely to hold a degree or HNC in Electrical/Electronic Engineering and will have had a minimum of two years' experience in solid-state design, preferably in consumer electronics.

ELECTRONIC DEVELOPMENT ENGINEERS

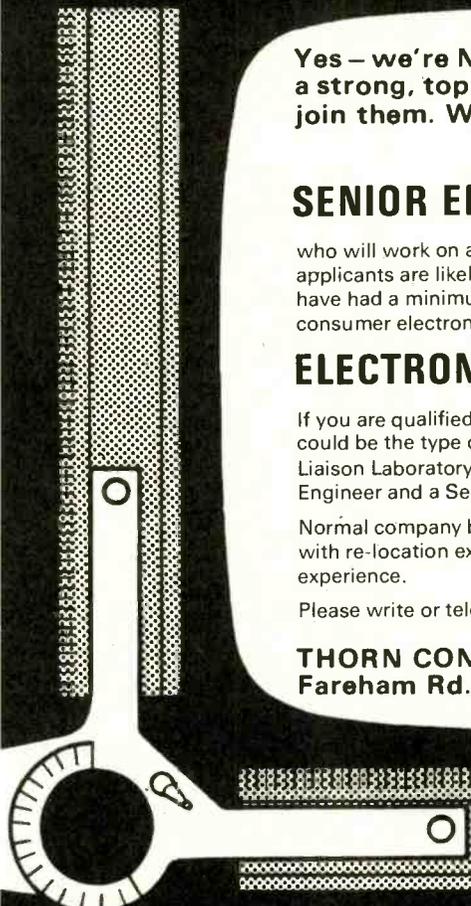
If you are qualified in RADAR, COMMUNICATIONS, RADIO or TELEVISION, you could be the type of person we are looking for to fill vacancies in our Engineering Liaison Laboratory. Due to continuing expansion of this company, a Development Engineer and a Senior Development Engineer are required.

Normal company benefits apply for the above positions and assistance can be given with re-location expenses. Salary will be negotiated according to qualifications and experience.

Please write or telephone for an application form to Geoff Connolly.

THORN CONSUMER ELECTRONICS (GOSPORT) LTD.,
Fareham Rd., Gosport PO13 0AU. Tel.: Fareham 6181.

3556



ultra

ELECTRONIC VACANCIES

Engineers

Draftsmen • Designers

Service and Test Engineers

Technicians • Technical Authors

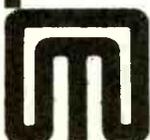
Sales Engineers

£1,600-£5,000 pa
Permanent or Contract

Phone **MICHAEL NORTH**
01-388 0918

**MALLA TECHNICAL
STAFF LIMITED**

334 Euston Rd., London NW1 3BG



3400

X-ray Field Engineers

Our current expansion programme now calls for experienced electro-mechanical engineers to support our existing field staff. They will become involved in a variety of interesting activities covering the installation, service and maintenance of diagnostic medical X-ray equipment in hospitals.

Progressive opportunities exist in a number of our Branches throughout the UK.

Applicants should be qualified to ONC or City & Guilds equivalent and previous experience on any of the following—X-ray engineering, closed-circuit television, electronics, logic circuitry—would be a distinct advantage.

Good salaries and fringe benefits will be offered to the successful applicants and a company car will be provided as soon as an acceptable stage of proficiency in our product is reached.

For further details and application form please contact:

GEC
Medical

Mr. P. B. Blackmore, Personnel Officer,
GEC Medical Equipment Limited,
East Lane, North Wembley, Middlesex.
Tel: 01-904 1288, stating in which
area you are interested in working.

3552

TELEVISION ENGINEERS

Our colour television operation is highly successful. Continued growth has created vacancies for engineers with a flair for tackling the wide variety of projects handled by the Post Design Section of our laboratories at Chessington.

This Section is involved in all engineering aspects of our countrywide colour and monochrome television rental organisation.

Applications are invited from engineers with a sound knowledge of audio equipment, television receivers and/or experience of quality assurance work.

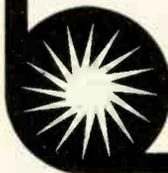
Formal qualifications, whilst desirable are not essential, where an applicant can demonstrate his practical ability.

Excellent salaries are offered, up to £2,600 p.a. and generous assistance with relocation expenses may be given where appropriate.

Interested?

Then write to:—

John Sinclair,
Rediffusion Consumer Electronics Ltd.
Fullers Way South,
CHESSINGTON,
Surrey



REDIFFUSION

3342

ELECTRONIC ENGINEERS

In 1961 we introduced the world's first electronic desk-top calculators, with the trade name of ANITA. There have been many changes in technology since then, but we have remained leaders in the field and our calculators have been sold in many countries around the world including the U.S.A. and Japan. Due to further expansion of our activities with calculators and more complex systems we have vacancies for service engineers at our National Service Centre at Hemel Hempstead. Our range of electronic business equipment is wide and our engineering requirements are correspondingly varied. We are now seeking additional staff ranging from junior technicians (with day release, where appropriate) to qualified, experienced engineers. The positions are permanent and we offer first class conditions of employment. Please write or telephone for an application form from D. D. Davies, SUMLOCK COMPTOMETER LTD., 1, FROGMORE ROAD, HEMEL HEMPSTEAD, HP3 9RJ, HERTS. TEL: 0442—61771 3427



Rockwell International

OPPORTUNITIES IN AUSTRALIA for VIDEO/CTV/CCTV TECHNICIANS

Progressive Company, member of major Australian Group expanding rapidly in video field requires experienced Technicians in colour TV, video system, closed circuit TV systems including cameras.

Top salary, car supplied, assistance in travelling and housing.

Locations—HOBART,
MELBOURNE,
SYDNEY.

Telephone
ANNE GRAHAM,
LONDON 636 0541
for further details

[3524]

THURROCK TECHNICAL COLLEGE Woodview, Grays, Essex.

TECHNICIAN GRADE T1-3 to join an enthusiastic team providing a Resources (A/V Aids) service to the College.

The person appointed will have knowledge and skills in one of the following servicing fields: Video (C.C.T.V.), Audio, Reel and Cassette Recorders.

A proven capacity for faultfinding on electronic equipment will count more than formal qualifications.

Opportunities for day release provided.

Salary Scale: Up to £1,644 per annum, according to age, qualifications and experience.

Application forms are obtainable from the College Administrative Officer, to whom they should be returned within fourteen days of the appearance of this advertisement.

[3517]

CIVILIAN INSTRUCTORS GRADE III

Two posts for men with the Ministry of Defence (Army at Catterick Garrison, Yorkshire)

**POST 1
Instructor Grade III (Telecoms—Wireless and Line)**—required to teach Royal Signals technicians the basic principles of electricity, electronics and telecommunications principles together with the maintenance of current service telecommunications equipment.

**POST 2
Instructor Grade III (Telecoms—Line and Radio)**—required to teach Royal Signals telegraphists Morse and Keyboard operating together with message handling procedures. Selection is by test and interview. For both posts applicants must be experienced in the subject generally and where appropriate, possession of ONC, C&G or equivalent qualification is desirable.

Salary Scale: £1971 (at aged 28 years and over) rising by four annual increments to a maximum of £2403 (These rates are currently under review and any adjustment is expected to be retrospective to 1 January 1974).

Prospects of pensionable appointment and promotion. Opportunities exist for further technical study and day release will be granted wherever possible.

Write for application forms and specimen test papers to CEPO Catterick, Peronne Lines, Catterick Garrison, Yorkshire. Closing date for receipt of completed forms: 11 March 1974.

[3493]

TECHNICIAN/ ENGINEER AT THE OPEN UNIVERSITY

The Electronics Laboratory designs and develops electronic equipment for The Open University which includes home instruction kits.

We have need of a Technician/Engineer to assist on new designs, improving existing designs and the development of test sets for them. He may also assist with the design of research aids, the preparation of television demonstrations and assist occasionally at Summer Schools.

The job will involve some construction work although the applicant must show a keen interest in modern electronics and a desire to learn.

Salary on Technician Scale Grade 4: £1848-£2163 per annum.

Contributory pension scheme, 18 days annual leave, plus a week at Christmas and Easter when the University is closed. There are prospects of promotion.

Further particulars and application forms are available from The Personnel Manager (EL6), The Open University, P.O. Box 75, Walton Hall, Milton Keynes, MK7 6AL. Applications should be returned as soon as possible.

[3496]

Royal Holloway College
(University of London)
Egham Hill, Egham, Surrey

ELECTRONICS TECHNICIAN

required in the Physics Department. Candidates should have O.N.C., H.N.C. or equivalent qualifications. Duties will include assistance with practical classes and research. Preference will be given to candidates with an interest in vacuum and electronics techniques, 4 weeks holidays a year plus discretionary days. Salary on scale £1848-£2163. Please apply to Personnel Officer at the above address.

[3501]

TEST ENGINEERS

The leading U.K. manufacturer of high grade TV monitors require Test Engineers for their expanding Test Department.

Situated in the Berkshire town of Maidenhead, the Company offers pleasant working conditions, good salaries and friendly environment. Duties will cover the testing and trouble-shooting of monochrome and colour TV monitors together with other ancillary sophisticated TV broadcast equipment manufactured by the company. Previous experience of TV equipment would be an advantage. Please apply to:

PROWEST ELECTRONICS
Boyn Valley Road,
Maidenhead, Berks.
Maidenhead 29612

[3523]

Customer Support Group

With the establishment of this new department, Racal Instruments Limited at Windsor wish to recruit the following personnel:—

Electronic Engineers

To be involved in the in-house servicing of the complete range of Racal Instruments products. These extend from D.C. to GHz and include high technology atomic frequency standard and precision signal generators.

Applicants must be qualified up to H.N.C. standard, and experience in the instrumentation field would be an advantage.

The above position offers competitive rates of pay, a sick pay scheme and in addition a contributory pension and free life assurance scheme.

Interested? Then write giving brief details of previous experience, to:—

Communicate with Racal

Mr. A. J. Franklin, Personnel Manager,
Racal Instruments Limited,
Duke St., Vansittart Estate
Windsor, Berks. SL4 1SB
Telephone Windsor 69811

RACAL
The Electronics Group [3531]

NEW ZEALAND MINISTRY OF TRANSPORT

Applications are invited for the undermentioned vacancies:

TELECOMMUNICATION ENGINEERS

Salary: Salaries are in the range up to \$8637 per annum.

Duties: To work on systems planning, equipment procurement and installation for communications and navigation aids. The work lies in the fields of civil aviation, road transport traffic law enforcement, meteorological services and marine services. Appointees will be located in Wellington.

Qualifications desired: Applicants should preferably be corporate members of the I.E.E. or of equivalent status.

Passages: Fares for appointee and his wife and family will be paid.

Incidental expenses: Up to NZ\$120 for a single man and up to NZ\$800 for a married man can be claimed to cover the cost of taking personal effects to New Zealand.

Application forms and general information are available from the High Commissioner for New Zealand, New Zealand House, Haymarket, London SW1Y 4TQ, with whom applications will close on April 26th 1974.

Please quote reference B13/5/33 when enquiring.

[3518]

Development Engineers

Colour Television Receiver Design Up to £3200

GEC (Radio and Television) Limited are among the top five leading British designers and manufacturers of colour television. Because of considerable expansion in new markets and other new product areas we need to considerably strengthen our development teams. The work is interesting and varied and close-knit teams work 'informally' on projects, reporting through to the Chief Engineer. There will also be opportunities to work on peripherals such as video record and play-back devices, data display and remote control systems. We would like to hear from engineers experienced in tuner, signal and scanning circuits design.

Qualifications to degree or HND standard are desirable but of paramount importance is three or four years' experience in the above or similar fields, preferably with a knowledge of mass production requirements.

Salaries are negotiable up to £3200 according to age and experience. Other fringe benefits include excellent contributory pension and sickness schemes, more than three weeks' holiday and relocation expenses if appropriate. This is an excellent opportunity to work for a major British Company, vigorously expanding and where promotion prospects are positive.

Please write or telephone with brief career details to:

**Mr. E. Norris, Technical Director,
GEC (Radio and Television) Limited,
Wexham Road, Slough, Bucks.
Telephone: Slough 24541.**

3547



RADIO OPERATORS

Leaving the Service in the next 18 months? If your trade involves radio operating, you qualify to be considered for a Radio Officer post with the composite signals organisation.

On satisfactory completion of a 7 months specialist training course, successful applicants are paid on a scale rising to £2,893 p.a.; commencing salary according to age—25 years and over £2,126 p.a.

During training salary also by age, 25 and over, £1,607 p.a. with free accommodation. The future holds good opportunities for established status, service overseas, and promotion.

Training courses commence at intervals throughout the year. Earliest possible application advised.

Applications only from British born U.K. residents up to 35 years of age (40 years if exceptionally well qualified) will be considered.

Full details from:

Recruitment Officer,
Room A/1105,
Government Communications Headquarters,
Priors Road, Oakley, Cheltenham,
Glos., GL52 5AJ.
Telephone Cheltenham 21491 Ext. 2270.

[92]

ROBERT GORDON'S
INSTITUTE OF TECHNOLOGY
ABERDEEN

School of Electronic and
Electrical Engineering

ELECTRONICS TECHNICIANS

with experience of electronic engineering and at least ONC or equivalent. For design, construction and maintenance of electronic equipment.

Salary scale £1,848-£2,163, with placing according to qualifications and experience.

Details from:

Charles Birnie, Esq., MBE,
Secretary,
Robert Gordon's Institute of
Technology,
Aberdeen, AB9 1FR.

[3495]

THE KINGDOM OF
SAUDI ARABIA

**Broadcasting Station
Engineers and Technicians**

The Ministry of Information of the Kingdom of Saudi Arabia invites applications for service in its MF and HF broadcasting system in the undermentioned posts.

Contracts will be for two years in the first instance, renewable thereafter, and successful applicants will be based in Riyadh, Jeddah or Dammam.

Candidates will be required to provide written proof of their technical competence.

A good knowledge of the English language is required.

The age limit is 55 years.

STATION MAINTENANCE ENGINEERS

Applicants must possess a diploma in Electrical or Telecommunications engineering, equivalent to the British B.Sc. (Eng.), H.N.D. (Higher National Diploma) or H.N.C. (Higher National Certificate) and have had several years' practical experience in the operation, maintenance and supervision of broadcasting stations and studio complexes.

Salary: Minimum 5000 Saudi Arabian Rials per month, subject to negotiation during interview, plus allowances.

STATION MAINTENANCE TECHNICIANS

Applicants must possess a recognised certificate of technical competence equivalent to the British O.N.D. (Ordinary National Diploma) or O.N.C. (Ordinary National Certificate) and have had several years' practical experience in the operation and maintenance of broadcasting studios.

Salary: Minimum 3000 Saudi Arabian Rials per month, subject to negotiation during interview, plus allowance.

Allowances (all successful candidates). Annual housing allowance equal to two months' salary, or a maximum of SR 8000. Car allowance or SR 300 per month.

Income Tax: Salaries and allowances are subject to Saudi Arabian Income Tax. Details will be given to applicants.

Interviews: Selected applicants will be interviewed in Paris, Brussels, Frankfurt, Amsterdam and Brighton.

Applications: In writing to the Personnel Manager, Preece, Cardew & Rider, of 165/167, Preston Road, Brighton BN1 6AF, Sussex, England who have been instructed to act on behalf of the Ministry of Information, quoting reference GET/PERS./3071.

[3513

The University of Leeds
DEPARTMENT OF
PHYSIOLOGY
CARDIOVASCULAR UNIT

Applications are invited for the post of EXPERIMENTAL OFFICER in Electronics. A degree or HNC is required. Responsibilities include PDP12 and PDP8 computers, electronic equipment in three physiological laboratories and three hospital catheter laboratories, and the supervision of four electronics technicians. Salary scale £1563-£2187. Preliminary enquiries may be made to the Director of the Cardiovascular Unit, Department of Physiology, The University, Leeds, LS2 9JT.

Forms of application and further particulars from the Registrar, The University, Leeds LS2 9JT (please quote 43/12/C1).

[3274

When replying to
Box nos
please mention
Wireless World.

CREATIVE DEVELOPMENT ENGINEERS Up to £3000

If you are keen to develop your career by working for an expanding Company in the forefront of Telecommunications/ Systems Design then read on:

We are looking for young engineers with a degree or HNC in electronics or others with at least two years' experience in the following fields:

Message Switching—Hardware and Software

Radio—H.F. and Microwave

Broadcast—Sound and Vision Transmitters

You will be responsible for the development of the above equipments from initial design through to final production.

The Company is situated in the developing county town of Chelmsford only 35 mins. by train from London. Generous relocation allowances will be paid to successful applicants and assistance with obtaining accommodation is available.

For further information complete the attached coupon and send it to:

Gordon Short,
Marconi Communication Systems Ltd.,
Marconi House, New Street,
CHELMSFORD, Essex, CM1 1PL.
or telephone Chelmsford 53221 Ext. 114.

NAME _____

ADDRESS _____

AGE _____ PRESENT POSITION _____

**Marconi
Communication
Systems**
A GEC-Marconi
Electronics Company

3558

Technician Engineer (Solid State Circuits)

If you know about solid state circuitry read this — then ring us — but you must be experienced in maintenance, design and construction of solid state electronic circuits, preferably in communications and CCTV.

If you are the right man — preferred age range 25/40 — you will share the responsibility for the maintenance of a wide range of sophisticated electronic devices and a radio communications network. Technical competency in your field will lead to additional design and installation responsibilities under guidance of the Company's electro-mechanical research and development group.

The job is based in Central London and starting salary is up to £2,100. If you think you can handle it, **phone 01-405 5200 (reversing charges) to tell us about yourself, and to get more details.**

3573

radio/audio/tv engineer

QUALITY-CONTROL

The opportunity has arisen at our Liverpool Laboratories for a suitably-qualified engineer to join a small team concerned with the technical appraisal of domestic radio, audio and T.V. products.

This is an especially interesting position involving the examination of samples from the U.K. and abroad. The standards of quality required for inclusion in our Mail Order Catalogues are secured by direct personal contact with our suppliers.

Applicants should be qualified to at least HNC standard, and are unlikely to have less than five years' production experience in the domestic radio and television field, including a close association with design

and manufacturing activities. A familiarity with quality-control and inspection procedures would be an added advantage.

An attractive salary will be offered to the successful applicant, together with generous relocation expenses where necessary.

Reply, giving details of yourself and your career to:— John Cordrey, Appointments Manager, Littlewoods, JM Centre, Old Hall Street, Liverpool X.

Littlewoods

3560

RADIO TECHNICIANS

The Ministry of Posts and Telecommunications has vacancies for Radio Technicians at Government Buildings, STANMORE near (Canons Park Underground). Radio Technicians are also liable to be employed at Waterloo Bridge House, Waterloo Road, S.E.1 (opposite Waterloo Station).

- Applicants must be at least 19, have a sound knowledge of electricity and radio combined with 2 years practical workshop experience of maintenance and the use of radio/electronic test gear, and hold GCE 'O' level passes in English Language, Mathematics and/or Physics, or City & Guilds Telecommunications Technician Intermediate Certificate or equivalent qualifications.
- Future prospects of promotion to Telecommunications Technical Officer grades and above.
- Pay—according to age—£1,383 at 19 rising by annual increments to £2,158 plus London Weighting.
- Hours—41 gross, 5 day week.
- Paid Holidays—18 days a year rising to 22 days after 10 years total service, plus public and privilege holidays.

For application forms and interview apply to:—

Miss J. P. Chapman
MINISTRY OF POSTS AND TELECOMMUNICATIONS
Personnel Services Branch (RT)
Room 203, Waterloo Bridge House
Waterloo Road, London SE1 8UA

[3539]

At ICN Instruments we are continuing to grow fast in the dynamic field of

NUCLEAR MEDICINE

WE REQUIRE

SERVICE REPRESENTATIVES

in the South East and North Midlands to work with our full range of Scintillation Counters and imaging equipment. Qualifications to the level of H.N.C. in electronics engineering or a background of electronic application in physics or chemistry would be desirable.

The job is demanding with considerable travel involved but will give satisfaction to those who can work independently and with initiative.

Earnings are likely to be in excess of £2,500 per annum plus superannuation scheme and a company Cortina 1600 XL.

MAKE YOUR CHANGE NOW

Telephone or write to:

The Sales Manager,
ICN Pharmaceuticals (UK) Limited,
Instruments Division,
2 Riverdene Industrial Estate,
Molesey Road, Hersham, Surrey.
Tel: Walton-on-Thames 44441

[3492]



International leaders in
Electronics, Records
and Entertainments.

RF Development Engineers Cable TV & Aerial Systems

EMI Sound & Vision Equipment Ltd., major U.K. suppliers of cable TV and transmitting aerial equipment are expanding their business in all areas. Recently awarded contracts have created opportunities for:—

Electronics Engineers

With design experience of VHF/UHF broadband active and passive devices using modern techniques, to work on new developments in the cable TV field.

Aerial Engineers

With a knowledge of transmission line techniques associated with VHF/UHF transmitting aerial projects of advanced design. Preference will be given to engineers willing to climb mast structures and available to travel in the U.K. and abroad for short periods.

Attractive salaries will be paid and assistance with removal expenses will be given where appropriate.

Please write or telephone:— **Mr. K. E. Goodman, Personnel Department, EMI Limited, 135, Blyth Road, Hayes, Middlesex. Tel: 01-573 3888 Ext. 2523.**

3545

Radio Technicians

Do you have an interest in Airline Radio backed by at least 5 years' general radio experience? Then you could work for one of the world's largest airlines, servicing radio equipment.

Located at Heathrow your pay would start at £38.24 (Daywork Monday-Friday) rising to £40.17 after approximately 3 months' familiarisation. There are opportunities for advancement leading to a salary of £43.12 per week plus shift pay. Salaries are currently being reviewed.

There is an excellent contributory pension scheme. Other benefits include a first-class sports and social club and opportunities for concessional holiday travel worldwide.

If you are interested please write or phone for an application form quoting reference 188/WW/BW to:

Manager Selection Services, British Airways -Overseas Division, PO Box 10, Heathrow Airport - London, Hounslow TW6 2JA. 01-897 5329.

British airways

PERSONABLE CHEMISTS or PHYSICISTS Currently in the Electronics Industry TO DEVELOP SALES OF IMPORTANT CONDUCTING and INSULATING COATINGS

Applicants should be experienced in production or quality control in at least **one** of the applicational fields to be covered, which include:- Cathode Ray Tubes, Capacitors, Resistors, Potentiometer Tracks, Cables, Silk Screen Printing, Screening and Anti-Static Developments.

Applicants should be qualified to at least HNC level and be in the preferred age range 26-35 years. Successful applicants will be based in the north or south of England.

Good salary subject to regular review, Ford Cortina 1600 XL, changed every 25,000 miles, modern contributory pension scheme, B.U.P.A., Life Insurance and other fringe benefits.

Applications including Curriculum Vitae marked **Personal** to :-

**G. J. D. BROOKS,
ACHESON COLLOIDS COMPANY,
PRINCE ROCK,
PLYMOUTH PL4 0SP**

[3526]

Opportunities in Computer Training

Our Educational Services Department, located in Reading, provides a first-class service to both our customers and our own Company personnel. The rapid expansion of this activity has opened up several opportunities for determined people.

If you are interested or experienced in teaching, and have experience allied to the hardware engineering or programming and software disciplines, and are interested in joining the world leaders in mini computer systems, we have a future to offer.

The responsibilities will expand beyond merely "reeling off" courses. You will be expected to become involved in the development of a wide range of courses, using and investigating up-to-date training and techniques. You will be a member of a team whose constructive views and opinions will have a direct influence on our continuing development.

Our continuing progress and expansion depends on individuals with drive and initiative, and the salaries we offer directly reflect the importance we attach to these appointments. If you feel you have the qualities to accept this challenge, write for an application form, quoting reference WW127, to the Personnel Department.

DIGITAL EQUIPMENT COMPANY LIMITED
Fountain House, Butts Centre, Reading RG1 7QN. Tel: 0734 599049

digital the pdp
giants 3382

SONY®

Bench Service Engineers

Due to continued growth, we now have vacancies for additional Bench Service Engineers at the following locations:

Central Service Centre, Ascot Road, Bedford.

Bristol, Halesowen, Leeds, Ely, and Central London.

Applications are invited from Engineers with previous experience of TV (Colour & Monochrome), Radio, Hi-Fi, Cassette/Tape Recorders and V.T.R. servicing. Preference will be given to holders of C & G certificates but practical ability may outweigh formal qualifications.

Our progressive grading system, which is approved by the Pay Board, has a basic starting salary of up to £2,054 p.a. depending upon the grade achieved by examination. With Company Bonus and Overtime, Grade One engineers can obtain earnings around £2,400 in the first year. Other benefits include L.Vs, Contributory Pension and Generous Staff Purchase schemes.

Interested candidates are invited to apply with details of past experience, age and current salary to:

The Personnel Manager, SONY (UK) LIMITED,
Pyrene House, Staines Road, West,

3549

UNIVERSITY OF LIVERPOOL

ELECTRONICS TECHNICIAN/ENGINEER

An Electronics Technician/Engineer is required for a position in the Electronics Workshop of the Department of Electrical Engineering and Electronics. This post would be suitable for a person holding either H.N.C. or C. & G. Final Certificate for telecommunications technicians with practical experience of the lay-out of printed circuit boards and the use of linear and digital integrated circuits. The successful applicant will assist in the development and production of a wide range of instruments used in the teaching and research laboratories of the Department. Initial salary within a range up to £2,382 per annum, according to qualifications and experience. Application forms may be obtained from the Registrar, The University, P.O. Box 147, Liverpool, L69 3BX. Quote Ref. RV/WW/80713.

[3568]

ELECTRONICS TECHNICIAN/ENGINEER

TO DEVELOP TEACHING EQUIPMENT

The Electronics Laboratory designs and develops home instruction kits for the Open University.

We now need a Technician/Engineer to assist on new designs, the improvement of existing designs, and the development of test sets. He will also help to design electronic equipment for research work, and may assist in the preparation of television demonstrations, and assist at summer schools.

Salary in the range of £1650-£1920.

Contributory pension scheme. 18 days annual leave, plus a week at Christmas and a week at Easter, when the University closes down. There are prospects of promotion.

Application Forms and further particulars are available from The Acting Personnel Manager (ETS), The Open University, P.O. Box 35, Walton Hall, Milton Keynes, MK7 6AL. (Telephone Milton Keynes 74066 Extension 3068). Applications should be returned as soon as possible.

[3437]

ELECTRONICS ENGINEER

Guildford Engineer required for interesting work on a wide range of devices and systems used by and for blind people.

A sound basic knowledge of analogue and digital techniques, together with several years experience in a field of design, development and maintenance is necessary. Some experience of light electro-mechanical devices would be an advantage. Applications in writing, giving full details of education, qualifications and experience, including present post and salary, to Personnel Officer, Royal National Institute for the Blind, 224 Gt. Portland Street, London WIN 6AA.

[3362]

Electronics Engineers up to £5000

Many jobs which would suit you down to the ground – either in the U.K. or overseas – are never advertised. Yet it will cost you nothing whatever to give yourself the opportunity to be considered for them. Join the Lansdowne Appointments Register – used by hundreds of employers to select electronics engineers. You have nothing to lose, everything to gain – and it's all conducted in strict confidence. So post the coupon – find out exactly how you can make use of a service which is all the more valuable for being free!

To: **Stuart Tait, Lansdowne Appointments Register, Design House, The Mall, London W5 5LS. Tel: 01-579 6585 (anytime – 24 hour answering service).**

Please send me further details.

Name

Age (20-45 only)

Address

WW29/3

Lansdowne Appointments Register

UNIVERSITY OF THE WEST INDIES—JAMAICA

Applications are invited for the post of

SENIOR LABORATORY TECHNOLOGIST (ELECTRONICS)

in a laboratory serving the needs of the Faculties of Medicine and Natural Sciences. Applicants should have at least five years' experience in electronics and workshop practice. Duties will include the servicing and maintenance of existing equipment, the construction and testing of experimental, electro-mechanical, scientific and medical instruments. A practical knowledge of printed circuit techniques will be an asset. Appointee should possess an O.N.C., City and Guild Certificate or equivalent.

Salary scale: J\$3,300-J\$5,160 p.a. (£1 sterling = J\$2.00 approximately).

Reply, stating age, experience, relevant qualifications and the names and addresses of two referees to the Vice-Dean, Faculty of Natural Science, University of the West Indies, Mona, Kingston 7, Jamaica, W.I.

[3502

Electronics Engineers

Lecture on computer servicing.

ICL, Europe's leading computer manufacturer, is looking for Electronics Engineers to teach the practicalities of computer servicing.

At the largest training centre of its kind in Europe, first of all we will ground you in computer technology and education training. We will then ask you to train Customer Engineers to such a standard that they will be able to maintain computers at optimum operational specification.

You will need to have a thorough competence in electronics and the ability to put across your own first-rate knowledge. Ideally, you will have an HNC or Forces' training in electronic engineering and at least three years' experience, preferably in digital electronics or computers.

Based at the training centre in Letchworth, Herts, your starting salary will commence at £2200. ICL depends on talent and rewards it accordingly. You will be encouraged and expected to progress; your development could be throughout the ICL Group. Relocation expenses will be considered where appropriate.

For an application form, write to A E Turner, quoting reference WW588C, at International Computers Limited, 85/91 Upper Richmond Road, Putney, London SW15 2TE.

International Computers



think computers think ICL

3559

Engineers

Thames Television have vacancies for two Engineers at their Teddington Studios in Middlesex.

The successful applicants will assist with specific duties in our engineering complex, involving the maintenance and operation of video-tape, telecine, master control and central apparatus room equipment.

Applicants, aged between 20 and 30, should have general engineering experience, a basic knowledge of electronics and be educated to ONC level or equivalent. Initiative and a

keen interest in television engineering are essential personal characteristics.

The salary for this position will be in the range of £2,100 per annum to £3,000 per annum, depending upon experience. Other benefits include an excellent pension scheme, good restaurant facilities and an active sports and social club.

Written application should be addressed to: The Staff Relations Officer, Thames Television Limited, Teddington Lock, Teddington, Middlesex.

THAMES

3543

Electronics Appointments Register

We can get you a better job than you can get yourself.

The best jobs don't necessarily appear in the sits. vac. columns.

They are often to be found in the Electronics Appointments Register.

Our individual approach gives you a wider choice—we have lots of jobs on our specialised registers and we may well have one tailor-made for you.

The service is absolutely free to you and completely confidential.

In effect we offer you the chance to find your ideal job, all for the cost of a phone-call.

So capitalise now on your specialised knowledge.

Call 01-734 6536, or fill in the coupon and we will send you an enrolment form by return of post.

G A R

Graduate Appointments Register

Please send me details of how to enrol on one of your Appointment Registers:

Name _____

Address _____

Please Indicate Salary Range £ _____

Post to G.A.R. 76 Dean Street London W.1. 01-734 6536

WW6

3468

VENTEK

One of Britain's most successful small
computer companies
requires two first-class

LOGIC DESIGN ENGINEERS

with considerable design experience
in the computer field

SALARY NEGOTIABLE UP TO £3,000 p.a.

Please apply in writing to:

Andy Reichert

Co-ordinator, Product Development
Ventek Ltd

112 North Acton Road

London, NW 10

01-965 9722

giving full details of career to date, including present and expected salary.

3394

BRITISH RELAY TV require Electronic/ Telecomms Technician

To operate small service department dealing with the maintenance and performance testing of cable television equipment.

Practical experience with ability to produce results without direct supervision is of primary importance.

Applicants should be qualified to ONC or City and Guilds Final Technicians certificate (or equivalent).

This is a permanent pensionable position with salary commensurate with qualifications and experience.

Please write, giving summary of experience to date, qualifications, etc., to:

*Technical Manager
British Relay Ltd (Div.1)
41 Streatham High Road
LONDON SW16 1EP*

3584

Radio Survey Engineers Overseas Careers Posts

Radio Survey Engineers are required for overseas locations to work on VHF/UHF narrow band and broad point-to-point and tropospheric scatter links. Applicants will have had 3-5 years' experience in their respective fields and preferably hold qualifications up to at least Ordinary National Level.

The Engineers' duties will include practical field survey work and a knowledge of test methods and associated equipment will be required. Experience in path loss assessment methods under varying propagation conditions will be required, together with the ability to give advice and support to field construction teams at all stages up to and including the commissioning phase.

They must be able to organise survey work and enjoy applying their own initiative in a challenging, but attractive environment.

These appointments offer excellent tax free salaries and allowances and in addition, free furnished accommodation, free medical attention and free passages to the United Kingdom every two years.

Please apply in writing to:
Personnel Officer (Overseas),
Recruitment Officer (DT001),
International Aeradio Limited,
Aeradio House, Hayes Road, Southall, Middlesex,
or telephone 01-574 2411 for application form.

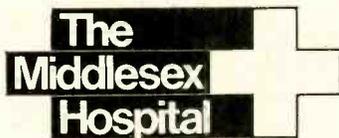
3546

IAL INTERNATIONAL AERADIO

The Middlesex Hospital
London W1N 8AA

Department of Clinical Measurement

Electronic Technician required as soon as possible for work involved in the design, development and maintenance of medical electronic equipment. Applicants should have experience in the layout and wiring of small signal analogue and digital circuitry and will be part of a team of engineers and technicians. Opportunities exist for day release for further study. Salary on Whitley B Scales, Medical Physics Technician III £1,719-£2,211 p.a. plus £126 London Weighting. Application forms obtainable from the Establishment Officer, The Middlesex Hospital, London W1N 8AA (Tel: 636 8333 Ext. 536).



3542

BOTSWANA ASSISTANT ENGINEER GRADE I

Required by the Posts and Telecommunications Department to be responsible for an area including rural automatic exchanges, open wire carrier systems, VF telegraphs, some plant and 2 GHz microwave equipment. Candidates, preferably 30-45 years, must hold the City and Guilds Final Certificate in Telecommunications or an equivalent qualification and have a minimum of five years' experience, excluding training, in a transmission/radio field. Candidates with some knowledge of automatic exchange and subscriber apparatus will be preferred. Commencing salary including Supplement will be in the range of £2,300 to £3,280. A substantial gratuity is also payable. **Because of lower rates of Income Tax in Botswana, the gross emoluments are roughly equivalent to UK salaries of**
£3,450 to £4,550 for a single man
£4,250 to £4,900 for a married man with two children
Other benefits include—Subsidised Accommodation; Holiday Visit Passages; Education Allowances; Free Family Passages; Appointment Grant £100/£200 and Car Loan Normally Payable; 24-36 Month Tour.
The post described is partly financed by Britain's programme of aid to developing countries administered by the Overseas Development Administration of the Foreign and Commonwealth Office.
For further particulars you should apply, giving brief details of experience to

crown agents

M Division, 4 Millbank, London SW1P 3JD, quoting reference number M2K/730428/WF.

[3440

Electronic Test Engineers

Ramsgate or Bracknell Housing Available



Racal Communications Limited, who are engaged in the design and manufacture of professional communications equipment, have vacancies at their Thanet Division in Ramsgate, Kent for
**SENIOR TEST ENGINEERS,
TEST ENGINEERS AND TESTERS**
who will be involved in the testing of sophisticated P.C.B. and modular assemblies. A knowledge of transistorized transmitter and receiver techniques is required, and previous experience of production testing would be an advantage.

For the right men these are excellent opportunities to become involved in an ambitious new enterprise.

In addition to the vacancies at our Thanet Division, we also require Test Engineers and Testers at our Company in Bracknell, Berkshire, to work on similar equipments. **Housing may be available both in Bracknell and Ramsgate for suitable applicants.**

These positions command good salaries together with excellent conditions of service including sick pay and pension schemes.

Communicate with Racal

If you are interested, please write, enclosing brief details of previous experience, stating the area preferred, to:

Mr. A. J. Franklin,
Personnel Manager,
Racal Communications Limited,
Western Road, Bracknell,
Berkshire.

RACAL
The Electronics Group | 3530

Wanted Alive!

The Post: **Designer/ Draughtsman** **Development Engineer**

The Job: Electromechanical Design Receiver and Transmitter Development

The Product: Marine Communications Equipment

Experience: Small Mechanical Assemblies 2 Years in Linear PCB Layouts Circuit Design

Qualifications: Proven Ability Degree or HNC Standard

Location: Croydon

Interested?

Phone: **Sarah Lemmon — 01-684 9771**
International Marine Radio Company Ltd., Peall Road,
Croydon CR9 3AX

ITT Marine

3368

PHILLIPS MEDICAL SYSTEMS LTD.

require

SERVICE ENGINEER

IN NORTH LONDON

Suitable applicants should have experience in electro-medical and closed circuit TV equipment.
 Applicants with minimum ONC or equivalent qualifications and relevant experience should apply in writing to:—

The Personnel Manager,
 Philips Medical Systems Ltd.,
 45 Nightingale Lane, London, S.W.12.

[3366]

A really worthwhile job

(Electronic Test Technicians)

GEC Medical Equipment Limited, based in North Wembley, is a world wide leader in the manufacture of a wide range of medical diagnostic X-ray apparatus which is every day helping sick and injured throughout the world.

Because of the ever increasing demands for our equipment both at home and overseas and in order to maintain the high standard of reliability of our products, we need additional electronics test technicians with practical electrical/electronic experience, preferably qualified to City and Guilds or ONC standards.

The work involves testing and fault finding on a wide variety of medical X-ray apparatus to associated units such as close circuit television and image intensifiers using orthodox and specialist test equipment.

There are excellent opportunities for career development. If you would like to know more about working with this company please write giving details or telephone P. B. Blackmore, Personnel Officer, GEC Medical Equipment Limited, East Lane, North Wembley, Middlesex. Tel: 01-904 1288.

[3500]

TECHNICIANS

We are engaged in the manufacture and servicing of sophisticated audio electronic equipment for the music industry. Due to expansion there are now vacancies for Technicians experienced in this field and top salaries plus fringe benefits are being offered.

For further details please phone or write, giving qualifications and experience to:

MAVIS LTD.,
 11a Sharpleshall Street,
 London N.W.1.
 Tel. 722 7161.

[3327]

WORK IN CENTRAL AMERICA

Radio Technician
 needed for Guatemala.
 Radio Engineer
 needed for Honduras.

Work with the British Volunteer Programme.

Information: Fran Chadwick,
 Overseas Volunteers, 41 Holland Park, London, W.11.

[3346]

HI-FI AND AUDIO SPECIALISTS

have vacancies for the following positions:

TELEVISION AND AUDIO SERVICE ENGINEERS

SENIOR SERVICE ENGINEER
 to take charge of busy department
SERVICE ENGINEERS
 bench and field work

CCTV SERVICE AND INSTALLATION ENGINEERS
 for expanding department

WORKSHOP MANAGER AND PROGRESS CHASER
 to take charge of busy service department

Must be able to organise work flow and deal with customers. Applicants with previous experience preferred.

Top wages, permanent positions.

Please write, giving brief career details, or telephone

Mr. Mark Murray
 REW AUDIO VISUAL CO.
 REW House, 10/12 High Street
 Colliers Wood SW19 2BE. Tel: 01-540 9684

[3324]

HI-FI ENGINEERS

This could be the opportunity you've been looking for. Due to continued expansion we are looking for experienced engineers to join our teams in Liverpool, Manchester and Preston.

You will be fully experienced in servicing a wide range of audio equipment and will be capable of supervising a modern, busy workshop.

Salary negotiable around £1,750.

Assistance with re-location expenses will be given by the company.



Applications in writing to
The Managing Director
Hardman Radio
33 Dale Street
Liverpool L2 2HF

3551

COMMUNICATIONS ENGINEERS

WELLINGBOROUGH

Career opportunities offered by Britain's leading communications company to qualified

PAX AND PABX
Estimating and Project Engineers

ALARM & CONTROL
Estimating and Project Engineers

SOUND BROADCASTING
Estimating and Planning Engineers

TECHNICAL AUTHOR
Assistance with relocation to this delightful part of England.

Write or phone H. Hill,
RELIANCE SYSTEMS LTD.,
Turnells Mill Lane, Wellingborough,
Northants NN8 2RB. Tel. 093 33 5000.

[3514]

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

SCHOOL OF PHYSICAL & MOLECULAR SCIENCES

ELECTRONICS TECHNICIAN GRADE 5

RE-ADVERTISEMENT

Applications are invited for the post of Electronics Technician Grade 5 in the above mentioned School.

The successful applicant would be concerned with the servicing and maintenance of existing electronic equipment for teaching and research and with the development and construction of new specialised equipment.

Applicants should have had several years' practical experience in digital and linear solid state electronics, preferably in industry, coupled with theoretical knowledge to about H.N.C. standard.

Salary at an appropriate point on scale:

£2,007-£2,382 per annum.

Pension Scheme.

Applications (two copies), giving full details of age, qualifications and experience together with the names and addresses of two referees should be submitted to the Secretary and Registrar, University College of North Wales, Bangor, by not later than the 29th March, 1974.

[3511]

EMI RECORDS LIMITED

Maintenance Electronic Engineer

Due to the continuing expansion of the Tape Record Division, we wish to appoint two additional Electronic Engineers to work on a double day shift basis.

The Engineers are required primarily to diagnose and rectify faults which occur on a wide range of audio recording equipment. Some of the time, however, will be devoted to new development projects which are being introduced into the Division.

Applications for these positions are invited from Engineers of proven ability (preferably with Hi-Fi experience), who are qualified to at least City and Guilds standard.

If you have a keen interest in audio reproduction and you would like to join a progressive company offering a good basic salary and conditions, please telephone for an application form or write with a brief summary of experience to:

R. Flower, Personnel Officer, EMI Records Limited,
1/3 Uxbridge Road, Hayes, Middlesex. Tel: 01-561 8722 Ext: 176.

3572

GENERAL MANAGER MALAWI

We are seeking an executive capable of managing a well established and profitable radio manufacturing Company within the M.D.C. group.

The company specialises in the manufacture of transistor portables for AM application on M.W. and S.W. Plans are in hand for the use of ICs in the near future.

The applicant should be a good administrator with a knowledge of accounts budgets and financial controls. He will be solely responsible to the Board of Directors for the efficient and profitable operation of the Company. A knowledge of semi-conductor technology as applied to the set making industry would be an advantage.

Salary would be negotiable. Other benefits include a 25% gratuity on the completion of a 3-year contract; passages paid for the Officer, his wife and family if residing outside Malawi, a Company car and house would be provided.

Please apply to **MALAWI BUYING AND TRADE AGENTS, Recruitment Section,** c/o Berners Hotel, Berners Street, London, W1A 3BE for application form and further particulars quoting reference number B180.

[3564]

SENIOR TEST & SERVICE ENGINEER FOR TELECOMS TEST EQUIPMENT

Applications are invited for the above position. Candidates should possess H.N.C. (electronics), City and Guilds final certificate (telecomms) or equivalent qualifications, and have a minimum of five years applicable experience. A knowledge of digital circuits and basic programming will be a decided advantage.

The successful candidate will become a member of a small group providing service on a wide range of high precision measuring instruments for the telecomms industry. The work will include installation and proof testing of computerised automatic measuring systems at customers' premises.

The position offers a salary in the range of £2400-£2900 with generous annual bonus and a pension scheme. Excellent working conditions for 37½ hour week.

Send application and resume to:

WANDEL & GOLTERMANN (UK) LTD.
40-48 HIGH STREET
ACTON, LONDON, W3
Telephone: 01-992 6791

[3498]

Grow with Pye as a development engineer

We at Pye Audio Products are making a whole new range of sophisticated audio products, at our modern Stevenage plant, including car radios, radiograms and stereo equipment. We now have an interesting and rewarding opportunity for a Development Engineer.

Because of the continual demand for our equipment and therefore expansion of our product range, we need someone to work in our laboratory, who is capable of self-motivation and possesses the ability to work on a complete project with the minimum of supervision.

Ideally the person we are looking for will be qualified to a minimum of HNC in Electronic Engineering and have experience in design techniques for

R.F. (A.M. and V.H.F. stereo reception) and A.F. (powers up to 20 watts) applications, as applied to equipments for domestic markets. He will be dealing mainly in equipment for large volume production with costs playing an important part of the approach to a project.

Salary level and benefits are commensurate with a major company serving an international market.

Are YOU looking for a position with good prospects and opportunity for career development? Come and grow with PYE.

Write briefly to: Gillian Charter, Pye Limited, Audio Products Division, Caxton Way, Stevenage or telephone for an application form: Stevenage 50241



Pye Limited

Pye Audio Products, Caxton Way, Stevenage.
Tel: Stevenage 50241

A Member of the Pye of Cambridge Group

3555



International leaders in
Electronics, Records
and Entertainments.

MATV Development

A senior engineering appointment to be made in the Cable TV Department of EMI Sound and Vision Equipment Ltd., Hayes, Middlesex.

Section Head MATV

We need an outstanding engineer to lead a small team in the design and development of VHF/UHF cable television products.

He will be required to help formulate equipment policy and be responsible for the execution of the agreed product development plan within time and cost budgets.

The man we require will probably be in his early thirties, with several years' experience in the development of electronic equipment in the RF field. Applicants must have an engineering degree or equivalent and preference will be given to Chartered Engineers.

Starting salary will not be less than £3500.00 and there is a contributory pension scheme. Assistance with removal expenses will be given where appropriate.

Please write giving brief details of experience to:
Mr. K. E. Goodman, Personnel Department, EMI Limited, 135, Blyth Road, Hayes, Middlesex.

THE CONTINUALLY EXPANDING MILLBANK ELECTRONICS GROUP

Bellbrook Estate, Uckfield, Sussex,
TN22 1PS
Tel: Uckfield (0825) 4166

REQUIRES A

TEST ENGINEER

Must be experienced in the testing and servicing of audio power amplifiers, mixers and associated equipment.

This is a Staff position and carries full benefits including membership of a private medical scheme.

If you are interested please apply in writing enclosing curriculum vitae to Mr Keith Goodsell, Production Manager.

[3499]

University of Bath Educational Services Unit

TECHNICIAN

Closed Circuit Television

The successful applicant for this position will service the television and film equipment in the Unit, and would also be expected to assist in productions. Previous experience in television servicing and qualifications to O.N.C. or equivalent is desirable.

The starting salary will be within the range £1700-£2160 according to qualifications and experience.

Application forms and further particulars are available from The Registrar (S), University of Bath, Claverton Down, Bath BA2 and should be returned as soon as possible quoting reference 73/153R.

[3507]

ELECTRONICS TECHNICIAN

with interest in telecommunications required.

Apply: **Physiology Department, University College, Galway.**

[3525]

TECHNICAL PERSONNEL

are required at

RANK VIDEO LABORATORIES

to operate and maintain a wide range of sophisticated electronic broadcast equipment, including AVR-1 machines, flying spot telecine, HS100 Computer Controlled Editing equipment and Cassette Duplicating machinery. A broadcast background is desirable.

The position will be in Wardour Street, London, W.1, but applications should be made initially, giving brief details of experience to:-

**The Divisional Personnel Manager
Rank Film Laboratories Limited
North Orbital Road
Denham, Uxbridge
Middlesex UB9 5HQ**

or telephone Denham 2323 for application form.

[3380]

LONDON BOROUGH OF
HOUNSLOW
EDUCATION DEPARTMENT

**AUDIO VISUAL AIDS
TECHNICIAN (T.1/3)**

required at Chiswick Polytechnic, Bath Road, W.4, to join a team of two others to service five departments. Applicants should preferably have experience of modern teaching aids including closed circuit television but persons with an interest in educational technology will be considered. 36 hour week with some evening duties, required. Salary scale £777-£1,749.

Application forms from The Principal, Chiswick Polytechnic, Bath Road, Chiswick, W.4. Closing date: 14 days after publication. Tel. 01-995 3801.
[3519]

City of London Polytechnic
Psychology Section

**ELECTRONICS TECHNICIAN
GRADE 3**

A vacancy exists in the above department for a technician dealing with the design, development and construction of various electronic equipment. The successful applicant should be familiar with recent techniques and have some experience with digital as well as analogue circuits.

Salary in the range £1,650-£1,920 plus London Weighting Allowance of £174.

Applications should be made in writing to Dr. Balanescu, Psychology Section, City of London Polytechnic, Central House, Whitechapel High Street, London, E1 7PF, stating relevant experience and the names of two referees. [3494]

**EXPERIENCED
AUDIO TESTER**

REQUIRED BY
LEADING MUSICAL COMPANY

FOR TRANSISTOR AND VALVE
MIXERS, AMPLIFIERS AND
ECHO UNITS.

wem

66 OFFLEY ROAD

S.W.9

01-735 6568

3270

**Workshop
Service
Engineers**

to repair calculator printed circuit boards. Good basic electronic knowledge required and experience in a Service Department. Salary up to £2200.

Apply to:
Mr. V. Knight,
Automatic Business Machines
Limited,
104 New Kings Road,
Fulham, London, S.W.6.
Tel: 01-736 5196.

[3522]

**TECHNICIANS AND ENGINEERS
FOR ST. ALBANS AND LUTON**

QUALIFIED OR NOT!

OPPORTUNITIES for challenging work on testing and calibrating valve and solid-state electronic measuring equipments embracing all frequencies up to u.h.f. in Production, Service and Calibration departments.

APPLICATIONS are invited from people of all ages with experience or formal training in electronics and from Ex-Service technicians.

HIGHLY COMPETITIVE SALARIES, negotiable and backed by valuable fringe benefits. Overtime normally available.

GENEROUS RE-LOCATION EXPENSES available in most instances.

CONDITIONS excellent; free life assurance, pension schemes, canteen, social club.

37½ hour, 5-day, working week.

WRITE or phone for application forms quoting reference WW



MARCONI INSTRUMENTS LTD,
Longacres, St. Albans, Herts
Tel: St. Albans 59292
Luton Airport, Luton, Beds
Tel: Luton 33866



THE QUEEN'S AWARD
TO INDUSTRY 1971
94

A GEC-Marconi Electronics Company

IOR

**ELECTRONIC
DESIGN ENGINEER**

(Specialized Test and Automation Equipment)

JOB FUNCTION:

Design of (a) test equipment for use in the production of semiconductor devices and (b) electronic systems for automated production of devices.

AGE:

Not really important, but probably in 25-35 age bracket.

EXPERIENCE:

Wide knowledge of present day electronic techniques including I/Cs, F.E.T., etc. An awareness of the problems of high current and high voltage measurements would also be advantageous.

QUALIFICATIONS:

Are less important than experience — but we anticipate that the ideal man will be educated/experienced to about HNC level.

APPLY TO:

Mr R. Sutton, Personnel Manager

INTERNATIONAL

RECTIFIER



Hurst Green Oxted Surrey RH8 9BB Oxted 3215

3554

ELECTRONICS

Maintenance & Prototype Construction

Reckon you've got a flair for electronics? If so, we'd like to hear from you. We are a highly successful expanding outfit, among the leaders in the field of electronic components. To get the most out of our wide range of new equipment, we need a number of highly skilled technicians who really know what they're doing. There's plenty of work, lots of money to be made, and a secure long-term future, plus good prospects for promotion if you're interested.

For full details call 01-300 9017 at any time (24 hour answer service).
ITT Semiconductors, Footscray, Kent.

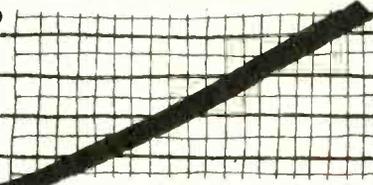
Semiconductors **ITT**

3564

COMPUTER ENGINEERS



£ 3500
£ 3000
£ 2500
£ 2000
£ 1500



your line to success as a **computer service engineer**

Vacancies exist in the London, Manchester and Liverpool areas for engineers with computer or electronic or electro-mechanical experience. In addition a number of senior vacancies exist for engineers (particularly with teleprocessing experience) who wish to develop their existing management skills. The Company pays attractive salaries together with generous fringe benefits including bonus, car allowance and non-contributory Pension Scheme.

For further details write or telephone.



COMPUTER FIELD MAINTENANCE LTD. *a member of the Computer World Trade Group of Companies.*
99 Bancroft, Hitchin, Hertfordshire Telephone: Hitchin (0462) 51511

3196

COMPUTER ENGINEERING

We require additional Electronic and Electro-Mechanical Engineers, to be involved in the maintenance of medium to large scale digital computing systems.

Training programmes will be arranged for successful applicants, 21 years of age and over, who have a good technical background to ONC/HNC level, City & Guilds or Radio/Radar experience in the Forces.

After training, and in appropriate circumstances, shift allowances will enhance the competitive basic salary, as will our twice yearly bonus. A contributory pension plan includes generous life insurance.

Opportunities also exist for more junior trainees, aged 18 and over, who should have a good standard of education, an aptitude for, and an interest in, mechanics, electronics and computers.

Please write for an application form, Quoting Ref. WW to:— E. J. Young, NCR
1000 North Circular Road, London NW2 7TL.

Plan your future with

NCR

3255

**CENTRAL ELECTRICITY
GENERATING BOARD**
South Eastern Region

**DUNGENESS
POWER STATION**

VACANCY:

INSTRUMENT MECHANIC

Applications are invited for the post of Craftsman (Instruments) at Dungeness Nuclear Power Station, Romney Marsh, Kent.

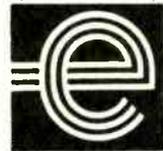
The successful candidate can earn up to **£45** per week, including productivity bonus payments. This post offers most excellent opportunities for a good Instrument Mechanic to broaden his experience in the field of modern electronics.

Applicants will be considered from candidates with experience of electronic instrumentation and/or closed circuit television.

The employment offers generous holidays with pay (plus one day off with pay each month), sick pay scheme, contributory pension scheme, canteen facilities and Sports & Social Club, etc.

- A rented council house may be available to a married man living outside the normal daily travel area.

Applications in writing giving full details of age, experience and career to date, should be sent to:



STATION SUPERINTENDENT,
CENTRAL ELECTRICITY GENERATING
BOARD, DUNGENESS NUCLEAR
POWER STATION, ROMNEY MARSH,
KENT, TN29 9PP. To arrive 8th April,
1974, quoting Vacancy No. 5068/74.
(WWW)

3591

CIRCUIT DEVELOPMENT ENGINEERS TELEVISION SYSTEMS SALARY RANGE £7,000 (OPEN)

The Grass Valley Group, Inc. (USA), a leading manufacturer of television line and terminal equipment, has immediate openings for highly qualified circuit development engineers. Specifically, we are looking for creative and resourceful people who are capable of carrying ideas through to completed products. Applicants are expected to be familiar with the latest solid state devices and techniques, and preferably should have experience in the design of video switching systems, video processing systems, and possibly digital video systems. Some experience in television studio operations and techniques is also desirable. Educational requirements are a C.E. or a B.Sc. in electronic engineering. A minimum of five years' design experience is required.

If you are interested in a challenging and rewarding career with an expanding company, please airmail a resume of your educational and technical background, work experience, and personal history to William L. Rorden, Chief Engineer, The Grass Valley Group, Inc., P.O. Box, 1114, Grass Valley, California 95945, USA. Resumes need not be formal; however, we are interested in learning as much about you and your experience as possible. Immediate consideration will be given and response made to suitable applicants, with a view toward arranging personal interviews in London in early 1974. All resumes will be treated in confidence. References will be required at or prior to the time of interview.

Grass Valley is a small town located in the foothills of the Sierra Nevada mountains in northern California, adjacent to summer resort and ski areas, and 2 1/2 hours from San Francisco.

THE GRASS VALLEY GROUP, INC. 

3570

Storno

RADIO COMMUNICATION SYSTEMS

We have vacancies for:

SERVICE TECHNICIANS

for our Service Department based in Camberley. Applicants should be familiar with transmitter/receiver practice and have practical knowledge of radio communications.

ELECTRONIC TEST TECHNICIANS

based in Camberley to work on preparation, development, test and fault finding of special FM/VHF/UHF communications and control systems, preferably with previous experience in radio communications technology and control systems.

FIELD SERVICE TECHNICIANS

in the Greater London area. Applicants should have experience in fault finding and testing of UHF/VHF radio equipment. Current driving licence essential, company vehicle provided.

REPAIR GROUP TECHNICIANS

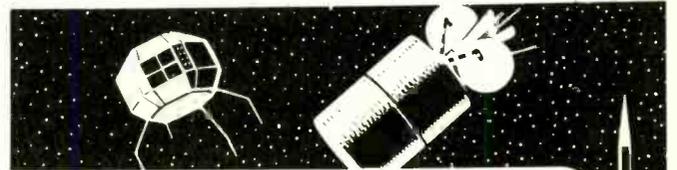
based in Camberley to work on fault finding and repair of electronic sub-assemblies and main equipments.

SALARIES UP TO £2000 PER ANNUM PLUS OVERTIME.

The Company has much to offer those who are interested in the sophisticated, modern world of radio-telecommunications and who can demonstrate their ability in this field.

Please contact: **The Personnel Officer, Storno Ltd.,
Frimley Road, Camberley, Surrey.
Telephone 0276 29131.**

3592



A Long-term future in **BRISTOL**

DRAUGHTSMEN

are required to support our Technology teams who are currently working on a number of new and exciting projects in both our Guided Weapons and Electronics & Space Systems Groups. Applicants must have previous design, detail or layout experience in an electronic or electrical environment. Some experience of printed circuit board layout and design would be desirable for electronics applicants.

Please phone or write to:-

**Mr. P. M. Farmer,
Personnel Officer (Ref. GW/231),
British Aircraft Corporation,
Guided Weapons Division,
Filton, Bristol, BS99 7AR.
Tel: Bristol 693831 Ext. 778**



GUIDED WEAPONS DIVISION

3561

Electronics Engineers

In order to fully meet our future programmes we find it necessary to strengthen our existing design teams and are therefore seeking experienced electronics engineers for positions in one or other of the following design areas.

R.F. Engineering as required in the development of F.M. and A.M. tuners.

Audio engineering as required in the development of tape recorders and high-fidelity amplifiers.

Candidates should be of graduate or equivalent status with proven ability in one of the above areas or a related area.

Good salaries will be offered and the prospects in these expanding teams are excellent. Help can be given with removal expenses where necessary.

Applicants are invited to write or telephone in the first instance for an application form to: Personnel Officer, Decca Radio & Television, Golf Course Lane, Leicester. Tel. 0533 872101 Ext. 54.

DECCA

Electronic Technicians WALSGRAVE HOSPITAL

Electronic Technicians are required for the Electronics Department dealing with the maintenance of a wide variety of electronic and electro-medical apparatus.

Applicants must possess H.N.C., H.N.D. or O.N.C. in electronics or equivalent City and Guilds Certificate.

General diagnostic maintenance experience in the electronic field is necessary. Training in maintenance of specialised hospital equipment will be given.

Salary scale from £1,719 to £2,211 p.a. Additional payments are made if overtime is required.

Applications stating age, qualifications and experience, together with two referees should be sent to the Group Engineer, Coventry Hospital Management Committee, P.O. Box 92, The Birches, Tamworth Road, Keresley End, Coventry.

Coventry Hospital Management Committee



3553

Avionics Inspector

Due to continued growth and expansion in our Avionics Service Centre, an interesting opportunity exists for an experienced electronic test engineer to join our Quality Control team as Avionics Inspector.

Have You?:

ONC or equivalent.
Practical electronic equipment experience including calibration.
Working knowledge of Ministry and C.A.A. procedures.

If so, you could be the engineer we are seeking.

Attractive salary negotiable from £2,200.
3 weeks' paid annual leave, excellent sickness benefits, and contributory pension scheme.

Please apply immediately for interview:

Mr. M. J. Hinge, FieldTech Limited, Heathrow Airport (London), Hounslow, TW6 3AF. Tel: 01-759 2811, ext 28.



3548

Electro-Medical Service
Department requires

ENGINEERS

for testing and servicing electronic apparatus. Applicants should be aged 20-30, and should be of O.N.C. standard.

Apply in first instance in writing to:

SIEREX LIMITED
Electro-Medical Department,
Heron House, Wembley Hill Road,
Wembley, Middlesex, HA9 8BZ

[3244]



Opportunities in the ELECTRONICS FIELD

Men with analogue or digital qualifications/experience seeking higher paid posts in:
TEST — SERVICE — DESIGN — SALES

Phone Roger Pearce 01-629 7306
NEWMAN APPOINTMENTS
360 Oxford St. W.1.

3345

QUEEN MARY COLLEGE (University of London)

Computer Science Laboratory

Applications are invited for the post of

ELECTRONICS TECHNICIAN

The newly formed Computer Science Laboratory contains two Interdata mini-computers with a variety of peripherals including discs, drum, cassette, sophisticated graphics terminal, etc., which are to be used for teaching undergraduate and postgraduate students and computer science research. A third computer will be installed during 1974.

An electronics technician (Grade 5) is required to design and construct simple peripheral interfaces, and to be responsible for the day to day maintenance of the minicomputers. Applicants should preferably have some experience in the maintenance of digital systems. The post does not involve shift work.

Salary in the range £2007 x £75 to £2382, plus £175 London Weighting.

Applications to Assistant Secretary (Establishment), (WW) Queen Mary College, Mile End Road, London E1 4NS, giving details of age, qualifications and experience.

[3497]



become a RADIO-AMATEUR!

learn how to become a radio-amateur in contact with the whole world. We give skilled preparation for the G.P.O. licence

free! Brochure, without obligation to:
BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL P.O. BOX 156, JERSEY, CHANNEL ISLANDS
 NAME: _____
 ADDRESS: _____
 WW B34.
 BLOCK CAPS please

13233

YOUR CAREER in RADIO & ELECTRONICS ?

Big opportunities and big money await the qualified man in every field of Electronics today—both in the U.K. and throughout the world. We offer the finest home study training for all subjects in radio, television, etc., especially for the **CITY & GUILDS EXAMS** (Technicians' Certificates); the Grad. Brit. I.E.R. Exam.; the **RADIO AMATEUR'S LICENCE**; P.M.G. Certificates; the R.T.E.B. Servicing Certificates; etc. Also courses in Television; Transistors; Radar; Computers; Servo-mechanisms; Mathematics and Practical Transistor Radio course with equipment. We have **OVER 20 YEARS'** experience in teaching radio subjects and an unbroken record of exam. successes. We are the only privately run British home study College specialising in electronics subjects only. Fullest details will be gladly sent without any obligation.

To: **British National Radio & Electronics School, P.O. Box 156, Jersey, C.I.**

Please send **FREE BROCHURE** to

NAME Block
 ADDRESS Caps.
 Please
 W.W.C. 34

BRITISH NATIONAL RADIO AND ELECTRONICS SCHOOL

13330

M.Sc. Course in Electrical Engineering

with specialisation in any one of the following:

- Electrical Machines,**
- Power Systems,**
- Communication Systems,**
- Electronic Instrumentation Systems,**
- Control Engineering and Digital Electronic Systems,**
- Design of Pulse and Digital Circuits and Systems,**

The Course, which commences in October 1974, may be taken on a Full Time, Part Time, sandwich or Block Release basis, and is open to applicants who will have graduated in Engineering or Science, or who will hold equivalent qualifications, by that date. The Science Research Council has accepted the Course as suitable for the tenure of its Advanced Course Studentships.

Research in Electrical Engineering

Applications are also invited from similarly qualified persons who wish to pursue a course of research leading to the Degree of M.Phil. or Ph.D. in any of the above subjects.

Application forms and further particulars from the Head of the Department of Electrical Engineering (Ref: M.Sc. 5), The University of Aston in Birmingham, BIRMINGHAM B4 7PB.



THE UNIVERSITY OF ASTON IN BIRMINGHAM

2607

Run your own hi-fi store

A unique opportunity to become the outright owner of a franchise that's the first of its kind in Britain.

Tandy Corporation (Branch UK) is completely new to Britain. A division of the Tandy Corporation of America, where its 'Radio Shack' operation has now grown to approaching some 2,000 outlets.

Nowhere else will you find a similar operation, because a Tandy franchise is your very own business.

You'll be selling exclusive Tandy brands of radio, audio and communications equipment, plus parts and kits. All of the highest possible quality, yet so competitively priced that you can be assured of high volume and substantial profits within a surprisingly short time.

Previous radio trade experience is not essential. You get the full benefit of Tandy's 50 years' experience—covering everything from your grand opening to everyday routines—plus regular newspaper advertising and full merchandising and promotional support.

A minimum of £14,000 initial investment is required.

Company-owned and managed shops are now actively trading and are available for franchise in Birmingham, Coventry, the Potteries, West Midlands and Manchester areas. Additional shops will also shortly be available for franchise in Bristol, Cheltenham, Doncaster, Gloucester, Liverpool, Nottingham and Worcester.

If you would like more information, please write in confidence to the Senior Vice-President, Mr. Richard O'Brien.

TANDY

TANDY Corporation
(Branch UK), Bilston Rd.,
Wednesbury, WS10 7JN, Staffs.

LOUGHBOROUGH TECHNICAL COLLEGE

Principal: F. Lester, B.Sc., Ph.D., F.R.I.C.

DEPARTMENT OF ELECTRICAL ENGINEERING

Applications are invited for places in September 1974 to study for the

Diploma in Radio, Television and Electronics

Applicants for this three-year full-time course should expect to gain 'O' level or good CSE grades in Mathematics and a Science subject and be keenly interested in electronics.

A large element of practical work and two periods of industrial placement are included. Students will also sit for Parts I and II of the City and Guilds Technicians Certificate in Radio, Television and Electronics.

Further details may be obtained from:

G. M. Allen, B.Sc.(Eng.), D.L.C., C.Eng., M.f.E.E.,
 Head of Department of Electrical Engineering,
 Loughborough Technical College,
 Radmoor, Loughborough, Leics. LE11 3BT.
 Tel: 5831

[3503]

SOUTHALL**COLLEGE OF TECHNOLOGY**Beaconsfield Road, Southall,
Middlesex.Telephone:
01-574 3448

CEI PART II

Options by

PART-TIME STUDY

in

Electronics—Telecommunications, etc.,
 The Engineer in Society

Apply: Head of Department of Electrical and Electronic Engineering [3491]

TECHNICAL TRAINING

Get the qualifications you need to succeed. Home study courses in Electronics and Electrical Engineering, Maintenance, Radio, TV, Audio, Computer Engineering & Programming. Also self build radio kits. Free details from: International Correspondence Schools, Dept. 734D3, Intertext House, London, SW8 4UJ. [90]

COLOUR TV SERVICING

Make the most of the current boom. Learn the techniques of servicing Colour & Mono TV sets through new home study courses, approved by leading manufacturers. Also radio and audio courses. Free details from: International Correspondence Schools, Dept. 734D2, Intertext House, London, SW8 4UJ. [89]

ARTICLES WANTED**ELECTRO-TECH COMPONENTS LTD.**

Are buyers of all types of electronic components and equipment. They will be pleased to view clearance stocks anywhere in Great Britain at one or two days notice

*and negotiate on the spot!***ELECTRO-TECH COMPONENTS LTD.**

315/317 Edgware Road, London, W.2
 Tel: 01-723 5667. 01-402 5580

[37]

WANTED

RC 460/S FREQUENCY SYNTHESISER by G.E.C.

Non-working model may be considered.
 Write W. S. Metcalf,

1 Macfarlane Close, Impington, Cambs.,
 or telephone Histon 2365

Buyer will collect.

Other type of Synthesiser may be considered.

[3575]

**WANTED
830/7 RECEIVER**

Faulty unit considered.
 Buyer will collect.

Write:

J. DOWSETT,

9 Common Hill, Saffron Walden,
 or phone Saffron Walden 22693
 (after working hours)

[3574]

CAPACITY AVAILABLE**PRINTED CIRCUIT AND
ARTWORKED DESIGNED**

and prepared. Development test and repair of electrical equipment. Batch reproduction capacity.

Tech-Art Electronics,
 29 Clyde Road, Stanwell, ASHFORD, Middlesex
 Tel: Ashford (69) 58942

[3520]



University of Wales Institute of Science and Technology

Department of Applied Physics M.Sc./DIPLOMA COURSE IN ELECTRONICS

Applications are invited for places in the full-time one-year M.Sc./Diploma course in Electronics, commencing 2nd October, 1974.

Further details can be obtained from the Academic Registrar, UWIST, King Edward VII Avenue, Cardiff, CF1 3NU.

Application forms should be completed and returned to the College as soon as possible.

3439

Scholarships Awarded by the Institution of Electrical Engineers

The Council of the Institution of Electrical Engineers will consider for award this year Undergraduate and Postgraduate Scholarships with a maximum value of £600 per annum.

The closing date for the receipt of applications is 1st May, 1974 and late applications cannot be considered.

Full particulars of the conditions governing the award of these Scholarships may be obtained from:—

The Education and Training Officer at the Institution of Electrical Engineers, Savoy Place, London WC2R 0BL.

[3505]

CITY & GUILDS EXAMINATIONS

Make sure you succeed with an ICS home study course for C & G Electrical Installations, Telecommunications Technicians and Radio Amateurs. Free details from: International Correspondence Schools, Intertext House, Dept. 734D, London, SW8 4UJ. [88]

TAPE RECORDING ETC.**RECORDS MADE TO ORDER**

DEMO DISCS
 MASTERS FOR
 RECORD COMPANIES

VINYLLITE
 PRESSINGS

Single discs, 1-20, Mono or Stereo, delivery 4 days from your tapes. Quantity runs 25 to 1,000 records PRESSED IN VINYLLITE IN OUR OWN PLANT. Delivery 3-4 weeks. Sleeves/Labels. Finest quality NEUMANN STEREO/Mono Lathes. We cut for many Studies UK/OVERSEAS. SAE list.

DEROY RECORDS
 PO Box 3, Hawk Street, Carnforth, Lancs.
 Tel. 2273

[82]

IMMEDIATE CAPACITY

Available for electronic assembly. Batch or prototype work, cableforming, wiring and PC assembly.

BSF INDUSTRIES

26 Goodways Drive, Bracknell, Berks.
 Phone: Bracknell 28243

[3132]

ELECTRONIC DESIGN ASSEMBLY

Highest quality at competitive prices

Contact:

MULTIFORM ELECTRONICS LTD.
 27 Ferry Road, Teddington, Middlesex
 Tel. 01-977 9389

[3527]

TEST EQUIPMENT

MARCONI TF1073, 100dB STEP ATTENUATOR £20.00

MARCONI TF1289, VSWR INDICATOR £50.00

MARCONI TF1237, NOISE GENERATOR £50.00

MARCONI TF791D, DEVIATION METER, 4MHz-1GHz £150.00

MARCONI TF995A/1, AM/FM SIGNAL GENERATOR, 2-216MHz £300.00

MARCONI TF894A, AUDIO TESTER 100Hz-27kHz £30.00

ADVANCE J2, AF SIGNAL GENERATOR, 15Hz-50kHz £30.00

AIRMEC 252 SIGNAL GENERATOR, 30Hz-300kHz £35.00

AIRMEC 251, 10kV IONISATION TESTER £25.00

WAYNE KERR VHF FREQUENCY STANDARD, 12 channel £20.00

WAYNE KERR A321 WAVEFORM ANALYSER, 1Hz-1200kHz £30.00

PYE ELECTROSTATIC GALVANOMETER, 0-20kV, mains £15.00

BRIT. PHYS. LABS. CZ960 COMPONENT COMPARATOR £40.00

BRIT. PHYS. LABS. CZ457/3 COMPONENT COMPARATOR, with Automator UNIT CZU457/2 £85.00

TEKTRONIX 524AD OSCILLOSCOPE £100.00

TEKTRONIX 535 OSCILLOSCOPE, with 1A2 dual trace plug in unit, plus type L plug in unit, as new, recently calibrated/overhauled £275.00

FRIDEN FLEXOWRITER, good condition with tape reader £120.00

FRIDEN FLEXOWRITER, less tape reader, suitable as spares £80.00

GRESHAM LION WAVEFORM GENERATOR, 625 line staircase £25.00

GRESHAM LION WAVEFORM GENERATOR, 405 line staircase £15.00

GRESHAM LION COMPOSITE WAVEFORM GENERATOR, 405/525/625 sine, square, pulse, bar £50.00

GRESHAM LION MS1, RANDOM NOISE MEASURING SET, 405/525/625 £50.00

ROHDE & SCHWARZ SIGNAL GENERATOR BN4105 30-300 MHz A.M. £300.00

AIRMEC SIGNAL GENERATOR Type 701 30kHz-30MHz £30.00

MARCONI BEAT FREQUENCY OSCILLATOR 0-20kHz £10.00

MARCONI SIGNAL GENERATOR TF762B 300-600MHz £50.00

MARCONI VIDEO OSCILLATOR TF885/A 0-12MHz £45.00

ROHDE & SCHWARZ DIAGRAPH BN3561 30-300MHz £300.00

TEKTRONIX OSCILLOSCOPE Type 524D DC-10MHz £70.00

NAGARD DOUBLE-PULSE GENERATOR Type 5002A.O. 1Hz-1MHz £65.00

AIRMEC MODULATION METER Type 210 3-300MHz £100.00

ROHDE & SCHWARZ SIGNAL GENERATOR BN41404 AM/FM 4-300MHz £600.00

MARCONI 'Q' MAGNIFICATION METER TF329G £45.00

MARCONI PULSE GENERATOR Type TF675E 100-50kHz £35.00

ADVANCE SIGNAL GENERATOR C2/H Push-button selectivity £30.00

ADVANCE AUDIO GENERATOR Model HI 15Hz-50kHz £20.00

MARCONI SIGNAL GENERATOR Type TF801A 10-300MHz £40.00

MARCONI VALVE VOLTMETER Type TF426C 0-300 volt D.C. £28.00

AIRMEC SIGNAL GENERATOR Type 201 30kHz-30MHz £75.00

MARCONI SIGNAL GENERATOR Type TF867/2 15kHz-30MHz £100.00

MARCONI SIGNAL GENERATOR Type TF801B/3/S 12-485MHz £110.00

MARCONI SIGNAL GENERATOR Type TF144G 85kHz-25MHz £25.00

ROHDE & SCHWARZ UHF ATTENUATOR & DUMMY LOAD BN33662/50 50 ohm 0-600MHz £60.00

AIRMEC SIGNAL GENERATOR Type 201A 30kHz-30MHz £125.00

AIRMEC 853 WAVE ANALYSER 30kHz-30MHz £50.00

AIRMEC BRIDGE HETERODYNE DETECTOR Type 775 £65.00

BERCO MAINS VOLTAGE STABILISER Type CVS4 240 volt/32 amp £75.00

HEWLETT-PACKARD UHF SIGNAL GENERATOR Type 814A 800-2300 MHz £175.00

ROHDE & SCHWARZ UHF TEST RECEIVER BN1523 280-940MHz £440.00

ROHDE & SCHWARZ DEVIATION METER BN4620 20-300MHz £300.00

MARCONI CIRCUIT MAGNIFICATION METER Type TF1245 £60.00

MARCONI VARIABLE ATTENUATOR Type TF338B £10.00

MARCONI OUTPUT POWER METER Type TF340 £20.00

E.M.I. OSCILLOSCOPE Type WMB DC-15MHz. Complete with plug-in unit £45.00

AVO VALVE CHARACTERISTIC METER Complete with hand-book £55.00

TELONIC SWEEP GENERATOR 450-900MHz £80.00

THE FOLLOWING ITEMS INCLUSIVE OF VAT. PLEASE ADD 20p for Post and Packing, except where stated.

TERMS: STRICTLY CASH WITH ORDER

MAINS ISOLATING TRANSFORMERS, 375VA, tapped primary, 240V output, new, carriage 50p £5.50

PYE LYNX (TV CAMERA) MANUAL, TVC/1 £1.50

SILICON RECT. STACKS, 200V at 18A, with finned heat sink 80p

IMSLIDE, telescopic rack runners, 23 in. long, 12 sections per pair £1.10

PYE MF TRANSMITTERS, 2 x 5B254Ms in final. VFO in 340/540kHz, 2 x 5B254Ms in modulator, CW/MCW, units complete but no PSUs, with circuits, brand new, carriage £1.50 £20.00

PYE 25 in. PICTURE MONITORS, monochrome, 6 channel inputs, blue metal cabinets, carriage £1.50 (prefer buyer collect) £25.00

RACK VENTILATION UNITS, 19 in., incorporating mains blower, carriage 50p £5.50

CANNON RIGHT ANGLED PLUGS, XLR LNR 15 75p

PABST FANS, TYPE 1200, 110/127V, with suitable start capacitor £2.20

MULLARD TUBULAR CERAMIC TRIMMERS, 1-18pF, new per 100 £10.00

PLEASE ADD 10% VAT - CARRIAGE £1.50

B. BAMBER ELECTRONICS

20 Wellington St., Littleport, Cambs. Ely

Phone (0353) 860185

WANTED

ALL TYPES OF ELECTRONIC COMPONENTS, SURPLUS STOCKS and TEST EQUIPMENT

[3490



NIGHT VIDEO SERVICES LIMITED

SUPPLIERS OF LOWLIGHT LEVEL AND SECURITY SURVEILLANCE CLOSED CIRCUIT TELEVISION SYSTEMS

NOW APPOINTED SOLE AGENTS FOR MULLARD ELECTRO-OPTICAL DEVICES

- VIDICON TUBES
- PLUMBICON TUBES, MONOCHROME OR R.G.B., IN SETS OR SINGLE
- SILICON VIDICONS
- IMAGE INTENSIFIERS

Write for data sheets or telephone for demonstration:

NIGHT VIDEO SERVICES LTD.

1 LEVERSON ST, LONDON, SW16 6DD. TEL. 01-769 8569

3594

Quality Test Equipment Fully Tested and Recalibrated

TEKTRONIX SPECTRUM ANALYSER TYPE 491 10 MHz to 40 GHz -110dBm resolution, portable, solid state, a very fine instrument and a current production item, complete with accessory kit. PRICE £1,200.

TEKTRONIX 524AD £85. HEWLETT PACKARD 175A. 50 MHz scope with dual channel plug in type 1750B, spare high gain. 5mV/cm type 1752A plug in and delay time base type 1781B plug in. £400. TELEQUIPMENT 532AR. £40. HEWLETT PACKARD 130B. 1mV/cm DC vertical and horizontal input 1uS/cm time base, excellent single beam scope for £50.

HEWLETT PACKARD 8690B sweep generator main frame £400. Plug ins for the above instrument: TYPE H01-8692B, 1.7-4.3 GHz brand new £550. TYPE 8693B 4-8 GHz good condition £300.

HEWLETT PACKARD 693D sweeper generator 4-8 GHz slightly older equipment but still in good working order FROM £150. TELONIC PD3B sweep generator 100-250 MHz 40 watts o/p £200. TELONIC PD3 as above but 4 watt o/p £100. TELONIC SM2000 with LHZM plug-in. 0.5 to 110 MHz sweeper £100. MARCONI TF 801A/1 £25. MARCONI TF 801B-C-D/1 from £95.

Large quantity of crystal detectors and coaxial line components available. Send for lists.

MARCONI VYM TYPE TF 1100 £30. MARCONI VYM TYPE TF 1041B £30. HEWLETT PACKARD 430C microwave power meter 10 MHz-12.4 GHz complete with 477B thermister head £45. PRD THERMO-ELECTRIC POWER METER TYPE 6685 complete with 10 mW head £100.

VENNER 3436 frequency and time measuring equipment 1MHz £35. RHODE & SCHWARTZ POLY-SKOP SWOB 0.5-400 MHz complete swept test system including leads, etc. One brand new instrument available at £750.

BECKMAN 6144AH TIMER COUNTER, full facilities. £52. AIRMEC Type 248 wave analyser 5-300 MHz £55. AIRMEC Type 858 oscillator 5 KHz-30 MHz £25. WANDEL & GÖTTERMANN pebblemeter type TPFM-43 and pebblemeter type TFP5-42 p.o.a.

GENERAL RADIO UNIT OSCILLATORS covering ranges 0.5 MHz to 2 GHz sweeping attachments and psu's available, many models. Send for lists.

BENCH POWER SUPPLIES. APT twin supply 0.50 a 1.2A £45.

SOLARTRON AS757.2 single supply 0.50 V a 1A £25.

FULL CATALOGUE AVAILABLE ON REQUEST.

CAMTRONICS

32 NORFOLK WAY, BISHOP'S STORTFORD, HERTS.

Telephone: (0279) 59367

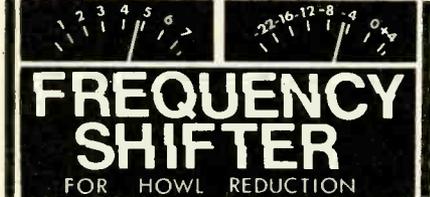
[3371

PEAK PROGRAM METERS TO BS4297

also 200KHz version for high speed copying.
Drive circuit, 35 x 80mm, for 1mA L.H. zero meters to ED 1477.
Gold 8-way Edge con supplied.

	2 off	4 off	10 off
Complete kit	£8.00	£7.60	£7.20
Built and aligned	£12.00	£11.40	£10.80

ERNEST TURNER PPM meters. Below scalings stocked. Type 642, 71 x 56mm £9.90; 643, 102 x 79mm £11.77
Twin movement, scale 86 x 54mm £31.00



PUBLIC ADDRESS : SOUND REINFORCEMENT
In any public-address system where the microphones and loudspeakers are in the same vicinity acoustic feedback (howl-round) occurs if the amplification exceeds a critical value. By shifting the audio spectrum fed to the speakers by a few Hertz the tendency to howling at room resonance frequencies is destroyed and an increase in gain of 6-8dB is possible before the onset of feedback. The 5Hz shift used is perceptible on both speech and music.
SHIFTERS IN BOXES with overhead LED, shift/bypass switch, BS4491 mains connector and housed in strong diecast boxes finished in attractive durable blue acrylic. Jack or XLR audio connectors.

Type	A	B	C
Input impedance	200kOhm	200kOhm	10kOhm BALANCED
Output impedance	2kOhm	20 or 800 Ohm	20 or 600 Ohm BAL
PRICE	£68.00	£68.00	£84.00

SHIFTER CIRCUIT BOARDS FOR WW July 1973 article
Complete kit and board £21.00 Including p.s.u. and DESIGNER
Board built and aligned £28.00 mains transformer APPROVED

SURREY ELECTRONICS
The Forge, Lucks Green, Cranleigh,
Surrey GU6 7BG. (STD 04866) 5997
CASH WITH ORDER, less 5% UK post free, add VAT 3430

WIRED TELEVISION SPARES

AMPLIFIER type TA 902 at £6.60
AMPLIFIER type RA 211 at £5.50
AMPLIFIER type RA 016 at £5.50
SUBSCRIBERS Tap type RE151-40, RE141-28, RE161-34. All at £1.10
SPLITTERS type RD501, RD502, RD503, RD504, RD505, RD111. All at 88p each
GREENPAR COAXIAL CONNECTORS type GE27517-C3, GE27519-C3, GE27574-C15, GE27886. All at 22p each
SEALCTRO SUB-MINIATURE CONNECTORS type 3000, 3002, 3003, 3005, 3014, 3024, 3100, 3102, 3103, 3104, 3105, 3114, 3124, 5775. All at 22p each
TEXAS OP-AMPS type SN 72771 at £4 each
PLESSEY DUAL COMPARATORS type SL717 at 55p each
DISC CERAMICS .01uf 50v.w., .02uf 50v.w., at 50p per 100
MORGANITE BIPOLAR LADDER SWITCHES type 241-2 at £15 each
X BAND 5 mW GUNN DIODES at £3 each
MORGANITE BINARY LADDER NETWORKS type 211-All 5K at £5.50, type 211-B12 5K at £10 each, type 211-A12 10K at £5 each, type 262B-100K at £8 each

J. BIRKETT
25 The Strait, Lincoln LN2 1JF
Tel: 20767 [38]

ELECTRONIC TEST EQUIPMENT

AMPLIFIERS
E.M.I. 1A. Selective freq. Amplifier, 300H-6KHz... £60.00

ANALYSERS
Muirhead D-669-A Freq. Analyser, 30Hz-30KHz... £95.00
G.R. 1556-B Impact Noise Analyser, 5Hz-20KHz... £85.00
Dawe 142A Impact Noise Analyser... £45.00

BRIDGES
Microwave 3055 Thermistor Bridge... £40.00
Muirhead A-168-A Capacitance Bridge, 100PF-1uF... £45.00
Wayne Kerr B-121 Component Bridge... £45.00
Wayne Kerr B01 R.F. Component Bridge, 15Hz-15MHz... £70.00

COUNTERS
Gresham Lion GFT15 6 digit 15MHz Timer/Counter—New... £165.00
Recal SA501 A 4 digit, 110KHz... £45.00
Venner 3334 4 digit, 1.2MHz... £45.00
Venner 3336 6 digit, 1.2MHz... £50.00

METERS
Marconi TF1300 Vacuum Tube Voltmeter... £25.00
Marconi TF1205 Power Meter, 500W 500MHz... £75.00
Airmec 284 Phase Meter 50KHz-100MHz... £90.00
Radiometer BFK6 Distortion Meter... £130.00
D.V.M. Solartron LM1620 4 Digit: 1999, 0-1000V, 100uV sensitivity—NEW... £75.00

OSCILLOSCOPES
Cossor CDU110 Dual Beam, 20MHz, CDU 111 Plug In £140.00
Tektronix 531A Dual Trace, 15MHz, 'G' Plug In... £150.00
" 545 Dual Trace, 33MHz, CA Plug In... £250.00
" Sampling Scope, 4S1 Dual Trace Sampling Unit... £400.00
Elliott 8100 Transistor Curve Tracer, C/W Manual... £150.00

POWER SUPPLIES
Brandenburg 705 0-15K Volt, C/W Probes... £50.00
K.S.M. HVV 5025 Up to 5KV-25mA... £60.00
Robson T134 Variable Voltage Twin 0-50V 1A/Channel... £50.00
T168 Transistorised 6-15V 10A... £30.00

MISCELLANEOUS
Radiometer CLT1 Linearly Test Set... P.O.A.
Kerry Freon Vapour Tank Cleaner... £100.00
Dawe Vibration Calibrator... £45.00
Philips LD1 1000 Portable Video Tape Recorder, C/W Servicing Manuals... £250.00
10% V.A.T. to be added on all items. Carriage extra at cost.

URGENTLY WANTED, GOOD QUALITY ELECTRONIC TEST GEAR AND ENVIRONMENTAL TEST EQUIPMENT.

MARTIN ASSOCIATES
Greensward Lane, Arborfield, Nr. Reading, Berks.
Telephone: Arborfield Cross (0734) 780810 [3504]

RESISTOR BARGAINS
BRAND NEW MILITARY SPEC.

1/2 W 5% ...	0.75p	1 W 5% ...	1p
1/2 W 2% ...	1.05p	1 W 2% ...	2p
1/2 W 1% ...	3.00p	1 W 1% ...	6p
1/2 W 5% ...	0.75p	2 W 5% ...	2p
1/2 W 2% ...	1.05p	2 W 2% ...	4p
1/2 W 1% ...	4.00p	All in E24 Series	

Subject to stocks remaining and 10% V.A.T.
C.W.O. P. & P. 10p per order, min. qty. 10 can be mixed.

ELLIOTT BLUNT AUDIO LTD.,
40 York Street, Twickenham, Middx., TW1 3LJ
[3294]

BUILD OR BUY a MINIATURE TRANSMITTER



The smallest transmitter available in the UK. Only 2" x 1". Fits in the palm of your hand. Can pick up and transmit voices and minute sounds. Receive on a VHF radio. Excellent range. Can be worn round the neck, held in the hand or operated on a shelf. Works almost anywhere. Uses PP3 battery (very Long Life). Simply switch on; no other connections. Completely self contained. Transistorised, printed circuit. Used the world over. Many applications. Fully g'nead.

ASSEMBLED UNIT £15.50
Kit with step-by-step assembly instructions £11.50
If receiving suitable radio for receiving transmitter £13.25

Insurance/P. & P. 45p.
MAIL ORDER (all items).

MULHALL ELECTRONICS (WW)
Ardglass, Co. Down, UK, BT30 7SF
DIRECT SALES (constructed items only):
Peter Spencer (London Agent),
39 Oxford Gardens, London, W10.
Telephone: 969 3564.
RAE licence required

36

CARBON FILM RESISTORS
High Stab. 1/2W 5%, 1p, 62p/100, £4.50/1000 (22Ω-2MΩ) E12
RESISTOR KITS 10Ω-1M E12 SERIES:
10E12KIT, 10 of each value (Total of 610) £3.10
25E12KIT, 25 of each value (Total of 1525) £7.20

FREE CATALOGUE ON REQUEST
Metal Film 1/2W 5%, 1p, £1.10/100; £8.25/1000
15E12KIT (10Ω-1M) Total of 915 £8.00
C.W.O. P. & P. 10p on orders under £5. Overseas extra.

BH COMPONENT FACTORS LTD.
Dept. WW., 61 Cheddington Road, PITSTONE,
Leighton Buzzard, Beds., LU7 9AQ. [32]

ENAMELLED COPPER WIRE

S.W.G.	1lb Reel	1/2lb Reel
10-14	£1.40	80p
15-19	£1.40	80p
20-24	£1.43	83p
25-29	£1.52	91p
30-34	£1.57	97p
35-40	£1.69	£1.04

Please add 10% to all above prices to cover V.A.T.
The above prices cover P. & P. in U.K. supplied by
INDUSTRIAL SUPPLIES
102 Parrawood Road, Withington, Manchester 20
Tel.: 061-224-3553 [85]

PRECISION POLYCARBONATE CAPACITORS

Close tolerance. High stability. Extremely low leakage. All 63V D.C. Plus or minus 1% tolerance: 0.47uF-56p; 1.0uF-80p; 2.2uF-80p; 4.7uF-£1.30; 6.8uF-£1.64; 10.0uF-£2.00; 15uF-£2.75. Also available ±2% and ±5%, ex. Stock.

TANTALUM BEAD CAPACITORS: Values available: 16/20v or 25v; 22.0uF at 6/10v or 16v; 33.0uF at 6v or 10v; 47.0uF at 3v or 6v; 100uF at 3v.
All at 10p each; 10 for 95p; 50 for £4.00.

TRANSISTORS: BC107, BC108, BC109; all at 9p each; 6 for 31p; 12 for 96p. May be mixed for quantity price. BC182 and BC212 at 10p each; AF178 at 30p each. All brand new and marked. Full spec. devices.

POPULAR DIODES IN914—6p each; 8 for 45p; 18 for 90p. IN918—8p each; 6 for 45p; 14 for 90p. IS44—5p each; 11 for 50p; 24 for £1. All brand new and marked.

NEW LOW PRICE—400 mW Zeners. Values available 4.7, 5.6, 6.8, 7.5, 8.2, 9.1, 10, 11, 12, 13.5, 15V. Tol. ± 5% at 5 mA. All new and marked. Price 7p each; 6 for 39p; 14 for 84p. Special offer 6 of each voltage (66 zeners) £3.65.

RESISTORS. Carbon film 5%, 1/2 W at 40°C, 1/3W at 70°C. Range from 2.2Ω to 2.2MΩ in E12 series, i.e. 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades. High stability, low noise. All at 1p each; 8p for 10 of any one value; 70p for 100 of any one value. Special pack—10 of each value 2-2Ω to 2.2MΩ (730 resistors) £5.

440V A.C. CAPACITORS. 0.1uF, size 1 1/2in x 1/2in, 40p; 0.25uF, size 1 1/2in x 1/2in, 55p; 0.47 and 0.5uF, size 1 1/2in x 1/2in, 66p; 1.0uF, size 2in x 1/2in, 85p; 2.0uF, size 2in x 1in, £1.15p each.

SILICON PLASTIC RECTIFIERS 1.5 AMP. Brand new wire-ended DO27, 100PIV at 7p each or 4 for 26p; 400PIV at 8p each or 4 for 30p; 800PIV at 11p each or 4 for 42p.

7p post and packing on all orders below £5.00
Export Orders—please add cost of air/sea mail
PLEASE ADD 10% V.A.T. TO ALL ORDERS

Send S.A.E. for lists of other ex-stock items, L.E.D.'s, disc capacitors, electrolytics etc. Wholesale price lists available to bona fide companies.

MARCO TRADING
Dept. D3, THE MALTINGS, STATION ROAD, WEM,
SALOP. Tel: NANTWICH (CHESHIRE) 63291

zero88

Build a mixer to your own spec. using our easy to wire **AUDIO MODULES**
For full details contact Richard Brown at Zero 88, 115 Hatfield Road, St. Albans, Herts, AL1 4JS Tel. 63727

[3536]

ECONOMISE ON SEMICONDUCTORS

All prices include VAT

LED Red Hewlett-Packard + Data		1+	10+	25+
799C Op Amp	8 pin DIL	28	26	24
793C Regulator	14 pin DIL	32	30	28
741C Op Amp	8 pin DIL	65	60	57
748C Op Amp	8 pin DIL	36	34	32
LM 308 Super Op Amp	8 pin DIL	39	37	35
NE555 Timer-Oscillator+Data		98	90	85
BC107 BC108 BC109		90	85	80
7400 02 03	22 7441	90	7474	42
7404 05	24 7442	82	7476	48
7410 20	22 7447	125	7490 92 93 85	
7413	27 7473	43		
BC109C	10 BC212	11	1N4002	6
BC177	13 BC214	11	1N4004	7
BC178	13 BF244B	27	BZY88C 3V3-15 10p	
BC182	10 2N3055	47	Minitor	
BC184	10 1N914/4148	5	3015F	1.30

TAD100 Radio IC + IF filter + Data £1.60
Carbon Film Resistors 5%, 1/2W 10-1M E12 Values 1p each 10 same value 8p

P & P 6p (UK) By Return service. All goods new Texas, Motorola etc. Linear circuits include data.

SILICON SEMICONDUCTOR SERVICES
41 Dunstable Road, Caddington, Luton, LU1 4AL [3402]

SURPLUS BARGAINS KLEINSCHMIDT S.C.M. TELEPRINTER OUTFITS



Comprising, Teletypewriter (page printer) type TT-271B/FG (known as Kleinschmidt 160) Repetitor-Transmitter (tape printer) type TT-272A/FG with table FN-65/FG. Both units are supplied with change wheels for 45 & 50 bauds the whole equipment operates on 115 or 230V 50cycles in very choice condition £55. (carr £4).

VARIACS 25amp 0-270v as new less handle & cover £2.50
(£2) TRANSFORMERS 240/110.3KVA New £15. (£11.00)
Constant Voltage 50watt £18. (£1) ditto 125 watt £8. (75p). FRAGMO MOTORS 240v AC 1/2h.p. 6000 rpm £4.50 (37p) AVO CT38 Electronic Meters £18. (£1) BC221 £12. (£1) AMPEX VIDEO TAPE 2in x 1670 new £9. (50p) SINTERED NICKEL CADMIUM ACCUMULATORS 1.2v 7a.h. size 90x30x60mm with electrolyte and instructions 80p (8p) PRINTED CIRCUIT KITS £1.25. (21p). CT53 £10. (£1). FERRIC CHLORIDE 25p a lb. (18p) 10lbs £2.50 (paid) KENT CHART RECORDERS 115VAC £20. (£1.50) MULTI-POINT £30. (T856 IQ Meter) Magnification Meter from £15. (£1). FRIEDEN FLEXOWRITERS £80 (£4) tape to suit £1. for 3. RACAL MA188 DUAL DIVERSITY Switch new £50. only VEEDER ROOT 4 Digit resettable counters 115v £1.25 (8p) ELECTRONIC TIMER KIT. 0.8secs to 100sec. comprises A.E.I. Transistorised Module, Relay, & all electrical components for 115 or 240v A.C. operation £1.75 (16p). Loads of surplus to clear. Large S.A.E. for list ALL PLUS V.A.T.

CASEY BROS.
233-237, Boundary Road, St. Helens, Lancs. 86

SITUATIONS VACANT

CAN YOU WRITE CLEAR, concise technical handbooks? If you think you could, and have a thorough understanding in electronics, why not join us as a technical author. Obviously, previous experience would be an advantage but is not necessary as full training would be given. We have vacancies in many parts of the country. Starting salaries are high with excellent prospects for advancement. Box No. WW 3414.

DIALYSIS ORDERLY required for the Regional Renal Unit at St. Leonard's Hospital (in conjunction with St. Bartholomew's Hospital). Successful applicant will be responsible for the preparation, cleaning and maintenance of equipment. The post is most suitable for a young man wishing to gain experience in hospital mechanical/electronic engineering. Average pay £31.60 per week including overtime. Applications in writing stating age, experience and the names of two referees, to the Hospital Secretary, St. Leonard's Hospital, Nuttall St., London N1 5LZ. [3509]

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL
THERE is a vacancy for an Electronics Technician in the Clinical Pharmacology Section of the Medical Unit. Applicants should have a suitable, recognised qualification in Electronics or Telecommunications, and preferably some practical experience. Salary according to Whitley Council scale from £1440+£126 L.W. Application forms from the Secretary. Quoting ref MU/2. [3506]

HIFI AUDIO ENGINEERS. We require experienced Junior and Seniors and will pay top rates to get them. Tell us about your abilities. 01-437 4607. [19]

JAPANESE radio importers require engineers for servicing transistor radios, etc., part or full time to work in our London office near Moorgate underground station. Tel.: 01-628 6157. [3303]

ARTICLES FOR SALE

ARVAK ELECTRONICS. 3-channel sound-light converters, from £18. Strobes, £25. Rainbow Strobes, £132.—12A Bruce Grove, N17 6RA. 01-808 9096. [23]

BUILD IT in a DEWBOX quality plastic cabinet 2 in. x 2 1/2 in. x any length. D.E.W. Ltd. (W.), Ringwood Rd., Fernwood, Dorset. S.A.E. for leaflet. Write now—Right now. [76]

BACK copies of Wireless World for sale, 1961-1970 almost complete. Offers: Harris, 'Chislehurst', Winsor Estate, Pelynt, near Looe, Cornwall, or telephone Lanreath 367. [3508]

MARX-LÜDER ELECTRIC MOTORS

A range of high efficiency reversible D.C. motors are now offered complete with stackable epicyclic gears giving the following range of gear ratios:—3, 4, 5, 6, 12, 15, 18, 20, 24, 30, 60, 72, 90, 120, 360. Extra gear sets extend the range to fill most requirements. Four sizes of motor with pile gears are available all with 6v windings and output as under:—

- EM136P 1 1/2 watts @ 8000rpm. Size 24x24x74mm £. Max. gearbox torque 2kg.cm. 5-65
- EM136P/1 Spare gear set with 3, 4, 5, 6 ratios. 1-70
- EM141P 8 watts @ 8000rpm. Size 35x35x109mm Max. gearbox torque 5kg.cm. 6-45
- EM141P/1 Spare gear set with 3, 4, 5, 6 ratios. 1-80
- EM145P 20 watts @ 8000rpm. Size 52x52x180mm Max. gearbox torque 10kg.cm. 8-25
- EM 146P 30 watts @ 4500rpm. Size 52x52x200mm Max. gearbox torque 10kg.cm. 10-20

MOTORS without gearboxes:

- EM131 0.8 watt; 20 g.cm torque; 8000rpm; Ø 17mm. 3-95
- EM136 1.5 watt; 40g.cm torque; 8000rpm; Ø 21mm 3-80
- EM139 4.2 watt; 160g.cm; torque; 8500rpm; Ø 30mm 3-60
- EM141 8 watt; 320g.cm torque; 8500rpm; Ø 30mm. 4-20

Suggested applications. Laboratory stirrers, pump drives, servo systems, positioning of aerials, dampers, doors etc., powering models, trains, boats, curtains, garage doors, etc.

S.A.E. for DATA SHEET

'Motivator' Curtain Cord Controllers

A few of these new units have just become available. Ultra slim design, e.g. size 40x185x185mm. Screws flat on wall behind curtains without showing. Can be connected directly to existing corded curtains. Incorporates internal auto limit switches and power supply. May be operated remotely by 3-way switch (supplied).

- Motivator Model B with 2 year battery pack. Kit. 18-00
- Fully assembled and tested as above 24-00
- Motivator Model M with mains power supply. Kit. 22-00
- Fully assembled and tested as above 30-00

Additional Information gladly supplied on request. All prices are inclusive in U.K. only.

MAIL ORDER ONLY FROM

AID-US PRODUCTS
 Dept. W1, 8 Hillview Rd., Pinner HA5 4PA, Middlesex

COLOUR. UHF and TV SPARES. Colour and UHF lists available on request. New Philips G6 single standard convergence panels complete, incl. 16 controls, coils, P.B. switches, leads, etc. and circuit data £3.75, or with yoke £5.00, P/P 30p. New Colour Scan Coils, Mullard or Plessey plus convergence yoke and blue lateral, £10.00, P/P 40. Mullard AT1025/05 Convergence Yoke, £2.50, P/P 25p. Mullard or Plessey Blue Laterals, £1.25, P/P 10p. BRC 3000 type Scan Coils, £4.00, P/P 40p. Delay Lines DL20, £3.50, DL1E, DL1, £1.50, P/P 25p. Lum. Delay Lines, 50p, P/P 15p. EHT Colour Quadripler for Bush Murphy CTV 25 111/174 series, £8.25, P/P 25p. EHT Colour Tripler ITT TH25/ITH suitable most sets, £2.00, P/P 25p. KB CVC1 Dual Stand. convergence panels complete incl. 22 controls, £3.75, P/P 35p. CR1 Base Panel, £1.75, P/P 15p. Makers Colour surplus/salvaged Philips G8 panels part complete: Decoder incl. I/C, £2.50, IF incl. 5 modules, £2.50, T. Base, £1.00, P/P 25p. CRT base, 75p, P/P 15p. GEC 2040 panels, Decoder, £3.50, T. Base, £1.00, RGB and Sound, £1.00, P/P 25p. Pye CT70 Colour LOPT assembly incl. EHT output and Focus Control, £3.50, P/P 35p. B9D valve bases 10p, P/P 6p. VARICAP TUNERS. UHF ELC 1043 NEW, £4.50, Philips VHF for Band 1 and 3, £2.85 incl. data. Salvaged VHF and UHF Varicap tuners, £1.50, P/P 25p. UHF TUNERS NEW, Transistorised, £2.85 or incl. slow motion drive, £3.85. 4 position and 6 pos. push-button transist., £4.95. UHF/VHF basic integrated tuners, £3.25. Cydon UHF valve tuners, £1.50. All tuners P/P 30p. Transist. UHF/VHF IF panels salvaged, £2.50 P/P 25p. MURPHY 600/700 series complete UHF Conversion Kits incl. tuner, drive assy., 625 IF amplifier, 7 valves, accessories housed in cabinet plinth assembly, £7.50 P/P 50p. SOBELL/GEC 405/625 Dual standard switchable IF amplifier and output chassis incl. cct., £1.50 P/P 35p. THORN 850 Dual standard time base panel, £1.00 P/P 35p. PHILIPS 625 IF amplifier panel incl. cct., £1.00 P/P 30p. VHF turret tuners AT7650 incl. valves for K.B. Featherlight, Philips 19TG170, GEC 2010, etc., £2.50. PYE miniature incremental for 110 to 830. Pam and Invicta, £1.95. A.B. miniature with UHF injection suitable K.B. Baird, Ferguson, 75p. New fireball tuners Ferguson, HMV, Marconi, £1.90 P/P all tuners 30p. Large selection LOPs, Scan Coils. FOPTs available for most popular makes. PYE/LABGEAR transist. Mast-head UHF Booster, £5.75, Power Unit, £4.65 P/P 30p or Setback battery operated UHF Booster, £4.65 P/P 30p. MANOR SUPPLIES, 172 WEST END LANE, LONDON, N.W.6 (No. 28, 59, 159 Buses or W. Hampstead Bakerloo and Brit. Rail) MAIL ORDER: 64 GOLDERS MANOR DRIVE, LONDON, N.W.11. Tel: 01-794 8751.

CONSTRUCTION AIDS—Screws, nuts, spacers etc., in small quantities. Aluminium panels punched to spec. or plain sheet supplied. Fascia panels etched aluminium to individual requirements. Printed circuit boards—masters, negatives and board, one-off or small numbers. Send 6p for list. Ramar Constructor Services, 29 Shelbourne Road, Stratford on Avon, Warwks. [28]

JAN CRYSTALS

Fast delivery of prototype and production military quality crystals. Competitive prices all frequencies; LF crystals a speciality. Details from:

INTERFACE INTERNATIONAL
 29 Market Street, Crewkerne, Somerset.
 Tel: (046031) 2578. Telex: 46377. [3521]

MARINE radio telephone. Old Redifon GR60. A complete and believed working order with instruction manual. £15 ono. Ring 01-876 7917 (Richmond, Surrey). [3569]

RADIO TELEPHONE EQUIPMENT. Expand your radio telephone system. 12 1/2 kc. G.P.O. approved units. PYE, COSSOR, G.E.C., ULTRA-BURNDEPT, etc., High Band, Marine, Lowband AM and FM. Exports to Africa and Middle East. Spa-Radio, 335/337, High Road, Cheltenham, Glos. [3229]

QUANTITY of V.H.F. mobile equipment and small components S.A.E. for lists. Quantity of 1000 PIV 10A Silicon stud diodes, 6 for £1; 200 PIV ditto, 8 for £1; 2N708 transistors, 12 for £1. B. M. Sandall, Amber Croft, Higham, Derby, DE5 6EH. [3588]

SELLING Wireless World (1930-1939). £3.95 per volume. Jones, 43 Dundonald Road, Colwyn Bay, Denbs. [3587]

STYL. Finest quality for most Crystal & Magnetic Cartridges: Double-Diamond, Diamond, Diamond/Sapphire, Double Sapphire, Sapphire, at lowest prices. Quick Service. FREE List sent for S.A.E. FELSTEAD ELECTRONICS (WW) LONGLEY LANE, GATLEY, CHEADLE, CHESHIRE SK8 4EE. [3577]

TRANSISTORISED U.H.F. T.V. tuner units for sale. Brand new in cartons. Details from Mr. Kennedy, 01-703 4040. [3418]

"WIRELESS WORLD" magazines for sale, 1924-73, complete with indices. Offers, Batley 474939. [3586]

LABGEAR distribution amplifiers, 14 signal amplifiers, 5 splitters. Cost £190+. Sell £100. Heywood, 14 Darling Road, SE4 1YQ. 01-692 6977. [3581]

1500 PIECES of copper clad bakelite for printed circuits. Approx. sizes 10in. x 6in. x 1/16in. Offers wanted. Lowplas Co., 261 Whapload Road, Lowestoft 3017. [3585]

EXCLUSIVE OFFERS

NEVER BEFORE OFFERED

WORLD-WIDE RANGE
COMPLETE TRANSPORTABLE H.F. COMMUNICATIONS CENTRE housed in Air Conditioned TRAILER fitted two COLLINS KWT-6 500W S.S.B. Transmitter-Receiver and one COLLINS Receiver all fully tuneable 2 to 30 mcs digital readout synthesised frequency control, with line amplifiers and inputs, operating position and remote control facilities and ancillary equipment. Power input 115V or 230V A.C. Full details on application.
PHILCO RC-150 POINT-TO-POINT STRIP RADIO HF RECEIVERS 2/30 mcs. Ten fully tuneable channels to 0-5 mcs with synthesizers. Single and diversity reception on 1SB, DSB, SSB with 4 sub-bands to each channel. Full details and prices on application.

HIGHEST QUALITY 19" RACK MOUNTING CABINETS & RACKS

Our Height Ref. in inches	Width in inches	Depth in inches	Rack Space in ins.	Panel	Price
CD 69	21	13	68		£10.00
CE 82	22	24	77		£14.00
CF 87	23	26	80		£12.50
CH 88	24	30	75		£14.00
CJ 83	24	24	75		£13.00
CK 83	24	12	75		£10.00
CL 30	60	36	42		£18.00
CP 69	24	26	61		£13.00
CR 69	30	30	—		£24.00
CT 70	69	27	—		£45.00
CU 87	26	17	—		£20.00
DE 52	40	24	91		£30.00
DF 75	22	26	68		£18.00
DH 70	23	24	122		£26.00
DK 85	22	26	79		£20.00
DL 54	24	19	69		£18.00
DP 74	24	24	66		£18.00
DR 14	21	12	10		£7.00
DS 89	30	20	63		£28.00

Also Consoles, twin and multi-way Cabinets, OPEN RACKS

Our Height Ref. in inches	Channel in inches	Depth in inches	Rack Space in ins.	Base	Price
RE 108	8	104	Boles		£9.00
RD 80	8	77	24 inches		£8.00
RC 66	8	63	Boles		£8.00
RE 78	7 1/2	70	Boles		£7.00

Full details of all above on request.

We have a large quantity of "bits and pieces" we cannot list—please send us your requirements we can probably help—all enquiries answered.

- ★ Philips PM230 d/h 10 mcs Scopes £45.00
- ★ Solartron 0/25000 cye. Oscillators £24.00
- ★ Dave 630 Phase Meters £22.00
- ★ Southern Inst. 1800 F.M. Meters £24.00
- ★ Belling Lee T.V. Relay Equipment P. U. R.
- ★ 75ft self-supporting Towers P. U. R.
- ★ Adio 8 track Tape Readers £48.00
- ★ Rally 8 track Tape Readers £48.00
- ★ 80 column Card Hand Punches £40.00
- ★ 75 foot sectional self supporting Towers £300.00
- ★ Mullard High speed Valve Testers & cards £25.00
- ★ Metro-Vickers miniature Oscilloscopes £12.00
- ★ Pergraph 3CFN Tape Recorders £35.00
- ★ Auto Electric Carillon Chimes £250.00
- ★ CV-157 Hoffman 1SB/SSB Converters £95.00
- ★ 10 foot Triangular Lattice Mast Sections
- ★ 6 inch slides £9.00
- ★ Casella Asmann Electric Hygrometers £24.00
- ★ Racal MA-150 Synthesizers £95.00
- ★ Racal MA-250 Decade Generators £125.00
- ★ Racal RA-98 S.B.B./D.S.B. Adaptor £75.00
- ★ Avo Geiger Counters, new £27.00
- ★ Servomex 2KV Voltage Regulators £34.00
- ★ Double Co-axial Blowers 6x6 220 v. A.C. £8.00
- ★ Ampex S.E.10 Auto Degaussers £45.00
- ★ Uniselectors 10 bank 25 way full wipe £3.00
- ★ R.C.A. 5 element 420 mcs Yagi Beams £4.00
- ★ Hexplex 600 watt 230 v./115v. Isolation Transformers £9.00
- ★ Multihed D.888 Analysers £80.00
- ★ Laboratory Radio Interference Filters £2.00
- ★ Eye Scalpam Galvos £14.00
- ★ Caswell Type 1471 Variable Filters £70.00
- ★ 54in. dia. Meteorological Balloons £1.50
- ★ Plann Microwave Attenuators 4/12 EMC £40.00

FREE
 40-page list of over 1,000 different items in stock available—keep one by you.

INSTRUMENTATION TAPE RECORDER-REPRODUCERS

- AMPEX**
- FR-100B 1" 14 tracks 6 speeds
- FR-600 1" and 1/2" 14 and 7 tracks 4 speeds Transistorised

- MINCOM**
- CMP-100 1/2" 1" 7 tracks 6 speeds

- E.M.I.**
- TD-1 1/2" 4 tracks 7 speeds
- Several other smaller decks.
- Full details on request.

Prices of above are from £100 to £400.

COMPUTER HARDWARE

- ★ CARD READER 80 col. 600 c.p.m.
- ★ PRINTER, High speed 1000 lines p.m.
- ★ TAPE READER, High speed 5/8 track 800 c.p.m.
- ★ 400 Channel Spectrum Analyser

Prices on Application
 PLEASE ADD V.A.T. TO ABOVE

P. HARRIS ORGANFORD — DORSET
 BH16 6ER
 BOURNEMOUTH-05051



BLOWER MOTORS

Small double ended blower for use on 6 to 28v. DC. Size overall 6 x 3 1/2". New £1.90.

POTENTIOMETERS

Dual gang 10K ea. section w.w. with knob and dial. 2 1/2" dia. £1.25.

TRIMMERS

20pf air spaced ceramic, 10 for 60p.

C.R.T.s

Type SSP11A O.Gun tube £17.60. Type 3UP1 £9.40. Both new.

ATTENUATORS

N type, in 10 and 16dB 4 watt disp. £1.10 each.

H.V. CONDS

2uf 7.5Kv Wk £4.40, and 2uf 12.5Kv £4.62.

RACK BLOWERS

By Imoffs, 19", 5" high, 14" deep, 240v. motor, £5.

RACK CABINETS

19" size ext. 41" high, 22 x 22" useable int. size 36" high, with front door, £11.

R.F. SWITCHING RELAYS

With 12v. coils uses reeds for 75 ohm coax circls. as 2 NC and 1 NO RF circ. plus 2 NO aux contacts, size 1 1/2 x 1 x 1" ex equip. 55p each.

LINEAR AMPLIFIERS

Redifon type GA406, 2 to 18 Mc/s, provision for 4 channels 19" rack unit with int. 240v. P.U. rating 500w. CW or 750w. PEP. Note supplied less valves 2 type QV4-400 or sim. req., all other circls. solid state. £40.70.

TRANS

H.T. types Pri. 230v. Sec. 2.6Kv. at 600 Ma OC (Bi. Phase) £14.30; also 1125-0-1125v. at 565 Ma, £8.25, match. choke £1.50; also 380/420v. 3 phase isolation trans. 600 watts, £17.60.

LAB TYPE MAINS FILTER

By Filtrons 2 x 25 amp, 250v AC 0 to 400c/s £22.

TEST GEAR

TF801A Sig. Gen. 10 to 310 Mc/s with spare valve kit-£44. TS505 Elec. Multimeters DC volts 0 to 1000 in 9 ranges, AC volts 0 to 250 in 7 ranges, Res. 1 ohm to 1000 Meg in 7 ranges, RF to 500 Mc/s with probe 115v. 50 c/s I/P, £24.80. TS382 AF sine wave Osc. 20 c/s to 200 Kc in 4 ranges, O/P 1Uv to 10v in 7 ranges, built-in o/p meter and freq. check, 115v. 50 c/s I/P, £28.15.

TS452 SWEEP GEN

5 to 100 Mc/s with marker generator, 3" display, o/p atten. etc. 115v. 50 c/s I/P, £40.15.

MOTOR DRIVE UNIT

Motor 115v 1/12th HP, O/P 110 RPM to 1 rev in 3 min in 9 stages, elec G.B. £17.60.

NOTE:

TEST GEAR SUPPLIED WITH 240/110v. Trs where req. Tested and Supplied with copy of instruction book where available. Also new stock items available.

COAXIAL LEADS

BNC to BNC 75 ohm 1 metre, £1.50.
BNC to BNC 50 ohm 1 metre, £1.50.
UHF to UHF 50 ohm 1 metre, £1.47.
N to N type 50 ohm 1 metre, £2.03.
BNC to Croc clips 1.5 mt., £1.07.
UHF to Croc clips 1.5 mt., £1.07.
Other lengths and combinations available on request.

All above prices include carr. and VAT.
SAE for List or enquiry.
Carriage charges apply to mainland only.

A. H. SUPPLIES

57 MAIN ROAD
SHEFFIELD S9/5HL
444278 (0742)

TRANSFORMERS

DOUGLAS GUARANTEED
(Prices include P. & P. and 10% VAT)

Output V. & Amps.	Ref. No.	Price
12V x 2 250 mA x 2	MT 111 CS**	£1 55
12V x 2 500 mA x 2	MT 213 *†	£1 99
12V x 2 1A x 2	MT 71 CT	£2 45
12V x 2 2A x 2	MT 18 CT	£3 04
12V x 2 3A x 2	MT 70 AT	£3 95
12V x 2 4A x 2	MT 108 AT	£4 49
12V x 2 5A x 2	MT 72 AT	£5 28

Output Amps.	Ref. No.	Price
500 mA	MT 112 CT	£1 81‡
1A	MT 79 CT	£2 51‡
2A	MT 5 AT	£3 77
3A	MT 20 AT	£4 31

Output Amps.	Ref. No.	Price
500 mA	MT 102 AT	£2 36‡
1A	MT 103 AT	£3 50‡
2A	MT 104 AT	£4 74

Output Amps.	Ref. No.	Price
500 mA	MT 124 AT	£2 60
1A	MT 128 AT	£3 70

Power output	Winding tapped at	Ref. No.	Price
20 VA	0-115-210-240	MT 113 CT	£1 48
75 VA	"	MT 64 AT	£2 95
150 VA	0-115-200-220-240	MT 4 AT	£3 61
200 VA	"	MT 65 AT	£4 31
300 VA	"	MT 66 AT	£5 06

VA	Ref. No.	Price
60	MT 149 AT*	£4 17
100	MT 150 AT*	£4 61
200	MT 151 AT*	£9 22

400 V. Output at 50 HZ. Ref. IT3 AT
C-D Ignition system by R. M. Marston Eq.
Wireless World. £4 26

EQUIPMENT RANGE

Sec. Output (r.m.s.)	Ref. No.	Price
3-0-3 V.	MT 238 CS**	£1 39
0-0-9	MT 13 CS**	£1 39
12-0-12	MT 239 CS**	£1 39
20-0-20	MT 241 CS**	£1 39
0-20 x 2	MT 214 CT**	£2 13
0-8-9 x 2	MT 207 CT**	£2 53
0-15-20 x 2	MT 205 AT**	£3 39
0-15-27 x 2	MT 203 AT*	£3 78
0-15-27 x 2	MT 204 AT*	£3 78
20-12-0-12-20	MT 221 AT*	£1 96

AT indicates open universal fixing with tags; CT is open U-clamp fixing with tags; CS is open U-clamp fixing with P.C. splices; * with interwinding screen; † untapped 240V Primary; ‡ tapped at 210-240V; other Primaries tapped at 200-220-240V.

Over 200 types in stock through agents or direct. Send for lists.
DOUGLAS ELECTRONIC INDUSTRIES LTD., Direct Sales Dept.
Thames Street, LOUTH, Lincs. LN11-7AD

Quartz Crystal Units
ACCURATE RELIABLE

Private enquiries, send 5p in stamps for brochure

THE QUARTZ CRYSTAL CO. LTD.
Q.C.C. WORKS, WELLINGTON CRESCENT,
NEW MALDEN, SURREY. 01-942-0334 & 2988

THE ONLY COMPREHENSIVE RANGE OF RECORD MAINTENANCE EQUIPMENT IN THE WORLD!

Send P.O 15p for 48 page booklet providing all necessary information on Record Care.

Cecil E. Watts Limited
Orby House
Sunbury-on-Thames, Middx.

BRAND NEW FULL SPEC. DEVICES

U.K. CUSTOMERS ADD 10% VAT TO TOTAL

MICROCIRCUITS: 709 31p; 710 41p; 723 58p; 741 (14 pin) 37p; 749 41p; SN76013-07 £1.70. **TRANSISTORS:** 2N3053 19p; 2N3055 48p; AC126/7/8 18p; AF14/5/6/7 18p; BC107A 12p; BC107B 13p; BC108A 11p; BC108B 12p; BC109 11p; BC109B 12p; BC109C 13p; BFY50/51/52 20p; OC4/45/70/71 12p; OC72/81 18p. **ZENERS:** BZY88 Series 11p. **1 AMP RECTIFIERS:** 50V 41p; 100V 5p; 200V 5p; 400V 6p; 800V 61p; 1000V 7p. **14 PIN IC SOCKETS** 14p. **SOLDERCONS** 1p per pin. **DALO PC PEN** 68p. **1W CARBON FILM RESISTORS:** 10 of one value per 7p. **PANEL MOUNTING LED** with data 22p. Prices at 4th January. Check our list.

Discounts start at 10% for 10+ Semiconductors of one type.

JEF ELECTRONICS (W.W.3)

York House, 12 York Drive, Grappenhall, Warrington, WA4 2EJ.

Mail Order Only. C.W.O. P. & P. 10p per order minimum, or at cost if more.

LIST FREE

Satisfaction or your money back.

PROMPT SERVICE

Lodge Trading Company

For Amplifiers, Speakers with and without cabinets, Changer Units, Plinths and Covers, Tape Recorders, four and eight track for car or home, Car Radios, Colour TVs, Aerials, Flex, and Cables, Large stocks of components.

ALL AT WHOLESALE PRICES

A VISIT WILL SAVE YOU MONEY

5 Day Week 9-6. Easy Car Parking.

Sorry no lists.

21 LODGE LANE, N. FINCHLEY, LONDON, N.12

01-445 2713, 01-445 0749

J. LINSLEY HOOD LOW DISTORTION AMPLIFIERS IN KIT FORM

1. 10 Watt Class A £5.25
2. 20 Watt Class B £20 (Incl. P.S.U)
3. 20-75 Watt Direct coupled £11.80

Also 'Texan' Amplifier Kits in pack form Bailey, Texas, Toshiba and Sanken Systems. Send large SAE for detailed lists.

TELERADIO HI FI

325 Fore St., London N9 0PE
01-807 3719 (Closed Thursdays)

TRANSFORMER LAMINATIONS enormous range in Radiometal, Mumetal and H.C.R., also "C" & "E" cores. Case and Frame assemblies.

MULTICORE CABLE IN STOCK CONNECTING WIRES

Large quantities of miniature potentiometers (trim pots) 20 ohm to 25K. Various makes. Wholesale and Export only.

J. Black

OFFICE: 44 GREEN LANE, HENDON, NW4 2AH

Tel: 01-203 1855. 01-203 3033

STORE: LESWIN ROAD, N.16

Tel: 01-249 2260

WILMSLOW AUDIO

The firm for speakers!



Baker Group 25 3 8 or 15 ohm	£6.60
Baker Group 35, 3 8 or 15 ohm	£7.50
Baker Deluxe 12" d/cone	£9.75
Baker Major	£7.50
Baker Major Module	£9.50
Baker Regent	£7.00
Celestion PST8 (for Unilex)	£2.55
Celestion MF1000 horn	£10.45
Celestion HF1300	£6.16
EMI 13 x 8, 3 8 or 15 ohm	£2.15
EMI 13 x 8, 150 d/c 3, 8, 15 ohm	£2.35
EMI 13 x 8, t/cw. 450, 3, 8, 15 ohm	£3.60
EMI 13 x 8 type 350 8 ohm	£8.25
Fane Pop 100 watt 18"	£22.50
Fane Pop 60 watt 15"	£13.00
Fane Pop 50 watt 12"	£11.00
Fane Pop 25/2 12"	£6.40
Fane Pop 15 watt 12"	£4.40
Fane Crescendo 18	£47.50
Fane Crescendo 15	£36.00
Fane Crescendo 12A or 12B	£29.00
Fane Crescendo 12BL	£30.00
Fane 807T 8" roll surr. 8 or 15 ohm	£3.85
Elac 59RM109 15 ohm, 59RM114 8 ohm	£2.65
Elac 6 1/2" d/c roll surr. 8 ohm	£3.35
Elac 4" tweeter TW4	£1.21
Goodmans 8P 8 or 15 ohm	£4.49
Goodmans 10P 8 or 15 ohm	£4.70
Goodmans 12P 8 or 15 ohm	£11.65
Goodmans 15P 8 or 15 ohm	£18.00
Goodmans 18P 8 or 15 ohm	£13.00
Goodmans 12PD 8 or 15 ohm	£15.25
Goodmans 12PG 8 or 15 ohm	£14.50
Goodmans Audiomax 12AX	£39.65
Goodmans Audio 100	£9.50
Goodmans Axent 100	£6.60
Goodmans Axiom 401	£15.10
Goodmans Twinaxiom 8	£6.79
Goodmans Twinaxiom 10	£7.61
Kef T27	£4.75
Kef T15	£5.75
Kef B110	£6.75
Kef B200	£7.50
Kef B139	£11.75
Kef DN8	£1.92
Kef DN12	£4.12
Kef DN13	£2.75
Richard Allan CGBT 8" d/c 8 ohm	£6.35
Wharfedale Super 10 RS/DD	£9.80
Wharfedale Linton 11 kit (pair)	£19.25
Wharfedale Glendale (pair)	£34.50
Wharfedale Dovedale (pair)	£52.00
Richard Allan Twinkit each	£8.25
Richard Allan Triple 8 each	£13.00
Richard Allan Triple each	£18.00
Richard Allan Super Triple each	£21.50
Goodmans DIN 20 each	£8.75
Fane Model I each	£9.90
Helme XLK25 (pair)	£18.17
Helme XLK50 (pair)	£37.18
Kefkit 11 each	£23.50
Kefkit 111 each	£34.00
STC 400IG Super Tweeter	£6.19

PRICES INCLUDE VAT

Cabinets, for HiFi and PA., wadding, vynair etc
Send for free booklet—"Choosing a Speaker"
FREE with orders over £7—HiFi Loudspeaker enclosures book
All units guaranteed new and perfect.
Prompt despatch
Carriage and insurance: Speakers 35p each, Kits 75p each (£1.50 pair) Tweeters and crossovers 20p each.

Telephone Wilmslow 29599

(Discount HiFi/radio sales at 10 Swan Street

WILMSLOW AUDIO,

Dept WW,

Swan Works, Bank Square, Wilmslow, Cheshire SK9 1HF.

WW—140 FOR FURTHER DETAILS

SHENNANTON



Model DRT 24 Decade Process Timer

- Accurate low cost timing from 0.99 or 0.9.9 seconds ON and OFF recycling continuously.
- Accuracy: ±2% of setting.
- Repeatability: ±0.1%.
- Independent time settings ON and OFF obtained by thumbwheel decade switches.
- Relay output — changeover contacts for 3A 250V.
- Timing circuits temperature compensated.
- Voltage supplies internally stabilised.
- A very versatile unit capable of solving many timing problems.

Send for further information and literature covering our complete range of timing modules, mains modules and triac modules.

SHENNANTON ELECTRONICS LTD.
CHURCH STREET, KIRKCOWAN, WIGTOWNSHIRE, SCOTLAND
TEL: KIRKCOWAN 353

WW—141 FOR FURTHER DETAILS

PRINTED CIRCUITS & ELECTRONIC EQUIPMENT

- LARGE & SMALL QUANTITIES
- FULL DESIGN & P.T.H. PROTOTYPE SERVICE
- ASSEMBLIES AT REASONABLE PRICES

for full details contact



K.J. BENTLEY & PARTNERS

18 GREENACRES ROAD, OLDHAM

Tel 061 624 0939

P O APPROVED

DEIMOS LTD

TAPE RECORDERS FOR RESEARCH, INDUSTRY AND PROFESSIONAL AUDIO

single and multichannel
SIMMONDS ROAD, WINCHEAP

CANTERBURY, KENT
0227-68597

SOWTER TRANSFORMERS

FOR SOUND RECORDING AND REPRODUCING EQUIPMENT
We are suppliers to many well-known companies, studios and broadcasting authorities and were established in 1941. Early deliveries. Competitive prices. Large or small quantities. Let us quote.

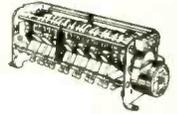
E. A. SOWTER LTD.
Transformer Manufacturers and Designers
7 Dedham Place, Fore Street, Ipswich IP4 1JP
Telephone 0473 52794

GAS DETECTOR AND ALARM

Fire, Gas and Smoke are all killers. Home Office figures recently published show that on average every 12 mins a fire occurs in somebody's home and these fires often break out at night when the family is asleep.
Don't live in a fool's paradise IT COULD HAPPEN TO YOU. Have the latest electronic protection. Install SAGA (four smoke and gas alarm). This uses the fantastic electronic sensor G.P.I. which "smells" smoke and gas and sounds the alarm immediately. In a next case measuring approx. 5" x 3 1/2" x 2 1/2". SAGA has its own internal alarm, also a supply to external bells. You just plug it in to the mains (Special introductory price—complete kit of parts including the case £5.99 or made up tested and working £6.99 plus 30p post and packing).

HONEYWELL PROGRAMMER

This is a drum type timing device, the drum being calibrated in equal divisions for switch setting purposes with trips which are infinitely adjustable for position. They are also arranged to allow 2 operations per switch per rotation. There are 15 changeover micro switches each of 10 amp type operated by the trips thus 15 circuits may be changed per revolution. Drive motor is mains operated 5 revs per min. Some of the many uses of this timer are Machinery control, Boiler firing, Dispensing and Vending machines, Display lighting, animated and signs, Signalling, etc. Price from makers probably over £10 each. Special snip price £6.33 plus 25p post and Insurance. Don't miss this terrific bargain.

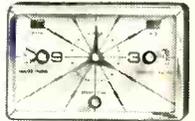


MINIATURE SEALED RELAY

American made. Our Ref. No. REL A1. Measures only 1 1/2" wide x 1 1/4" thick and 1" high and it's a double change over, we don't know the contact rating but estimate this at 3/5 amps. The coil resistance is 600 ohms and 9-12 volt will close it. Ideal for models and miniaturised equipment. It's a plug in relay but we supply complete with base. Price 33p including base.

ISA ELECTRICAL PROGRAMMER

Learn in your sleep. Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famous maker with 18 amp, on/off switch. Switch on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price £2.15 + 20p p. & p. or with glass front chrome bezel 83p extra.



MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied.
Model 1153 500mW power output 72p.
Model 1172 750mW power output 94p.
Model EP9000 4 watt power output £1.60.
EP 9001 twin channel or stereo per amp. £1.98.



MULTI-SPEED MOTOR

Six speeds are available 300, 850 and 1,100 r.p.m. and 8,000, 12,000 and 15,500 r.p.m. Shaft is 1/8" diameter and approximately 1 in. long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful! motor size approx. 2 in. dia. x 5 in. long. Price 97p plus 23p postage and insurance.

CURRENT CATALOGUE AND NEXT 12 MONTHLY SUPPLEMENTS 66p. POST PAID

EXTRACTOR FAN

Suitable for kitchens, bathrooms, factories, changing rooms, etc. Compact, quiet. Dia. 5 1/2 in. with 5 1/2 in. fan blades. Kit comprise, motor, fan blades, sheet metal casing, pull switch, mains connector and fixing brackets. £2.75. 30p p. & p.



SOLDER GUN

A must for every busy man, gives almost instant heat also illuminates job. 100 watt £2.47 plus post & ins. 20p.

SLIDE SWITCHES

Slide Switch, 2 pole change over panel mounting by two 6 BA screws. Size approx. 1" x 1 1/4" rated 250v lamp. 8p each, 10 for 72p.
Ditto as above but for printed circuit 7p each, 10 for 65p.
Sub Miniature Slide Switch, DPDT 19mm (3/8" approx.) between fixing centres. 14p each or 10 for £1.28.



DOUBLE LEAF CONTACT

Very light pressure closes 10th contacts. 8p each, 10 for 72p. Plastic push-rod suitable for operating 6p each, 54p for 10.

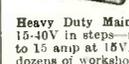
UNISELECTORS

As used in automatic switch boards, etc. 24v. operated. New—11 25 way full wiper type. We have the following in stock:

3 Bank	£4.40	5 Bank	£6.60
3 Bank + C	£4.40	6 Bank	£8.80
3 Bank Split C	£4.40	10 Bank	£9.90
4 Bank	£5.50	12 Bank	£12.00

12 VOLT 1 1/2 AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 mfd smoothing. Price £2.20, plus 20p post & packing.

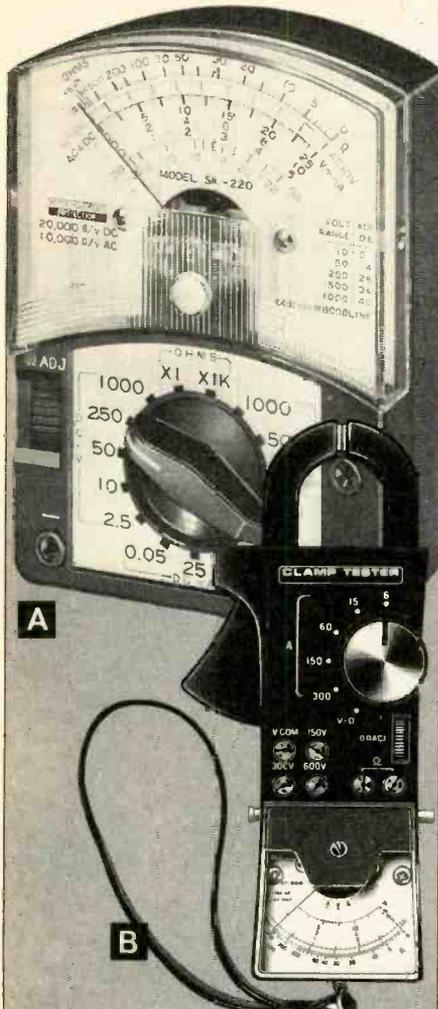


Heavy Duty Mains Power Pack. Output voltage adjustable from 15-40V in steps—maximum load 250W—that is from 6 amp at 40V to 15 amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price £6.33 plus 65p post.

PLEASE ADD 10% VAT
BARGAIN LIST AVAILABLE. 25p.
ADD 25p POSTAGE IF ORDER IS UNDER £5

J. BULL (Electrical) LTD.

(Dept. W.W.) 7 PARK STREET, CROYDON CRO 1YD
Callers to 102/3 TAMWORTH ROAD, CROYDON



A AC-DC VOM MULTI-TESTER

MODEL SK-220

Compact-sized VOM for schools and service shops. • Easy-to-read 2 color scale. • Double jeweled 2% meter. • Single positive action switch. • Stabilized 1% resistors.

SPECIFICATIONS:

• Sensitivity: DC Volts—20,000 Ω /V, AC Volts—10,000 Ω /V • Accuracy: DC $\pm 3\%$ of Full Scale, AC $\pm 4\%$ of Full Scale • Resistance: 4K Ω with 35 Ω Midscale, 40K Ω with 350 Ω Midscale • Decibels: -20 ~ +62, Upper Freq. Limit 7kHz • Power source: One (1) AA 1.5V, Eveready 915 or Equal • Size & Weight: 116 x 84 x 39mm, 300g.

B CLAMP TESTER

MODEL CT-300

SPECIFICATIONS:

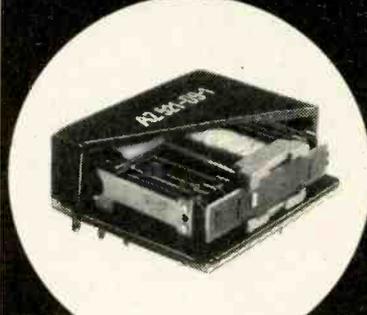
• Range of Measurement: AC: A 6A, 15A, 60A, 150A, 300A, AC: V 150V, 300V, 600V Resistance: 1K Ω (center: 30 Ω) • Internal battery and fuses: UM-3 battery, 1.5 volts, 0.1A fuses (9.5 ~ 11.5 Ω), Max. circuit voltage: 500V Size & Weight: 190 x 85 x 45mm, 320g Accessories: Test leads, Leather carrying case.

• For catalog, please write to:

Taisei Electronics Co., Ltd.
C.P.O. Box 847, Tokyo, Japan.
Cable Address: "NESCOELECTRO TOKYO"
Telex: J24788 SIGMARON Tel: 256-9054, 9055

WW—142 FOR FURTHER DETAILS

The Young Generation Relay



Flatform Relay AZ 521

Cradle relay with 4 change-overs, dustproof cover, with single or bifurcated contacts.

Contact material:
Fine silver, silver palladium, gold nickel, fine silver with hard gold flashing, silver cadmium oxide.

Switching 2 A/2.5 A
capability 110 V/125 V.D.C. ~ 30 W/100 VA

Operating power ca. 400 mW
Coil voltage maximum 60 V
Surface area 36 x 30 mm
Height 11 mm

ZETTLER

Zettler UK Division



Equitable House,
Lyon Rd., Harrow,
Middx. HA1 2DU
Tel. (01) 863 6329

Please look us up at the
I.E.A., Stand No. 657

WW—143 FOR FURTHER DETAILS

LONDON CENTRAL RADIO STORES

TELEPHONE CABLE. Plastic covered grey 4-core coloured coded. 74p per yd.
RECORD STORAGE UNITS. Brand new. Anti-warp. 'Compact 200' stores 200 records. £14.41. P.P. £1.54. 'Compact 100' stores 100 records. £7.15. P.P. 77p. Leaflets available. S.A.E. ELECTRICITY SLOT METERS (6p. in slot) for A.C. mains. Fixed tariff to your requirements. Suitable for hotels, etc. 200/250v. 15 A. £7.42. 20 A. £8.25. P.P. 75p. Other amperages available. Reconditioned as new 2 years, guarantee.
MODERN DESK PHONES, red, green, blue or topaz, 2 tone grey or black, with internal bell and handset with 0-1 dial £5.50.
5-WAY PRESS-BUTTON INTER-COM TELEPHONES in Bakelite case with junction box handset. Thoroughly overhauled, guaranteed. Price £5.25. Wiring diagram on request, send s.a.e.
10-WAY PRESS-BUTTON INTER-COM TELEPHONES in Bakelite case with junction box handset. Thoroughly overhauled. Guaranteed. £6.75 per unit. Wiring diagram on request, send s.a.e.
20-WAY PRESS-BUTTON INTER-COM TELEPHONES in Bakelite case with junction box. Thoroughly overhauled. Guaranteed. £7.75 per unit. Wiring diagram on request, send s.a.e.
The '98' Set. This transceiver, weighs approx. 5 1/2 lbs. and measures 3 1/2 in. x 5 1/2 in. x 9 1/2 in. It is a 4 frequency channel set 41-44 mc/s. Crystal Controlled and operates from a dry battery H.T./L.T. 94/1. v. I.E. Ruben Malloy Type No. 1 and employs the following 14 valves, 3A4, 1 off; 1L4, 6 off; 1T4, 4 off; 1B5, 1 off; 1A3, 2 off. £5.50 plus 75p P. & P.
All prices subject to fluctuation

23 LISLE ST. (437 2969) LONDON W.C.2
Open all day Saturday

WIRE H.C. Copper, P.V.C. Insulated 24 A.W.G. (0.2 sq. m.m.) in P.V.C. Colours Black: Yellow, Blue or White. Reels 8 ozs. 95p; 1lb £1.80; 2lbs £3.50; 4lbs £6.75 including VAT and postage. Larger Reels available C.W.O.

H. A. WAINWRIGHT & CO. LTD.
9A Farncombe Street, Farncombe, Godalming, Surrey
Tel. Godalming 23545

THE TEXAN



HI QUALITY AMPLIFIER BY TEXAS

Booklet & Parts List 35p Post Incl.

FULL KIT OF PARTS £29.50
or READY MADE £38.50

PACK 1. RESISTORS	pp 15p	80p
PACK 2. SMALL CAPS	pp 15p	£1.50
PACK 3. LARGE CAPS	pp 15p	£1.40
PACK 4. SUNDRIES	pp 15p	£2.50
PACK 5. SWITCHES	pp 15p	£1
PACK 6. CONTROLS	pp 15p	£1.45
PACK 7. SEMI COND.	pp 15p	£8.25
PACK 8. TRANSFORMER	pp 25p	£5.95
PACK 9. P.C. BOARD	pp 15p	£2.50
PACK 10. CHASSIS, ETC.	pp 25p	£4.50
PACK 11. CABLES & LEADS	pp 15p	40p
PACK 12. TEAK CABINET	pp 30p	£2.75
POST EXTRA		VAT EXTRA

NOW ON DEMONSTRATION AT

TELERADIO HI FI

325/7 FORE ST., EDMONTON, LONDON, N9 OPE.
01-807 3719

SPECIAL NOTICE TO ALL MANUFACTURERS

in the
ELECTRONIC, RADIO, TELEVISION and ALLIED TRADES.

Please note that we will purchase any redundant and surplus stocks which you may have available after stocktaking, or wishing to make space for more important items. We are particularly interested in large quantities of components, raw materials, etc.

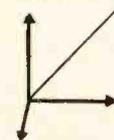
BROADFIELD & MAYCO DISPOSALS LTD.

21 Lodge Lane, N. Finchley, London, N12 8JG.

Telephone: 01-445 0749 01-445 2713 01-958 7624

QUARTZ CRYSTAL UNITS from

- 1.0-80.0 MHZ
- FAST DELIVERY
- HIGH STABILITY
- TO DEF 5271-A



WRITE FOR LEAFLET AT - 1

McKNIGHT CRYSTAL Co.
HARDLEY INDUSTRIAL ESTATE, HYTHE, SOUTHAMPTON SO4 8ZY.

TEL HYTHE 8961
STD CODE 042 14

OVERNIGHT

Prototype Printed Circuits
Fastest in London Area
48 hour and Overnight Services
Electronic & Mechanical Sub-Assembly
Co. Ltd., Highfield House, West Kingsdown, Nr. Sevenoaks, Kent.
Tel: West Kingsdown 2344

WE PURCHASE

OSCILLOSCOPES, SIGNAL GENERATORS,
PEN RECORDERS, COMPUTERS, RECEIVERS.
PLEASE SEND US YOUR LISTS.
BEST PRICES PAID.
ELECTRONIC BROKERS LTD.
49 Pancras Road, London, N.W.1. 01-837 7781

WE PURCHASE ALL FORMS OF ELECTRONIC EQUIPMENT AND COMPONENTS, ETC. SPOT CASH
CHILTMEAD LTD.
7, 9, 11 Arthur Road, Reading, Berks.
Tel: 582 605

EX-COMPUTER STABILISED POWER SUPPLIES

RECONDITIONED, TESTED AND
GUARANTEED

Ripple <10mV. Over-voltage protection on all except 24v. 7A. unit. 120-130v. 50 c/s Input. Stepdown transformer to suit about £3.

Post & Packing £1.50

5-6v. 8A. £12 24v. 7A. £14
5-6v. 12A. £14 30v. 7A. £14
5-6v. 16A. £16

PAPST FANS 4½ x 4½ x 2in. 100 cfm. £3.50 (30p).

PAPST FANS 6in. dia. x 2½in. deep Type 7576 £5.00 (30p).

WOODS FANS 6in. Plastic rotor £6.00 (36p).

ELECTROLYTICS

4000µ 70v., 3,600µ 40v., 10,000µ 50v., 4½ x 2in. dia. 55p (14p)
10,000µ 35v., 5,000µ 35v., 40p (12p)
2,000µ 30v., 1,000µ 16v., wire ends 15p (6p)
4,000µ 100v., 4½ x 2½ 55p (22p)

EX-COMPUTER PC PANELS 2 x 4in., min. 35 transistors with data 50p (12p). 25 boards for £1 (30p).

PANELS WITH 4 POWER TRANSISTORS SIM OC28 50p (10p).

QH Bulbs, 12v. 55w. 50p (6p)
250 Mixed Resistors 60p (9½p)
250 Mixed Capacitors 60p (9½p)
200 SI Planar Diodes 50p (7p)
Microswitches 8 for 50p (9p)
Min. Glass Neons 8 for 50p (6p)
10-way Terminal Blocks 10 for 55p (15p)

Postage and package shown in brackets

Please add 10% VAT to TOTAL

KEYTRONICS

Mail Order only.

44 EARLS COURT ROAD, LONDON, W.8
01-478 8499

APPLICATIONS OF OPERATIONAL AMPLIFIERS

by Burr-Brown PRICE £7.50

THE TRUE SOUND OF MUSIC
by Hans Fantel Price £2.65

LOGICAL DESIGN OF SWITCHING
CIRCUITS by D. Lewin
New Edition Price £5.00

HOW TO LISTEN TO THE WORLD
by BBC Price £2.00

HIGH FIDELITY AUDIO AMPLIFIER
CIRCUITS by Texas Instruments
Price £1.10

SILICON RECTIFIER HANDBOOK
by Motorola Price £1.30

MANUAL OF ACTIVE FILTER
DESIGN by J. L. Hilburn Price £6.50

DESIGNER'S HANDBOOK SOLID-
STATE POWER CIRCUITS by RCA
Price £3.55

TRANSISTOR AUDIO & RADIO
CIRCUITS by Mullard Price £1.90

RADIO & ELECTRONIC LABORA-
TORY HANDBOOK by M. G. Scroggie
Price £5.50

REFERENCE DATA FOR RADIO
ENGINEERS by I.T.T. Price £10.25

SEMICONDUCTOR CIRCUIT
DESIGN VOL I & II by B. Norris
Price £10.00 set

★ALL PRICES INCLUDE POSTAGE★

THE MODERN BOOK CO.

SPECIALISTS IN SCIENTIFIC
& TECHNICAL BOOKS

19-21 PRAED STREET,
LONDON, W2 1NP

Phone 723 4185
Closed Sat. 1 p.m.

A DEXTER DIMMASWITCH

ALLOWS COMPLETE

LIGHTING CONTROL



The DEXTER DIMMASWITCH is an attractive Dimma unit which simply replaces the normal light switch. It is available as a complete "ready to install" unit or "simple to assemble" kit. Two models are available controlling up to 300W or 600W of all lights, except fluorescents, at mains 200-250V, 50Hz. All DEXTER DIMMASWITCH models have built-in radio interference suppression.

600 watt £3.52 Kit form £2.97
300 watt £2.97 Kit form £2.42

All plus 12p post and packing
Prices include VAT. Please send c.w.o. to:

DEXTER & COMPANY

4 ULVER HOUSE
19 KING STREET
CHESTER CH1 2AH
Tel: 0244-25883

AS SUPPLIED
TO H.M. GOVERNMENT
DEPARTMENTS, HOSPITALS,
LOCAL AUTHORITIES,
ETC.

ARTICLES WANTED

CASH AVAILABLE for surplus semiconductors and I.C. Phone 01-452 2583. [3195]

PRINTED Circuit Board in 6 widths: 2 in., 2½ in., 3 in., 3½ in., 4 in. and 5 in. x any length: 1/16 in. single-sided fibreglass, 2p per 3 sq. in. Double sided 1p per sq. in. P & P 5p per order. SAF quotations for other sizes and quantity discounts. - J. Knopp, 11 Connaught Gardens, Braintree, Essex, CM7 6LY. Tel. Braintree 25254. [15]

VACUUM is our speciality. New and second-hand rotary pumps, diffusion outfits, accessories, coaters, etc. Silicone rubber or varnish outgassing equipment from £40. V. N. Barrett (Sales) Ltd., 1 Mayo Road, Croydon. 01-684 9917. [24]

WANTED, Wireless World 1930-1932 inc. Publisher's bindings preferred. Litherland, 11 Birch Grove, Chippenham. Tel. 50707. [3415]

WANTED, all types of communications receivers and test equipment.—Details to R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [63]

60 KHz MSF Rugby and 75 KHz Neuchatel Radio Receivers. Signal and Audio outputs. Small, compact units. Two available versions £35 and £60. Toolex, Bristol Road, Sherborne (3211), Dorset.

600 7490 I.C.s. wanted. Must be new and full manuf. spec. Cash waiting, phone Whitchurch (Bucks) 680. [3512]

WANTED. Dual Trace Oscilloscope. S. State around 10 MHz. Tel: Worcester 25956. [3288]

BOOKS, INSTRUCTIONS, ETC.

SEVERAL "Wireless World" 1950/54, 1965/73. Enquiries to Hewitt, 15 Priestfield Road, Redditch, B97 5LR. [3583]

WORLD RADIO TV HANDBOOK 1974 (published December), £3.15 inclusive. Delivered from Denmark if ordered before publication! David McGarva, PO Box 114W, Edinburgh EH1 1HP. Ask about quantities, two and up. [12]

COURSES

RADIO and Radar M.P.T. and C.G.L.I. Courses. Write: Principal, Nautical College, Fleetwood, FY7 8JZ. [25]

OVERSEAS AGENTS REQUIRED

See important announce-
ment on page 40.

CAPACITY AVAILABLE

AIRTRONICS LTD. for Coil Winding—large or small production runs. Also PC Boards Assemblies. Suppliers to P.O., M.O.D., etc. Export enquiries welcomed 3a Walerand Road, London, SE13 7PE. Tel. 01-852 1706. [61]

ASSEMBLY, alignment and wiring work undertaken. Outworker can do up to 50 hours per week to a high standard. Collection and delivery by arrangement. Ian Bowden, 165 Lancaster Road, New Barnet, Herts. 01-440 2979. [3589]

BATCH Production Wiring and Assembly to sample or drawings. Deane Electricals, 19B Station Parade, Ealing Common, London, W.5. Tel: 01-992 8976. [20]

DESIGN, development, repair, test and small production of electronic equipment. Specialist in production of printed circuit assemblies. YOUNG ELECTRONICS, 54 Lawford Road, London, N.W.5. 01-267 0201. [29]

DESIGN and Development of electronic circuits and systems. Experienced and qualified engineers available for analogue or digital projects. Box No. WW 3300.

DAVANT ELECTRONICS—have capacity available for batch electronic assembly of PCBs, units and panels. 11 Croft Close, Shrewsbury, Salop. Telephone: Shrewsbury 50550. [3582]

CAPACITY available to the Electronic Industry. Precision turned parts, engraving, milling and grinding both in metals and plastics. Limited capacity available on Mathey SP33 JIG BORER. Write for lists of full plant capacity to C.B. Industrial Engineering Ltd., 1 Mackintosh Lane, E.9 6AB. Tel. 01-985 7057. [14]

PRINTED CIRCUITS, quick service, competitive prices, roller tinning, drilling etcetera. Short runs welcomed. Jamiesons, 1-5 Westgate, Bridlington, Yorkshire. Tel: (0262) 4738 7787. [3386]

SMALL Batch Production, wiring, assembly, to sample or drawings. Specialist in printed circuit assemblies. D. & D. Electronics, 42 Bishopsfield, Harlow. Essex. Harlow 33018. [17]

NEW GRAM AND SOUND EQUIPMENT

GLASGOW.—Recorders bought, sold, exchanged; cameras, etc., exchanged for recorders or vice-versa.—Victor Morris, 343 Argyle St., Glasgow, C.2. [11]

RECEIVERS AND AMPLIFIERS— SURPLUS AND SECONDHAND

HRO Rx's, etc., AR88, CR100, BRT400, G209, S640, etc., etc. in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [65]

SERVICE & REPAIRS

AUDIO ENGINEER, available shortly, seeks commissions in consultative, advisory, creative, instalational or sub contract work. Enquiries and offers to Box No. WW 3580.

ELECTRONIC test equipment repair service offered on Avometers, Signal Generators Pulse/A.M./F.M./C.W./A.F., Frequency Counters, D.V.M.s, P.S.U.s, Oscilloscopes. Production test problems? Why not try us. "Q" Services Electronic (Camberley) Ltd., 29 Lawford Crescent, Yateley, Camberley, Surrey, Yateley 871048. [13]

FREELANCE technical author/electronics engineer invites enquiries for technical writing commissions. Box No. WW 3235.

SCRATCHED TUBES. Our experienced polishing service can make your colour or monochrome tubes as new again for only £2.75, plus carriage 75p. With absolute confidence sent to Retube Ltd., North Somercote, Louth, Lincs, or phone 0507-85 300. [27]

SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc. in stock!—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [64]

TAPE RECORDING ETC.

IF quality, durability matter, consult Britain's oldest transfer service. Quality records from your suitable tapes. (Excellent tax-free fund raisers for schools). Modern studio facilities with Steinway Grand.—Sound News, 18 Blenheim Road, London, W.4. 01-995 1661. [3433]

VALVES WANTED

WE buy new valves, transistors and clean new components, large or small quantities, all details, quotation by return.—Waltton's, 55 Worcester St., Wolverhampton. [62]

MANUALS AVAILABLE

MARCONI	SOLARTRON	COSSOR	TEKTRONIX	TELEQUIPMENT	ADVANCE	PYE	FURZEHILL		
TF329G	AS516	339	422	S31	TF1041	CT436	TC1A	CAMBRIDGE	O160
TF801B	AS517	1035	511AD	S32A	TF1100	CD523S.2	T2	BANTAM	1684
TF801B/3/S	ASW51A	1049	515A	D43	TF1101	AD557	TC2A	REPORTER	HEWLETT PACKARD
TF8010	SRS151&151A	E.M.I.	524AD	WAYNE KERR	TF1104/1	CD711S	D1	RADIVET	200CD
TF867A	SRS152&152A	WM2	531	B221	TF1300	CD814	D2	211	130A
TF868A	VF252	WM8	541	B121	TF1345/2	OD910	J	RACAL	BC221
TF885	CD546	WM16	541A-B	B521		CD1014	AIRMEC	SA28	HARTLEY 13A
TF886A	D300		555			CD1016	701	SA33	AVO CT38

This is only a small example of the manuals we have in stock. S.A.E. with your enquiries — we may be able to help.

CHILTMEAD LTD

7-9 ARTHUR ROAD, READING, BERKS. (rear Tech. College) Tel.: Reading 582605

INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 115-147

	PAGE		PAGE		PAGE
Aero Electronics Ltd.	63	Fairley Electronics Ltd.	21	Parker, A. B.	63
Acoustical Mfg. & Co. Ltd.	12	Farnell Instruments Ltd.	77	Patrick & Kinnie	112
Adcola Products Ltd.	45	Ferroglyph Co. Ltd.	45	Phoenix Electronics (Portsmouth) Ltd.	65
A. H. Supplies	148	Fi-Comp Electronics	84	Powertran Electronics	66, 67
AKG	10	Fitch Tape Mechanisms	84	Purnell Radio	Loose Insert
Amtron U.K.	34	Forgestone Components	60	Quality Electronics Ltd.	56
A.N.T.E.X. Ltd.	5	Foulsham-Tab Ltd.	84	Quartz Crystal Co. Ltd.	148
Ancom Ltd.	64	Future Film Developments Ltd.	113	Racal Amplivox Communications Ltd.	35
Anders Electronics Ltd.	3, 58	Fyde Electronic Labs. Ltd.	60	Radio Soc. of Great Britain	82
Arrow Electronics Ltd.	38	Gale Electronics & Design Ltd.	71	Rafte, P. F.	103
A.S.P. Ltd.	59	Gardners Transformers Ltd.	44, 52	Rank Audio Visual	44
Audix B.B. Ltd.	43	Goldring Ltd.	37	RCA Ltd.	60
AVO Ltd.	53, 76	Gramplan Reproducers Ltd.	52	RCS Electronics	82
Barrie Electronics Ltd.	101	Harris Electronics (London) Ltd.	61, 82	Research Communications Ltd.	46
Bauch, F.W.D.	51	Harris, P.	147	Rogers Developments (Electronics) Ltd.	61
Bedford Electronics	84	Hart Electronics (London)	90	Rola Celestion Ltd.	32
Bentley, K. J., & Partners Ltd.	149	Hatfield Instruments Ltd.	33	R.S.C. Hi-Fi Centres Ltd.	86
B.I.E.T.	55, 58	Heath (Gloucester) Ltd.	7	R.S.T. Valves Ltd.	102
Bi-Pak Semiconductors	88, 89	Henry's Radio Ltd.	92, 93	Salford Electrical Insts. Ltd.	40
Bi-Pre Pak Ltd.	96, 105	Henson, R., Ltd.	148	Scopex Instruments	53
Bias Electronics Ltd.	46	Hepworth, B. & Co. Ltd.	105	Scott, James (Elec. Eng.) Ltd.	36, 42
Black Arrow Electronics	42	H.H. Electronics	63	S. E. Laboratories Ltd.	8, 9
Black, J.	148	Hitachi Shibaden (U.K.) Ltd.	59	Service Trading Co.	107
Bradley, G. & E. Ltd.	cover iii	Hy-Q Electronics	57	Servo & Electronics Sales Ltd.	104
Brandenburg Ltd.	48	Hy-Q Antennas	52	Shennanton Electronics Ltd.	149
Broadfields & Mayco Disposals	150	I.C.E. Electronic Systems	84	Shure Electronics Ltd.	74
Bryans Southern Insts. Ltd.	75	I.E.A. Exhibition	49	Sinclair Radionics Ltd.	72, 73, 80, 81
Bulgin, A. E., Ltd.	33	Industrial Tape Applications Ltd.	37, 39	S.M.E. Ltd.	27
Bull, J. (Electrical) Ltd.	149	Integrex Ltd.	85	Sowter, E. A., Ltd.	149
Butterworth & Co. Ltd.	82, 113	Jackson Brothers (Ldn. Ltd.)	32	Special Product Distributors Ltd.	48
Cambridge Learning	19	J.E.F. Electronics	148	Strumech Eng. Co. Ltd.	54
Cavern Electronics	113	Jermyn Industries	30	Studio Electronics	65
Chessell Ltd.	26	Josty (UK) Ltd.	79	Sugden, J. E., & Co. Ltd.	56
Chiltmead Ltd.	40, 114, 150, 152	K.E.F. Electronics Ltd.	18	Sullivan, H. W., Ltd.	66
Chinaglia	62	Keytronics Ltd.	151	Taisei Electronics Co. Ltd.	150
Chromasonic Electronics Ltd.	47	Laskys	97, 98, 99	Teleprinter Equipment Ltd.	83
Colomor (Electronics) Ltd.	94	Ledon Instruments Ltd.	56	Tequipment Products (Tektronix U.K.) Ltd.	68
Consumer Microcircuits Ltd.	Readers Card	Levell Electronics Ltd.	78	Telegadio Special Products	148, 150
Consumers Association	Loose Insert	Light Soldering Developments Ltd.	23	Teonex Ltd.	4
Cosmocord Ltd.	20, 55	Limrose Electronics Ltd.	40	Texas Insts.	54
Crichton, John	104	Linstead Electronics	36	Thomson-CSF Electrical Tubes Ltd.	6
C.T. Electronics Ltd.	91	London Central Radio Stores	150	Thorn Radio Valves & Tubes Ltd.	13, 31
Danavox (G.B.) Ltd.	11	Longs Ltd.	55	Trampus Electronics	101
Davenport, S. B., Ltd.	63	Lyons Instruments Ltd.	63	Trannies Ltd.	96
Decon Labs. Ltd.	51	Macfarlane, W. & B.	86	Turner, Ernest, Elec. Insts. Ltd.	58
Deimos Ltd.	149	Macinnes Labs. Ltd.	56	Ultron	28
Dexter & Co.	151	Manor Engineering	64	Valradio Ltd.	46
Dixons Technical CCTV Ltd.	61	Marconi Instruments Ltd.	cover ii	Vero Electronics Ltd.	29
Douglas Electronic Industries Ltd.	148	Marshall, A., & Sons (London) Ltd.	101, 106	Vitavox Ltd.	34
Drake Transformers Ltd.	50	McKnight Crystal Co.	150	Vortexion Ltd.	16
Dymar Electronics Ltd.	2	Microflame Torches	75	Watts, Cecil E., Ltd.	148
Dynamo (ADT) Ltd.	75	Mills, W.	90	Wayne, Kerr, The, Co. Ltd.	17
East Cornwall Components	64	Milward, G. F.	100	West Hyde Developments Ltd.	113
Eddystone Radio Ltd.	39	M.O. Valve Co. Ltd.	44	Wainwright, H. A., & Co. Ltd.	150
Electronic Brokers Ltd.	108, 109, 110, 111, 150	Modern Book Co.	151	West London Direct Supplies	102
Electronic Mech. Sub Assembly Co. Ltd.	150	Mordaunt-Short Ltd.	56	Wilkinson, L. (Croydon) Ltd.	104
Electro-Tech. Components Ltd.	112	Motorola Semiconductors Ltd.	41	Wilmslow Audio	149
Electrovalve	95	Mullard Ltd.	14, 15	Yates Electronics	87
EMI Ltd.	57	Multicore Solders Ltd.	cover iv	Z. & I. Aero Services Ltd.	50
English Electric Valve Co. Ltd.	1, 70	National Panasonic	24, 25	Zettler GmbH	150
		Nombrex (1969) Ltd.	51		
		OCLI Optical Coatings Ltd.	57		
		Oliver Pell Control Ltd.	22		
		Olson Electronics Ltd.	62		

You can't afford to ignore the new Bradley 234. It's a two-channel, eight digit 100MHz Counter Timer that offers all the facilities you would expect from an expensive instrument – but at the very realistic UK price of £275.

The 234 provides Frequency, Totalise, Period, Period Average, Ratio, Time Interval Average down to 25 ns and Time facilities in a compact and sturdy package. The 10 MHz clock is temperature compensated; alternatively, you can specify, for a moderate extra cost, a high stability clock in a temperature controlled oven. And there's a third 'C' channel for an external clock, or for ratio measurements.

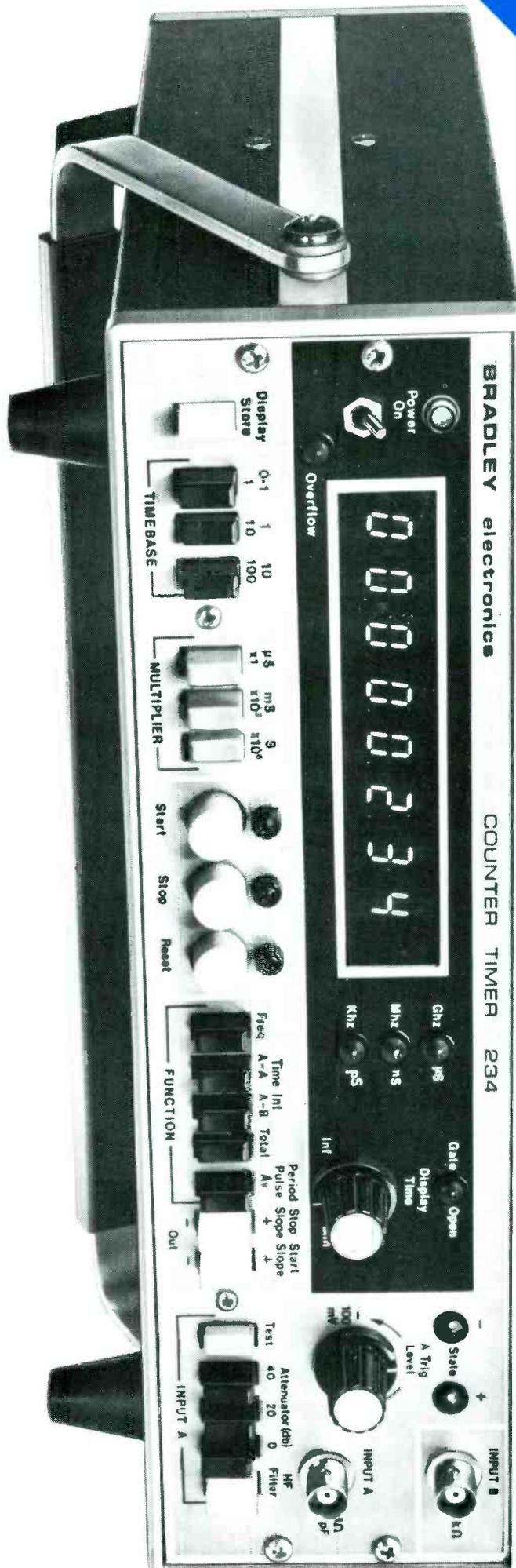
Solid state circuitry incorporates an HF filter which permits low frequency measurements to be made in the presence of high frequency interference.

Other features include display storage and standby mode facility. And the Bradley 234 comes complete with a rugged, impact-resisting case and combination carrying handle and adjustable stand.

To find out more about the 234 Counter Timer, one of the new generation of precision instruments from Bradley, please telephone 01-450 7811. Ask for Jim Clarke on Ext. 113. Or drop him a line at the address below.

Price quoted does not include VAT

Our own BCS Certificate is available.



**JUST £275 FOR
A 100 MHz COUNTER TIMER**

G & E BRADLEY LIMITED,
Electral House, Neasden Lane,
London, NW10 1RR
Telephone: 01-450 7811
Telex: 25583
A Lucas Company

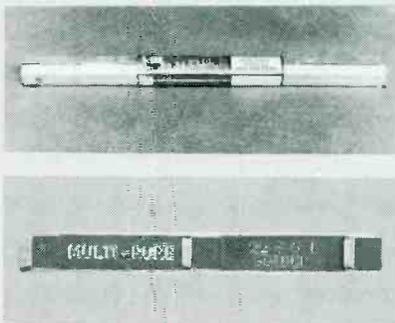


Multicore- the complete answer for printed circuit soldering.

Most printed circuit soldering problems can be avoided by using quality products and seeking quality advice. Naturally, we suggest ours. First, let's talk about quality products.

Extrusol and Multipure.

EXTRUSOL Extruded Bars and MULTI-PURE Cast Bars are made from specially processed ultra high purity solder. EXTRUSOL bars and pellets are protected by plastic film from the moment they are made to the moment they are used. And MULTI-PURE bars are probably the smoothest and brightest solder bars you will ever see.



Ersin Multicore Savbit.

This cored solder has countless uses. For instance, it avoids erosion of copper plating and wires as well as prolonging the life of soldering iron bits.



Liquid Fluxes.

We have a whole family of them, so you're bound to find the right one for your job. One of our latest is Activated RESIN 366 flux, exceptionally fast but non-corrosive and non-conductive.

ROSIN BASE

ERSIN Flux No.	Type	Solids Content w/w	Specifications
0360	non-activated	38%	MIL-F-14256D Type R; DTD 599A DIN 8527 F-SW 31
5381	mildly activated Chloride and Bromide free	25%	MIL-F-14256D Type RMA; DTD 599A
304D | 304W |	mildly activated Halide Free	10% | 25% |	DIN 8527 Type F-SW 32 DTD 599A
PC. 21A	activated	38%	DTD 599A; DIN 8527 F-SW 26
PC. 25	activated	25%	DTD 599A; DIN 8527 F-SW 26
366	activated (extra fast)	38% |	Meet DIN 8511 Type F-SW 26 and pass DTD 599A Corrosion Test
366A-25	activated (extra fast)	25% |	
ORGANIC ACID			
PC. 101	water base	12% |	Water soluble residues must be removed after soldering.
PC. 112	solvent base, fast drying	9.5% |	
INORGANIC ACID			
ARAX	water base extremely active	40%	Used with most "very difficult to solder" metals. Not for electronics assembly joints.

Solderability Test Instrument.

Already used by major electronic companies throughout the world, this novel instrument saves production costs by controlling solderability of component leads which, unlike a printed circuit, cannot be assessed by a simple "immersion and inspection" test.

Multicore Soldering Chemicals.

We make a complete, compatible range to assist in soldering processes. They clean, protect and preserve.



For full information on these or any other Multicore products, please write on your company's letterhead direct to:
Multicore Solders Limited, Maylands Avenue, Hemel Hempstead, Hertfordshire HP2 7EP.
Tel: Hemel Hempstead 3636. Telex: 82363.

