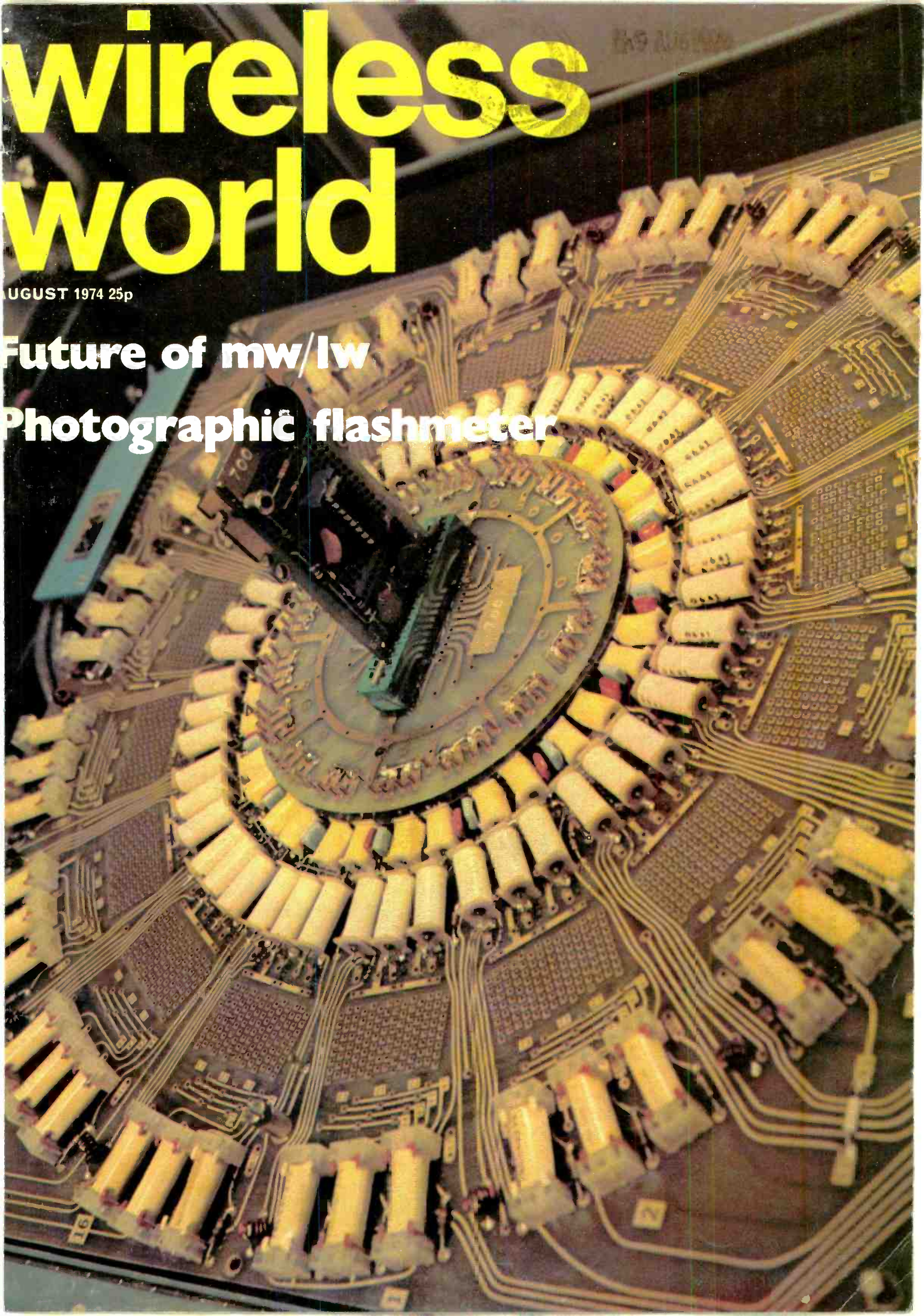
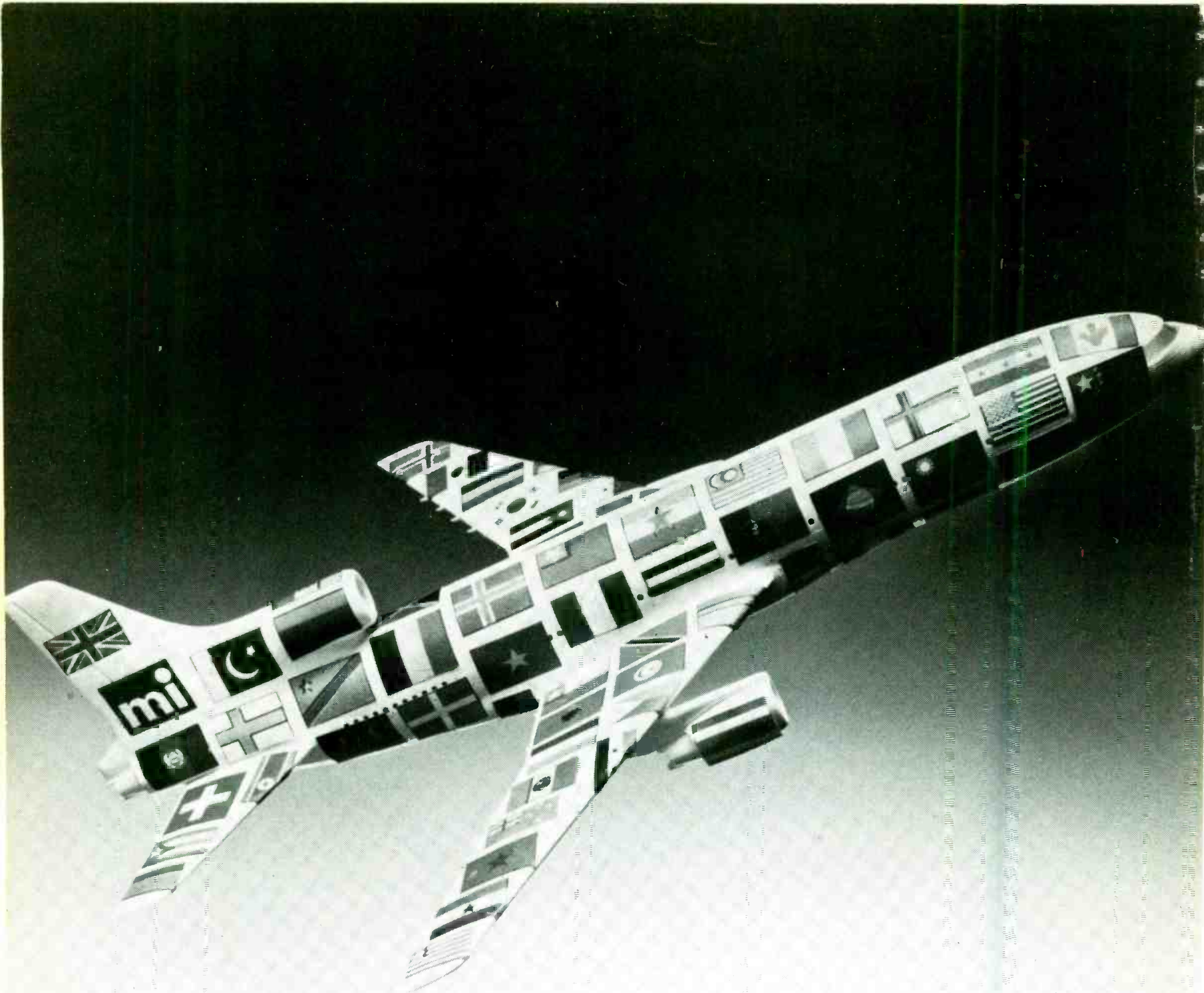
# wireless world

AUGUST 1974 25p

## Future of mw/lw

## Photographic flashmeter






# Spairline

We don't claim that **mi** actually runs its own airline, of course. But we do claim to be strategically sited for delivery to a remarkably large number of airports. Which is handy for getting those spares airborne in double-quick time. In fact most of our orders are shipped the day they're received.

Then, too, our servicing and spares set-up is unusually large. In fact, our three B.C.S.-approved laboratories in the U.K. issue more calibration certificates for electrical measurement than any other organisation in the country. And our Service Division at Luton Airport is the first organisation of its kind to be registered on the M.o.D. defence contractors' list. We run our own sizeable fleet of vans to ensure the minimum of delay in collection and delivery.

Abroad, there are **mi** service operations in, among other places, France, Germany, Australia, U.S.A., Canada and South America.

Put all those facts together and you get what is probably the surest and speediest servicing operation in the business. And that holds good whether you're in Manchester or Marseilles, Sydney or São Paulo.

## mi :THE PERFECTIONISTS

MARCONI INSTRUMENTS LIMITED

Longacres • St. Albans • Hertfordshire AL4 0JN • England • Telephone: St. Albans 59292 • Telex: 23350

A GEC-Marconi Electronics company.

WW—001 FOR FURTHER DETAILS

# LOW COST VOLTMETERS

**LEVELL**

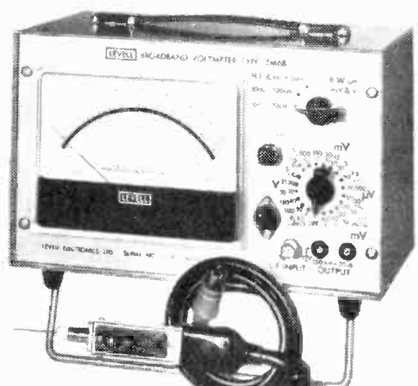
**PORTABLE INSTRUMENTS**

These highly accurate instruments incorporate many useful features, including long battery life. All A type models have 3¼″ scale meters, and case sizes 5″ x 7″ x 5″. B types have 5″ mirror scale meters and case sizes 7″ x 10″ x 6″.

## A.C. MICROVOLTMETERS

**VOLTAGE & db RANGES**: 15μV, 50μV, 150μV ... 500V f.s.d. Acc. ± 1% ± 1% f.s.d. ± 1 μV at 1 kHz. − 100, − 90 ... + 50dB, scale − 20dB/+ 6dB rel. to 1mW/600Ω.
**RESPONSE**: ± 3dB from 1 Hz to 3MHz, ± 0·3dB from 4Hz to 1 MHz above 500 μV. Type TM3B can be set to a restricted B.W. of 10Hz to 10 kHz or 100 kHz.
**INPUT IMPEDANCE**: Above 50mV : > 4·3MΩ < 20pf. On 50 μV to 50mV : > 5MΩ < 50pf.
**AMPLIFIER OUTPUT**: 150mV at f.s.d.

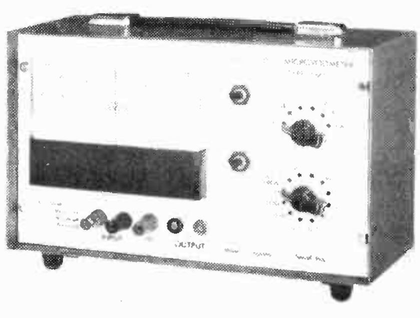
type TM3A **£62** type TM3B **£77**



## BROADBAND VOLTMETERS

**H.F. VOLTAGE & dB RANGES**: 1mV, 3mV, 10mV ... 3V f.s.d. Acc. ± 4% ± 1% of f.s.d. at 30MHz. − 50dB, − 40dB, − 30dB to + 20dB. Scale − 10dB/+ 3dB rel. to 1mW/50 Ω. ± 0·7dB from 1 MHz to 50MHz. ± 3dB from 300kHz to 400MHz.
**L.F. RANGES**: As TM3 except for the omission of 15μV and 150μV.
**AMPLIFIER OUTPUT**: Square wave at 20Hz on H.F. with amplitude proportional to square of input. As TM3 on L.F.

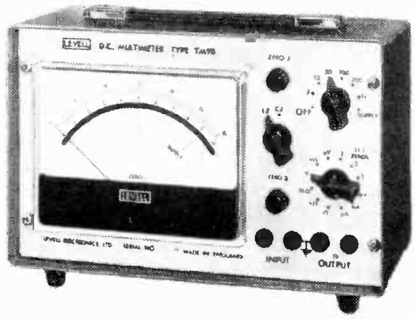
type TM6A **£105** type TM6B **£120**



## D.C. MICROVOLTMETERS

**VOLTAGE RANGES**: 30μV, 100μV, 300μV ... 300V. Acc. ± 1%, ± 2% f.s.d., ± 1 μV. CZ scale.
**CURRENT RANGES**: 30 pA, 100 pA, 300 pA, 300 mA. Acc. ± 2%, ± 2% f.s.d., ± 2 pA. CZ scale.
**LOGARITHMIC RANGE**: ± 5μV at ± 10% f.s.d., ± 5 mV at ± 50% f.s.d., ± 500 mV at f.s.d.
**RECORDER OUTPUT**: ± 1V at f.s.d. into > 1kΩ

type TM10 **£65**



## D.C. MULTIMETERS

**VOLTAGE RANGES**: 3μV, 10μV, 30μV ... 1kV. Acc. ± 1% ± 1% f.s.d. ± 0·1 μV. LZ & CZ scales.
**CURRENT RANGES**: 3pA, 10pA, 30pA ... 1mA (1A for TM9BP) Acc. ± 2% ± 1% f.s.d. ± 0·3pA. LZ & CZ scales.
**RESISTANCE RANGES**: 3 Ω, 10 Ω, 30 Ω ... 1kM Ω linear. Acc. ± 1%, ± 1% f.s.d. up to 100M Ω.
**RECORDER OUTPUT**: 1V at f.s.d. into > 1k Ω on LZ ranges.

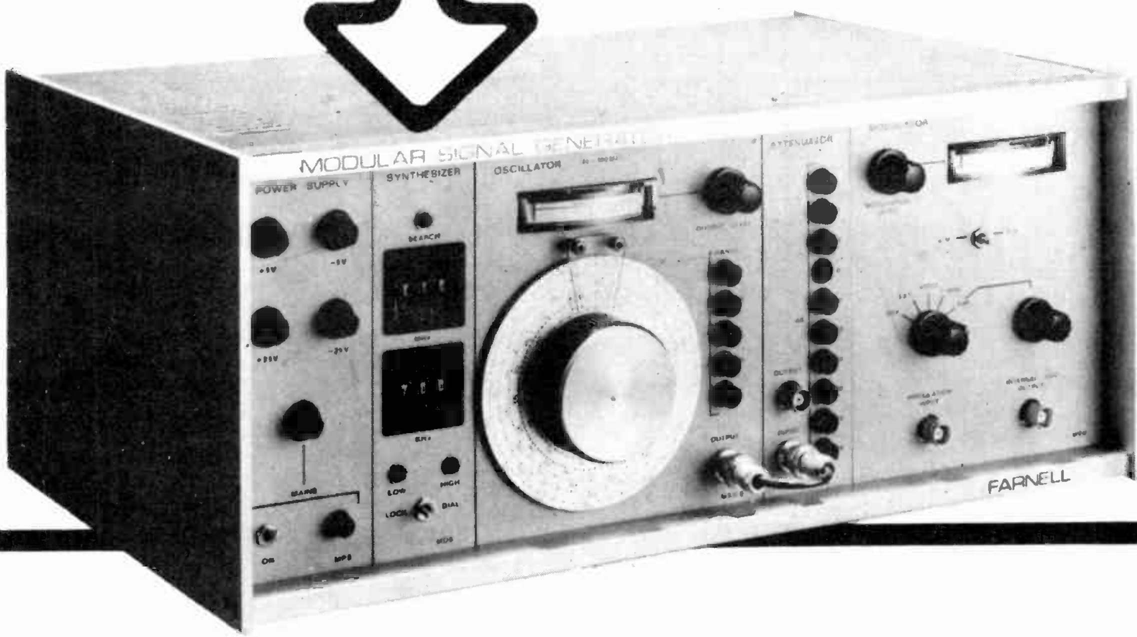
type TM9A **£90** type TM9B **£105** type TM9BP **£110**

**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.

WW—048 FOR FURTHER DETAILS

# Thanks to this new module . . .




## . . . we can offer an accurate and drift-free phase-lock synthesized signal generator

## for around £800

The Farnell range of modular signal generators now includes synthesized models, M1/ADM and M2/ADM, to cover frequency ranges of 100kHz to 12MHz and 10MHz to 108MHz respectively.

Frequency is controlled by a six decade bank of thumbwheel switches to an accuracy of ± 5PPM. The oscillator automatically chooses the correct range and seeks the required frequency, a search lamp extinguishing when it has found it. And there the frequency will stay with crystal accuracy and stability until an alternative is selected. A 1kHz frequency change takes only milliseconds and a change as wide as 10MHz to 100MHz (which involves four range changes) is completed in about five seconds.

Like all Farnell r.f. signal generators and sweepers, there is facility for remote programming via TTL compatible BCD 1248 inputs through a rear connector.

Narrowband sweep application.
The M1/ADM is an excellent narrowband sweeper ideal for setting up receiver filters or discriminator circuits on an individual or production line basis.

Centre frequency is controlled with crystal accuracy and stability by the digital synthesizer module while the frequency modulator unit is used to provide sweep. Full a.m./f.m. modulation facilities are available after alignment tests.

For details of all Farnell r.f. test equipment contact:-

FARNELL INSTRUMENTS LIMITED,
TELECOMMUNICATIONS DIVISION,
SANDBECK WAY, WETHERBY,
LS22 4DH. YORKSHIRE.
TEL: 0937 3541, TELEX 557294
LONDON OFFICE TEL: 01-802 5359

Farnell

WW—065 FOR FURTHER DETAILS

# The one you can't ignore!


Our picture illustrates some of the U-type JVC VCR features. They are not the only ones that matter.

For instance. You can use any colour or monochrome receiver or monitor to view your recordings. Automatically repeat or return to a scene of interest. And the picture is always locked in colour before it is displayed.

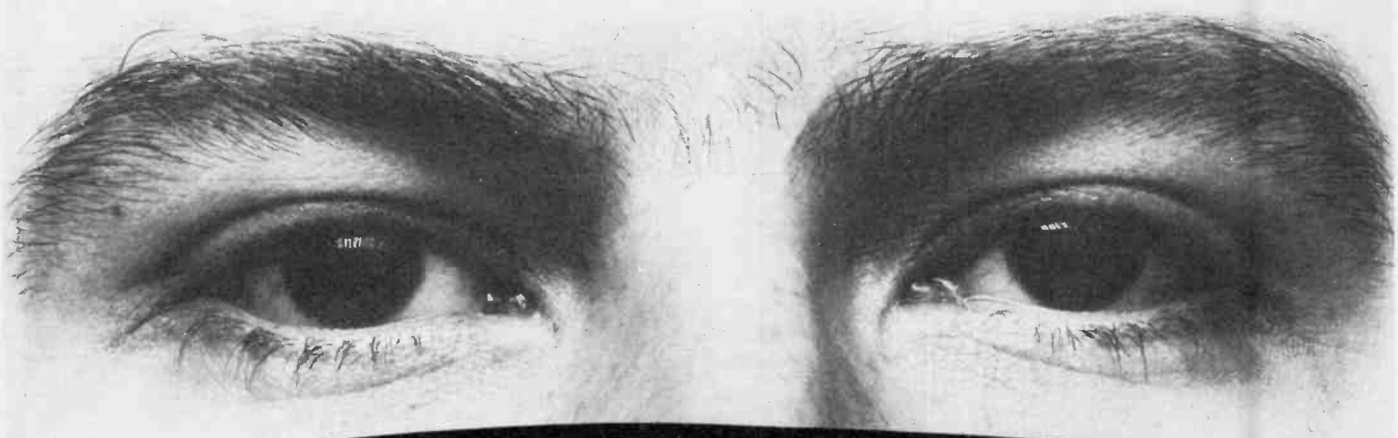
Such excellent features, in fact, that you ought not to buy a video cassette recorder until you've seen the complete specification of the JVC machine. **And it is available now.**

In addition to the CR 6000E ¾″ U-type recorder/player there is the CR 5000E for playback only. CR 6000E, price from £749; CR 5000E, from £664 (prices exclude VAT).

We'd like to tell you more. Telephone Bell & Howell's Video Systems Division on 01-902 8812 or write to Bell & Howell A-V Ltd., Freepost, Wembley, Middlesex, HA0 1BR (no stamp required).

**BELL & HOWELL**

**JVC U VCR**



It's a demanding job, viewing a monitor or data display screen, hour after hour. There's the responsibility. And there is the discomfort and fatigue...... so often the result of intense concentration at the display terminal.

Brimar have developed a range of data display tubes with many refinements. The current range now incorporates tubes with bonded, tinted and etched faceplates giving an improved contrast performance and considerably reduced specular reflection, and which are ideal for close range working.

The wide range of Brimar phosphors with varying fluorescent colours and persistence allows manufacturers to select phosphor screens which are most suitable for their particular data terminal applications. The range extends from 7 inch to 24 inch with an exceptionally comprehensive selection of 15 inch tubes.

**28mm neck diameter**

M38-100.. 90° deflection Rimguard
M38-101.. 90° deflection Rimguard
M38-102.. 90° deflection Bonded
M38-104.. 90° deflection Bonded
M38-120.. 110° deflection Monopanel
M38-121.. 110° deflection Rimguard
M38-122.. 110° deflection Bonded
M38-140.. 110° deflection Monopanel (with high voltage focus gun)

**38mm neck diameter**

M38-110.. 90° deflection Rimguard
M38-111.. 90° deflection Bonded
M38-112.. 90° deflection Rimguard
M38-113.. 90° deflection Rimguard

You'd like the complete picture?
Drop us a line or telephone 01-804 1201.

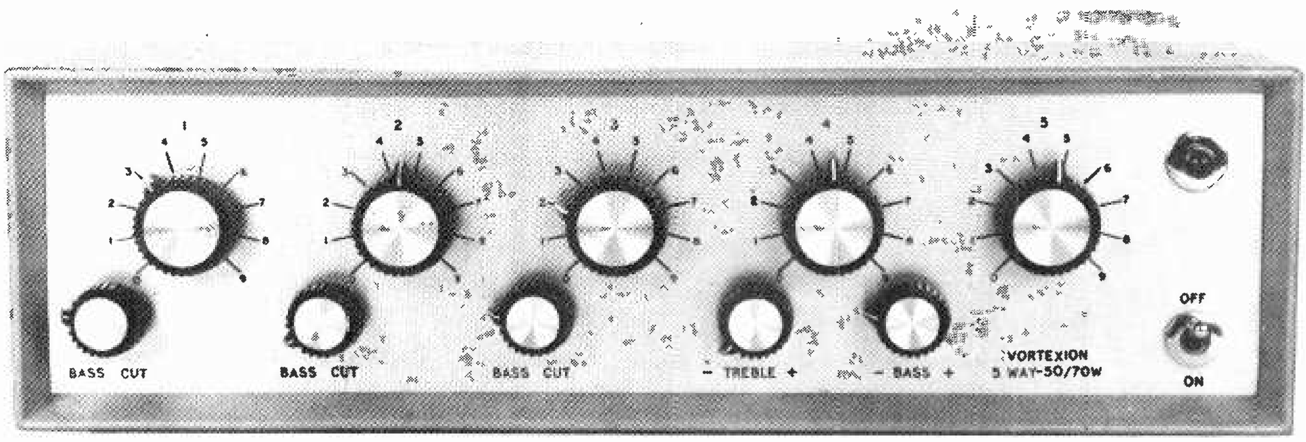
BRIMAR

Thorn Radio Valves & Tubes Ltd.,
Mollison Avenue, Brimsdown,
Enfield, Middlesex EN3 7NS
Tel: 01-804 1201

THORN

# Vortexion

## QUALITY AMPLIFIERS FOR THE PROFESSIONAL




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

---

| | |
|---|---|
| **£121.12** plus VAT | **50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4-WAY MIXER** |
| **£125.58** plus VAT | **100 WATT ALL SILICON AMPLIFIER** |
| **£166.98** plus VAT | **THE 100 WATT MIXER AMPLIFIER** |
| **£50.82** plus VAT | **20/30 WATT MIXER AMPLIFIER** |
| **£123.42** plus VAT | **CP 50 AMPLIFIER** |
| **£196.02** plus VAT | **200 WATT AMPLIFIER** |
| PRICES ON APPLICATION | **F.E.T. MIXERS AND PPMs** |

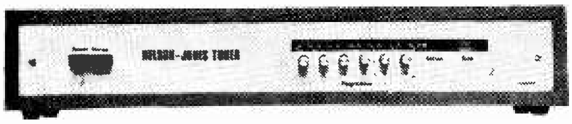
# Vortexion Ltd

TEL: 01-542 2814 and 01-542 6242-3-4 TELEGRAMS: 'VORTEXION' LONDON SW19

**257-263 THE BROADWAY · WIMBLEDON · SW19 1SF**

WW—051 FOR FURTHER DETAILS

# THE NEW NELSON-JONES FM TUNER



## PUSH-BUTTON VARICAP DIODE TUNING
## (6 Position) ('WW' JUNE '73)
### Exclusive Designer Approved Kits

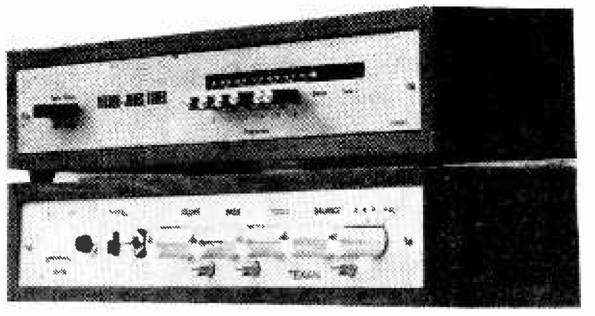
**What are the important features to look for in an FM tuner kit? Naturally it must have an attractive appearance when built, but it must also embody the latest and best in circuit design such as:—**

- **MOSFET** front end for excellent cross modulation performance and low noise.
- **3 GANG** tuning for high selectivity.
- **VARICAP** tuning diodes in back to back configuration for low distortion.
- **CERAMIC** 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 FM band (88-104).
- **IC STABILISED** and S/C protected power supply.
- **CABINET** double veneered against warp.

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.

Typ. Specn: 20 dB quieting 0.75uV. Image rejection —70dB.I.F. Rejection —85 dB

Basic tuner module prices start as low as **£11.40**, with **complete** kits starting at **£24·95** (mono) + PP 60p. 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 **£6.50** 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.



Access

You can order these goods by Telephone on Access. Simply quote your Access Number.

# NEW LOW COST STEREO TUNER

*PLEASE PHONE OR WRITE FOR FULL DETAILS*

No alignment required. Mullard LP1186 front end module used with Ceramic IF and IC amplifier. Push button tuning (6 position) with **Interstation Mute,** restricted range **AFC,** single LED tuning indicator, phase locked IC decoder, and complete metalwork and veneered cabinet. Complete with IC regulated PSU and full assembly instructions. (Mechanically identical to N-J Tuner.)

**TYP. SPECIFICATION**
**2μV for 30dB S/N**
**Image rejection 40dB**
**IF rejection 65dB**

**PRICE:** Complete Mono kit **£22.40** Complete Stereo kit **£26.32** p.p. 60p.
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 PRACTICAL PAPERBACKS FROM FOULSHAM-TAB

| | |
|---|---|
| Colour TV Repair *by Martin Clifford* | £1.40 |
| Basic Audio Systems *by Norman H. Crowhurst* | £1.60 |
| Everymans Guide to Car Maintenance *by George Zwick* | £1.50 |
| Matv Systems Handbook *by Allen Pawlowski* | £1.40 |
| Mobile Radio Handbook *by Leo G. Sands* | £1.50 |
| Rapid Radio Repair *by G. Warren Heath* | £1.60 |
| Understanding and Using the VOM and EVM *by John Cunningham* | £1.50 |
| Handbook of Electronic Tables *by Martin Clifford* | £1.40 |
| How to use your VOM and VTVM and Oscilloscope *by Martin Clifford* | £1.50 |
| Introduction to Medical Electronics *by Burton R. Klein* | £1.70 |
| Modern Radio Repair Technique *by Art Margolis* | £1.70 |
| Practical Colour TV Service Techniques *by Robert L. Goodman* | £1.95 |
| TV Troubleshooters Handbook *by Editors of Electronic Technician/Dealer* | £1.75 |
| Acoustic Techniques for Home and Studio *by F. Alton Everest* | £1.50 |
| 199 Colour TV Troubles and Solutions *by R. L. Goodman* | £1.50 |
| IC Projects for Amateur and Experimenter *by Wayne Green* | £1.45 |
| Japanese Colour TV Service Manual *by Hitachi Etc.* | £1.90 |
| Radio Electronics Hobby Projects *by Editors of Radio-Electronics* | £1.45 |

**FOULSHAM-TAB LTD.**
**YEOVIL ROAD. SLOUGH. BUCKS.**

---

# ELECTRONIC ORGAN KITS

There are 5 superb models in kit-form specially designed for the D-I-Y enthusiast. With our free and generous after sales service you can build in sections, and the whole project can be extended over several months. All specialised components can be purchased separately.
We also stock keyboards, volume pedals, MOS master oscillators, ICs., transistors, ETC. for W/W synthesiser and W/W electronic piano. Send 50p for catalogue and vouchers worth 50p or send your own parts list, enclosing SAE for quotation.

**ELVINS ELECTRONIC MUSICAL INSTRUMENTS**
Components suppliers to the music industry
**12 Brett Rd., Hackney, London E8 1JP. Tel: 01-986 8455**

---

MODEL U-50DX

# sanwa MULTI TESTERS

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

6 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 U5DDX | £15.60 | MODEL 460ED | £35.89 |
| MODEL A3D3TRD | £17.45 | MODEL EM800 | £81.06 |
| MODEL K3D THD | £24.01 | MODEL R1000CB | £75.27 |
| MODEL F8DTRD | £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.

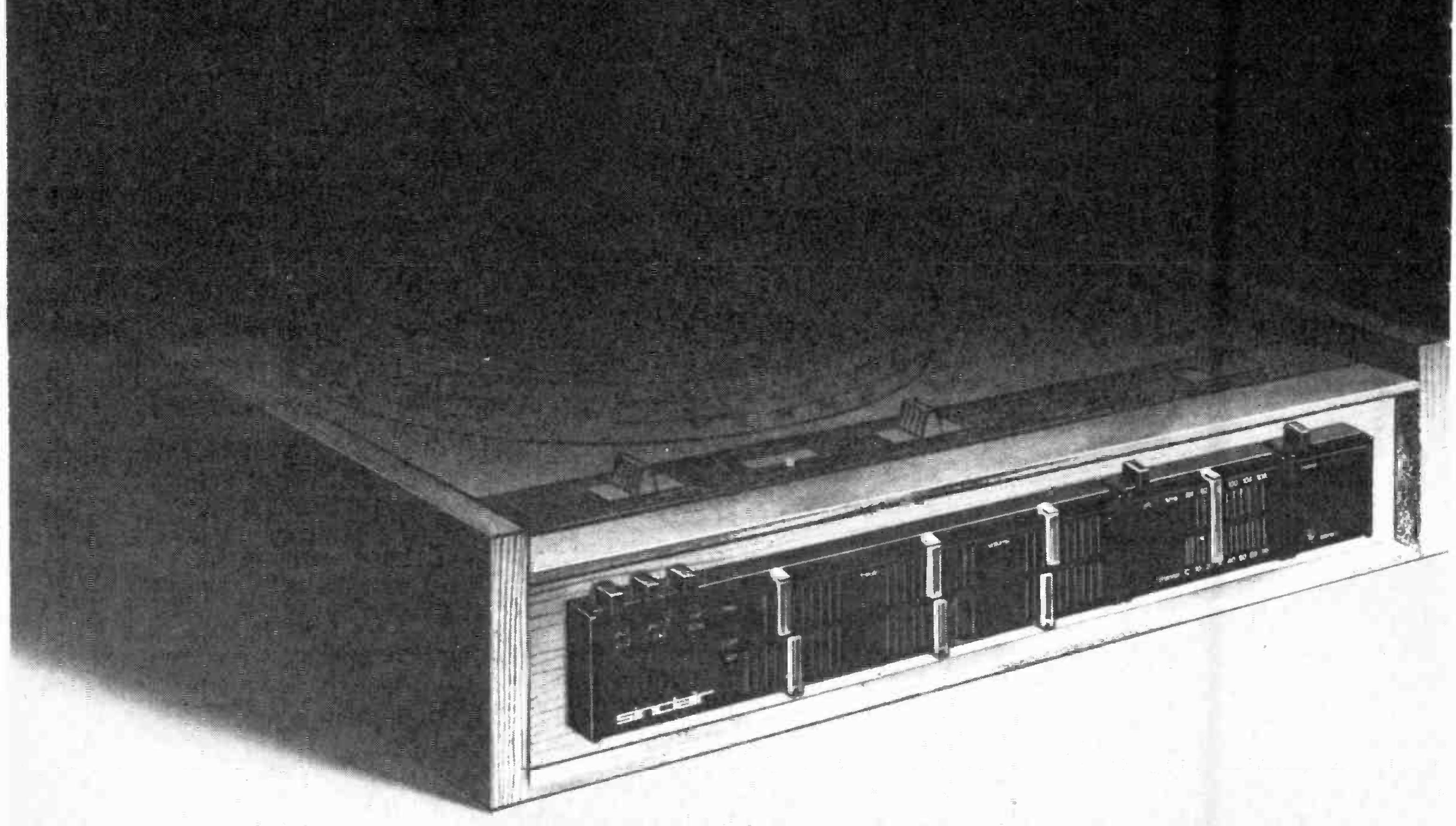
Please write for illustrated leaflet of these and other specialised Sanwa meters

SOLE IMPORTERS IN U.K.
**QUALITY ELECTRONICS LTD.**
47-49 HIGH STREET, KINGSTON-UPON-THAMES, SURREY. KT1 1LP
Tel: 01-546 4585

WW—032 FOR FURTHER DETAILS

# Project 80

## a brilliant new concept in modular hi·fi




Project 80 is going to be the ultimate in modular hi-fi construction for a very long time to come. It combines the qualities most demanded of any modern domestic system – good circuitry, reliability and fine performance – with other features to be found nowhere else in the world. For example, *compactness* – Project 80 control units are $\frac{3}{4}$" deep × 2" high, and each one is completely self-contained. *Elegance* – all of Sinclair's design leadership has been concentrated on producing designs of outstanding functional elegance unsurpassed for styling and simplicity. *Flexibility* – the size and styling of Project 80 modules makes them the most versatile units ever. Combine them how you will, where you will, the Project 80 System of your choice gives you the best.

sinclair

# FROM THE SPECIALISTS – POWERTRAN ELECTRONICS

## WIRELESS WORLD AMPLIFIER DESIGNS

Component packs for a choice of three outstanding amplifiers are stocked together with packs for a regulated power supply suitable for use with a pair of any of them. Also stocked are packs for a very well-established pre-amplifier—the Bailey-Burrows design which features six inputs, a scratch and rumble filter and wide range tone controls which may be either rotary or slider operating.

**30W BAILEY**

| | |
|---|---|
| Pk. 1 F/Glass PCB | £0.80 |
| Pk. 2 Resistors, capacitors, pots | £1.75 |
| Pk. 3 Semiconductor set | £4.70 |

**30W BLOMLEY**

| | |
|---|---|
| Pk. 1 F/Glass PCB | £0.85 |
| Pk. 2 Resistors, capacitors, pots | £2.15 |
| Pk. 3 Semiconductor set | £5.60 |

**20W LINSLEY-HOOD**

| | |
|---|---|
| Pk. 1 F/Glass PCB | £0.85 |
| Pk. 2 Resistors, capacitors, pots | £2.40 |
| Pk. 3 Semiconductor set | £3.35 |

**60V REGULATED POWER SUPPLY**

| | |
|---|---|
| Pk. 1 F/Glass PCB | £0.75 |
| Pk. 2 Resistors, capacitors, pots | £1.40 |
| Pk. 3 Semiconductor set | £3.10 |

**BAILEY-BURROWS PRE-AMP**

| | |
|---|---|
| Pk. 1 F/Glass PCB | £2.05 |
| Pk. 2 Resistors, capacitors, pre-sets, transistors | £4.95 |
| Pk. 3R Rotary potentiometer set | £1.60 |
| Pk. 35 Slider potentiometer set (with knobs) | £2.70 |

## STUART TAPE RECORDER

A set of three printed-circuit boards has been prepared for the stereo integrated circuit version of this high-performance Wireless World published design.

| | | |
|---|---|---|
| TRRP Pk. 1 | Reply amplifier F/Glass PCB | £0.90 |
| TRRC Pk. 1 | Record amp./meter drive cct. F/Glass PCB | £1.40 |
| TROS Pk. 1 | Bias/erase/stabilizer cct. F/Glass PCB | £1.00 |

For details of component packs for this design please write for free list.

## 20 WATTS/CHANNEL


## TOROIDAL T20 + 20

Developed from the famous Practical Wireless Texan

Designed by Texas engineers and published in a series of articles in **Practical Wireless**. The TEXAN was a remarkable breakthrough in delivering true Hi-Fi performance at exceptionally low cost. Now further developed to include a true Toroidal transformer, this slimline integrated circuit design, based upon a single F/Glass PCB, features all the normal facilities found on quality amplifiers, including scratch and rumble filters, adaptable input selector and headphones socket.

**FREE** TEAK CASE and HANDBOOK with full kits

KIT PRICE only **£28.25** post free (U.K.)

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

## ACTIVE FILTER CROSSOVER

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, though 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 board 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 | £0.70 |
| 2 | Set of resistors, capacitors pre sets (not including O/P coupling capacitors) | £1.10 |
| 3 | Sets of semiconductors | £2.40 |

6 off each pack required for stereo system

| | | |
|---|---|---|
| 4 | Special heat sink assembly for set of 3 amplifiers | £0.85 |
| 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 | £0.50 |
| 2 | Set of rectifiers, zener diode, capacitors, fuses, fuse holders | £2.60 |
| 3 | Toroidal transformer | £4.95 |

ENQUIRIES WELCOME
For quality sets of speakers

### SEMICONDUCTORS AS USED IN OUR RANGE OF QUALITY AMPLIFIERS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2N699 | £0.25 | 2N4302 | £0.60 | BC182L | £0.10 | MJ481 | £1.20 | TIP29C | £0.71 |
| 2N1613 | £0.20 | 2N5087 | £0.42 | BC184L | £0.11 | MJ491 | £1.30 | TIP30C | £0.78 |
| 2N1711 | £0.25 | 2N5210 | £0.54 | BC212L | £0.12 | MJE521 | £0.60 | TIP31A | £0.60 |
| 2N2926G | £0.10 | 2N5457 | £0.45 | 8C214L | £0.14 | MPSA05 | £0.30 | TIP32A | £0.70 |
| 2N3053 | £0.15 | 2N5459 | £0.45 | 8CY72 | £0.13 | MPSA12 | £0.55 | TIP33A | £1.00 |
| 2N3055 | £0.45 | 2N5830 | £0.30 | BD529 | £0.85 | MPSA14 | £0.35 | TIP34A | £1.50 |
| 2N3442 | £1.20 | 40361 | £0.40 | BD530 | £0.85 | MPSA55 | £0.35 | TIP41A | £0.74 |
| 2N3704 | £C 10 | 40362 | £0.45 | BDY56 | £1.60 | MPSA65 | £0.35 | TIP42A | £0.90 |
| 2N3707 | £0.10 | BC107 | £0.10 | BF257 | £0.40 | MPSA66 | £0.40 | IN914 | £0.07 |
| 2N3711 | £0.09 | BC108 | £0.10 | BF259 | £0.47 | MPSU05 | £0.60 | IN916 | £0.07 |
| 2N3819 | £0.23 | BC109 | £0.10 | BFR39 | £0.25 | MPSU55 | £0.70 | IS920 | £0.10 |
| 2N3904 | £0.17 | BC125 | £0.15 | BFR79 | £0.25 | SN72721P | £0.58 | 5B05 | £1.20 |
| 2N3906 | £0.20 | BC126 | £0.15 | BFY50 | £0.20 | SN72748P | £0.58 | | |
| 2N4058 | £0.12 | BC182K | £0.10 | BFY51 | £0.20 | TIP29A | £0.50 | | |
| 2N4062 | £0.11 | BC212K | £0.12 | BFY52 | £0.20 | TIP30A | £0.60 | | |

*for further information please write for FREE LIST* ***NOW!***

V.A.T. Please add 10%* to all U.K. orders

(*or at current rate if changed)

U.K. ORDERS—Post free (mail order only)

OVERSEAS—Postage at cost + special packing

Dept. WW06
**POWERTRAN ELECTRONICS**
PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3NN

# The Great Sound of Vitavox

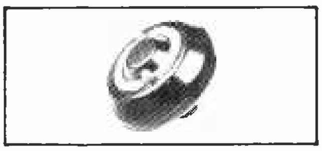
Nothing succeeds like success.
You met the new Vitavox power range last year. Its success was instantaneous, and has been growing ever since.
Good – but not good enough for us. We have been, and are, continuously improving our units. We want to give you the best value and performance – so now we offer you, improved on 1973, the latest . . .

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

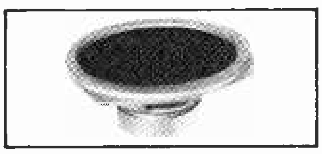
## The matchless range ~now better than ever...

## Giving You...

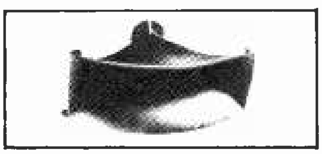
**S** *Sensitivity*



**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* ______________________

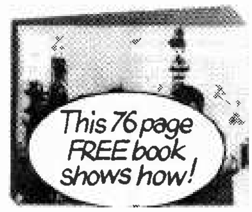
______________________ V7

WW—010 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.

POST NOW

**CUT OUT THIS COUPON**

***CHOOSE A BRAND NEW FUTURE HERE!***

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

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

To B.I.E.T. BWW06 Aldermaston Court, Reading RG7 4PF OK BWW06

NAME (Block Capitals Please)

ADDRESS

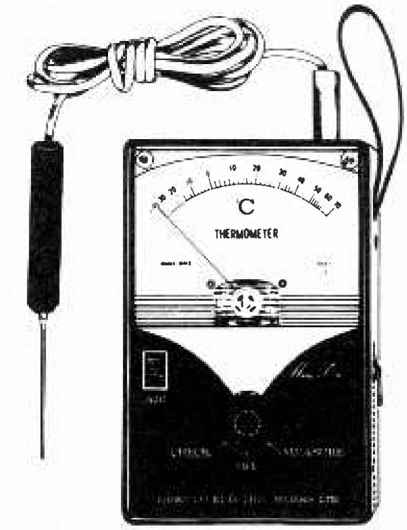
Other subjects Age

*Accredited by C.A.C.C.* *Member of A.B.C.C.*

**BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY**

---

# 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

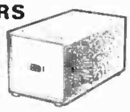
**HARRIS ELECTRONICS (LONDON),**
**138 GRAY'S INN ROAD, LONDON WC1X 8AX**
**('Phone 01-837 7937)**

WW—026 FOR FURTHER DETAILS

# A.S.P for quick service!

# TRANSFORMERS

## CASED TRANSFORMERS



Housed in smart resin coated steel cases, with 3-core power cable and outlet socket, fused primary winding. Isolation types are fitted with 3-pin outlet sockets, and are available with 110 volt or 240 volt output. (Please state.) Auto types are fitted with 2-pin flat style sockets up to 500 VA. 3-pin sockets from 750 to 3000 VA. See Auto and Isolation sections for prices.

## SAFETY ISOLATING

Prim. 120/240V. Sec. 120/240V. Centre Tap with screen

| VA (WATTS) | REF. No. | PRICE Cased £ | PRICE Open £ | Post £ |
|---|---|---|---|---|
| 60 | 149 | — | 3·74 | 0·38 |
| 100 | 150 | — | 4·16 | 0·52 |
| 200 | 151 | 9·48 | 7·48 | 0·52 |
| 250 | 152 | 12·05 | 9·57 | 0·65 |
| 350 | 153 | 14·00 | 11·44 | 0·80 |
| 500 | 154 | 15·80 | 13·20 | 1·00 |
| 1000 | 156 | 30·70 | 27·46 | 1·20 |
| 2000 | 158 | 60·95 | 55·44 | O.A. |
| 3000 | 159 | 79·63 | 72·49 | O.A. |

## MINIATURE & EQUIPMENT

Primary 240V with Screen

| VOLTS Sec. 1 | VOLTS Sec. 2 | MILLIAMPS Sec. 1 | MILLIAMPS Sec. 2 | TYPE No. | PRICE £ | Post £ |
|---|---|---|---|---|---|---|
| 3-0-3 | — | 200 | — | 238 | 1·23 | 0·10 |
| 0-6 | 0-6 | 500 | 500 | 234 | 1·30 | 0·10 |
| 0-6 | 0-6 | 1000 | 1000 | 212 | 1·68 | 0·22 |
| 9-0-9 | — | 100 | — | 13 | 1·23 | 0·10 |
| 0-9 | 0-9 | 330 | 330 | 235 | 1·43 | 0·10 |
| 0-8-9 | 0-8-9 | 500 | 500 | 207 | 2·28 | 0·22 |
| 0-8-9 | 0-8-9 | 1000 | 1000 | 208 | 3·03 | 0·30 |
| 15-0-15 | — | 40 | — | 240 | 1·23 | 0·10 |
| 0-15 | 0-15 | 200 | 200 | 236 | 1·30 | 0·10 |
| 20-0-20 | — | 30 | — | 241 | 1·23 | 0·10 |
| 0-20 | 0-20 | 150 | 150 | 237 | 1·30 | 0·10 |
| 0-15-20 | 0-15-20 | 500 | 500 | 205 | 2·97 | 0·38 |
| 0-20 | 0-20 | 300 | 300 | 214 | 1·76 | 0·22 |
| 0-20 | — | 3500 | No Screen | 1116 | 3·00 | 0·40 |
| 20-12-0-12-20 | — | 700 (D.C.) | — | 221 | 1·55 | 0·30 |
| 0-15-20 | 0-15-20 | 1000 | 1000 | 206 | 3·80 | 0·38 |
| 0-15-27 | 0-15-27 | 500 | 500 | 203 | 3·08 | 0·38 |
| 0-15-27 | 0-15-27 | 1000 | 1000 | 204 | 3·24 | 0·38 |

## 12 and 24 VOLTS PRIMARY 200-240 Volts.

| AMPS 12V | AMPS 24V | TYPE No. | PRICE £ | Post £ |
|---|---|---|---|---|
| 0·3 | 0·15 | 242 | 1·34 | 0·22 |
| 0·5 | 0·25 | 111 | 1·34 | 0·22 |
| 1 | 0·5 | 213 | 1·59 | 0·22 |
| 2 | 1 | 71 | 2·09 | 0·22 |
| 4 | 2 | 18 | 2·75 | 0·38 |
| 6 | 3 | 70 | 3·56 | 0·42 |
| 8 | 4 | 108 | 3·96 | 0·52 |
| 10 | 5 | 72 | 4·67 | 0·52 |
| 12 | 6 | 116 | 5·67 | 0·52 |
| 16 | 8 | 17 | 6·64 | 0·52 |
| 20 | 10 | 115 | 10·23 | 0·69 |
| 30 | 15 | 187 | 13·75 | 0·97 |
| 40 | 20 | 232 | 18·26 | 1·00 |
| 60 | 30 | 226 | 22·52 | 1·10 |

## 30 VOLTS

PRIMARY 200/240V.
SECONDARY 12, 15, 20, 24, 30V.

| AMPS | Ref. No. | Price £ | Post £ |
|---|---|---|---|
| 0.5 | 112 | 1·58 | 0·22 |
| 1 | 79 | 2·20 | 0·38 |
| 2 | 3 | 3·19 | 0·38 |
| 3 | 20 | 3·96 | 0·42 |
| 4 | 21 | 4·68 | 0·52 |
| 5 | 51 | 5·80 | 0·52 |
| 6 | 117 | 6·93 | 0·52 |
| 8 | 88 | 9·00 | 0·67 |
| 10 | 89 | 10·00 | 0·67 |

## 50 VOLTS

PRIMARY 200/240V.
SECONDARY 24, 30, 48, 60V.

| AMPS | Ref. No. | Price £ | Post £ |
|---|---|---|---|
| 0·5 | 124 | 2·10 | 0·38 |
| 1 | 126 | 2·97 | 0·38 |
| 2 | 127 | 5·77 | 0·42 |
| 3 | 125 | 7·15 | 0·52 |
| 4 | 123 | 9·35 | 0·67 |
| 5 | 40 | 11·55 | 0·67 |
| 6 | 120 | 13·57 | 0·82 |
| 8 | 121 | 16·00 | 1·00 |
| 10 | 122 | 19·40 | 1·00 |
| 12 | 189 | 21·62 | 1·10 |

## 60 VOLTS

PRIMARY 200/240V.
SECONDARY 19, 25, 33, 40, 50V.

| AMPS | Ref. No. | Price £ | Post £ |
|---|---|---|---|
| 0·5 | 102 | 2·11 | 0·30 |
| 1 | 103 | 3·08 | 0·38 |
| 2 | 104 | 4·29 | 0·42 |
| 3 | 105 | 5·77 | 0·52 |
| 4 | 106 | 7·48 | 0·52 |
| 6 | 107 | 11·00 | 0·67 |
| 8 | 118 | 14·19 | 0·97 |
| 10 | 119 | 17·60 | 0·97 |

## BATTERY CHARGER TRANSFORMERS

| | Price £ | Post £ |
|---|---|---|
| 2 Amp 2–6–12 Volts | 2·45 | ·35 |
| 4 Amp 2–6–12 Volts | 3·29 | ·35 |
| 6 Amp 6–12 Volts | 4·95 | ·50 |
| 12·5 Amp 2–6–12 Volts | 7·80 | ·68 |

RECTIFIERS NOT INCLUDED

## NEW PRODUCTS!

*Don't chance it!*
*isolate it!*

### "SPLASH PROOF" SAFETY TRANSFORMER

**750 VA Isolation Unit (Interwinding Screen)**

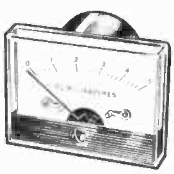
Housed in a tough Fibreglass case, with carrying handle. Complete with heavy duty 3-core power cable, splash proof outlet plug and socket, internal fuse. 110 Volt and 240 Volt versions available.

**PRICE £26·20**
**CARRIAGE £1·30**

## AUTO TRANSFORMERS

| VA (Watts) | Ref. No. | PRICE CASED | PRICE OPEN | POST |
|---|---|---|---|---|
| Tapped at 115, 220, 240 Volts. | | | | |
| 20 | 113 | 2·52 | 1·32 | 0·30 |
| 20 | 113 | | 1·32 | 0·22 |
| 75 | 64 | | 2·63 | 0·30 |
| Tapped at 115, 200, 220, 240 Volts. | | | | |
| 150 | 4 | | 3·29 | 0·39 |
| 200 | 65 | 5·56 | 3·96 | 0·40 |
| 300 | 66 | | 4·64 | 0·52 |
| 500 | 67 | 9·50 | 8·03 | 0·67 |
| 1000 | 84 | 15·92 | 13·50 | 0·82 |
| 2000 | 95 | 29·70 | 25·30 | 1·50 |
| 3000 | 73 | | 33·00 | 1·20 |

## NEW! 2″ AND 4″ PANEL METERS



2″ SIZE: 60mm Wide × 45mm High × 40mm Deep.
4″ SIZE: 110mm Wide × 82mm High × 43mm Deep.

| 2″ Movement | I.R. Ohms | 4″ Movement | I.R. Ohms |
|---|---|---|---|
| 0–50 micro A | 1250 | 0–50 micro A | 1400 |
| 0–100 micro A | 580 | 0–100 micro A | 730 |
| 0–500 micro A | 170 | 0–500 micro A | 200 |
| 0–1 mA | 170 | 0–1 mA | 200 |
| 0–5 mA | 170 | 0–5 mA | 200 |
| 0–10 mA | 6 | 0–10 mA | 6 |
| 0–50 mA | 0·5 | 0–50 mA | 0·5 |
| 0–100 mA | 0·5 | 0–100 mA | 0·5 |
| 0–500 mA | 0·5 | 0–500 mA | 0·5 |
| 0–1 AMP | 0·5 | 0–1 AMP | 0·5 |
| 0–2 AMP | 0·5 | 0–2 AMP | 0·5 |
| 0–25 Volt | 15K | 0–25 Volt | 15K |
| 0–50 Volt | 50K | 0–50 Volt | 50K |
| 0–300 Volt | 300K | 0–300 Volt | 300K |
| "g" Meter | 170 | "g" Meter | 200 |
| VU Meter | 5250 | VU Meter | 5250 |

VU Meters are complete with detectors. Modern wide view.
Price 2″ £2·95 Post 10p. Price 4″ £3·95 Post 10p.
Lamps 55p per set

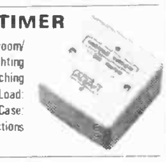
## C1000 MULTI-METER

**Special Offer AUGUST ONLY**
Compact General Purpose Mini Multimeter
Input Resistance 1000 ohms per volt.
Ranges: AC Volts 0–15 50 250 1000 Volts
DC Volts 0–10 50 250 1000 Volts
DC Current 0–1 mA 0–100 mA
Resistance 0–150K ohms
Size 60 × 24 × 90 mm
Complete with, Batteries, Test Prods, Instructions
Special price **£3.20** Post 20p.

## MINIATURE NEONS

6 mm dia., 12 mm length, leads length approx. 20 mm. Recommended ballast resistor 150K ohms for 240 Volt operation. Price: Packet of 10 for 50p Postage 10p

## ELECTRONIC MAINS TIMER

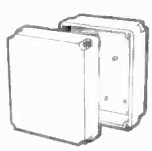


A reliable unit ideal for timing Bathroom/Toilet Ventilators, Stairway/Cloakroom Lighting etc. Gives up to 30 mins delay before switching off. Delay: 1–30 mins adjustable. Max Load: 400 VA or 1000 Watts resistive. Ivory Case: 3⅜in × 3⅜in × 2in. Fitting Instructions included. Trade Price: £5·80. Post 20p.

## 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.

## QUALITY INSTRUMENT CASE



Strongly moulded in High Gloss Grey Plastic (Flame Retardant ABS). Two interlocking halves secured by four corner bolts (supplied).
Interior Size: 6¾″ × 5¼″ × 2¾″.
Wall Thickness: ⅛″.
Weight 11½ ozs.
Price £1·50. Post 15p.

## BRIDGE RECTIFIERS

| ONE AMP | Price | TWO AMP | Price |
|---|---|---|---|
| 50 P.I.V. | 0·25 | 50 P.I.V. | 0·35 |
| 100 P.I.V. | 0·25 | 100 P.I.V. | 0·40 |
| 200 P.I.V. | 0·28 | 200 P.I.V. | 0·45 |
| 600 P.I.V. | 0·30 | 400 P.I.V. | 0·50 |
| **FOUR AMP** | | **SIX AMP** | |
| 100 P.I.V. | 0·55 | 50 P.I.V. | 0·65 |
| 200 P.I.V. | 0·59 | 100 P.I.V. | 0·70 |
| 400 P.I.V. | 0·65 | 200 P.I.V. | 0·80 |
| 600 P.I.V. | 0·75 | 400 P.I.V. | 0·90 |

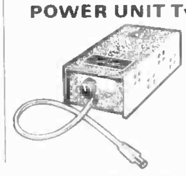
## ¼ WATT CARBON FILM RESISTORS

¼ watt at 70°C E 12 range 10Ω-1MΩ. 5% tol. above 470 KΩ 10% tol. at **95p** per 100.

## POWER UNIT TYPE A125

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.

## POWER UNIT Type CC12–05

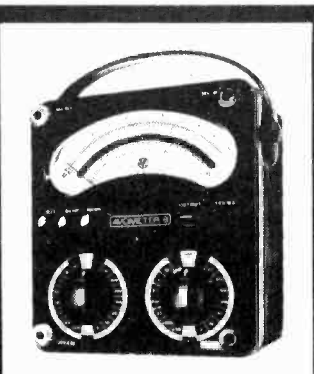


Output switched 3, 4·5, 6, 7·5, 9 and 12 Volts at 500 mA D.C. Operates from 240 V mains, suitable for Radios, Tape Recorders, Record Players etc. Size 7·5 × 5·0 × 14·0 cm. Price £3·95. Post 25p.

A.S.P. (Dept. WW8), SIMMONDS RD., WINCHEAP, CANTERBURY, KENT CT1 3RW. Tel: Canterbury (0227) 52436

PLEASE ADD 10% FOR V.A.T.

---



MODEL 8 MK. V

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

# REPAIRS OF ELECTRICAL MEASURING INSTRUMENTS

**Industrial and Precision Grade**

*7-14 DAYS SERVICE*

TO SOLVE YOUR INSTRUMENT PROBLEMS CONTACT

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

## LEDON INSTRUMENTS LTD.

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

**SM-118A**

**SM-128A**

# Top quality plus kit building satisfaction

with these Heathkit frequency counters . . .

**IB-1100** 30MHz counter with 5 digit readout, 8 digit capability; 100mV sensitivity; time-base stability ± 3 ppm. K/IB-1100 kit **£74.80**

**IB-1101** 100MHz counter with 5 digit resolution, 8 digit capability; 50–100mV sensitivity; wide range input. K/IB-1101 kit **£93.50**

**IB-1102** 120MHz counter with 8 digit readout; 45–125mV sensitivity; time-base stability better than ± 1 ppm. K/IB-1102 kit **£167.20**

**IB-1103** 180MHz counter with phase-locked frequency multiplier; 8½ digit display plus over-range; 50–100mV sensitivity; time-base stability better than ± 1 ppm. K/IB-1103 kit **£222.20**

(Above kits are also available assembled and calibrated)

The **SM-118** and **SM-128** have full autoranging capability. The SM-118 gives guaranteed performance to 30MHz and the SM-128 to 110MHz with typical performances considerably better. A front panel sensitivity control gives adjustment of the input amplifier trigger level from 10mV, and the two preset gate intervals of 1 sec. or 10mS are switch selectable. Assembled and calibrated: A/SM-118 **£149.00** and A/SM-128 **£215.00** (Not available in kit form)

Kit prices include VAT and carriage and packing. Assembled prices include carriage and packing but do not include VAT.

For details of these and many more instruments in the Heathkit range send now for two FREE catalogues.

Please send me the FREE Heathkit
☐ Electronic Kit Catalogue
☐ Electronic Instrument catalogue

Name ______________________

Address ______________________

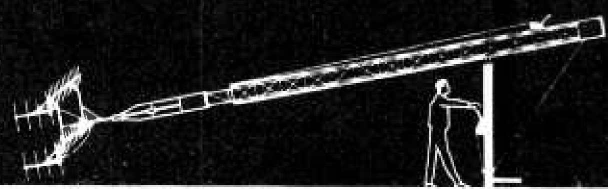
______________________

HEATH Schlumberger

Heath (Gloucester) Ltd., Dept. WW/8/74
Bristol Rd., Gloucester GL2 6EE
(Showroom, factory and head office)

London Showroom: 233 Tottenham Court Road, W.1.

## 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.

WW—034 FOR FURTHER DETAILS

## THINKING OF BUYING

Sullivan Taylor AVO MEGGER ?

**THEN CONTACT THE APPOINTED U.K. DISTRIBUTORS:–**

**REPAIR AND RECALIBRATION SERVICE AVAILABLE ON AVO MULTIMETERS**

Farnell

FARNELL INSTRUMENTS LIMITED, SANDBECK WAY, WETHERBY, YORKSHIRE LS22 4DH TEL: 0937 3541 TELEX 557294 LONDON OFFICE TEL: 01-802 5359

WW—030 FOR FURTHER DETAILS

## JES AUDIO INSTRUMENTATION

Illustrated the Si452 Distortion Measuring Unit—low cost distortion measurement down to .01% **£35·00**

Si451 **£42·50**
Comprehensive Millivoltmeter
350µ Volts 20 ranges

Si453 **£50·00**
Low distortion Oscillator
sine square RIAA

*prices plus VAT*

**J. E. SUGDEN & CO. LTD.** Tel. Cleckheaton (09762) 2501
**CARR STREET, CLECKHEATON, YORKSHIRE**

WW—022 FOR FURTHER DETAILS

# New Course in Digital Design

## Understand the latest developments in calculators, computers, watches, telephones,

**television, automotive instrumentation....**

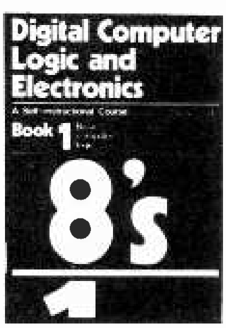
Each of the 6 volumes of this self-instruction course measures 11¾" x 8¼" and contains 60 pages packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra, to memories, counters and simple arithmetic circuits, and on to a complete understanding of the design and operation of calculators and computers.

After completing this course you will have broadened your career prospects and considerably increased your fundamental understanding of the changing technological world around you.

## Design of Digital Systems

A Self-Instruction Course in 6 Volumes

1. Computer Arithmetic
2. Boolean Logic
3. Arithmetic Circuits
4. Memories & Counters
5. Calculator Design
6. Computer Architecture



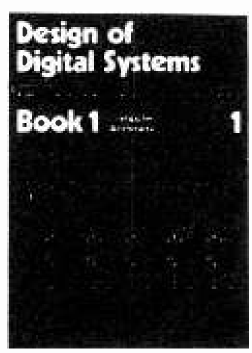

Also available — a more elementary course assuming no prior knowledge except simple arithmetic.

In 4 volumes:

1. Basic Computer Logic
2. Logical Circuit Elements
3. Designing Circuits to Carry Out Logical Functions
4. Flip flops and Registers

**£3.95 inc p&p**

Offer Order this together with Design of Digital Systems for the bargain price of £9.25.




**£5.95**

including packing and surface post anywhere in the world. (VAT zero rated). Payment may be made in foreign currencies. Quantity discounts are available on request.

**Designer**
**Manager**
**Enthusiast**
**Scientist**
**Engineer**
**Student**

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

### Guarantee – no risk to you

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

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

*Please send me.....set(s) of Design of Digital Systems at £5.95 each,
*or.....set(s) of Digital Computer Logic and Electronics at £3.95 each,
*or.....combined set(s) at £9.25 each.

Name.................................................................

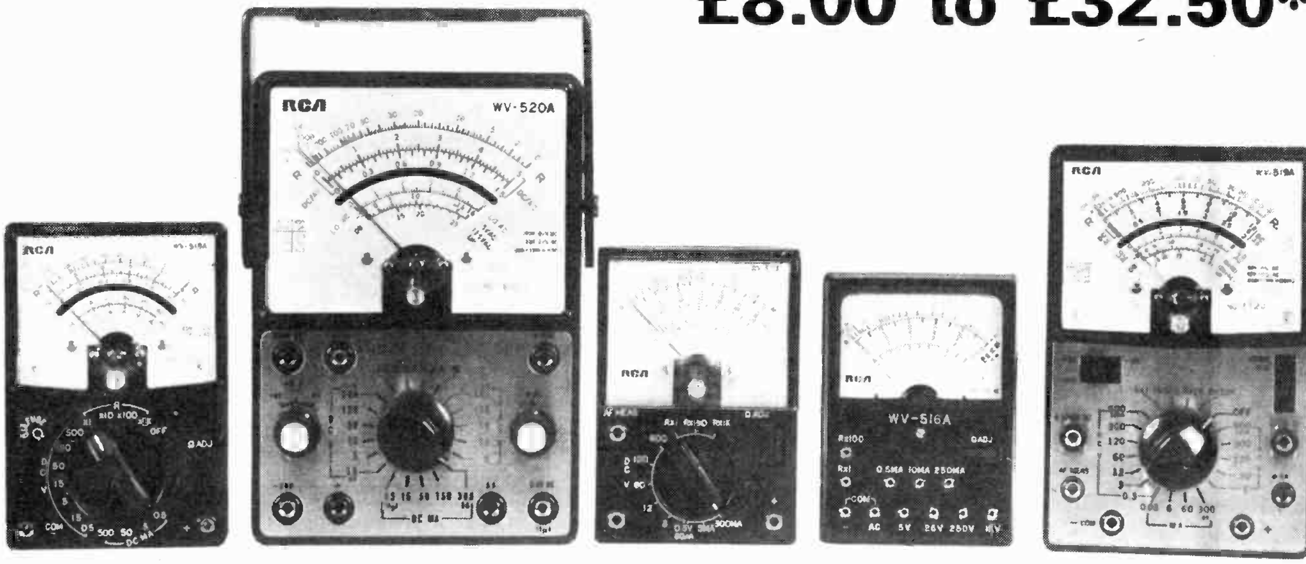
Address.............................................................

.........................................................................

.........................................................................

* delete as applicable.

# Five RCA VOM's priced from £8.00 to £32.50*




There are 14 additional RCA Voltmeters to choose from . . . All 19 instruments come complete with test leads. Full RCA guarantee (12 months parts and labour). **To buy: order from RCA Limited, Sunbury-on-Thames, Middlesex. Phone: Sunbury-on-Thames 85511**
*excluding V.A.T.

**RCA Electronic Components**

ELECTRONIC COMPONENT SUPPLIES (WINDSOR) LTD.
THAMES AVENUE,
WINDSOR, BERKSHIRE
Telephone: WINDSOR 68101

EDMUNDSON ELECTRONIC COMPONENTS LTD.
30–50 OSSORY ROAD,
LONDON SE1 5AN
Telephone: 01-237 0404

BLACK ARROW ELECTRONICS LTD.
Wirelect House,
ST. THOMAS STREET, BRISTOL 1
Telephone: BRISTOL 294313

## Phoenix Electronics (Portsmouth) Ltd

139–141 Havant Road,
Drayton, Portsmouth, Hants PO6 2AA

Full member of AFDEC—the industry's association of franchised electronic component distributors.

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.

**THIS MONTH'S BARGAIN OFFER—**
Panel hardware kit.
2 × F296 fuseholders, 10 fuses, 4 each K107, K430, K498, K499 knobs, 2 × SM270 DPCO switches, 2 × P429/P430 plugs and sockets, 2 each crocodile and pin clips.
**BARGAIN PACK PEP5—£3.90**

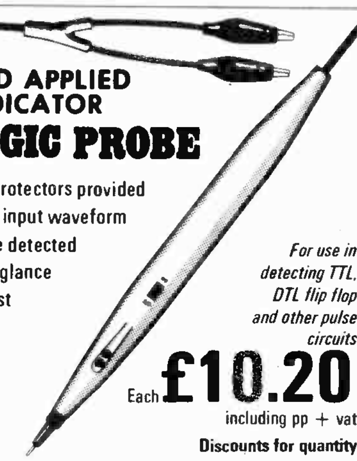
Please send your catalogue—free!
Name ..............................................
Address ..............................................
.................................................... WW8


AEL GATWICK HOUSE, HORLEY, SURREY, ENGLAND
Tel: Horley (02934) 5353
Telex: 87116 (Aerocon Horley) · Cables: Aerocon Telex Horley

WW—025 FOR FURTHER DETAILS

**RED & GREEN-LED APPLIED LOGIC LEVEL INDICATOR**

## Model 320 LOGIC PROBE



* Wrong polarity and overload protectors provided
* Detection of the peak value of input waveform
* Open circuit or faulty IC can be detected
* All logic levels are visible at a glance
* Powered from circuit under test
* Built-in storage circuit
* Up to 12 MHz

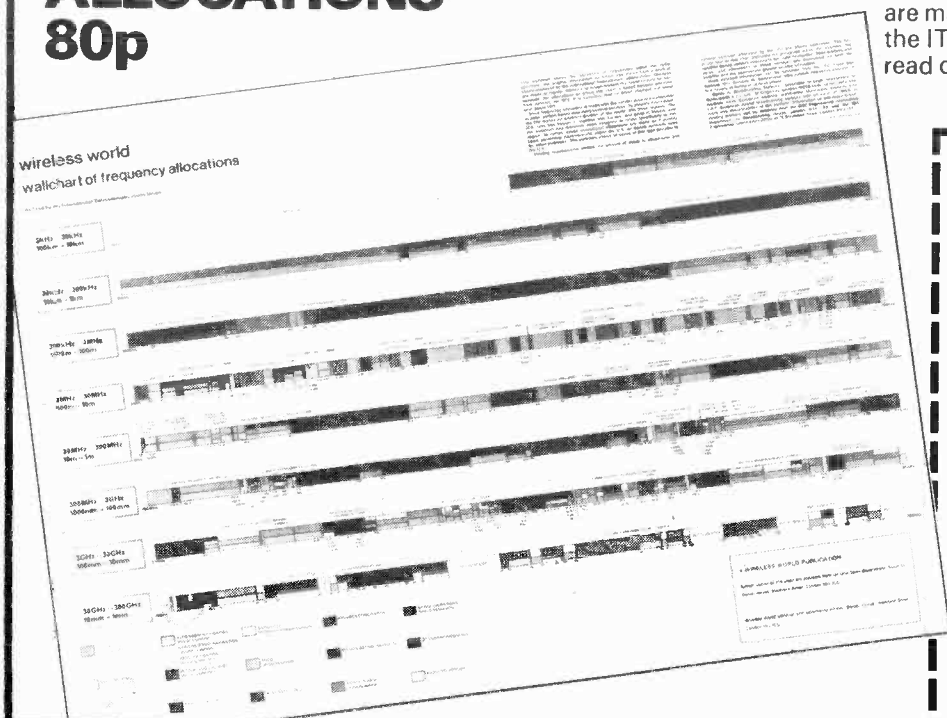
*For use in detecting TTL, DTL flip flop and other pulse circuits*

Each **£10.20**
including pp + vat
**Discounts for quantity**

JH ASSOCIATES LIMITED
Bishop's Stortford, Herts. Tel. 0279 56347. Telex 81675 JaylampsStort

WW—031 FOR FURTHER DETAILS

# Wireless World
## FULL COLOUR WALLCHART OF FREQUENCY ALLOCATIONS
## 80p




The wallchart shows the allocation of frequencies within the radio spectrum ranging from 3 kHz to 300 GHz and is scaled on eight logarithmic bands contriving 15 main categories of transmissions which are identified by colours. All the important spot frequencies and 'special interest' frequencies are marked. The information is taken from the ITU and has been condensed into easily read chart form. Measures 2′ 11″ × 1′ 11″.

**ORDER FORM**

To: IPC Electrical-Electronic Press Ltd.,
General Sales Dept., Room 11,
32 Stamford Street, London SE1 9LU

Please send me ............ copies of the Wireless World Wallchart of Frequency Allocations at 80p each inclusive.

I enclose remittance value £ ............
(cheque/p.o. payable to IPC Business Press Ltd.)

Name ............
(please print)
Address ............

Registered in England No. 677128
Regd. office: Dorset House, Stamford Street, London SE1 9LU

---

## DC/AC SINEWAVE TRANSVERTORS
### (transistorised Invertors/Convertors)

TYPE D12/400S

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 | Input Volts | Output | Price & 10% VAT |
|---|---|---|---|
| C12/30S | 12 | 115/230v 50Hz 30W Sine Wave | £35.70 |
| R12/250/24R | 12 | 24 7A DC | £75.55 |
| R24/250/50R | 24 | 50 3A Regulated | £97.25 |
| D12/400S | 12 | 115/230 400W 50Hz Sine Wave | £197.00 |
| D24/500S | 24 | 115/230 500W 50Hz Sine Wave | £197.00 |

All prices +10% VAT. All 50Hz $\pm\frac{1}{4}$Hz. Also available 60Hz $\pm\frac{1}{4}$Hz 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—060 FOR FURTHER DETAILS

---

# At least £2,500 for Closed Circuit TV Engineers

Dixons Technical need CCTV Engineers with a good grounding in Philips (and allied) systems.

We pay well. At least £2,500, more for more experience. And a lot of opportunities if you've got the ambition. Plus 3 weeks annual holiday and all the benefits a big but friendly company can offer.

Phone Mike Biddle on 01-734 5668 or write to him at
DIXONS TECHNICAL,
3 SOHO SQUARE,
LONDON W1.
(Today.)

**Dixons Technical Ltd**
OF SOHO SQUARE

WW—062 FOR FURTHER DETAILS

# wireless world

**Electronics, Television, Radio, Audio**

AUGUST 1974 Vol 80 No 1464

SIXTY-FOURTH YEAR OF PUBLICATION



**This month's cover picture** shows part of a Tektronix equipment for dynamic testing of digital and linear i.cs and modules. Device in test socket is an active audio notch filter, having its response curve automatically plotted.
*(Photographer Paul Brierley)*

## Contents



### IN OUR NEXT ISSUE
(published September 4)

**Electronic speedometer** and average speed indicator. Device with digital display and c.m.o.s. electronics operated from a transducer attached to back of existing car speedometer.

**Dummy heads.** A potted history of artificial head recording for stereo and "surround-sound" effects.

**Thyristor speed control** for shunt-wound d.c. motors. A design with circuitry for avoiding the speed instability common in the control of shunt motors.

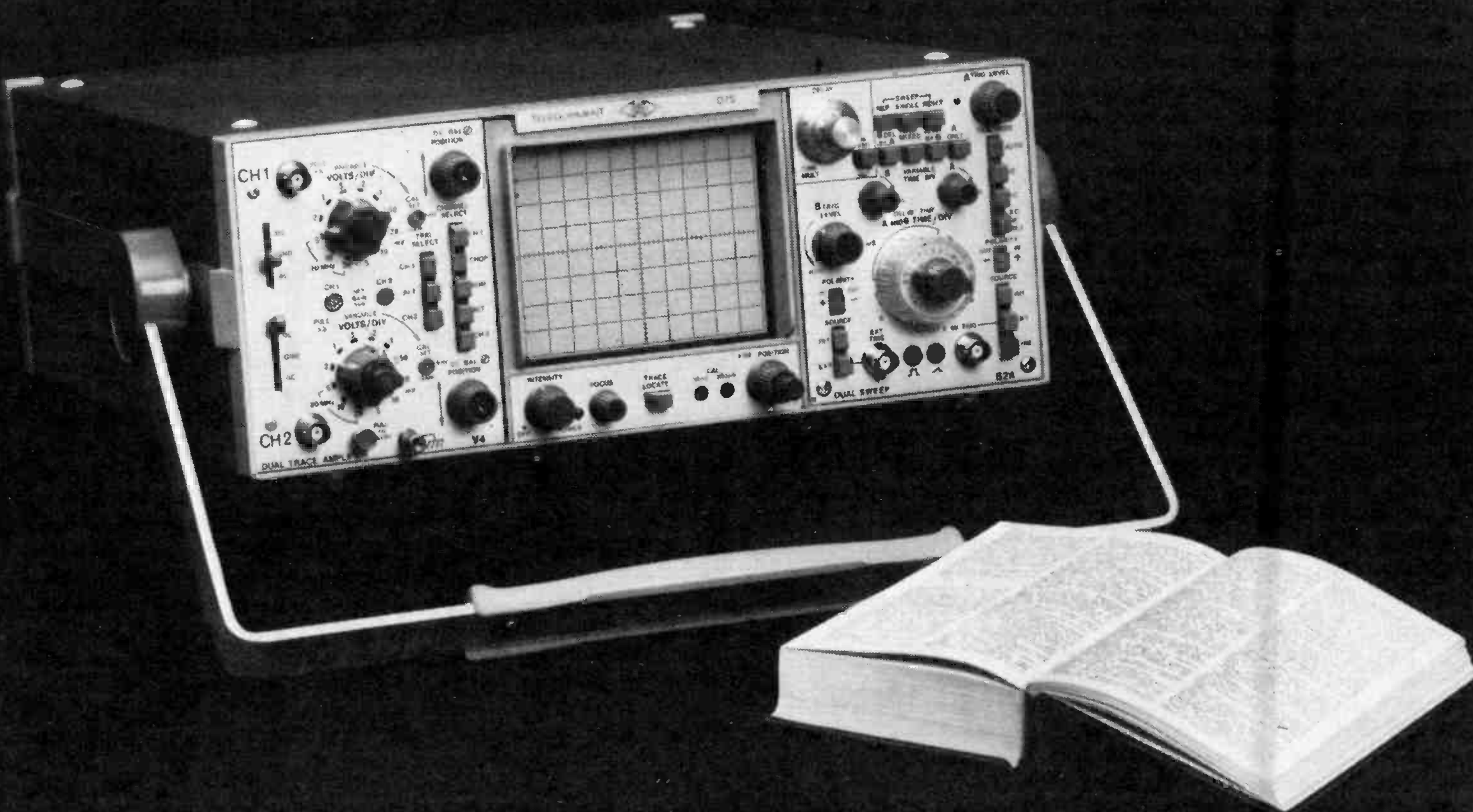

ibpa
International Business Press Associates

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





Price 25p (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: 1 year, £5 UK and overseas ($13 USA and Canada), 3 years, £14 UK and overseas ($36 USA and Canada). Student rates: 1 year, £2.50 UK and overseas ($6.50 USA and Canada), 3 years, £7 UK and overseas ($18.20 USA and Canada).
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.




# in one word value

**'Value' is an overworked and underrated word. But still the most effective way to describe Telequipment's D75 50 MHz Dual Trace portable oscilloscope costing only £460.***

In more detail it is:

Lightweight ☐ 50 MHz bandwidth at 5 mV/div ☐ 15 MHz at 1 mV/div ☐ 3% accuracy ☐ Mixed sweep ☐ Calibrated sweep delay ☐ Gated trigger ☐ Bright 8 x 10 cm display

Developed by engineers for engineers this newcomer from Telequipment is easy to handle and offers unprecedented value when compared with other 50 MHz instruments.

Its outstanding specification includes a wide-range dual timebase incorporating sweep intensifying, delaying, mixed sweep and single-shot facilities, an 8 x 10 cm CRT operating at 15 kV, and dual-trace operation in the alternate and chopped modes with 5mV/div sensitivity all the way up to 50 MHz.

Don't take our word for it. Write or telephone for a full specification and a demonstration of the D75 now!

TELEQUIPMENT

**Tektronix U.K. Ltd.**
**Beaverton House, P.O. Box 69, Harpenden, Herts.**
**Telephone: Harpenden 63141 Telex: 25559**

*Exclusive of VAT

wireless world

# Using channels efficiently

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
A. PETTERS *(Classified Advertisements)*
Phone 01-261 8508 or 01-928 4597
JOHN GIBBON *(Make-up and copy)*
Phone 01-261 8353

An article in this issue referring to the forthcoming re-planning of the m.f. and l.f. broadcasting bands draws attention, once again, to the permanent problem of finding enough space in the frequency spectrum for all the radio systems we would like to set up. We tend to be so preoccupied with the frequency spectrum, thinking up ways of making the most efficient use of what bandwidth is available to us, that perhaps we do not pay enough attention to the other constituents of every communications system—time and signal-to-noise ratio. Do we in fact make the most efficient use of these also?

There is not much we can do with signal-to-noise ratio except to trade it for more information in a given channel, as in the stereo broadcasting system, but time seems to offer more possibilities. It is a sobering thought that every night we switch off for several hours hundreds of megahertz of broadcasting bandwidth and numerous communications channels. However, to make use of all this for day-time purposes we would have to devise systems with storage or recording facilities. But there are plenty of opportunities of making more efficient use of time during day-time operations, particularly in mobile communications where channels are not continuously loaded but tend to be used intermittently for separate messages. Of course with mobile radio the time gaps between messages are already utilized to some extent in systems where different users time-share a single channel—radio taxis, for example. But this is a haphazard process and does not make the best use of the available channel capacity.

One systematic method of utilizing a group of channels efficiently, called dynamic channel assignment, was proposed by J. F. Craine at the recent Communications 74 conference at Brighton. In this the use of a number of channels is controlled automatically by an exchange, rather as in the trunk telephone system. When a call is made from a station the exchange assigns it to a free channel in the same manner as an automatic line exchange would find a free trunk route. The receiving station must then be informed that a call is being made and that its equipment has to be tuned to the appropriate channel.

Another possible system, suggested by S. R. McConoughey of the American FCC, is based on the principle of trading signal-to-noise ratio for more information, as mentioned above. Each user has access to multiple channels and the system simultaneously shares the same radio spectrum with other users. Instead of experiencing channel blocking, a user would observe only a gradual degradation of signal-to-noise ratio as the loading increased.

Undoubtedly such systems would be very complicated, but should certainly be feasible with the present technology of digital processing and large-scale integrated circuits at our disposal. This complication is the price we would have to pay for more efficient utilization of channel capacity.

# The future of medium- and long-wave broadcasting

## Problems facing the forthcoming planning conference

by J. G. Spencer
*BBC Research Department*

The organization of broadcasting, in respect of transmitter frequencies and powers, requires a high degree of international co-operation if optimum coverage with minimum mutual interference is to be achieved. This applies particularly in the medium-frequency band, in which a transmitter having a service area radius of, say, 50km can produce interference by sky-wave propagation during the hours of darkness at fifty times that distance to other transmissions sharing its frequency channel. This co-operation is organized by the International Telecommunications Union and Fig. 1 shows the three regions into which the world is divided for radio planning purposes.

The present situation in Region 1 is based on the European Broadcasting Convention, concluded at Copenhagen in 1948, and the regional agreement for the African broadcasting area, drawn up in Geneva in 1966. However, the number of transmitters actually operating at the present time in the European area is some three times greater than the number for which provision was made in the plan. Region 3 has currently more than 1800 transmitters in operation but no overall formal plan. By common consent, comprehensive re-planning is well overdue. This conclusion will be endorsed by anyone in Britain that tunes a m.f. receiver, after dark, across the m.f. band.

It has now been agreed that a Regional Administrative Broadcasting Conference will convene this year in Geneva to commence the re-planning of frequency assignments in the m.f. and l.f. bands for Regions 1 and 3. The first session of this conference is scheduled for October 7th to 25th, 1974, and will, it is hoped, determine such technical parameters as the channel spacing, modulation system, protection ratios and propagation data to be used in the second session of the conference that will produce the final plan. The date for this second session will be some time in 1975 or 1976.

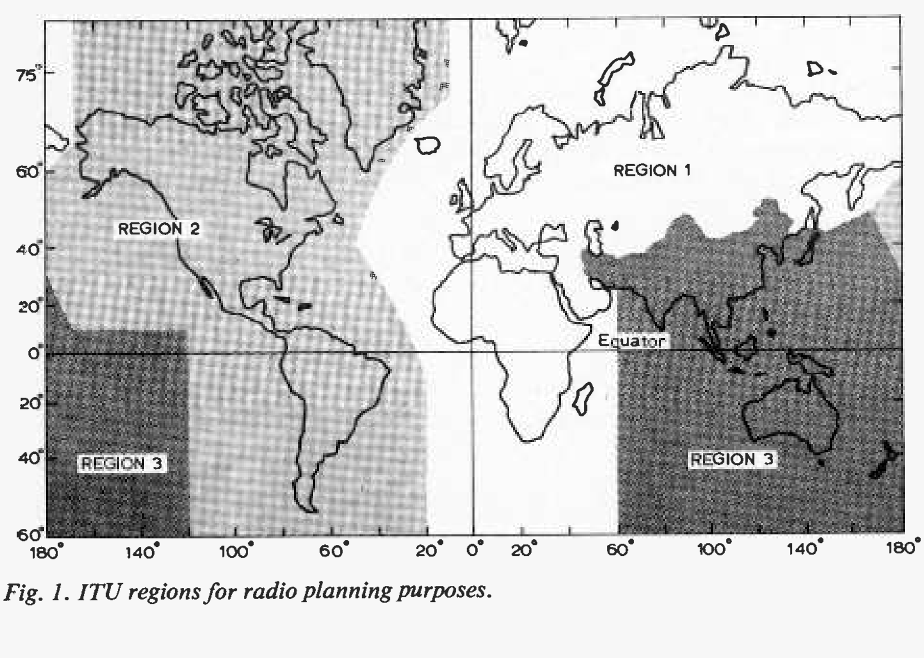



*Fig. 1. ITU regions for radio planning purposes.*

### Propagation

Among the important factors in determining the optimum utilization of the m.f. and l.f. bands are the propagation characteristics of the medium. These are illustrated, for the range of distances of interest for a ground-wave service, in Fig. 2, which shows field strength as a function of distance for a base-fed vertical-mast radiator of the type commonly used at m.f. and l.f. transmitters. The curves labelled with frequency values represent the ground wave, while those labelled with values of mast height, $h$, represent the sky wave. Some features of this figure will bear explanation for readers unfamiliar with the subject.

(i) The curves are drawn for a constant cymomotive force of 300 volts. The cymomotive force is numerically the limiting value of the product of the field strength and the distance from the transmitter as this distance is reduced towards zero. This extrapolation ignores effects in very close proximity to the aerial (within about one wavelength). The product has the dimensions of voltage ($\frac{E}{d} \times d$) and the term is usually abbreviated to c.m.f. or alternatively written as $E_o d_o$. The c.m.f. of 300V in these curves corresponds to a radiated power of 1 kW for a short aerial ($h \ll \lambda$), reducing to about 0.5 kW for $h = 0.575\lambda$. The magnitude of the radiated signal can alternatively be expressed in terms of the effective monopole radiated power (e.m.r.p.). This can be regarded as the signal produced when the stated power is fed into a perfect, lossless, vertical radiator of height much less than one quarter wavelength. As implied above, a c.m.f. of 300V corresponds to an e.m.r.p. of 1kW.

(ii) The level and shape of the sky-wave curve depends on the vertical radiation pattern (v.r.p.) of the transmitting aerial and hence on the radiator height. For values of $h$ approaching zero, the v.r.p. follows a cosine law relative to the angle of elevation above the horizontal. This produces the sky-wave curve for $h \ll \lambda$ and holds with reasonable accuracy up to about $h = 0.2\lambda$. As $h$ is further increased, the radiation becomes more concentrated in the horizontal plane, and the high angle radiation illuminating the ionosphere is correspondingly reduced, until a value of $h = 0.475\lambda$ is reached. The corresponding sky-wave curves are omitted from Fig. 2 for the sake of clarity. Had they been shown, they would be of similar shape to those for $h \ll \lambda$ and $h = 0.475\lambda$ and would fall between them. As $h$ is increased beyond $0.475\lambda$, the main-lobe radiation above the horizontal is further reduced but a side lobe appears in the v.r.p. that produces a relatively rapid increase in high-angle radiation. This is manifested in the sky-wave curves by the characteristic double-humped shape. The progressive increase in the near-field sky-wave at distances up to some 100 to 200km is caused by the high-angle side-lobe radiation while the progressive fall in the sky-wave at greater distances results from the continuing reduction in the illumination of the ionosphere by the main lobe. With simple base-fed mast radiators, if $h$ is increased beyond $0.575\lambda$ the proportion of the input power that is radiated in the horizontal plane falls and the proportion radiated at high angles increases. Both of these features are undesirable for a ground-wave service. Also, if $h$ is reduced much below about $0.15\lambda$, the radiation resistance falls sharply and the reactive component of the impedance rises. As a result, the losses in the earth resistance rise with consequent loss of efficiency and it may become difficult, particularly at l.f., to secure correct matching between transmitter and aerial over the required bandwidth.

(iii) Fig. 2 should not be regarded as universally valid. It represents one specific set of conditions. For example, the curves are drawn for good ground conductivity typical of that found over much of the U.K. If the propagation path were all over the sea, the ground-wave field strength at 1500kHz would be about an order higher and if it were over ground of poor conductivity it could be an order lower. The sky-wave field strength also depends to some extent on the ground conductivity in the vicinity of the aerial.

Fig. 2 illustrates very clearly one fundamental restriction on ground-wave services. A limit to the satisfactory service range at night is set by the minimum acceptable ratio of ground-wave to sky-wave. The sky-wave curves are plotted assuming unity reflection coefficient in the ionosphere. In fact, over the range of distances and diurnal periods of interest in planning, the sky-wave will suffer about 10dB ionospheric attenuation at m.f. and about 15dB at l.f. Thus, if we assume that a 10dB ratio of ground to sky-wave is the minimum to give a service acceptably free from fading and differential sideband distortion, the maximum service range is given in Fig. 2 for m.f. by the distance at which the sky-wave and ground-wave curves intersect, or, for l.f., at which the sky-wave is 5dB greater than the ground-wave. This limit is independent of transmitter power but is very dependent on transmitter frequency.

One of the main factors limiting the total number of transmitters that can be accommodated in a given area and a given band is the interference between co-channel, and to a lesser extent adjacent-channel, transmitters that occurs after dark as a result of long-distance sky-wave propagation. Fig. 3 shows a sky-wave propagation curve applicable to the m.f. band. The level of the sky-wave signal can only be predicted statistically. It is subject to continuous fluctuation, varying from minute to minute due to turbulence in the ionosphere, with additional longer-term changes over periods of hours, days, seasons and years, the causes of which are not all fully understood. As a result, the sky-wave propagation information

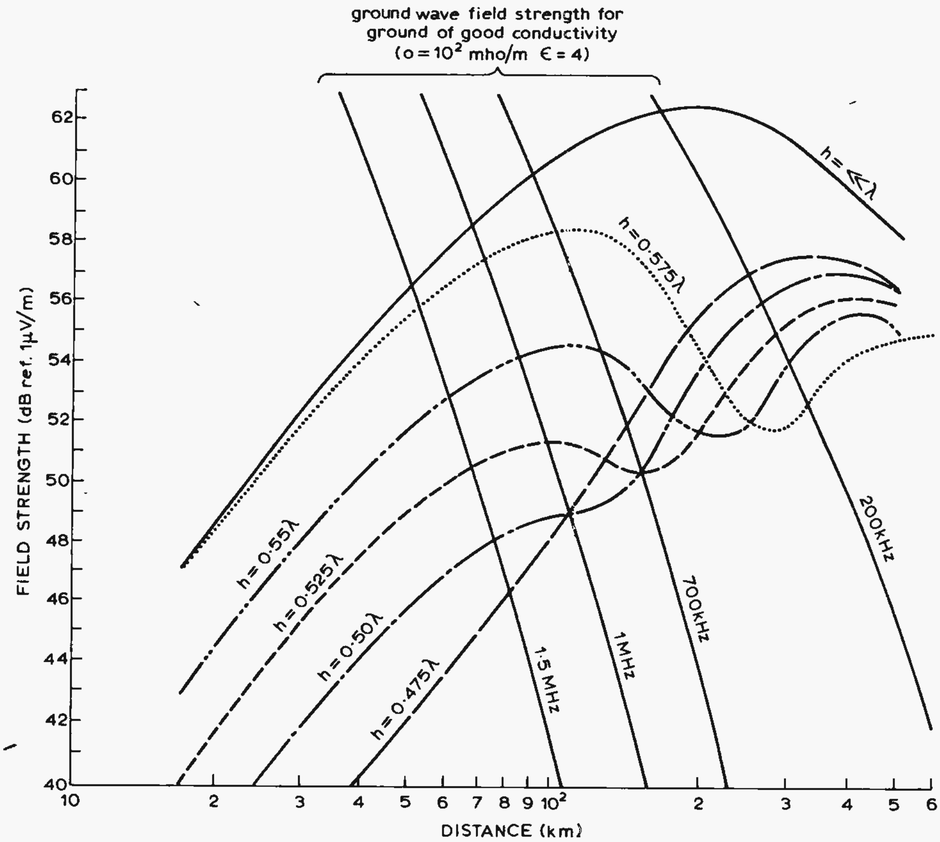



*Fig. 2. Field strength from base-fed vertical aerial on ground of good conductivity. Layer height 100km, with unity reflection coefficient; c.m.f. = 300V; transmitting aerial velocity factor = 0.9, physical height = h; ground reflection factor = 1.9; loop receiving aerial.*

available to the planners is continually being up-dated as more measurement data are collected. Fig. 3 is a recently-proposed curve based on the continuing studies in this field carried out by the members of the International Radio Consultative Committee (CCIR) and the European Broadcasting Union (EBU). It shows the median field strength as a function of distance for a c.m.f. of 300V.

## Co-channel and adjacent-channel interference and basic planning lattices

The essence of the planning problem is how to give listeners the maximum number of programmes consistent with an acceptable level of interference from other transmitters. The two important sources of interference are transmitters sharing the same channel and those in the two adjacent channels; transmissions at greater frequency spacings can be ignored in this context. It is first necessary to determine the channel frequency spacing. In Europe,

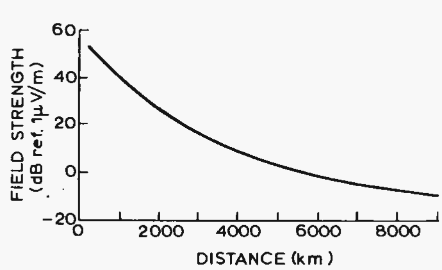



*Fig. 3. Sky-wave propagation curve.*

this is at present 9kHz over most of the bands in question but this is not necessarily the optimum.

The protection ratio, i.e. the ratio of wanted to interfering signal for a given degree of impairment, is shown in Fig. 4 as a function of channel spacing. This is the curve recently adopted by the CCIR and is based on the performance of current receivers. It is plotted in terms of the relative protection ratio, that is the protection ratio at the stated frequency spacing, relative to that for co-channel interference, to give the same level of impairment of reception.

Suppose that we have to accommodate, in a fixed frequency band, a given number of transmitters within a finite area. If we adopt a large channel spacing, say 15kHz, adjacent-channel interference will be negligible but the number of channels available will be reduced; as a result the geographical separation between co-channel transmitters will have to be reduced, and co-channel interference will be greatly increased. On the other hand, if we reduce the channel spacing to, say, 5kHz, giving many more channels, co-channel interference will be reduced at the expense of a large increase in adjacent-channel interference. Somewhere between these limits there will be an optimum spacing, and this has been calculated on the basis of idealized transmitter location plans in the form of a regular geometrical lattice. The simplest form of elementary lattice is shown in Fig. 5. The transmitters sharing channel $n$

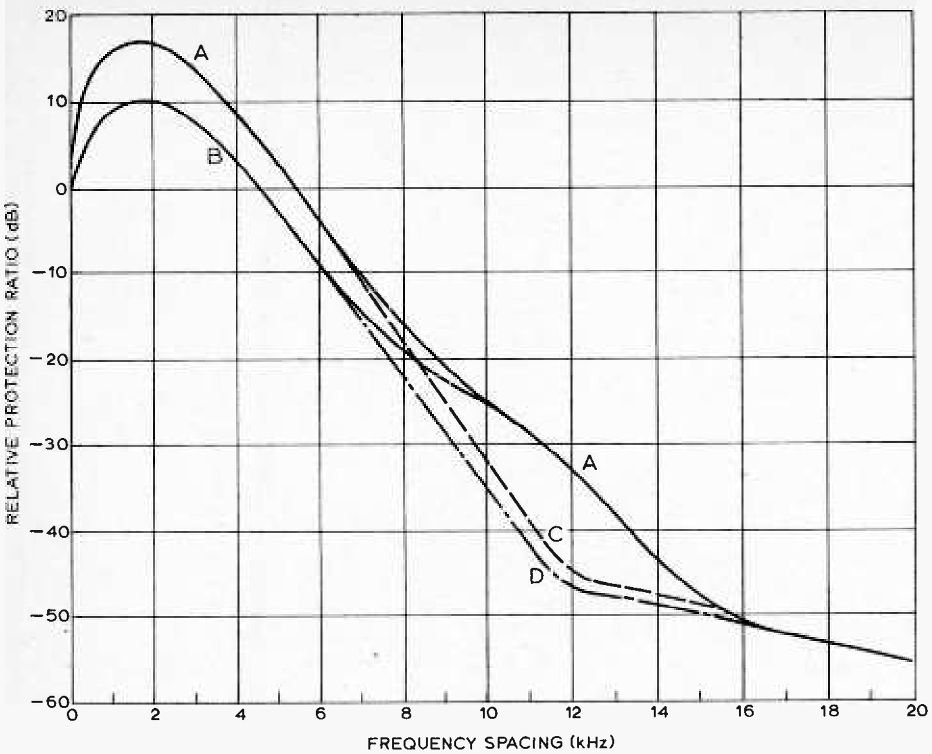



*Fig. 4. Relative protection ratio. Curve A: limited degree of modulation compression at transmitter. Curve B: high degree of modulation compression at transmitter. Curve C: as Curve A but with a.f. bandwidth restricted to about 4.5kHz at transmitter. Curve D: as Curve B but with a.f. bandwidth restricted to about 4.5kHz at transmitter.*

are disposed at the corners of an equilateral triangle of side $D$, which is repeated as necessary to fill the area being planned. Transmitters sharing channel $n+1$ and $n-1$ are similarly arranged, with the three individual channel lattices meshed so that each triangle of co-channel stations has one adjacent-channel station at its centre. With this arrangement, assuming that the layout of Fig. 5 is continuously repeated, each transmitter is surrounded by a ring of six co-channel transmitters at a distance $d$ and six adjacent-channel transmitters at a distance $D/\sqrt{3}$.

This elementary model is obviously over-simplified, for example it gives us nowhere to locate the transmitters on channels $n+2$, so the next step is to distort the lattice to provide for a practicable number of channels. An example is illustrated in Fig. 6; the elementary cell of the lattice has become a rhomb, which again can be repeated as required to cover the area, with provision for 26 channels. The lattice gives the ratio of co-channel to adjacent-channel distance. From the sky-wave propagation curve, of which Fig. 3 is an example, this ratio of distances can be translated into a ratio of interfering signal levels. The relative impairment produced by co- and adjacent-channel interference is then obtained from Fig. 4. From studies of this type, based both on idealized lattice models and on actual transmitter site plans, it appears that the optimum channel spacing is very close to 8kHz and many broadcasting authorities, including the BBC, will urge that 8kHz should be adopted as the standard m.f./l.f. channel spacing in the forthcoming plan.

This lattice model is useful not only for channel spacing calculations, it is a powerful general-purpose tool for planning. It is quite feasible to construct a lattice for a hundred or more channels, the total number available in the m.f. band, but this would be of little practical use since in any one lattice it is assumed that all transmitters are of substantially identical powers, and we would not wish to be limited only to one size of transmitter. A practicable method of planning an area the size of an ITU region would be to decide how many categories of transmitter power are needed. Let us assume we require three, low power for purely local coverage, medium power for large conurbations and high power for regional areas. These three categories of transmitter could then each be allocated its own section of the m.f. band. Fig. 2 shows that the lower

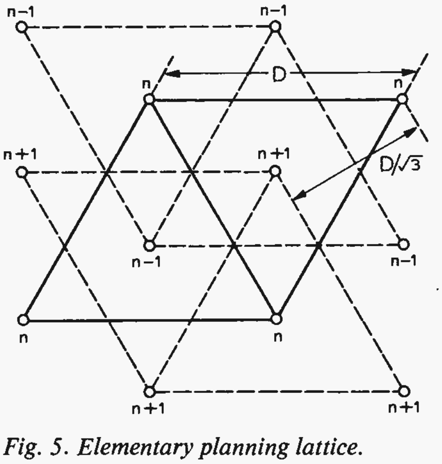



*Fig. 5. Elementary planning lattice.*

frequency channels are more suitable for large-area coverage and the higher frequencies for small areas. A separate lattice could then be prepared for each transmitter category, the co-channel distance ($D$ in Fig. 6) being adjusted to suit the power, from about 1000km for the low-power lattice to about 4000km for the high power one. To avoid awkward adjacent-channel problems at the junction points in the spectrum where differing power bands adjoin, one or two channels could be allocated at each junction as international common-wave channels. These could be used by very-low-power transmitters on an unplanned basis but perhaps subject to an upper limit on the total power radiated by any one country on any one channel. Such a limit could be adjusted according to the area of the country concerned.

Strict adherence to a lattice-plan geographical distribution of transmitters would give, in an ideal situation, optimum area coverage. However, what we usually require is not optimum area coverage but optimum population coverage. Furthermore, we have also to take account of local terrain. Who wants a m.f. transmitter on top of a granite mountain of low ground conductivity in the middle of a desert where nobody lives? These factors can be allowed for. If a transmitter were required to be at a given specific location, it could be assigned the channel frequency appropriate to the nearest available lattice position but its permitted radiated power would be reduced by an amount sufficient to ensure that the interference caused to its co-channel and adjacent-channel neighbours would not exceed that produced by strict adherence to the theoretical lattice plan. It has been calculated that a displacement of 10% of the co-channel distance would entail a power reduction of between 2dB and 4dB but a higher power could be permitted if the displaced transmitter employed a directional aerial system.

One of the planning parameters that the Geneva conference will have to decide is the acceptable co-channel protection ratio. The EBU is recommending that this shall be 30dB. Nobody pretends that interference at this level is negligible but it should be remembered that it will, in the great majority of cases, occur only at night and will be suffered only by listeners at the fringe of a transmitter service area.

The value of this protection ratio determines the ratio of the radius of the transmitter service area to the co-channel distance. Thus, if the approach to planning is that a stipulated, fixed number of transmitters must be accommodated in a fixed number of channels in a given area, this determines the co-channel distance and the co-channel protection ratio then determines the interference-limited service area.

On the other hand, if the approach is that a given service area per transmitter is required with a given co-channel protection ratio at its limit, then the value of that protection ratio determines the co-channel distance, and hence the number of transmitters that can be accommodated in each channel.

### The options: ground-wave or sky-wave, alternative modulation systems

Two assumptions have been implicit in the foregoing discussion, first that m.f. broadcasting, in Europe at least, will be planned mainly on the basis of ground-wave services and, second, that the modulation system used will continue to be double sideband a.m., as in the past. In the course of the wide-ranging discussions that have been going on among broadcasters during the run-up period to the forthcoming conference, both of these assumptions have been called into question. Let us consider first the question of ground-wave versus sky-wave.

There are three possible approaches to the planning of the m.f. band.

(i) To plan for two separate transmitter networks, one for sky-wave coverage at night, the other for ground-wave coverage by day.

(ii) To plan for maximum ground-wave coverage in daylight, considering only ground-wave interference and ignoring the incidence of sky-wave-propagated interference during dark hours.

(iii) To plan for maximum coverage by ground-wave services at night, regarding the increased coverage during daylight as a welcome bonus.

It has been argued that system (i), above, is technically the most efficient since it would give the listener the greatest choice of programmes both by day and by night, and this is undoubtedly true. However, it is subject to a number of disadvantages. Firstly, a sky-wave service is subject to fading and to the distortion resulting from selective sideband fading. Recent developments in technology may permit the production of inexpensive synchronous-detector receivers that eliminate the non-linear distortion produced by fading signals but no such receivers that are reasonable in price and easy to tune have yet appeared on the market. In any case the linear spectrum distortion will remain and, certainly with the envelope-detector receivers that are in universal use at present, sky-wave signals can only be regarded as providing a low-grade service. Secondly, sky-wave propagation is efficient because the signal attenuates only slowly with distance and a high-power transmitter can serve a very large area. The sky-wave network would therefore consist of relatively few high-power transmitters, spaced very widely apart. In Europe, where most countries are small compared to a sky-wave service area, this means that most if not all of the programmes available to listeners would originate outside their own countries. Language difficulties would severely limit the choice of programme material; indeed it is difficult to imagine what the programme could consist of apart from music, and this is not likely to have a wide appeal in view of the poor quality obtained from a sky-wave channel. In many countries also, the idea of providing access

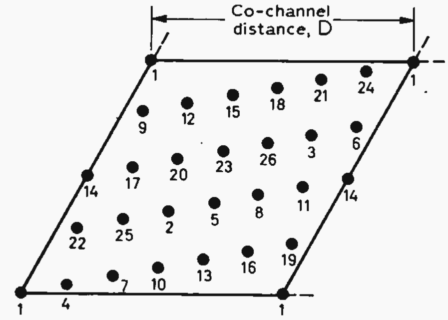



*Fig. 6. A 26-channel lattice.*

to extra-territorial broadcasting services may be politically unacceptable. Thirdly, we must consider the confusion produced in the minds of listeners by the twice-daily switchover from ground-wave to sky-wave network. These switching times would not be fixed but would cycle throughout the year with the changing seasons. The result would probably be that only the most dedicated radio enthusiasts would know what programmes to expect on what channels. To those lacking that degree of interest, the m.f. band would have all the characteristics of a lucky dip. Also, the performance of both networks would be sub-standard for a period around the switching time because the transition from day to night propagation conditions is gradual and not instantaneous. To summarize, although this proposal has features that appeal to engineers in so far as it is technically elegant and efficient, it does not appear on balance to have much to offer to the average listener that he would find of value.

System (ii) is not really practicable. Sky-wave interference would be so heavy after dark that the services would be virtually unusable. In winter months in high latitudes, this condition would apply over most of every day.

We are thus left with alternative (iii), to base our planning on ground-wave services taking into account the night-time level of sky-wave interference, and this will probably be the decision of the conference for planning the greater part of the m.f. band. There are two important applications, however, for which a section of the m.f. band might be set aside for sky-wave services. One is for domestic broadcasting in countries covering very large areas (the USSR is an obvious example in Region 1). The other is if it is decided to permit part of the band to be used specifically for external or international services.

Turning now to the question of alternative modulation systems, the possibility of using some form of single-sideband (s.s.b) transmission system for broadcasting in the l.f. and m.f. bands has been extensively canvassed during the last few years. The advantage to be gained by such a system, compared to double-sideband (d.s.b.) modulation, is either a reduction of interference with the existing number of transmitters or an increase in the number of transmitters that could be accommodated with existing interference levels. The disadvantages are the heavy cost to the public of re-equipping with new and probably substantially more expensive receivers, and the difficulty of maintaining adequate broadcasting services during the interim period while the changeover is taking place. A further advantage frequently claimed for s.s.b. is that it reduces the non-linear distortion produced by selective-sideband fading in sky-wave propagation conditions. This is not strictly true; the reduction of this form of distortion is primarily due to the use of synchronous detection which is necessary in s.s.b. receivers, not to the modulation system itself.

**Compatible single-sideband (c.s.s.b.)** preserves the correct modulation envelope but confines the transmitted energy very largely to the carrier and one sideband. It is designed for receivers with conventional envelope detectors. As with the other s.s.b. systems discussed below, any overall improvement in the planning situation would rely on the use of new receivers with the appropriate narrower i.f. bandwidth. Recent international discussions have, however, tended to reject c.s.s.b. on the grounds of distortion in receivers with reasonably simple i.f. filters that are not phase corrected. Also, it would rule out the option of using synchronous-detector receivers to reduce non-linear distortion on fading signals.

**Vestigial-sideband (v.s.b.)** can be regarded as derived from a d.s.b. transmission by the use of an asymmetrical filter with 6dB attenuation at the carrier frequency. It gives full transmission of one sideband and full suppression of the other sideband beyond a certain distance from the carrier (e.g., 1kHz). Provided that the modulation depth is restricted to 70% or 80%, i.e., the carrier component has an amplitude 2dB or 3dB greater than the peak sum of the sidebands, this system has a substantial degree of compatibility with existing receivers. For a given carrier-to-sideband ratio the compatibility is slightly better than with s.s.b.-plus-carrier.

**Single-sideband (s.s.b.)** with no carrier transmitted is widely used in commercial point-to-point communication networks. It has the advantages that it eliminates the carrier-beat component that is a significant part of adjacent-channel interference and also reduces the level of ionospheric intermodulation ("Luxembourg effect"). It has the disadvantages that there is no means for operating a satisfactory a.g.c. system and also that the receiver must synthesize the demodulating carrier with an accuracy of about $10^{-6}$ without a reference component in the transmission to assist it. It is also not compatible with existing receivers.

**SSB with carrier component** overcomes the two major drawbacks of the system referred to above by radiating a carrier component. If the peak sideband level were restricted to about 70% of the carrier amplitude, this system would have a reasonable measure of compatibility with existing envelope-detector receivers.

**Independent-sideband (i.s.b.)** with no carrier transmitted is similar to s.s.b. but uses the upper and lower sidebands to carry two different programmes. It has the same advantages and disadvantages as s.s.b. and, in addition, it makes very stringent demands on the receiver design if adequate rejection of the unwanted sideband is to be achieved. This latter point is considered further below.

**ISB with carrier component** is similar to i.s.b. but with the addition of a carrier component to provide a.g.c. and assist in the regeneration of the demodulating carrier. Two different methods of operating this system may be distinguished. In the first method, the two sideband signals are radiated from the same transmitter. In this case the field strengths and fading characteristics of the two signals are sensibly identical at the receiving site, the common carrier component provides adequate a.g.c. information for both, but the receiver is required to achieve a high degree of unwanted sideband suppression. With this method of operation, the system is not compatible. In the second method, the upper and lower sideband signals are radiated from two transmitting stations which are geographically separated. In this case the two signals would require protection ratios of about 20dB against mutual interference in order to prevent confusion of the receiver a.g.c. system by the carrier of the unwanted transmission. This method would require a lower degree of unwanted sideband suppression in the receiver and would also have a measure of compatibility with existing receivers if the carrier component were sufficiently large, say 3dB greater than the peak sideband.

CSSB is not regarded as a serious contender for the reasons outlined above. SSB and i.s.b. without carrier are thought to be impracticable, primarily because of the difficulty in providing satisfactory a.g.c. in the receiver. VSB is receiving support in some quarters in Europe but is not generally a preferred system. It offers, in comparison to s.s.b.-plus-carrier, slightly better compatibility but requires a larger channel spacing. Also, being a s.s.b. system at high modulation frequencies, it requires a synchronous-detector receiver for distortionless detection but, being d.s.b. at low modulation frequencies, the regenerated carrier must be phase-locked to the carrier component of the incoming signal. This phase-locking represents a further complication in the receiver that is not required for s.s.b. or i.s.b.

SSB and i.s.b., in both cases with a carrier component, are the two alternatives to d.s.b. that are currently receiving most attention in Europe.

Part of the argument in favour of s.s.b., in all its forms, is that the relatively complex receivers required will not prove to be unduly expensive in view of the rapid developments now taking place in technology. This may be true but, in the U.K. at least, the great majority of sound radio listening on the m.f. and l.f. bands is with battery portable receivers. It is therefore necessary, in order to make the new receivers acceptable to the public, that not only must the initial cost be reasonable but the battery drain must also not be excessive. This latter requirement may well be difficult to satisfy. One prime requirement in receivers for either v.s.b., s.s.b. or i.s.b. is to re-generate a demodulating carrier. For s.s.b. or i.s.b. this need not be phase-locked to the incoming carrier and can have a frequency error of up to 2Hz. It can therefore be produced either from the incoming carrier component by filtering and amplitude limiting or by locking a free-running oscillator, or by generating it locally in a synthesiser of high accuracy without reference to the incoming signal. For v.s.b. the demodulating carrier must be phase-locked to the incoming carrier and the option of using a locally-synthesised frequency without reference to the incoming signal is not practicable.

Of the various methods proposed, the local-synthesis method is the one most likely to give reasonable ease of tuning. In any method deriving the demodulating carrier directly from the received signal or locking a free-running oscillator to it, there is difficulty in reconciling the conflicting requirements of ease of tuning with those of immunity to fading and spurious locking to adjacent-channel signals or to sidebands of the wanted signal.

Receivers for i.s.b. would need to provide adequate rejection of the unwanted sideband. If the two separate sideband signals associated with each carrier were radiated from the same transmitter, a rejection of at least 40dB would be required. This would be impracticable by i.f. selectivity alone and would require the use of post-detector quadrature networks giving a constant 90° phase shift over the whole modulation-frequency band. For broadcasting use this bandwidth extends from, say, 50Hz to 5kHz and the problems of production of such networks to the required tolerances and at an economic price may be very difficult to solve. If the two sideband signals were radiated from geographically separated transmitters they would require protection, in their respective service areas, against mutual interference as discussed above. Assuming a protection ratio of about 20dB, this would ease the requirement for unwanted-sideband suppression. The quadrature-filter technique would still be necessary but the tolerances in the filters could be considerably relaxed.

Receivers for any new modulation system would need to be compatible with d.s.b. transmissions, which would still be radiated during the changeover period. VSB receivers, and i.s.b. receivers with 40dB unwanted-sideband suppression, would be automatically compatible since they would in effect treat an incoming d.s.b. signal as v.s.b. or i.s.b. and demodulate it normally. SSB receivers, and i.s.b. receivers with a lower order of unwanted-sideband suppression would require some additional circuit features in order to cope with d.s.b. The simplest method would probably be to provide a conventional envelope detector, with an appropriate adjustment of the i.f. bandwidth if necessary, brought into circuit by a manually-operated or automatic switch. If it were decided to change the system of modulation to v.s.b. or s.s.b.-plus-carrier, it is difficult to foresee precisely how the process of conversion would be organized. Two alternative methods might be possible. One would be to set aside a portion of the m.f. band for use by transmitters operating on the new system and expand this in successive stages as suitable receivers were purchased by an increasing proportion of the public. The alternative would be to convert transmitters, a few at a time, initially to a more-or-less compatible form of s.s.b. with an enhanced carrier component and preserving the original d.s.b. channel spacing and later, in the final stages of the transition, convert to full non-compatible s.s.b. with closer-spaced channels.

With either method, the successive stages of conversion would need to be implemented by all countries in the planned area proceeding in unison. Eventual completion of the changeover could only be realized when virtually all listeners had acquired receivers suitable for the new system. Unless the receivers were fully acceptable to the public in terms of first cost, running costs and operational convenience, there would be a danger of the conversion plan remaining in its interim stages for an indefinite period. During this period, owners of old-type receivers would suffer increased distortion, increased interference and possibly a restriction in their choice of programmes, with no compensating advantages.

If the new system were i.s.b.-plus-carrier, conversion would still have to be on a stage-by-stage basis as the new receivers came into use but international planning would be far simpler. It could be left to individual countries to convert their own channel assignments to i.s.b. operation with two programmes per channel, if and when they wished, or to continue indefinitely with d.s.b.

Thus, even if the decision of the Geneva conference is to aim for the ultimate conversion of the m.f. and l.f. bands to operation with some novel modulation system, this conversion would have to be spread over a considerable period of time. The immediate plan will have to be based on d.s.b. operation, at least over the greater part of the bands in question.

One cautionary note. Although the present situation on the m.f. and l.f. bands in Europe owes little to formal planning, it is the result of a great deal of empirical cut-and-try experience. It is, therefore, not to be expected that the outcome of the planning conference will be a staggering reduction in interference levels all round. The most we can hope for is a moderate improvement.

## Channel frequencies and bandwidth

Apart from the fundamental requirements of good planning, i.e. ensuring that transmitters are put in the right places and on the right channels and that there are not too many of them, there are some other measures that can be adopted in order to minimize interference. If all transmitter carrier frequencies of receivers were made integral multiples of the channel spacing (i.e., with 8kHZ spacing, all carrier frequencies and i.fs would be on $8n$ kHz with $n$ integral), the interference resulting from spurious responses in receivers (image channel and the like) would produce carrier beats either at zero frequency or at the channel spacing frequency. This would be much less troublesome than the present situation where such interference can produce whistles anywhere in the audio-frequency range. With present-day receiver designs this proposal would not give any great benefit because of the tolerances in i.f. values. With future improvements in receiver manufacturing techniques, particularly if simple types of frequency synthesizer are used as local oscillators, the potential benefit may be realizable. The conference may well decide that the proposal is worth implementing as far as frequencies are concerned.

Another operational measure that is being adopted by a number of broadcasters, including the BBC, is the limitation of the modulation-frequency bandwidth of m.f. and l.f. transmitters. The principle of this is that the sidebands corresponding to modulation frequencies above about 5kHz are so heavily attenuated in present-day receivers that they do not contribute significantly to the quality of the received programme but do contribute significantly to the interference produced in the adjacent channels. It has been suggested that the audio frequency bandwidth transmitted should be limited to no more than one half the channel frequency separation. Then, if the receiver i.f. bandwidth were similarly limited, adjacent-channel interference would not occur. If this suggestion were adopted, it would mean that the quality of reproduction for all listeners, at all times, would be limited for a benefit needed by only fringe area listeners after dark. The preferred BBC practice is to equip l.f. and m.f. transmitters with low-pass filters at the modulation input that have a slightly rising response between 1kHz and 4.5kHz and then a fairly rapid cut above 5kHz. This has been found to give a modest benefit in adjacent-channel interference with no perceptible degradation of quality on average receivers.

## How do we make the best use of the m.f./l.f. bands?

When the Geneva conference has completed its task, the broadcasters have to decide how to make best use of the channels they have got.

In the U.K. we have hitherto tried as far as possible to duplicate our main programmes in the m.f./l.f. and the v.h.f. bands but, with Radio 1 and 2 sharing one v.h.f. channel and the Open University and schools transmissions taking over the Radio 3 and Radio 4 v.h.f. networks from time to time, this policy has become progressively harder to implement. With increasing demands for specialist programmes for language minorities, road information to motorists and so on, it may well be that duplication is a luxury that we shall have to abandon. Should this be so, it is obviously desirable that the allocation of services between the m.f./l.f. and v.h.f. bands should take account of the characteristics of the channel and the requirements of the programme and its audience.

Some types of specialist audience are easy to distinguish, for example motorists. The m.f. and l.f. bands offer many advantages for a programme intended primarily for car radio reception. The area of coverage of transmitters is greater, particularly at the lower carrier frequencies, than with v.h.f., hence the receiver requires less frequent re-tuning and the motorist is less frequently distracted from his primary duty of keeping himself and other road users alive. The signal level is more consistent and less liable to the extreme variations that occur close to ground level at v.h.f. The superior quality and signal-to-noise ratio possible with v.h.f. are less important in the unfavourable acoustic environment of a car and even the dynamic compression that we are compelled to use on the m.f. and l.f. bands, to improve the signal-to-noise ratio, can be a positive advantage for car reception where soft passages tend to become inaudible against the high acoustic noise level.

Another listening situation in which m.f./l.f. would often be preferred to v.h.f. is for what might be termed the mobile audience; the housewife carrying a portable receiver round the house to provide a background to the daily chores or the picnicker with a portable receiver on the beach. The standing-wave pattern existing at v.h.f. inside houses can produce a situation in which either a v.h.f. portable will not work satisfactorily in some positions or the signal will fluctuate and periodically drop below a usable level as the listener moves about. In the open air, the receiver is usually standing on the ground, and the field strength at ground level of a v.h.f. signal horizontally polarized, as the great majority of Band II transmissions are, is theoretically zero and in practice often nearly so.

The audience to whom the characteristics of v.h.f. would appear to be most suitable are those listening at home on a fixed receiver, particularly those to whom sound radio is a major contributor to their home entertainment and who are prepared to acquire a receiver giving high-quality reproduction. Perhaps one could attempt a generalization, that m.f. and l.f. are better suited to casual listening and v.h.f. to serious listening. Having done this, we are not much further forward unless we can classify programmes into those intended for casual and for serious listening. That is a rather more difficult problem, bearing in mind that what is memorable to one listener is trivial to another. Perhaps we should be thankful that some problems in broadcasting do not fall to us, the engineers, to solve.

**Acknowledgements.** The author wishes to thank the Director of Engineering of the BBC for permission to publish this article and his colleagues in the BBC Research Department for assistance in preparing it.

# Sixty Years Ago

**From our August, 1914 issue . . .**

"The efforts to solve for the vision the problem or problems of space which the telephone has solved for the ear bears a close enough resemblance to some of the problems in the wireless field to permit us to follow with sympathetic interest the endeavours which scientists are making to reach a practical solution. Hopeful results were foreshadowed in a communication made during the past month to the Academy of Sciences in Paris by Professor Lippmann on behalf of M. Georges Rignoux, who has devoted himself to this subject for many years. M. Rignoux has now devised an improved apparatus to which he has given the name of Telephote, and which is just a scale of shade and light. There is a transmitting and receiving apparatus connected by two wires. At the transmitting station a concave mirror throws the rays of a 200 candle-power Nernst lamp upon the object which is to be reproduced at the other end of the wire. Each point thus illuminated is shown through a magnifying glass upon a screen composed of cells of selenium metal, of which the electric resistance varies in accordance with the intensity of the light thrown upon it. An electric current is passed through this screen, and, thanks to the peculiar properties of selenium, is transmitted in varying strength according to the amount of light on each portion of the screen. The currents are transmitted over a wire to the receiver, which emits through a Nicol prism rays of light corresponding in intensity with the current received. These rays are cast through a lens upon a revolving mirror, which reflects upon a screen a picture of the light and shade of the object at the other end of the wire, drawn in small rays of light. M. Rignoux claims to have succeeded in his laboratory in thus producing letters of the alphabet, and he is hopeful of further progress."

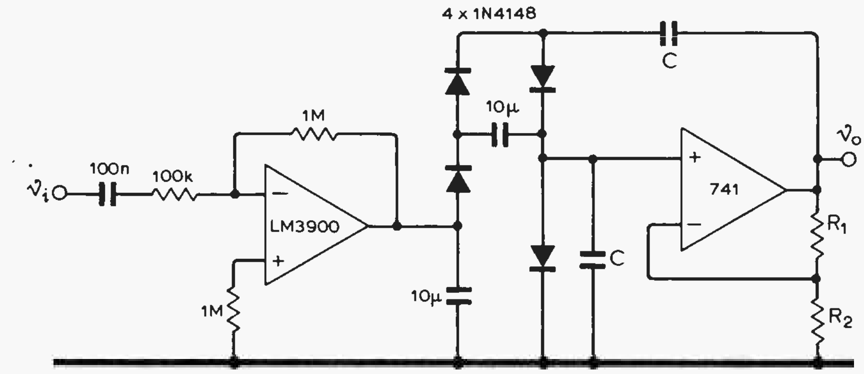
# Circuit Ideas

## Oscillator with current-controlled frequency

The principle of this circuit is based on the current-controlled Wien bridge built up by four diodes of the type 1N4148 and by two capacitors of the same capacitance, $C$. Current is fed to the bridge by means of the current-mode amplifier of the National Semiconductor LM3900.

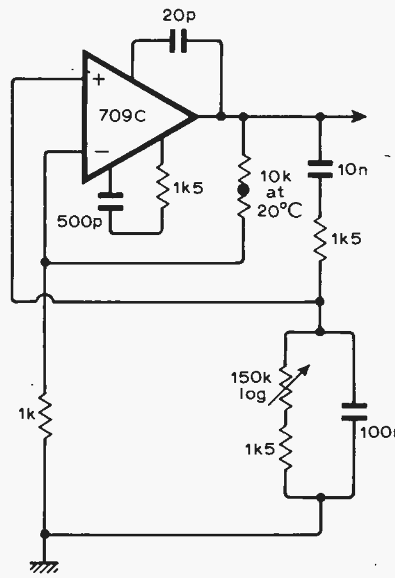
For an amplifier of this type, which can be taken as a "super" transistor with a $\beta$ of $10^6$, small variations of input voltage $v_i$ result in frequency changes over a wide frequency range.

The resonant frequency of the oscillator is directly proportional to the control current. The circuit designed can operate in the frequency range from about 10Hz to 50kHz in which the proportionality between current and frequency holds. In this range the changes in frequency are caused by current variations from about 1 to $10^4$ µA. The recommended value of $C$ is 700pF. Assuming an ideal operational amplifier, the voltage gain needed is $R_2/(R_1 + R_2) > 3$.
Kamil Kraus,
Czechoslovakia.




## Wien oscillator with single component frequency control

Unlike the conventional Wien bridge oscillator, this circuit uses a single-gang potentiometer to control the frequency of oscillation. This is achieved by making the components in the two arms of the bridge in a large ratio to one another, in such a way that the attenuation of the network alters only slightly as one of the resistors is varied. Such a change of attenuation can then be compensated for by the usual thermistor in the negative feedback path of the maintaining amplifier.




Attenuation of the Wien network in the circuit, at zero phase shift, varies from 12 to 11.01 as the potentiometer is varied from zero to 150kΩ; the frequency of oscillation varies by 10:1.

The circuit shown has been built and operates from 340Hz to 3.4kHz; it gives a constant output over the range. A log-law variable resistor is essential to achieve an even distribution of frequencies as the spindle is rotated. A 709C op-amp was used as one was to hand, but a 741 op-amp could be used without the need to include external frequency compensation components in the circuit.
P. C. F. Healy,
RAF Medmenham,
Bucks.

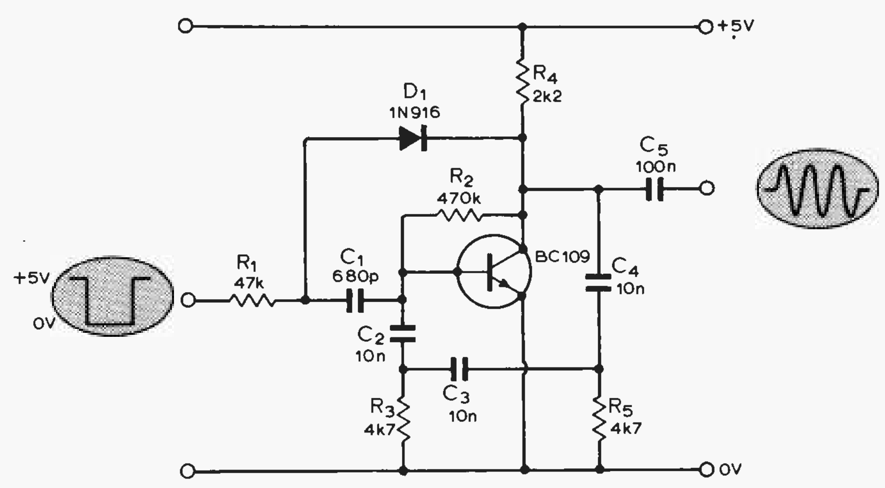
## Gated oscillator with rapid start

The transistor is used as a conventional phase-shift oscillator, with its operating frequency determined by $C_2$, $C_3$, $C_4$, $R_5$, $R_3$, and the input impedance of the transistor. With the components shown the frequency of operation is about 1kHz.

With +5V present at the input, diode $D_1$ is forward biased via $R_1$, thus almost 100% negative feedback is applied to the oscillator via $D_1$ and $C_1$ preventing oscillation. When the input signal goes to 0V, diode $D_1$ is reverse biased, removing the negative feedback. At the same time, the edge of the input pulse is applied to the transistor base, thus "kicking-off" the oscillator on its first half-cycle.

The value of $C_1$ is chosen so that the oscillator starts rapidly, but with no overshoot on the first half-cycle.

The first half-cycle is always in phase with the falling edge of the input signal.
G. F. Butcher,
Cheltenham,
Glos.



# Photographic flashmeter

## Measures incident light and indicates directly in f-numbers

by Ralph Lewis

A flashmeter is a type of photographic lightmeter which measures the light produced by electronic flashlamps, prior to taking a picture, and enables the camera's lens aperture to be set to the appropriate f-number for the light measured. It differs from a conventional exposure-meter in that it is required to include, in the actual measurement, the effect of the duration of the light as well as its intensity. Also, because of the difficulty of preventing some portion of ambient light energy being measured with the flashlight (it's not usually convenient to have to make measurements in a darkened room), the lower sensitivity of an instrument designed for incident light measurements is generally preferable to that of one designed to measure reflected light—although this is by no means meant to imply that all flashmeters measure only incident light.

To take some of the apprehension out of estimating exposures when using electronic flash lighting, the use of a meter is a great aid. It can be almost essential when shooting colour transparencies where the allowable latitude in exposure is small, especially when more than one lamp illuminates the subject, each from a different position, Bracketing half a stop either way as a safeguard may get you by with a still subject, but with a live one the best shot usually turns out to be the one that's over exposed.

In the instrument described (see photo) incident light is measured and indicated on a meter directly calibrated in f-numbers from f2 to f64 in three ranges. The film speed selector enables films of 12 ASA to 650 ASA to be set and the sensing element is contained in a probe attached to the meter by a short lead. This allows readings to be taken in situations where placing the body of the instrument in a similar position would disturb the subject.

The duration of light pulses likely to be encountered will vary between one or two microseconds for a high-speed unit and about three and a half milliseconds for a low voltage studio flash, with probably something in the region of one millisecond being the most common.

Although the author did not have access to a high-speed lamp, tests were made with a light-emitting diode fed from a low impedance sinewave source of constant amplitude over a frequency range of 50Hz to 500kHz. Placing the l.e.d. half an inch from the photocell enabled the integration of a train of light pulses of constant mark/space ratio to be timed. The time required for the voltage on the integrating capacitor to reach a set value was the same at all frequencies ($RLA_2$ in Fig. 1 was bridged for this test), and it is fairly safe to assume that the instrument will cope with the fast rise and short duration of a high-speed unit.

The complete circuit of the flashmeter

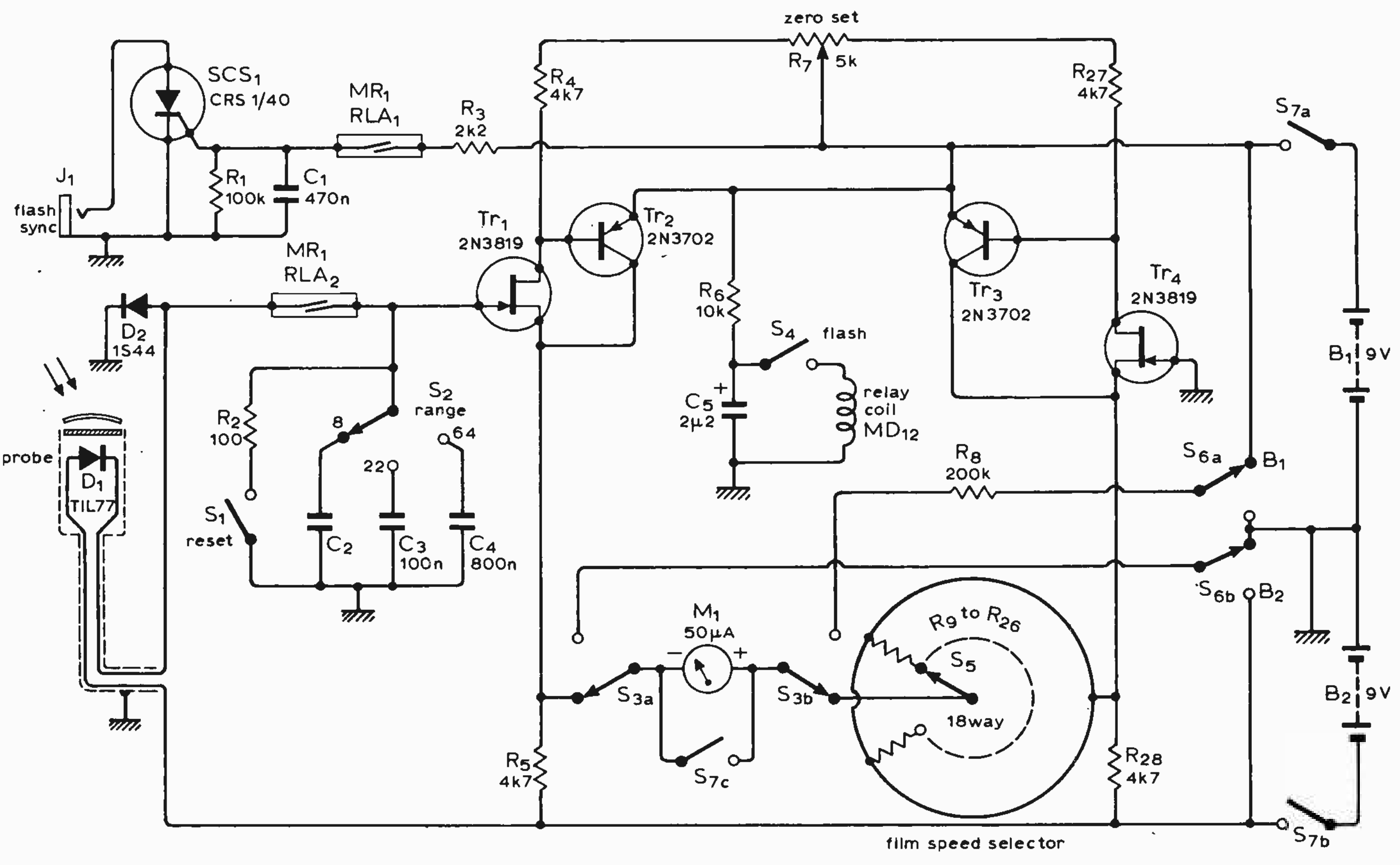



*Fig. 1. Complete circuit diagram of the flashmeter.*

is shown in Fig. 1. The light sensing element is a silicon photodiode operating in the photoconductive mode, which is connected in series with a battery and a capacitor for the duration of the flash. The photocurrent is integrated over the period by charging the capacitor to a potential directly proportional to the duration and intensity of the illumination, and inversely proportional to the magnitude of the capacitance. That is,

$$V_C = \frac{1}{C}\int_{t_1}^{t^2} i\,\mathrm{d}t$$

Where $t_1$ and $t^2$ are the times of the beginning and end of the flash pulse. The capacitor voltage is measured by an f.e.t. voltmeter which has an input resistance in excess of ten thousand megohms, so that the charge is not appreciably reduced by the measuring instrument before it can be read.

The purpose of the diode $D_2$ is to prevent photocurrent produced by ambient lighting being integrated at the same time as the flashlight current. If a reverse biased junction diode is connected to a current source (very high resistance) and the reverse current is below the saturation level, the p.d. across the diode is, for practical purposes, zero and it is not until the current closely approaches the saturation limit that the p.d. begins to rise. Once saturation is reached, the p.d. is independent of the diode and is dependent solely upon other factors in the circuit.

By choosing a diode with a suitable value of reverse current, one can ensure that the cathode of $D_1$ is clamped to chassis potential until the current in it exceeds the reverse current requirements of $D_2$, thus preventing the photocurrent caused by a reasonable amount of room lighting being passed to the integrating capacitor.

A Texas Instruments TIL77 was chosen as the photodiode because its spectral response is very similar to that of the human eye. Normally, silicon photodiodes are most sensitive in the infra-red region, and filtering is necessary to prevent the heat radiation which accompanies xenon flash discharges from overriding the effect of the visible emission.

To increase the sensitivity of the TIL77 (reduced by internal filtering) a large chip has been used and its self-capacitance is rather high—nominally 750pF at −3 volts. Such a high value of self capacitance could cause difficulties if one were to use it to measure the instantaneous intensity of a high-speed flash, as would the capacitance of the screened probe lead—some 400pF. However, in this circuit, all the capacitances are, in a sense, in parallel and charge concurrently; so that the effect of the self capacitances is not to ruin the pulse response but to waste some of the charge that would be passed to the integrating capacitor if they were not present.

A factor of the diode capacitance to be considered is its variation with any change in value of the reverse voltage applied. At the beginning of the integration the voltage across $D_1$ is 9 volts, while at the end, it is 9 volts minus the potential on the integrating capacitor. This varies from 12.5mV ($\frac{1}{8}$ full scale with a 650 ASA film) to 5.09 volts (f.s.d. with a 12 ASA film), and represents a change of approximately 4 volts in the diode voltage.

The diode used by the author measured 380pF at 9 volts and 500pF at 3 volts, so that, allowing for a 1 volt fall in battery voltage during a period of use, a variation of something in the region of 25% is possible. The effect of this must be made insignificant by the choice of a suitable minimum value for the integrating capacitance.

A reed relay has been used to connect the photodiode to the integrating capacitor for the duration of the flash. Without this switching the intensity of the room lighting would have to be very precisely controlled because, if it did not cause saturation in $D_2$, the capacitor would choose this path to discharge, and if it provided more current than was required by $D_2$ the difference would charge up the capacitor and, in quite a short time, make nonsense of the flash reading.

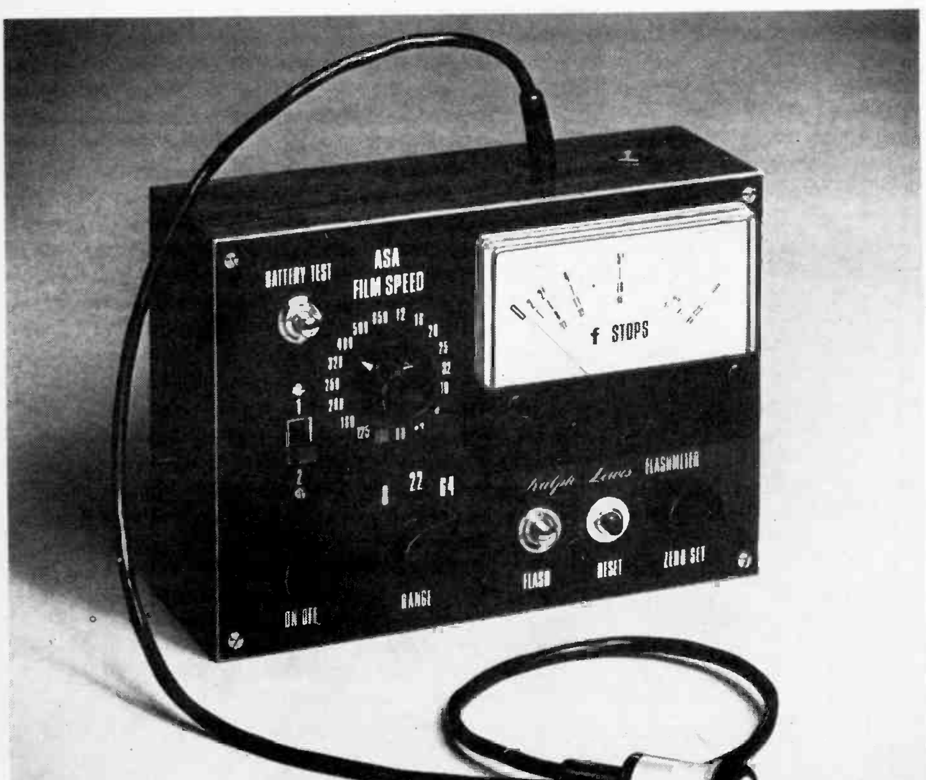
Another reed switch is utilized to trigger the flash unit while the gating reeds are closed. To prevent the contacts being welded by the current in the flash unit's own trigger circuit, a thyristor has been interposed to isolate them from it.

The reeds $RLA_1$ and $RLA_2$ are activated by a common coil $MD_{12}$. When the "flash" switch $S_4$ is closed the charge on $C_5$ momentarily energizes the coil and causes the contacts to close for approximately 5 milliseconds.

Of the two reed switches used the one chosen for $RLA_2$ must be the one that closes at the lower energizing current in the coil. (One can easily ascertain this by connecting the coil in series with a 9-volt battery and a variable resistor and slowly reducing the resistance while transferring the leads of an ohmmeter from one set of contacts to the other, until one closes.) This more or less ensures the flash is not triggered before $RLA_2$ is closed. To make certain, a 0.5ms delay is introduced into the gate circuit of the thyristor $SCS_1$. After the flash trigger pulse has been initiated by conduction in the thyristor, $RLA_2$ remains closed for about 4.5ms to allow the complete flash to be integrated. The times are very approximate and may need to be increased slightly to suit individual reeds but should be kept as short as possible consistent with reliable operation. A slight increase in the values of $C_1$ or $C_5$ may therefore be required.

The f.e.t. voltmeter makes use of a unity-gain differential amplifier utilizing source followers with complementary bipolar transistors in the c.s.-c.e. configuration. The output resistance is considerably reduced with this arrangement because any shunting of the source-collector load resistance, tending to lower the voltage across it, will tend to raise the f.e.t. gate potential and increase the drain current which flows mainly into the base of the bipolar transistor. This would cause an increase in the collector current and correct the voltage across the load.

The lowering of the output resistance is necessary to prevent its adding significantly to the values of the multiplier resistances, especially on the higher film-speed ranges. The output resistance "seen" by the meter circuit in Fig. 1 is in the teens of ohms and is inversely proportional




*The complete flashmeter.*

to the product of $g_m$ and beta in each f.e.t. bipolar pair. It will not, however, be constant because $g_m$ is very dependent on drain current which varies due to the wide range of potentials seen by the gate of $Tr_1$. But, with good bipolar transistors, beta will be the major factor and the resistance will be small enough to be ignored throughout the range of gate potentials occurring with the higher film speeds.

Another important advantage of this combination is that the voltage gain becomes very close to unity, which is not possible with an f.e.t. alone unless a very high load resistance can be used.

The ratio of the values of the fixed components $R_4$ and $R_{27}$ to the variable component $R_7$ in the resistor network used to balance the source potentials of $Tr_1$ and $Tr_4$ is much less than usually specified in similar circuits. This is to enable unmatched transistors to be used; but even with this value some adjustment of the values of either $R_4$ or $R_{27}$ may be required to obtain balance because of the spread in the characteristics of available f.e.ts. The aim should be to increase the value of one rather than reduce the value of the other so as to cause as much as possible of the drain currents to flow into the bases of $Tr_2$ and $Tr_3$. However, it may be necessary to do both.

I suggest that constructors set a lower limit of 3kΩ for $R_4$ and $R_{27}$ and, if still unable to set zero, they should try another 10–15kΩ if necessary. The main thing is to achieve balance while providing the highest possible degree of feedback. (No difficulty in setting zero has been experienced despite the large variable component.)

Variation of exposure in a camera follows a geometric progression and, as the sensing circuit is linear, the meter must be scaled geometrically if it is to be read directly in f stops. A limit is therefore set to the number of stops that can be included between zero and full-scale. Because each stop occupies twice the scale length of the one preceding it, the divisions become progressively more cramped towards the lower end of the scale, and for the sake of clarity and accuracy, four stops is really the limit, while three is to be preferred. If one opts for three, an overall range of f2.8 to f64 can be encompassed in three overlapping ranges—f2.8 to f8, f8 to f22 and f22 to f64. An additional f2 calibration point can be inserted between "0" and f2.8 for good measure if desired.

I suggest that each stop be divided into thirds, as this is generally considered to be the limit of accuracy that it is possible to work to in practical photography. (For instance: Kodak issue speed correction sheets accurate to one-third of a stop for "Ektachrome E3" sheet and roll film.) A scale designed along these lines will look like the one in Fig. 2. The f2 point is at $\frac{1}{16}$ f.s.d., the f2.8 at $\frac{1}{8}$ f.s.d., the f4 point at $\frac{1}{4}$ f.s.d., the f5.6 point at $\frac{1}{2}$ f.s.d. and the f8 point at full scale.

The third and two-third stop calibration points are found by noting the number of degrees encompassed by the preceding whole stops divisions and multiplying it by 1.26 and 1.59 respectively. For example, if the original scale is divided into 90 degrees, then 22.5 degrees are included between f4 and f5.6. So 22.5 × 1.26 or 28.35 degrees from the f4 mark is the position for the f5.6 plus one-third stop mark, and 22.5 × 1.59 or 35.8 degrees from the f4 mark is the position for the f5.6 plus two-thirds stop mark.

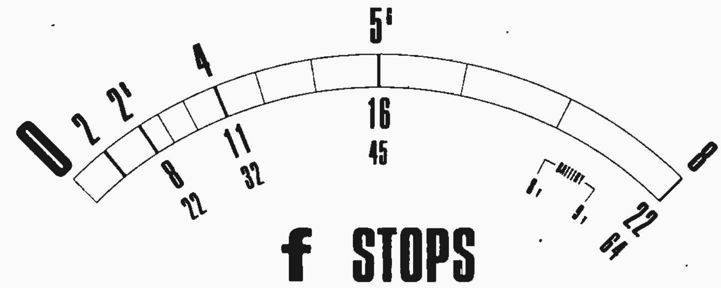



*Fig 2. Direct reading scale designed to fit a SEW SW100 meter.*

There are two obvious methods available to expand the scale by six stops in two ranges. The first is by introducing neutral density filters of 0.9 and 1.8 density between the photocell and the illumination. The second is to increase the value of the integrating capacitance by eight times and sixty-four times respectively. The advantage of the first is that the range of illumination falling on the cell is the same on each range and makes the linearity requirements of the photocell—over a very wide range of illumination—considerably less stringent. The advantage of the second is that it is simpler mechanically because suitable switches are readily available, whereas a filter switch would have to be fabricated specially, and would add considerably to the complexity of the probe housing.

A disadvantage of the second method would be if the photocell were unable to respond linearly to the range of illumination entailed. The range of film speeds catered for is 12 ASA to 650 ASA, which represents a change in illumination equal to five and two-thirds stops, or just over 50:1. Adding the complete scale of the meter, which is ten stops, gives an overall change of fifteen and two-thirds stops, or over 50,000:1.

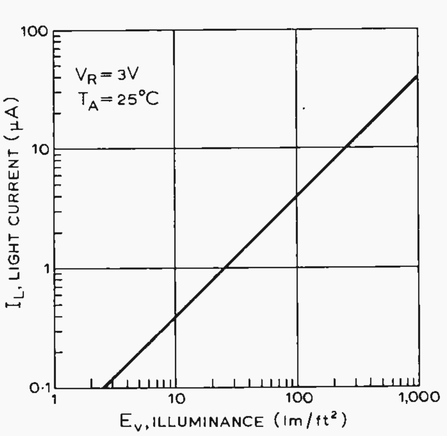



*Fig. 3: Graph of light current vs. illuminance for the TIL77.*

Texas Instruments do not supply data covering such a range and only give a graph covering 2.5 to 1,000 lm/ft² for the TIL77, as it was originally intended for use at the low light levels encountered with ordinary exposure meters (see Fig. 3). Mullard publish a graph for their BPY13 over the range $10^2$ to $10^5$ lux (1 lm/ft² = 10.76 lux) but even if the two are taken together, the total range is less than 4000:1. However, both graphs display an extraordinary degree of linearity and give the impression that they might continue indefinitely, and it was on the assumption that the TIL77 would maintain linearity throughout the range required that the second method was tried. After comparing readings with a 0.9 density filter in front of the probe on the f8–f22 range with those on the f22–f64 range without a filter, they were found to be identical, so the second method was the one adopted.

Adjustment for different film speeds is accomplished by switching the resistors $R_9$ to $R_{27}$ in series with the meter $M_1$ so that the voltage required for full scale deflection is increased by $2^{\frac{1}{3}}$ for each decrease in the ASA index table.

A table illustrating the method of calculation of the resistor values is overleaf. The minimum f.s.d. of 0.1 volt was decided upon as it allows a reasonable portion of the multiplier resistance to be external to the meter, and means that on the highest voltage range there is sufficient potential across the photodiode—even with some fall in battery voltage—to ensure its correct operation.

The choice of values for the three integrating capacitances is affected by a number of considerations. They should not be so large that the correct exposure is indicated without any neutral density between the cell and the illumination, because the inclusion of a filter here is a convenient way of compensating for the different sensitivities of individual diodes during calibration. Large capacitances also require large peak currents to produce the necessary p.d. and require high levels of cell illumination to produce them. Looked at from the other point of view, the smallest capacitance $C_2$ must not be so small that it is easily discharged by the input resistance of $Tr_1$, or leakage in the "range" switch $S_2$ and the "reset" switch $S_1$. The combination of $C_2$, the cell capacitance and the capacitance of the probe lead must also be large enough to sufficiently swamp any change in the cell capacitance mentioned previously.

If a value of 0.1µF is adopted for $C_3$, the diode and probe lead capacitances make up little more than 1% of it and can be neglected initially to simplify calculations. $C_4$ then becomes 0.8µF and $C_2$ plus the diode and lead capacitances become 12.5nF. A 25% variation in the nominal capacitance of the photodiode is 750pF divided by four, or 187.5pF. As that represents only 1.5% of 12.5nF, it will not introduce any noticeable error into the results. Also the value of $C_4$ will not place any strain on the current capabilities of either components or battery because the peak current with a 1ms flash duration will only be about 10mA.

This can be calculated from basic principles on the assumption that the peak current is likely to be between two and three times the mean value and the maximum voltage is practically 5 volts.

$$I_{mean} = \frac{VC}{t} = \frac{5\times 8\times 10^{-7}}{10^{-3}} = 4\text{mA}.$$

$$I_{peak} \simeq 4\times 2.5 \text{ or } 10\text{mA}.$$

Having obtained the current, one can, as a matter of interest, obtain a figure for the probable peak illumination falling on the photocell. A glance at Fig. 3 shows the sensitivity to be 2µA per 50 lm/ft². Therefore, the peak illuminance would be

$$\frac{10^{-2}}{2\times 10^{-6}}\times 50 \text{ or } 2.5\times 10^5 \text{ lm/ft}^2.$$

Taking the average value of the diode capacitance as 656pF, adding the probe lead's 400pF and subtracting the sum from 12.5nF, one is left with 11,444pF as the value of $C_2$. (This value is calculated merely to illustrate the next point. The actual value required is most easily found by trial and error during the calibration so that variations from the nominal values are automatically taken care of.)

Of three 2N3819s tested by the author none had an input resistance of less than $5\times 10^{11}$ ohms. With a figure like that and an 11.44nF capacitance, the time taken for a fall of 10% from the full scale reading is approximately nine minutes with a 650 ASA film. With slower films it is proportionately longer, and even if the resistance were no larger than $10^{10}$ ohms it would still take at worst about 11 seconds.

Leakage in the switches can be kept very low by suitable choice of insulation and modern capacitors can have extremely high leakage resistances so that stability of indication can be more than adequate if care is taken in the construction.

Before going on to the construction, it would be as well to refer briefly again to $D_2$. A suitable value for its reverse saturation current was found to be 10nA. This value allows a fair amount of room lighting in which to take the readings, while at the same time being too small a percentage of the mean current required to charge $C_2$ to the f2.8 point with a 650 ASA film to matter whether or not the 10nA is wholely provided by ambient lighting or part of it by the flashlight. In other words, any current bypassing $C_2$ to bring $D_2$ to saturation will not be missed.

## Construction

A view of the component layout is shown in Fig. 4. Everything is attached to the front panel with the exception of the "flash sync" jack socket $J_1$ which is secured to the side of the case alongside the probe lead. The transistor circuitry is laid out on the piece of Veroboard shown at the top of the panel and the relay circuitry on the piece in the centre, between the meter and $S_5$. The integrating capacitors are shown at the bottom, wired directly to the "range" switch $S_2$; and the thyristor, $R_1$ and $C_1$ connect directly to the tags of $J_1$.

To realise the extremely high input resistance of the f.e.t. when it is connected into circuit, certain precautions must be taken. The gate wire of $Tr_1$ should not be connected to the Veroboard but bent around, a wire joined to it and taken to the pole of $S_2$, which should have ceramic insulation. Paxolin is definitely not a suitable insulating material for this switch. The "reset" switch $S_1$ must have similarly low leakage. Being unable to procure a ceramic push-switch, I tried an Eagle miniature push-switch and found it to be quite satisfactory. The gate side of $RLA_1$ must also be kept off the circuit board and connected directly to the pole of $S_2$. In this most sensitive part of the circuit—as far as leakage is concerned—all wiring should be self-supporting, and even when insulated should be prevented where possible from touching anything not directly connected to it. If all these precautions are taken meter indications will remain stable for a considerable period of time in a dry room. In humid conditions however, it may be necessary to moisture-seal the case and include a bag of desiccant inside.

A convenient way of measuring the reverse current while testing the suitability of diodes for the $D_2$ position is by making use of the high input resistance of the f.e.t. voltmeter. By temporarily replacing one of the integrating capacitors with a 10-megohm resistor, and connecting the diode under test between the 9-volt negative rail and the gate of $Tr_1$, the value of its reverse current can be obtained from the reading on the meter in conjunction with the table of multiplier resistances. Start with $S_5$ in the 12 ASA position and increase the film speed setting until the meter reads full scale or thereabouts. Obtain the voltage that this represents from Fig. 4 and divide it by $10^7$ to obtain the diode current. For example, the 650 ASA setting is represented by 0.1 volt at full scale. Dividing this by $10^7$ gives 10nA. The exact current is not critical but should be a little higher rather than lower than 10nA.

Any ordinary silicon diode may be used in this position and any you have in your possession should be tried first. If not successful in finding one to suit among them, you will probably have to purchase five or six to find one suitable. A word of caution: if connecting them for test with solder, allow plenty of time for them to cool to room temperature before taking a reading, and shield them from the light and heat of any bench lamps. Even the ones in black containers are sensitive to the effect of radiant heat on reverse current.

The probe housing is made from a Bulgin D105/white lampholder which is first stripped down and the screw-hole in the plastic end-cap enlarged to take a Bulgin cable sleeve No. 8819 tightly. The probe lead is a yard of screened-twin 7/0.1mm p.v.c. which is a good fit for the sleeve. If sufficient length of braid is splayed out, it can be clamped between the end-cap and the metal barrel when assembled. The photodiode is secured to the ends of the twin-lead by beads of solder so that when assembled the lens lies just below the end of the barrel. After assembly the diode can be centralized either by packing glass wool around it or by making a polythene washer with a hole which just allows the cell case to

**Table of resistor values for the "film speed" switch $S_4$**

| film speed ASA | volts f.s.d. | total multiplier resistance for 50-µA meter. kΩ | circuit ref. | nearest preferred value after subtracting meter resistance of 1,000 Ω. kΩ | % error |
|---|---|---|---|---|---|
| 650 | $0.1\times 1 = 0.100$ | 2.00 | $R_9$ | 1.0 | 0 |
| 500 | $0.1\times 2^{1/3} = 0.126$ | 2.52 | $R_{10}$ | 1.5 | −1.4 |
| 400 | $0.1\times 2^{2/3} = 0.159$ | 3.18 | $R_{11}$ | 2.2 | +0.9 |
| 320 | $0.1\times 2 = 0.200$ | 4.00 | $R_{12}$ | 3.0 | 0 |
| 250 | $0.1\times 2\times 1.26 = 0.252$ | 5.04 | $R_{13}$ | 4.0 | −1.0 |
| 200 | $0.1\times 2\times 1.59 = 0.318$ | 6.36 | $R_{14}$ | 5.6 | +4.5 |
| 160 | $0.1\times 2^2 = 0.400$ | 8.00 | $R_{15}$ | 6.8 | −2.9 |
| 125 | $0.1\times 2^2\times 1.26 = 0.504$ | 10.00 | $R_{16}$ | 9.1 | +1.1 |
| 100 | $0.1\times 2^2\times 1.59 = 0.636$ | 12.70 | $R_{17}$ | 12.0 | +2.6 |
| 80 | $0.1\times 2^3 = 0.800$ | 16.00 | $R_{18}$ | 15.0 | 0 |
| 64 | $0.1\times 2^3\times 1.26 = 1.00$ | 20.10 | $R_{19}$ | 20.0 | +4.7 |
| 50 | $0.1\times 2^3\times 1.59 = 1.27$ | 25.40 | $R_{20}$ | 24.0 | −1.6 |
| 40 | $0.1\times 2^4 = 1.60$ | 32.00 | $R_{21}$ | 30.0 | −3.2 |
| 32 | $0.1\times 2^4\times 1.26 = 2.01$ | 40.20 | $R_{22}$ | 39.0 | −0.5 |
| 25 | $0.1\times 2^4\times 1.59 = 2.54$ | 50.90 | $R_{23}$ | 51.0 | +2.2 |
| 20 | $0.1\times 2^5 = 3.20$ | 64.00 | $R_{24}$ | 62.0 | −1.6 |
| 16 | $0.1\times 2^5\times 1.26 = 4.02$ | 80.40 | $R_{25}$ | 82.0 | +3.3 |
| 12 | $0.1\times 2^5\times 1.59 = 5.09$ | 102.00 | $R_{26}$ | 100.00 | −1.0 |

slide through, and which is a friction fit in the barrel.

Constructors using the SEW meter could if they wished photocopy the scale in Fig. 2 and make a single weight print of it to the size required. The print could then be fixed to the reverse side of the original metal scale with dry mounting tissue or some other suitable adhesive. Precise sizing is not possible with bromide paper because of its stretching during processing, but, with care, the error in the length of the scale would be too small to be important with regard to the needle swing and would automatically be allowed for in the calibration.

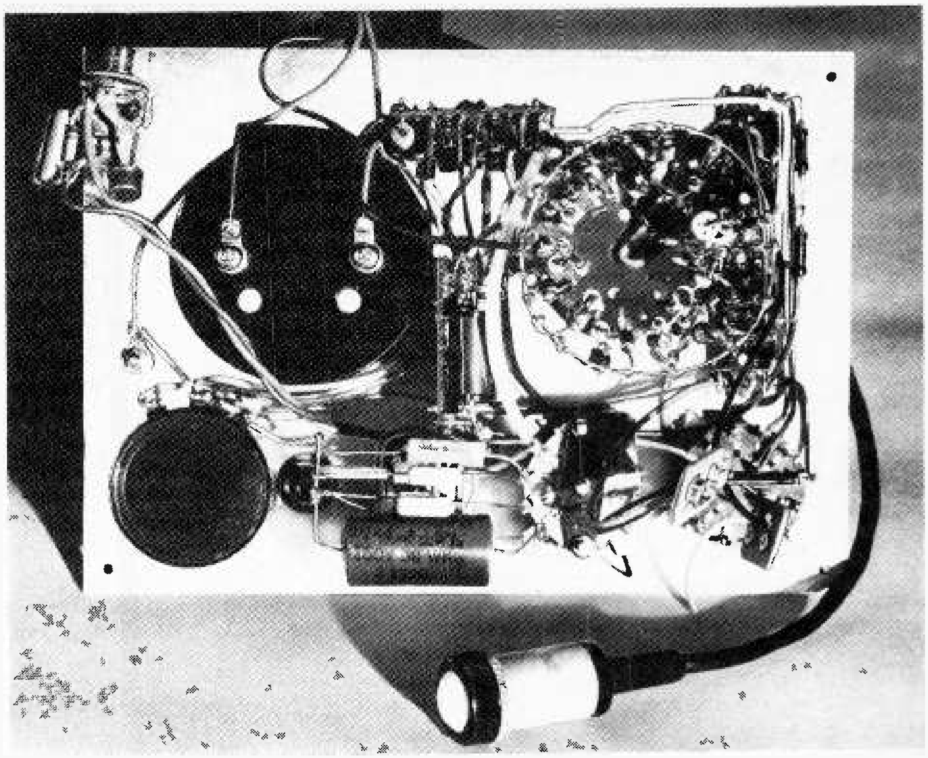


*Fig. 4. Layout of components, showing the probe in front.*

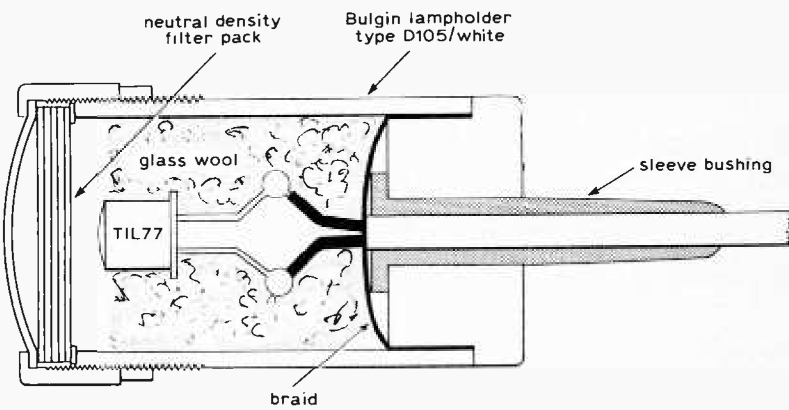



*Fig. 5. Sectional diagram of the probe housing (not to scale).*

## Calibration

The calibration procedure described is not meant as a precise scientific method but it does enable the instrument to be adjusted to produce the results that any individual photographer will expect from his own meter.

It will be necessary to have, already made up, a flash sync lead of about 20ft in length, terminated with plugs to suit $J^1$ and the flash unit in use.

Before proceeding further, constructors would be wise to check the linearity of the film-speed settings. Do this by connecting a suitable potential divider between the 9-volt negative rail and chassis, so that by connecting $Tr_1$ gate to the slider its potential can be varied from zero to minus $5\frac{1}{2}$–6 volts. Set $S_5$ to 650 ASA and the pot. to give f.s.d. Then reduce the "film-speed" switch settings by one-third stop intervals, noting the accuracy with which they correspond with the meter calibration marks. It will be necessary, from time to time, to adjust the gate voltage in order to cover the full range. Any deviation from the marks, in excess of that expected due to the errors listed in the table plus the tolerance of the resistors used, can be noted and either corrected or an allowance made during the calibration.

A neutral density of approximately 0.9 should be fitted to the probe at the beginning otherwise you will be unable to make a sensible assessment of the amount of ambient lighting in which to carry out the calibration.

To start with, both the probe and the flash-head should be fixed to stands 10 feet apart. (There is no magic in the distance but it makes guide-number computation simple and is probably the average flash-to-subject distance used in flash photography.) The flash unit should preferably be mains powered so that the capacitor is charged to a fixed voltage (assuming a stable mains supply) throughout the tests, and does not vary as some battery powered units with battery-saving circuitry do. If a unit without mains facilities must be used, always trigger the flash immediately the charge cycle is completed, by waiting for the audible oscillation to just cease—that is when the charge is at its peak. The light output between recycling limits may vary by as much as one-third of a stop.

Switch the meter on, set the "film speed" switch to 650 ASA and pressing the "reset" button, adjust "zero set". With the flash disconnected, turn the "range" switch to select $C_3$ and operate the "flash" switch $S_4$. If the meter needle moves more than its own thickness, keep operating $S_4$ while reducing the room lighting until it doesn't.

Switch on the flash and connect the sync lead. Turn $S_5$ to a film speed that you know requires a stop between f8 and f22 with this flash at 10ft in this particular room. Press $S_4$ and note the reading. Reset and repeat several times to satisfy yourself the reading is consistent. When satisfied, add or remove neutral density to or from the amount in the probe housing until the meter indicates the precise stop anticipated.

Having satisfied yourself that the readings are consistently accurate, turn $S_5$ until the meter reads exactly full scale. If unable to position the meter needle exactly on the mark with $S_5$, vary the position of the flash-head relative to the probe while taking readings at each position until a precise full scale indication is achieved.

Next, turn to the $C_4$ position of the "range" switch and connect capacitors in parallel to the approximate value of 0.8μF to the switch tag. Adjust the exact capacitance until flash readings are precisely three stops less than the one obtained in the previous paragraph.

Switch back to $C_3$ and ascertain whether or not the "film speed" switch is in such a position that its setting can be reduced by three stops. That is, it must be set to a higher speed than 80 ASA. If it is not, set it now to 100 or 125 ASA and adjust the lamp-to-probe distance for exactly f.s.d.

Set $S_5$ nine exposure indices lower—which will be 12 or 16 ASA and set the "range" switch to the $C_2$ position. Starting with a value of 12nF for $C_2$, gradually adjust the value until you obtain precisely f.s.d.—taking into account any deviation in the linearity noted in the ranges of $S_5$ earlier. Check before accepting these readings that they are not being unduly influenced by room lighting, because its effect will be more noticeable on this range than either of the others.

Any inconsistency in the results (that cannot be attributed to the light source) may be caused by failure of the relays to synchronize properly. It may be necessary to increase the value of the timing capacitors as mentioned previously.

To test the functional accuracy of the original meter, a set of test exposures were made of a grey card placed a fixed distance from the camera. The camera lens was set to the 10ft engraving on the lens mount to minimize any error caused by lens extension and a one-dioptre supplementary lens added to enlarge the image. The probe was clamped in the centre of the image field—at the point of focus—with the card resting centrally against it for each exposure. A flash unit was positioned one side of the camera and its distance and power varied to give exact f-stop readings from f4 to f32 with a 125 ASA film. Exposures were made at the appropriate stops and a contact print made on a common sheet of paper. (The central portion of the card from each exposure is shown side by side in Fig. 6.) The difference in density between the negatives was less than one-third of a stop in the central area of the card and if one can take the mean density as correct any error is within one-sixth of a stop—10% approximately. (Theoretically, one could make a fractional adjustment to the value of neutral density in the probe to place the mean density "on the button", but as one could not be certain of the speed of the film used—to the necessary degree of precision—it is not very practical.)

Compared with some modern commercial instruments, the one constructed by the writer may be larger ($7\frac{3}{4} \times 5\frac{1}{2} \times 3\frac{1}{4}$ in) than many would like—due to the use of many standard sized components and the large meter employed—but there is no reason why it could not be reduced in size if miniature parts are used throughout.

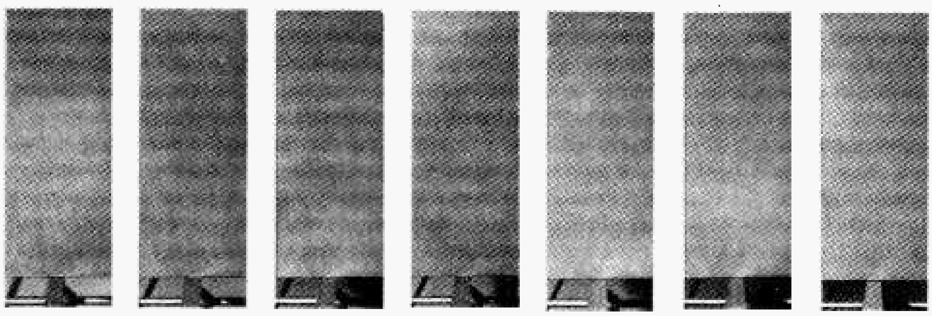


*Fig. 6. A series of exposures taken of a grey card at various lens stops with a 125 ASA film. The exact stop was indicated by the flashmeter. Left to right: f4, f5.6, f8, f11, f16, f22 and f32 (see text).*

### Components list

**Semiconductors**
$D_1$ TIL77
$D_2$ 1S44 (see text)
$Tr_1$, $Tr_4$ 2N3819
$Tr_2$ $Tr_3$ 2N3702 or similar
$SCS_1$ CRS 1/40 or similar

**Capacitors**
$C_1$ 0.47 μF polyester
$C_2$ 12.5 nF nominal less the lead and photodiode capacitance.
Adjust during calibration. See text.
$C_3$ 0.1 μF polyester
$C_4$ 0.8 μF nominal. Adjust during calibration. See text.
$C_5$ 2.2 μF electrolytic, 10V.

**Resistors**
$R_1$ 100 kΩ
$R_2$ 100Ω
$R_3$ 2.2 kΩ
$R_4$ 4.7 kΩ, may require adjustment. See text.
$R_5$ 4.7 kΩ
$R_6$ 10 kΩ
$R_7$ 5 kΩ linear
$R_8$ 200 kΩ, h.s. 1%.
$R_9$ to $R_{26}$ h.s. 1%. See table for values.
$R_{27}$ 4.7 kΩ. May require adjustment. See text.
$R_{28}$ 4.7 kΩ
All resistors may be 5% tolerance except where stated.

**Switches**
$S_1$ Extremely low leakage push switch. See text.
$S_2$ Single-pole, 3-way ceramic rotary switch.
$S_{3a,b}$ d.p.c.o. push-switch. Bulgin SM419/2 or similar.
$S_4$ s.p.m.b. push-switch. Bulgin SM365 or similar.
$S_5$ Single-pole, 18-way rotary switch. Bulgin S435 or similar.
$S_{6a,b}$ d.p.c.o. slide switch. Bulgin SM596/2 or similar.
$S_7$ 3-pole, 2-way rotary on-off switch. Third pole short circuits meter for transit.

**Relays**
$RLA_1$, $RLA_2$ Miniature reed relays
$MD_{12}$ 12-volt, 120 a.t. coil.
Obtainable from Electrovalue Ltd.

**Meter**
$M_1$ SEW SW100 50μA f.s.d.

**Probe housing**
1 Bulgin D105/white MES lampholder.
2 Bulgin sleeve bushings. P/No. 8037.
1 yard twin screened 7/0. 1mm p.v.c. or similar.
$J_1$ Jack socket or similar.
$B_1$, $B_2$ PP3 batteries with connectors.

**Neutral density filters** in 5cm gelatin squares are available (through photographic retailers) from Kodak Ltd, and one each of 0.9, 0.3 and 0.1 density should enable a suitable pack to be built up. (Note: the density of an undyed gelatin is approximately 0.05 or 1/6th stop.)

# Coming events

Two courses to be held at Norwood Technical College, Knight's Hill, London SE27 0TX are: **Modern Colour TV Receivers** covering recent circuit techniques and development of 110° colour television receivers, lasting nine weeks from 6.30 to 8.30 p.m. each Tuesday evening commencing October 8, fee £3; **Optoelectronics** covering optoelectronic and liquid crystal technology, systems and applications, lasting nine weeks from 6.30 to 8.30 p.m. each Thursday evening, commencing October 10, fee £3.

Two courses at The Polytechnic, Queensgate, Huddersfield HD1 3DH are: **Large and Medium Scale Integration**—applications in circuit design, a two-day residential course on September 18, 19; also an introductory course on the principles of integration and on basic ideas in digital and linear systems. Further details are available from the above address.

The Systems Reliability Service of the UK Atomic Energy Authority is running in collaboration with Liverpool University a course on **An Introduction to Reliability Assessment, Theory and Practice**, to be held at the University from September 16 to 17. It includes the mathematics of probability and its application to testing and maintenance of equipment. Applications at a fee of £160 (£135 for associate members of SRS) exclusive of v.a.t. and accommodation should be sent to Mr A. C. Wilson, Systems Reliability Service, U.K. Atomic Energy Authority, Wigshaw Lane, Culcheth, Warrington, WA3 6AT.

**Integrated Circuit Design Workshop** is a weekly afternoon laboratory design course of ten weeks duration beginning on November 13 at the Barking Precinct of North East London Polytechnic, Department of Electrical Engineering, Longbridge Road, Dagenham, Essex RM8 2AS. The course extends over two academic terms and the fee is £7.50 for each part.

**Harlow and District Amateur Radio Society**, Mark Hall, Essex will be holding their annual Mobile Rally on Sunday, September 22 at Netteswell Comprehensive School, Harlow. There will be trade stands, bring and buy, free entrance and car park etc. Contact for the rally is B. W. Nappey, G3YD1 QTHR.

# Letters to the Editor

## Tuning electronic pianos

Readers who are tempted to construct the novel design of electronic piano by G. Cowie, and who try to use the tuning method outlined in the third part of his article (May), will find themselves faced with a very difficult task. Tuning any instrument to equal temperament is not easy, but the job is straightforward, if a little arduous, if the method used by professional piano- and organ-tuners is employed.

The main difficulty arises because the major third is such an imprecise interval. An instrumentalist who can vary the pitch of his instrument (a violinist, for example) will say that he varies the interval of his major thirds (and minor ones, for that matter) according to the mood and tension of the music; yet the interval still sounds in tune. The same cannot be said of the mathematically defined intervals of an octave, fifth or fourth. I put these intervals in that order deliberately, because we can tolerate mis-tuning least in the octave, more so in the fifth, and most in intervals like the third, sixth, second and seventh.

This suggests that we should tune a scale by means of the intervals to which the ear is most acutely sensitive, the octave (I am neglecting the unison, since it is not relevant to laying a scale) and fifths and fourths. This sounds simple enough, but this is where the arduous part comes in. Because in the Western world we are used to music in dodecaphonic scales (containing twelve intervals) we like to be able to use these intervals freely to construct scales starting on any key-note. It is also convenient to be able to modulate from key to key at will without losing proper tuning, and herein lies the problem. A scale of C major, for example, constructed mathematically by using the exact ratios of the octave (1:2) and the fifth (2:3) has twelve intervals which are not all equal, and when these are used in other keys, the different sized intervals occur in the wrong places, making the scale out of tune. In equal temperament, all intervals are theoretically made equal. Like George Orwell's animals, some turn out, in practice, to be more equal than others, but as an ideal to aim for, it is satisfactory.

In order to make the intervals equal, the intervals are "bent" slightly, the fifths being made slightly flat and the fourths slightly sharp. Octaves are of course tuned exactly. Around middle C, the amount of this flattening or sharpening is a little less than one beat per second on average, and takes a careful ear to hear and quantify it. It is easiest to notice if the interval is first tuned exactly (no beats apparent) and then narrowed or widened slightly accordingly.

The method, then, is as follows: tune A (440Hz) exactly with a fork; take the A below middle C (which the divider circuits have tuned for you) tune up to E, up to B, down to F sharp, down to C sharp, up to G sharp, down to D sharp, up to A sharp (B flat), down to F, down to C, up to G, down to D, and if you are lucky, up to A. The first time round, you will probably find you have overdone the interval "bending", but work back in the opposite direction and adjust slightly until you have laid a perfect, equally tempered scale, then celebrate by playing the entire 48 Preludes and Fugues by J. S. Bach, written for just such a keyboard instrument.

Interested readers can find an excellent article on tuning and temperament in Percy Scholes' *Oxford Companion to Music,* which gives more details than I can.

David K. Taylor,
Charlbury,
Oxford.

## FM tuning indication

I have been following the articles on the f.m. tuner in *Wireless World* with some interest, as some of the principles involved resolve long standing difficulties inherent in most other units. I must, however, make a number of points with respect to the single lamp tuning indicator described by Mr Skingley in the June issue.

Firstly, I do not agree that adjustment for a maximum response is essential for the understanding of the layman. If one regards, in a more general sense, a human being and a machine as a part of a control loop, there are many instances in which the layman has to make some adjustment to achieve a particular setting, rather than a maximum. When driving a car in a built-up area, for example, the driver adjusts the accelerator to maintain a speedometer reading of 30 m.p.h., which, if safe, is the optimum speed at which to travel.

Secondly, I maintain that the output of an f.m. tuner contains more information than that of an a.m. tuner to assist tuning. The a.m. tuner output can only show that a tuning error exists, i.e. output less than maximum, whereas an f.m. tuner output can show whether the tuning is set to too high a frequency or too low. The output of the f.m. tuner is thus bidirectional, in common with most analogue transducers used in control, whereas the output of the a.m. tuner is only proportional to the modulus of the tuning accuracy. It is for this reason that a.f.c. is more easily accomplished on f.m. tuners than on a.m. tuners.

Thirdly, on psychophysical grounds, because of the logarithmic nature of human senses, it is easier to detect when *two* quantities are the same, or which of the two is greater, than it is to make an absolute estimation of a single quantity. In addition, absolute estimation is highly dependent on ambient conditions, which is why, for instance, street lights look very dim if they are on in broad daylight.

If one plots Mr Skingley's graph of diode current versus input voltage on a logarithmic vertical axis, to obtain eye response, the peak is less pronounced and, more important, in the area of correct tuning, it is very flat.

Fourthly, in an unnecessary attempt to condescend to the layman, Mr Skingley's circuit literally throws away half of the information provided by the tuner, in as much as the "long tailed triple" is a modulus circuit, which effectively lowers the tuning information to that of an a.m. tuner.

The non-technical user can establish from a single light system that an error exists but he cannot tell which way to turn the knob, so that there is no longer a fifty-fifty chance of making the tuning worse before it gets better.

In one commercial tuner I have seen, two lights were incorporated, whose lenses were in the form of arrows, so that one was in no doubt as to which way to tune. A colleague has pointed out that when tape recording from a distant station with a.f.c. out, the two-light system would be the only one usable, as with a single light it is necessary to make an exploratory movement of the tuning to find out which side of the maximum one is, which could spoil the recording.

Finally, I humbly submit that a maximum reading "magic-eye" valve, as found on some old f.m. tuners, with its linearly sensed display (displacement rather than brightness), is theoretically superior to a single logarithmic l.e.d. I do of course intend this last remark to be philosophical rather than sardonic!

J. R. Watkinson,
Institute of Sound and Vibration Research,
Southampton.

## Plug-in p.c. boards

It was refreshing to read the letter from Mr R. N. Goodman of The Decca Record Company in your April issue. Too often the emphasis during the design stages of a p.c.b. based product is to "cost reduce" without true consideration of the longer term cost improvement which can be gained by a slightly higher first buy price.

Mr Goodman underlines the very major advantages of the two part connector; the type he mentions in his letter, the ISEP male, is probably the most reliable connector of its type in service in its various versions worldwide.

The misfortune of dropping a board utilizing this connector type does not necessarily mean replacement; the profile of the insulating section ensures exact alignment of contacts before electrical connection is made. This same profile gives considerable protection against accidental damage.

Increasingly other manufacturers are realizing the very real advantages of the two part connector, a trend we are confident will continue.

M. A. Tebbutt,
ITT Components Group Europe,
Milford Haven,
Pembrokeshire.

## Electrostatic forces on pickups

The electrostatic forces on Mr Hide's pickup (Letters, June) have been in the reverse direction to those on mine.

I recently purchased a Goldring GL78P/C deck fitted with a G820E cartridge incorporating an elliptical stylus. I found that the reproduction occasionally suffered from momentary breaks as if there was a bad connection in the circuit. An alternative, more robust, G800 cartridge was free from the failing.

While re-checking the playing weight (1.5gm) and balance of the arm with a record on the turntable I found that the arm appeared to be well out of balance. On removing the record to make the appropriate adjustment the arm was found to be perfectly balanced.

A telephone call to the makers revealed that a very small addition to their quoted maximum playing weight of 2.0gm can cause the moving magnetic element to "bottom" on its protecting surround. The electrostatic force added to the intended playing weight was causing the excessive stylus pressure.

I have overcome the effect by reducing the playing weight position to a little under 1gm, but the actual playing weight must be a very variable quantity depending on the state of charge of the record. In fact it is possible to play a record using the electrostatic attraction alone. May I add that I always brush my records with the simple Watts Parostatik Disk Preener (with a moistened inner wick) before use.

I have not tried to measure the added effective weight as something more sophisticated than a simple stylus balance seems to be needed to avoid discharging the record.

Can any reader offer a more satisfactory approach to ensure constant, known stylus pressure?

R. G. Holder,
Moordown,
Bournemouth.

My own gramophone equipment does not suffer from Mr Hide's problem (Letters, June) but I can suggest two remedies which I used successfully in a different situation. Both involve spraying the affected area with a stream of ionized particles, and are in widespread use in industry where electrostatic fields would otherwise be troublesome or dangerous. Besides reducing any undesired forces on the pickup, static elimination may be expected to help to keep records clean.

The first, and much the superior method consists of a radioisotope of polonium, suitably encapsulated, which emits alpha-particles. These particles are harmless to life, since they cannot penetrate the skin, but are extraordinarily effective in neutralizing e.s. fields. Packaged emitters are available on annual lease from the 3M Company, though their issue is restricted for obvious reasons, and might exclude domestic users. The annual cost is also quite high, roughly equal to that of Mr Hide's equipment.

An alternative is to ionize the air in the vicinity of the field. This may be done by applying a high alternating voltage between suitable electrodes; a commercially available assembly consists of a pointed cone surrounded by a coaxial annulus, and insulated by p.t.f.e. I used about 5kV, from an ignition transformer advertised in *Wireless World*. It is essential to limit the secondary current by inserting a resistor in the primary circuit, otherwise the electrode could kill even Mr Hide's friend's cat, if his friend has not already done so.

S. J. Pardoe,
Datac Ltd,
Altrincham,
Cheshire

## Amateur computer society

The AFACO (French society of amateur computer builders) has just been created. Coming after the US Amateur Computer Society and the English Amateur Computer Club, its purpose is to establish a link between people interested in building their own e.d.p. machines. A newsletter will be published every two months and sent to all members. To the best of my knowledge, it is the first French association of this kind. Right now we are about thirty members and I would like to be able to increase this number.

Membership of AFACO for the year July 1, 1974 to June 30, 1975 costs 30 French francs (35 for overseas members) and includes all copies of the "Bulletin de l'AFACO".

Michel Dreyfus,
Association Française des
Amateurs Constructeurs d'Ordinateurs,
42 Rue de la Barre, Villa No. 3,
95880 Enghien,
France.

## Doppler in loudspeakers

Mr J. Moir, in his article "Doppler distortion in loudspeakers" (April issue), must explain his second paragraph more precisely. The concept of a loudspeaker cone vibrating at two or more sinusoidal frequencies involves a mental mathematical (Fourier) transform. At a particular instance in time, an element of the cone can only be in one spatial position. If we try to draw graphically the combined effect of several sinusoidal coil currents on the cone, we make the same transformation as the transducer to arrive at a single complex waveform. This is the actual wave performed by the cone (apart from distortion). Physically the cone cannot move in any other way than that determined by the transformation.

Without disagreeing with Mr Moir's *mathematical* analysis, the Doppler effect is also *physical* and must be explained by physical movement. Unless this is seen to be the case, some of us will still contend that Doppler effect in loudspeakers does not exist.

David H. Edgar,
Ascension Island,
South Atlantic.

## Electronic piano design

I was pleased to read Mr Cowie's series of articles "Electronic piano design", which should appeal to a great many readers. However, I feel that many will not part with the £70 required to construct this instrument without a critical review of the circuits, especially since there is considerable circuit duplication.

I consider that this particular design can be improved in both technique and cost, and I would suggest that the serious constructor consults recent literature before starting this project. The booklet *Integrated Circuits for Electronic Musical Instruments, 1973* from ITT Semiconductors, Foots Cray, Sidcup, Kent, is one such example. This is a useful, practical booklet, giving background information and alternative approaches to that described in Mr Cowie's article but using modern electronic techniques, and it also describes some purpose-built integrated circuits intended for electronic musical instruments.

On the scheme of cost reduction the 12 tone oscillators could be replaced by simpler circuits. One alternative is to use the dual op-amp type 747 instead of the 741, thus reducing the number of i.cs by six. A more cost effective solution would be to employ just two t.t.l. 74137 hex Schmitt trigger packages. Since these will directly drive the 7493 dividers used in the design, a total of ten integrated circuits, 12 transistors, and 36 resistors would be eliminated.

Not only are simpler designs possible than the one described so far in the article, but more complex designs can be easily built with the available i.cs at about the same cost and employing techniques such as those for the formation of sound by tuned filters or by sound synthesis.

Keith Mitchell,
Maidstone,
Kent.

# Flat colour television display

## Experimental device uses gas discharge to excite colour phosphors

An experimental flat colour television display device, using colour phosphor elements excited by electrical discharges in gas, has been developed in Japan at the research laboratories of Hitachi (see News of the Month, July issue). Measuring 160mm wide and 120mm high, the panel is constructed as a "sandwich" of front and rear glass covers with, in the middle, flat strip electrodes running vertically and horizontally to form gas discharge cells where they intersect. Details of the construction can be seen from Fig. 1. The cathode strips, running horizontally, have circular holes etched in them, exposing the surface of a glass insulating layer, and within each hole a washer-shaped ring of phosphor is deposited on the glass. In the centre of the phosphor ring the glass insulating layer has a hole in it which exposes the surface of an anode strip electrode, running vertically. The cells so formed are filled with a xenon gas mixture, and the electrical discharge in each cell takes place between the wall of the cathode hole and the central anode, passing across the phosphor ring and exciting it into fluorescence.

There are 19,200 of these cells, arranged into horizontal rows of 160 cells and vertical columns of 120 cells, with a spacing of 1mm between cell centres. Along a row the colour phosphors are deposited in a red, green, blue, red, green blue sequence, and each column has the same phosphor colour in all its cells. In each cell the gas discharge takes place when a voltage is applied across the anode and cathode electrodes intersecting at that point, and the brightness of the cell fluorescence is determined by the current in the discharge. The area of the cathode (wall of the hole) is sufficient to allow a discharge current of more than 2mA. Peak luminance for the red phosphor is 9,300 cd/m$^2$, for the green phosphor 37,800 cd/m$^2$ and for the blue phosphor 4,800 cd/m$^2$.

To display a television picture on this structure the information in the television signal must be converted into appropriate patterns of direct currents to be applied to the anode-cathode matrix of electrodes. The method of doing this is shown in the block schematic Fig. 2. Red, green and blue colour signals derived from a con-

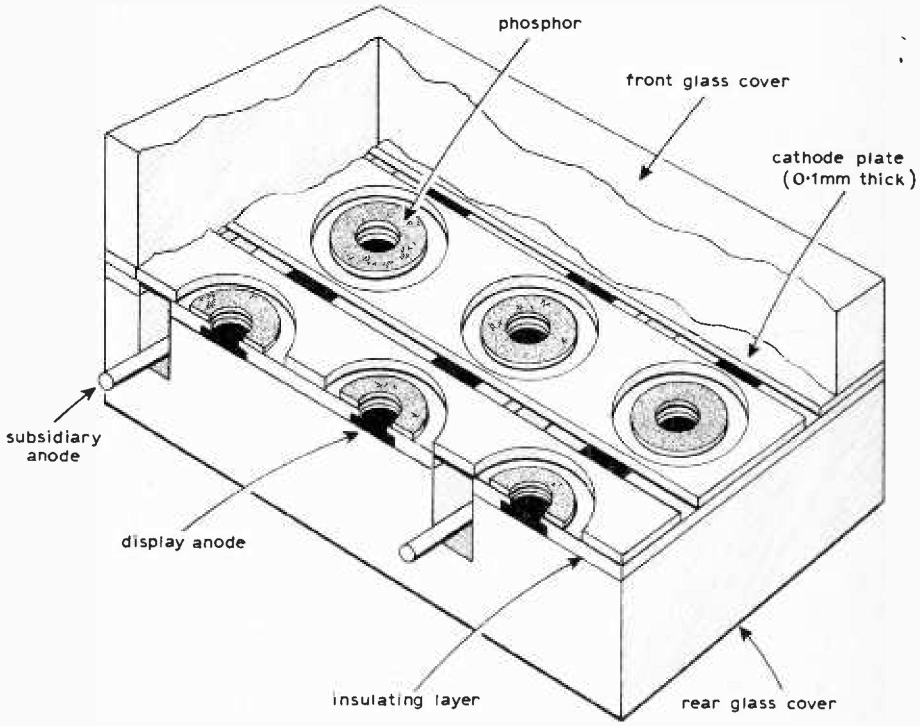
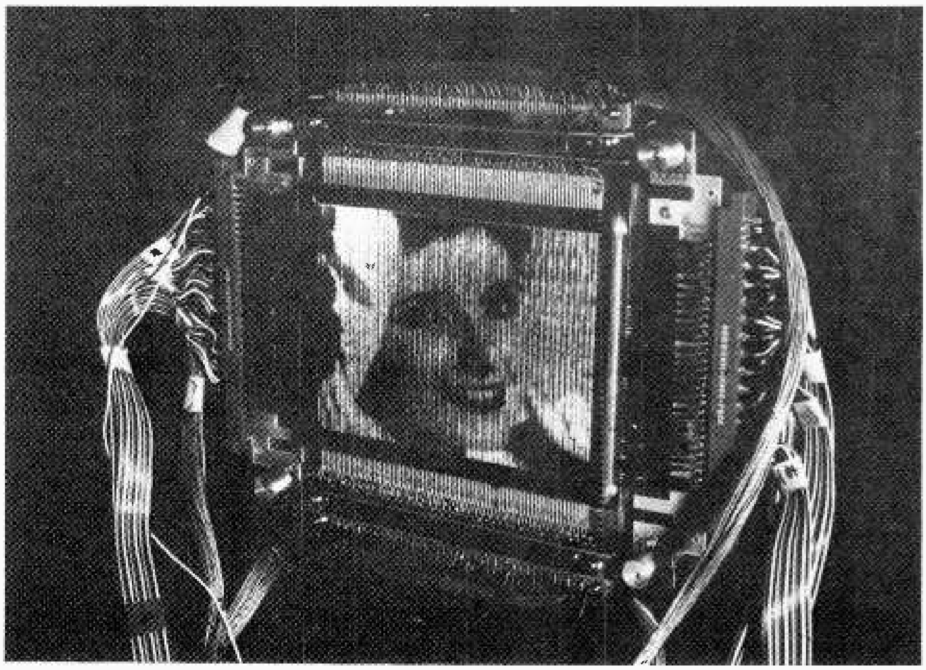



*Fig. 1. Simplified cross-sectional view of the display panel.*



*The display panel with a television test picture.*

ventional television receiver are digitized into six bits by an analogue-to-digital converter and the digital information is fed into memories sequentially. The information corresponding to one row of the display (160 cells) is read out of the memories and converted into two sets of three-bit pulse-width-modulated (p.w.m.) signals. These p.w.m. signals are made up of different combinations of three pulse lengths, 5μs, 9μs and 20μs. This allows eight combinations altogether and each combination represents a particular level of an eight-level grey scale.

The drive circuits of the display anodes are composed of two constant current sources of two magnitudes. The two sets of p.w.m. signals are connected to these sources so that modulation of the luminance can be obtained by the addition of two magnitudes of p.w.m. currents. Since the display panel has only 120 rows, half of the television picture is displayed without interlacing. A full television image is obtained by using signals of alternate horizontal lines of a field. The luminance of the display has a linear relationship to the input levels, i.e. to the total current pulse width.

In Fig. 1 the "subsidiary anode" wires produce subsidiary discharges in the grooves in the rear glass cover. Charged particles, metastables and photons generated in a subsidiary discharge diffuse throught a channel cut in the cathode electrode (not shown) into the main discharge space of each display cell. The purpose of this is to decrease the breakdown voltage and shorten the build-up time of the display discharges.

The resolution of the display is 1mm, while the area luminance (white) is 17 cd/m$^2$. Power consumption is 14 watts and the efficiency (white) is 0.05 lm/W (although a luminous efficiency of 0.5 lm/W has been obtained in a test cell using a green phosphor). The contrast ratio obtainable (between the highest and lowest display discharge light levels) is 8:1. The chromaticity co-ordinates of the colour phosphors are: red, $x=0.56$, $y=0.31$; green, $x=0.22$, $y=0.68$; and blue, $x=0.17$, $y=0.14$.

The information presented here has been supplied by Masakazu Fukushima of the Central Research Laboratory of Hitachi in Tokyo.

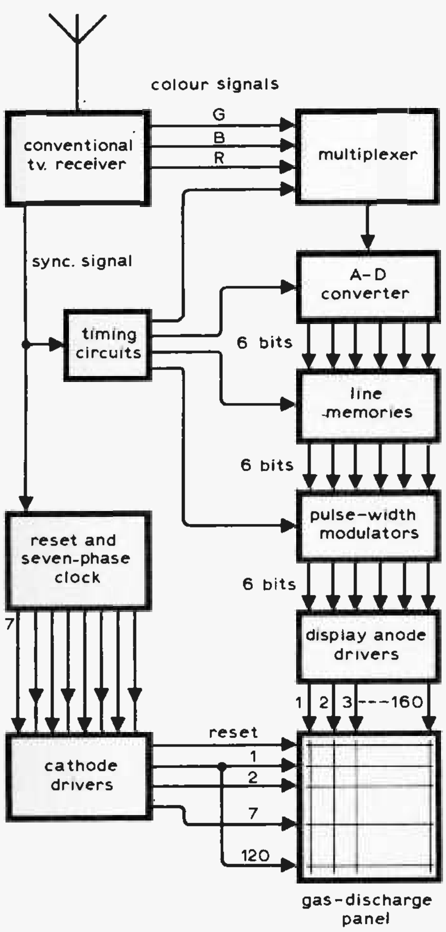



*Fig. 2. Driving system for the display panel.*

# Books Received

**Electrical and Electronic Equipment for Yachts**, by John French, is suitable for people concerned with the performance, reliability and future development of marine electrical and electronic equipment. The book is written in "layman's" language with many photographs and illustrations including maps of all the main coastal waters throughout the world which show the positions of direction finding beacons with the frequency and type of transmission from each one. There are fifteen chapters in the book each dealing with a separate topic, covering virtually every aspect of marine equipment. Price £5.50. Pp. 238. Adlard Coles, Granada Publishing, 3 Upper James Street, Golden Square, London W1R 4BP.

**Integrated Circuits and Transistor Gadgets Construction Handbook, Radio Receiver Construction using ICs and Transistors**, both by B. B. Babani and priced at 60p each. Pp. 96. Babani Press, The Publishing Division, Babani Trading and Finance Co Ltd, The Grampians, Shepherds Bush Road, London W6 7NF.

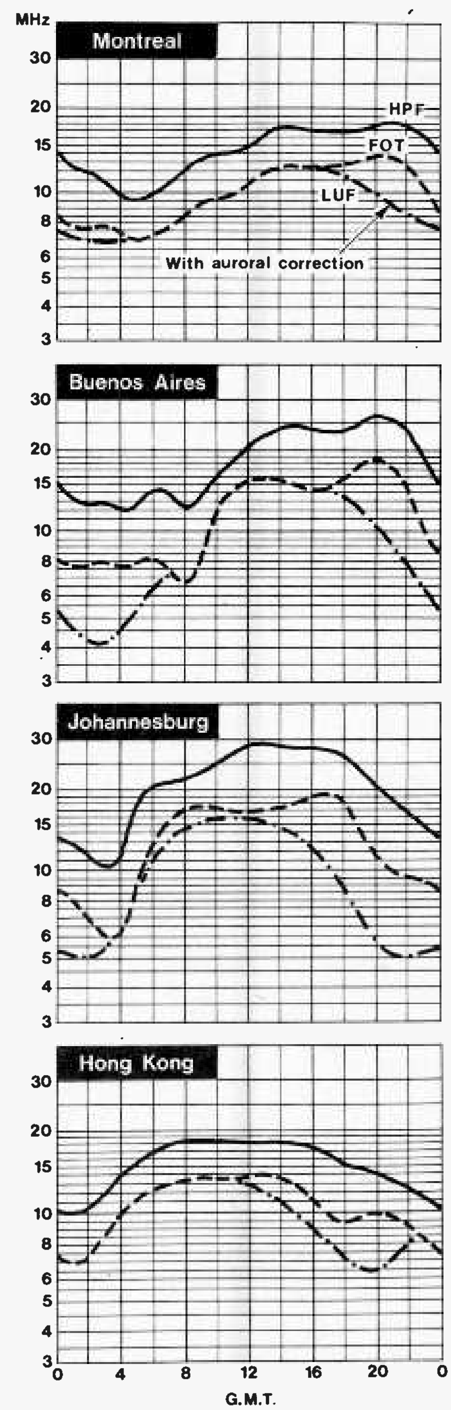
**Electronics—A Handbook for Engineers and Scientists**, by G. H. Olsen, is intended for non-specialists and those who find formal texts unsuitable. The opening chapters introduce passive components and their response to changing voltage and current. A further chapter deals with semiconductor devices. The book then goes on to explain indicating instruments, power supplies, amplifiers and oscillators. Final chapters provide an introduction to logic and digital circuits, and miscellaneous measuring instruments. Price £7. Pp. 482. The Butterworth Group, Borough Green, Sevenoaks, Kent TN15 8PH.

Six pocket data books entitled **Transistors—data table Europe band 1, USA band 3, Japan band 5, Diodes comparison tables, Thyristor Triac Diac UJT and PJT data table**, and **Transistor comparison table**, are split into four sections, each section being written in a different language (English, French, Italian and German). The books are priced from £1.25 to £1.50. Electro-Replacement Ltd, 30 Rushgrove Avenue, Colindale, London NW9 6QR.

# HF predictions for August

It should be noted that whilst HPF and FOT curves are applicable for routes tc and from the U.K. the LUFs shown are for reception in the U.K. only. This is because atmospheric noise level at a given GMT is not the same at all receiver locations. They are also dependent on transmitter power and aerial gain. The curves shown are for point-to-point services. They would be about the same for domestic reception of high power broadcasts but a few megahertz higher for the amateur service.

Generally poor conditions experienced during the past few months should improve during autumn.



# Digital meter for the blind

## A three-decade instrument with audible balance indication

by T. C. R. S. Fowler, B.Sc.
*University of Bristol*

A combined recording level indicator and d.c. voltmeter built in 1972 for a blind man was the forerunner of the instrument to be described here. In the voltmeter mode the original instrument indicates the magnitude of the voltage by the frequency of an audible output note, and a 12-way switch enables any one of twelve reference voltages to be switched in for comparison. The reference voltages rise in constant-ratio ("3dB") increments from 50mV to 2.26V, an external attenuator being used at the input to provide higher voltage ranges as required.

At a later stage, the requirement arose for a wider range of reference voltages and it was decided to select the references by means of rocker switches in a binary-coded decimal array. Resistance measurement is now made possible, the complete instrument becoming a 3-digit volt-ohmmeter costing around £15.

Instead of giving a continuously-variable output frequency controlled directly by the input voltage, the digital instrument includes a comparator which causes the audible output frequency to change abruptly, generally from a steady high note to a steady low note, as soon as the reference voltage is made to exceed the voltage being measured; only if the two voltages are very nearly equal does the output frequency "dither" in the intermediate range. All three types of output sound are clearly identifiable, even by the non-musical!

The 12 rocker switches are arranged in three columns of four, with weightings of 4, 2, 2 and 1 in each column, most significant digit column on the left. In addition, a lever bar like the spacer bar on a typewriter actuates a microswitch and enables one further least significant digit to be added and removed repeatedly and easily. Thus the full-scale reading is "10.00" rather than "9.99", and the stabilized voltage is set to 10.000V when calibration is carried out.

To take a measurement, all rocker switches are initially set to "off" (left-hand side down); a high note output should result. The switches are then operated in order, starting with the most significant "4", each being left on if the note does not change, but switched off again if the note changes. Finally a stage is reached when operating the lever bar causes the note to change. The state of the rocker switches, representing the numerical value of the quantity being measured in 3-digit decimal form, is then read by touch by the operator.

### Circuit description

Fig. 2 is the circuit diagram of the instrument with the reference voltage generator network shown in block form; the circuit of this network is given in Fig. 3, in which $S_4$ to $S_{15}$ inclusive are the 12 rocker switches, and $S_{16}$ the microswitch actuated via the lever bar.

An equivalent circuit for a reference voltage generator of this type comprises a direct voltage generator variable in steps between the terminal voltages of the stabilized power supply used and of a constant output resistance $R_0$ equal to that of all the digital-to-analogue network resistors in parallel. Here the equivalent generator is variable in 10mV steps from 0 to +10 volts, and $R_0 = 0.4R$, where $R$ is the resistor associated with the most significant "4", viz. $R_1$ in Fig. 3. (It may be of interest to note that where the extra least-significant-digit facility is provided, as by $R_{13}$ and $S_{16}$ here, the relationship $R_0 = 0.1nR$ holds for any number of decades, where $R$ is the "most significant" (lowest) resistor of the network and $n$ is the numerical value associated with it.) To keep power consumption reasonably low yet the values of $R_0$ and the highest resistors $R_{12}$ and $R_{13}$ not unduly high, a value of approximately 5000 ohms was chosen for $R$. In practice, a 4.7kΩ (nominal value) high-stability resistor, measured and found to be of 4720 ohms, was used in the prototype for $R_1$ and as the basis for all the other resistors in the reference voltage network, giving $R_0$ = 1888Ω and $R_{12}$, $R_{13}$ = 1.888 MΩ. In the prototype, a "main" resistor close to the required value was used in combination with one or more "auxiliary" resistors, in parallel, in series, or in series-parallel configurations; for example, for $R_2$ and $R_3$ a high-stability resistor of nominal value 10kΩ was used as the "main" resistor; shunting it with two resistors, nominally 470kΩ and 10MΩ respectively, gave the required value in both cases. Where, as in this example, the parallel resistors were of relatively high value, carbon film types were considered adequate.

On the 10V and 100/1000V settings, switch $S_{2A}$ connects the output of the reference voltage generator directly to the inverting input of the comparator $IC_1$ (a "741" operational amplifier). On the other ranges, resistive attenuators are used, the constant output resistance $R_0$ of the reference generator giving attenuation.

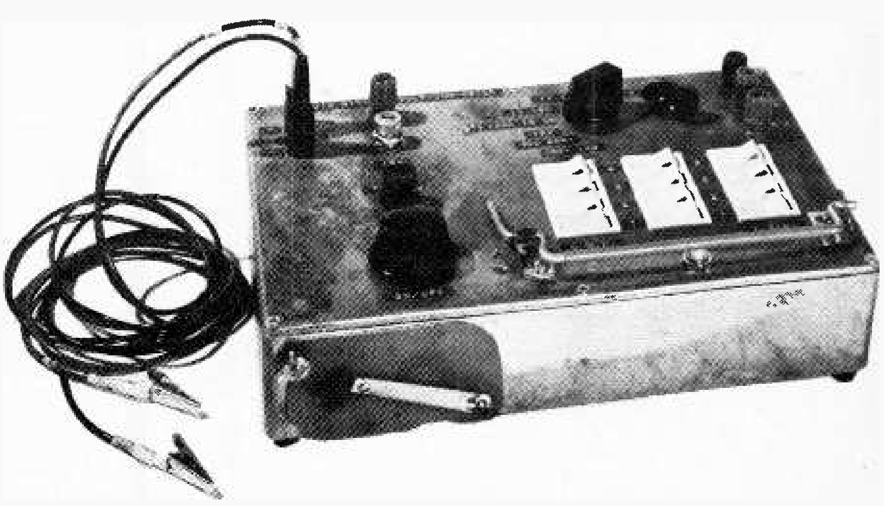


*Fig. 1. The complete instrument. The multiplier lead may be substituted for one of the crocodile clip leads.*

The voltage present between the input terminals is applied, virtually unattenuated on the 1V, 5V and 10V ranges, and attenuated by a factor of ten on the higher ranges, between the "0V" line and the non-inverting input of the comparator $IC_1$, switch $S_{2B}$ being used to make the necessary connections. On the former group of ranges the 10kΩ resistor $R_{18}$ and diodes $D_1$, $D_2$ and $D_3$ give overload protection, and $R_{18}$ with $C_2$ provide smoothing; on the higher ranges $R_{18}$ is replaced by the 1:10 attenuator network $R_{17}$, $R_{19}$, $R_{20}$, $R_{21}$ and $R_{22}$, the last two resistors providing a small positive bias voltage which compensates for the effect due to the input current of $IC_1$ and the rather high output resistance (about 200kΩ) of the attenuator network.

The input resistance on the 50V and 100V ranges is very approximately that of $R_{17}$ and $R_{19}$ in series; viz. 2.22 MΩ. For the 500V and 1000V ranges the multiplier lead is used, adding approximately 20 megohms. Thus the instrument has a resistance of approximately 22,000 ohms per volt on the 100V and 1000V ranges, and 44,000 ohms per volt on the 50V and 500V ranges.

The output state of the comparator $IC_1$ is indicated by the audible output of the instrument, which is generated by $Tr_1$, $Tr_2$ and associated components forming an astable circuit, the emitter follower $Tr_3$, and the loudspeaker. Generally, of course, the output voltage of the comparator is "hard over" at either the upper or the lower limit, and the values shown for $R_{23}$, $R_{24}$, $R_{35}$ and $R_{36}$ were chosen to give a very distinct, though not extreme, frequency change when the comparator switches. The values of the capacitors $C_4$ and $C_5$ in the astable circuit were made unequal for power economy. The tonal quality of the output sound is considered not unpleasant, although the provision of a jack socket for headphone operation as an alternative to the loudspeaker might nevertheless be a worthwhile addition.

The connection of $R_{23}$ to the "B+" line is used to give a rough audible indication of the positive battery voltage—if this is low, both frequencies from the astable circuit are appreciably lower than with the nominal 18 volts, though still remaining clearly distinguishable from each other. If the "B−" voltage is very low, the astable

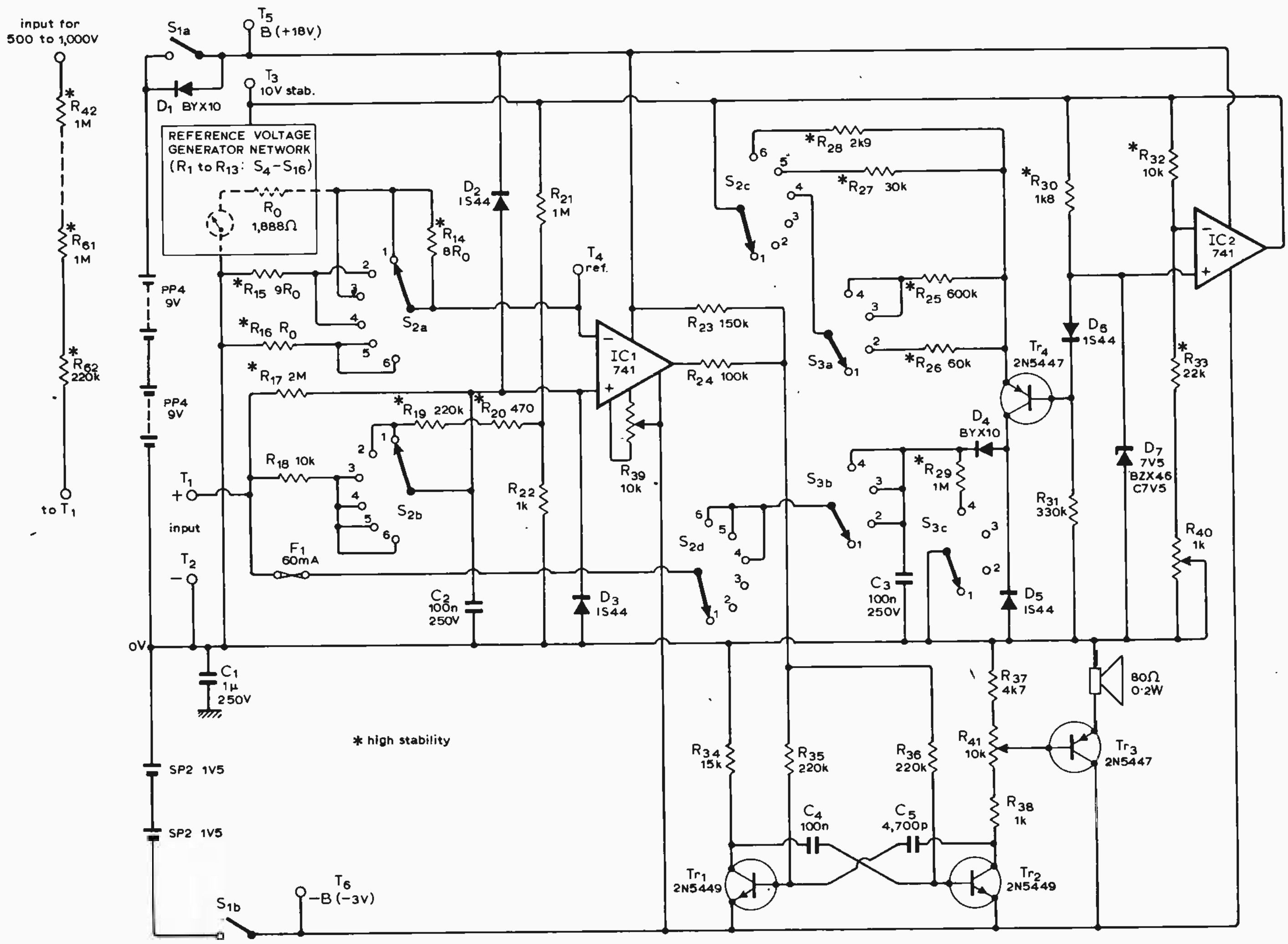



*Fig. 2. Circuit diagram of the meter. Resistors marked with an asterisk are high-stability.*

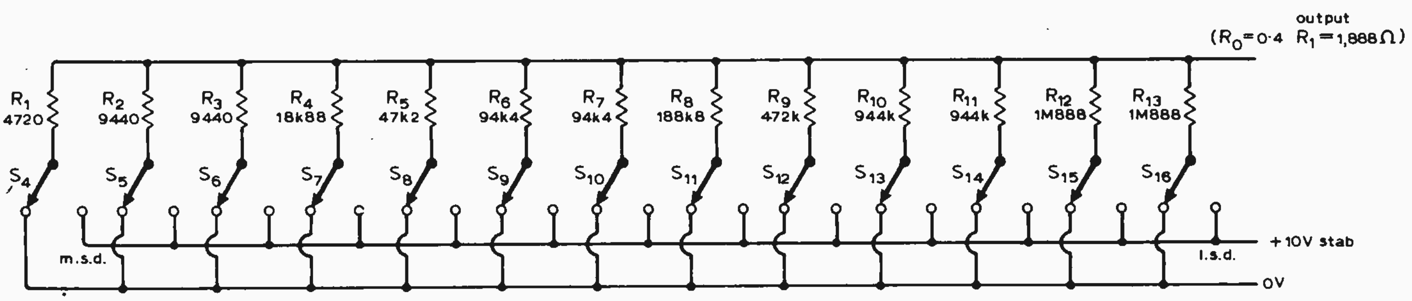



*Fig. 3. Reference voltage generator network.*

circuit will not operate. A further case of non-operation of the astable circuit should be mentioned here; it will not start if the B− voltage is switched on after the B+ voltage; this trouble can be obviated by the use, as in the prototype, of a two-position rotary wafer switch for $S_1$, the wafer contact being filed if necessary to ensure that the B− supply is always switched on first. No such filing proved to be necessary in the prototype, and non-starting has not been a problem.

The comparator offset adjustment potentiometer $R_{39}$ is set so that on all the voltage ranges, with all the rocker switches set at "off", and the input leads short-circuited, the high output note results, but pressing the bar to add one least significant digit produces the low output note. (Once set, $R_{39}$ should seldom need to be readjusted, so this trimmer is mounted on a circuit board rather than on the control panel.) The relevant reading is thus that obtained from the rocker switches when these have been set so that pressing the bar causes the output frequency to change; the extra least significant digit added by pressing the bar should not be included in the reading.

The necessary 10-volt stabilized supply is generated by means of a second 741 operational amplifier $IC_2$. Reference diode $D_7$ is nominally a 7.5V type, but in the interest of power economy it is run in this circuit at under 2mA and gives a reference of about 6.9V. The accuracy and stability of the "10-volt" line are nevertheless reasonably satisfactory, variations being typically less than ± 5 mV after an initial settling period. If a suitable digital voltmeter is available, the monitoring terminal $T_3$ and fine adjustment facility provided by $R_{40}$ on the control panel make it easy for a sighted person to check and if necessary readjust the line to 10.000V.

The reference diode voltage also controls, via temperature compensator $D_6$, the base voltage of $TR_4$ which provides at its collector the selection of "constant" currents required for the various resistance ranges. These currents are 1mA, 100μA and 50μA, respectively, for the 1kΩ, 10kΩ, and 100kΩ ranges, and 5μA for both the 1MΩ and the "HR" range. Thus the full-scale voltage is 1V on the first two of these ranges (switch $S_2$ at positions 6 and 5 respectively, $S_3$ at "R"), and 5V on the other three ($S_2$ at position 4, $S_3$ at "R", "IM" and "HR" respectively).

Since the current from $Tr_4$ on each range is not completely independent of collector voltage, it is best to trim resistors $R_{25}$ to $R_{28}$ inclusive to give the correct current when the maximum resistance for the particular range is being measured, viz. 1MΩ, 100kΩ, 10kΩ and 1kΩ respectively, using a digital current meter between the resistor and the negative ("0-volt") input terminal. Once the correct current has been set up, the current meter should be removed from the circuit (or short-circuited) to eliminate the voltage drop introduced by it; accurate measurements of resistance should then be possible. The high-stability resistor $R_{29}$ is switched in on the "HR" range; when $R_{25}$ has been trimmed to give the requisite 5μA on the 1MΩ range, switching to the "HR" range should give a full-scale reading with no external resistor connected, i.e. with input terminals open-circuited. In the prototype it was preferred to set the current marginally on the low side, giving an open-circuit reading on the "HR" range of 0.995, so that the open-circuit reading would remain measurable even if there were a slight upward drift subsequently; using this method the quantity $x$, the reading obtained as a fraction of full-scale, referred to later, is strictly the reading divided by 0.995, but a good approximation for $x$ when close to unity is obtained by subtracting the reading from 0.995, and subtracting the result from unity, e.g. a reading of 0.975, giving a difference of 0.02, would give $x=0.98$. (If the open-circuit reading changes after a time, say to 0.997, this new value should of course be substituted for 0.995 in calculating $x$.) It might be worthwhile to add a front-panel trimmer for $R_{25}$, to enable the open-circuit reading to be set to full-scale each time the "HR" range was used, enabling $x$ to be read directly.

Diodes $D_4$ and $D_5$ and the 60mA fuse are included to protect $Tr_4$ in the event of voltages being applied when the instrument is set to measure resistance; a high positive voltage will be "isolated" by the resulting high-resistance state of $D_4$, while if a negative voltage is applied $D_5$ clamps the collector of $Tr_4$ to the "0-volt" line, the fuse blowing if the current through the diodes is excessive. The current-generating circuit is disconnected from the input terminals in all cases except those in which the two selector switches, $S_2$ and $S_3$, are correctly set for a resistance measurement.

## Choice of code

The 4,2,2,1 code was selected for use in this instrument in preference to the binary 8,4,2,1 code to make it impossible to set up a number greater than 9 in any decade, as this might be confusing. The digits 2 to 7 inclusive in each decade can thus each be set up in two different ways, which fact can be used for occasional "cross-checks", and for short cuts in getting a reading, e.g. if the first "2" has been found too large, the "1" in the same decade should next be tried, "by-passing" the second "2" switch, to save time in getting the reading.

It would appear that a 4,3,1,1 code and a 3,3,2,1 code would offer similar advantages, and there may be little to choose between these three codes from either mathematical or "hardware" considerations, but perhaps some "human factor" reason why one of the three codes is to be preferred. If it has not already been done, it would seem desirable to resolve this choice as soon as possible, so that an optimum standard code for this type of instrument can be made widely known.

## Mains power supplies

Mains-derived d.c. supplies of similar voltage, viz. nominally +18V and −3V, may be used in place of the batteries; as mentioned above, there is considerable latitude on these values, +12V and −2V being adequate. The "B+", "B−" and "−" input terminal may conveniently be used for the connections, and as long as the on/off switch $S_1$ is left at "off" the batteries need not be removed; but if the positive supply voltage to be used exceeds the battery voltage the positive battery lead should be unclipped to prevent unwanted conduction through diode $D_1$; diode $D_2$ will of course continue to give overload protection as long as the positive rail remains connected to a low-impedance voltage source.

## Construction

Fig. 1 is a photograph of the instrument, for which a die-cast box approximately 10.75×6.75×2.25 in. has been used.

All the signal terminals, switches and controls are mounted on the lid of the box, with labelling as shown for the benefit of sighted users or helpers. On the underside of the lid are the two electronic circuit boards —one carrying the d–a resistor network, the other all the active devices and associated components—most of the interconnecting wiring, and the fuseholder. The two boards have flexible lead connections and may be pivoted away from the underside of the lid for servicing, if necessary.

Only the battery housing and the loudspeaker are fitted to the lower part of the box. These are connected by flexible leads to the relevant points on the underside of the lid, so that the instrument can be operated with the lid removed and inverted for servicing, as shown in Fig. 4. A pivoted flap locked by a single knurled nut gives access to both battery housing tubes, one of which houses two PP4's for the positive supply, the other two SP2's for the negative supply. The loudspeaker is mounted facing downwards, a number of holes drilled in the base of the box, and the rubber feet which support the unit, providing an adequate air path for the sound; the speaker thus occupies no top panel space, and should also remain relatively dust-free.

For all external connections 4mm socket terminals are used. The two terminals on the left in Fig. 1 are the signal input terminals. For these two plain crocodile clip leads are provided, together with a third lead (not shown in Fig. 1) with an insulated probe clip and a multiplier box a few inches from the 4mm plug end, containing a series resistor chain which gives the multiplier lead a resistance of approximately 20 megohms. This multiplier lead is used, in either the positive (upper terminal) line or negative (lower terminal) line, as appropriate, in the measurement of positive and negative voltages in excess of 100 volts: it converts the 50-volt and 100-volt ranges to 500-volt and 1000-volt ranges. (Neither input terminal is connected to the case. Either can be so connected, as required.)

A little to the right of the input terminals are a monitoring terminal and screwdriver adjustment potentiometer for the 10-volt stabilized supply, while a fourth terminal, in the upper right-hand corner, enables the reference voltage present at the comparator to be monitored or connected to other equipment.

The two remaining terminals, also on the right-hand side of the panel, monitor the positive and negative battery voltages respectively. The instrument can be used to measure its own battery voltages, the positive one directly; the negative voltage can be measured by connecting to it the negative terminal of a 4.5-volt battery, measuring the net positive voltage and subtracting it from the external battery voltage.

## Operation

The rocker switch array and l.s.d. microswitch bar are clearly shown in Fig. 1. To the left of them are the on/off switch and volume control, and above them (i.e. further from the operator) are the two range selection switches. The right-hand range selection switch is set to the most anti-clockwise position ("V") for all voltage readings, and to the next position ("R") for all resistance ranges except "1M" (1 megohm), for which the third position of the switch is used, and "HR" (high resistance), for which the fourth, most clockwise, switch position is used.

With the right-hand switch set at "V", the left-hand range selection switch gives voltage ranges of 100V, 50V, 10V, 5V, 1V, and 1V (again), starting at the anti-clockwise limit. The first two of these ranges are converted to 1000V and 500V respectively by using the multiplier lead in place of one of the two direct input leads, as described above. On the 500V, 50V and 5V ranges the numerical value obtained from the rocker switches must be divided by two (or the switch weightings thought of as 2,1,1,½ instead of 4,2,2,1), so that the other ranges, on which the numerical value obtained is directly relevant, seem likely to be preferred except where maximum resolution is required.

With the right-hand range selection switch set at "R", resistance ranges of 1000 ohms, 10,000 ohms and 100,000 ohms are obtained from the left-hand switch set at positions 6 (most clockwise), 5 and 4 respectively. For the 1 megohm and high resistance ranges the left-hand switch is set at position 4 and the right-hand switch at "1M" or "HR" as required.

Measurement of resistance is straightforward on all but the "HR" range, i.e. the rocker switches having been set and read, and the position of the decimal point determined according to the range in use (as in voltage measurements), the numerical value obtained is a reading in ohms of the resistance connected between the input terminals. On the "HR" range the same constant current supply is used as on the 1 megohm range but, as $R_{29}$ is included in the circuit, the reading obtained represents the resistance of this and the external resistor in parallel, from which the value of the latter can be calculated ($R = x/(1-x)$ megohms, where $R$ is the external resistor being measured and $x$ the reading obtained as a fraction of full-scale). This method is used to avoid the necessity for an even lower constant current supply on the "HR" range than the 5 microamps required on the 1 megohm range, as ideally the current used should be large compared with possible variations in comparator input current for the latter to cause negligible inaccuracy.

| $x$ | 0.50 | 0.667 | 0.75 | 0.80 | 0.833 | 0.875 | 0.90 | 0.95 | 0.98 | 0.99 |
|---|---|---|---|---|---|---|---|---|---|---|
| $R$ (megohms) | 1 | 2 | 3 | 4 | 5 | 7 | 9 | 19 | 49 | 99 |

Using the expression $\frac{1}{1-x} - 1$ megohms for $R$ may be found to simplify the mental arithmetic; the "− 1" may be ignored with little error at very high resistance values. Where only a rough measurement of a high resistance is required, it may be found expedient to do a rough interpolation between a few memorized spot values on the "HR" range as shown in the table.

For the blind user wishing to avoid mental arithmetic completely, a comprehensive conversion table in braille for the "HR" range could be prepared, and might be worthwhile if many high resistance measurements to maximum accuracy were required. The "HR" range is the one rather complicated range to use on this instrument, but the facility it gives was considered worthy of inclusion.

In setting up the rocker switches according to the frequency (high or low) of the audible output, the operator performs manually a sequence of a type which is carried out electronically in certain a–d converters; this may sound laborious, but in practice proves quite quick and acceptable. A blind user has reported, after only a few days' use, that setting the switches takes very little time indeed, and has pointed out that when using his moving-coil multimeter he must allow a little time for the needle to settle before clamping it; and he considers the few seconds involved in setting the switches a small price to pay for the accuracy of the voltage and resistance measurements, which was just not available to him previously.

The readout from the rocker switches is of course of a clear and positive nature, requiring no braille labelling, and is hence readily usable also by blind people not familiar with braille, as well as by sighted people.

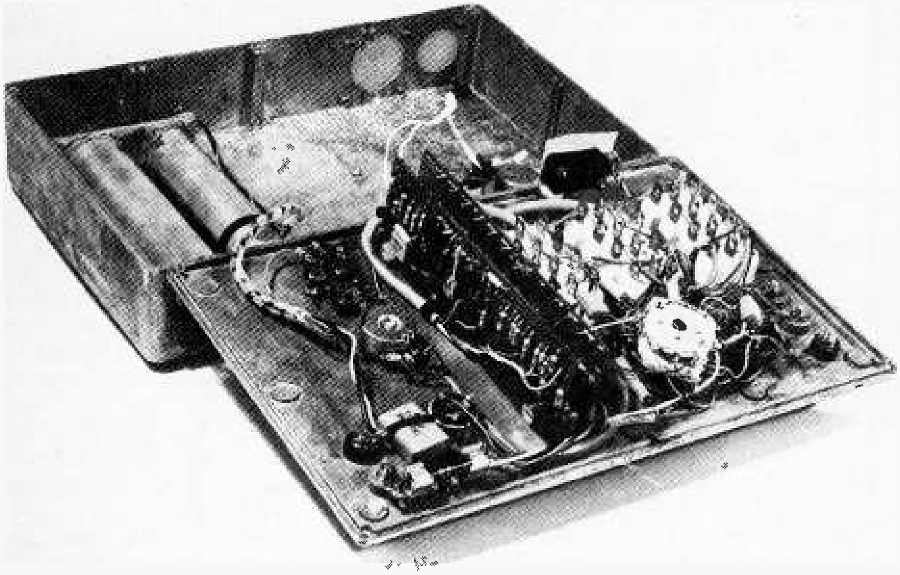


*Fig. 4. The unit can be operated when opened for servicing.*

# About people

**J. Stuart Sansom**, O.B.E., F.I.E.R.E., has been appointed director of studios and engineering at Thames Television. Mr Sansom began his career in television in 1953 with a firm working on the development of high-quality telerecording systems, joining Television Wales and West in 1957 to become head of maintenance. He later went to ABC Television as head of development, in which capacity he was involved in the investigations into colour television systems prior to the final choice of PAL. He became chief engineer of Thames in 1966, and was appointed technical controller in 1970. Mr Sansom has served on many committees, including the EBU Technical Committee.

*J. Stuart Sansom*


Five years ago came the now legendary message of July 20, 1969, 4.17.40 p.m. Eastern Daylight Time, "Houston, Tranquility Base here. The Eagle has landed". Less than seven hours later, Neil Armstrong cautiously placed his foot on the moon and was joined after a few minutes by Edwin Aldrin. More than two hours were spent on the lunar surface, taking photographs, collecting rock and soil samples and deploying scientific instruments. Forty-six pounds of the moon were collected for return to Earth.

Six Mercury flights between 1961 and 1963 proved man could survive in space; ten Earth-orbiting Gemini flights in 1965 and 1966 proved man could work in space, that he could control spacecraft to rendezvous and dock with another, that he could stay in space for up to two weeks and that he could work outside the spacecraft and do meaningful work on these "space walks". Also conducted were three unmanned flights, testing the Saturn 1B rocket and Apollo command and service modules. The price for this development has been high: $392 million for Mercury, $1.28 billion for Gemini and $21.349 billion for Apollo up to the first manned lunar landing. Three astronauts—Grissom, White and Chaffee—died in the Apollo 204 fire while testing their spacecraft on the launch pad less than a month before their scheduled Earth-orbit flight. Their deaths, the highest cost so far, delayed the programme but resulted in improvements in the spacecraft which made it a safer and more reliable vehicle.

Two lunar landings, and the four that followed in the early 1970s, gave scientists around the world a variety of sample material, photographs and electronic data that will keep them busy for years. Five of the six scientific stations left on the surface of the moon were still transmitting data when the Apollo follow-on manned flight programme, Skylab, was launched.

The 12 Americans who left their footprints in the lunar dust totalled 166 man-hours of surface exploration. They traversed almost 60 miles and brought about 850 pounds of rock and soil samples back to Earth. They left 60 major scientific experiments on the moon and conducted 34 more in lunar orbit.

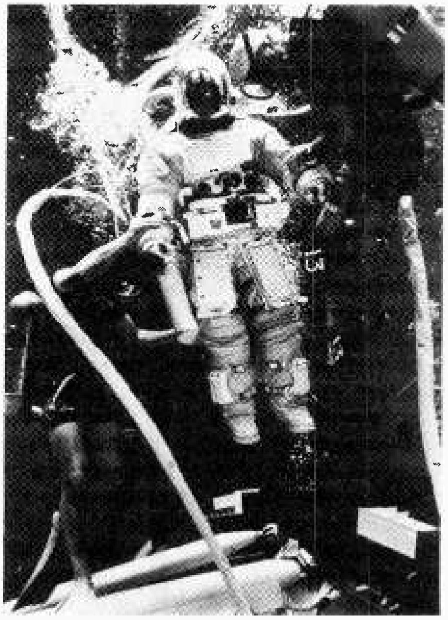
Apollo, in early planning, was scheduled for ten landing attempts, but one and then two more were cancelled because of cuts in NASA funding. Apollo's final cost—$25 billion. Some of the preliminary findings from Apollo were as follows:

- a definite and reliable lunar history time scale;
- general agreement that the dark "sea" regions are extensive lava flows and that most of the craters are projectile impacts;
- a variable magnetic field much stronger than expected and an interior also hotter than expected;
- distinct differentiation between the chemical composition of the moon and that of the Earth, a significant constraint on the theory that the moon was originally a part of the Earth. Data did not rule out, however, any of the three major theories on the moon's origin—separation, capture from circumsolar orbit, or formation from a dust cloud surrounding the Earth.

Withdrawal of funds from the Apollo programme has switched the emphasis of space exploration to deep space probes and the Earth-orbiting Skylab project, so developments are still coming thick and fast.

## Apollo-Soyuz test project

The first co-operative space venture between Russia and the United States will include in-orbit docking of a US Apollo Command Module with a Soviet Soyuz spacecraft in the summer of 1975. This will be accomplished using a docking module designed to accommodate the two spacecraft and provide a passageway from one to the other. After the docking phase of the mission, the two spacecraft and the docking module will separate. Equipment consisting of a transmitter mounted in the docking module and a receiver mounted in the Apollo Service Module utilizes two-frequency v.h.f. Doppler tracking, developed by Raytheon. The link will measure extremely small variations in separation velocities between the two modules as they gradually drift apart out to 500 kilometres. This technique, known as low-low satellite tracking, will enable small anomalies in the Earth's gravitational field to be identified.



*Astronauts selected for a Skylab mission are assisted by scuba divers during a neutral buoyancy test to simulate extravehicular activities.*

As part of a long-term National Aeronautics and Space Administration-sponsored programme aimed at earthquake hazard assessment, these measurements will supplement other studies of the tectonic plate structure of the Earth. Movement of these plates is associated with continental drift and fault systems such as the well-known San Andreas Fault in California.

Although previous space communications have been relayed between ground stations using communications satellites, the Apollo-Soyuz project will make the first use of a satellite to relay television and other communications from spacecraft to Earth stations. The Applications Technology Satellite (ATS-F) will provide the link and will permit communications during approximately 50% of the mission and will greatly increase the amount of real-time data available to investigators on the ground as well as television coverage of the flight.

The 1,270kg ATS-F, measuring 15.7m from tip to tip of its solar panels and 8.4m in height, will carry a nine-metre parabolic steerable antenna through which Apollo-Soyuz transmissions will be relayed. Orbiting at 35,900km, ATS-F will point its antenna toward the edge of the Earth as seen from that altitude, waiting for the spacecraft to appear over the western horizon and generate a signal for the manned spacecraft to lock-on to. Apollo, using a wide-band antenna, will transmit telemetry, voice communications and live TV to the satellite. Signals will then be relayed to a ground station near Madrid, Spain, and the ground station will then relay them via other satellites to the Johnson Space Center, Houston, Texas.

## Exploring the outer planets

The traditional approach in exploring a new planet has been to begin with a fly-by mission, then an orbiter mission, and then send a spacecraft to fly into its atmosphere. However, with the experience gained by trips like Pioneer 10's safe passage through Jupiter's enormous radiation belts, as well as advances in atmosphere probe technology, scientists are now thinking about plunging directly into the atmospheres of planets like Jupiter, Saturn and Uranus. Relatively small and cheap atmosphere probe spacecraft would make it possible to take the somewhat increased risks.

The cold outer planets are believed to be made of the primordial material from which the solar system was formed. Mainly because of the low temperatures that prevail in that part of the solar system, objects can still be found where the evolution has been so slow that conditions today are not so very different from what they were at the time of their formation. By combining studies of several planets, scientists can compare and learn more about the formation of the individual planets, the formation of the solar system and the evolution of Earth.

Two spacecraft are destined for Venus in 1978. A detailed investigation of Venus's atmosphere and clouds will be conducted which could provide information leading to a better understanding of our own atmosphere. Experiments will deal with the composition and structure of the Venus atmosphere down to the surface, the nature and composition of the clouds, the circulation pattern of the atmosphere and the radiation field in the lower atmosphere. The upper atmosphere and the magnetic and radiation environment of the planet will also be studied.

NASA will use two Pioneer-class spacecraft for the mission. One of these will launch four scientific probes toward the surface of Venus and then enter the atmosphere itself, transmitting additional data to Earth until it burns up. The sister ship will have been placed in orbit around the cloud-shrouded planet about a week earlier to study the planetary conditions before entry of the probes.

The probe portion of the mission will be a bus, a large probe and three small probes. The spacecraft will be spin-stabilized, use solar power, and will weigh, including probes, about 832kg at launch. The trip from Earth to Venus will take 125 days and will include two or three mid-course manoeuvres. Like its sister craft, the Venus orbiter will be spin-stabilized, use solar cells for power and weigh about 517kg at launch. The trip from Earth will take about 190 days. The spacecraft for the atmosphere probe is scheduled to be launched in May, 1978, about three months prior to the launch of the orbiter. Both will arrive in the vicinity of Venus within a few weeks of each other in December, 1978.

By comparing the atmospheres of Venus, Mars and Earth, it is hoped to be able to construct a better model of the Earth's atmosphere for use in predicting long-term changes in climate as well as short-term effects caused by environmental pollution.

### Understanding weather patterns

Study of terrestrial weather patterns does not depend purely on probes to the outer planets. The first Synchronous Meteorological Satellite, SMS-A, was launched from the Kennedy Space Center during May. From its initial position 34,781km over the equator, just off the coast of Brazil, the satellite will transmit electronic data to produce day and night pictures of the Western Hemisphere every 30 minutes; receive and transmit environmental information from up to 10,000 manned and unmanned data-collection platforms; transmit and relay weather data and pictures to hundreds of small receiving stations; and monitor solar flare activity for future manned spacecraft and supersonic aircraft flights.

The basic payload of the spacecraft consists of a telescope/radiometer, called the Visible Infrared Spin-Scan Radiometer (VISSR), providing both infrared and high-resolution visible photography, a communications system for data collection and distribution and a space environment monitoring subsystem. Nine channels of VISSR data are transmitted from SMS over a 25MHz bandwidth r.f. link to a command and data acquisition station during the 18 to 20 degrees of satellite rotation that the radiometer views the Earth, or during 30ms of the total 600ms satellite spin period.

The received data is fed to a synchronizer/data buffer, which stores the data during the 30ms Earth-viewing time for stretching or reducing the bandwidth for simplification of handling. The Earth-viewing and 480ms stretched data-transmission times are synchronized to ensure completion of both transmissions within the nominal spin period. Telemetry and command transfer is on v.h.f. during orbit transfer and S-band on station. The VISSR operates 1.7GHz downlink and 2.0GHz uplink.

The tropics receive half of the sunshine that strikes Earth and fuels the atmosphere's circulation. Much of this solar heat is first stored in the tropical oceans and then transferred from sea to air, carried upward and transported from the tropics by high-velocity winds. These inadequately understood processes affect weather conditions all over the Earth.

Infrared heat detection photographs measure atmospheric temperatures and show colder areas as lighter shades and warm areas as darker portions of the picture. The signal is transmitted from the spacecraft and is transformed to a visual photograph by a laser which is modulated by the video signal. The film is a dry silver type, developed by heat instead of the usual liquid, and the pictures have a resolution of about half a nautical mile, compared with about two to four miles for the Automatic Picture Transmission units now in use throughout the world.

Communications and data-handling subsystems for atmosphere exploration consist of four distinct areas: telemetry, tracking, command and control and the antennas. Telemetering of the instrument and spacecraft data can be accomplished using encoders employing redundancy techniques for reliability, spacecraft clocks, tape recorders and S-band and v.h.f. transmitter.

Redundant v.h.f. transmitters telemeter data in real time and operate in the 137MHz band, employ p.c.m./p.m. and radiate a minimum power of 1W.

The p.c.m. telemetry for the Atmosphere Explorer Satellite (AE-C) was as follows: telemetry—p.c.m. 16,384 b.p.s. real time and tape record, p.c.m. 131,072 b.p.s. playback; transmitter — v.h.f. 137.23MHz, S-band 2289.50MHz, p.c.m./p.m.; encoder—main frame channels at 16 eight-bit samples per second, subcommunication channels at one eight-bit sample per four seconds and one eight-bit sample per eight seconds.

*Satellite tracking station in Raisting, West Germany.*

### Spin-off

It is cheaper to search for some kinds of weeds from 65,000 feet in the air than from the ground. A case in point is the "Dudaim melon", considered one of the worst weeds in California. It is an annual inedible variety of cantaloup introduced from India in 1953. In asparagus, Dudaim melon plants quickly grow to the tops of the 20-metre-high ferns to spread out to 100m diameter. The weed effectively smothers the asparagus to decrease yield by 60%, with a reported loss of up to $3 million annually. In one 80-acre field, interpretation of infrared photographs from a NASA Earth Resources Aircraft flight revealed a probable Dudaim melon infestation that had not been detected after 100 man hours of ground survey.

# News of the Month

## Ceefax news

The BBC is seeking Government approval to carry "real" news in its experimental Ceefax transmissions. Using the unified "system 3" Ceefax format, distilled from the original BBC and IBA proposals (see May News, page 115), the number of pages will be increased to reach 100 in the autumn. Up-to-date information such as news headlines, sports results, weather forecasts, travel news, TV and radio programmes, stock market reports, best selling records, shopping news, recipes, and a host of others including information for specialized audiences (by transmitting at arranged times) will be possible if the "pilot" transmissions are given the go-ahead. This phase of Ceefax transmissions will enable demand to be assessed for different kinds of information. Anyone who can obtain a Ceefax decoder will be able to receive the information, to be transmitted initially on all BBC1 transmitters.

Decoders using conventional t.t.l. circuits and taking advantage of all the facilities available will be expensive. But it is expected that l.s.i. chips will be available in the near future that will bring cost down by an order of magnitude. Simplifications in the decoder are possible, for example by displaying only upper or lower case characters, or by displaying just one line at a time. The pilot run should also provide manufacturers with information about what options or compromises are appropriate and possibly a whole range of decoders will become available as well as being built in to receivers.

## Pick-up in permanent magnets

New applications for permanent magnets are being developed in the applications laboratory at Mullard's Crossens magnetic materials plant in Southport. Electromagnets requiring high continuous alternating fields have until recently provided the only means of switching a magnetic field, by taking advantage of the non-permanent magnetic properties of certain materials. It is possible however to use magnetic "keepers" through which the fields of a permanent magnet can be switched by comparatively low currents lasting only a few milliseconds. The field can be concentrated through the keeper or directed through the lower surface of the magnet so that ferrous objects can be picked up or dropped at will using very low, short duration current pulses.

Of the types of magnetic components manufactured at Crossens, all are processed from basic raw materials with the exception of nickel-zinc high frequency soft ferrites where the powder is preprocessed before arrival at the plant. All ferrites are based on iron oxide with additives. The three basic magnetic materials manufactured are: Ferroxcube, a versatile soft ferrite ceramic material; Magnadur, a hard ferrite ceramic material for permanent magnets and Ticonal, the classic metal permanent magnet.

## IBA container station opens

The first of a new type of u.h.f. television relay station has recently been opened by the Independent Broadcasting Authority at Morpeth, Northumberland.

This low-power relay station on Channel 25 should improve reception on Tyne Tees Television programmes for about 9,000 people in those parts around Morpeth where reception of the high-power transmitters at Pontop Pike has been unsatisfactory.

All the transmitting equipment at Morpeth, for both ITV and BBC channels, is installed within a "steel container". This method enables much of the technical equipment to be assembled before transportation of the complete container on a special purpose-built vehicle to the site. All equipment used in these new stations relies entirely on semiconductors.

Viewers should use Group A aerials with the aerial rods vertical and carefully positioned to receive good signals from the direction of the transmitter which is about 1½ miles north-east of Morpeth.

Viewers who can receive the recently started BBC transmission from the Morpeth relay should find their aerials equally suitable for the reception of Tyne Tees programmes.

## Flight simulation developments

Four XY recorders form part of a sophisticated flight simulation system for the training of Lockheed Tristar and BAC1-11 pilots and flight engineers operated by Court Line Aviation. As the trainees sit in a detailed simulation of the aircraft cockpit, every movement of their aircraft is plotted through take-off, flight and landing.

To plot each stage of the simulated flight, the recorders can be operated in a number of modes as selected by a central computer. At the start of a flight, the console operator selects a large scale mode and the recorder plots the location of major ground features, radio beacons etc. When this is completed, the operator selects the "track" mode and the recorder is ready to plot the computerized data on aircraft movement, up to take-off. Meanwhile, a second recorder has been set to the smaller scale and plots ground features of the flight itself. Every moment of the flight is plotted on this recorder

*Engineer seen operating the remote unit of a Tellurometer microwave measuring system during winch-out of "Graythorp One", the world's largest oil rig, on the first stage of its 250-mile journey to BP's Forties Field.*

until the trainee pilot reaches his landing approach. Then the first recorder comes in again to record landing at the larger scale and the second recorder changes over to plot his glide-slope down to the runway also at the larger scale. In the de-briefing room, four charts are available for discussion, showing all aircraft movements including its actual position in a simulated crisis situation compared to the theoretically correct position. The system was manufactured by Redifon and uses Bryans Southern recorders.

## Design Council competition

An annual competition to encourage the art, science and practice of engineering design in mechanical, electrical and electronic engineering in universities, colleges and polytechnics has been announced by the Design Council. Called the "Molins" prize, the scheme has been sponsored by Molins Ltd, precision engineers, and will be administered by the Design Council in association with the Institution of Mechanical Engineers and the Institution of Electrical Engineers. Prizes will be given annually and the competition will be open to students (excluding postgraduates) following diploma or degree courses in engineering, engineering science or related disciplines at a university college or polytechnic in Great Britain. Each college will be allowed only one submission per year and three principal prizes of £500, £250 and £100 will be given. Full details and submission forms for the competition can be obtained from Anthony H. L. Key, The Design Council, 28 Haymarket, London SW1.

## Audio exhibitions merger?

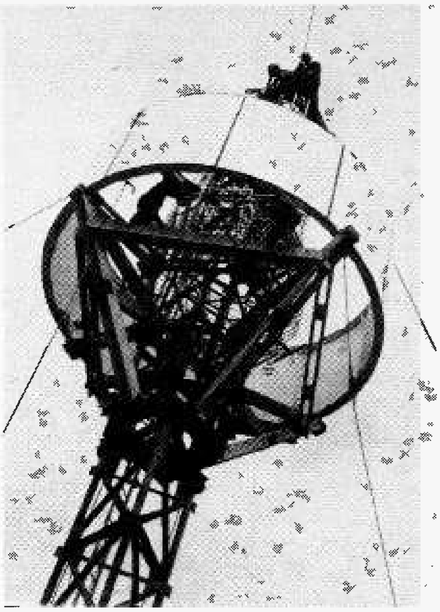
It has been decided at an open meeting held by British Audio Promotions Ltd, to set up a committee to organize a united representative audio show next spring. This year's spring show near London Airport was split into rival factions, Sonex and a new group known as Hi-Fidelity '74. It was agreed at the meeting that dissension did not serve the needs of the manufacturers, importers or, least of all, those of the consumer.

## Bus monitoring system

It takes more than a time-table to run 900 buses and transport 560,000 passengers daily. Dublin, like any other large city, has a traffic problem and, although the existing radio control system has improved traffic communications in vehicles that have it fitted, a greater degree of vehicle control is required to improve traffic-flow and maintain running costs at a reasonable level. The radio control system could not be extended because of the limited radio frequencies available so, because of the large number of vehicles involved, an automatic vehicle monitoring system has been developed by a consortium comprising Storno Ltd, Digital Systems Ltd, Leasco Ltd and Digital Equipment Co.

The main problem is providing high speed "polling" of individual buses. This has been overcome by a data transmission system capable of handling high-speed information. A base computer automatically interrogates each bus in service every two minutes via a radio link. A data store in the bus automatically responds with the vehicle's location and other relevant information. This is then stored in a second computer and, on request from a human traffic controller, the information is transmitted over telephone lines to a visual display unit at each garage. The visual display unit shows a map of the route requested, together with the scheduled and actual position of each bus on that route. The controller thus obtains instant warning of buses running too close, those running behind schedule, traffic jams, breakdowns and so on, and remedial action can be taken through the two-way radio telephone link direct with individual buses.

The automatic vehicle monitoring system is now being installed and a pilot scheme will be in operation by April 1975. By 1976 it is expected that the entire Dublin bus fleet will be equipped.



*Riggers at work positioning the antenna elements in the first ring of a v.h.f. array which EMI is building for the third-of-a-mile high communications tower in Toronto, Canada. When completed, the antenna complex will radiate most of Toronto's f.m. and TV broadcasts.*

## IBC 1974 breaks new ground

The organizers of the International Broadcasting Convention feel that the event this year is even more international than ever before. Describing it as an industry event organized by the broadcasting industry, they announce that 40% of the papers given will be by overseas authors. This year's Convention has a higher-than-usual proportion of papers on sound broadcasting (25%), with E. M. Tingley's paper on the work of the EIA National Quadraphonic Radio Committee (USA) in assessing multichannel broadcast systems promising to be one of the most interesting.

Session topics include studio operations (includes dummy-head stereo), signal origination (includes Ceefax/Oracle), satellite broadcasting, recording and storage, service planning, transmitter monitoring and testing, transmitter and transposer design, and maintenance philosophy. As well as these "formal" sessions, there are less formal specialist ones on Ceefax/Oracle, service planning and quadraphony. The Convention will be held at Grosvenor House, Park Lane, September 23 to 27. The display area has 57 exhibitors. IBC Secretariat is at the IEE, Savoy Place, London WC2R 0BL.

## Doram dedicated to amateurs

The Electrocomponents Group, of which RS Components is a member, has established a new subsidiary company named Doram Electronics Ltd, dedicated to the needs of amateur radio, electronics and hi-fi enthusiasts. The Doram range will be described in a 64-page catalogue which, priced at 25p including postage, is available from PO Box TR 8, Wellington Road Industrial Estate, Leeds LS12 2UF. The catalogue will incorporate full particulars of each product including, where applicable, circuit diagrams, operating parameters, photographs and dimensional diagrams, in addition to the price of each individual item.

## Briefly

**New ITU member.** By its accession to the International Telecommunication Convention (Montreux, 1965), registered on May 27, 1974, by the General Secretariat of the International Telecommunication Union, the Republic of the Gambia became the 147th member country of the ITU.

**Voltage drop.** A Hewlett-Packard vector voltmeter fell (accidentally) 180 feet from a BBC aerial mast. When it was plugged in and switched on, it was found to be working perfectly.

**Crystal ball.** Readers may have noticed the APRS (Association of Professional Recording Studios) exhibition reported in the July issue was labelled 1975. We are not really clairvoyant as this took place in June.

**Yo yo-ing egg prices.** R. Whittaker, secretary of Thames Valley Eggs, was outright winner of the accountants' Dial a Computer competition for his plan to help stabilize egg prices by using a computer terminal to accurately forecast egg production.

# What is e.m.f.?

## Can it be distinguished from p.d.?

by M. G. Scroggie

A curious thing about the subject of electricity (and magnetism), on which most of what appears in this journal depends, is that the more elementary and fundamental the aspects of it the less likely are you (and I mean you) to be able to give a clear account of them. This is hardly surprising, because so many teachers and textbooks are hazy and contradictory in this area. In part this is because education is, as someone has pointed out, a process of diminishing deception. One does not simply begin at the beginning, go on to the end, and then stop. The way two-year-olds are taught English at home lacks some of the finer points that will be included when they go over the ground again and again at school and university. Some of the grammatical usages that were accepted from us in infancy would have been blue-pencilled if they had appeared on our exam papers. What distinguishes the subject of electricity is that by the time students get on to practical applications they are so often too involved in them to go back to the beginning and learn the basics properly.

This line of thought was stimulated by the discovery that someone whose name is a respected household word in *Wireless World* and beyond, and who has made world-famous contributions to circuit design, was baffled by my description of what happened in a circuit consisting of a coil in a steadily changing magnetic field connected to a resistor (Fig. 1). He saw it in *Phasor Diagrams*, Appendix 1, where I had tried to justify my assertion that no generally accepted distinguishing line between electromotive force (e.m.f.) and potential difference (p.d.) existed. (Incidentally, in the eight years since the book appeared no one has ventured to refute this claim.)

To enable you to amuse yourselves with the game of "Beat the Expert" I quote in full the passage that puzzled him:

> "Looking at Fig. 1 let us suppose that a magnetic field linked with the turns of the coil L is steadily growing at such a rate that the electric field strength it creates in the wire, multiplied by the length of the wire, is equal to 10 volts, positive at the A end. Electrons in the wire are consequently attracted towards that end, causing a surplus there and a deficiency at B. In other words B becomes positively charged with respect to A. The surplus electrons find their way through R to B, constituting a positive current from B to A. This increases until the p.d. across R falls short of the 10 volts of field generated by L by only enough to leave a surplus capable of driving the current from A to B through the resistance of L. For simplicity we shall assume this is zero. There is then no resultant electric field in L. The field due to B being positively charged with respect to A is equal and opposite to that due to the varying magnetic field linking L."

What confused my friend, of course, was my saying that what was generated in L was + at the A end whereas a voltmeter would show that L was + at the B end. The "electricity made easy" books, and even some quite serious textbooks, make no attempt to describe in electrical terms what happens in a generator of electricity but instead liken it to a pump which can make water flow upwards, against its natural downward tendency due to gravity. Or, evading explanations altogether, they simply state as a fact to be accepted that certain things such as dynamos and batteries have this almost magical capability called, for want of a better word, electromotive force, which makes an electric current flow from − to + (inside the dynamo or battery) instead of from + to − as happens everywhere else.

The less superficial books then go on to deal with energy and power in this context. If current is found to flow into the negative terminal of a device and out at the positive (I am accepting the conventional direction of current flow as that of positive charges and opposite to that of electrons) then the device is (or contains) a generator of electrical energy. The current through a motor or resistor, on the contrary, goes in at the positive end, a fact which can be taken to show that it is receiving electrical energy and converting it into some other form such as mechanical energy or heat. Of course a bit more explanation is needed to cover the situation where a battery is being charged and the current is going in at the positive end, notwithstanding the continued presence there of an e.m.f.

This is the point at which an explanation of the difference between e.m.f. and p.d. (both reckoned in volts) is in order. It is also the point at which the books fall into hopeless disorder. If they are not inconsistent with themselves in their later chapters (and there is a strong possibility that they will be) they will certainly be inconsistent with one another.

In saying this I am not being so arrogantly critical and know-all as I may sound. The teaching of that celebrated mathematician Lewis Carroll, through the mouth of his spokesman Humpty Dumpty, governs the teaching of electrical theory: "When I use a word it means just what I choose it to mean." So if someone chooses to make "e.m.f." mean something different from another person, or even from what he himself says elsewhere, that is his privilege. But in practice it is enormously convenient if technical terms, such as this, can always be relied upon to mean exactly the same thing. We should never forget, however, that even when one standard meaning has been established, that meaning is what everyone collectively concerned chooses to make it mean; it is not something imposed on man by nature.

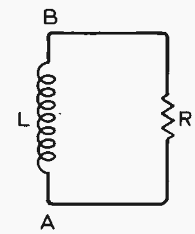



*Fig. 1 Even such a simple circuit as this can generate doubt and discussion.*

Not only are technical terms arbitrary; so are concepts. Fields, for example. We find them a very convenient concept for discussing certain observed natural phenomena. But I am sure that if there was another planet inhabited by beings having a knowledge of electricity and magnetism roughly at the same stage as our own they could well be found to account for the same facts in terms of basically different concepts.

Be that as it may, even on our earth the fact that people have different explanations for the action of basic electric circuits doesn't mean that some of them are bound to be wrong. Some people find one way of looking at a thing clearer and more helpful than another.

All this adds up to saying that I make no claim that the paragraph quoted from *Phasor Diagrams* is the one true revelation on the subject and all others are dangerous heresies. I am not at all sure that if I were coaching some simple soul having no high ambitions in the realms of electrical science I would not decide he would find the simpler and more conventional treatment adequate for his purpose, and less likely to confuse him. In that case, being free from the obligation of going into detail about the action of an e.m.f., I would undoubtedly find it expedient to follow the simplified books and show a battery rather than L. It looks simpler and more practical, being familiar to all in such things as electric torches. (But it would be the very devil to explain from first principles.)

Right now, however, I am addressing people who may be wizards at using integrated circuits but sometimes find themselves in trouble because of a hazy and half-forgotten understanding of those first principles; or anyone who finds the mere statement that an e.m.f. makes possible the reversal of the "natural" direction of current inadequate when he is forced back to those principles by an unusual problem, and who finds my quoted paragraph raises more questions than it answers.

First of all, bowing respectfully to Humpty Dumpty, I must state the facts and conventions I intend to use.

Electric charges come in two opposite kinds or polarities, conventionally called positive and negative. It is a physical fact, not a convention, that charges of the same polarity ("like charges") repel one another, and unlike charges attract. The space between opposite charges is in a peculiar state distinguished by the fact that it exerts a force on any charge therein. The name given to this state is electric field. The direction of the force on a charge in it is deemed to be the direction of the field, and is indicated in diagrams (such as Fig. 2) by lines, called lines of force. But of course these lines must not be taken to imply that the force itself has a line structure. Conventionally the direction (sense) of the field is that in which a positive charge ($+Q$ in Fig. 2) is urged by the force, and therefore (because of the like-charge fact) is from positive to negative of the charges creating the field. The strength of the field is suggested in diagrams by the closeness together with which the lines of force are drawn, and in SI units is reckoned in volts per metre. In a uniform field the p.d. between two points on the same line of force is equal to the field strength multiplied by the distance. But in general one has to integrate the product along the distance between the two points, taking account of its angle with the force.

A movement of charges in any direction is known as an electric current. $6{\cdot}24 \times 10^{18}$ electrons per second passing any point on the path of flow is a current of one ampere.

There is another way of creating an electric field, without using any charges. A variation of magnetic field strength, or the movement of a magnetic field, will do. In Fig. 3 the shaded area is a cross-section of space (occupied, perhaps, but not necessarily, by an iron core) through which a magnetic field passes at right angles. As long as the magnetic field is constant, no electric field is created by it. But suppose now that the magnetic field, of the polarity conventionally regarded as directed away from you through the paper, increases at a constant rate. At once an electric field appears anticlockwise around the magnetic field. It is strongest at the circumference of the shaded area, and decreases directly with the radial distance from it because that is how the length of the circular lines of force increases, spreading the fixed number of volts generated by the variation of the magnetic field over a greater distance. (It also decreases as the path shrinks, inside the core, because there the amount of magnetic field enclosed decreases as the *square* of the radial distance from the centre.)

Note that with this kind of electric field the well-known rule that each line of force begins from a positive charge and ends on a negative charge, as in Fig. 2, does not hold.

If, in an electric field, charges are more or less free to move because the space is electrically conducting, an electric current is caused. In Fig. 2, if the charges creating the field are not replenished from outside they will cross the field space as currents until they have neutralized one another, bringing field and current to an end. Usually only the electrons will so move, since positive charges are bound to the structure of the material, but the end result is the same. In Fig. 3, if the arrow-headed circle represents a wire ring, current will flow around it in the direction shown. (We know this because Lenz's law tells us that the magnetic field created by this induced current will tend to counteract the change in magnetic field causing it. If the magnetic field is indeed localized by a ferromagnetic core, current will flow in this core with the same effect, which is why magnetic cores are laminated to break up conducting paths.)

What happens energywise when a charge moves in an electric field (however created) is important. If it is allowed to move as a result of the field force, it receives energy from the field. In empty space (as in a cathode-ray tube) this energy gives it increasing velocity (kinetic energy), but along a uniform wire the velocity due to a constant field is constant, and the energy is given off as heat. If by any means the charge is made to move *against* the field force, energy has to be given to it. In SI units, if a charge equal to one coulomb moves through a p.d. of one volt, the energy received or given is one joule. Current is the amount of charge moved *per second*, so a current of one ampere flowing through a p.d. of one volt means that energy is received or given at the rate of one joule per second. Energy per second is better known as power, and so is its SI unit, the watt. Nearly everyone knows what follows from all this, namely that volts $\times$ amps $=$ watts, but not so many could say why.

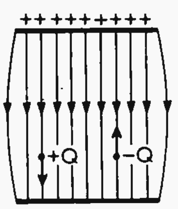



*Fig 2 The usual electric field conventions.*

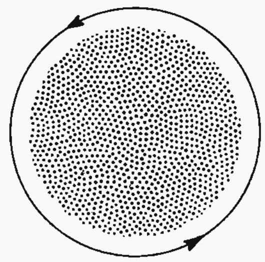


*Fig. 3 Induction of an electric field around a varying magnetic field.*

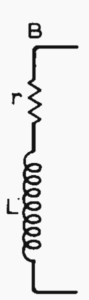



*Fig. 4 The usual way in which the resistance r distributed through L is shown in this equivalent diagram.*

Now at last we can look back at Fig. 1. L is a length of wire situated in a uniformly changing magnetic field. It is shown as a coil because a convenient method in practice would be by means of a high-permeability core through the coil and also through another coil in which current was made to grow at such a rate as to produce the prescribed result, namely a steady ten volts between A and B, positive at B, as easily checked by a voltmeter. We can say, then, that there is 10V p.d. between the horizontal leads, and therefore an electric field between them, with the upper (B) lead positively charged relative to the lower (A). L being ignored for the moment, the only route the surplus electrons in A can take under the influence of the field to neutralize the positive surplus in B is via R. So a current flows through R, conventionally from B to A. Without L it would be very short-lived and the p.d. would disappear.

With L connected, but without the varying magnetic field, and assuming L to have no resistance, the charge would have passed instantaneously through it in preference to the resistance of R. Electrons already in the L wire would be situated in the electric field created by the charges on A and B and would respond very smartly to it. The fact that when the magnetic field through L varies they do not do so, but on the contrary B remains positive to A in spite of a continuous flow of charges through R is very remarkable indeed and should lead us to consider it carefully.

A first impulse might be to say that of course there is an induced e.m.f. in L, positive at B. But further thought should convince us that is nonsense. Our voltmeter has shown that B is charged positive to A, so there must be an electric field between them, conventionally directed towards A. But in spite of this no electrons are being caused by it to take the easy route through L. The only possible explanation is that the electric field towards A due to the charges must be neutralized by an equal *and opposite* field due to the varying magnetic field. The induced field must, therefore, total ten volts, *positive at A*. The two electric fields cancel out, in L only, since that only is influenced by the varying magnetic field.

One of the things that puzzled my friend was my mention of electric fields in the L wire, since one of his recollections of electricity and magnetism was the impossibility of an electric field inside a perfect conductor. But only the theory of opposing fields (which paradoxically had also puzzled him) explains this fact.

Attentive readers will have noticed that my approach just now was slightly different from the book; in fact, exactly the opposite. This was not accidental. Teachers will probably agree that where one approach fails another may succeed. It may be that my assumption this time that B and A were already oppositely charged by some unexplained agency, however unpractical, will to some readers make the establishing of the polarity of the induced field needed to explain the observed facts somewhat clearer. The book began more realistically with the induced field, positive at A and so directed upwards. By the law of attraction between unlike charges it attracts electrons to that end and away from B until the electric field set up by them, positive at B, exactly balances the induced field in L. It does not balance it anywhere else. In particular it drives current through R, which would speedily dissipate the charges if it were not for the continued existence of the induced field in L. Even an infinitesimal drop in the charge field results in a net field in L and therefore a flow of electrons downward through it, which in a steady state will be exactly equal to that upward through R. In other words, a current around the circuit.

To clinch our understanding of this state of affairs it is instructive to consider it energywise. Suppose we have in our hand a positive test charge, $Q$. If we carry it by any air route from the A to the B lead we find we have to exert a force ("like charges repel") over that distance, and therefore impart to it a certain amount of energy. If we take the trouble to measure that energy we find it is equal to $QV$, $V$ in this case being 10. If we now let go of $Q$ it will fly back to A and hit it with the release of the energy we gave it. Alternatively, if we slip it in at the top end of R it will flow through it steadily, releasing the energy as heat, until it reaches A. When it gets to the foot of L it is able to go right up to B without our giving it any energy at all. How so? Because, of course, there is no net electric field in L. Is this then a way of beating the law of conservation of energy? Not at all; the energy comes from whatever is keeping the magnetic field steadily growing.

The basic principles having, I hope, by now been made clear to all, we can proceed to do away with one unrealistic assumption, namely, that L has no resistance. (Actually in these days it is not altogether unrealistic, as superconductivity is being introduced into practical electrical engineering, but most of us expect some internal resistance in our sources of electricity.) The modification is quite simple. We can treat L as a resistanceless source in series with a resistor $r$ (Fig. 4). Although L still generates its full 10V, this is divided between $r$ and R, so the p.d. between A and B is less than 10V.

Actually, of course, $r$ is distributed along L, but the principle is the same. We have already seen the extreme case of this, in Fig. 3, if the ring is a uniform wire. Throughout its length there is a uniform anticlockwise induced field, which makes the electrons in the wire go round and round clockwise. But there is never any net redistribution of charges, so no charge electric field, so no p.d. between any two points on the wire. We have an e.m.f. without a p.d. If on the other hand R and L were removed from Fig. 1 leaving the leads charged we would have a p.d. without an e.m.f.

If all this makes you think that the distinction between e.m.f. and p.d. should be quite clear and give no scope for disagreement, consult any two or three dozen textbooks on this point. And finish up with the latter part of Appendix 1 in *Phasor Diagrams*. That book as a whole shows that for *practical* purposes there is no need to bother about making the distinction.

# A pocket v.h.f. transceiver

## 2. Construction and setting up

by D. A. Tong, B.Sc., Ph.D. (G8ENN)

Because of the relatively few wound coils in the transceiver its construction should be reasonably straightforward provided that full miniaturization is not attempted, and provided some previous experience of r.f. circuitry is available. Interaction between circuits in the receiver is only likely in the sections associated with $Tr_{21,22,23}$, and this is the section which requires the greatest care in layout. The same applies to the r.f. section of the transmitter. Other potential trouble areas are in the treatment of the earth returns around $IC_8$ and in the prevention of rectification of transmitter output in $Tr_1$ or $IC_1$.

Intending constructors are advised to obtain manufacturers' data sheets for all the i.cs used in the circuit, and in particular the application notes published for the SL630 and SL612[7]. The earth layout shown in Fig. 3 for the SL612 should be followed. Concerning the second point above, one needs to bear in mind that rectification cannot occur in a device unless r.f. voltages reach the junctions and that resistors make adequate r.f. stoppers but only if the leads between the resisive element and the transistor are very short. In Fig. 1 the connections from $Tr_1$ should be no longer than say 6mm. It is also good sense to construct the r.f. output section as far as possible from the modulator input. Capacitor $C_{17}$ was used in the originals to shunt away any r.f. voltage picked up on the microphone wires. These were only 3in long and inside the metal case of the transceiver. If

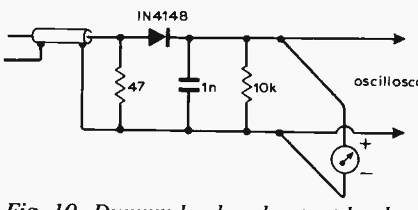



*Fig. 10. Dummy load and output level tester for the transceiver.*

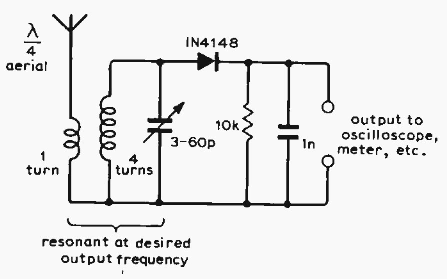



*Fig. 11. Field strength meter for setting up the helical aerial.*

an external microphone wire is used, further filtering may be required.

The circuitry diagrams (Figs. 1 and 3) may appear to show some redundant components, or rather, some whose functions are not immediately obvious. It is emphasized that the circuit is the result of several months of careful experimentation with a breadboarded system and over one year of daily operational use. Every component has at least one function and any alterations or omissions should not be undertaken lightly and preferably not at all.

### Testing and alignment

Assuming that a version of the transceiver has been constructed, the following procedure should be adopted.

(1) Do not connect the battery until testing is complete and the transceiver is working properly, because its internal resistance is low enough to cause serious damage in the event of a wiring error or accidental short-circuit. Connect the transceiver to a variable supply with variable current limit.

(2) Begin with the current limit set to 30mA and slowly increase the supply voltage from zero while depressing the transmit switch repetitively. $VR_1$ should be at the $R_{27}'$ end of its rotation and $R_{27}$ should be shorted out. This ensures that

*Fig. 15. Layout of components, through links, and some of the cross-links as seen from side A (component side) of the printed circuit board. For reasons of space, only the digits in the component identifiers are shown. Thus for example $C_{21}$ is shown as 21 and $R_9$ as 9.*

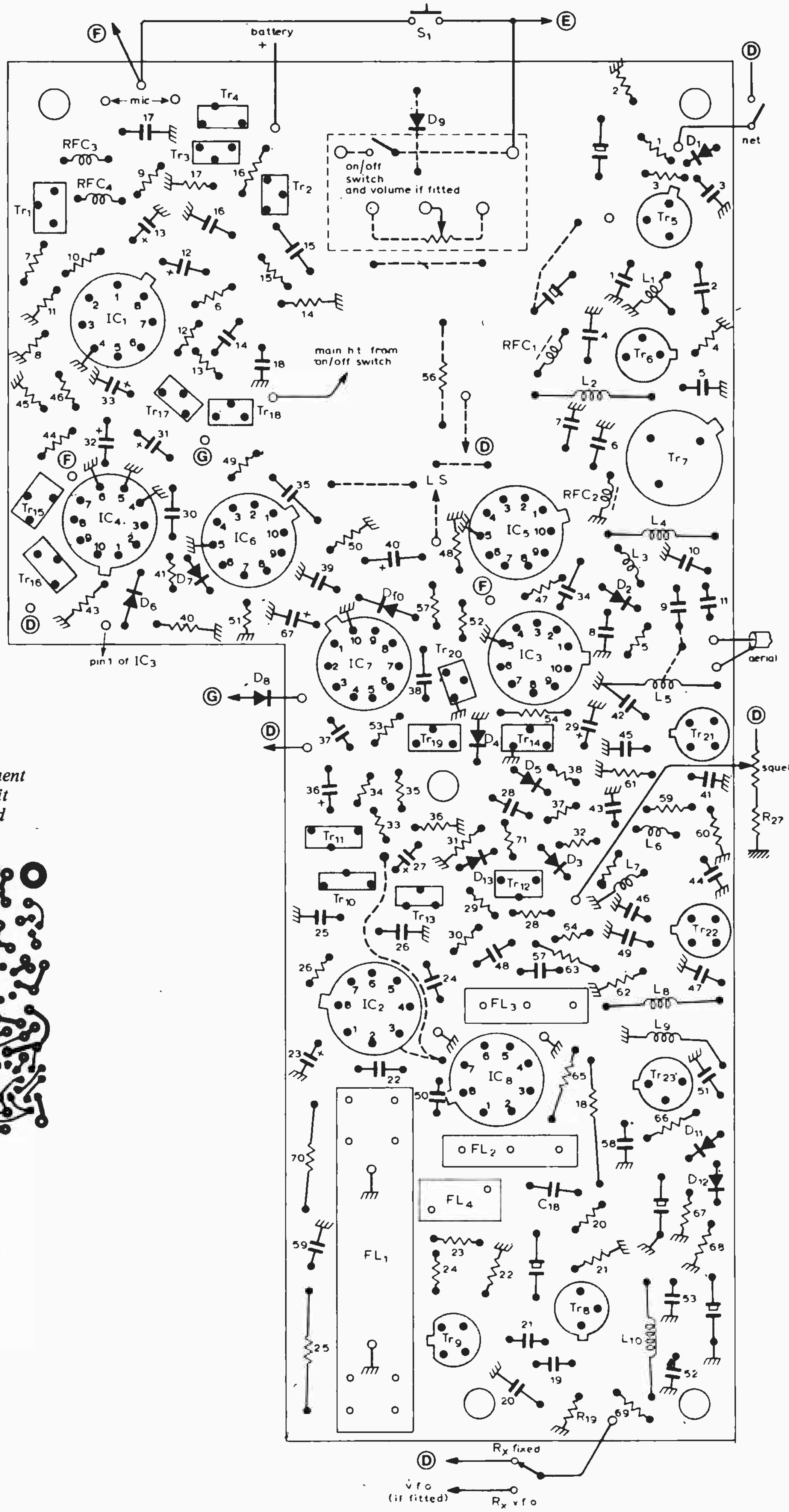
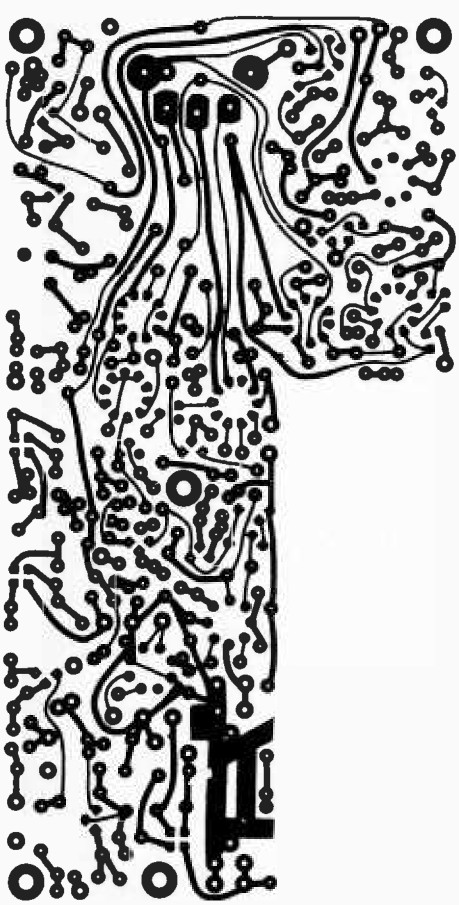



*Fig. 12. Mask for side B (non-component side) of the double-sided printed circuit board. Black areas represent unetched copper.*



the "normal" receiver mode is selected and that the receiver is not squelched. If everything is in order the receiver current will be about 25mA at 9.6 volts and the transmit current will be anything between 2 and 100mA depending on whether or not $Tr_5$ is oscillating. Hiss should be audible in the loudspeaker.

(3) Monitor the receiver's switched h.t. line (e.g., at one terminal of $VR_1$) using a voltmeter and mute the receiver by rotating $VR_1$. (If muting is impossible, reduce $R_{28}$; see step 15.) After about ten seconds the voltage should drop rapidly to zero, and then "blip" on for about 200ms every three seconds. This oscillation should also be visible on the light emitting diode.

(4) Rotate $VR_1$ to its other extremity (i.e., unmute the receiver). At the next receiver "on-period" the receiver should latch on, the h.t. should remain high, and the receiver should bleep until the transmit button is pressed momentarily. After this the receiver will still remain on but instead of the "bleep", background noise will be audible and will be affected by the setting of the volume control.

Assuming that everything so far is working correctly, the receiver r.f. sections should next be aligned as follows.

(5) Adjust $L_{10}$ until oscillation occurs as detected by an external receiver, or by a sensitive absorption wavemeter lightly coupled to $L_{10}$, or by a sudden change in the receiver noise level. (If $L_{5,6,7,8,9}$ are far from the correct tuning point, the change in noise level may not be perceptible.) The setting is quite critical.

(6) Adjust $L_9$ for maximum local oscillator injection (i.e., maximum receiver output with a modulated input signal).

(7) Adjust $L_8$ as for $L_9$. The tuning is much sharper since $L_9$ is heavily damped by $Tr_{23}$ collector.

(8) Peak $L_7$, $L_6$, and $L_5$ at the desired operating frequency.

(9) The physical separation between $L_6$ and $L_7$ should be just greater than that which gives maximum output signal from the receiver (the a.g.c. voltage at pin 7 of $IC_2$ gives a useful indication of signal strength).

(10) The separation of $L_8$ from $L_9$ affects the receiver gain and should be set so that front-end noise in a fully aligned receiver just fails to initiate a.g.c. action.

(11) After each alteration to the separation of $L_{6,7}$ and $L_{8,9}$ their tuning should be reset. The process is iterative.

(12) If the r.f. tuning has been carried out correctly the receiver output noise level will be high and will vary markedly as $L_{6,7,8}$ are tuned and to a lesser extent as $L_5$ and $L_6$ are tuned.

(13) Final precise setting of the local oscillator frequency is carried out by fine adjustment of $L_{10}$.

(14) Remove the short from $R_{27}$ and check the range of control of $VR_1$. Normally the squelch threshold will be at about mid-rotation of $VR_1$. Reduce $R_{27}$ to mute earlier, reduce $R_{28}$ to mute later.

(15) It is likely that the threshold for the first i.f. a.g.c. line is not correct due to tolerances in $D_4$, $IC_2$ and $IC_8$. The threshold can be altered by changing either $R_{35}$ or $R_{36}$. If miniaturization is not important, they could with advantage be replaced by a potentiometer. The correct threshold is the one that gives the best compromise between signal-to-noise ratio for medium strength signals and overload on very strong signals. Monitor pin 7 of $IC_8$ while testing.

(16) The squelch control alters two thresholds; that for audio muting and that for holding "on" the receiver when a signal is detected during sampling. If the two thresholds differ noticeably, the former can be adjusted separately by altering $R_{55}$.

(17) The value of $R_{38}$ determines the extent to which the squelch threshold is unaffected by interference pulses. If overcompensation occurs its value should be increased. Conversely, if the receiver "bleeps" on interference $R_{38}$ should be reduced.

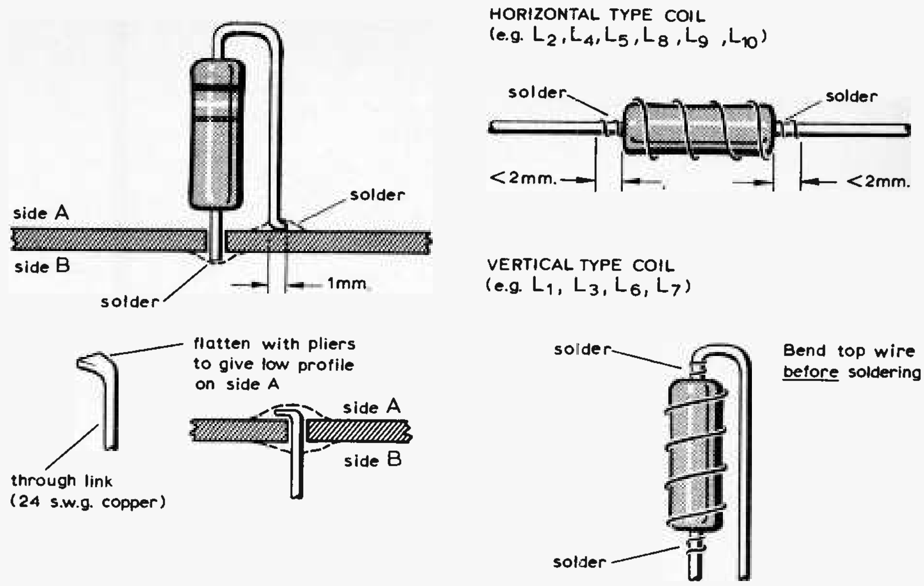



*Fig. 14. Details of soldering technique and r.f. coil construction.*

**Transmitter adjustment proceeds as follows**

(18) Set current limit on the power supply to 100mA. Connect a temporary jumper lead across the transmit switch. Monitor the transmitter frequency on a receiver and adjust $L_1$ until $Tr_5$ oscillates. This should cause the power supply current to increase considerably.

(19) Connect a monitoring circuit such as that shown in Fig. 10 to the transmitter

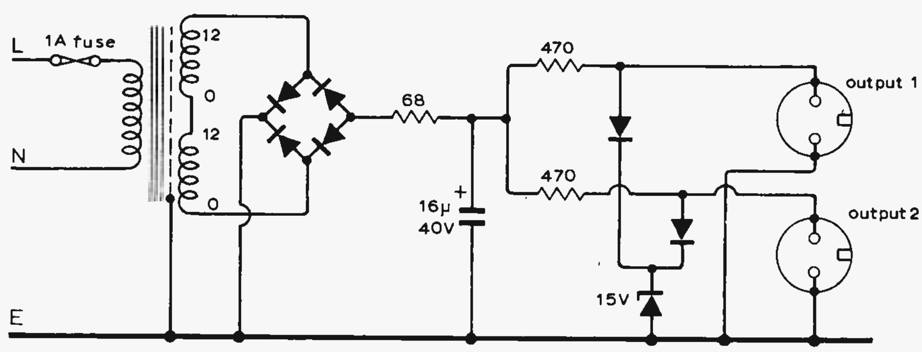



*Fig. 16. A battery charger which can fully charge two transceivers (at the correct charging rate of 20mA) in 14 hours. The zener diode ensures that the voltage applied to the set never exceeds a safe value even if the battery should accidentally become disconnected while the radio is on charge and in use.*

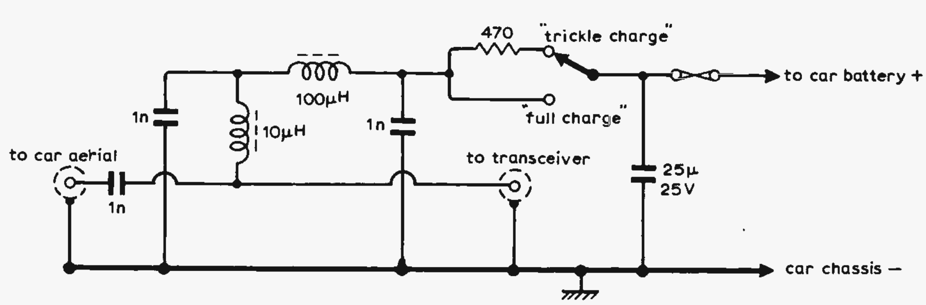



*Fig. 17. A "terminal" which allows a transceiver to recharge from a car battery via the feeder from the car aerial.*

output and if possible connect an oscilloscope to the detector output as shown. Initially tune $L_1$, $L_2$, $L_3$, $L_4$ for maximum output with no modulation then tune for best modulation linearity consistent with an output near to the maximum while whistling near the microphone.

(20) Adjust $L_{11}$ until the output frequency is exactly right.

(22) Connect the transceiver to the helical whip aerial and readjust $L_3$ and $L_4$ for best results using a field strength meter (e.g., as shown in Fig. 11).

### Miniaturization

The following details of the printed circuit layout used for the two prototypes are intended only as a guide to those interested in making miniaturized versions of the device. Such a project should definitely only be attempted by those possessed of a high degree of skill and experience. Success depends on extreme attention to detail and on rigorous checking at all stages, bearing in mind that the removal of a component from the completed board is not easy. The reliability of the finished product depends very much on the care taken in the construction of the p.c. board.

The wiring plan for the printed circuit is shown in Fig. 12 and refers to the "B-side", that is, the opposite side to that bearing the components. The component side of the board (hereafter called the "A-side") is covered by a copper earth plane which is continuous except for discs about 2mm in diameter around each component hole. These discs are removed after etching and drilling by using a large drill (e.g., number 5) as countersink. Notice that not all holes should be treated in this way; the ones that should *not* are shown in Fig. 13.

The printed circuit board (which should be made from epoxy/fibre-glass laminate with copper on both sides) represents a lot of work after it has been etched and drilled, and it is important that it is not damaged in subsequent soldering operations. It is therefore well worth checking every transistor, resistor, and capacitor with an ohmmeter before soldering them in. If any component does have to be removed, a desoldering tool of the suction type is invaluable.

Most earthy component leads are soldered directly to the earth plane on side A, but in the region around $IC_8$ an earthy section of copper on side B is used as an earth return. It is necessary to first solder in all the earthy components because there is not enough room to do so when all the other components are mounted. The earthy components are marked with an asterisk in the components list. Each component should be ticked off on this list immediately after it is fitted. There are also a number of links used to connect a copper band on side B to the earth plane on side A. These should be fitted at an early stage and are shown in Fig. 15. Mounting and soldering details are shown in Fig. 14 and the detailed component layout in Fig. 15.

It is advisable to connect resistors 28, 36, 38, and 55 temporarily on to short flying leads until their final values are

## Components List

**Capacitors**

| | | |
|---|---|---|
| *$C_1$ | 47 pF | polystyrene |
| $C_2$ | 10 pF | polystyrene |
| *$C_3$ | 470 pF | ceramic |
| *$C_4$ | 470 pF | ceramic |
| *$C_5$ | 470 pF | ceramic |
| $C_6$ | 10 pF | polystyrene |
| *$C_7$ | 10 pF | polystyrene |
| *$C_8$ | 470 pF | ceramic |
| $C_9$ | 470 pF | ceramic |
| *$C_{10}$ | 22 pF | polystyrene |
| $C_{11}$ | 22 pF | polystyrene |
| $C_{12}$ | 1.0 μF | 35V tantalum |
| *$C_{13}$ | 1.0 μF | 35V tantalum |
| $C_{14}$ | 100 pF | polystyrene |
| $C_{15}$ | 4700 pF | polystyrene |
| *$C_{16}$ | 2000 pF | polystyrene |
| *$C_{17}$ | 470 pF | ceramic |
| *$C_{18}$ | 50 nF | ceramic |
| $C_{19}$ | 68 pF | polystyrene |
| *$C_{20}$ | 68 pF | polystyrene |
| $C_{21}$ | 10 pF | polystyrene |
| $C_{22}$ | 10 nF | ceramic |
| *$C_{23}$ | 1.0 μF | 35V tantalum |
| *$C_{24}$ | 1.0 μF | 35V tantalum |
| *$C_{25}$ | 20 nF | ceramic |
| *$C_{26}$ | 10 nF | ceramic |
| $C_{27}$ | 1.0 μF | 35V tantalum |
| $C_{28}$ | 1 nF | ceramic |
| *$C_{29}$ | 0.47 μF | 35V tantalum |
| $C_{30}$ | 20 nF | polyester (miniature) |
| $C_{31}$ | 1.0 μF | 35V tantalum |
| $C_{32}$ | 1.0 μF | 35V tantalum |
| *$C_{33}$ | 1.0 μF | 35V tantalum |
| $C_{34}$ | 10 nF | ceramic |
| $C_{35}$ | 10 nF | polyester (miniature) |
| $C_{36}$ | 1.0 μF | 35V tantalum |
| $C_{37}$ | 10 nF | ceramic |
| $C_{38}$ | 10 nF | ceramic |
| *$C_{39}$ | 10 nF | ceramic |
| $C_{40}$ | 32 μF | 10V tantalum |
| *$C_{41}$ | 470 pF | ceramic |
| *$C_{42}$ | 10 pF | polystyrene |
| *$C_{43}$ | 10 nF | ceramic |
| *$C_{44}$ | 10 pF | polystyrene |
| *$C_{45}$ | 470 pF | ceramic |
| *$C_{46}$ | 10 pF | polystyrene |
| *$C_{47}$ | 10 pF | polystyrene |
| *$C_{48}$ | 50 nF | ceramic |
| *$C_{49}$ | 10 nF | ceramic |
| *$C_{50}$ | 10 nF | ceramic |
| *$C_{51}$ | 10 pF | polystyrene |
| *$C_{52}$ | 1 nF | ceramic |
| *$C_{53}$ | 68 pF | polystyrene |
| *$C_{54}$ | 4.7 nF | ceramic (sub-min) |
| *$C_{55}$ | 4.7 nF | ceramic (sub-min) |
| *$C_{56}$ | 1.0 μF | 35V tantalum |
| $C_{57}$ | 1 nF | ceramic |
| *$C_{58}$ | 1 nF | ceramic |
| $C_{59}$ | 10 nF | ceramic |
| $C_{60}$ | 10 nF | ceramic (underneath p.c. board) |
| $C_{61}$ | 1.0 μF | 35V tantalum |
| $C_{62}$ | 1.0 μF | 35V tantalum |
| $C_{63}$ | 47 pF | polystyrene |
| $C_{64}$ | 10 nF | polyester (miniature) |
| $C_{65}$ | 1 nF | ceramic (not on p.c. board) |
| $C_{66}$ | 10 nF | ceramic (mounted with short leads under p.c. board) |

Note: Components marked with an asterisk have one or more leads soldered to the earth plane.

| | |
|---|---|
| $R_1$ | 1.5 kΩ |
| *$R_2$ | 3.9 kΩ |
| $R_3$ | 270 Ω |
| *$R_4$ | 68 Ω |
| $R_5$ | 100 kΩ |
| $R_6$ | 47 Ω (determines mic. sensitivity) |
| $R_7$ | 3.9 kΩ |
| *$R_8$ | 27 kΩ |
| $R_9$ | 6.8 kΩ |
| $R_{10}$ | 12 kΩ |
| *$R_{11}$ | 15 kΩ |
| $R_{12}$ | 470 kΩ |
| $R_{13}$ | 27 kΩ |
| *$R_{14}$ | 12 kΩ |
| $R_{15}$ | 22 kΩ |
| $R_{16}$ | 4.7 kΩ |
| *$R_{17}$ | 1.8 kΩ |
| $R_{18}$ | 220 Ω |
| *$R_{19}$ | 2.2 kΩ |
| $R_{20}$ | 68 kΩ |
| *$R_{21}$ | 33 kΩ |
| *$R_{22}$ | 470 kΩ |
| $R_{23}$ | 270 kΩ |
| *$R_{24}$ | 330 Ω |
| $R_{25}$ | 2.2 kΩ |
| $R_{26}$ | 100 Ω |
| $R_{27}$ | 68 kΩ (sets range of squelch potentiometer) |
| $R_{28}$ | 220 kΩ (sets range of squelch potentiometer) |
| $R_{29}$ | 39 kΩ |
| $R_{30}$ | 27 kΩ |
| *$R_{31}$ | 1 kΩ |
| $R_{32}$ | 47 kΩ |
| $R_{33}$ | 12 kΩ |
| $R_{34}$ | 12 kΩ |
| $R_{35}$ | 6.8 kΩ |
| *$R_{36}$ | 12 kΩ (adjust for best r.f. a.g.c.) |
| $R_{37}$ | 470 kΩ |
| $R_{38}$ | 39 kΩ (sets noise compensation) |
| $R_{39}$ | 820 kΩ |
| *$R_{40}$ | 150 kΩ |
| $R_{41}$ | 4.7 MΩ (sets off-time) |
| $R_{42}$ | zero (sets on-time) |
| *$R_{43}$ | 150 kΩ |
| $R_{44}$ | 5.6 kΩ |
| *$R_{45}$ | 680 Ω |
| $R_{46}$ | 100 kΩ |
| $R_{47}$ | 470 kΩ |
| *$R_{48}$ | 150 kΩ |
| $R_{49}$ | 10 MΩ |
| *$R_{50}$ | 68 kΩ |
| *$R_{51}$ | 18 kΩ |
| $R_{52}$ | 820 kΩ |
| $R_{53}$ | 6.8 kΩ |
| $R_{54}$ | 150 kΩ |
| *$R_{55}$ | 22 kΩ (affects squelch threshold) |
| $R_{56}$ | 12 kΩ |
| $R_{57}$ | 150 kΩ |
| $R_{58}$ | 330 Ω |
| $R_{59}$ | 150 kΩ |
| *$R_{60}$ | 150 kΩ |
| *$R_{61}$ | 270 Ω |
| *$R_{62}$ | 330 Ω |
| $R_{63}$ | 1.8 kΩ |
| $R_{64}$ | 680 Ω |
| $R_{65}$ | 1 kΩ |
| $R_{66}$ | 22 kΩ (4.7K in 2-channel version) |
| $R_{67}$ | 5.6 kΩ |
| $R_{68}$ | 5.6 kΩ |
| $R_{69}$ | 680 Ω |
| $R_{70}$ | 220 Ω |
| $R_{71}$ | 470 Ω |
| $R_{72}$ | 82 Ω |
| *$R_{73}$ | 47 kΩ |

**Diodes**

| | |
|---|---|
| $D_1$ | 1N4148 |
| $D_2$ | 1N4148 |
| $D_3$ | 1N4148 |
| *$D_4$ | BZY88 C4V7 |
| $D_5$ | 1N4148 |
| $D_6$ | 1N4148 |
| $D_7$ | 1N4148 |
| $D_8$ | l.e.d. |
| $D_9$ | 1N4148 |
| $D_{10}$ | 1N4148 |
| $D_{11}$ | 1N4148 |
| $D_{12}$ | 1N4148 |
| $D_{13}$ | 1N4148 |
| $D_{14}$ | 1N4148 |
| $D_{15}$ | 1N4148 |
| $D_{16}$ | 1N4148 |
| $D_{17}$ | 1N4148 |

**Transistors**

| | |
|---|---|
| $Tr_1$ | ZTX530 |
| $Tr_2$ | ZTX109 |
| $Tr_3$ | ZTX502 |
| $Tr_4$ | BFS97 |
| $Tr_5$ | V405A |
| $Tr_6$ | BFX44 |
| *$Tr_7$ | 2N4427 |
| $Tr_8$ | ZTX109 |
| $Tr_9$ | 40823 |
| $Tr_{10}$ | ZTX109 |
| $Tr_{11}$ | ZTX500 |
| $Tr_{12}$ | ZTX109 |
| $Tr_{13}$ | ZTX109 |
| *$Tr_{14}$ | ZTX500 |
| $Tr_{15}$ | ZTX109 |
| $Tr_{16}$ | ZTX502 |
| $Tr_{17}$ | ZTX109 |
| $Tr_{18}$ | ZTX500 |
| $Tr_{19}$ | 2N5460 |
| *$Tr_{20}$ | ZTX109 |
| $Tr_{21}$ | 40673 |
| $Tr_{22}$ | 40673 |
| $Tr_{23}$ | V405A |
| $Tr_{24}$ | 2N5457 |

**Integrated circuits**

| | |
|---|---|
| *$IC_1$ | TBA221 (Mullard TO-5 version of μA741) |
| *$IC_2$ | LM 372 (National Semiconductors) |
| *$IC_3$ | MP102B (Plessey Microelectronics) |
| *$IC_4$ | MP102B (Plessey Microelectronics) |
| *$IC_5$ | MP104B (Plessey Microelectronics) |
| *$IC_6$ | MP102B (Plessey Microelectronics) |
| *$IC_7$ | SL630 (Plessey Microelectronics) |
| $IC_8$ | SL612 (Plessey Microelectronics) |

**Filters**

| | |
|---|---|
| $FL_1$ | Murata CFS-455I (Ceramic ladder filter; 455kHz) |
| $FL_2$ | Vernitron FM-4 (Monolithic ceramic bandpass filter, 10.7MHz) |
| $FL_3$ | Vernitron FM-4 (Monolithic ceramic bandpass filter, 10.7MHz) |
| $FL_4$ | Murata BFB-455A (455kHz single ceramic resonator) |

**Coils**

All coils except $L_{11}$ are made by winding s.w.g. self-stripping enamelled copper wire on to ISKRA 1/5-watt carbon film resistors type UPM033. The resistance value is unimportant provided it is greater than say 200kΩ. These resistors have dimensions 6×2.3mm.

The wire is soldered as close to the body of the resistor as possible and should be close wound initially. Tuning is carried out by stretching the coil during testing and alignment.

| | | | |
|---|---|---|---|
| $L_1$ | 8 turns, centre-tapped | $L_6$ | 6½ turns |
| $L_2$ | 8 turns | $L_7$ | 7 turns |
| $L_3$ | 6 turns | $L_8$ | 9½ turns |
| $L_4$ | 3½ turns | $L_9$ | 8 turns |
| $L_5$ | 6 turns tapped at 1.5 turns from the earthy end | $L_{10}$ | 11 turns |
| | | $L_{11}$ | 10 turns on FX1886 toroid |

**RF chokes**

| | |
|---|---|
| $RFC_1$ | 2 turns on FX1115 ferrite bead |
| $RFC_2$ | 2 turns on FX1115 ferrite bead |
| $RFC_3$ | 3 turns on FX1115 ferrite bead |
| $RFC_4$ | 3 turns on FX1115 ferrite bead |
| $RFC_5$ | A commercial 10μH choke was originally used here but a duplicate of $RFC_4$ should be equally effective. |

**Quartz crystals**

| | |
|---|---|
| $X_1$ | 5th overtone type at one-half the transmitter frequency. |
| $X_2$ | Fundamental type, frequency 10.245MHz. |
| $X_3$ | 5th overtone type at a frequency equal to ½(receiving frequency—10.700)MHz. |

All three crystals should be in the wire ended miniature holder type HC18/U.

**Controls**

| | |
|---|---|
| $VR_1$ | 100 kΩ preset linear potentiometer. "SQUELCH". |
| $VR_2$ | 5 kΩ linear potentiometer (edge-type). "VOLUME". |
| $S_1$ | push-to-make switch. "TRANSMIT". |
| $S_2$ | double-pole changeover, with centre-off, miniature toggle switch. "ON (NORMAL) /OFF/ON (NO BLEEP)". In position A the receiver is held permanently in the "bleep-disabled" mode. |

**Miscellaneous**

| | |
|---|---|
| $P_1$ | Miniature two-pin polarized socket (RS Components) used for battery charging. |
| $P_2$ | Belling Lee miniature coaxial socket type L1465 used for the aerial feed and also for battery charging. |
| Battery: | 9.6-volt, 200 mAH, nickel cadmium accumulator type 8VB18, SAFT (U.K.) Ltd., Castle Works, Station Rd., Hampton, Middlesex. |
| Microphone: | Low-impedance ex-hearing aid magnetic type. |
| Loudspeaker: | 2¼in diameter moving coil. An impedance of 35 ohms would give a better match to the SL630 output but in the two original transceivers, 8-ohm loudspeakers are used. |

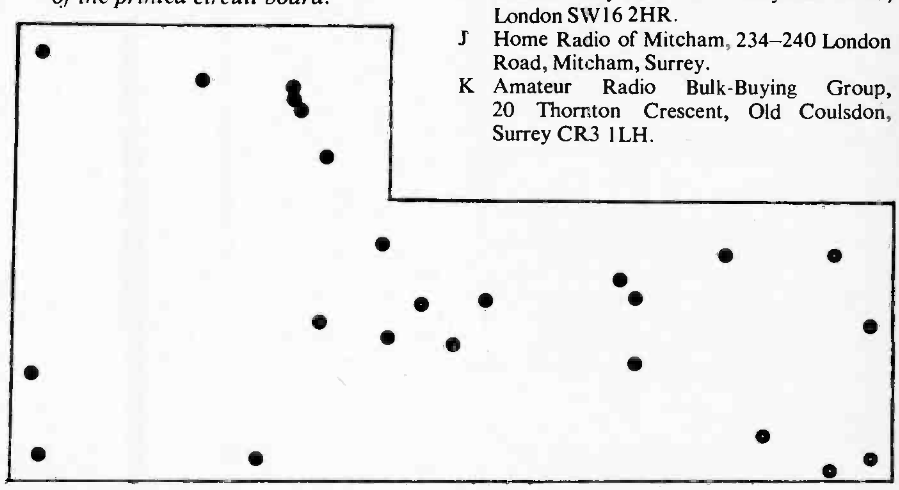


*Fig. 13. The black marks show the holes which should* not *be countersunk into the copper foil on side A (component side) of the printed circuit board.*

**Sources of components**

| | |
|---|---|
| Polystyrene capacitors: | A |
| Tantalum electrolytic capacitors: | A,B |
| Ceramic capacitors: | A,C |
| Resistors, ISKRA type UPM 033 (0.2W): | B |
| Diodes: | B |
| Transistors | |
| Ferranti types (all ZTX and BFS97): | D |
| BFX44 (Mullard), 2N4427, V405A: | E |
| 40673 (RCA), 40823 (RCA): | G |
| 2N5460, 2N5457 (Motorola) | F |
| Integrated circuits; | |
| TBA221 (Mullard), LM372 (National) | E |
| MP102B, MP104B, SL630, SL612 | E,H |
| Quartz crystals: | I |
| Filters | |
| Vernitron FM-4 | J |
| Murata CFS 4551, BFB-455A | K |

(Note: although CFS455I was used in the prototypes, the 4kHz bandwidth is a bit too narrow and the CFS 455H (b.w. 6kHz) would be better. Also the smaller and cheaper CFR 455H would give a performance adequate for most purposes. The p.c. board layout is designed to take any of these filters.)

No specific suppliers can be quoted for the remaining components but most should be obtainable through advertisers in *Wireless World* or *Radio Communication.* This also applies to the other components. Farnell and R.S. Components will only supply components against an official order from registered companies.

Key:

- A Doram Electronics Ltd, P.O. Box Tr8, Wellington Road Estate, Leeds LS12 2UF.
- B G.S.P.K. Ltd., Hookstone Park, Harrogate HG2 7BU.
- C J. Birkett, 25 The Strait, Lincoln LN2 1JF.
- D Swift-Hardmans Electronic and Automation Distributors, Hardale House, Baillie Street, Rochdale.
- E Farnell Electronic Components Ltd., Canal Road, Leeds LS12 2TU.
- F A. M. Lock, Neville Street, Middleton Road, Oldham, Lancs.
- G R.E.L. Equipment and Components Ltd., Croft House, Bancroft, Hitchin, Herts SG5 1BU
- H S.D.S.—WEL Components Ltd., Hilsea Industrial Estate, Portsmouth PO3 5JW,
- I Senator Crystals, 36 Valleyfield Road, London SW16 2HR.
- J Home Radio of Mitcham, 234–240 London Road, Mitcham, Surrey.
- K Amateur Radio Bulk-Buying Group, 20 Thornton Crescent, Old Coulsdon, Surrey CR3 1LH.

determined during testing. The horizontally mounted coils should be spaced about 6mm from the earth plane. Components which have no mounting holes and which are soldered on to the back or at the side of the board after everything else is fitted are $D_9$, $Tr_{24}$, $D_{15}$, $R_{56}$, $C_{60}$, $C_{62}$, $C_{63}$, $C_{64}$, $C_{66}$, $C_{17}$. Capacitors 25 and 61 share one mounting hole. Certain linking wires are also required on side B or A (whichever is most convenient). Some are shown dotted on Fig. 15 and the rest of the necessary external connections, also on Fig. 15.

Note that the layout drawing and p.c. master include the version of the local oscillator shown in Fig. 4, except that no provision is made for the two trimmer capacitors. Resistors 67 and 68 each have only one mounting hole on the board and capacitors 54 and 55 are intended to mount on the A side and are not shown in Fig. 15.

Space is also allowed on the p.c. layout for two transmitter crystals which were to be switched as shown in Fig. 15. Both of the prototypes eventually used only one channel for receive and transmit. The netting switch was also not used. Neither was the combined edge-type volume control and on/off switch which the p.c. board was originally designed to accept.

The author wishes to emphasize that the printed circuit layout is published purely for the guidance of skilled constructors. No responsibility can be accepted for anyone who gets into difficulties with such an intricate piece of construction, and if one has the slightest doubt about one's ability to complete the project successfully using the information given in this article and bearing in mind that a full understanding of the circuitry may be essential during trouble-shooting, it should not be attempted.

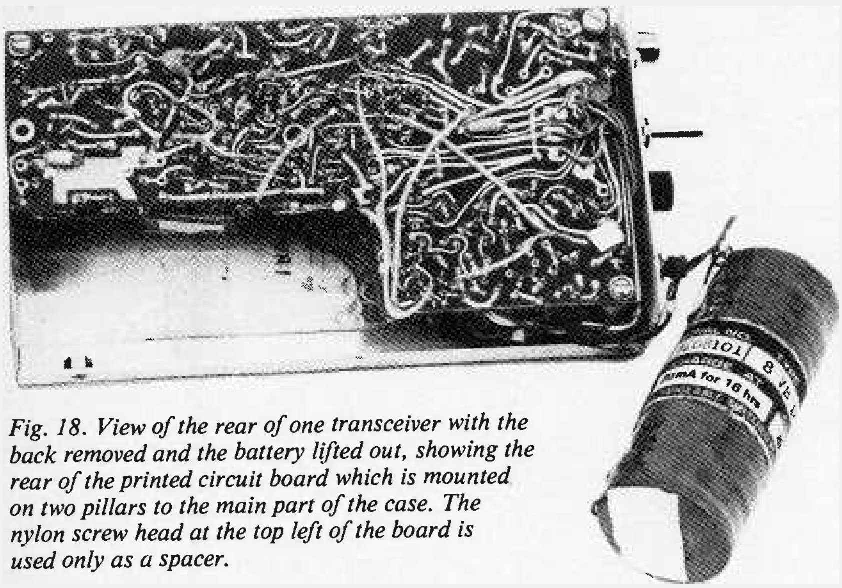


*Fig. 18. View of the rear of one transceiver with the back removed and the battery lifted out, showing the rear of the printed circuit board which is mounted on two pillars to the main part of the case. The nylon screw head at the top left of the board is used only as a spacer.*

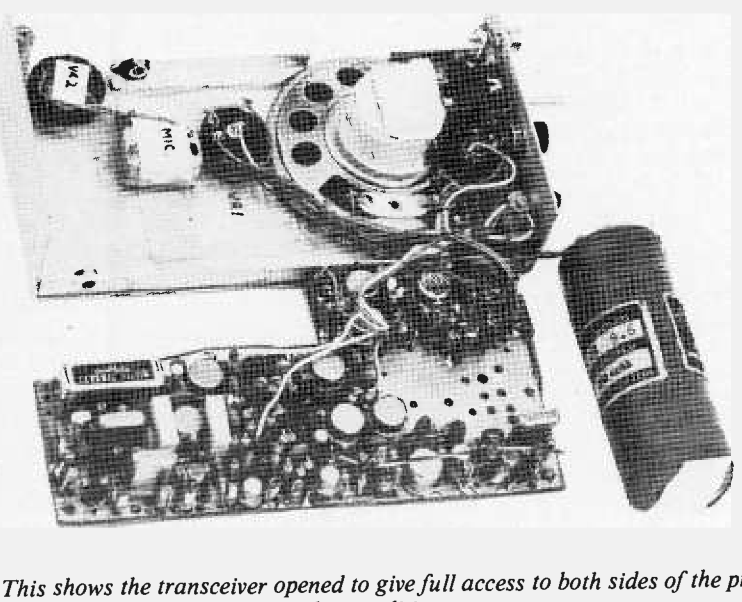



*Fig. 19. This shows the transceiver opened to give full access to both sides of the printed circuit board. It is fully operational in this condition.*

## Appendix 1. Performance figures

**Transmitter**

**Average r.f. output:** greater than 100mW.

**Modulation:** greater than 90% amplitude modulation capability.

**Speech processing:** symmetrical a.f. clipper with subsequent low-pass filter.

**Crystal frequency:** $f_{out}/2$.

**Receiver**

**Modulation:** a.m. only.

**Intermediate frequencies:** 10.7MHz and 455kHz.

**First i.f. bandwidth:** <200kHz at −3db.

**Second i.f. bandwidth:** 4kHz at −6db, 10kHz at −70db.

**A.g.c. range:** 100db approximately.

**Squelch:** Triggers reliably on signals which are too weak to be readable (<0.2μV). Compensated against impulsive interference. A rotation of the squelch control through 90° from the noise threshold setting changes the threshold to 0.6μV.

**Noise limiter:** post-detection active system mutes the receiver during noise pulses.

**Battery economiser:** On-time 200ms approx.; off-time 3 seconds. Begin sampling about 10 seconds after last squelch opening. Receiver locks "on" with inputs greater than or equal to 0.2μV. Receiver "bleeps" at full volume when a signal is received after the sampling mode has been regained.

**Spurious responses:** see following table. The first crystal frequency is 67.075MHz, and the second is 10.245MHz.

| MHz | dB | | | | |
|---|---|---|---|---|---|
| 211.92 | −72 | 211.01 | — | 10.70 | −80dB |
| 190.52 | −64 | 189.61 | — | 9.79 | — |
| 144.85 | 0 | 143.94 | −62 | 0.455 | not detectable |
| 123.45 | −42 | 122.54 | — | | |
| 77.77 | −53 | 76.86 | — | | |
| 56.37 | −90 | 55.46 | — | | |

Frequencies in the middle column represent the image response of the second mixer. They will be 62dB below the corresponding figure in the left-hand column.

## Appendix 2. Battery charging

The circuit of a battery charger which charges two of these transceivers simultaneously in 14 hours is shown in Fig. 16. It was built inside the shell of a 13-amp two-way mains adaptor and is shown in the photograph in Part 1 (July).

In a car the transceiver can be charged from the car battery via the feeder from the car aerial. The circuit of the adaptor to be fitted into the car is shown in Fig. 17. There is no adverse effect on the performance of the transceiver.

## References


1. "Hand-portable transceiver", D. A. Tong, *Wireless World*, April 1972, 154–160.
2. "Noise Silencer for AM Receivers", D. A. Tong, *Wireless World*, October 1972, 483–484.
3. "Impulsive noise reduction in radio receivers", W. Gosling, *The Radio and Electronic Engineer, 43*, No. 5, May 1973, 341–347.
4. "A battery-saving circuit for portable communication receivers", D. A. Tong, *Wireless World*, March 1972, 124–125.
5. Antennas, Kraus, McGraw-Hill, 1950.
6. "Wide-frequency-range tuned antennas and circuits", A. G. Kandoian and W. Sichak, I.R.E. National Convention Record, Part 2, Antennas and Components, 1953, 42–47.
7. SL600 Series Application Manual, The Plessey Company Ltd., Plessey Semiconductors, Cheney Manor, Wiltshire.

# Choose the right f.e.t.

## Blind use of any old f.e.t. can result in disastrous circuit performance and possibly catastrophic failure of a device. These notes should help you select an appropriate device for the six applications illustrated.

by T. Jones

*Siliconix Ltd*

### Constant current source

In one of the lesser-used applications, the f.e.t. approaches the ideal current source. Operation in the pinch-off (see Fig. 1) region results in virtually-constant $I_D$ for large variations in $V_{DS}$ and constant $V_{GS}$. This is due to the low output conductance ($g_{OSS}$) of the f.e.t. defined by $\Delta I_D/\Delta V_{DS}$. It is related to the more commonly used term "dynamic impedance" ($Z_D$) of a current source by $Z_D = 1/g_{OSS}$. For good regulation $g_{OSS}$ should be as low as possible.

Fig. 2 shows a basic current source. Resistor $R_S$ is used to set the value of $V_{GS}$ and thus the value of constant $I_D$. For a given $I_D$, the required value of $V_{GS}$ is

$$V_{GS} \approx V_p\left(1-\sqrt{\frac{I_D}{I_{DSS}}}\right)$$

which enables $R_S$ to be calculated from $R_S = V_{GS}/I_D$.

If $R_S$ is made variable, a wide range of $V_p$ and $I_{DSS}$ values can be accommodated provided $I_{DSS} \nless I_D$. However, if a nominal $I_D$ is required and trimming of $R_S$ is not practical, choose an f.e.t. with small "data sheet" spreads of $V_p$ and $I_{DSS}$.

The resultant dynamic impedance of Fig. 2 is

$$Z_D = \frac{1+R_S G_{fs}}{g_{OSS}}$$

and therefore high $g_{OSS}$ devices are desirable.

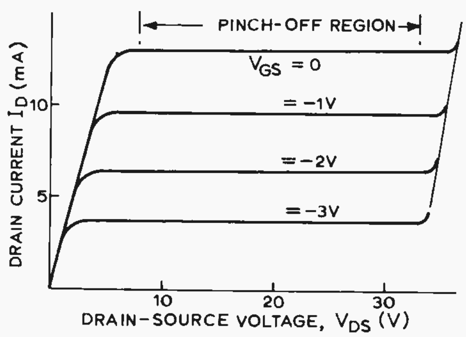



*Figure 1*

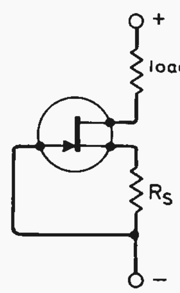



*Figure 2*

Another requirement for good regulation is that the drain-to-source voltage $V_{DS}$ is maintained above the pinch-off voltage, otherwise $g_{OSS}$ will be greatly increased (and dynamic impedance reduced). Ideally $V_{DS}$ should be at least twice the value of $V_p$. Therefore, for correct operation the total voltage across the f.e.t. and $R_S$ should be a minimum of $2V_p + V_{GS}$.

In certain circumstances the permitted voltage drop across the current source may be limited. If so, choose an f.e.t. with a low $V_p$.

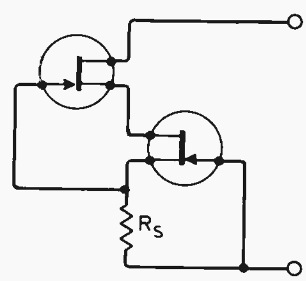



*Figure 3*

Fig. 3 shows an improved current source using two cascaded f.e.ts. The resulting dynamic impedance is

$$Z_D = \frac{g_{fs}(1+R_S g_{fs})}{g_{OSS1} g_{OSS2}}$$

### Analogue switch

Figure shows an n-channel junction f.e.t. in a basic analogue switch configuration. The on-resistance $r_{DS}$ should be as low as possible if a significant error in the sampled voltage is to be avoided. The error due to $r_{DS}$ (at low frequency) is

$$e_{in.} \frac{R_S + r_{DS}}{R_S + R_L + r_{DS}},$$

where $R_S$ is the signal source impedance and $R_L$ the load impedance.

In the off condition, the f.e.t. exhibits a certain amount of drain-to-source leakage current ($I_{D\,off}$) which gives rise to an error voltage developed across $R_L$. The error due to $I_{D\,off}$ at low frequency is $I_{D\,off} \cdot R_L$. For this reason, $I_{D\,off}$ must be correctly specified.

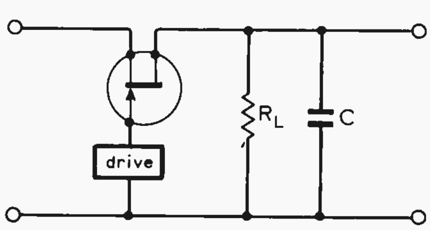



*Figure 4*

To turn the f.e.t. off, the gate must be driven negative with respect to the source by at least the value of $V_p$. Thus the required drive voltage is

$$V_{G(min)} = V_p + V_{analogue(pk)}$$

If the available drive voltage is limited, use low $V_p$ devices.

## Voltage-controlled resistor

Where operated with very low values of $V_{DS}$, f.e.ts exhibit predictable changes in $R_{DS}$ for given changes in $V_{GS}$. Under such conditions, f.e.ts can be considered as a resistor whose value is determined by the value of the applied $V_{GS}$. Hence the term voltage-controlled resistor.

This characteristic makes the f.e.t. an ideal candidate for potential divider, attenuator and a.g.c. applications. Circuit shows an n-channel junction device used in a basic potential divider. Here, the $R_{DS}$ should be significantly lower than $R_L$. The $R_{DS}$ can be defined as $R_{DSO}/(1-V_{GS}/V_p)$, where $R_{DSO} = R_{DS}$ at $V_{GS} = 0$.

As can be seen in the graph, the output characteristics are extremely linear in the region $|V_{DS}| \ll |V_p|$. This bilateral characteristic can be used to advantage for the a.g.c. of low-level a.c. signals. If, however, $V_{DS}$ exceeds 0.1 $V_p$, the output characteristics becomes markedly non-linear.

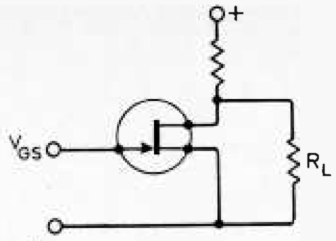



*Figure 5*

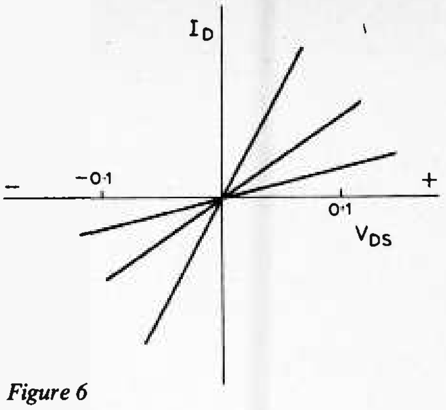



*Figure 6*

## Low frequency amplifier

Under normal amplifier operation, the gate/source junction is a reverse-biased diode which presents a high impedance to the input signal. It is this high input impedance which makes the f.e.t. superior to its bipolar counterpart if loading of the input signal is to be avoided. The input impedance can be characterized by the gate current $I_G$ which should be specified at the $V_{DG}$ and $I_D$ required for normal operation.

Circuit shows the basic common-source amplifier. The gain is

$$\frac{g_{fs}.R_L}{1+g_{fs}.R_S}$$

and if $R_S$ is decoupled at the frequencies in question by a suitable capacitor, it becomes $\approx g_{fs}R_L$.

Graph shows a typical transfer characteristic. As $g_{fs}$ is the slope of the characteristic at any given point, $g_{fs}$ is a maximum when $V_{GS} = 0$. The $g_{fs}$ at any other point on the curve can be found from $g_{fs} = g_{fs0}(1-V_{gs}/V_p)$ or $g_{fs0}/\sqrt{I_{DSS}/I_D}$, where $g_{fs0} = g_{fs}$ at $V_{gs} = 0$ and $I_{DSS} = I_D$ at $V_{gs} = 0$.

Drain current decreases with increasing temperature by approximately 0.7% degC. This phenomenon can result in undesirable variations in stage gain. Fortunately, this drift can be minimized by another effect which causes the effective $V_{GS}$ to decrease by approximately 2.2mV/degC. This latter phenomenon causes $I_D$ to increase with increasing temperature. Minimal d.c. drift will occur at the point where the two effects cancel each other. This point can be defined as $I_{DZ} = I_{DSS}(0.63/V_p)^2$, where $I_{DZ} = I_D$ for zero d.c. drift. High-$V_p$ devices must be biased to low values of $I_D$, with a resultant drop in $g_{fs}$.

For low-noise applications, care should be taken in specifying the noise performance of the device. The major contribution of noise is from $1/f$ noise. This is normally characterized by manufacturers as "en" (short-circuit equivalent noise voltage in $nV/\sqrt{Hz}$) at various spot frequencies. However, for high signal-source impedances, the effect of noise current ($i_n$) becomes significant; since, at low frequencies, $i_n$ is a function of gate leakage current, low $I_G$ is desirable. Both $i_n$ and $I_G$ should be specified at the operating values of $V_{DS}+I_D$.

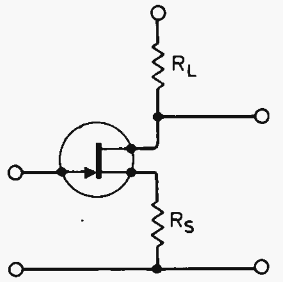



*Figure 7*

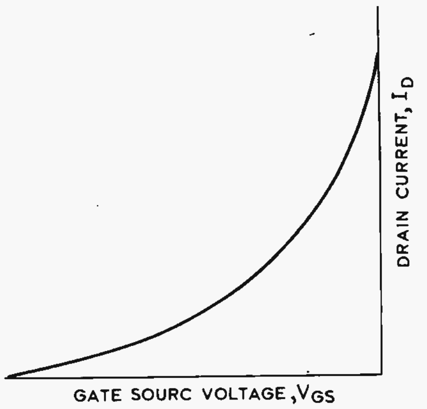



*Figure 8*

## Electrometer circuit

The high input impedance of the f.e.t. makes it the ideal choice for electrometer applications. The basic electrometer circuit shown uses two and an inexpensive operational amplifier. Transistor $Tr_1$ is a source follower with $Tr_2$ acting as a dynamic source impedance. Resistor $R_f$ sets the measuring range and $R_1$ through $R_3$ provide intermediate scaling. Choose $Tr_1$ to have low $I_{GSS}$, and the $I_{DSS}$ of $Tr_1$ and $Tr_2$ to be matched as closely as possible; although $R_4$ will null some mismatch in addition to nulling the offset of the op-amp. Typically, $Tr_1$ and $Tr_2$ would be a dual f.e.t.

The value of the feedback resistor ($R_f$) is the reciprocal of the measuring range, with a scaling factor of unity.

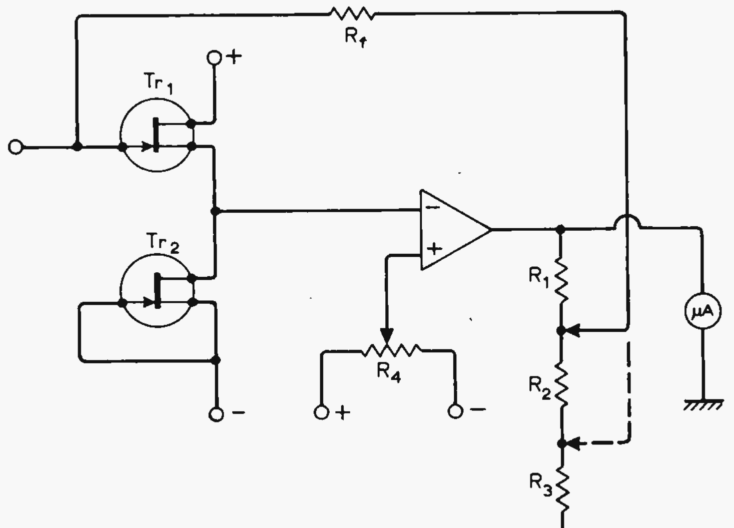



*Figure 9*

### Differential amplifier

The circuit below uses three junction devices in a differential amplifier configuration. The $I_{DSS}$, $g_{fs}$ and $V_{GS}$ of $Tr_1$ and $Tr_2$ should be matched as closely as possible; the $V_{GS}$ match should be specified at the operating value of $I_D$. If good matching is ensured, the gain is

$$\frac{g_{fs}R_L}{1+g_{os}R_L}$$

Using low $g_{os}$ devices, this approximates to $g_{fs}R_L$.

In practice, $Tr_1$ and $Tr_2$ may be either a matched pair of discrete devices or a dual f.e.t. Dual f.e.ts tend to be cheaper than their matched-pair equivalent and, with the increasing use of monolithic duals, are inherently more reliable. Also, with the two semiconductor elements in close proximity in the same package, either two-chip or monolithic, thermal behaviour is more predictable.

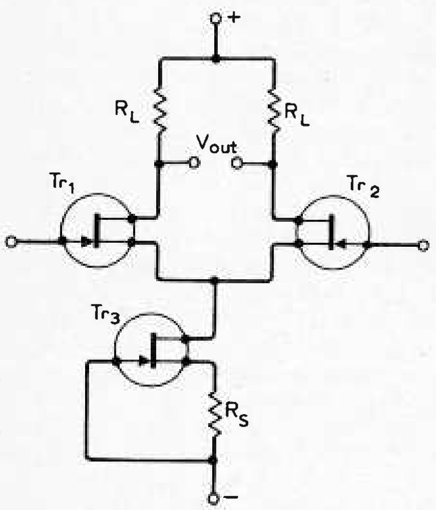



*Figure 10*

The common-mode gain of the differential stage is approximately

$$\frac{g_{fs}R_L}{1+2Z_Sg_{fs}}$$

assuming perfect matching of the f.e.ts and load resistors, and where $Z_s$ is the source impedance.

Therefore inclusion of $Tr_3$ as a current source presenting a high dynamic source impedance greatly reduces the common-mode gain. The minimum $I_{DSS}$ of $Tr_3$ must be the sum of $Tr_1$ and $Tr_2$ bias currents.

### Further reading

Siliconix application notes Field Effect Transistor Current Source, by J. S. Sherwin
FETs As Analogue Switches, by Shelby Givens
Biasing FETs For Zero D.C. Drift, by Lee L. Evans

# Salvation for city traffic

"New eyes, new ears and a new voice for drivers" is the claim for a communication system developed by Toyota known as Multifunctional Automobile Communication (MAC) which consists of four sub-systems: two to transmit danger signals to the driver, one designed to reduce congestion by helping him to choose the most traffic-free route through a crowded city area, and one offering a personal radio-telephone service.

Already tested on two prototype vehicles in Tokyo, one of the world's most congested cities, the MAC installation consists of a telephone handset (or microphone and speaker), a push-button keyboard and a visual display panel mounted near the driver's line of sight. An integrated system of high- and low-power radio transmissions links it continuously with a central control centre which acts as a "funnel", channelling routine and emergency information to the driver as well as connecting him to other telephone users, either fixed or mobile.

Warnings of fog, accidents, severe congestion or other emergencies are broadcast from a traffic control centre, from low-powered "leak" cables laid beside busy roads and motorways, and direct from emergency vehicles such as police cars, ensuring complete coverage of vehicles in the area. A receiving unit in the car continuously monitors emergency broadcasts from central and roadside transmitters, and automatically tunes and adjusts the volume of the normal car radio to relay them to the driver.

Information normally conveyed by road signs—speed limits, pedestrian crossings, banned right or left turns, etc.—is reinforced by a visual display and audible warning signal inside the car. The display unit on the two Toyota prototypes is an illuminated panel on top of the facia which can present up to 34 different messages; simultaneously a warning bell indicates the degree of danger by sounding at varying frequencies.

The signals are transmitted by loop aerials embedded in the road surface, and received by an unobtrusive pick-up coil mounted under the rear bumper.

A computerized traffic information centre collects data from several hundred key road junctions. Using his telephone keyboard the driver can simply select the code number of any intersection on his intended route, and receive a visual display of the density of traffic approaching that point from all directions. Instant information allows him to choose the best route even more effectively than regular traffic broadcasts without the interruption of other programmes.

Outgoing calls using the telephone system are made by "dialling" the number required on the push-button selector. Instead of each car having a fixed telephone number, the numbers are allocated to individual *drivers*, who can use the equipment in any car by inserting a plastic card. Incoming calls are routed to the vehicle in which the subscriber is travelling, and his outgoing calls are automatically charged to his account.

The transmission network of the MAC system, a joint project between Toyota, the Nippon Denso Company and the Japanese Industrial Technology Agency, makes maximum use of limited available channels. Two types of channel, voice and pulse-code, are used, with combinations of channels designed to cover a complete city area without mutual interference. Broadcast stations may transmit to an area, by leaky cable to a particular stretch of road, or to a single point near a traffic hazard. The system automatically switches channels when a vehicle moves from one zone to another, maintaining constant radio contact.

With attention currently being focused on alternative means of city transport, Toyota makes a final point, "The MAC system is a valuable tool for solving urban transport problems, but it need not be limited to the automobile. It can be modified and applied to many of the new transport systems now being developed around the world".

# High-fidelity Designs

One of the most popular subjects with both professional engineers and amateur electronics enthusiasts is the high-quality reproduction of sound. One of the ways in which we are constantly made aware of this is in a stream of requests for photo-copies of articles which have become standards in the field. Issues of the journal become unobtainable within weeks and, while photo-copies are useful, they are not very presentable, particularly in the way photographic illustrations are reproduced.

In an effort to ensure that these articles are available more easily, we have collected a number of them together in a new book, entitled "High-fidelity Designs". The designs we have reprinted cover the whole range of equipment needed for a comprehensive system, including tape, disc-playing equipment, radio, amplifiers, speakers and headphones. The articles treat both the design of the units and practical aspects of construction and form, in effect, a course on the design of high-fidelity systems.

The book is now available at a price of £1.00 from booksellers, or £1.35 by post from General Sales Dept, IPC Electrical-Electronic Press, Room 11, Dorset House, Stamford St, London SE1 9LU.

### Radford Electronics

We have been asked by Radford Electronics to inform our readers that Radford Electronics Ltd and associated companies have no connection with Radford Hi-Fi Ltd.

# World of Amateur Radio

## Speech processing

Although the benefits bestowed by effective processing of audio signals for s.s.b., a.m. and n.f.b.m. transmissions have been known to amateurs for many years—and the technique of speech clipping of an s.s.b. signal on its r.f. waveform to avoid in-band harmonics advocated since 1964—it is only in the past two or three years that this system has been at all widely used. Yet with careful engineering and adequate power capability of the transmitter, effective gains equivalent to about a 10dB power increase can be achieved, provided that some of the benefits of clipping (plus the disadvantages of non-linear operation) are not already being obtained by "flat-topping". A 400-watt p.e.p. transmitter (the legal limit in the UK) can be given the "talk power" of a 4kW p.e.p. rig. Good speech clipping can thus be as effective as the addition of a high-power linear amplifier.

A number of add-on systems using r.f. clipping for use with existing transmitters have been appearing on the market, several of them based on an a.f./s.s.b.-at-v.l.f./a.f. closed-loop system that allows the unit to be directly inserted between the microphone and an unmodified transmitter. A system of this type, for broadcast applications, was described at IBC70 by engineers of "Radio Liberty". For amateurs a pioneer system of this type was the very successful Comdel CSP-11 made in the United States. A recent British unit is the Datong Electronics "universal r.f. clipper" based on c.m.o.s. and op-amp integrated circuits with phasing-type 60kHz s.s.b. generation and digital r.f. phase shifter. Other r.f. clippers include a G3LLL unit specifically for the Yaesu FT101 transceiver and the RF Magnum Six.

This is a trend that provides amateurs with at least part of the benefits of the infinitely-clipped Lincompex signals of professional communicators.

## Microwave progress

The increased amateur activity on the microwave bands is significantly raising the standards of achievement. During May, members of the Barry Radio Society (GW4BRS) and George Birt (GM30XX) extended the British 10GHz distance record with a contact between Snowdon and the Cairnsmore of Carsphairn, a distance of 151.4 miles (243.6km). Both stations used 10mW Gunn diodes and 3ft dish aerials.

A few weeks later George Birt carried some 70lb of equipment almost 2,000ft up Snaefell in the Isle of Man and was rewarded with 10GHz contacts with G8BKE, St Bee's Head, England; GM3DXJ at both Abbey Head and the Mull of Galloway in Scotland; and GW4BRS again on Snowdon: four countries linked on microwaves in the same day.

Similar enthusiasm is reported from Australia where early this year Des Clift, VK2AHC (formerly G3BAK), Dave Ralph, VK2SB, and Norman Champion, VK2ZND, set up a new Australian record for the 5.8GHz band with a 59-km contact, using home-made horn aerials having gains of about 23dB. The same path was also spanned on 3.4GHz and 10GHz.

## Bandwidth compression experiments

An interesting series of experiments in bandwidth compression has been taking place in Australia where J. A. Adcock, VK3ACA, of Preston, Victoria has been successfully developing a technique long recognized as feasible but extremely difficult to achieve in practice: compression of the audio baseband by broadband frequency division before transmission, with compensating frequency multiplication within the receiver. Experiments using an ingenious mechanical technique for frequency division were carried out some 30 years ago by Dr D. Gabor, but J. A. Adcock has succeeded in halving the audio baseband electronically, using analogue computing elements. Although there remain certain forms of distortion which he believes stem from inaccuracies in the low-cost analogue integrated circuits (795), he has reached the stage where individual voices are quite recognizable and intelligible through the system: "The results are good enough to be exciting," he reports. He feels that with further development it might even be possible to contemplate such a system as a potential means of reducing the shortage of medium-wave broadcast channels in Europe—no easy matter owing to the susceptibility of music to distortion in frequency compression.

## Moonbounce and satellites

During one of the 144MHz moonbounce (E-M-E) tests by WA6LET using the 150-ft dish aerial at Stanford Research Institute, California, 37 contacts were made with 25 amateur stations in 13 States and two Canadian provinces. Most contacts were made using c.w. but VE2DFO, W6PO and K8III were contacted on s.s.b. Lowest power was 150 watts to a 40-element colinear array used by WA6GUY.

Among recent British amateurs to gain the Satellite DX Achievement Award are F. V. Kershaw, G3GKI, and W. A. Scarr, G2WS, a former president of the RSGB. An American station, K4TI, who has already "worked all states" through Oscar 6, is the first to work and achieve confirmation from stations in five out of the six continents: he now needs only Asia for an Oscar WAC.

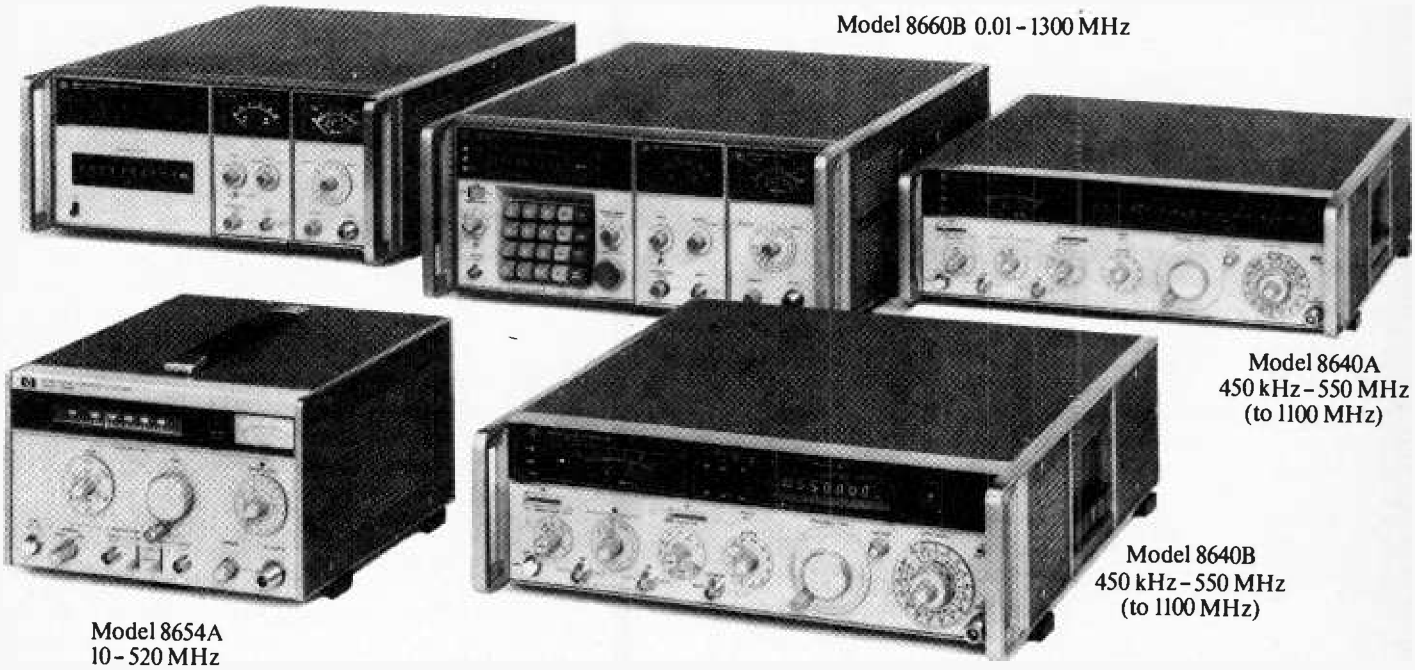
## In brief

An American amateur, Bill Parker, W8DMR, is using an all-solid-state imaging device, based on a Fairchild 100 by 100 element charge-coupled device, to transmit his amateur television test pattern. . . . Noel B. Eaton, VE3CJ, has been formally elected the seventh president of the International Amateur Radio Union, formed in Paris in 1925. . . . News bulletins in Morse code (18 w.p.m.) are transmitted on the ARRL headquarters station, W1AW, several times each week: a convenient time for British listeners is 2030 GMT on Tuesdays and Thursdays (frequencies include 3580, 7080, 14080 and 21080kHz); for "night owls" the bulletins also go out Mondays to Fridays at 0000 GMT. . . . Top scoring stations in the 6th Giant r.t.t.y. flash contest were I6NO, I1BAY and W3EKT; the only British entrant in the transmitting section was G3RDG who finished 38th, reports Professor Franco Fanti. . . . He also reports that the winner of the 4th World-wide ssTV contest was W9NTP: again only one British entrant, G3IAD, who finished eleventh. . . . The GB3PI Mark 2 repeater station is now in operation at Barkway. . . . Tibet and Zanzibar have been deleted from the ARRL list of countries. . . . The death has been reported of Bill Pope, G3HT, who was first licensed as PZX in 1911. . . . A Radio Amateurs Old-Timers Association net is planned for the first Thursday of each month at 1100 local time on 3740kHz with G2DX as net control. . . . It is proposed to start a Radio Society at the University of Durham and anyone interested should get in touch with Peter Whittle, G4BBU, 1 Blinco Road, Urmston, Manchester or during term at Chad's College, South Bailey, Durham. . . . Sixty years ago, in July 1924, amateurs staged an early demonstration of mobile radio when a special coach, containing a 440-metre amateur station 6ZZ, was attached to a north-bound LNER express train and showed the feasibility of telephony to and from a moving train. . . . A v.h.f. convention is to be held in Dundee on September 28. . . . The special call GB3BIJ will be used on h.f. bands from the Scout and Guide Jamboree on Brownsea Island from August 20 to September 1 (G8FFG/P on 144 MHz). . . . GB3RN will be operational from HMS *Belfast* from August 3 to 10 and during Portsmouth Navy Days August 24 to 26.

PAT HAWKER, G3VA

*Whatever your application, whatever your budget, there is a technically advanced Hewlett-Packard instrument to meet your specification.*

# Hewlett-Packard offers total capability in RF signal generators




The Hewlett-Packard range of RF Signal Generators provides you with a state-of-the-art instrument for almost every application and every budget.

It begins with the compact Model 8654A, ideal for use in field service conditions or as an economical instrument in lab and production applications.

Then comes the high performance Model 8640 in two versions, the "A" with dial readout and the "B" with 6-digit counter readout and phase-lock, both suitable for the stringent full-performance testing of virtually any type of HF, VHF and UHF receiver.

And finally, the plug-in Model 8660 system, combining the precision, stability and programmability of a synthesizer with the modulation and output control features of a signal generator. Also available in two versions, the "A" for systems applications and the "B" with its calculator derived keyboard for bench use, the 8660 is ideally suited for testing modern communications systems and for use in automatic test applications.

Outstanding spectral purity and noise performance are just two of the features of the Hewlett-Packard family of signal generators. There is a lot more that would interest you.

**You ought to get the details.**

Just write to Hewlett-Packard Ltd, 224 Bath Road, Slough, Berks. SL1 4DS.

HEWLETT hp PACKARD

**Sales, service and support in 172 centres in 65 countries.**

WW—009 FOR FURTHER DETAILS

# Sinclair Cambridge kit. Was £27·45. Now only £14·95! (INC VAT) You save £12·50!

**An advanced 4-function calculator in kit form**

The Cambridge kit is the world's largest-selling calculator kit.

It's not surprising – no other calculator matches the Sinclair Cambridge in functional value for money ; and buying in kit form, you make a substantial saving.

Now, simplified manufacture and continuing demand mean we can reduce even the kit price by a handsome £12·50. For under £15 you get the power to handle complex calculations in a compact, reliable package – plus the interest and entertainment of building it yourself !

**Truly pocket-sized**

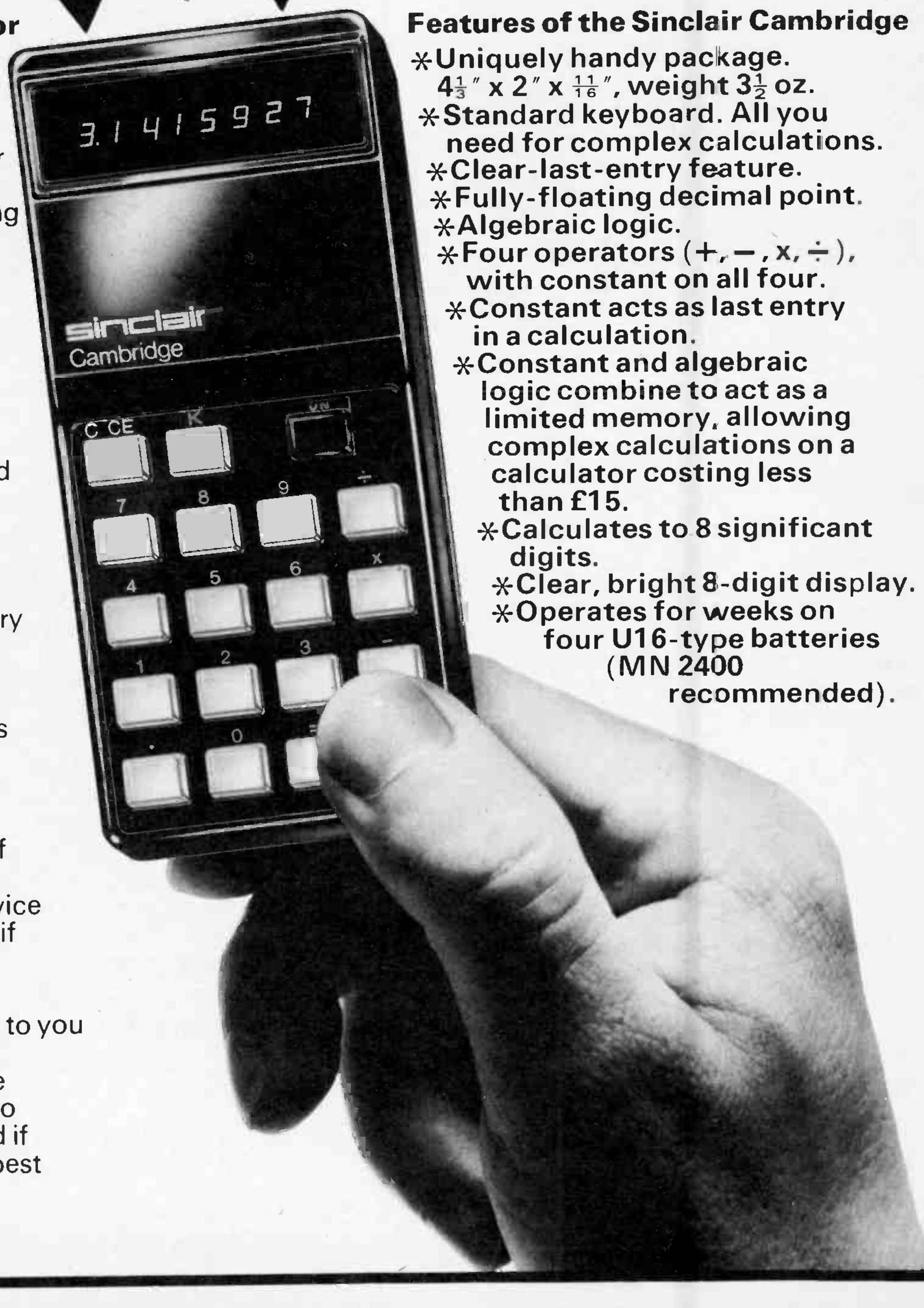
With all its calculating capability, the Cambridge still measures just $4\frac{1}{3}$" x 2" x $\frac{11}{16}$". That means you can carry the Cambridge wherever you go without inconvenience – it fits in your pocket with barely a bulge. It runs on U16-type batteries which gives weeks of normal use before 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 £14.95 !**

The Sinclair Cambridge kit is supplied to you direct from the manufacturer. Ready assembled, it costs £21·95 – so you're saving £7 ! 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. $4\frac{1}{3}$" x 2" x $\frac{11}{16}$", weight $3\frac{1}{2}$ oz.
- Standard keyboard. All you need for complex calculations.
- Clear-last-entry feature.
- Fully-floating decimal point.
- Algebraic logic.
- Four operators (+, –, x, ÷), with constant on all four.
- Constant acts as last entry in a calculation.
- Constant and algebraic logic combine to act as a limited memory, allowing complex calculations on a calculator costing less than £15.
- Calculates to 8 significant digits.
- Clear, bright 8-digit display.
- Operates for weeks on four U16-type batteries (MN 2400 recommended).

# 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!


**4⅓" long x 2" wide x 11/16" deep**

## 'his valuable book – free!

you just use your Sinclair Cambridge for )utine arithmetic – for shopping, onversions, percentages, accounting, ıllying, and so on – then you'll get more than our money's worth.

ut if you want to get even more out of it, ou can go one step further and learn how to nlock the full potential of this piece of ectronic technology.

ow? It's all explained in this unique ooklet, written by a leading calculator esign consultant. In its fact-packed 32 ages it explains, step by step, how you can se the Sinclair Cambridge to carry out omplex 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 80 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: £13·59 + £1·36 VAT. (Total: £14·95)**
**Price fully built: £19·95 + £2·00 VAT. (Total: £21·95)**

To Sinclair Radionics Ltd, London Road, St Ives, Huntingdonshire, PE17 4HJ

Please send me

☐ a Sinclair Cambridge calculator kit at £13·59 + £1·36 VAT (Total: £14·95)

☐ a Sinclair Cambridge calculator ready built at £19·95 + £2·00 VAT (Total: £21·95)

*I enclose cheque for £__________, made out to Sinclair Radionics Ltd, and crossed

*Please debit my *Barclaycard/Access account. Account number__________

*Delete as required.

Name __________

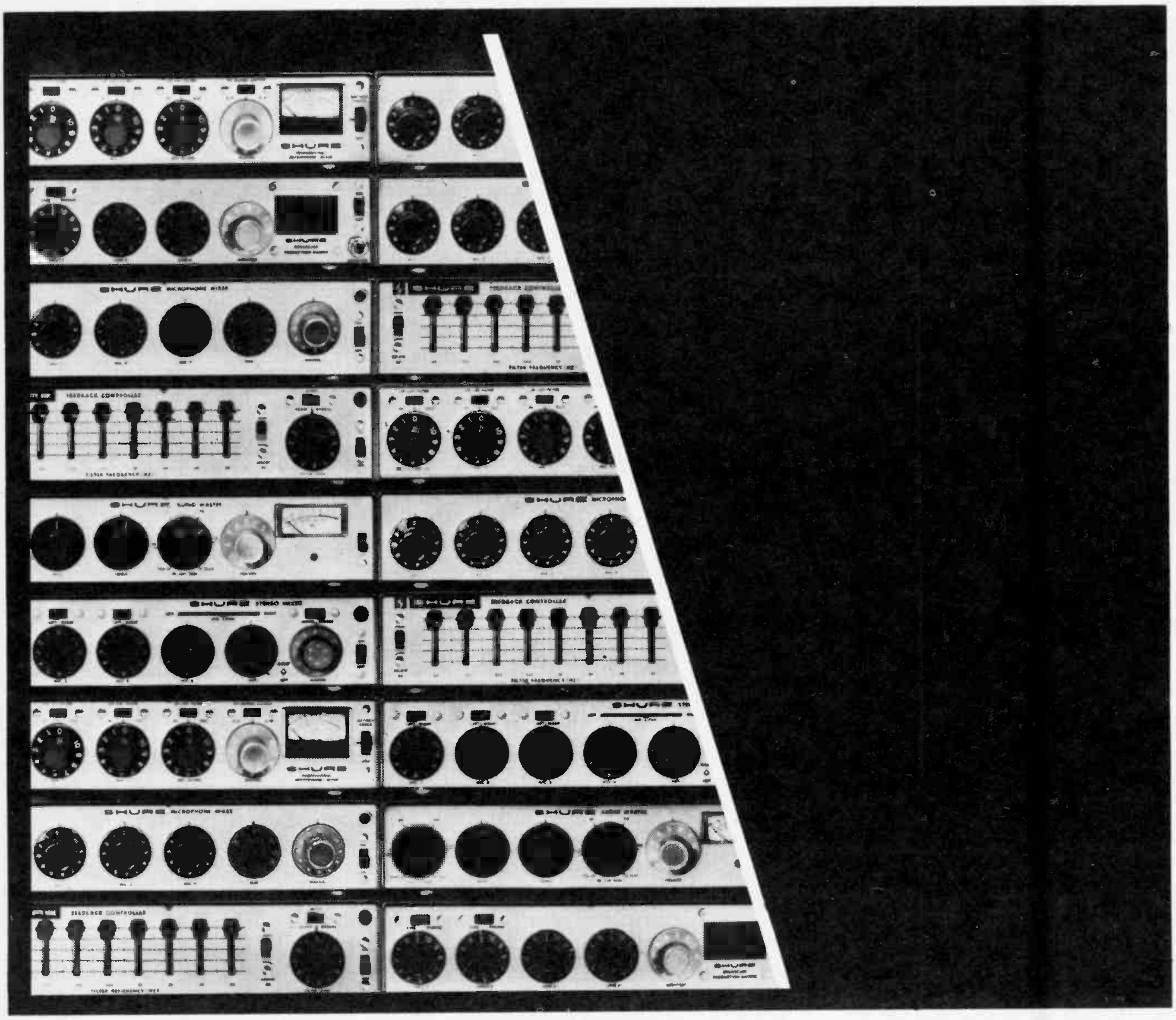
Address __________

WW/8/74

sinclair

ıclair Radionics Ltd, London Road, St Ives, Hunts.
ı.no: 699483 England VAT Reg.no: 213 8170 88

WW—012 FOR FURTHER DETAILS



# Bridge oscillators

by F. Arthur, Ph.D.
*City of Birmingham Polytechnic*

A bridge oscillator is one employing both positive and negative feedback at the inputs of an operational amplifier. By this means it is possible to imitate, using only resistors and capacitors, a high-$Q$ $LC$ oscillator which manifestly behaves in the same way, i.e. with high frequency stability and low harmonic distortion; although neither of these properties can be associated with the often misnamed Wien bridge circuit shown in Fig. 1. The latter does not possess a bridge structure and only shows the properties described when modified to include negative feedback via a resistive arm as in Fig. 5. Nevertheless, it is the most common form and such oscillators are commercially available with a 10/1 variation in frequency per dial turn and overall coverage of $10^6/1$ from, say, 1 Hz to 1 MHz. They possess two major advantages over $LC$ oscillators, viz.;

(1) They have a wideband tuning capability. Thus, whereas in an $LC$ oscillator a 10/1 variation in $L$ or $C$ produces a 3·16/1 variation in frequency, a 10/1 change in the $R$ or $C$ of a Wien bridge network produces a 10/1 change in the oscillation frequency.

(2) At frequencies below several kilohertz the linear inductors required for an $LC$ oscillator become unwieldy and expensive.

The two other common forms of $RC$ bridge circuit, the balanced form of the symmetrical twin T, Fig. 2, and the bridged T, Fig. 3, possess similar advantages over $LC$ networks. Furthermore, with the proviso that when used in an oscillator the same amplifier is used in all three $RC$ configurations, they produce an output with lower harmonic distortion and better frequency stability than the Wien bridge.

Bridge oscillators are not, however, exclusively of the $RC$ type. Another form in common use is the Meacham bridge shown in Fig. 4, which employs a crystal instead of an $RC$ network in the frequency selective arm. The existence of feedback via $R_1$ and $R_2$ increases the frequency stability and decreases the harmonic distortion compared to that of an oscillator in which the frequency is controlled by a crystal alone. The factor of improvement is of the order of the amplifier gain.

Since the behaviour of each of the three $RC$ bridge networks is very similar the earlier sections of the ensuing discussion will give a comparison (from the standpoint of harmonic distortion and frequency stability) of oscillators in which they are incorporated. This will be followed by an examination of the Meacham bridge. The final section will deal with the problem of amplitude stabilization.

## Harmonic distortion

In a self-starting oscillator the amplitude of oscillation increases until the amplifier gain × feedback fraction is unity. In the process, the active device will, for any real output swing, be operating over a large portion of its characteristics and consequently non-linearity distortion will be introduced. The harmonics thus produced may be treated as additional signals within the feedback loop and each harmonic will be acted upon by the factor

$$K_n = \frac{H_o}{H_a} = \frac{1}{(1-AB_n)}$$

where $H_o$ is the harmonic distortion in the oscillator, $H_a$ the harmonic distortion in the amplifier, $A$ the amplifier gain and $B_n$ the feedback fraction for the $n$th harmonic. At the frequency of oscillation, $f_o$,

$$AB_o = 1 \text{ and } K_n = \frac{1}{A(B_o-B_n)},$$

i.e.

$$|K_n| = \frac{1}{|A||(B_o-B_n)|} \quad (1)$$

Since it is desirable to produce an almost sinusoidal output then the harmonic distortion should be small. Each of the harmonics produced in the amplifier is modified by the factor $|K_n|$ and for a well designed network this factor should be as small as possible. For a given amplifier this will occur when $B_o - B_n$ is large.

The more selective the feedback network

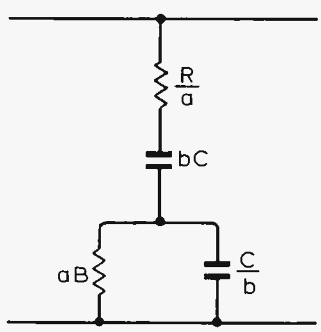



*Fig. 1. Wien network, which becomes a bridge when completed by a resistive arm.*

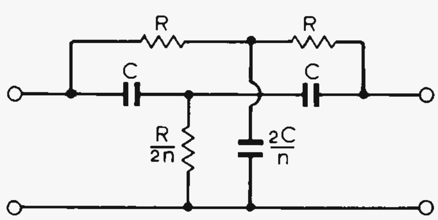



*Fig. 2. Twin T RC network.*

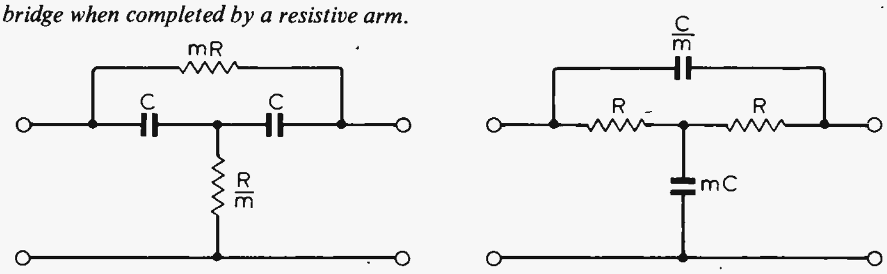



*Fig. 3. Two forms of bridged T network, giving identical results.*

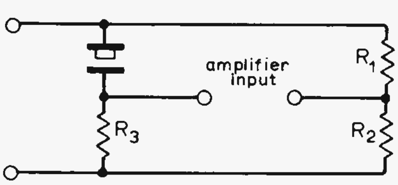



*Fig. 4. Meacham bridge crystal network.*

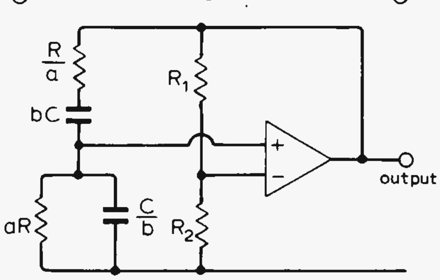



*Fig. 5. General form of Wien oscillator.*

the greater is the value of $|B_o - B_n|$ and, for a given degree of amplifier distortion, the more pure will be the output wave. From this point of view, therefore, the relative quality of two oscillators can be obtained by comparing their respective $|K_n|$ factors. Such a comparison will now be made for oscillators employing the feedback networks shown in Figs. 2, 3 and 5.

**Wien bridge.** To incorporate the Wien bridge into an oscillator, the amplifier must have both an inverting and non-inverting input terminal. Since the frequency selective arm of the bridge has a maximum transmission at resonance then it is connected to the non-inverting terminal and negative feedback is applied via the resistive arm to the inverting input.

Assuming the amplifier input resistance is large compared to $aR$ and $R_2$ the feedback fraction is given by Appendix 1 as

$$B = \frac{1}{(x + ju/ab)} - B_r \qquad (2)$$

where $x = 1 + \frac{1}{a^2} + \frac{1}{b^2}$,

$$u = (\omega/\omega_o - \omega_o/\omega),$$

$$B_r = \frac{R_2}{(R_2 + R_1)}.$$

Substituting for $B_o$ and $B_n$ in Eq. (1) gives $|K_n| = xab/A\{(x^2/u^2 + (1/ab)^2\}^{\frac{1}{2}}$ and this takes the values shown in Table 1 for the second and third harmonics.

**Table 1**

| | $K_2$ | $K_3$ |
|---|---|---|
| $a=b=1$ | $6.69/A$ | $4.5/A$ |
| $a=b=\sqrt{3}/2$ | $3.39/A$ | $2.53/A$ |

Obviously the larger is the value of $A$ the smaller are the factors $K_2$ and $K_3$. Thus for the completely unbalanced bridge where there is no resistive feedback and the amplifier gain $= x$ then $K_2 = 6.69/x$. Using an amplifier gain of $100x$ reduces this factor a hundredfold but requires the introduction of resistive feedback in which the feedback ratio is controllable to within 1% of $1/x$.

**Twin T.** The twin T, being a minimum transmission network, is connected in the negative feedback loop when employed in oscillator circuits. The transfer response of the unloaded network is given by references 1, 2 and 3 as

$$\frac{v_o}{v_{in}} = \frac{1}{1 - 4j/u}$$

where $u = \omega/\omega_o - \omega_o/\omega$ and $\omega_o = n^{\frac{1}{2}}CR$. The sensitivity[3] of this function with respect to $n$, i.e. $d|(v_o/v_{in})|/dn$ is a maximum for $n = 1$ and this accounts for the fact that in oscillator circuits it is more generally seen in the form shown in Fig. 6. For this reason attention will be restricted to this type of network in which

$$B_{tt} = B_r - \frac{1}{1 - 4j/u}$$

where $B_r = R_2/(R_1 + R_2)$. Making the relevant substitutions in Eq. 1 gives the results shown in Table 2.

**Table 2**

| $K_2$ | $K_3$ |
|---|---|
| $8.85/A$ | $1.81/A$ |

From a comparison of Tables 1 and 2 it would seem, therefore, that the twin T oscillator shows lower harmonic distortion. Unfortunately, variation of the oscillator frequency requires that three elements be altered simultaneously. In general, therefore, twin T oscillators are only used in cases of fixed frequency operation.

**Bridged T.** The bridged T network may take either of the forms shown in Fig. 3, there being no difference in their behaviour. Since the circuit is a minimum transmission network it is used in the negative feedback arm as in Fig. 7 to provide the frequency selectivity necessary in an oscillator.

The feedback fraction $B_{bt}$ is given by:[1]

$$B_{bt} = B_r - \frac{(m - 2j/u)}{(m - j(m^2+2)/u}$$

where $B_r = R_2/(R_1 + R_2)$ and $u = (\omega/\omega_o - \omega_o/\omega)$. Substituting for $B_o$ and $B_n$ in Eq. 1 gives:

$$|K_n| = \frac{1}{m^3 A}(2 + m^2)\left(m^2 + \frac{(m^2+2)^2}{u^2}\right)^{\frac{1}{2}}$$

which leads to the results shown in Table 3, where the factors $m = 2.5$ and $m = 3$, since they approximately correspond to the values for $m$ where $|K_2|$ ($m = 2.5$) and $|K_3|$ ($m = 3$) are at their minimum.

**Table 3**

| $m$ | $K_2$ | $K_3$ |
|---|---|---|
| 1 | $6.69/A$ | $6.3/A$ |
| 2.5 | $2.55/A$ | $2.14/A$ |
| 3 | $3.22/A$ | $2.08/A$ |

## Frequency stabilization

The frequency of oscillation is identically that for which the phase shift round the loop is zero. If some parameter of the amplifier should change and produce a phase shift then the oscillation frequency will change to re-establish the zero phase condition. For example, if the change in the amplifier produces a phase shift of, say, 1° and if the phase shift of the bridge network in the neighbourhood of the oscillation frequency is −10° per 1000Hz then there will be an increase in the oscillation frequency of 100Hz. Obviously the greater the rate of change of phase with frequency of the bridge the greater will be its frequency stability.

The 100Hz change in oscillator frequency due to the parameter change in the amplifier was calculated on the basis that

$$\Delta f = \frac{\Delta\phi}{S_f'}$$

where $\Delta f = 100$Hz, $\Delta\phi = 1° =$ phase shift

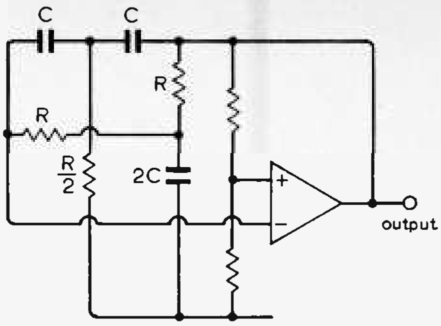



*Fig. 6. Twin T oscillator.*

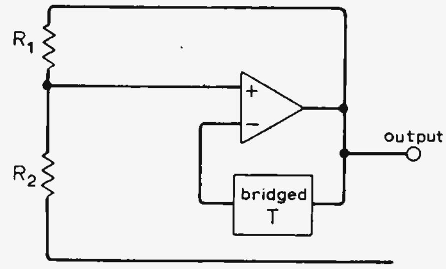



*Fig. 7. Bridged T oscillator.*

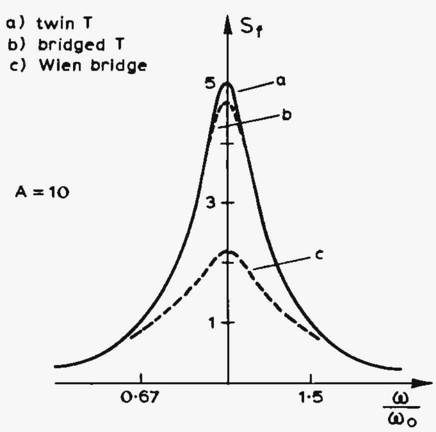



*Fig. 8. Variation of frequency stability factor with frequency.*

in amplifier, and $S_f' = d\phi/df = 0.01°$/Hz, which is the rate of change of phase with frequency of the frequency-determining network. From a practical point of view it is much more important to know the fractional change in frequency i.e. $\Delta f/f_o$. Consequently, in making a comparison of the frequency stability of oscillation it is usual to use a stability factor $S_f = f_o S_f'$ of the frequency selective network as the basis of the comparison. A phase shift of $\Delta\phi$ in the amplifier then produces a fractional change of $\Delta f/\Delta f_o = \Delta\phi/S_f$.

As shown in Appendix 2, $S_f$ for each of the three networks so far considered has a maximum value of $0.5A$ for the twin T, $0.47A$ for the bridged T and $0.22A$ for the Wien bridge. When $S_f$ is plotted as a function of $f/f_o$, for $A =$ constant $= 10$, the curves take on the form shown in Fig. 8. Increasing $A$ produces curves with a similar shape but with a higher peak value and a faster rate of fall off. It can be seen from these curves that, again, the twin T, inherently, gives the best oscillator.

**Meacham bridge.** The Meacham bridge oscillator shown in Fig. 9 combines the properties of a high-$Q$ $LC$ circuit and an almost balanced bridge network to effect an extremely precise frequency standard, with the highest stability of any cricuit yet devised. The positive feedback is frequency dependent attaining a maximum at the series resonant frequency of the crystal. Assuming there is no phase shift in the amplifier, oscillation takes place at this frequency.

Using the equivalent series model of the crystal the feedback fraction $B_{mb}$ is given by:

$$B_{mb} = \frac{R_3}{(R_3+r+j\omega L+1/j\omega C)} - B_r$$

where $B_r = R_2/(R_1+R_2)$. Substituting $N = r/R_3 \doteq 1/(LC)^{\frac{1}{2}}$ and $Q = L/r$ this becomes

$$B_{mb} = \frac{1}{(N+1)+jNQu} - B_r.$$

This equation is of the same form as Eq. (2) for the Wien bridge, the factors $N+1$ and $QN$ being analogous to $x$ and $1/ab$ respectively. By analogy it follows that the factor $K_n$ for the Meacham bridge may be obtained using the earlier results and replacing $x$ and $ab$ by their analogies. Hence

$$K_n = \frac{(N+1)}{AQN}\left\{\frac{(N+1)^2}{u^2}+Q^2N^2\right\}^{\frac{1}{2}}$$

For all harmonics $u = (\omega/\omega_o - \omega_o/\omega) > 1$ so that $(N+1)/u^2 > (N+1)$. Furthermore, since $Q$ is very large (typically 20,000) and providing $N$ is not too much smaller than unity this approximates to

$$K_n = \frac{(N+1)}{NA}$$

which is completely independent of the resistive side of the bridge.

In a similar manner by substituting for $x = (N+1)$ and $QN = 1/ab$ the expression for the frequency stability factor $S_f$ at the frequency of oscillation is (Appendix 2)

$$S_f = -\frac{(2QNA)}{(N+1)^2}$$

This function is geometrically symmetrical about $N = 1$ and has a maximum value of $-QA/2$ at this point.

### Amplitude stabilization

The amplitude stability of an oscillator is the sensitivity of the oscillation amplitude $V_o$ to variations in temperature, supply voltage etc. In particular, the amplitude stability factor is defined as

$$S\mu = \frac{\Delta V_o/V_o}{\Delta\mu/\mu}$$

where $\mu$ is the parameter within the oscillator which is subject to variation. Obviously, the lower the value of $S\mu$ the more stable will be the output amplitude and frequently amplitude control elements are used to provide the necessary stabilization.

To demonstrate the function of these control elements imagine that the feedback resistor $R_2$ of the Wien bridge network increases with the voltage across it. If the output amplitude should increase then $R_2$ and hence the feedback fraction $R_2/(R_1+R_2)$ will increase. This reduces the voltage fed back and causes a decrease in output.

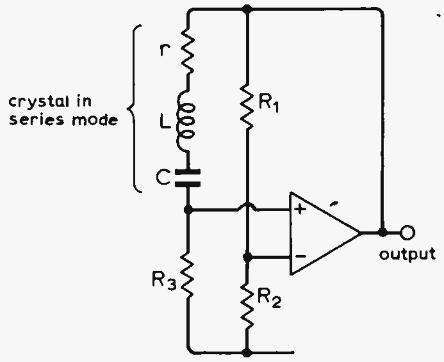



*Fig. 9. Meacham bridge oscillator, showing the crystal as a tuned circuit.*

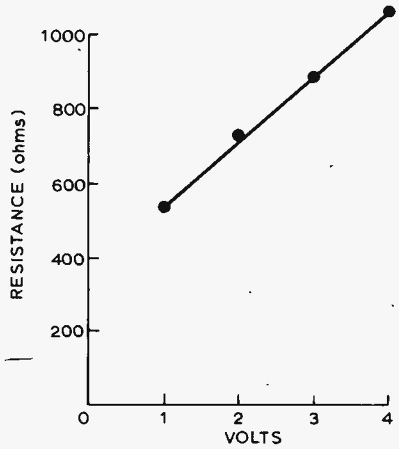



*Fig. 10. Characteristics of a 6V, 0.36W tungsten-filament bulb.*

One form the stabilization element may take is a tungsten filament lamp. Typically these lamps have a characteristic of the form shown in Fig. 10 in which case over a wide voltage range the resistance $R_2$ is given by:

$R_2 = R_o + KV_r$; $V_r$ = volts across lamp.

Under oscillatory conditions

$$B_r = \frac{R_2}{R_1+R_2} = \left(\frac{1}{3}-\frac{1}{A}\right) \text{ and } B_rV_o = V_r$$

therefore

$$\mathrm{d}B_r = \frac{KR_1}{(R_o+KV_r+R_1)^2}\mathrm{d}V_r = \frac{\mathrm{d}A}{A^2}$$

But

$$\frac{R_1}{R_o+KV_r+R_1} = 1-B_r = \frac{2}{3}+\frac{1}{A}$$

$$\simeq \frac{2}{3} \text{ for large } A.$$

Hence

$$\frac{\mathrm{d}A}{A} \simeq \frac{2KA}{3(R_o+R_1+KV_r)^2}\mathrm{d}V_r$$

and

$$S_A = \frac{\mathrm{d}A/A}{\mathrm{d}V_o/V_o} = \frac{2K}{3A(R_1+R_o+KV_r)}\frac{\mathrm{d}V_o}{\mathrm{d}V_r}V_o.$$

Since $V_r = 1/3V_c$ then $\mathrm{d}V_r = 1/3\mathrm{d}V_o$ and

$$S_A = \frac{2KV_o}{9A(R_1+R+K/3V_o)}.$$

In the limit as $K$ tends to infinity then $S_A$ tends to a maximum of $2/3A$.

The amplitude control element may take many different forms. In the Meacham bridge circuit the resistor $R_2$ needs to increase as $V_o$ increases. Practically this may be accomplished using an f.e.t.[4,5]. The output voltage is rectified and used to control the drain-source resistance of the f.e.t. Quantitively the stabilization factor may be assessed in a manner similar to that used for the Wien bridge.

### Appendix 1

For the Wien bridge the voltage, $v_f$, fed back is given by:

$$v_f = \frac{\dfrac{aR}{(aR+b/j\omega C)}\cdot\dfrac{b}{j\omega C}}{\dfrac{1}{j\omega bC}+\dfrac{R}{a}+\dfrac{aR}{(aR+b/j\omega C)}\dfrac{b}{j\omega C}} - B_r$$

$$= \frac{abR}{(a/b)R+(b/a)R+abR+1/j\omega C+j\omega CR^2} - B_r$$

$$= \frac{1}{\left(1+1/a^2+1/b^2+\dfrac{j\omega CR-j/\omega CR}{ab}\right)} - B_r$$

$$= \frac{1}{x+ju/ab} - B_r. \quad \text{(A1)}$$

where $x = 1+1/a^2+1/b^2$, $u = (\omega/\omega_o - \omega_o/\omega)$ and $\omega_o = 1/CR$.

### Appendix 2

From Appendix 1 it follows that at the frequency of oscillation

$$B_{wb} = \frac{1}{x} - B_r.$$

Also, at this frequency the loop gain—$AB_{wb} = 1$ so that $B_{wb} = 1/A$. It follows that $B_r = 1/x - 1/A$. Substituting for this factor in Eq. A1 gives

$$B_{wb} = \frac{\dfrac{x}{A}+\dfrac{ju}{ab}(1/A-1/x)}{x+ju/ab} \quad \text{(A2)}$$

The loop gain $AB_{wb} = |AB_{wb}|\,\phi$ where $\phi$ = phase shift. Assuming there is no phase shift in the amplifier, $\phi = \phi_{wb}$ (phase shift of $B_{wb}$). Hence from Eq. A2

$$\phi_{wb} = \tan^{-1}\frac{Au}{xab}(1/A-1/x) - \tan^{-1}(u/xab)$$

$$S_f = f_o\frac{\mathrm{d}\phi}{\mathrm{d}\omega} = \left[\frac{A}{xab}\left\{\frac{1}{A}-\frac{1}{x}\right\} \times \left\{\frac{1}{1+\{Au/xab(1/A-1/x)\}^2}\right\} - \left(\frac{1}{xab}\right)\left(\frac{1}{1+u^2/x^2a^2b^2}\right)\right]$$

$$\times [1+\omega_o^2/\omega^2]. \quad \text{(A3)}$$

When plotted as a function of $\omega/\omega_o$, $S_f$ takes a maximum value when this ratio is unity. Under this condition Eq. A3 simplifies to give

$$S_f = \frac{2}{xab}(-A/x)$$

$$= -0.22A \text{ when } a = b = 1.$$

Similarly for the twin T

$$B_r = 1/A$$

$$B_{tt} = \frac{(1/A-1)-4j/Au}{(1-4j/u)}$$

$$\phi_{tt} = \tan^{-1}(4/u(A-1))+\tan^{-1}(4/u)$$

$$S_f = \{1+\omega_o^2/\omega^2\}\left\{\frac{-4}{u^2(A-1)+16/(A-1)}\right\}$$

$$-\frac{4}{u^2+16}.$$

At $\omega = \omega_o$, $u = 0$ and $S_f = -A/2$.

Finally, for the bridged T

$$B_r = 1/A+2/(m^2+2)$$

$$B_{bt} = \frac{\{m/A-m^3/(m^2+2)\}-j(m^2+2)/Au}{m-j(m^2+2)/u}$$

$$\phi_{bt} = \tan^{-1}(m^2+2)/Au\alpha + \tan^{-1}(m^2+2)/mu;$$

$$\alpha = m/A-m^3/(m^2+2)$$

$$S_f = \{1+\omega_o^2/\omega^2\}\left\{\frac{(m^2+2)}{A\alpha}\right\} \times \left\{\frac{1}{u^2+(m^2+2)^2/A^2\alpha^2}\right\}$$

$$-\frac{(m^2+2)/m}{u^2+\{(m^2+2)/m\}^2}.$$

Substituting $m = 2.5$ and $\omega = \omega_o$ (i.e. $u = 0$) gives $S_f = -0.47A$.

### References


1. Mehta, B. M., *Electron. Engg.*, Sept. 1967, p. 582.
2. Girling, F. E. J. and E. F. Good, *Wireless World*, Oct. 1969, p. 461.
3. Valley, G. E. and H. Wallman, "Vacuum Tube Amplifiers", McGraw-Hill, New York (1948), Chapter 10.
4. Strauss, L., "Wave Generation and Shaping", Second Ed., McGraw-Hill (1970), Chapter 16.
5. Clarke, K. K. and D. T. Hess, "Communication Circuits", Addison-Wesley, 1971, Chapter 6.


# Books Received

**Radio Wave Propagation**, by Armel Picquerand, is suitable for radio engineers who want a better understanding of the phenomena. The initial chapters of the book summarize the present state of our knowledge of wave propagation as far as it concerns the telecommunications engineer. Following chapters give graphs which can be used for the calculation of the principal parameters of communication circuits. An appendix gives a brief review of those concepts of mathematical physics required for the comprehension of the theoretical discussions in this book. Price £10. Pp. 343. Macmillan, 4 Little Essex Street, London WC2 RLF.

**Electrotechnology Basic Theory and Circuit Calculations for Electrical Engineers**, by M. G. Say, starts with a chapter on units and physical quantities. A second chapter deals with the physical nature of electric charge and conduction and then explains the effects in practical terms. A third chapter deals with network analysis, starting with basic circuit parameters and outlining some of the short-cut techniques devised to solve particular groups of problems. The book concludes with a chapter on special techniques of circuit analysis. Price £1.70. Pp. 176. Newnes-Butterworths Ltd, Borough Green, Sevenoaks, Kent TN15 8PH.

**Electronic Circuit Analysis**, by Wade, Edwards and Clark, has been designed for technical college students. An engineering approximation approach is used to provide an understanding of practical electronic circuits. The basic circuit theories required are Ohm's law, Kirchhoff's laws, Thévenin's and Norton's theorems. Numerous diagrams and worked examples are included to illustrate the analytical techniques employed. Price £12 (£8.25 paper back). Pp. 640. John Wiley and Sons Ltd, Baffins Lane, Chichester, Sussex.

**Slow Scan Television Handbook** is suitable for the amateur interested in s.s.t.v. After a brief historical introduction the book explains the basic principles involved together with some popular circuits used in s.s.t.v. A chapter on monitors gives several full circuit diagrams and parts lists. Subsequent chapters deal with flying spot scanners, live vidicon cameras, colour equipment and applications of audio filters. The book concludes with chapters on test gear and commercial equipment. Price £2 plus 20p postage and packing. Pp. 248. British Amateur Television Club, c/o "White Orchard", 64 Showell Lane, Penn, Wolverhampton, Staffs WV4 4TT.

**Questions and Answers Integrated Circuits**, by R. G. Hibberd, is a pocket book aimed at helping students or technicians understand i.cs. The sections in the book are: basic aspects of i.cs., i.c. technology, digital, linear and m.o.s. i.cs., m.s.i. and l.s.i. and applications. Price 75p. Pp. 96. Butterworth & Co Ltd, Borough Green, Sevenoaks, Kent TN15 8PH.

**The Bruneval Raid**, by George Millar, is not a technical book, but a well-researched description of the events leading up to the decision to capture an intact German radar ground station in 1941. British and German scientists had reached a comparable state of knowledge in the development of radar, but the German ground systems were beginning to constitute a problem for Bomber Command. It became known that a station existed near Le Havre at Bruneval and Combined Operations pulled off the raid which was useful not only in the acquisition of the relevant information, but in supplying a very necessary boost to morale at a particularly dismal period of the war. Price £2.50. Pp. 208. Bodley Head Ltd, 9 Bow Street, London WC2.

Now available from RCA is the 74 series of data books which comprise **COS/MOS Digital Integrated Circuits—SSD-203B, Thyristors, Rectifiers and Diacs—SSD-206B, Power Transistors and Power Hybrid Circuits—SSD-204B, RF Power Devices—SSD-205B, Linear Integrated Circuits and MOS Devices application notes—SSD-202B**, and **Linear Integrated Circuits and MOS Devices Selection Guide—SSD-207B**. All the volumes are priced at £1.50 or £6 for the set of six. RCA Ltd, Sunbury-on-Thames, Middx TW16 7HW.

**Logical Design of Switching Circuits**, by Douglas Lewin, is a tutorially-written book intended as a text for courses on logical design with an engineering approach rather than the more usual mathematical treatment being adopted. The book initially explains the principles of switching and the design of combinational switching circuits and sequential circuits. Subsequent chapters deal with circuit implementation, automatic design, and logic design with complex integrated circuits. A final chapter gives an introduction to computers and computer programming. Throughout the book problems with worked solutions are provided to aid private study. All the logic symbols in the book follow the American MILSPEC system. Price £4.75. Pp. 404. Thomas Nelson & Sons Ltd, 36 Park Street, London W1Y 4DE.

**Basic Audio Systems**, by Norman H. Crowhurst, **Mobile Radio Handbook**, by Leo G. Sands, and **Rapid Radio Repair**, by G. Warren Heath, priced at £1.60 (£1.50 Mobile Radio Handbook) are the latest additions to the Foulsham-Tab series. Foulsham-Tab & Co Ltd, Yeovil Road, Slough, Bucks.

**Pioneer of Science and Discovery: Michael Faraday and Electricity**, by Brian Bowers, is the story of Faraday from early life to retirement. Although it is not a technical book, many of Faraday's experiments are explained together with photographs and diagrams. Price £2.25. Pp. 96. Priory Press Ltd, 101 Gray's Inn Road, London WC1X 8TX.

**Electrical Indicating Instruments**, by G. F. Tagg, is suitable for engineers concerned with the design and manufacture of instruments. This book describes general instruments as well as providing information on components and the overall performance. After a chapter on general principles, the suspension and control systems are discussed followed by a chapter on damping and response times. Subsequent chapters deal with permanent magnets and the book concludes with chapters on dynamometer, thermal and electrostatic instruments. Price £6. Pp. 227. Butterworth & Co Ltd, Borough Green, Sevenoaks, Kent TN15 8PH.

# Research Notes

## New encapsulation for thick film circuits

Work on the visual prosthesis for blind people at the Institute of Psychiatry, London (see *WW*, May 1971, pp. 214–217) has brought to light a promising method of encapsulating integrated and hybrid circuits. The prosthesis will make use of four-layer thick film hybrid circuits implanted beneath the scalp and wired through a hole in the skull to the visual cortex of the brain. Coupling to photo-electric units (a crude television camera) outside the body will be inductive, eliminating lead-outs through the skin which might be entry points for infection.

The problem is to make the fairly complex circuits fit into the small available space. Although integrated circuits are themselves small the usual kinds of encapsulation increase the volume perhaps several hundred times. Mr P. E. K. Donaldson, the electronic engineer on the project, has established that a thin covering of a silicone compound may provide adequate protection. He has been testing circuits encapsulated in this way immersed in a warm saline solution to simulate conditions in the body, with good results. Silicone seems at first sight to be an unsuitable encapsulant because it allows water vapour to pass. However, water vapour as such is not harmful and the silicone does not allow enough to pass to form liquid water on the circuitry.

## Radio spectrometry on the fringe of the universe

According to one familiar system of cosmology the velocity away from the Earth of distant stars and galaxies is proportional to their distance from us. The velocity can be detected by optical spectrometry because it causes light to be Doppler-shifted to a lower frequency. This is the "redshift" and it causes the characteristic emissions of light from hot elements in the stars to be shifted to longer wavelengths.

Two compact radio galaxies of the "quasar" type (quasi-stellar objects) with enormous redshifts were recently identified by optical telescopes. They are presumably among the most distant objects in the visible universe. The radio astronomers have now taken a more careful look at them. Ten observatories in different parts of the world (including Cambridge) have collaborated to make measurements of the strength of the radio emissions on different frequencies and so compile a radio spectrum of the emission.

Both quasars have a low-frequency cut-off at a few hundred MHz but are still transmitting at full strength at the highest frequency measured (85GHz). Both show a peak at about 1GHz. One has a dip at 20GHz. There is some evidence (not conclusive) that one is fluctuating in strength over periods of a few weeks. If confirmed this will give an indication of the size of the object since there is good reason to believe that fluctuations do not occur at rates shorter than the time it takes light to traverse the source. On this basis the evidence suggests a diameter of about one light month for the fluctuating quasar. Compare this with the diameter of around 100,000 light *years* for a galaxy like our own and it is clear that quasars emit astonishingly large amounts of power for their size. The two quasars in question are around 8000 million light years away and therefore represent the universe at a primitive stage. Perhaps contemporary galaxies emit so much less energy because most of the available fuel has been used up in the meantime.

*Nature*, June 21, 1974, p. 743

## Transistor absolute thermometers

Most semiconductor thermometers operate by sensing either a change in bulk resistance (as in a thermistor) or a change in the forward voltage drop of a p–n junction with temperature. A variation on the theme has been explored at Manchester University. It uses the change of short-circuit collector-base leakage current with temperature. This leakage depends on the Boltzmann factor $q/kT$ and is therefore a measure of temperature. If the transistor thermometer is calibrated at one known temperature it becomes an absolute thermometer for other temperatures. Comparisons with other forms of thermometer such as mercury-in-glass and copper-Constantan thermocouples show agreement within 0.5°K over the range 100–400°K.

*Physics Bulletin*, June 1974, p. 225

## Ultrasonic tumour detection

Careful engineering at the Royal Marsden Hospital has produced an ultrasonic detection system capable of finding very small tumours in the liver and other organs. The system works by preserving information which is usually discarded. This is the scatter by very small irregularities such as tiny blood vessels, whose presence in unusual places can indicate abnormal tissue. To avoid losing these small signals in the presence of much larger ones it is necessary to amplify the received signals in low noise amplifiers which compress the strong signals while preserving the weak ones. Objects down to about 2mm diameter are then detectable at the frequency and pulse length used.

## Primary cell

A new primary cell with good power-to-weight ratio was discovered by accident during laser research in the U.S.A. The cell is based on lithium and carbon with liquid compounds of chlorine as electrolyte—all relatively cheap materials. It has a power-to-weight ratio eight times that of a dry Leclanché cell and better shelf life.

The laser research involved dissolving rare-earth compounds in liquid chlorine compounds such as phosphorus oxychloride and seeing if the passage of a current caused emission of light. It did, but the research workers also noted that the rare-earth metal was being plated out on the anode while the cathode released chlorine gas. They correctly interpreted this as a sign that they had the makings of a primary cell—without the rare earth compounds, of course.

*Science*, May 3, 1974, p. 554

## Laser superhets at work

Radio operators are familiar with the effect of switching on the b.f.o. of a receiver when there is no signal present. "Mush" appears in the audio output. This arises in part because the b.f.o. beats with i.f. noise, down-converting it to audio frequencies.

A similar effect is put to good use in a laser device for monitoring air pollution designed at the Jet Propulsion Lab. at Cal. Tech., U.S.A. The "laser heterodyne radiometer" detects the infra-red radiation which is emitted by pollutants on characteristic wavelengths.

A fast germanium photoconductor is illuminated simultaneously by the infra-red emission of the gas and by a tunable laser (the "b.f.o.") on approximately the same wavelength. The beat-noise output of the photocell is amplified in a wide band (600MHz) i.f. amplifier and detected. The researchers calculate from their laboratory tests that the system should detect ozone in a layer of air about 1km thick at concentrations down to 2 parts in $10^9$.

Lasers are also potentially useful in astronomy, but this time as up-converters where the "i.f." is higher than the signal frequency. The point is that the photomultipliers which are used to measure the light from stars are not sensitive at long wavelengths. If long-wavelength "light" is up-converted the sensitivity improves. In experiments at Arizona University a crystal of lithium iodate was used as the frequency changer. The crystal was pumped with a high peak output ruby laser which generated TEM-00 mode oscillations. At the high power the crystal is optically non-linear and frequency changing takes place when light from the telescope is introduced along with the laser light.

*Science*, May 3, 1974, p. 570 (monitor)
*Nature*, June 14, 1974, p. 638 (conv.)

# Current-differencing amplifiers

## 1—signal processing circuits

by J. Carruthers, J. H. Evans, J. Kinsler and P. Williams

**Three sets of Circards cover current-differencing amplifiers of the LM3900 kind. This article introduces the first, dealing with signal processing, and two subsequent ones will discuss generation and measurement and detection applications.**

In the process of improving on previous designs a stage is reached where further advances are won only with great difficulty. At that point the problem has to be changed if it is to be solved. Conventional operational amplifiers have reached a very high level of performance but the demands from industry were for still lower cost and for more functions in a given space. This could be met by packing four amplifiers into a standard 14-pin dual in-line package, using two pins for the power supplies and two inputs/one output for each amplifier. Unfortunately the chip size then increases to a level where yields fall off and the cost-saving in the packaging is partially neutralized.

When this conclusion was set alongside the continuing demand for amplifiers capable of operating from a single supply such as car batteries, a discontinuity appeared in the design process—an integrated-circuit amplifier was designed that depended on the difference between two input currents for its performance rather than the voltage differencing action of the conventional operational amplifier with its input long-tailed pair. The resulting design is brilliant, simple in concept but very subtly implemented.

To take advantage of its novel characteristic the user must re-think his philosophy. Most functions that can be carried out with operational amplifiers can be carried out with current-differencing amplifiers; the configurations may look similar; the component values may be comparable. This surface conformity can obscure the underlying differences, and the user should be chary of attempting a direct transposition of familiar circuits. The problems are similar to those faced by valve designers when transistors first appeared—transistors could be forced to operate in the known valve circuits but alternative arrangements were soon found to exploit the unique properties of these cold and fragile new devices that lacked the warming glow of the familiar friends.

It is to be assumed that what we are now seeing is but the first generation of current-differencing amplifiers, devices that seek to capture the largest possible market by accepting compromises in many areas. Before this article is published there may be high frequency/low noise/high power current-differencing amplifiers on sale, but the basic design techniques should be applicable to these just as users of the 709 can transfer their skills to the super-$\beta$, infinite bandwidth, zero drift op-amps that every self-respecting manufacturer now seems able to offer. In this article two sub-circuits are discussed which when combined give the prototypical form of the current-differencing amplifier now available as a quad amplifier in 14-pin dual in-line form.

One of these sub-circuits is a very old friend. Fig. 1 shows a common-emitter amplifier driving a common-collector or emitter follower stage. The current in the input stage is low enough, while a high current gain minimizes the output impedance. If overall feedback is applied as in Fig. 2, the transimpedance of the circuit is reasonably well-defined by $R_3$, i.e., for an input current $i$, the output voltage swing is close to $-iR_3$. This is assuming high enough gains that the input behaves as a virtual earth to signals. The quiescent $V_{be}$ of $\approx$0.6V prevents accurate low-level d.c. amplification, and this is a limitation shared by the monolithic i.c. based on this concept.

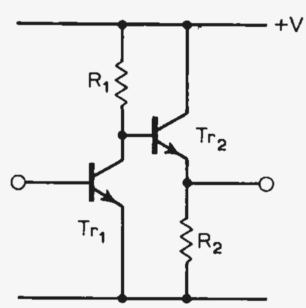


*Fig. 1*

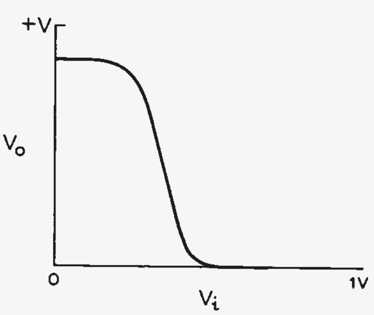


*Fig. 3*

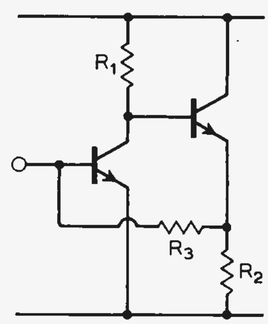


*Fig. 2*

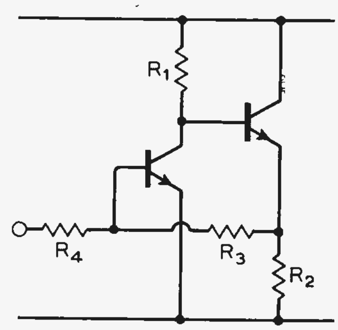


*Fig. 4*

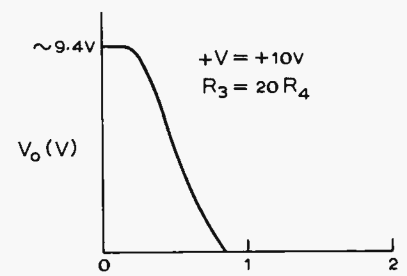


*Fig. 5*

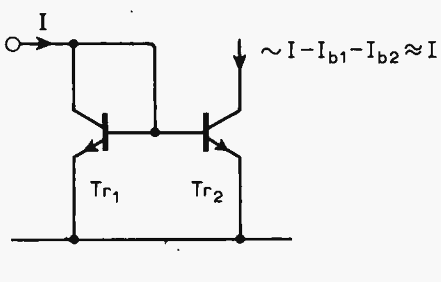


*Fig. 7*

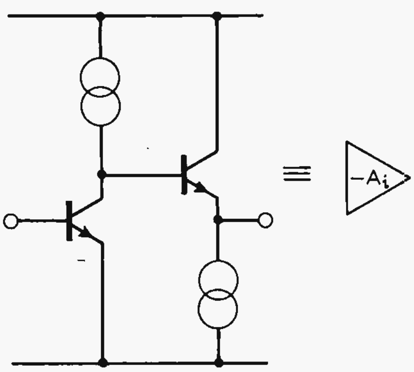


*Fig. 6*

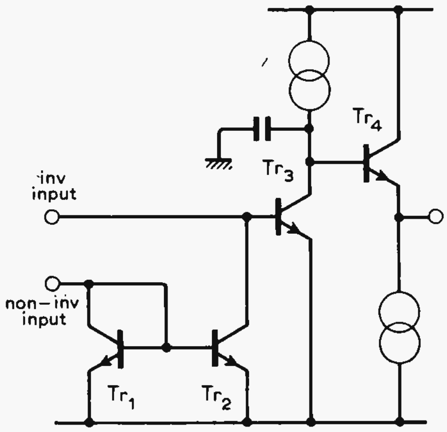


*Fig. 8*

The voltage transfer function is non-linear with a steep slope corresponding to a fairly high voltage gain, from a few tens to a few hundreds depending on supply voltage, resistance values, etc. An input resistor can be added to produce an elementary see-saw amplifier and the resulting voltage transfer function as shown in Fig. 5 is linearized by the negative feedback. Use of a voltage source short-circuits the negative feedback in the circuit of Fig. 2 which is intended as a current in/voltage out or transimpedance stage.

The circuit is the d.c. feedback pair and is already one of the most versatile problem-solvers for the hard-pressed designer. In monolithic i.c. form the ready availability of constant-current sources allows them to replace $R_1$ and $R_2$, as in Fig. 6. Two benefits accrue. First, the increased dynamic resistance boosts the gain, and secondly the transistor currents can be tightly controlled against wide variations in supply voltage and temperature. This latter effect ensures that the voltage gain is stabilized as well as being increased.

A second sub-circuit which is also well known is now added. Fig. 7 shows the current-mirror which plays the dual role in these amplifiers, to that played by the long-tailed pair in operational amplifiers. For well-matched transistors operated at equal $V_{be}$, the collector currents are comparable. The differences arise partly from inevitable imbalance in the transistors, partly because as shown the base currents contribute an error and partly because the collector-emitter voltages may differ. When a current-mirror is added to the d.c. feedback pair from Fig. 6 then a complete, albeit limited performance, current-differencing amplifier results (Fig. 8).

With negative feedback added the third source of error listed above is removed, because the collector potential of $Tr_2$ is constrained to equal that of $Tr_3$ base, i.e., $Tr_1$ and $Tr_2$ have comparable $V_{ce}$ values as well as identical $V_{be}$ values. With resistive feedback the output voltage is controlled by the difference between the two input currents. That at the inverting input would normally flow on through the feedback path (provided $Tr_3$ base current is small) while that at the non-inverting input is mirrored in the current drawn by $Tr_2$ collector, reducing the net input. Both currents are normally positive. Transistors $Tr_1$, $Tr_2$ are inoperative for negative currents while that in the inverting input may have either polarity. As a main advantage of the amplifier is that it can perform complex functions while requiring only a single-polarity supply, negative currents are not normally present except for some a.c./pulse circuits. Additional networks are provided in the practical amplifiers to clamp the inputs on negative voltage swings.

A more detailed description of the practical circuit will be given in a following article. This set of Circards (no. 16) is concerned with signal amplifying and processing, which will be followed by a series on the generation of signals and waveforms. In each of these areas novel solutions can be found, and we can only hope as users to match the ingenuity of the designers of these new amplifiers.

## Titles of cards in set 16 of Circards are

1 Current differencing amplifiers
2 Basic amplifiers 1
3 Basic amplifiers 2
4 Logic gates
5 High voltage amplifiers
6 Power amplifiers
7 Bandpass amplifiers
8 Notch filters
9 Low-pass/high-pass filters
10 Gain-controlled amplifiers

## What are Circards?

Circards are a new method of collating and presenting data about circuits in a compact and easily retrievable way. The sets of 203×127 mm (8×5-in) double-sided cards are designed for easy filing in standard boxes and for easy access at the desk or at the bench, where transparent plastics wallets keep the cards in good condition.

Each card normally describes operation of a selected circuit, gives *measured* performance data and graphs, component values and ranges, circuit limitations and modifications to alter performance. Suggestions for further reading are included together with cross references to related circuits on other cards. The Circard concept was outlined more fully in the October 1972 issue of *Wireless World.*

## How to get Circards

Order a subscription by sending £13.50 for a series of ten sets to
Circards
IPC Electrical-Electronic Press Ltd
General Sales Department, 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 £1.50, postage included (all countries). Make cheques payable to IPC Business Press Ltd.

Topics covered so far in Circards are
1 active filters
2 switching circuits (comparator and Schmitt circuits)
3 waveform generators
4 a.c. measurement
5 audio circuits (equalizers, tone controls, filters)
6 constant-current circuits
7 power amplifiers (classes A, B, C & D)
8 astable multivibrator circuits
9 optoelectronics: devices and uses
10 micropower circuits
11 basic logic gates
12 wideband amplifiers
13 alarm circuits
14 digital circuits
15 pulse modulators

Three sets deal with the uses of current differencing amplifiers—the first, set 16, being available shortly. Further sets will cover two-transistor circuits, multipliers and dividers, code converters, d.c. amplifiers and choppers, amplitude modulation and detection, transistor arrays, a.f. oscillators and voltage-to-frequency converters.

# New Products

## Power source

A power source capable of delivering 250VA single-phase output over the frequency range 45Hz to 20kHz is available from Wessex. Known as the model 251T, two or three can be combined with the appropriate oscillator to provide a 500 or 750VA three-phase supply. The unit employs overload protection by means of sensing both the magnitude and phase of the load current. Instantaneous reset occurs when the overload condition is corrected. Wessex Electronics Ltd, Stover Trading Estate, Yate, Bristol BS17 5QP.
**WW311 for further details**

## Portable oscilloscope

Telequipment have introduced the D32, a portable, dual trace, 10MHz oscilloscope with a provisional price of £250 inc. batteries. It will operate continuously for four hours on its internal batteries which are trickle-charged, from a built-in charging unit, when the instrument is powered from the mains supply. The D32 measures 105×235×288mm and facilitates a 70×56cm c.r.t. which uses a 3kV accelerating potential. A maximum sensitivity of 10mV/division is offered by both vertical amplifiers with the full bandwidth response. Television triggering facilities are incorporated and the dual-trace display is automatically switched from chopped sweep to alternate mode at sweep speeds above 0.1ms/division. Tektronix UK Ltd, Beaverton House, PO Box 69, Harpenden, Herts.
**WW313 for further details**

## Fan-top heat sinks

Clip on, fan-top heat dissipators for TO-5 transistor cases are claimed to more than double the allowable dissipation in free air. The TXBF-032-025B type dissipators employ beryllium copper spring fingers finished in black cadmium, and measure $\frac{1}{4}$in high by $\frac{3}{4}$in diameter. GDS Sales Ltd, Michaelmas House, Salt Hill, Bath Road, Slough, Bucks.
**WW314 for further details**

## RF speech clipper

A self-contained speech clipper which plugs in series with a microphone will effectively give ten times the peak power from a transmitter. The speech input signal is translated to a 60kHz s.s. suppressed-carrier signal and then amplified and "clipped". The signal is then filtered and demodulated to give an audio output with a greatly increased average-to-peak voltage ratio and greatly reduced harmonic distortion. The circuit, which uses c.m.o.s. and operational amplifiers, has an input sensitivity at 1kHz (at clipping threshold) of 8mV pk-to-pk and an input impedance of 60kΩ. The s/n ratio at clipping threshold is 45dB and the degree of r.f. clipping obtainable before the input stage begins to limit is 26dB. The unit, which uses a PP9 battery, costs £45 + v.a.t. Datong Electronics Ltd, 11 Moor Park Avenue, Leeds LS6 4BT.
**WW300 for further details**

## Insulated heat pipes

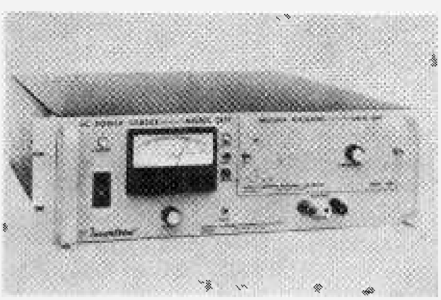
An electrically-insulated, thermally-conductive range of heat pipes is now available from Jermyn. The pipes, which are constructed from copper or stainless steel, have a ceramic insert along part of the tube and a wick material composed of continuous amorphous silica fibres which will withstand temperatures of up to 1,000°C. Multi-input assemblies can be manufactured with electrical isolation but thermally coupled to provide central cooling and thermal equalization. Jermyn Manufacturing, Sevenoaks, Kent.
**WW302 for further details**

## Flameproof resistors

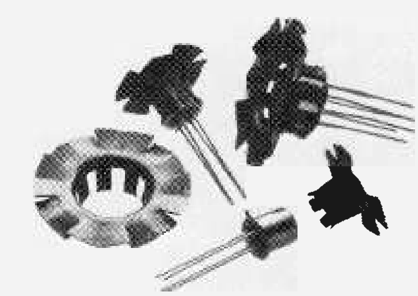
A range of self-extinguishing resistors named Flameproof act as fuses when overloaded instead of igniting as is the case with standard types. The resistors, which exist in ranges from $\frac{1}{4}$ to 10W, are available in values from 10Ω to 1.5MΩ (depending on rating) and with tolerances of 2 or 5%. Electrosil Ltd, Corning Electronics Europe, PO Box 37, Pallion, Sunderland, Durham SR4 6SU.
**WW301 for further details**

## Display screens

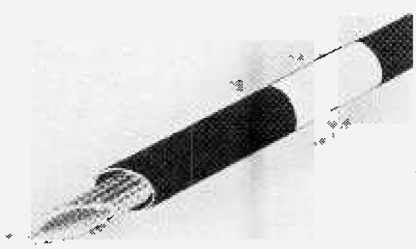
A series of 25 × 18cm display screens housed in modular cases have input terminals connected directly to the scan coils and have a transistorized e.h.t.



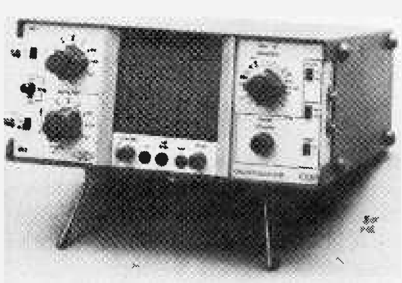
WW311



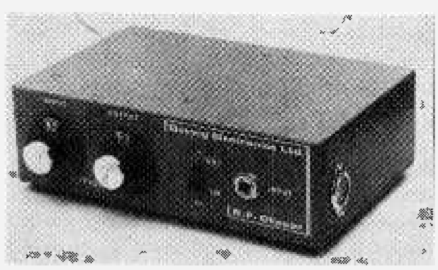
WW314



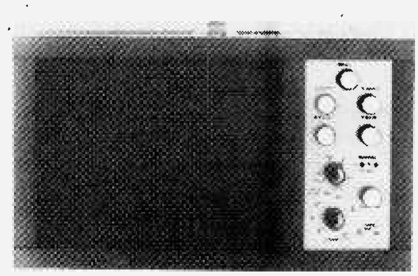
WW302



WW313



WW300



WW309

system fitted. A special blanked-off section is incorporated in the design for installing additional circuitry as required. The blanked-off sections are a similar size in each module but these sections can be sized to customer requirements. The photograph shows a wobbulator module, a complete instrument available from Chiltmead Ltd, 7/9 Arthur Road, Reading, Berks.
**WW309 for further details**

## Record brush

A record brush from Decca utilises over a million synthetic, electrically conductive fibres each with a diameter of nine microns. These fibres are small enough to penetrate the grooves of a record and remove any dust that may be present. The brush also has an aluminium top that allows static present on the disc to be discharged through the bristles into the body of the user. The record brush comes complete with its own cleaner/stand and costs £4.95 inc. v.a.t. Decca Special Products, Ingate Place, Queenstown Road, London SW8 3NT.
**WW315 for further details**

## Print-out calculator

The Centex 330 calculator features a silent print-out based on a thermal printing system developed by Contex Research. This system is completely solid state and will print at a speed of 45 digits per second. The calculator incorporates memory storage, overflow/underflow, percent operation with discount/nett feature, floating/fixed decimal point, and buffered keyboard. The buffer function stores all the information entered and automatically prints it in the correct sequence during calculation. The calculator, which is manufactured in Denmark, weighs approximately 4lb and costs £169 plus v.a.t. Broughton & Co Ltd, 6 Priory Road, Clifton, Bristol.
**WW316 for further details**

## L.e.d. dual sockets

Augat Inc. have introduced a new range of l.e.d. (or filament) display sockets suitable for mounting on p.c. boards. The sockets, which can be ganged up to ten units by means of a special extension, have gold-over-nickel-plated beryllium copper contacts which will accept round or flat leads. The range of sockets include models with 7 and 16 pins, as well as inclined sockets at 45°, 60° and 90°. Rastra Electronics Ltd, 275–281 King Street, London W6 9NF.
**WW305 for further details**

## Breadboards

A range of breadboards and bus strips with a 0.1in grid allows discrete components and i.cs to be plugged in and removed without soldering. Each terminal consists of five inter-connected tie points formed from prestressed, spring-loaded nickel/silver alloy giving secure mechanical and low-resistance electrical connections. The components plug in the breadboard and are interconnected with 24 s.w.g. hook-up wires. Bus strip is used to connect to a power supply. Jermyn Manufacturing, Sevenoaks, Kent.
**WW310 for further details**

## U.h.f. power amplifier

The latest addition to the MPD range of class A amplifiers is the model LWA 510-20. This unit will deliver 20W saturated power over the frequency range 500 to 1000MHz. The amplifier requires a d.c. supply of 24V at 5.5A to provide a gain of 48dB with a noise figure of 10dB and harmonics of −20dB minimum at 1dB compression. Microwave and Electronics Division, REL Equipment and Components Ltd, Croft House, Bancroft, Hitchin, Herts SG5 1BU.
**WW312 for further details**

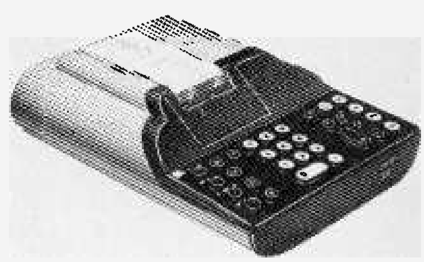
## Gain/phase meter

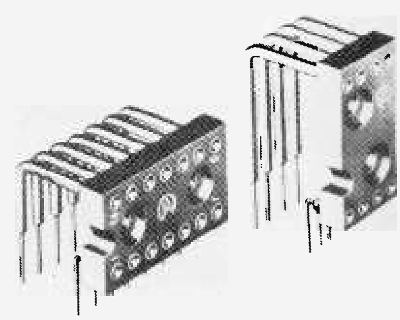
The model 305-PA-3009 gain/phase meter will give a direct digital readout of phase angle from −180° to +360° with input signals from 2Hz to 500kHz at levels from 1mV to 150V. An accuracy of ±0.1° in the frequency range 50Hz to 50kHz and ±0.25° from 2Hz to 500kHz is quoted for the meter. The instrument, which will also measure signal gain, has a switch to select reference voltage, signal voltage, signal/reference voltage ratio or signal/reference phase angle. These four quantities are also available simultaneously as proportional analogue voltages. A warning lamp is incorporated, indicating where the reference or signal levels exceed or fall below the permitted ratings of the input channel. Euro Electronic Instruments Ltd, Shirley House, 27 Camden Road, London NW1.
**WW317 for further details**

## Multiway connectors

The 30600 series of plug and socket connectors is designed to provide multiway patchboard programming on automatic test and computer equipment. The units feature a screw-operated insert/extract mechanism together with polarising pins. A variety of configurations up to 300 ways are available with each 1mm diameter, gold-on-silver plated pin having a rating of 7A at 250V r.m.s. The plug is fitted with a removable metal cover for access and the socket has drilled flanges for mounting on

WW315


WW316


WW305

equipment. Channel Electric Equipment Ltd, 18 Cross Street, Reading, Berks RG1 1BR.
**WW319 for further details**

## Hand-held multimeter

This multimeter is based on the Chinaglia 80μA moving coil unit. Range selection is by means of test lead sockets, and indication is on six coloured scales. The full-scale ranges are 100mV to 1.0kV d.c., and 5.0V to 1.5kV a.c., 100μA to 1.0A d.c., and 5.0mA to 0.5A a.c., 10kΩ to 1.0MΩ, and decibels from −10 to +65dB. The instrument's sensitivity is 10kΩ/V d.c. and 2kΩ/V a.c. with an accuracy of ±2.5% d.c. and ohms, ±3.5% a.c. The meter, which is powered by 2×1.5V batteries, measures 90×90×28mm and weighs 165 grams. Chinaglia, 19 Mulberry Walk, London SW3.
**WW304 for further details**

## Differential a.c. amplifier

The type 9454 differential amplifier exhibits a common mode rejection of 130dB at 1kHz and intermodulation products of 0.003% typical. The bandwidth of the 9454 is 0.1Hz to 2MHz at the −3dB point. The gain may be set to within 1% over the range 100 to 19dB. The controls for the instrument include bandwidth selection, high and low pass filters switchable in decade steps, line reject and external filter facilities, which may be switched in or out. L.e.ds are provided to indicate prefilter overload, and gain uncalibrated. The physical dimensions of the unit are 18×87×285mm. Brookdeal Electronics Ltd, Market Street, Bracknell RG12 1JU, Berks.
**WW303 for further details**

## Miniature axial fan

The 126LF is a 50/60Hz axial fan with a rotational speed of 2700r.p.m. at 50Hz and a corresponding maximum delivery of 13 litres/second. To obtain this delivery the motor requires 11W at 240V and will rise in temperature by 35°C. The fan has a five-bladed, glass-filled, flame-retardant impeller mounted in a diecast aluminium alloy housing. The motor is a two-pole, shaded-pole induction type with built-in impedance protection. A life expectancy of five years is claimed under normal generating conditions and in a temperature range from −10 to +70°C. The assembly is mounted by two square flanges containing fixing holes. Amphenol Ltd, Thanet Way, Whitstable, Kent CT5 3JF.
**WW308 for further details**

## Video delay unit

A variable video delay unit type UN3/9 can be inserted into 75Ω coaxial cable via BNC connectors to provide a delay from 3ns to 9ns, which is the equivalent of two to six feet of cable. The device is also useful in situations where temperature variations cause a delay change, in which case the unit is simply readjusted. Matthey Printed Products Ltd, William Clowes Street, Burslem, Stoke-on-Trent.
**WW325 for further details**

## Instrument cases

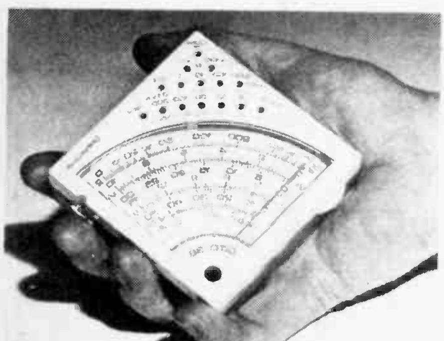
Two series of small instrument cases have now been added to Imhof-Bedco's range of enclosures. Series A cases are available in three sizes and have a single extrusion on each side with the top and bottom covers being formed to meet the side extrusions. The B series, available in four sizes, have extrusions at both the top and bottom of the sides which are joined by protruding handles. Adequate ventilation is provided on all models and an adjustable tilt foot is available as an optional extra. Imhof-Bedco Ltd, Ashley Works, Ashley Road, Uxbridge, Middlesex UB8 2SQ.
**WW307 for further details**

## High-power op-amp

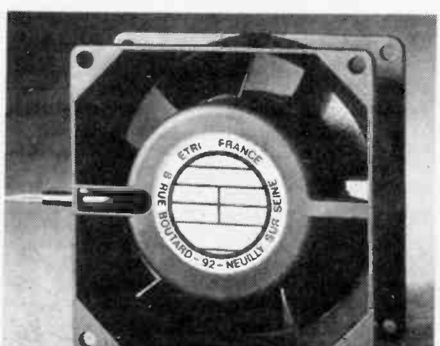
The IS741H150 is a high-power op-amp capable of driving loads as low as one ohm. The manufactures claim that the unit will deliver nearly 200W continuously into four ohms making it suitable for servo, switching and audio applications. The device is a hybrid type with thermal compensation, and an electrically-isolated heat sink. The amplifier, which plugs into a nine-pin socket, features 0.01% harmonic distortion at 1kHz, 30dB gain at 150W, and a unity-gain bandwidth of 2MHz. Application notes are available on request. Integral Systems, 500 Waltham Street, North Wilmington, Massachusetts 01887.
**WW326 for further details**

## Ferrite cores

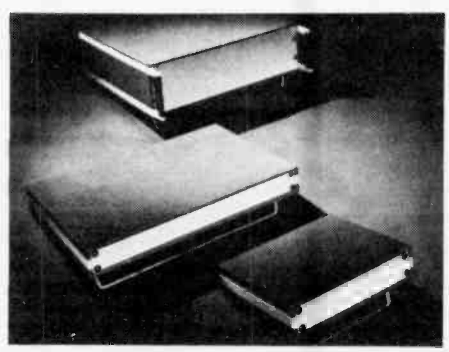
Mullard have announced a new series of four ferrite transformer cores. The cores have been developed for use in high frequency (25kHz), switched-mode power supplies from 50 to 500W. The improved ferrite material used in the construction maintains its magnetic characteristics at temperatures greater than 100°C. The cores are E-shaped and by means of bolts



WW304

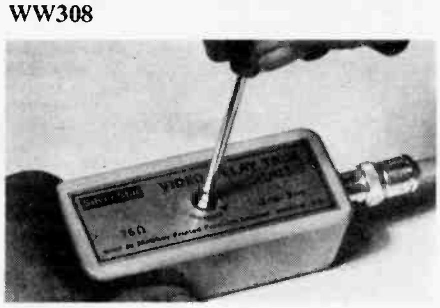



WW308

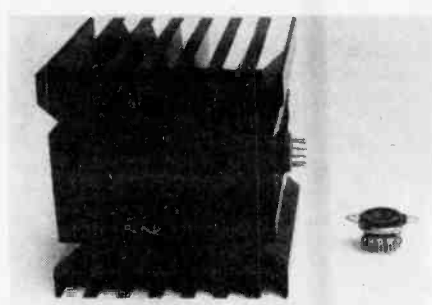


WW307


WW303



WW325



WW326

through grooves in the outer arms, two can be clamped together to make a transformer core assembly. For further information a booklet is available. Requests for copies, quoting reference TP1450, should be made on company-headed paper to: Instrumentation and Control Electronics Division, Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD.
**WW306 for further details**

## Variable oscillator

Ampex have introduced the VS-10 variable speed oscillator for professional audio recording applications. The unit is specifically designed for use with the Ampex MM-1100 and AG-440 series of recorders and is available with a four-digit electronic display. A range of ±1 full tone in quarter-tone steps is offered with a coarse/fine variable speed adjustment. The device, which will drive up to three recorders, weighs 2.5lb. Ampex Ltd, Acre Road, Reading, Berks.
**WW320 for further details**

## Multiturn potentiometer

A carbon-track multiturn preset potentiometer suitable for fine tuning applications is available with a rotation of either 25 or 40 turns. Designated the 197, the potentiometer offers a standard resistance of 100kΩ linear and diode law, with "specials" in the range 100Ω to 4.7MΩ linear, and 1kΩ to 2.2MΩ log. The device has a slipping clutch stop and has a life of 100 traverses in both directions within the temperature range of −30 to +60°C. AB Electronic Components Ltd, Abercynon, Glamorgan CF45 4SF.
**WW318 for further details**

## Miniature cut-out switch

A cut-out switch designed to prevent overload damage to motors and transformers is actuated by an overcurrent conditions only. In the "off" position a button projects which can only be reset manually. The switch mechanism incorporates a trip-free release, and three mounting options are available for central, slip-in or flange-with-map fixing. The overall size of the switch is 40×15×11mm and the maximum, ratings are 15A at 24V a.c./d.c., 6A at 240V a.c. with a breaking capacity of 10× input current. Swiss Instruments & Components Ltd, Swissinco House, Roebuck Road, Chessington, Surrey.
**WW327 for further details**

## Proximity switch

The model 8-210 solid-state proximity switch from Elliot Relays has a sensing distance, for ferrous metals, of 0.25 ±0.05in, and 0.10 ±0.01in for a precision version. These distances are approximately 50% less for non-ferrous metals. The switch, which weighs 1.5 oz, is housed in moulded epoxy resin with solder/push-on terminals. The device features a response time of 3ms for rapid and repetitive operation, together with different output options. Reverse polarity and momentary (60s) short-circuit protection is incorporated in the unit, which will supply 100mA at 20–30V d.c. into a resistive or inductive load. Elliott Relays, 70 Dudden Hill Lane, London NW10 1DJ.
**WW328 for further details**

## Etch-resistant transfers

A transfer set comprising ten cards has been introduced by PCB Transfer Systems. Each card has a different set of shapes such as d.i.l. i.cs, edge connectors, bands, etc., with board No. 1 being a mixed collection of symbols. The method of using these transfers is to rub down the p.c.b. with abrasive paper in order to clean it. Place the tacky side of the symbol down on the p.c.b. and rub the reverse side with a ball pen, lift off the film and smooth over by rubbing with the released paper to ensure that there is no "lift off" at the edges. The p.c.b. now only requires etching. The transfers can be rubbed away with wire wool to reveal the copper shape required. A complete set of ten cards costs £2; individual cards can be purchased for 22p each. E. R. Nicholls, 46 Lowfield Road, Stockport, Cheshire.
**WW329 for further details**

# Solid State Devices

**The names of suppliers of devices in this section are given in abbreviation after each entry and in full at the end of the section.**

## Photodiode array

A two-dimensional self-scanned array of photodiodes called the IPL2D1 has been announced by IPL. The device consists of a matrix of 64 × 64 sensors and is intended for measurement of width/area, particle counting, character recognition or similar applications. Scanning speeds are up to 5MHz giving over 1,000 frames per second. The device is on a silicon chip ¼in square encapsulated in a 24-lead d.i.l. package with a glass window. Customer "specials" can be produced with arrays from 5 × 20 up to 200 × 200 sensors using m.o.s. techniques. The price of the standard device is £200 each for 100 up quantities.
**WW 350 for further details** IPL

## Dual gate f.e.t.

Two new dual gate f.e.t.s from Motorola offer a common source power gain of 10dB and a noise figure of 6dB maximum at 500MHz. The 3N209 TO-27, and 3N210 micro-H package feature a low reverse transfer capacitance of 0.03pF maximum and built-in input protection zener diodes. The devices have a maximum drain-source voltage of 25V and maximum power dissipation of 300mW.
**WW 351 for further details** Motorola

## Silicon power transistors

The 2N6469, 2N6246, 47 and 48 are epitaxial base p-n-p power transistors featuring high gain at high current. Another series called the 2N6470, 71 and 72 are n-p-n types and may be used as complements to the above types. All of the transistors are in the TO-3 package and have a power dissipation rating of 125W at case temperatures up to 25°C. They differ in voltage ratings and in the currents at which the parameters are controlled.
**WW 352 for further details** RCA

## Clamper/damper diodes

A series of silicon diodes called CD-1 and DG-1 are designed for clamping circuits in horizontal deflection systems and damper applications. The diodes have a glass passivated construction and are hermetically sealed. The peak forward surge current at 75°C is 50A with an average forward current at 50°C of 1.5A. The typical forward recovery voltage is 30V for CG-1 and 25V for DG-1.
**WW 353 for further details** General Instrument

## Suppliers

Integrated Photomatrix Ltd, The Grove Trading Estate, Dorchester, Dorset.
Motorola Semiconductors, PO Box 8, 16 Chemin de la Voie-Creuse, 1211 Geneva 20, Switzerland.
RCA Ltd, Solid State-Europe, Sunbury-on-Thames, Middlesex.
General Instrument Europe S.p.A., 20149 Milano, P.zza Amendola 9, Italy.

# Real and Imaginary

by "Vector"

## Just drop me a line . . ?

Of all the sacred cows which ruminate at our expense over this sceptr'd isle, none are more permanent features of the landscape than the Post Office and the two broadcasting authorities. There's a curious love/hatred relationship between them and us; we heave a brick at one or the other now and again but it never occurs to us to have them put down and to replace them with an improved breed. The landscape without them would be rather like The Stag at Bay without the stag.

One reason for this, I suppose, is that they were there before we were born; institutions which always have been and always will be and which, like the laws of the Medes and Persians, alter not. Which is by no means the case, of course. The Post Office's monopoly in matters of telegraphic and telephonic communication dates back to less than a century; the BBC as a corporation is not yet 50 years old, while the IBA has chalked up a mere 20 years. So while it may be heresy to consider their destruction, it's by no means treasonable to question where the arm-lock they collectively exercise upon communications is justified.

Let's look at the Post Office first. Seemingly inviolate by reason of its monopolistic powers, it goes on losing millions every year while it fights a losing battle against events. Its parcel- and letter-carrying service is demonstrably much inferior to what it was 50 years ago; so also is its telegram service, which has been priced almost out of existence. On the credit side, it's making strenuous efforts to improve the telephone service although, perhaps inevitably, there's a school of thought that doesn't agree with the approach.

To return for a moment to letter-carrying, the reasons for the deterioration are plain to see. One is the sheer bulk of correspondence which now has to be handled and another is the high cost of labour necessary to move what is literally a mountain of paper around the country every day. Faced with such a situation, it's characteristic of a Civil Service-orientated monopoly to put a perfunctory patch on the creaking structure in the pious hope that the mechanism will continue to grind along until retirement, when the buck will pass to somebody else. As for the general public, they can lump it; they have to, because there isn't an alternative carrier.

It only needs a little touch of the Jules Verne to see that the letter, as we know it, is an archaic method of communication. I see that a recent estimate of the average cost of producing a business letter puts the figure at £3, which doesn't get us off to a promising start. Surely, in view of the electronics technology now available or in early prospect, the rational approach would be to dictate a communication to an office machine for automatic transference to a reciprocal device at destination, where a permanent record could be made if required? Private correspondence could be similarly dealt with; it could easily be arranged that no outside access to the message was possible.

I'll come back to this shortly but for the moment let's digress on to radio communication and broadcasting in particular, which is another thing we tend to accept without question.

Now, in terms of keeping in touch with mobile objects such as ships, aircraft and land vehicles, radio is the only feasible method, but for entertainment dissemination it could be a very different story. True, a case for the continuance of sound broadcasting can be advanced on the basis of its use by motorists; privately, I've an uneasy feeling that car radios, by diverting concentration, may be the cause of more accidents than is generally admitted, but we won't argue that one. Instead, let's put television broadcasting under the spotlight.

As a system it wastes power. In order that the signals should reach the places we want them to, they must also dissipate themselves unprofitably in all sorts of useless ways—in girderwork, building and even (as recent correspondence in *Wireless World* has pointed out) in trees. With the quasi-optical ranges obtainable at v.h.f. and u.h.f. we have to have a proliferation of stations in order to cover such a small area as the UK and even then with a degeneration in sig./noise ratio all the way. The video component takes up a lot of bandwidth in relation to the amount of information it carries, while further sizeable sections of the band have to lie fallow in the cause of station separation; this is serious because r.f. bandwidth is an inelastic commodity and in acutely short supply.

As you'll have gathered by now, over in the blue corner, sparring away busily with all digitals, is radio's traditional enemy the cable. If, instead of broadcasting the TV signals, you transfer them from analogue to digital form and pipe them to destination, all sorts of advantages accrue. *En-route* signal distortion is considerably reduced; there are no fringe areas of reception because the signals can conveniently be boosted at intervals; a far more efficient use is made of the power input (you're not wasting kilowatts any more) and a greater choice of programmes becomes possib e. Whereas, under the broadcast system, four services are the maximum for the foreseeable future, line communication by coaxial cable, waveguide or possibly the fibre-optics approach, can provide as many as you want.

The advantages by no means end there; the receiver itself becomes simpler; the unsightly assortment of fishbone arrays which clutter our rooftops could be turned into scrap and re-cycled, while the picture itself would be freed from the vagaries of the ionosphere and troposphere, with co-station interference a thing of the past. With plenty of bandwidth to play with, something approaching realism in colour reproduction could be achieved, either by transmitting full R-G-B information or even, perhaps, by moving to seven-colour reproduction! Over and above all this, the radio frequencies now allocated to television broadcasting would be freed for other and more vital services where radio communication is essential.

Unfortunately, there's just one leetle snag in these proposals, namely that neither industry in its factories and offices, nor Joe Bloggs in his semi-detached, has anything more wideband than a nineteenth-century telephone line connecting him with the outside world. Nor, as far as I can see, have they any prospect of getting a wideband service in the reasonably near future. Which brings us back to the Post Office and its monopoly. Presumably their standpoint is that they've neither the money nor the effort.

Fair enough. But we're no longer in the nineteenth century; we're almost in the twenty-first, and our information is still being humped around by the ton instead of by weightless electrical signals. So why not remove the Post Office monopoly on installing cable for money and let private enterprise see what it can do? If broadcasting as we know it founders in the process, what does it matter if it's replaced by something better?

In the USA they order things differently and—let's admit it—not always for the best. But over there, cable systems seem to be making significant headway after only a relatively short period, and although at the moment they don't offer any real threat to the "off-air" broadcasts there are already over 90,000 installations in New York. Other cities are following suit.

To conform with the requirements of the Federal Communications Commission, four kinds of access channels are provided, namely, public, educational, government and leased. Of these, the public access channel is a new phenomenon: the cable company provides a minimal amount of equipment—cameras, v.t.rs and so on—and anyone who fancied his or her chance with entertainment or a message can have five minutes' free time, or longer if it's paid for at cost. This "do-it-yourself" local broadcasting tramples across the mystique-laden fields of professional programme production. It might catch on; it might die the death; but at any rate one can never accuse the USA of reluctance to have a go.

# All's clear even in fog.

# With EEV millimetre wave magnetrons.

Photograph by courtesy of British Airport Authority.

London Heathrow is the world's busiest international air terminal. At peak periods it handles over 800 flights a day, and over 20,000,000 passengers a year.

To avoid ground collisions, controllers must know where everything is at all times – in all weathers.

At Heathrow they get a clear view even in fog with high-definition radar incorporating EEV's millimetre wave magnetrons.

EEV has one of the most extensive and advanced millimetre wave tube capabilities in the world.

EEV's M5059 is an 8mm frequency agile magnetron with advanced piezo-electric tuning. This is the tube for rapid tuning, long life and complete reliability.

The lightweight M5057 is a unique EEV 4mm pulse magnetron which operates at pulse lengths as short as 4nS with high rates of rise in voltage.

For the clearest answers to all questions of high definition radar – commercial or military – ask our microwave engineers at Chelmsford. Write or 'phone for data.

LAP 89

## EEV and M-OV know how.

ENGLISH ELECTRIC VALVE CO LTD, Chelmsford, Essex, England CM1 2QU. Tel: 0245 61777. Telex: 99103. Grams: Enelectico Chelmsford. GEC E

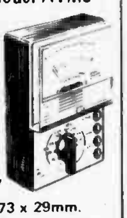
WW—021 FOR FURTHER DETAILS

WW—050 FOR FURTHER DETAILS

# ASK LASKYS and make no mistake

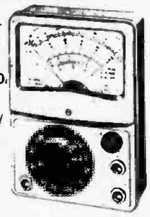
## AUDIOTRONIC Model ATM1

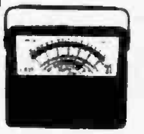
Top value 1,000 opv pocket multi-meter. Ranges:–0/10/50/250/1,000 volt AC and DC. DC current 0·1mA/100mA. Resistence: 0/150k ohms. Decibels: –10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.
**OUR PRICE £3.25** P&P 15p

## AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgwise 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 £3.95** P & P 20p

## MODEL TH12

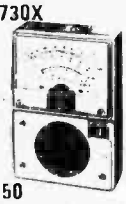
20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. –20 to +50dB.
**OUR PRICE £5.95** P&P 30p

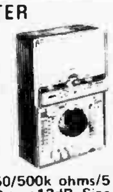
## HIOKI Model 720X VOM

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 £5.97** P&P 30p

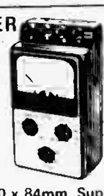
## MODEL PL436

20,000 opv DC. 8000 opv AC. Mirror scale 6/3/12/30/120/600V DC. 3/30/120/600V DC. 50/600µA/60/600mA. 10/100K/1 Meg/10 Meg Ohm. –20 to +46 dB.
**OUR PRICE £6.97** P&P 30p

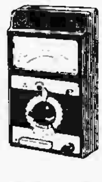
## U4323 MULTIMETER

20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: x 10, x 100, x 1,000, x 10,000 (50Ω, 500Ω, 5kΩ, 50kΩ centre scale) Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.
**OUR PRICE £7.00** P&P 30p

## MODEL HIOKI 730X

30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/µA/30mA/300mA. 2K/200K/2 Meg Ohm. 10 to 63 dB.
**OUR PRICE £7.50** P&P 30p

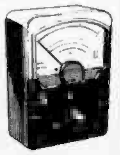
## U4324 MULTIMETER

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. Resistence: 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 30p

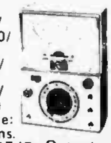
## U435 MULTIMETER

20,000opv. Overload protected. Ranges: 75mV/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 30p

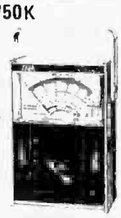
## U4312 MULTIMETER

extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/60/600mA/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 50p

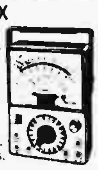
## U91 Clamp VOLT AMMETER

For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.
**OUR PRICE £10.50** P&P 30p

## 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/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.
**OUR PRICE £13.95** Carr. paid
Leather case for above £1.75

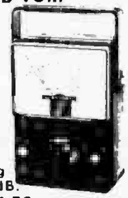
## HIOKI 750X VOLT-OHM-MILLIAMETER

43 ranges: 0–0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0–3/6/15/30/60/120/300/600/1,200V AC. Current: 0–30/60uA/1.5/3/15/30/150/300 mA/6/12A. Resistence: 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

## TMK MODEL TW50K

46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistence: 10k/100k/1 Meg/10 Meg ohms. –20 to +81.5dB.
**OUR PRICE £12.50** P&P 20p

## HIOKI MODEL 700X

100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. –20 to +63dB.
**OUR PRICE £14.95** P&P 30p

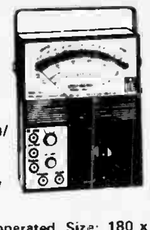
## Model HT100B4 MULTIMETER

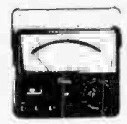
Overload protected, shock proof circuits. 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1/50/250/500/1,000 Volts DC. 2.5/10/50/250/1,000 Volts AC. DC resistence' 0–20/200k/2/20 Meg. ohms. DC current:– 10/250uA/2.5/25/250 mA/10A. AC current:–0–10A. –20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.
**OUR PRICE £17.50** P&P 40p

## MODEL AS.100D VOM

100,000 opv. Mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10µA/6/60/300mA/12 Amp. 0/2K/200K/2M/200 Meg Ohm. –20 to 17dB.
**OUR PRICE £17.50** P&P 30p.

## KAMODEN TT35 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 £17.50** P & P 40p

## KAMODEN 360 MULTIMETER

High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0,5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100M ohms. Decibels –20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with, test leads etc.
**OUR PRICE £17.50** P & P 40p

## TMK MODEL 117 FET ELECTRONIC VOLTMETER

Battery operated. 11 Meg input, 26 ranges. Large 4¼" mirror scale. Size: 149x117x60mm. 0.3–12000V DC. 3–300V RMS AC. 8–800V P-P. DC current 0.12–12mA. Resistence up to 2000MOhms. Decibels: –20 to +51dB. Supplied complete with leads and instructions.
**OUR PRICE £18.50** P&P 20p

## TMK 100K LAB TESTER

100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/10/100/500mA/2.5/10A. Resistence: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: –10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.
**OUR PRICE £19.95** P&P 30p

## 370WTR MULTIMETER

Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC. 0/2.5/10/50/250/500/1000V 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 £19.95** P&P 30p

## KAMODEN 72.200 Multitester

High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges:–0/.06/.3 3/30/120/600/1200V DC. 0/3 12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.
**OUR PRICE £22.50** P&P 30p

## U4317 MULTIMETER

High sensitivity instrument for field and laboratory work. Knife edge pointer, 86mm. mirror scale. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V 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 40p

## 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/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3 /7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.
**OUR PRICE £49.00** P&P 50p

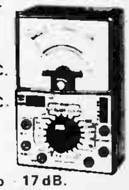
**ALL PRICES EXCLUDE VAT**

## TE65 VALVE VOLTMETER

28 ranges. DC volts 1.5–1500V. 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 50p
Additional probes available: RF £2.12, HV £2.50

## LB3 TRANSISTOR TESTER

Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.
**OUR PRICE £3.95** P&P 20p

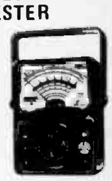
## MODEL AF.105 VOM

50,000 opv. Mirror scale. Meter protection. 0/3/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600/1200V DC. 0/30µA/6/60/300 mA/12 Amp. 0/10K/1m/10m/100 Meg Ohms. –20 to 17dB.
**OUR PRICE £12.50** P&P 30p.

## LB4 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

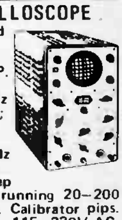
## U4341 Multimeter & Transistor Tester

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. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k 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 30p

## S100TR MULTIMETER TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/6/12A DC 0/10k/1 Meg/100 Meg. –20 to +50dB. 0.01–0.2 MFD Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.
**OUR PRICE £19.95** P&P 25p

## KAMODEN HMG500 insulation resistance tester

Range 0–1,000 Megohms, 500V. Battery operated. Wide range clear meter 4" x 4¾". Complete with deluxe carrying case, batteries and instructions.
**OUR PRICE £19.95** P&P 30p

## CI5 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1–25; HOR. AMP. Bandwidth: 500kHz. Sensitivity ay 100kHz VRMS/mm: 0.3–25 Preset triggered sweep 1–3000usec. Free running 20–200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115–230V AC.
**OUR PRICE £39.00** Carr. paid

## RUSSIAN CI16 Double Beam OSCILLOSCOPE

5 MHz 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

Also see following pages

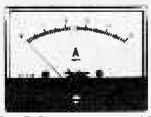
# SEW CLEAR PLASTIC PANEL METERS

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.

*Items with asterisk are Moving Iron type, all others are Moving Coil

## CLEAR PLASTIC MODEL SD640
Size: 85 x 64mm



| | | | |
|---|---|---|---|
| 50uA | £3.80 | 10V DC | £3.65 |
| 100uA | £3.75 | 20V DC | £3.65 |
| 200uA | £3.70 | 50V DC | £3.65 |
| 500uA | £3.65 | 300V DC | £3.65 |
| 50-0-50uA | £3.75 | 15V AC | £3.75 |
| 100-0-100uA | £3.70 | 300V AC | £3.75 |
| 1mA | £3.65 | VU Meter | £3.90 |
| 5mA | £3.65 | | |
| 10mA | £3.65 | | |
| 50mA | £3.65 | | |
| 100mA | £3.65 | | |
| 500mA | £3.65 | | |
| 1A DC | £3.65 | | |
| 5A DC | £3.65 | | |
| 10A DC | £3.65 | | |
| 5V DC | £3.65 | | |

## CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm

| | | | |
|---|---|---|---|
| 50uA | £4.60 | 150V AC | £4.45 |
| 100uA | £4.50 | 300V AC | £4.45 |
| 500uA | £4.30 | VU Meter | £4.90 |
| 50-0-50uA | £4.50 | | |
| 100-0-100uA | £4.45 | | |
| 1mA | £4.30 | | |
| 1A DC | £4.30 | | |
| 5A DC | £4.30 | | |
| 20V DC | £4.30 | | |
| 50V DC | £4.30 | | |
| 300V DC | £4.30 | | |

## EDGWISE MODEL PE70
Size: 90 x 34mm

| | |
|---|---|
| 50uA | £4.15 |
| 100uA | £4.10 |
| 200uA | £4.05 |
| 500uA | £3.90 |
| 50-0-50uA | £4.10 |
| 100-0-100uA | £4.05 |
| 1mA | £3.85 |
| 300V AC | £3.95 |
| VU Meter | £4.30 |

## MODEL ED107 EDUCATIONAL METER
Size: 100 x 90 x 150mm including terminals

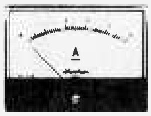
A range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working.

| | | | |
|---|---|---|---|
| 50uA | £8.50 | 20V DC | £7.60 |
| 100uA | £7.90 | 50V DC | £7.60 |
| 50-0-50uA | £7.90 | 300V DC | £7.60 |
| 1mA | £7.60 | 500mA/5A DC | £8.60 |
| 1-0-1mA | £7.60 | 5V/50V DC | £8.60 |
| 1A DC | £7.60 | 5V/15V DC | £8.60 |
| 5A DC | £7.60 | 1/5A DC | £8.60 |
| 5V DC | £7.60 | 1A/15A DC | £8.60 |
| 10V DC | £7.60 | | |
| 15V DC | £7.60 | | |

## CLEAR PLASTIC MODEL MR 85P
Size: 120 x 110mm

| | | | |
|---|---|---|---|
| 50uA | £5.45 | 300V DC | £5.20 |
| 100uA | £5.40 | 15V AC | £5.30 |
| 200uA | £5.35 | 300V AC | £5.30 |
| 500uA | £5.25 | S Meter 1mA | £5.20 |
| 50-0-50uA | £5.40 | VU Meter | £5.55 |
| 100-0-100uA | £5.35 | 1A AC | * £5.20 |
| 500-0-500uA | £5.20 | 5A AC | * £5.20 |
| 1mA | £5.20 | 10A AC | * £5.20 |
| 1-0-1mA | £5.20 | 20A AC | * £5.20 |
| 5mA | £5.20 | 30A AC | * £5.20 |
| 10mA | £5.20 | | |
| 50mA | £5.20 | | |
| 100mA | £5.20 | | |
| 500mA | £5.20 | | |
| 1A DC | £5.20 | | |
| 5A DC | £5.20 | | |
| 15A DC | £5.20 | | |
| 30A DC | £5.40 | | |
| 10V DC | £5.20 | | |
| 20V DC | £5.20 | | |
| 50V DC | £5.20 | | |
| 150V DC | £5.20 | | |

## CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm



| | | | |
|---|---|---|---|
| 50uA | £4.30 | 10V DC | £4.10 |
| 100uA | £4.25 | 20V DC | £4.10 |
| 200uA | £4.20 | 50V DC | £4.10 |
| 500uA | £4.15 | 300V DC | £4.10 |
| 50-0-50uA | £4.25 | 15V AC | £4.20 |
| 100-0-100uA | £4.20 | 300V AC | £4.20 |
| 1mA | £4.10 | VU Meter | £4.40 |
| 5mA | £4.10 | | |
| 10mA | £4.10 | | |
| 50mA | £4.10 | | |
| 100mA | £4.10 | | |
| 500mA | £4.10 | | |
| 1A DC | £4.10 | | |
| 5A DC | £4.10 | | |
| 10A DC | £4.10 | | |
| 5V DC | £4.10 | | |

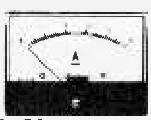
## CLEAR PLASTIC MODEL MR 45P
Size: 50 x 50mm

| | | | |
|---|---|---|---|
| 50uA | £3.20 | 300V AC | £3.05 |
| 100uA | £3.15 | S Meter 1mA | £2.95 |
| 200uA | £3.10 | VU Meter | £3.40 |
| 500uA | £3.00 | 1A AC | * £2.95 |
| 50-0-50uA | £3.15 | 5A AC | * £2.95 |
| 100-0-100uA | £3.10 | 10A AC | * £2.95 |
| 500-0-500uA | £2.95 | 20A AC | * £2.95 |
| 1mA | £2.95 | 30A AC | * £2.95 |
| 5mA | £2.95 | | |
| 10mA | £2.95 | | |
| 50mA | £2.95 | | |
| 100mA | £2.95 | | |
| 500mA | £2.95 | | |
| 1A DC | £2.95 | | |
| 5A DC | £2.95 | | |
| 10V DC | £2.95 | | |
| 20V DC | £2.95 | | |
| 50V DC | £2.95 | | |
| 300V DC | £2.95 | | |
| 15V AC | £3.05 | | |

## CLEAR PLASTIC MODEL MR 38P
Size: 42 x 42mm

| | | | |
|---|---|---|---|
| 50uA | £3.10 | 20V DC | £2.80 |
| 100uA | £3.05 | 50V DC | £2.80 |
| 200uA | £3.00 | 100V DC | £2.80 |
| 500uA | £2.85 | 150V DC | £2.80 |
| 50-0-50uA | £3.05 | 300V DC | £2.85 |
| 100-0-100uA | £3.00 | 500V DC | £2.85 |
| 500-0-500uA | £2.80 | 750V DC | £2.90 |
| 1mA | £2.80 | 15V AC | £2.90 |
| 1-0-1mA | £2.80 | 50V AC | £2.90 |
| 2mA | £2.80 | 150V AC | £2.90 |
| 5mA | £2.80 | 300V AC | £2.90 |
| 10mA | £2.80 | 500V AC | £3.00 |
| 20mA | £2.80 | S Meter 1mA | £2.80 |
| 50mA | £2.80 | VU Meter | £3.20 |
| 100mA | £2.80 | | |
| 150mA | £2.80 | | |
| 200mA | £2.80 | | |
| 300mA | £2.80 | | |
| 500mA | £2.80 | | |
| 750mA | £.280 | | |
| 1A DC | £2.80 | | |
| 2A DC | £2.80 | | |
| 5A DC | £2.80 | | |
| 10A DC | £2.80 | | |
| 3V DC | £2.80 | | |
| 10V DC | £2.80 | | |
| 15V DC | £2.80 | | |

## CLEAR PLASTIC MODEL SD460
Size: 59 x 46mm



| | | | |
|---|---|---|---|
| 50uA | £3.50 | 10V DC | £3.30 |
| 100uA | £3.45 | 20V DC | £3.30 |
| 200uA | £3.40 | 50V DC | £3.30 |
| 500uA | £3.35 | 300V DC | £3.30 |
| 50-0-50uA | £3.45 | 15V AC | £3.45 |
| 100-0-100uA | £3.40 | 300V AC | £3.45 |
| 1mA | £3.30 | VU Meter | £3.65 |
| 5mA | £3.30 | | |
| 10mA | £3.30 | | |
| 50mA | £3.30 | | |
| 100mA | £3.30 | | |
| 500mA | £3.30 | | |
| 1A DC | £3.30 | | |
| 5A DC | £3.30 | | |
| 10A DC | £3.30 | | |
| 5V DC | £3.30 | | |

POSTAGE & PACKING 15p

## CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm

| | | | |
|---|---|---|---|
| 50uA | £3.95 | 300V DC | £3.70 |
| 100uA | £3.85 | 15V AC | £3.80 |
| 200uA | £3.80 | 50V AC | £3.80 |
| 500uA | £3.75 | 150V AC | £3.80 |
| 50-0-50uA | £3.85 | 300V AC | £3.90 |
| 100-0-100uA | £3.80 | 500V AC | £3.80 |
| 500-0-500 A | £3.70 | S Meter 1mA | £4.10 |
| 1mA | £3.70 | VU Meter | £3.70 |
| 1-0-1mA | £3.70 | 1A AC | * £3.70 |
| 5mA | £3.70 | 5A AC | * £3.70 |
| 10mA | £3.70 | 10A AC | * £3.70 |
| 50mA | £3.70 | 20A AC | * £3.70 |
| 100mA | £3.70 | 30A AC | * £3.70 |
| 500mA | £3.70 | 50mA AC | * £3.70 |
| 1A DC | £3.70 | 100mA AC | * £3.70 |
| 5A DC | £3.70 | 200mA AC | * £3.70 |
| 10A DC | £3.70 | 500mA AC | * £3.70 |
| 15A DC | £3.70 | | |
| 20A DC | £3.80 | | |
| 30A DC | £3.85 | | |
| 50A DC | £4.05 | | |
| 5V DC | £3.70 | | |
| 10V DC | £3.70 | | |
| 15V DC | £3.70 | | |
| 20V DC | £3.70 | | |
| 50V DC | £3.70 | | |
| 150V DC | £3.70 | | |

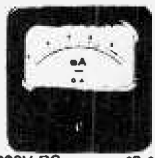
## BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm

| | |
|---|---|
| 50uA | £4.50 |
| 100uA | £4.45 |
| 500uA | £4.20 |
| 50-0-50uA | £4.45 |
| 100-0-100uA | £4.40 |
| 1mA | £4.20 |
| 1A DC | £4.20 |
| 5A DC | £4.20 |
| 20V DC | £4.20 |
| 50V DC | £4.20 |
| 300V DC | £4.20 |
| 300V AC | £4.30 |
| VU Meter | £4.70 |

## CLEAR PLASTIC MODEL MR 52P
Size: 60 x 60mm

| | | | |
|---|---|---|---|
| 50uA | £3.70 | S Meter 1mA | £3.30 |
| 100uA | £3.50 | VU Meter | £3.30 |
| 500uA | £3.35 | 1A AC | * £3.30 |
| 50-0-50uA | £3.50 | 5A AC | * £3.30 |
| 100-0-100uA | £3.45 | 10A AC | * £3.30 |
| 1mA | £3.30 | 20A AC | * £3.30 |
| 5mA | £3.30 | 30A AC | * £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 | | |
| 300V DC | £3.30 | | |
| 15V AC | £3.40 | | |
| 300V AC | £3.40 | | |

## BAKELITE MODEL MR 65 Size: 80 x 80mm



| | | | |
|---|---|---|---|
| 25uA | £5.25 | 300V DC | £3.60 |
| 50uA | £4.00 | 30V AC | * £3.60 |
| 100uA | £3.95 | 50V AC | * £3.60 |
| 500uA | £3.65 | 150V AC | * £3.60 |
| 50-0-50uA | £3.95 | 300V AC | * £3.60 |
| 100-0-100uA | £3.90 | 500V AC | * £3.60 |
| 500-0-500uA | £3.60 | VU Meter | £4.10 |
| 1mA | £3.60 | 1A AC | * £3.60 |
| 1-0-1mA | £3.60 | 5A AC | * £3.60 |
| 5mA | £3.60 | 10A AC | * £3.60 |
| 10mA | £3.60 | 20A AC | * £3.60 |
| 50mA | £3.60 | 30A AC | * £3.60 |
| 100mA | £3.60 | 50A AC | * £3.60 |
| 500mA | £3.60 | 500mA AC | * £3.60 |
| 1A DC | £3.60 | 50mV DC | £3.75 |
| 2A DC | £3.60 | 100mV DC | £3.75 |
| 5A DC | £3.60 | | |
| 10A DC | £3.60 | | |
| 15A DC | £3.60 | | |
| 30A DC | £3.60 | | |
| 50A DC | £3.80 | | |
| 5V DC | £3.60 | | |
| 10V DC | £3.60 | | |
| 15V DC | £3.60 | | |
| 20V DC | £3.60 | | |
| 50V DC | £3.60 | | |
| 150V DC | £3.60 | | |

**240° Wide Angle 1mA METERS**
MW 1–6 60x60mm
£6.50 P&P 15p

## YAMABISHI VARIABLE VOLTAGE TRANSFORMERS

Excellent quality at low cost. Input: 230V 50/60Hz. Output 0–260V.

MODEL S260 BENCH MOUNTING

| | | P&P |
|---|---|---|
| 1A | £10.50 | 50p |
| 2.5A | £12.00 | 50p |
| 5A | £17.50 | 50p |
| 8A | £30.35 | £1.00 |
| 10A | £33.75 | £1.00 |
| 12A | £35.40 | £1.00 |
| 20A | £85.00 | £1.50 |
| 25A | £87.50 | £1.50 |
| 40A | £99.95 | £1.50 |

MODEL S260B PANEL MOUNTING

| | | |
|---|---|---|
| 1A | £10.00 | 50p |
| 2.5A | £12.00 | 50p |

**ALL PRICES EXCLUDE VAT**

ASK LASKYS

**FOR MAIL ORDER**

We offer a speedy and efficient service by mail order. Remember to add 10% VAT to total value of goods including post and packing.

TO LASKYS HEAD OFFICE AND MAIL ORDER DEPARTMENT
Audiotronic House, The Hyde, London NW9 6JJ. Tel: 01-205 5651/3735

Please send me the following items ______

TOTAL PURCHASE PRICE ______ (inc. P&P and VAT)

HI-FI PRICE LIST — TICK HERE

I enclose cheque ☐ postal order ☐ money order ☐

I wish to pay by Barclaycard/Access and my number is ______

NAME ______

ADDRESS ______

Signature ______

Registered in England No 347947 at 12 Lower Grosvenor Place, London SW1 0EX WW8

ASK LASKYS about Hi fi

**CALL INTO YOUR NEAREST LASKYS BRANCH OR SEND COUPON BELOW FOR FREE HI-FI PRICE LIST**

### CENTRAL LONDON

| | |
|---|---|
| 481 OXFORD ST. | 01-493 8640 |
| 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 |
| 10 TOTTENHAM CT. RD. | 01-637 2232 |
| 27 TOTTENHAM CT. RD. | 01-636 3715 |
| 33 TOTTENHAM CT. RD. | 01-636 2605 |
| 42/45 TOTTENHAM CT. RD. | 01-636 0845 |
| 257/8 TOTTENHAM CT. RD. | 01-580 0670 |

### ESSEX
86 SOUTH ST. ROMFORD 20218

### KENT
53/57 CAMDEN RD., TUNBRIDGE WELLS 0892-23242

### LEICESTERSHIRE
45 MARKET PLACE, LEICESTER 0533-537678

### SURREY
1046 WHITGIFT CENTRE, CROYDON 01-681 3027
27 EDEN ST. KINGSTON 01-546 7845
32 HILL ST. RICHMOND 01-948 1441

### WARWICKSHIRE
116 CORPORATION ST., BIRMINGHAM 021-236 3503

ALL BRANCHES OPEN FROM 9am to 6pm MON. TO SAT.

West End Service Centre now open at 87 Tottenham Court Rd. W.1. 01-580 3739

**BARCLAYCARD & ACCESS**
Holders welcome call into any branch or telephone your order to head office.
CREDIT TERMS available for Personal Shoppers

**EXPORT** Personal exports arranged for overseas visitors. Goods specially packed, insured and despatched to all parts of the world at minimum cost exclusive of VAT. Payment by bank transfer, certified cheque, postal order or money order in any currency.

**NO DEPOSIT TERMS available on most goods for personal callers**

CHEQUES TO THE VALUE OF £30. ACCEPTED FROM PERSONAL SHOPPERS WITH BANKERS CARD. IN OTHER CASES AND FOR AMOUNTS IN EXCESS OF £30. PLEASE ALLOW TIME FOR CLEARANCE. BANKERS DRAFTS ACCEPTED.

All prices correct at 15/7/74 but subject to change

*A member of the Audiotronic Group of Companies*

# 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 sent free on request. 10p stamp appreciated.

**PLEASE ADD 10% V.A.T.**

## RESISTORS

½W Iskra high stability carbon film—very low noise—capless construction. ⅓W Mullard CR25 carbon film—very small body size 7·5 x 2·5 mm. ¼W 2% ELECTROSIL TRS.

| Power watts | Tolerance | Range | Values available | Price 1–99 | Price 100+ |
|---|---|---|---|---|---|
| ½ | 5% | 4·7Ω–2·2MΩ | E24 | 1.3p | 1·1p |
| ½ | 10% | 3·3MΩ–10MΩ | E12 | 1.3p | 1·1p |
| ¼ | 2% | 10Ω–1MΩ | E24 | 3·5p | 3p |
| ⅓ | 10% | 1Ω–3·9Ω | E12 | 1.3p | 1·1p |
| ⅓ | 5% | 4·7Ω–1MΩ | E12 | 1.3p | 1·1p |
| 4 | 10% | 1Ω–10Ω | E12 | 8p | 7p |

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 ½W, lin ½W).
Single, 14p. Dual gang (stereo), 49p. Single D.P. switch, 28p.

## 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.

## 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.

Detector GDI, £2. Suitable case £1.50. **Smoke and Gas Detector Kits**—Mains operated with audible alarm £5.60; mains operated meter indicator £7.90; mains/battery, gas leak detector £12.60; 12/24v battery operated £8.40; 12v battery operated two remote sensors £12.80.

NOTE The battery operated kits incorporate our potented circuit to minimise battery drain. Typically 120mA for 12v. These kits contain all parts required with the exception of case. Suitable case mains operated kit £1.60. Battery operated kits £5.

## MULLARD POLYESTER CAPACITORS C296 SERIES

160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, 3p. 0·1μF, 3½p. 0·15μF, 4½p. 0·22μF, 5p. 0·33μF, 6p. 0·47μF, 7½p. 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, 3½p. 0·1μF, 4p. 0·15μF, 0·22μF, 5p. 0·33μF, 6½p. 0·47μF, 8½p. 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, 3p. 0·04μF, 0·05μF, 0·023μF, 0·1μF, 6p.

## CERAMIC DISC CAPACITORS

100pF to 10,000pF, 2p each.

## ELECTROLYTIC CAPACITORS—MULLARD 015/6/7

(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, 4700/44, 21p.

## SOLID TANTALUM BEAD CAPACITORS 12p

0·1μF 35V, 2·2μF 35V, 22μF 16V, 0·22μF 35V, 4·7μF 35V, 33μ F10V, 0·47μ F35V, 6·8μF25V, 47μF 6·3V, 1·0μF 35V 10μF 25V 100μF 3V.

## VEROBOARD

| | 0·1 | 0·15 |
|---|---|---|
| 2½ x 3¾ | 26p | 22p |
| 2½ x 5 | 28p | 28p |
| 3¾ x 3¾ | 28p | 28p |
| 3¾ x 5 | 34p | 34p |
| 17 x 2½ | 95p | 77p |
| 17 x 3¾ | 130p | 108p |
| 17 x 3¾ (plain) | 86p | 72p |
| 17 x 2½ (plain) | — | 51p |
| 2½ x 5 (plain) | — | 18p |
| 2½ x 3¾ (plain) | — | 15p |
| Pin insertion tool | 62p | 62p |
| Spot face cutter | 52p | 52p |
| Pkt. 50 pins | 20p | 20p |

## JACK PLUGS AND SOCKETS

| | | | |
|---|---|---|---|
| Standard screened | 28p | 2·5mm insulated | 12p |
| Standard insulated | 18p | 3·5mm insulated | 12p |
| Stereo screened | 40p | 3·5mm screened | 18p |
| Standard socket | 20p | 2·5mm socket | 11p |
| Stereo socket | 30p | 3·5mm socket | 11p |

## D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin, 7 pin
**Plug 12p. Socket 8p.**
4 way screened cable, 25p/metre.
6 way screened cable, 30p/metre.

## BATTERY ELIMINATOR £1·70

9V mains power supply. Same size as PP9 battery.

## 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.

---

**E.H.T. POWERUNIT.** 110/240v. 50Hz giving 5 K.V. at 50 m/a. METERED OUTPUT. **£17·50.**

**COPPER LAMINATE P.C. BOARD**
11 x 3¼ x 1/16 in. **12p** sheet. 5 for **50p.**
10 x 4 x 1/16 in. **12p** sheet. 5 for **50p.**
10½ x 5¼ x 1/16 in. **15p** sheet. 4 for **50p.**
10 x 7 x 1/16 in. **18p** sheet. 3 for **50p.**
Offcut pack (smallest 4 x 2 in.) **50p** 300 sq. 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** (Solartron) 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.) **75p.** 3,150μf. 40v. (1½ x 4in.) **60p.** 10,000μf. 25v. (1½ x 4½in.) **60p.** 12,000μf. 40v. (2 x 4in.) **75p.** 16,000μf. 16v. (2 x 4in.) **60p.** 21,000μf. 40v. (2½ x 4in.) **£1.** 2,800μf. 100v. (4 x 2in.) **80p.** 15,000μf. 63v. (4½ x 2½in.) **£1.** 35,000μf. 40v. (3 x 4½in.) **£1.** P. & P. 8p.

**H.D. ALARM BELLS.** 6 in. Dome 6/8 volt D.C. **£2·25** P.P. 50p.

**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. 200/250v. Sec. 20/40/60v. at 2 amp. (Shrouded). **£2·25.** P.P. 40p.

**L.T. TRANSFORMER (H.D.)** 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. TRANSFORMER.** Prim 110/240v. Sec. 400v. 100 m/a. **£2.** P.P. 50p.

**E.H.T. TRANSFORMER.** 240v. Sec. 1800v. 50 mA. **£2·50.** P.P. 50p.

**1000W. ISOLATION TRANSFORMER.** 220/240v. 242v. ('C' Core type). **£12.** P.P. £1·50.

**1000W. STEP-DOWN TRANSFORMER.** (Double wound) 240/110v. 50 HZ. **£12.** P.P. £2.

**L.T. TRANSFORMER.** Prim. 240v. Sec. 16/0/16v. at 2 amp. **£1·60.** P.P. 20p.

**L.T. TRANSFORMER.** Prim. 110/240v. Sec. 23/0/23v. at 1.8 amp: 50v. at 300 m/a: 3.15/0/3.15v. at 300 m/a. **£1·75.** P.P. 20p.

**L.T. TRANSFORMER.** Prim. 200/240v. ('C' Core). Secs. 1v./3v./8v./9v. all at 1.5A: 50v. at 1 amp. **£2.** P.P. 25p.

**L.T. TRANSFORMER.** 110/240v. ('C' Core). Sec. 13.5v. 4A.: 39v. at 2A. **£2·50.** P.P. 25p.

**L.T. TRANSFORMER.** 110/240v. ('C' Core) 1v./3v./9v./20v./20v. all at 2 amp. **£3.** P.P. 35p. Same Secondaries but st 4 amp. **£4·25.** P.P. 40p.

**L.T. TRANSFORMER.** 110/240v. ('C' Core). Secs. 1v./3v./9v. all at 10 amp: 35v. at 1 amp: 50v. at 750 m/a **£8·25.** P.P. 50p.

**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) **17½p** yd. 100 yds. **£15.**
24 core (24 colours) **20p.** yd. 100 yds. **£17·50.**
30 core (15 colours) **22½p.** yd. 100 yds. **£18·50.**
Minimum order 10 yds

**RIBBON CABLE (8 colours)**
**£1·25** 10m. **£10** 100m.
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.D. RELAYS** (3 x 2 x 1 in.) with 10 amp. silver contacts 2 pole c/o **40p** ea.; 2 pole 3 way **40p.** P.P. 5p.

**24 VOLT H.D. RELAYS** (2 x 2 x ½ 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) 24v. D.C. 4 c/o contacts **65p.** P.P. 5p.

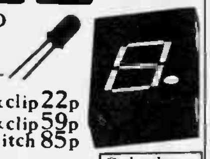
**SILICON BRIDGES.** 100 P.I.V. 1 amp. (½ x ½ x ½ in.) **30p** 200 P.I.V. 2 amp. **60p.**

**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

# TRAMPUS

MONEY BACK IF NOT SATISFIED
all brand new, full spec. Top grade.
Free fabulous NEW catalogue. Send S.A.E.



red+ data | 1/8" pin source | **LED's 17p!** Til209 & clip 22p
BIG 1/4 panel clip & RED LED 28p. GREEN & clip 59p
INFRA RED LED £1. IC photo amp 44p. & amp/switch 85p

**Digital Display** LED 1/3" 0-9DP. DIL. £1·69 | Calculator batt/mains from £25
Minitron type 0-9dPDIL £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.
kit: All parts & case. National chip. 4 digit £20. 6x £23.

## with data integrated circuits

GAS sensor TGS308 £2 KIT £4·69 fully built £8

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
1AMP+ REGULATOR 7805,5(&7-20)V. also 12 & 15V £1·49
AUDIO AMPS: mfc4000 50p; 1&2W £1·19; 3W £1·29; 6W...

**74N TTL** low prices.

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.
NEW 16pin counter/driver 90/47 £2·25 DALO p.c.b. 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 3½P 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. BFY51/2/3 15p TIS43 25p
2N2926 Oy 7p 2N3053 15p 2N3702/3/4/5/6/7/8/9/10/11 all 9p ea
2N3904/6 14p HEATSINKS 5f/TO5 18f/TO18 5p. TO3: 4YL 29p TV3 14p
CAPACITORS 25v 10, 50, 100uf 5p. DISCS 4p. PRESETS 5p. CARBON-POTS 11P. Switch+11P. Dual 55P. ULTRASONIC TRANSDUCERS £2 ea
FLUORESCENT LIGHTS, 8W. 13" 12VOLT £2·59

**Trampus electronics** ADD 10% VAT TO PRICES. P.&P. 10P. CWO.
P.O. BOX 29, BRACKNELL, BERKS.

---

# STEREO IC DECODER

**HIGH PERFORMANCE PHASE LOCKED LOOP**
**(as in 'W.W.' July '72)**

**MOTOROLA MC1310P EX STOCK DELIVERY**

**SPECIFICATION**

Separation: 40dB 50Hz-15kHz. Distortion: 0·3%
I/P level: 560mV rms O/P level: 485mV rms per channel.
Input impedance: 50kΩ. 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 — **ONLY £3·98** — **WHY PAY MORE?** post free.

**LIGHT EMITTING DIODE** Suitable as stereo 'on' indicator for above — **RED 29p GREEN 59p**

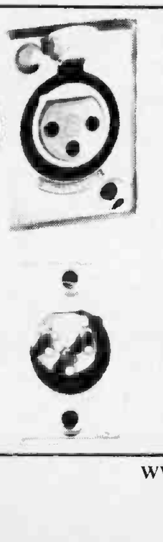
**MC1310P only £3·15 plus p.p. 6p**

**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, EGGINTON, DERBY, DE6 6GY**

---



# Audio Connectors

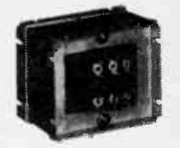
Broadcast pattern jackfields, jackcords, plugs and jacks
Quick disconnect microphone connectors
Amphenol (Tuchel) miniature connectors with coupling nut
Hirschmann Banana plugs and test probes
XLR compatible in-line attenuators and reversers
Low cost slider faders by Ruf

**Future Film Developments Ltd.**
**90 Wardour Street,**
**London W1V 3LE**
**01- 437 1892/3**

WW—029 FOR FURTHER DETAILS

---

# 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 p |
|---|---|---|---|---|---|
| 07 | 20 | 1 8 | 7·0× 7·0× 6·0 | 2·55 | 30 |
| 149 | 60 | 3 12 | 9·9× 7·7× 8·6 | 3·79 | 36 |
| 150 | 100 | 5 8 | 9·9× 8·9× 8·6 | 4·17 | 52 |
| 151 | 200 | 8 0 | 12·1× 9·3×10·2 | 7·34 | 52 |
| 152 | 250 | 13 12 | 12·1×11·8×10·2 | 9·25 | 67 |
| 153 | 350 | 15 0 | 14·0×10·8×11·8 | 11·35 | 82 |
| 154 | 500 | 19 8 | 14·0×13·4×11·8 | 13·30 | • |
| 155 | 750 | 29 0 | 17·2×14·0×14·0 | 21.20 | • |
| 156 | 1000 | 38 0 | 17·2×16·6×14·0 | 27·40 | • |
| 158 | 2000 | 60 0 | 21·6×15·3×18·1 | 49·25 | • |
| 159 | 3000 | 85 0 | 23·5×17·8×19·7 | 76·53 | • |
| 160 | 6000 | 173 0 | 35·0×20·4×29·3 | 135·89 | • |

## AUTO TRANSFORMERS

| Ref. No. | VA (Watts) | Weight lb oz | Size cm. | Auto Taps | £ | P & P p |
|---|---|---|---|---|---|---|
| 113 | 20 | 1 0 | 5·8× 5·1× 4·5 | 0-115-210-240 | 1·34 | 22 |
| 64 | 75 | 2 4 | 7·0× 6·7 ×6·1 | 0-115-210-240 | 2·64 | 36 |
| 4 | 150 | 3 4 | 8·9× 7·7× 7·7 | 0-115-200-220-240 | 3·18 | 36 |
| 66 | 300 | 6 4 | 9·9× 9·6× 8·6 | " " | 6·19 | 52 |
| 67 | 500 | 12 8 | 12·1×11·2×10·2 | " " | 9·20 | 67 |
| 84 | 1000 | 19 8 | 14·0×13·4×14·3 | " " | 13·50 | 82 |
| 93 | 1500 | 30 4 | 14·0×15·9×14·3 | " " | 17·50 | • |
| 95 | 2000 | 32 0 | 17·2×16·6×14·0 | " " | 25·35 | • |
| 73 | 3000 | 40 0 | 21·6×13·4×18·1 | " " | 32·80 | • |

## 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 & F 22p.

## LOW VOLTAGE TRANSFORMERS

**PRIMARY 200-250 VOLTS 12 AND/OR 24 VOLT RANGE**

| Ref. No. | Amps. 12V | Amps. 24V | Weight lb oz | Size cm. | Secondary Windings | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 111 | 0·5 | 0·25 | 8 | 4·8× 2·9× 3·5 | 0-12V at 0·25A×2 | 1·34 | 22 |
| 213 | 1·0 | 0·5 | 1 4 | 6·1× 5·8× 4·8 | 0-12V at 0·5A×2 | 1·58 | 22 |
| 71 | 2 | 1 | 1 12 | 7·0× 6·4× 6·1 | 0-12V at 1A×2 | 2·09 | 22 |
| 18 | 4 | 2 | 2 12 | 8·3× 7·7× 7·0 | 0·12V at 2A×2 | 2·95 | 36 |
| 70 | 6 | 3 | 3 8 | 8·9× 8·0× 7·7 | 0-12V at 3A×2 | 3·52 | 42 |
| 108 | 8 | 4 | 5 8 | 9·9× 8·9× 8·6 | 0-12V at 4A×2 | 3·96 | 52 |
| 72 | 10 | 5 | 6 4 | 9·9× 9·6× 8·6 | 0-12V at 5A×2 | 4·67 | 52 |
| 116 | 12 | 6 | 6 12 | 9·9×10·2×8·6 | 0-12V at 5A×2 | 5·61 | 52 |
| 17 | 16 | 8 | 8 12 | 12·1× 9·9×10·2 | 0-12V at 8A×2 | 7·22 | 52 |
| 115 | 20 | 10 | 18 8 | 14·0× 9·6×11·8 | 0-12V at 10A×2 | 9·20 | 67 |
| 187 | 30 | 15 | 15 8 | 14·0×12·1×11·8 | 0-12V at 15A×2 | 16·94 | 82 |
| 226 | 60 | 30 | 32 0 | 17·2×15·3×14·0 | 0-12V at 30A×2 | 22·50 | • |

**30 VOLT RANGE**

| Ref No. | Amps. | Weight lb oz | Size cm. | Secondary Taps | £ | P & P p |
|---|---|---|---|---|---|---|
| 112 | 0·5 | 1 4 | 6·1× 5·8× 4·8 | 0-12-15-20-24-30V | 1·56 | 22 |
| 79 | 1·0 | 2 4 | 7·0× 6·7× 6·1 | " " | 2·11 | 36 |
| 3 | 2·0 | 3 4 | 8·9× 7·7× 7·7 | " " | 3·18 | 36 |
| 20 | 3·0 | 4 8 | 9·9× 8·3× 8·6 | " " | 3·96 | 42 |
| 21 | 4·0 | 6 4 | 9·9× 9·6× 8·6 | " " | 4·67 | 52 |
| 51 | 5·0 | 6 12 | 12·1× 8·6×10·2 | " " | 5·83 | 52 |
| 117 | 6·0 | 8 0 | 12·1× 9·3×10·2 | " " | 6·94 | 52 |
| 88 | 8·0 | 12 0 | 12·1×11·8×10·2 | " " | 9·00 | 67 |
| 89 | 10·0 | 13 12 | 14·0×10·2×11·8 | " " | 11·36 | 67 |

**50 VOLT RANGE**

| Ref. No. | Amps. | Weight lb oz | Size cm. | Secondary Taps | £ | P & P p |
|---|---|---|---|---|---|---|
| 102 | 0·5 | 1 12 | 7·0× 6·4× 6·1 | 0-19-25-33-40-50V | 2·09 | 30 |
| 103 | 1·0 | 2 12 | 8·3× 7·4× 7·0 | " " | 3·08 | 36 |
| 104 | 2·0 | 5 8 | 9·9× 8·9× 8·6 | " " | 4·26 | 42 |
| 105 | 3·0 | 6 12 | 9·9×10·2× 8·6 | " " | 5·79 | 52 |
| 106 | 4·0 | 10 0 | 12·1×10·5×10·2 | " " | 7·69 | 52 |
| 107 | 6·0 | 12 0 | 14·0×10·2×11·8 | " " | 11·38 | 67 |
| 118 | 8·0 | 18 0 | 14·0×12·7×11·8 | " " | 12·40 | 97 |
| 119 | 10·0 | 25 0 | 17·2×12·7×14·0 | " " | 18·62 | • |

**60 VOLT RANGE**

| Ref. No. | Amps. | Weight lb oz | Size cm. | | £ | P & P p |
|---|---|---|---|---|---|---|
| 124 | 0·5 | 2 4 | 7·0× 6·7× 6·1 | 0-24-30-40-48-60V | 2·12 | 36 |
| 126 | 1·0 | 3 4 | 8·9× 7·7× 7·7 | " " | 2·97 | 36 |
| 127 | 2·0 | 6 4 | 9·9× 9·6× 8·6 | " " | 4·67 | 42 |
| 125 | 3·0 | 8 12 | 12·1× 9·9×10·2 | " " | 7·11 | 52 |
| 123 | 4·0 | 13 12 | 12·1×11·8×10·2 | " " | 9·20 | 67 |
| 40 | 5·0 | 12 00 | 14·0×10·2×11·8 | " " | 10·83 | 67 |
| 120 | 6·0 | 15 8 | 14·0×12·1×11·8 | " " | 13·35 | 82 |
| 121 | 8·0 | 25 00 | 14·0×14·7×11·8 | " " | 15·01 | • |
| 122 | 10·0 | 25 0 | 17·2×12·7×14·0 | " " | 19·60 | • |
| 189 | 12·0 | 29 00 | 17·2×14·0×14·0 | " " | 21·60 | • |

## MINIATURE TRANSFORMERS WITH SCREENS

| Ref. No. | MA | Weight lb oz | Size cm. | VOLTS | £ | P & P p |
|---|---|---|---|---|---|---|
| 238 | 200 | 2 | 2·8×2·6×2·0 | 3-0-3 | 1·44 | 10 |
| 212 | 1A 1A | 1 4 | 6·1×5·8×4·8 | 0-6 0-6 | 1·67 | 22 |
| 13 | 100 | 4 | 3·9×2·6×2·9 | 9-0-9 | 1·23 | 10 |
| 235 | 330, 330 | 4 | 4·8×2·9×3·5 | 0-9, 0-9 | 1·67 | 10 |
| 207 | 500, 500 | 1 00 | 6·1×5·4×4·8 | 0-8-9, 0-8-9 | 2.23 | 22 |
| 208 | 1A, 1A | 1 12 | 7·0×6·4×6·1 | 0-8-9, 0-8-9 | 3·00 | 30 |
| 236 | 200, 200 | 4 | 4·8×2·9×3·5 | 0-15, 0-15 | 1·67 | 10 |
| 214 | 300, 300 | 1 4 | 6·1×5·8×4·8 | 0-20, 0-20 | 1·76 | 22 |
| 221 | 700 (D.C.) | 1 8 | 7·0×6·1×3·1 | 20-12-0-12-20 | 1·55 | 30 |
| 206 | 1A, 1A | 2 12 | 8·3×7·7×7·0 | 0-15-20, 0-15-20 | 4·05 | 38 |
| 203 | 500, 500 | 2 4 | 8·3×7·0×7·0 | 0-15-27, 0-15-27 | 3·10 | 38 |
| 204 | 1A, 1A | 3 4 | 8·9×7·7×7·7 | 0-15-27, 0-15-27 | 3·15 | 38 |

## BATTERY CHARGER TYPES

**PRIMARY 200-250 VOLT (Secondary 2V, 6V, 12V)**

| Ref. No. | Amps. | Weight lb oz | Size cm. | | £ | P & P p |
|---|---|---|---|---|---|---|
| 45 | 1·5 | 1 8 | 7·0× 6·1× 6·1 | Please note, these units do not include rectifiers | 1·61 | 30 |
| 5 | 4·0 | 3 4 | 8·9× 7·7× 7·7 | | 2·93 | 42 |
| 86 | 6·0 | 6 4 | 9·9× 9·6× 8·6 | | 4·40 | 52 |
| 146 | 8·0 | 6 12 | 9·9×10·2× 8·6 | | 5·02 | 52 |
| 50 | 12·5 | 12 0 | 14·0×10·2×11·8 | | 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.

# ELECTROVALUE

*Present* **ELECTRONIC COMPONENTS FOR THE WIDEST POSSIBLE RANGE OF APPLICATIONS**

**EVERYTHING BRAND NEW AND TO SPEC ★ GOOD DISCOUNTS ★ FREE POSTAGE (U.K.)**

## ELECTROVALUE "SPECIALS"

Amongst an extensive range of specialised electronic components which we stock are
**Magneto Resistors**
**Liquid Crystal Displays**
**Hall Effect Probes**
**Touch Switch I.C.s**
**Magnetically operated I.C.s**
**Photo-electronic devices**

## FERRITE COMPONENTS

Pot cores in a wide range of useful sizes:
Double Aperture Cores:
Ring Cores

## 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. 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 BCD decoder driver 7447 **£1·15**
**3015G** showing + or – & 1 & dec. pt. **£1·20**

## CAPACITORS

### POLYESTER 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**

### TANTALUM BEAD

0.1, 0.22, 0.47, 1.0 mF/35V, 1.5/20V ea. **14p**
2.2/16V, 2.2/35V, 4.7/16V, 10/6.3V ea. **14p**
4.7/35V, 10/16V, 22/6.3V ea. **18p**
10/25V, 22/16V, 47/6.3V, 100/3V, 6.8/25V, 15/25V ea. **20p**

### POLYCARBONATE

Type B32540 Working Voltage—250V d.c.
Values in mF: 0.0047; 0.0068; 0.0082; 0.1; 0.012; 0.015 ea. **3p**
0.018; 0.022; 0.027; 0.033; 0.039; 0.047; 0.056; 0.068; 0.082; 0.1 ea. **4p**

Working voltage 100V d.c.
0.1; 0.12; 0.15 4p; 0.18 5p; 0.22 **6p**
0.27 7p; 0.33 8p; 0.39; 0.47 **9p**
0.56 12p; 0.68 **13p**

### SILVERED MICA

*Working voltage 500V d.c.*
Values in pFs—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 **25p**

### CERAMIC DISC

1000pF/500, 2000/500, 5000/500, 0.01mF/50, 0.02mF/50, 0.1mF/3—each **2p**; 0.05mF/50V—**3p**

### CERAMIC PLATE

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 **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

Linear or log. 4.7K to 1 meg. in all popular values ea. **30p**
Escutcheon plates, black, white or light grey ea. **10p**
Control knobs, blk/wht/red/yel/grn/blue/dk. grey/lt grey ea. **7p**

## JACKS AND PLUGS

### SOCKETS

2 circuit unswitched S1/SS **12p**
2 circuit 2 break contacts S1/BB **15p**
2 circuit unswitched (Not GPO) S3/SSS **17p**
3 circuit with 3 break contacts S3/BBB **20p**
2 circuit with chrome nut and black/white/red/green or grey unswitched S5/SS **16p**
with 2 break contacts S5/BB **20p**
Miniature 3.5mm 2 circuit, (black) 2 break contacts S6/BB **9p**

### PLUGS

2 circuit screened top entry P1 **24p**
side entry SEP1 **36p**
Line socket mono 231 **40p**
Line socket stereo 244 **45p**
3 circuit unscreened, black/grey/white P4 **46p**
2 circuit, unscreened, black/white/red/black/green/grey P2 **18p**
3 circuit screen top entry P3 **53p**
side entry SEP3 **55p**
Miniature 3.5mm 2 circuit screened P5 **13p**
Miniature 3.5mm 2 circuit unscreened various colours P6 **10p**

## INSULATED SCREW TERMINALS

In moulded polypropylene, with nickel plate on brass. With insulating set, washers, tag and nuts. 15A/250V In black/brown/red/yellow/green/blue/grey/white. Type TP.1 ea. **14p**

## DIN CONNECTORS

| | | |
|---|---|---|
| **2 way loudspeaker** | **Socket 10p** | **Plug 12p** |
| **3 way audio** | **Socket 10p** | **Plug 12p** |
| **5 way audio 180°** | **Socket 12p** | **Plug 15p** |
| **5 way audio 240°** | **Socket 12p** | **Plug 15p** |
| **6 way audio** | **Socket 13p** | **Plug 15p** |

## RESISTORS

| *Code* | *Watts* | *Ohms* | *1 to 9* | *10 to 99* | *100 up* (see note below) |
|---|---|---|---|---|---|
| C | 1/3 | 4.7–470K | **1.3** | **1.1** | **0.9** nett |
| C | 1/2 | 4.7–10M | **1.3** | **1.1** | **0.9** nett |
| C | 3/4 | 4.7–10M | **1.5** | **1.2** | **0.97** nett |
| C | 1 | 4.7–10M | **3.2** | **2.5** | **1.92** nett |
| MO | 1/2 | 10–1M | **4** | **3.3** | **2.3** nett |
| WW | 1 | 0.22–3.9Ω | **9** | **9** | **8** |
| WW | 3 | 1–10K | **7** | **7** | **6** |
| WW | 7 | 1–10K | **9** | **9** | **8** |

**Codes:**
C = carbon film, high stability, low noise.
MO = metal oxide, Electrosil TR5, ultra low noise.
WW = wire wound, Plessey.

**Values:** All E12 except C ⅓W, C ¾W, and MO ½W.
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 below 10Ω and MO ½W 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, **67p** each, 20W 7.5V to 75V **94p**. Clip to increase 1.5W rating to 3 watts (type 266F), **5p**.
20W 7.5V to 75V **69p** each

## VEROBOARD

Copper clad 0.1 matrix—2.5 × 3.75 ins. **27p**; 3.75 × 3.75 ins.—**30p**; 2.5 × 5 ins.—**30p**; 3.75 × 5 ins.—**33p**. Copper clad 0.15 in. matrix 2.5 × 3.75 ins.—**20p**; 3.75 × 3.75 ins.—**30p**; 2.5 × 5 ins.—**30p**; 3.75 × 5 ins.—**36p**.
Vero spot face cutter (any matrix) **43p**.
0.040 pins (for 0.1 matrix) per 100—**35p**
0.052 pins (for 0.15 matrix) per 100—**35p**

## CATALOGUE 7

**SECOND PRINTING** *(green & yellow cover)*

112 pages, thousands of items, illustrations, diagrams, much useful technical information. The 2nd printing of this catalogue has been updated as much as possible on prices. It still costs only 25p post free and still includes a refund voucher for 25p for spending when ordering goods list value £5 or more.

## COVERS & HEATSINKS

Many types including:
T03 Transistor cover, clip-on **7p**

**HEATSINK**
Type 6WI Extruded aluminium 1° C/W, undrilled **60p**
drilled 2 × T03 **78p**

## KNOBS

All for ¼" shafts in a very wide range of types from utilitarian to modern solid aluminium

## S-DEC

Unsurpassed for "breadboard work" can be used indefinitely without deterioration. Components just push into plug holes and connect automatically. Slot for control panel. 70 holes **£1·98**

## T-DEC

For more advanced work with 208 contacts in 38 rows. Will take one 16 lead carrier. **£3·63.** (Carriers supplied separately.)

## DESOLDER BRAID

6 ft strip **66p**
25 mtr. reel **£7·15**

## ELECTROLYTIC CAPACITORS

**Axial Lead**

| qF | 3V | 6.3V | 10V | 16V | 25V | 40V | 63V | 100V |
|---|---|---|---|---|---|---|---|---|
| 0.47 | — | — | — | — | — | — | **11p** | **8p** |
| 1.0 | — | — | — | — | — | **11p** | — | **8p** |
| 2.2 | — | — | — | — | **11p** | — | **8p** | **9p** |
| 4.7 | — | — | — | **11p** | — | **8p** | **9p** | **8p** |
| 10 | — | — | — | — | **8p** | **9p** | **8p** | **8p** |
| 22 | — | — | **8p** | — | **9p** | **8p** | **8p** | **10p** |
| 47 | **8p** | — | **9p** | **8p** | **8p** | **8p** | **10p** | **13p** |
| 100 | **9p** | **8p** | **8p** | **8p** | **9p** | **10p** | **12p** | **19p** |
| 220 | **8p** | **8p** | **9p** | **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 | **15p** | **18p** | **23p** | **26p** | **37p** | **41p** | — | — |
| 4,700 | **26p** | **30p** | **39p** | **44p** | **58p** | — | — | — |
| 10,000 | **42p** | **46p** | — | — | — | — | — | — |

***This is EV Service***

**GIRO ACCOUNT No. 38/671/4002**

## 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 pre-paid mail orders. For mail orders for £2 list value and under there is an additional handling charge of 10p. Overseas orders—carriage charged at cost.

## 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.*

**APPOINTED DISTRIBUTORS FOR SIEMENS FINE QUALITY PRODUCTS**

**ELECTROVALUE LTD**

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. Dept WW5 S.A.E. with enquiries requiring answers.

**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.

# The largest selection

## BRAND NEW FULLY GUARANTEED DEVICES

| | |
|---|---|
| AC107 | 0·22 |
| AC113 | 0·20 |
| AC115 | 0·22 |
| AC117K | 0·32 |
| AC122 | 0·13 |
| AC125 | 0·19 |
| AC126 | 0·19 |
| AC127 | 0·20 |
| AC128 | 0·20 |
| AC132 | 0·16 |
| AC134 | 0·16 |
| AC137 | 0·16 |
| AC141 | 0·20 |
| AC141K | 0·32 |
| AC142 | 0·20 |
| AC142K | 0·28 |
| AC151 | 0·17 |
| AC154 | 0·22 |
| AC155 | 0·22 |
| AC156 | 0·22 |
| AC157 | 0·27 |
| AC165 | 0·22 |
| AC166 | 0·22 |
| AC167 | 0·22 |
| AC168 | 0·27 |
| AC169 | 0·16 |
| AC176 | 0·22 |
| AC177 | 0·27 |
| AC178 | 0·31 |
| AC179 | 0·31 |
| AC180 | 0·22 |
| AC180K | 0·32 |
| AC181 | 0·22 |
| AC181K | 0·32 |
| AC187 | 0·24 |
| AC187K | 0·25 |
| AC188 | 0·24 |
| AC188K | 0·25 |
| ACY17 | 0·28 |
| ACY18 | 0·22 |
| ACY19 | 0·22 |
| ACY20 | 0·22 |
| ACY21 | 0·22 |
| ACY22 | 0·18 |
| ACY27 | 0·20 |
| ACY28 | 0·21 |
| ACY29 | 0·39 |
| ACY30 | 0·31 |
| ACY31 | 0·31 |
| ACY34 | 0·23 |
| ACY35 | 0·23 |
| ACY36 | 0·31 |
| ACY40 | 0·19 |
| ACY41 | 0·20 |
| ACY44 | 0·39 |
| AD130 | 0·42 |
| AD140 | 0·53 |
| AD142 | 0·53 |
| AD143 | 0·42 |
| AD149 | 0·55 |
| AD161 | 0·39 |
| AD162 | 0·39 |

| | |
|---|---|
| AD161 & AD162 (MP) | 0·75 |
| ADT140 | 0·55 |
| AF114 | 0·27 |
| AF115 | 0·27 |
| AF116 | 0·27 |
| AF117 | 0·27 |
| AF118 | 0·39 |
| AF124 | 0·33 |
| AF125 | 0·33 |
| AF126 | 0·31 |
| AF127 | 0·31 |
| AF139 | 0·33 |
| AF178 | 0·55 |
| AF179 | 0·55 |
| AF180 | 0·55 |
| AF181 | 0·55 |
| AF186 | 0·55 |
| AF239 | 0·41 |
| AL102 | 0·72 |
| AL103 | 0·72 |
| ASY26 | 0·28 |
| ASY27 | 0·33 |
| ASY28 | 0·28 |
| ASY29 | 0·28 |
| ASY50 | 0·28 |
| ASY51 | 0·28 |
| ASY52 | 0·28 |
| ASY54 | 0·28 |
| ASY55 | 0·28 |
| ASY56 | 0·28 |
| ASY57 | 0·28 |
| ASY58 | 0·28 |
| ASY73 | 0·28 |
| ASZ21 | 0·44 |
| BC107 | 0·14 |
| BC108 | 0·14 |
| BC109 | 0·15 |
| BC113 | 0·11 |
| BC114 | 0·17 |
| BC115 | 0·17 |
| BC116 | 0·17 |
| BC117 | 0·20 |
| BC118 | 0·11 |
| BC119 | 0·33 |
| BC120 | 0·88 |
| BC125 | 0·13 |
| BC126 | 0·20 |
| BC132 | 0·13 |
| BC134 | 0·20 |
| BC135 | 0·13 |
| BC136 | 0·17 |
| BC137 | 0·17 |
| BC139 | 0·44 |
| BC140 | 0·33 |
| BC141 | 0·33 |
| BC142 | 0·33 |
| BC143 | 0·33 |
| BC145 | 0·50 |
| BC147 | 0·11 |
| BC148 | 0·11 |
| BC149 | 0·13 |

| | |
|---|---|
| BC150 | 0·20 |
| BC151 | 0·22 |
| BC152 | 0·19 |
| BC153 | 0·31 |
| BC154 | 0·33 |
| BC157 | 0·20 |
| BC158 | 0·13 |
| BC159 | 0·13 |
| BC160 | 0·50 |
| BC161 | 0·55 |
| BC167 | 0·13 |
| BC168 | 0·13 |
| BC169 | 0·13 |
| BC170 | 0·13 |
| BC171 | 0·16 |
| BC172 | 0·16 |
| BC173 | 0·16 |
| BC174 | 0·16 |
| BC175 | 0·24 |
| BC177 | 0·21 |
| BC178 | 0·21 |
| BC179 | 0·21 |
| BC180 | 0·27 |
| BC181 | 0·27 |
| BC182 | 0·16 |
| BC182L | 0·16 |
| BC183 | 0·16 |
| BC183L | 0·16 |
| BC184 | 0·22 |
| BC184L | 0·22 |
| BC186 | 0·31 |
| BC187 | 0·31 |
| BC207 | 0·12 |
| BC208 | 0·12 |
| BC209 | 0·13 |
| BC212L | 0·14 |
| BC213L | 0·14 |
| BC214L | 0·18 |
| BC225 | 0·28 |
| BC226 | 0·39 |
| BC301 | 0·30 |
| BC302 | 0·27 |
| BC303 | 0·35 |
| BC304 | 0·40 |
| BC440 | 0·34 |
| BC460 | 0·40 |
| BCY30 | 0·27 |
| BCY30 | 0·27 |
| BCY31 | 0·29 |
| BCY32 | 0·33 |
| BCY33 | 0·24 |
| BCY34 | 0·28 |
| BCY70 | 0·16 |
| BCY71 | 0·22 |
| BCY72 | 0·16 |
| BCZ10 | 0·22 |
| BCZ11 | 0·28 |
| BCZ12 | 0·28 |
| BD115 | 0·68 |
| BD116 | 0·88 |
| BD121 | 0·66 |
| BD123 | 0·72 |
| BD124 | 0·76 |

| | |
|---|---|
| BD131 | 0·55 |
| BD132 | 0·66 |
| BD133 | 0·72 |
| BD135 | 0·44 |
| BD136 | 0·44 |
| BD137 | 0·50 |
| BD138 | 0·50 |
| BD139 | 0·61 |
| BD140 | 0·66 |
| BD155 | 0·88 |
| BD175 | 0·66 |
| BD176 | 0·66 |
| BD177 | 0·72 |
| BD178 | 0·72 |
| BD179 | 0·77 |
| BD180 | 0·77 |
| BD185 | 0·72 |
| BD186 | 0·72 |
| BD187 | 0·77 |
| BD188 | 0·77 |
| BD189 | 0·83 |
| BD190 | 0·83 |
| BD195 | 0·94 |
| BD196 | 0·94 |
| BD197 | 0·99 |
| BD198 | 0·99 |
| BD199 | 1·05 |
| BD200 | 1·05 |
| BD205 | 0·88 |
| BD206 | 1·05 |
| BD207 | 1·05 |
| BD208 | 1·05 |
| BDY20 | 1·10 |
| BF115 | 0·27 |
| BF117 | 0·50 |
| BF118 | 0·77 |
| BF119 | 0·77 |
| BF121 | 0·50 |
| BF123 | 0·55 |
| BF125 | 0·50 |
| BF127 | 0·55 |
| BF152 | 0·61 |
| BF153 | 0·50 |
| BF154 | 0·50 |
| BF155 | 0·77 |
| BF156 | 0·53 |
| BF157 | 0·61 |
| BF158 | 0·61 |
| BF159 | 0·66 |
| BF160 | 0·44 |
| BF162 | 0·44 |
| BF163 | 0·44 |
| BF164 | 0·44 |
| BF165 | 0·44 |
| BF167 | 0·24 |
| BF173 | 0·24 |
| BF176 | 0·39 |
| BF177 | 0·39 |
| BF178 | 0·33 |
| BF179 | 0·33 |
| BF180 | 0·33 |
| BF181 | 0·33 |
| BF182 | 0·44 |

| | |
|---|---|
| BF183 | 0·44 |
| BF184 | 0·28 |
| BF185 | 0·33 |
| BF187 | 0·30 |
| BF188 | 0·44 |
| BF194 | 0·13 |
| BF195 | 0·13 |
| BF196 | 0·16 |
| BF197 | 0·16 |
| BF200 | 0·50 |
| BF222 | 1·05 |
| BF257 | 0·50 |
| BF258 | 0·66 |
| BF259 | 0·94 |
| BF262 | 0·61 |
| BF263 | 0·61 |
| BF270 | 0·39 |
| BF271 | 0·33 |
| BF272 | 0·88 |
| BF273 | 0·39 |
| BF274 | 0·39 |
| BFW10 | 0·66 |
| BFX29 | 0·30 |
| BFX84 | 0·24 |
| BFX85 | 0·33 |
| BFX86 | 0·24 |
| BFX87 | 0·27 |
| BFX88 | 0·24 |
| BFY50 | 0·22 |
| BFY51 | 0·22 |
| BFY52 | 0·22 |
| BFY53 | 0·19 |
| BSX19 | 0·17 |
| BSX20 | 0·17 |
| BSY25 | 0·17 |
| BSY26 | 0·17 |
| BSY27 | 0·17 |
| BSY28 | 0·17 |
| BSY29 | 0·17 |
| BSY38 | 0·20 |
| BSY39 | 0·20 |
| BSY40 | 0·31 |
| BSY41 | 0·31 |
| BSY95 | 0·14 |
| BSY95A | 0·14 |
| Bu105 | 2·20 |
| C111E | 0·55 |
| C400 | 0·33 |
| C407 | 0·28 |
| C424 | 0·28 |
| C425 | 0·55 |
| C426 | 0·39 |
| C428 | 0·22 |
| C441 | 0·33 |
| C442 | 0·33 |
| C444 | 0·39 |
| C450 | 0·24 |
| MAT100 | 0·21 |
| MAT101 | 0·22 |
| MAT120 | 0·21 |
| MAT121 | 0·22 |
| MJE2955 | 0·95 |
| MJE3055 | 0·62 |

| | |
|---|---|
| MJE3440 | 0·55 |
| MPF102 | 0·46 |
| MPF104 | 0·41 |
| MPF105 | 0·41 |
| OC19 | 0·39 |
| OC20 | 0·70 |
| OC22 | 0·52 |
| OC23 | 0·54 |
| OC24 | 0·62 |
| OC25 | 0·42 |
| OC26 | 0·32 |
| OC28 | 0·55 |
| OC29 | 0·55 |
| OC35 | 0·46 |
| OC36 | 0·55 |
| OC41 | 0·22 |
| OC42 | 0·27 |
| OC44 | 0·17 |
| OC45 | 0·14 |
| OC70 | 0·11 |
| OC71 | 0·11 |
| OC72 | 0·16 |
| OC74 | 0·16 |
| OC75 | 0·17 |
| OC76 | 0·17 |
| OC77 | 0·28 |
| OC81 | 0·17 |
| OC81D | 0·17 |
| OC82 | 0·17 |
| OC82D | 0·17 |
| OC83 | 0·22 |
| OC139 | 0·22 |
| OC140 | 0·22 |
| OC169 | 0·28 |
| OC170 | 0·28 |
| OC171 | 0·28 |
| OC200 | 0·28 |
| OC201 | 0·31 |
| OC202 | 0·31 |
| OC203 | 0·28 |
| OC204 | 0·28 |
| OC205 | 0·39 |
| OC309 | 0·44 |
| OCP71 | 0·48 |
| ORP12 | 0·48 |
| ORP60 | 0·44 |
| ORP61 | 0·44 |
| P20 | 0·55 |
| P346A | 0·22 |
| P397 | 0·46 |
| ST140 | 0·14 |
| ST141 | 0·19 |
| TIS43 | 0·33 |
| UT46 | 0·30 |
| ZN414 | 1·20 |
| 2G301 | 0·21 |
| 2G302 | 0·21 |
| 2G303 | 0·21 |
| 2G304 | 0·27 |
| 2G306 | 0·44 |
| 2G308 | 0·39 |

| | |
|---|---|
| 2G309 | 0·39 |
| 2G339 | 0·22 |
| 2G339A | 0·18 |
| 2G344 | 0·20 |
| 2G345 | 0·18 |
| 2G371 | 0·18 |
| 2G371B | 0·13 |
| 2G373 | 0·19 |
| 2G374 | 0·19 |
| 2G377 | 0·33 |
| 2G378 | 0·18 |
| 2G381 | 0·18 |
| 2G382 | 0·18 |
| 2G401 | 0·33 |
| 2G414 | 0·33 |
| 2G417 | 0·28 |
| 2N388 | 0·39 |
| 2N388A | 0·61 |
| 2N404 | 0·22 |
| 2N404A | 0·31 |
| 2N524 | 0·46 |
| 2N527 | 0·54 |
| 2N598 | 0·46 |
| 2N599 | 0·50 |
| 2N696 | 0·14 |
| 2N697 | 0·15 |
| 2N698 | 0·27 |
| 2N699 | 0·39 |
| 2N706 | 0·09 |
| 2N706A | 0·10 |
| 2N708 | 0·13 |
| 2N711 | 0·33 |
| 2N717 | 0·39 |
| 2N718 | 0·27 |
| 2N718A | 0·55 |
| 2N726 | 0·31 |
| 2N727 | 0·31 |
| 2N743 | 0·22 |
| 2N744 | 0·22 |
| 2N914 | 0·16 |
| 2N918 | 0·33 |
| 2N929 | 0·23 |
| 2N930 | 0·23 |
| 2N1131 | 0·22 |
| 2N1132 | 0·24 |
| 2N1302 | 0·16 |
| 2N1303 | 0·16 |
| 2N1304 | 0·19 |
| 2N1305 | 0·19 |
| 2N1306 | 0·23 |
| 2N1307 | 0·23 |
| 2N1308 | 0·26 |
| 2N1309 | 0·26 |
| 2N1613 | 0·22 |
| 2N1711 | 0·22 |
| 2N1889 | 0·35 |
| 2N1890 | 0·50 |
| 2N1893 | 0·41 |
| 2N2147 | 0·79 |
| 2N2148 | 0·63 |
| 2N2160 | 0·66 |
| 2N2192 | 0·39 |
| 2N2193 | 0·39 |

| | |
|---|---|
| 2N2194 | 0·39 |
| 2N2217 | 0·24 |
| 2N2218 | 0·22 |
| 2N2219 | 0·22 |
| 2N2220 | 0·24 |
| 2N2221 | 0·22 |
| 2N2222 | 0·22 |
| 2N2368 | 0·19 |
| 2N2369 | 0·16 |
| 2N2369A | 0·16 |
| 2N2411 | 0·27 |
| 2N2412 | 0·27 |
| 2N2646 | 0·52 |
| 2N2711 | 0·23 |
| 2N2712 | 0·23 |
| 2N2714 | 0·23 |
| 2N2904 | 0·19 |
| 2N2904A | 0·23 |
| 2N2905 | 0·23 |
| 2N2905A | 0·23 |
| 2N2906 | 0·17 |
| 2N2906A | 0·20 |
| 2N2907 | 0·22 |
| 2N2907A | 0·24 |
| 2N2923 | 0·16 |
| 2N2924 | 0·16 |
| 2N2925 | 0·16 |
| 2N2926(G) | 0·14 |
| 2N2926(Y) | 0·12 |
| 2N2926(O) | 0·11 |
| 2N2926(R) | 0·11 |
| 2N2926(B) | 0·11 |
| 2N3010 | 0·77 |
| 2N3011 | 0·16 |

| | |
|---|---|
| 2N3053 | 0·19 |
| 2N3054 | 0·51 |
| 2N3055 | 0·55 |
| 2N3391 | 0·16 |
| 2N3391A | 0·18 |
| 2N3392 | 0·16 |
| 2N3393 | 0·16 |
| 2N3394 | 0·16 |
| 2N3395 | 0·19 |
| 2N3402 | 0·23 |
| 2N3403 | 0·23 |
| 2N3404 | 0·31 |
| 2N3405 | 0·46 |
| 2N3414 | 0·17 |
| 2N3415 | 0·17 |
| 2N3416 | 0·31 |
| 2N3417 | 0·31 |
| 2N3525 | 0·83 |
| 2N3614 | 0·74 |
| 2N3615 | 0·82 |
| 2N3616 | 0·82 |
| 2N3646 | 0·10 |
| 2N3702 | 0·13 |
| 2N3703 | 0·13 |
| 2N3704 | 0·14 |
| 2N3705 | 0·13 |
| 2N3706 | 0·13 |
| 2N3707 | 0·14 |
| 2N3708 | 0·09 |
| 2N3709 | 0·10 |
| 2N3710 | 0·10 |
| 2N3711 | 0·10 |
| 2N3819 | 0·31 |
| 2N3820 | 0·55 |
| 2N3821 | 0·39 |
| 2N3823 | 0·31 |
| 2N3903 | 0·31 |
| 2N3904 | 0·33 |
| 2N3905 | 0·31 |
| 2N3906 | 0·30 |

| | |
|---|---|
| 2N4058 | 0·13 |
| 2N4059 | 0·11 |
| 2N4060 | 0·13 |
| 2N4061 | 0·13 |
| 2N4062 | 0·13 |
| 2N4284 | 0·19 |
| 2N4285 | 0·19 |
| 2N4286 | 0·19 |
| 2N4287 | 0·19 |
| 2N4288 | 0·19 |
| 2N4289 | 0·19 |
| 2N4290 | 0·19 |
| 2N4291 | 0·19 |
| 2N4292 | 0·19 |
| 2N4293 | 0·19 |
| 2N5172 | 0·13 |
| 2N5294 | 0·60 |
| 2N5457 | 0·35 |
| 2N5458 | 0·35 |
| 2N5459 | 0·44 |
| 2N6121 | 0·75 |
| 2S301 | 0·55 |
| 2S302A | 0·46 |
| 2S302 | 0·46 |
| 2S303 | 0·61 |
| 2S304 | 0·77 |
| 2S305 | 0·86 |
| 2S306 | 0·86 |
| 2S307 | 0·86 |
| 2S321 | 0·62 |
| 2S322 | 0·46 |
| 2S322A | 0·46 |
| 2S323 | 0·62 |
| 2S324 | 0·77 |
| 2S325 | 0·77 |
| 2S326 | 0·77 |
| 2S327 | 0·77 |
| 2S701 | 0·44 |
| 40361 | 0·44 |
| 40362 | 0·50 |

### DIODES

| | |
|---|---|
| AA119 | 0·09 |
| AA120 | 0·09 |
| AA129 | 0·09 |
| AAY30 | 0·10 |
| AAZ13 | 0·11 |
| BA100 | 0·11 |
| BA116 | 0·23 |
| BA126 | 0·24 |
| BA148 | 0·16 |
| BA154 | 0·13 |
| BA155 | 0·16 |
| BA156 | 0·15 |
| BA173 | 0·16 |
| BY100 | 0·17 |
| BY101 | 0·13 |
| BY105 | 0·19 |
| BY114 | 0·13 |
| BY124 | 0·13 |
| BY126 | 0·16 |
| BY127 | 0·17 |
| BY128 | 0·17 |

| | |
|---|---|
| BY130 | 0·18 |
| BY133 | 0·23 |
| BY164 | 0·55 |
| BYX38/30 | 0·46 |
| BYZ10 | 0·39 |
| BYZ11 | 0·33 |
| BYZ12 | 0·33 |
| BYZ13 | 0·28 |
| BYZ16 | 0·44 |
| BYZ17 | 0·39 |
| BYZ18 | 0·39 |
| BYZ19 | 0·31 |
| CG62 (OA91 Eq.) | 0·06 |
| CG651 (OA70-OA79) | 0·07 |
| OA5 | 0·39 |
| OA5SL | 0·23 |

| | |
|---|---|
| OA10 | 0·15 |
| OA47 | 0·08 |
| OA70 | 0·08 |
| OA79 | 0·08 |
| OA81 | 0·08 |
| OA85 | 0·10 |
| OA90 | 0·07 |
| OA91 | 0·07 |
| OA95 | 0·08 |
| OA200 | 0·07 |
| OA202 | 0·08 |
| SD10 | 0·06 |
| SD19 | 0·06 |
| 1N34 | 0·08 |
| 1N34A | 0·08 |
| 1N914 | 0·06 |
| 1N916 | 0·06 |
| 1N4148 | 0·06 |
| 1S021 | 0·11 |
| 1S951 | 0·07 |

**FULL RANGE OF ZENER DIODES VOLTAGE RANGE** 2-33V. 400mV (DO-7 Case) 12p ea. 1½W (Top-Hat) 18p ea. 10W (SO-10 Stud) 32p ea. All fully tested 5% tol. and marked. State voltage required.

**10 amp POTTED BRIDGE RECTIFIER on heat sink. 100PIV. 99p each**

**NEW LINE**
Plastic Encapsulated 2 Amp. BRIDGE RECTS.

| | |
|---|---|
| 50v RMS | 35p each |
| 100v RMS | 40p ,, |
| 200v RMS | 45p ,, |
| 400v RMS | 50p ,, |
| 1,000v RMS | 55p ,, |

Size 15 mm × 6 mm.

**UNIJUNCTION**
UT46. Eqvt. 2N2646. Eqvt. TIS43. BEN3000 30p each, 25-99 28p 100 UP 22p.

**CADMIUM CELLS**
ORP12 48p

**GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N706/8. BSY-27/28/95A.** A.I.I usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

| | | £p |
|---|---|---|
| 20 | For | 0·55 |
| 50 | For | 1·10 |
| 100 | For | 1·92 |
| 500 | For | 8·25 |
| 1000 | For | 14·30 |

**SIL. G.P. DIODES £p**

| | | |
|---|---|---|
| 300mW | 30.. | 0·55 |
| 40PIV(Min.) | 100.. | 1·65 |
| Sub-Min. | 500.. | 5·50 |
| Full Tested | 1,000.. | 9·90 |

Ideal for Organ Builders.

## KING OF THE PAKS Unequalled Value and Quality

## SUPER PAKS NEW BI-PAK UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back

| Pak No. | | Description | Price |
|---|---|---|---|
| U 1 | 120 | Glass Sub-Min. General Purpose Germanium Diodes | 0·55 |
| U 2 | 60 | Mixed Germanium Transistors AF/RF | 0·55 |
| U 3 | 75 | Germanium Gold Bonded Sub-Min. like OA5, OA47 | 0·55 |
| U 4 | 30 | Germanium Transistors like OC81, AC128 | 0·55 |
| U 5 | 60 | 200mA Sub-Min. Silicon Diodes | 0·55 |
| U 6 | 30 | Sil. Planar Trans. NPN like BSY95A. 2N706 | 0·55 |
| U 7 | 16 | Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000 | 0·55 |
| U 8 | 50 | Sil. Planar Diodes DO-7 Glass 250mA like OA200/202 | 0·55 |
| U 9 | 20 | Mixed Voltages. 1 Watt Zener Diodes | 0·55 |
| U10 | 20 | BAY50 charge storage Diodes DO-7 Glass | 0·55 |
| U11 | 20 | PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904 | 0·55 |
| U13 | 30 | PNP-NPN Sil. Transistors OC200 & 28 104 | 0·55 |
| U14 | 150 | Mixed Silicon and Germanium Diodes | 0·55 |
| U15 | 20 | NPN Sil. Planar Trans. TO-5 like BFY51, 2N697 | 0·55 |
| U16 | 10 | 3 Amp Silicon Rectifiers Stud Type up to 1000PIV | 0·55 |
| U17 | 30 | Germanium PNP AF Transistors TO-5 like ACY 17-22 | 0·55 |
| U18 | 8 | 6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV | 0·55 |
| U19 | 25 | Silicon NPN Transistors like BC108 | 0·55 |
| U20 | 12 | 1·5 Amp Silicon Rectifiers Top Hat up to 1000 PIV | 0·55 |
| U21 | 30 | AF. Germanium Alloy Transistors 2G300 Series & OC71 | 0·55 |
| U23 | 25 | MADT's like MHz Series PNP Transistors | 0·55 |
| U24 | 20 | Germanium 1 Amp Rectifiers GJM Series up to 300 PIV | 0·55 |
| U25 | 25 | 300 MHz NPN Silicon Transistors 2N708, BSY27 | 0·55 |
| U26 | 30 | Fast Switching Silicon Diodes like IN914 Micro-Min. | 0·55 |
| U29 | 10 | 1 Amp SCR's TO-5 can, up to 600 PIV CRS1/25-600 | 1.10 |
| U32 | 25 | Zener Diodes 400mW DO-7 case 3-18 volts mixed | 0·55 |
| U33 | 15 | Plastic Case 1 Amp Silicon Rectifiers 1N4000 Series | 0·55 |
| U34 | 30 | Silicon PNP Alloy Trans. TO-5 BCY26 2S302/4 | 0·55 |
| U35 | 25 | Silicon Planar Transistors PNP TO-18 2N2906 | 0·55 |
| U36 | 20 | Silicon Planar NPN Transistors TO-5 BFY50/51/52 | 0·55 |
| U37 | 30 | Silicon Alloy Transistors SO-2 PNP OC200, 2S322 | 0·55 |
| U38 | 20 | Fast Switching Silicon Trans. NPN MHz 2N3011 | 0·55 |
| U39 | 30 | RF. Germ. PNP Transistors 2N1303/5 TO-5 | 0·55 |
| U40 | 10 | Dual Transistors 6 lead TO-5 2N2060 | 0·55 |
| U43 | 25 | Sil. Trans. Plastic TO-18 A.F. BC113/114 | 0·55 |
| U44 | 20 | Sil. Trans. Plastic TO-5 BC115/NPN | 0·55 |
| U45 | 7 | 3A SCR. TO66 up to 600PIV | 1·10 |
| U46 | 20 | Unijunction transistors similar to TIS43 | 0·55 |
| U47 | 18 | TO220AB plastic triacs 50V 6A | 1·10 |
| U48 | 9 | NPN Sil. power transistors like 2N3055 | 1·10 |
| U49 | 12 | NPN Sil. plastic power trans. 60W like 2N5294/5296 | 1·10 |

Code No's. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

## QUALITY TESTED SEMICONDUCTORS

| Pak No. | | | Price £p |
|---|---|---|---|
| Q1 | 20 | Red spot transistors PNP | 0·55 |
| Q2 | 16 | White spot R.F. transistors PNP | 0·55 |
| Q3 | 4 | OC 77 type transistors | 0·55 |
| Q4 | 6 | Matched transistors OC44/45/81/81D | 0·55 |
| Q5 | 4 | OC 75 transistors | 0·55 |
| Q6 | 5 | OC 72 transistors | 0·55 |
| Q7 | 4 | AC 128 transistors PNP high gain | 0·55 |
| Q8 | 4 | AC 126 transistors PNP | 0·55 |
| Q9 | 7 | OC 81 type transistors | 0·55 |
| Q10 | 7 | OC 71 type transistors | 0·55 |
| Q11 | 2 | AC 127/128 Complementary pairs PNP/NPN | 0·55 |
| Q12 | 3 | AF 116 type transistors | 0·55 |
| Q13 | 3 | AF 117 type transistors | 0·55 |
| Q14 | 3 | OC 171 H.F. type transistors | 0·55 |
| Q15 | 7 | 2N2926 Sil. Epoxy transistors mixed colours | 0·55 |
| Q17 | 5 | NPN 2 × ST.141 & 3 × ST.140 | 0·55 |
| Q18 | 4 | MADT'S 2 × MAT 100 & 2 × MAT 120 | 0·55 |
| Q19 | 3 | MADT'S 2 × MAT 101 & 1 × MAT 121 | 0·55 |
| Q20 | 4 | OC 44 Germanium transistors A.F. | 0·55 |
| Q21 | 4 | AC 127 NPN Germanium transistors | 0·55 |
| Q22 | 20 | NKT transistors A.F. R.F. coded | 0·55 |
| Q23 | 10 | OA 202 Silicon diodes sub-min. | 0·55 |
| Q24 | 8 | OA 81 diodes | 0·55 |
| Q25 | 15 | 1N914 Silicon diodes 75 PIV 75mA | 0·55 |
| Q26 | 8 | OA95 Germanium diodes sub-min. IN69 | 0·55 |
| Q27 | 2 | 10A 600 PIV Silicon rectifiers 1S425R | 0·55 |
| Q28 | 2 | Silicon power rectifiers BYZ 13 | 0·55 |
| Q29 | 4 | Silicon transistors 2 × 2N696, 1 × 2N697, 1 × 2N698 | 0·55 |
| Q30 | 7 | Silicon switch transistors 2N706 NPN | 0·55 |
| Q31 | 6 | Silicon switch transistors 2N708 NPN | 0·55 |
| Q32 | 3 | PNP Silicon transistors 2 × 2N1131, 1 × 2N 1132 | 0·55 |
| Q33 | 3 | Silicon NPN transistors 2N1711 | 0·55 |
| Q34 | 7 | Silicon NPN transistors 2N2369, 500MHz (code P397) | 0·55 |
| Q35 | 3 | Silicon PNP TO-5, 2 × 2N2904 & 1 × 2N2905 | 0·55 |
| Q36 | 7 | 2N3646 TO-18 plastic 300 MHz NPN | 0·55 |
| Q37 | 3 | 2N3053 NPN Silicon transistors | 0·55 |
| Q38 | 5 | PNP transistors 3 × 2N3703, 2 × 2N3702 | 0·55 |
| Q39 | 5 | NPN transistors 3 × 2N3704, 2 × 2N3705 | 0·55 |
| Q40 | 5 | NPN transistors 3 × 2N3707, 2 × 2N3708 | 0·55 |
| Q41 | 3 | Plastic NPN TO-18 2N3904 | 0·55 |
| Q43 | 5 | BC 107 NPN transistors | 0·55 |
| Q44 | 5 | NPN transistors 3 × BC 108, 2 × BC 109 | 0·55 |
| Q45 | 3 | BC 113 NPN TO-18 transistors | 0·55 |
| Q46 | 3 | BC 115 NPN TO-5 transistors | 0·55 |
| Q47 | 4 | NPN high gain transistors 2 × BC167, 2 × BC168 | 0·55 |
| Q48 | 3 | BCY 70 PNP transistors TO-18 | 0·55 |
| Q49 | 3 | NPN transistors 2 × BFY51, 1 × BFY52 | 0·55 |
| Q50 | 7 | BSY 28 NPN switch transistors TO-18 | 0·55 |
| Q51 | 7 | BSY 95A NPN transistors 300MHz | 0·55 |
| Q52 | 8 | BY100 type silicon rectifiers | 1·10 |
| Q53 | 25 | Sil. & Germ. trans. mixed all marked new | 1·65 |

**8th EDITION 250 pages**
TRANSISTOR EQUIVALENTS BOOK. A complete cross reference and equivalents book for European, American and Japanese Transistors. Exclusive to BI-PAK £1·85 each.

## NEW LOW PRICE TESTED S.C.R.'s

| PIV | 1A TO5 | 3A TO66 | 5A TO66 | 5A TO64 | 7A TO48 | 10A TO48 | 16A TO48 | 30A TO48 |
|---|---|---|---|---|---|---|---|---|
| 50 | 0·22 | 0·27 | 0·39 | 0·39 | 0·52 | 0·55 | 0·58 | 1·27 |
| 100 | 0·27 | 0·27 | 0·52 | 0·52 | 0·55 | 0·63 | 0·62 | 1·54 |
| 200 | 0·27 | 0·32 | 0·54 | 0·54 | 0·62 | 0·67 | 0·67 | 1·76 |
| 400 | 0·32 | 0·42 | 0·59 | 0·62 | 0·67 | 0·83 | 0·77 | 1·93 |
| 600 | 0·42 | 0·52 | 0·75 | 0·75 | 0·84 | 1·07 | 0·97 | — |
| 800 | 0·63 | 0·70 | 0·88 | 0·88 | 0·99 | 1·32 | 1·50 | 4·40 |

## POWER TRANS BONANZA!

**GENERAL PURPOSE GERM. PNP**
Coded GP100. BRAND NEW TO-3 CASE. POSSIBLE REPLACE:—OC25–28–29–30–35–36. NKT 401–403–404–405–406–430–451–452–453. TI3027–3028, 2N250A 2N456A–457A–458A, 2N511 A & B. 2G220–222. ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30–170.

| PRICE | 1-24 | 25-99 | 100 up |
|---|---|---|---|
| | 48p each | 44p each | 40p each |

**SILICON High Voltage 250V NPN**
TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHZ.
OUR PRICE EACH: 1-24 55p. 25-99 50p, 100 up 44p

**2N3055**
115 WATT SIL POWER NPN 55p EACH.

**LINEAR INTEGRATED CIRCUIT PAKS**

| | | |
|---|---|---|
| ULIC 709 | 10×709 | 0-55 |
| ULIC 710 | 7×710 | 0-55 |
| ULIC 741 | 7×741 | 0-55 |
| ULIC 747 | 5×747 | 0-55 |
| ULIC 748 | 7×748 | 0-55 |

**AD161/162** *PNP*
M/P COMP GERM TRANS. OUR LOWEST PRICE OF 75p *PER PAIR*

**SILICON PHOTO TRANSISTOR**
TO-18 Lens end NPN Sim. to BP × 25 and P21. BRAND NEW. Full data available. Fully guaranteed.

| Qty. | 1-24 | 25-99 | 100 up |
|---|---|---|---|
| Price each | 49p | 44p | 38p |

**JUMBO COMPONENT PAKS**
*MIXED ELECTRONIC COMPONENTS*
*Exceptionally good value*
Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. £1·65 only.

## F.E.T.'S

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2N3819 | 31p | 2N3820 | 55p | 2N3821 | 39p | 2N3823 | 31p |
| 2N5458 | 35p | 2N5459 | 44p | BFW10 | 66p | MPF105 | 41p |

## SILICON RECTIFIERS

| PIV | 300mA (DO 7) | 750mA (SO 16) | 1 Amp Plastic | | 1·5 Amp (SO 16) | 3 Amp (SO 1:) | 10 Amp (SO 10) | 30 Amp (TO 48) |
|---|---|---|---|---|---|---|---|---|
| 50 | 0·05 | 0·06 | 1N4001 | 0·05 | 0·08 | 0·15 | 0·21 | 0·60 |
| 100 | 0·05 | 0·07 | 1N4002 | 0·06 | 0·10 | 0·17 | 0·23 | 0·75 |
| 200 | 0·06 | 0·10 | 1N4003 | 0·07 | 0·12 | 0·22 | 0·25 | £1·00 |
| 400 | 0·08 | 0·15 | 1N4004 | 0·08 | 0·15 | 0·30 | 0·38 | £1·35 |
| 600 | 0·09 | 0·17 | 1N4005 | 0·10 | 0·18 | 0·36 | 0·45 | £1·90 |
| 800 | 0·12 | 0·19 | 1N4006 | 0·11 | 0·20 | 0·38 | 0·55 | £2·10 |
| 1000 | 0·14 | 0·30 | 1N4007 | 0·12 | 0·25 | 0·48 | 0·65 | £2·50 |
| 1200 | | 0·35 | | | 0·30 | 0·58 | 0·75 | £3·00 |

All Stud Silicon Rectifiers are available in reverse Polarity, i.e., Stud being Anode. When ordering Stud Anode type, please request 'Reverse Type'.

**TRIACS**

| VBOM | 2A | 6A | 10A |
|---|---|---|---|
| | TO-5 | TO-66 | TO-48 |
| | £p | £p | £p |
| 100 | 33 | 55 | 83 |
| 200 | 55 | 66 | 99 |
| 400 | 77 | 83 | 1·21 |

**DIACS**
FOR USE WITH TRIACS BR100 (D32) 25p each

**FREE**
One 50p Pak of your own choice free with orders valued £4 or over.

**BRAND NEW TEXAS GERM. TRANSISTORS**
Coded and guaranteed

| Pak No. | | | EQVT |
|---|---|---|---|
| T1 | 8 | 2G371B | OC71 |
| T2 | 8 | D1374 | OC75 |
| T3 | 8 | D1216 | OC81D |
| T4 | 8 | 2G381T | OC81 |
| T5 | 8 | 2G382T | OC82 |
| T6 | 8 | 2G344B | OC44 |
| T7 | 8 | 2G345B | OC45 |
| T8 | 8 | 2G378 | OC78 |
| T9 | 8 | 2G399A | 2N1302 |
| T10 | 8 | 2G417 | AF117 |

All 55p each pak.

**2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS.** Our price 28p each.

**120 VCR NIXIE DRIVER TRANSISTOR.** Sim. BSX21 & C407, 2N1893 FULLY TESTED AND CODED ND 120, 1-24 19p each. TO.5 NPN 25 up 17p each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 6p each. Any Qty.

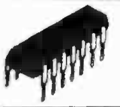
**A LARGE RANGE OF TECHNICAL AND DATA BOOKS ARE NOW AVAILABLE EX. STOCK. SEND FOR FREE LIST.**

**BI-PAKS NEW COMPONENT SHOP NOW OPEN WITH A WIDE RANGE OF ELECTRONIC COMPONENTS AND ACCESSORIES AT COMPETITIVE PRICES—**

**18 BALDOCK STREET (A10), WARE, HERTS. TEL. (STD 0920) 61593.**
OPEN MONDAY-SATURDAY 9 a.m. to 5.30 p.m., ALL PRICES INCLUDE VAT

# -the lowest prices!

## 74 Series T.T.L. I.C'S

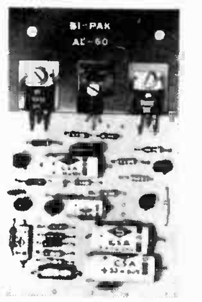


BI-PAK STILL LOWEST IN PRICE FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

| Type | 1 | 25 | 100+ | Type | 1 | 25 | 100+ | Type | 1 | 25 | 100+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SN7400 | 0·18 | 0·17 | 0·16 | SN7453 | 0·18 | 0·17 | 0·16 | SN74153 | £1·20 | £1·10 | £1·00 |
| SN7401 | 0·18 | 0·17 | 0·16 | SN7454 | 0·18 | 0·17 | 0·16 | SN74154 | £1·98 | £1·90 | £1·75 |
| SN7402 | 0·18 | 0·17 | 0·16 | SN7460 | 0·18 | 0·17 | 0·16 | SN74155 | £1·20 | £1·15 | £1·10 |
| SN7403 | 0·18 | 0·17 | 0·16 | SN7470 | 0·32 | 0·29 | 0·27 | SN74156 | £1·20 | £1·15 | £1·10 |
| SN7404 | 0·22 | 0·21 | 0·20 | SN7472 | 0·32 | 0·29 | 0·27 | SN74157 | £1·20 | £1·15 | £1·10 |
| SN7405 | 0·22 | 0·21 | 0·20 | SN7473 | 0·41 | 0·39 | 0·35 | SN74160 | £1·73 | £1·70 | £1·65 |
| SN7406 | 0·39 | 0·34 | 0·31 | SN7474 | 0·41 | 0·39 | 0·35 | SN74161 | £1·73 | £1·70 | £1·65 |
| SN7407 | 0·39 | 0·34 | 0·31 | SN7475 | 0·60 | 0·58 | 0·56 | SN74162 | £1·73 | £1·70 | £1·65 |
| SN7408 | 0·25 | 0·24 | 0·23 | SN7476 | 0·44 | 0·43 | 0·42 | SN74163 | £1·73 | £1·70 | £1·65 |
| SN7409 | 0·25 | 0·24 | 0·23 | SN7480 | 0·74 | 0·71 | 0·64 | SN74164 | £2·20 | £2·10 | £2·00 |
| SN7410 | 0·18 | 0·17 | 0·16 | SN7481 | £1·30 | £1·25 | £1·20 | SN74165 | £2·20 | £2·10 | £2·00 |
| SN7411 | 0·28 | 0·27 | 0·26 | SN7482 | 0·90 | 0·85 | 0·80 | SN74166 | £2·35 | £2·30 | £2·25 |
| SN7412 | 0·30 | 0·29 | 0·28 | SN7483 | £1·20 | £1·15 | £1·05 | SN74174 | £2·00 | £1·95 | £1·90 |
| SN7413 | 0·32 | 0·31 | 0·30 | SN7484 | £1·10 | £1·05 | £1·00 | SN74175 | £1·40 | £1·35 | £1·30 |
| SN7416 | 0·40 | 0·39 | 0·38 | SN7485 | £2·00 | £1·90 | £1·80 | SN74176 | £1·60 | £1·55 | £1·50 |
| SN7417 | 0·40 | 0·39 | 0·38 | SN7486 | 0·35 | 0·34 | 0·33 | SN74177 | £1·60 | £1·55 | £1·50 |
| SN7420 | 0·18 | 0·17 | 0·16 | SN7489 | £4·00 | £3·75 | £3·50 | SN74180 | £1·60 | £1·55 | £1·50 |
| SN7422 | 0·30 | 0·29 | 0·28 | SN7490 | 0·74 | 0·71 | 0·64 | SN74181 | £5·00 | £4·50 | £4·00 |
| SN7423 | 0·40 | 0·39 | 0·38 | SN7491 | £1·10 | £1·05 | £1·00 | SN74182 | £1·50 | £1·45 | £1·40 |
| SN7425 | 0·40 | 0·39 | 0·38 | SN7492 | 0·74 | 0·71 | 0·64 | SN74184 | £2·40 | £2·30 | £2·20 |
| SN7426 | 0·40 | 0·38 | 0·36 | SN7493 | 0·74 | 0·71 | 0·64 | SN74190 | £2·15 | £2·10 | £2·00 |
| SN7427 | 0·40 | 0·38 | 0·36 | SN7494 | 0·85 | 0·82 | 0·75 | SN74191 | £2·15 | £2·10 | £2·00 |
| SN7428 | 0·45 | 0·42 | 0·40 | SN7495 | 0·85 | 0·82 | 0·75 | SN74192 | £2·15 | £2·10 | £2·00 |
| SN7430 | 0·18 | 0·17 | 0·16 | SN7496 | 0·96 | 0·93 | 0·86 | SN74193 | £2·15 | £2·10 | £2·00 |
| SN7432 | 0·40 | 0·38 | 0·36 | SN74100 | £1·50 | £1·45 | £1·40 | SN74194 | £1·90 | £1·80 | £1·70 |
| SN7433 | 0·42 | 0·40 | 0·38 | SN74104 | 0·70 | 0·68 | 0·66 | SN74195 | £1·60 | £1·50 | £1·40 |
| SN7437 | 0·45 | 0·42 | 0·40 | SN74105 | 0·70 | 0·68 | 0·66 | SN74196 | £1·73 | £1·70 | £1·65 |
| SN7438 | 0·45 | 0·42 | 0·40 | SN74107 | 0·44 | 0·42 | 0·40 | SN74197 | £1·73 | £1·70 | £1·65 |
| SN7440 | 0·18 | 0·17 | 0·16 | SN74110 | 0·60 | 0·55 | 0·50 | SN74198 | £3·45 | £3·35 | £3·20 |
| SN7441 | 0·74 | 0·71 | 0·64 | SN74111 | 0·95 | 0·92 | 0·90 | SN74199 | £3·10 | £3·00 | £2·90 |
| SN7442 | 0·74 | 0·71 | 0·64 | SN74118 | £1·10 | £1·05 | £1·00 | | | | |
| SN7443 | £1·20 | £1·15 | £1·10 | SN74119 | £1·50 | £1·40 | £1·30 | | | | |
| SN7444 | £1·20 | £1·15 | £1·10 | SN74121 | 0·50 | 0·48 | 0·45 | | | | |
| SN7445 | £1·98 | £1·95 | £1·90 | SN74122 | 0·88 | 0·86 | 0·84 | | | | |
| SN7446 | £1·20 | £1·15 | £1·10 | SN74123 | £1·58 | £1·54 | £1·50 | | | | |
| SN7447 | £1·10 | £1·07 | £1·05 | SN74141 | 0·85 | 0·82 | 0·79 | | | | |
| SN7448 | £1·10 | £1·07 | £1·05 | SN74145 | £1·58 | £1·54 | £1·50 | | | | |
| SN7450 | 0·18 | 0·17 | 0·16 | SN74150 | £2·50 | £2·40 | £2·30 | | | | |
| SN7451 | 0·18 | 0·17 | 0·16 | SN74151 | £1·10 | £1·05 | £1·00 | | | | |

Devices may be mixed to quality for quantity price. (TTL 74 Series only) data is available for the above series of I.C.'s in booklet form. Price 35p.

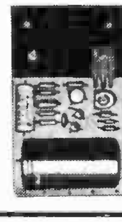
## NOW WE GIVE YOU 50w PEAK (25w R.M.S.) *PLUS* THERMAL PROTECTION! The NEW AL60 Hi-Fi Audio Amplifier FOR ONLY £3.95




- Max Heat Sink temp. 90 C.
- Frequency Response 20Hz to 100KHz
- 0·1% Distortion
- Distortion better than 1% at 1KHz
- Supply voltage 10-35 volts
- Thermal Feedback
- Latest Design Improvements
- Load—3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

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 MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63 mm × 105 mm × 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. Handbook available, 10p.

**TRANSFORMER BMT80 £2·15 p. & p. 25p**

## INTEGRATED CIRCUIT PAKS

Manufacturers "Fall 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 | Pak No. Contents | Price |
|---|---|---|---|---|---|
| UIC00=12×7400 | 0·55 | UIC46=5×7446 | 0·55 | UIC90=5×7490 | 0·55 |
| UIC01=12×7401 | 0·55 | UIC48=5×7448 | 0·55 | UIC91=5×7491 | 0·55 |
| UIC02=12×7402 | 0·55 | UIC50=12×7450 | 0·55 | UIC92=5×7492 | 0·55 |
| UIC03=12×7403 | 0·55 | UI351=12×7451 | 0·55 | UIC93=5×7493 | 0·55 |
| UIC04=12×7404 | 0·55 | UIC53=12×7453 | 0·55 | UIC94=5×7494 | 0·55 |
| UIC05=12×7405 | 0·55 | UIC54=12×7454 | 0·55 | UIC95=5×7495 | 0·55 |
| UIC06=8×7406 | 0·55 | UIC60=12×7460 | 0·55 | UIC96=5×7496 | 0·55 |
| UIC07=8×7407 | 0·55 | UIC70=8×7470 | 0·55 | UIC100=5×74100 | 0·55 |
| UIC10=12×7410 | 0·55 | UIC72=8×7472 | 0·55 | UIC121=5×74121 | 0·55 |
| UIC20=12×7420 | 0·55 | UIC73=8×7473 | 0·55 | UIC141=5×74141 | 0·55 |
| UIC30=12×7430 | 0·55 | UIC74=8×7474 | 0·55 | UIC151=5×74151 | 0·55 |
| UIC40=12×7440 | 0·55 | UIC76=8×7476 | 0·55 | UIC154=5×74154 | 0·55 |
| UIC41=5×7441 | 0·55 | UIC80=5×7480 | 0·55 | UIC193=5×74193 | 0·55 |
| UIC42=5×7442 | 0·55 | UIC81=5×7481 | 0·55 | UIC199=5×74199 | 0·55 |
| UIC43=5×7443 | 0·55 | UIC82=5×7482 | 0·55 | UICXI=25 Assorted 74's | 1·55 |
| UIC44=5×7444 | 0·55 | UIC83=5×7483 | 0·55 | | |
| UIC45=5×7445 | 0·55 | UIC86=5×7486 | 0·55 | | |

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 NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

**SPECIFICATION:**

| | | | |
|---|---|---|---|
| Frequency response | 20Hz—20kHz ±1dB | Bass control | ±15dB at 20Hz |
| Harmonic distortion | better than 0·1% | Treble control | ±15dB at 20kHz |
| Inputs: 1. Tape head | 3·25mV into 50KΩ | Filters: Rumble (high pass) | 100 Hz |
| 2. Radio, Tuner | 75mV into 50KΩ | Scratch (low pass) | 8kHz |
| 3. Magnetic P.U. | 3mV into 50KΩ | Signal/noise ratio | better than +65dB |
| All input voltages are for an output of 250mV. | | Input overload | +26dB |
| Tape and P.U. inputs equalised to RIAA curve | | Supply | +35 volts at 20mA |
| within ±1dB from 20Hz to 20kHz. | | Dimensions | 292×82×35 mm |

only £13·15

## MK 60 AUDIO KIT

Comprising: 2×AL60, 1×SPM80, 1×BTM80, 1×PA 100, 1 front panel, 1 kit of parts to include on-off switch, neon Indicator, stereo headphone sockets plus instruction booklets. Complete Prices: £28·75 plus 30p postage.

## TEAK 60 AUDIO KIT

Comprising: Teak veneered cabinet size 16½"×11⅝"×3¾", other parts include aluminium chassis, heatsink and front panel bracket, plus back panel and appropriate sockets etc. Kit price: £9·95 plus 30p postage.

## LINEAR I.C.'s—FULL SPEC.

| Type No. | Case | | 1 | 25 | 100+ |
|---|---|---|---|---|---|
| 72702 | DIL | 14 | 0·50 | 0·48 | 0·45 |
| 72709P | DIL | 8 | 0·33 | 0·31 | 0·29 |
| 72709 | DIL | 14 | 0·35 | 0·33 | 0·30 |
| 72710 | DIL | 14 | 0·45 | 0·43 | 0·40 |
| 72741 | DIL | 14 | 0·40 | 0·38 | 0·35 |
| 72741C | TO-5 | 8 | 0·45 | 0·43 | 0·40 |
| 72741P | DIL | 8 | 0·38 | 0·36 | 0·34 |
| 72748P | DIL | 8 | 0·38 | 0·36 | 0·34 |
| SL201C | TO-5 | 8 | 0·50 | 0·45 | 0·40 |
| SL701C | TO-5 | 8 | 0·50 | 0·45 | 0·40 |
| SL702C | TO-5 | 8 | 0·50 | 0·45 | 0·40 |
| TAA263 | TO-72 | 4 | 0·80 | 0·70 | 0·60 |
| TAA293 | TO-74 | 10 | £1·00 | 0·95 | 0·90 |
| TAA350A | TO-5 | 10 | £1·85 | £1·80 | £1·70 |
| µA703C | TO-5 | 6 | 0·28 | 0·26 | 0·24 |
| µA709C | TO-5 | 8 | 0·35 | 0·33 | 0·30 |
| µA711 | TO-5 | 10 | 0·45 | 0·43 | 0·40 |
| ZN414 | TO-18 | 4 | £1·20 | — | — |
| TBA800 | DIL | 14 | £1·50 | — | — |

## DTL 930 SERIES LOGIC I.C's

| Type | 1 | 25 | 100+ |
|---|---|---|---|
| BP930 | 0·15 | 0·14 | 0·13 |
| BP932 | 0·16 | 0·15 | 0·14 |
| BP933 | 0·16 | 0·15 | 0·14 |
| BP935 | 0·16 | 0·15 | 0·14 |
| BP936 | 0·16 | 0·15 | 0·14 |
| BP944 | 0·16 | 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 |
| BP9093 | 0·45 | 0·43 | 0·40 |
| BP9094 | 0·45 | 0·43 | 0·40 |
| BP9097 | 0·45 | 0·43 | 0·40 |
| BP9099 | 0·45 | 0·43 | 0·40 |

## DUAL-IN-LINE SOCKETS

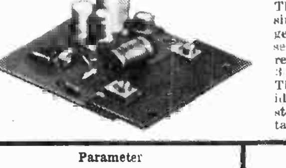
14 & 16 Lead Sockets for use with DUAL-IN-LINE I.C's. TWO Ranges PROFESSIONAL & NEW LOW COST.

| PROF. TYPE No. | 1–24 | 25–99 | 100up |
|---|---|---|---|
| TSO 14 pin type | 33p | 30p | 27p |
| TSO 16 ,, ,, | 38p | 35p | 32p |
| LOW COST No. | | | |
| BPS 14 ,, ,, | 16p | 14p | 12p |
| BPS 16 ,, ,, | 17p | 15p | 13p |
| BPS 8 pin type | 15p | 13p | 11p |

## NUMERICAL INDICATOR TUBES

| Type | Description | |
|---|---|---|
| 3015F | Minitron 7 Segment Indicator | £1·50 |
| MAN 3M | L.E.D. 7 Segment Display 0.127" High Characters | £1·90 |
| CD 66 | Side Viewing 'Nixie Type' Tube 16 mm. | £1·87 |
| GR 116 | Side Viewing 'Nixie Type' Tube 13 mm. | £1·70 |

## AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power device has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

| Parameter | Conditions | Performance |
|---|---|---|
| HARMONIC DISTORTION | Po=3 WATTS f=1KHz | 0·25% |
| LOAD IMPEDANCE | — | 8–16Ω |
| INPUT IMPEDANCE | f=1KHz | 100 kΩ |
| FREQUENCY RESPONSE ± 3dB | Po=2 WATTS | 50 Hz–25KHz |
| SENSITIVITY for RATED O/P | Vs=25V. Rl=8Ω f=1KHz | 75mV. RMS |
| DIMENSIONS | — | 3"×2½"×1" |

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

| Parameter | AL10 | AL20 | AL30 |
|---|---|---|---|
| Maximum Supply Voltage | 25 | 30 | 30 |
| Power output for 2% T.H.D. (RL=8Ω f=1 KHz) | 3 watts RMS Min. | 5 watts RMS Min. | 10 watts RMS Min. |
| PRICE | £2·20 | £2·59 | £3·3 |

## 3 TERMINAL POSITIVE VOLTAGE REGULATORS

TO.3 Plastic Encapsulation
µA7805/L129 5V (Equv. to MVR5) £1·76
µA7812/L130 12V (Equv. to MVR12V) £1·76
µA7815/L131 15V (Equv. to MVR15V) £1·76

## BI-PAK CATALOGUE & LISTS

**Send S.A.E. and 10p**

**EDSR 3166 TRIPLE 66 BIT DYNAMIC SHIFT REGISTER** TTL Compatible. Low Clock Capacitance, High Speed Diode Protected Inputs Wired 'OR' Capability SPECIFICATION SHEET AVAILABLE £2.50

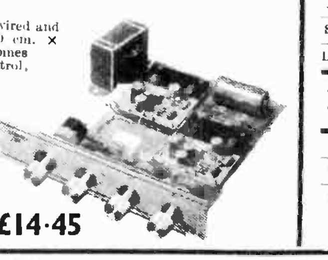
## TEAK VENEERED CABINET for: STEREO 20

**TC 20. £3.95 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 £30 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. × 14 cm. × 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.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ±12dB at 60Hz typically 0·25% at 1 watt. Treble con. ±14dB at 14kHz.



**£14·45**

**SHP80 STEREO HEADPHONES,** 4-16 ohms impedance. Frequency response 20 to 20,000 Hz Stereo/mono switch and volume controls £4.95

## TRANSFORMERS

T461 (Use with AL10) £1·60 P. & P. 15p.
T538 (Use with AL20) £2·30 P. & P. 15p.
BMT80 (Use with AL30 & AL50) £2·75 P. & P. 25p

## POWER SUPPLIES

PS 12. (Use with AL10 & AL20) 88p
SPM 80. (Use with also AL30 & AL50) £3·25

## 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 it 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 × 84mm × 35mm

**PRICE £4·35**

Frequency response—20Hz–50KHz (—3dB
Bass control—±12dB at 60H
Treble control—±14dB at 14KHz
*Input 1. Impedance 1 Meg. ohm Sensitivity 300mV
†Input 2. Impedance 30 K ohms Sensitivity 4mV

**FRONT PANELS FP12 50p**

*All prices inclusive of V.A.T. Giro 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***

# 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; AZ41 0·60; CBL31 1·00; CL33 1·50; CY31 0·50; DAF91 0·30; DAF96 0·50; DCC90 1·35; DF91 0·30; DF96 0·50; DK91 0·45; DK92 0·70; DK96 0·60; DL92 0·40; DL94 0·48; DL96 0·55; DM70 0·60; DY86/7 0·36

DY802 0·37; EABC80 0·38; EAF42 0·75; EAF801 0·50; EBC33 1·00; EBC41 0·75; EBC81 0·33; EBF80 0·40; EBF83 0·40; EBF89 0·32; EBL31 1·50; ECC40 1·00; ECC81 0·40; ECC82 0·33; ECC83 0·33; ECC85 0·40; ECC88 0·40; ECF80 0·35

ECF82 0·40; ECH35 1·25; ECH42 1·00; ECH81 0·30; ECH83 0·45; ECH84 0·45; ECL80 0·55; ECL82 0·35; ECL86 0·40; ECLL800 3·20; EF37A 1·20; EF39 1·20; EF41 0·65; EF52 1·25; EF80 0·25; EF85 0·35; EF86 0·30; EF89 0·28; EF91 0·37; EF92 0·50

EF98 0·75; EF183 0·30; EF184 0·35; EH90 0·55; EL33 1·75; EL34 0·60; EL37 2·50; EL41 0·90; EL42 0·90; EL84 0·28; EL91 0·50; EL95 0·40; EL360 1·25; ELL80 1·25; EM80 0·45; EM81 0·60; EM84 0·35; EY51 0·40; EY86 0·40; EZ40 0·75; EZ41 0·75

EZ80 0·28; EZ81 0·29; EZ90 0·40; GY501 0·80; GZ30 0·45; GZ32 0·50; GZ34 0·65; H63 0·90; HL41DD 0·70; HN309 1·50; KT61 1·75; KT66 2·50; KT81 (7C5) 1·30; KT88 2·90; KTW61 1·00; KTW62 1·00; N78 2·75

OA2 0·40; OB2 0·40; OZ4 0·45; PC86 0·60; PC88 0·60; PC900 0·48; PCC84 0·40; PCC89 0·50; PCC189 0·60; PCF80 0·40; PCF86 0·60; PCF801 0·50; PCF802 0·50; PCF805 0·90; PCF806 0·75; PCF808 0·90; PCL82 0·35; PCL83 0·66; PCL84 0·45; PCL85 0·60; PCL86 0·45

PD500 1·30; PEN45DD 0·75; PFL200 0·65; PL36 0·63; PL38 1·25; PL81 0·50; PL82 0·45; PL83 0·45; PL84 0·40; PL500 0·80; PL504 0·80; PL508 0·90; PL509 1·55; PL801 1·00; PL802 0·95; PY32 0·63; PY33 0·63; PY81/800 0·50

PY82 0·35; PY83 0·38; PY500 1·00; PY801 0·50; 8P41 3·00; 8P61 0·75; T41 1·00; U25 0·85; U26 0·85; U191 0·75; U404 0·70; U801 0·80; UABC80 0·40; UAF42 0·75; UBC41 0·75; UCH42 0·75; UBF80 0·40; UBF89 0·40; UCC85 0·45

UCH42 0·75; UCH81 0·40; UCL82 0·35; UCL83 0·70; UF41 0·75; UF89 0·40; UL41 0·85; UL84 0·43; UY41 0·48; UY85 0·40; VP4B 1·25; VR75/30 0·48; VR105/30 0·40; VR150/30 0·40; Y63 1·50; 1R5 0·45; 1S5 0·30; 1T4 0·30

3S4 0·40; 3V4 0·70; 5R4GY 0·80; 5U4G 0·40; 5V4G 0·50; 5Y3GT 0·45; 5Z4G 0·45; 6/30L2 0·90; 6AL5 0·25; 6AQ5 0·45; 6AS7 0·85; 6AT6 0·45; 6AU6 0·30; 6AV6 0·45; 6BA6 0·28; 6BE6 0·35; 6BH6 0·75; 6BJ6 0·55; 6BQ7A 0·55; 6BR7 1·00; 6BW6 0·90

6BW7 0·90; 6C4 0·35; 6CD6G 1·30; 6CH6 1·40; 6E5 1·00; 6F23 1·05; 6J5G 0·45; 6J5GT 0·45; 6J7GT 0·45; 6K6GT 0·75; 6K7GT 0·35; 6K8GT 0·50; 6P25 1·75; 6Q7GT 0·50; 6SG7M 0·45; 6SJ7GT 0·30; 6SL7GT 0·48; 6SN7GT 0·48; 6U4GT 0·75; 6U5G 0·75

6V6GT 0·50; 6X4 0·40; 6X5GT 0·45; 7B6 0·75; 7B7 0·70; 7C5 1·30; 7C6 0·75; 7H7 0·70; 7S7 2·25; 7Y4 0·75; 12AC6 0·70; 12AD6 0·65; 12AE6 0·65; 12AT6 0·40; 12AT7 0·40; 12AU6 0·45; 12AU7 0·33; 12AX7 0·33; 12BA6 0·45; 12BE6 0·50; 12BH7 0·50

30C15 1·05; 30C17 1·10; 30C18 0·90; 30F5 1·10; 30FL1 0·80; 30FL14 0·90; 30L15 1·05; 30L17 0·95; 30P12 1·05; 30P19 1·00; 30PL1 0·95; 30PL13 1·20; 30PL14 1·25; 35L6GT 0·75; 35W4 0·50; 35Z3 0·75; 35Z4GT 0·70; 50C5 0·60; 50CD6G 1·20; 80 0·60

807 0·50; 6080 2·25; 6146 2·00

**TUBES**

2AP1 4·00; 3BP1 3·50; 3DP1A 3·50; 3EG1 10·00; 3FP7 1·50; 3GP1 3·50; 5BP1 4·00; 5CP1 5·00; 5FP7 3·00; 88D 10·00; CV429 22·00; CV960 8·00; DG7-5 8·00; DG7-6 10·00; VCR138 8·00; VCR139A 8·00

## TRANSISTORS

1N21 0·17; 1N23 0·35; 1N4001 0·06; 1N4002 0·07; 1N4003 0·08; 1N4004 0·08; 1N4006 0·12; 18111 0·25; 18131 0·13; 18132 0·13; 2G220 0·63; 2G301 0·40; 2G302 0·40; 2N696 0·15; 2N697 0·15; 2N706 0·10; 2N706A 0·12

2N708 0·15; 2N1302 0·18; 2N1303 0·18; 2N1304 0·22; 2N1305 0·22; 2N1306 0·28; 2N1307 0·28; 2N2147 0·75; 2N2218 0·23; 2N2444 1·99; 2N2646 0·50; 2N2926 0·10; 2N3702 0·11; 2N3703 0·12; 2N3704 0·14; 2N3705 0·15; 2N3707 0·13

2N3709 0·10; 2N3710 0·11; 2N3711 0·11; 2N3819 0·35; 2N4286 0·15; 2N4289 0·15; AC126 0·25; AC127 0·25; AC128 0·20; AC176 0·25; AC187 0·20; AC188 0·20; ACY17 0·35; AD140 0·50; AD149 0·50; AD161 0·39; AD162 0·39; AF114 0·25; AF115 0·25

AF116 0·25; AF117 0·20; AF139 0·33; AFZ12 1·50; BC107 0·12; BC108 0·12; BC109 0·12; BC115 0·20; BC116 0·20; BC117 0·21; BC169 0·14; BCY34 0·45; BD121 1·00; BD123 1·00; BF115 0·22; BF173 0·28; BF180 0·35; BF181 0·35; BF194 0·13

BF195 0·13; BF196 0·15; BF197 0·15; BF861 0·25; BF898 0·25; BFY50 0·20; BFY51 0·20; BFY52 0·20; BTY79/100R 0·75; BY100 0·15; BY126 0·14; BY127 0·15; BZY88 Series 0·10; CRS1/05 0·30; CRS1-40 0·45

CRS3-40 0·55; CS10B 3·50; CV102 0·25; CV103 0·18; CV253 1·00; CV2154 2·00; CV2155 2·00; CV7108 3·50; CV7109 3·50; DD000 0·15; DD006 0·25; GET102 0·50; GET103 0·40; GET116 0·85; GET875 0·40; GEX66 1·25; GEX541 0·75

GJ7M 0·50; KS100A 0·20; MAT101 0·25; MAT120 0·20; MAT121 0·25; MJE370 0·68; MJE520 0·65; MJE2955 1·10; MJE3055 0·75; MPF102 0·40; MPF103 0·36; MPF104 0·35

NKT128 0·45; NKT211 0·25; NKT213 0·25; NKT214 0·24; NKT216 0·40; NKT217 0·45; NKT218 1·13; NKT301 0·85; NKT304 0·75; NKT401 0·75

NKT403 0·70; NKT404 0·60; NKT713 0·30; OA5 0·60; OA6 0·12; OA7 0·20; OA9 0·20; OA10 0·40; OA47 0·08; OA70 0·10; OA71 0·20; OA79 0·10; OA81 0·10; OA85 0·15; OA86 0·15; OA90 0·07; OA91 0·07

OA95 0·07; OA200 0·08; OA202 0·10; OA210 0·20; OA211 0·35; OAZ202 0·45; OAZ210 0·40; OAZ211 0·40; OAZ242 0·15; OAZ244 0·25; OAZ246 0·15; OC16 1·00; OC16T 1·00; OC19 0·50; OC20 2·00; OC22 1·00; OC23 1·25; OC24 1·10; OC25 0·40

OC26 0·40; OC28 0·70; OC29 0·65; OC30 0·40; OC35 0·55; OC36 0·85; OC41 0·35; OC42 0·40; OC43 0·70; OC44 0·18; OC44M 0·17; OC45 0·18; OC45M 0·18; OC46 0·27; OC57 0·60; OC58 0·60; OC59 0·60; OC66 0·50; OC70 0·18

OC71 0·15; OC72 0·25; OC73 0·50; OC74 0·30; OC75 0·30; OC76 0·30; OC77 0·55; OC78 0·25; OC78D 0·25; OC79 0·30; OC81 0·28; OC81D 0·28; OC81M 0·20; OC81DM 0·18; OC81Z 0·45; OC82 0·28; OC82D 0·25; OC83 0·25

OC84 0·30; OC123 1·10; OC139 0·40; OC140 0·65; OC141 0·80; OC169 0·20; OC170 0·25; OC171 0·30; OC200 0·55; OC201 0·80; OC202 0·90; OC203 0·55; OC204 0·65; OC205 1·00; OC206 1·10; OC207 1·00; OCP70 0·50; OCP71 1·00; ORP12 0·55

ORP60 0·45; ORP61 0·48; SX640 0·75; SX642 0·60; SX643 0·75; ZS21 0·30; ZS22 0·20; ZS170 0·10; ZS178 0·40; ZS271 0·18; ZT21 0·25; ZTX107 0·12; ZTX108 0·10; ZTX300 0·14; ZTX304 0·25; ZTX500 0·15; ZTX503 0·16; ZTX531 0·25

## Industrial Valves

1B3GT; 1B24; 1B35A; 1B63A; 1N21; 1N21B; 1N23B; 1N23CR; 1X2A; 1X2B; 2A3; 2AS15; 2C26A; 2C34; 2C39A; 2C43; 2D21; 2D21W; 2E26; 2J31; 2J33; 2J50; 2J54; 2J56A; 2K25; 2K26; 2K28; 2K45; 2X2A; 3A/107A; 3A/108A; 3A/108B; 3A/109B; 3A/110A; 3A/110B; 3A/146J; 3A/167M; 3A5; 3B/240M; 3B/241M; 3B24

3B28; 3B29; 3C22; 3C23; 3C24/24G; 3C45; 3CX100A5; 3E29; 3J/121E; 3J/160E; 3J/170E; 3Q/150E; 3Q/195E; 3S4; 3V/340B; 3V/390A; 3V/390B; 4-125A; 4-250A; 4-400A; 4B32; 4C35; 4CX250B; 4E27; 4J50; 4J52; 4J52A; 4J53; 4X150A; 4X150D; 4X250B; 5B/251M; 5B/252M; 5B/254M; 5B/255M; 5B/256M; 5B/257M; 5C22; 5D21; 5R4GY; 5U4GB

5Z3; 5Z4G; 6AF4A; 6AK5; 6AM5; 6AM6; 6AN5; 6AN8; 6AR5; 6AS6; 6AU4GTA; 6AU5GT; 6AU6; 6AV5GTA; 6AW8A; 6AX5GT; 6B4G; 6BA8A; 6BK4; 6BK7A; 6BL7GTA; 6BN6; 6BR7; 6BS7; 6BX7GT; 6BZ6; 6CB6; 6CH6; 6CL6; 6CW4; 6DK6; 6DQ6B; 6EA8; 6F33; 6H6(metal); 6K7GT; 6U8A; 6V6GT; 11E3; 11E13; 12AY7; 12B4A; 12BY7A

12E1; 12E14; 13D1; 13E1; 28D7; 29C1; 53KU; 75B1; 75C1; 83A1; 85A1; 85A2; 90AG; 90AV; 90C1; 90CG; 90CV; 95A1; 100TH; 150B2; 150B3; 150C1; 150C2; 150C3; 150C4; 250TH; 328; 329; 631-P1; 705A; 715A; 715B; 723A/B; 725A; 801; 803; 805; 807; 808; 811; 811A; 812A; 813

815; 828; 829B; 830B; 860; 866; 866A; 866E; 827A; 881R; 891R; 954; 955; 956; 957; 1625; 2050; 2050W; 2051; 4003A; 4212D or E; 4242A; 4313C; 4328A; 4687; 5544; 5545; 5642; 5644; 5651; 5670; 5672; 5676; 5687; 5696; 5702; 5718; 5719; 5725/6AS6W

5726/6AL5W; 5727/2D21W; 5749; 5750; 5751; 5802; 5814; 5823; 5840; 5963; 5965; 6005/6AQ5W; 6021; 6057; 6058; 6059; 6060; 6061; 6062; 6063; 6064; 6065; 6067; 6072; 6073; 6074; 6080; 6097C; 6130; 6136; 6189; 6197; 6201; 6202; 6203; 6205; 6360; 6442; 6463; 6550; 6807

6923; 6939; 7193; 7203; 7360; 7586; 8013; 8025A; 9001; 9002; 9003; 9004; 9005; 9006; 13201A; A1834; A2087; A2134; A2293; A2426; A2521; A2900; ACT6; ACT9; B1C 1E; BS90; BS156; BT5; BT35; BT45; BT79; BT83; C1C; C1K; CAA322; CV5; CV25; CV26

CV28; CV31; CV45; CV53; CV73; CV74; CV85; CV118; CV121; CV124; CV128; CV131; CV132; CV133; CV135; CV136; CV137; CV138; CV140; CV144; CV160; CV173; CV187; CV188; CV190; CV220; CV261; CV273; CV284; CV286; CV287; CV315; CV329; CV337; CV342; CV345; CV354; CV359; CV360; CV371; CV372; CV378; CV391; CV395; CV397

CV404; CV415; CV416; CV417; CV428; CV434; CV447; CV449; CV466; CV469; CV488; CV491; CV492; CV493; CV717; CV808; CV1072; CV1076; CV1092; CV1219; CV1343; CV1475; CV1476; CV1477; CV1478; CV1794; CV1480; CV1481; CV1482; CV1787; CV1832; CV1833; CV1835; CV1994; CV2000; CV2131; CV2154; CV2155; CV2160; CV2179; CV2235; CV2237; CV2238; CV2253; CV2289

CV2325; CV2361; CV2466; CV2516; CV2519; CV2520; CV2522; CV2721; CV2901; CV3523; CV3929; CV3986; CV3988; CV3991; CV3998; CV4001; CV4002; CV4003; CV4004; CV4005; CV4006; CV4007; CV4008; CV4009; CV4010; CV4011; CV4012; CV4013; CV4014; CV4015; CV4016; CV4017; CV4018; CV4019; CV4020; CV4022; CV4023; CV4024; CV4025; CV4028; CV4033; CV4035; CV4038; CV4039; CV4040

CV4043; CV4044; CV4046; CV4048; CV4053; CV4056; CV4059; CV4060; CV4062; CV4063; CV4064; CV4079; CV4501; CV4502; CV4503; CV4504; CV4507; CV4508; CV5060; CV6004; CV6008; CV6045; DA30; DA41; DA42; DA100; DET22; E55L; E80CC; E80FC; E80F; E80L; E80T; E81CC; E81L; E82CC; E83CC; E83F; E88CC; E90CC; E90L; E91H; E92CC; E180CC

E180F; E181CC; E182CC; E186F; E188CC; EA50; EA52; EA76; EC35; ECF804; EF50; EF54; EF55; EF804; EFP60; EL91; EN30; EN31; EN32; EN91; ESU74; ESU76; ESU77; F6057; F6060; F6061; F6063; FX219; FX225; FX227; G1,371K; G120/1B; G150/2B; G180/2M; G240/2D; G400/1K; GN4; GT1C; GTR120W; GTR150MS; GU18; GU20/21; GU50; GXU1

GXU2; GXU3; GXU4; GXU50; KT66; KT67; KT88; M8079; M8080; M8081; M8082; M8083; M8091; M8096; M8097; M8098; M8100; M8136; M8137; M8140; M8141; M8142; M8144; M8149; M8157; M8161; M8162; M8163; M8167; M8179; M8190; M8196; M8204; M8212; M8214; M8223; M8224; M8225; M8232; M8237; M8245; ME1400; ME1401

ME1403; ME1404; ME1500; ME1501; OA2; OA3; OA4G; OB2; OB3; OD3; OG3; OZ4; OZ4A; OT15; QA2400; QA2403; QA2404; QA2406; QA2407; QB3/300; QB3-5-750; QB4-1100; QF41; QF45; QQV02-6; QQV03-10; QQV03-20; QQV03-20A; QQV04-15; QQV06-40; QQV06-40A; QS70/20; QS75/20; QS75/40; QS75/60; QS83/3; QS92/10; QS95/10; QS105/45

QS108/45; QS150/15; QS150/30; QS150/36; QS150/40; QS150/45; QS150/80; QS1200; QS1202; QS1203; QS1205; QU37; QV03-12; QV04-7; QV05-25; QV06-20; QY3-125A; QY4-50A; QY4-400A; R10; R17; R18; S11E12; S130; S130P; STV280/40; STV280/80; SU41; SU42; TD03-10; TT15; TT21; TTR31MR; TZ40; U17; U19; U27; VLS631; Z300T; Z759; Z803U

## Integrated Circuits

7400 .. .. 0·20; 7401 .. .. 0·20; 7402 .. .. 0·20; 7403 .. .. 0·20; 7404 .. .. 0·20; 7405 .. .. 0·20; 7406 .. .. 0·40; 7407 .. .. 0·40; 7408 .. .. 0·25; 7409 .. .. 0·33

7410 .. .. 0·20; 7411 .. .. 0·23; 7412 .. .. 0·28; 7413 .. .. 0·30; 7416 .. .. 0·30; 7417 .. .. 0·30; 7420 .. .. 0·20; 7422 .. .. 0·28; 7423 .. .. 0·40; 7425 .. .. 0·37; 7427 .. .. 0·37; 7428 .. .. 0·43; 7430 .. .. 0·20; 7432 .. .. 0·37; 7433 .. .. 0·43

7437 .. .. 0·45; 7438 .. .. 0·43; 7440 .. .. 0·20; 7441AN .. 0·85; 7442 .. .. 0·85; 7450 .. .. 0·20; 7451 .. .. 0·20; 7453 .. .. 0·20; 7454 .. .. 0·20; 7460 .. .. 0·20; 7470 .. .. 0·33; 7472 .. .. 0·38; 7473 .. .. 0·44; 7474 .. .. 0·48; 7475 .. .. 0·59

7476 .. .. 0·45; 7480 .. .. 0·80; 7482 .. .. 0·87; 7483 .. .. 1·26; 7484 .. .. 1·00; 7486 .. .. 1·50; 7490 .. .. 0·75; 7491AN .. 1·10; 7492 .. .. 0·75; 7493 .. .. 0·75; 7494 .. .. 0·85; 7495 .. .. 0·85; 7496 .. .. 1·00; 7497 .. .. 4·32; 74100 .. 2·16

74107 .. 0·51; 74110 .. 0·57; 74111 .. 0·86; 74118 .. 1·00; 74119 .. 1·92; 74121 .. 0·57; 74122 .. 0·80; 74123 .. 1·44; 74141 .. 1·00; 74145 .. 1·44; 74150 .. 2·30; 74151 .. 1·15; 74154 .. 2·30; 74155 .. 1·15; 74156 .. 1·15

74157 .. 1·09; 74170 .. 2·88; 74174 .. 1·80; 74175 .. 1·29; 74176 .. 1·44; 74190 .. 2·30; 74191 .. 2·30; 74192 .. 2·30; 74193 .. 2·30; 74194 .. 1·72; 74195 .. 1·44; 74196 .. 1·58; 74197 .. 1·58; 74198 .. 3·16; 74199 .. 2·88

**LOW PROFILE SOCKETS**

14 pin DIL, 15p.
16 pin, DIL, 17p.

**Stockists of English Electric, Ferranti, M.O. Valve Co., Mullard, S.T.C.**

**FROM 1ST APRIL ALL ORDERS SUBJECT TO V.A.T. AT APPLICABLE RATE. THIS MUST BE ADDED TO TOTAL ORDER PRICE INCLUDING POSTAGE.**
**Terms of Business: Mon. to Sat. Open to callers 9 a.m. to 5 p.m. Closed Sat. 1 p.m. to 3 p.m. Express postage 5p. for one valve; 1p each additional valve. Express postage: 3p for one transistor, and 1p for each additional. Over 10 post free. All orders over £5 post free. Valves tested and released to A.R.B. specification if required. (Full valve availability list on request, S.A.E.) Prices correct when going to press.**

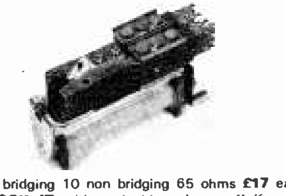
---

# 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.**

**LARGE STOCKS HELD OF G.E.C. MINIATURE SEALED AND ERICSSON CYLINDRICAL TYPE RELAYS.**



**MINIATURE UNISELECTOR** PO type 2201A 3 level 12 outlet fits into space occupied by one only PO type Relay 50 volt 250 ohm coil 2 bridging 1 non bridging wipers **£8.80** ea. PO type 2 UNISELECTORS all 25 outlet 8 level non bridging wipers 300 ohms **£14** ea. 11 level 1 bridging 10 non bridging 65 ohms **£17** ea. 4 pole 50 way all non bridging 75 ohms **£11** ea.
**LOCK IT** with a double pole on-off Key operated switch 2 amp 250 volt supplied with two Yale keys **£1.10** each.
**PO** type No 2 Switchboard Lamps 6 volts **£15.40** per 100. 24 volts **£22** per 100.
**MINIATURE DIGITAL INDICATOR** size of digits ⅜ inch illuminated by 28 volt midget flanged lamps. weight 3½ ozs. reading 0 to 9 with decimal points. quick disconnect rear of unit for easy lamp replacement **£4.40** ea.
**GEARED MOTORS** 3 r.p.m. 24 volts AC. 4 watts **£3.35** each 24 volt Transformer with 240 volt AC input available at **£1.73** ea.
**BRIDGE MEGGERS** 1000 Volts0/100 Megohms with Resistance Box 0/999 ohms. **£84.70** ea.
We hold large stocks of Standard Potentiometers Carbon, Wire Wound 1 to 50 watts, Precision and 2 gang types. Toggle switches Push and Rotary action types. Microswitches. Standard Carbon. Wire Wound Vitreous enamelled. High Stability types of Resistors. All British Meters Volts. Microamps. Milliamps.

**L. WILKINSON (CROYDON) LTD., LONGLEY HOUSE, LONGLEY RD., CROYDON. CR0 3LH. Phone 01-684 0236. Grams: WILCO CROYDON**

WW—045 FOR FURTHER DETAILS

---

# C.I.E.L.

**4/6 rue Victor Hugo — 94190 Villeneuve St Georgs, France**

## 4000 TYPES OF SEMICONDUCTORS AND TUBES

CATALOGUE ON REQUEST

| Transistors I.T.T. Si NPN | | | | | Price in £ | | | |
|---|---|---|---|---|---|---|---|---|
| | Vceo V | Icm A | Ptot mW | F Mhz | per 100 each | per 500 each | per 1000 each | per 5000 each |
| BF123 | 30 | 30 | 330 | 35 | 0.134 | 0.123 | 0.113 | 0.106 |
| BF127 | 30 | 25 | 330 | 335 | 0.133 | 0.116 | 0.106 | 0.100 |

# Henry's

**DON'T RELY ON YOUR MEMORY**
**BUY NOW AT BARGAIN PRICES**
*Hi Fi and Transistors – Up to date Brochures on request*

**HENRY'S CATALOGUE**
Due to rapid price changes, shortages of paper and raw materials, all prices in the existing catalogues no longer apply. Call or phone for latest prices. A new catalogue will be available for Aug/Sept. 1974.


## BUILD THE TEXAN
### 20 + 20WATT IC STEREO AMPLIFIER
As featured by *Practical Wireless* 1972

Now built and used by thousands of satisfied customers. Features slim design overall size in cabinet 15½" x 2¾" x 6½" 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 PREDOMINATE FEATURES – DEVELOPED BY TEXAS ENGINEERS FOR PERFORMANCE, RELIABILITY ANDEASE 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.

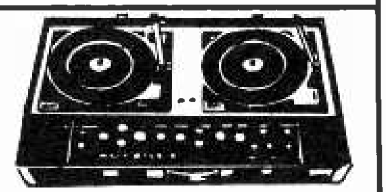
## BUILD THE NEW HENELEC
### STEREO FM TUNER

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, easy 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 2¾"x6½". 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 **£88·50**
As above but with Slider Controls **£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**
**NORTHCOURT**
400, 40 watt Mixer Amplifier **£37·50**
800, 80 watt Mixer Amplifier **£45·00**
**DISCO MIXER/PREAMPLIFIERS**
(OP for up to 6-100 watt amplifiers)
**SDLI** (rotary controls) **£49·50**
**SDLII** (slider controls) **£58·50**
**DISCO VOX** (slider controls) the complete disco preamp **£72·00**
**DJ100** 100 watt power amplifier for above **£49·50**
**DJ30L** Mk II 3 channel, 3 kW sound to light **£41·25**
**DJ30L** Mk III Slider Controls **£45·50**
**DJ DISCLITE** As 30L/II + Variable speed flashes **£54·00**



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 Trilite (mini with flashers) **£17·00**
Bubblemaker with 1 gall. Liquid **£22·50**
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.

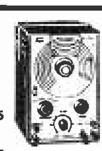
## LOW COST HI-FI SPEAKERS

**SPECIAL OFFERS**
EMI 13" x 8"—full 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, or **£7.40** per pair.
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 | 8" | 40 watt | £35·95 pair |
| LINTON 2 | | 20 watt | £18·30 pair |
| GLENDALE 3 | | 30 watt | £32·95 pair |
| DOVEDALE 3 | | 50 watt | £51·50 pair |
| KEF KK2 | | | £55·00 pair |
| KEF KK3 | | | £78·00 pair |

## TEST EQUIPMENT
## MULTIMETERS



(carr. etc. 30p)

| | | |
|---|---|---|
| ITI-2 | 20K/V Slimline | £5·95 |
| | 20K/Volt Slimline deluxe with case | £6·75 |
| TLH33D | 2K/Volt Robust with case | £7·50 |
| U4323 | +IF 8AF·OSC | £7·00 |
| AF105 | 50K/Volt | £12·50 |
| U4313 | 20K/Volt AC current. Steel case | £10·50 |
| U4341 | Plus Built In transistor tester | £10·50 |
| Model 500 | 30K/Volt (case £2.25) | £11·75 |

## OTHER EQUIPMENT

| | | |
|---|---|---|
| SE250B | Pocket Signal Injector | £2·25 carr. 15p |
| TE15 | Grid Dip meter 440kHz-280mHz | £16·50 carr. 30p |
| TE40 | AC Millivoltmeter 1·2mHz | £19·75 carr. 35p |
| TE65 | 28 Range valve voltmeter | £22·50 carr. 40p |
| TE20D | 120kHz-500mHz RF Generator | £18·95 carr. 40p |
| TE22D | 20Hz-200kHz Audio Generator | £19·95 carr. 40p |
| SE350A | Deluxe Signal Tracer | £12·95 carr. 20p |
| SE400 | Volts/ohms/R-C sub./RF field/RF gen. | £15·50 carr. 20p |

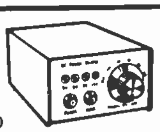
## MINIATURE AMPLIFIERS

**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 | £3·95 |
| 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, 2½ + 2½ watts 12 volt | £8·25 |
| 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 |
| SP40-5 2Z40/Stereo 80/P25 | £25·00 |
| SP40-6 2Z40/Stereo 80/P26 | £27·75 |
| SP60 2Z60/Stereo 80/P28 | £30·45 |
| Transformer PZ8 | £3.95 |

## CERAMIC FILTERS
10.7 MHz Ceramic filters now in stock
**40p** per pair

## POWER SUPPLIES FOR EVERY PURPOSE



(All cased unless stated chassis)

| | |
|---|---|
| 470C 6/7½/9 volt 300 MA (includes Multi-Adaptor for Tape Recorders, etc.) | £2·25 post 20p |
| Car Lighter Voltage Adaptors 300mA (State voltage 6v, 7½v, 9v) | £1·95 ea. post 25p |
| SC202 3/6/7½/9 volt 400mA | £4·25 carr. 30p |
| HC244R Stabilised version | £5·50 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 |
| P1080 12v 1 amp (chassis) | £4·70 post 20p |
| P1081 45v 0·9 amp (chassis) | £7·80 post 20p |
| P12 4½-12 volt 0·4-1 amp | £7·15 post 30p |
| SE101A 3/6/9/12 volt 1 amp (Stab.) | £12·75 post 25p |
| RP164 6/7½/9/12 1 amp (Stab.) | £13·45 post 30p |

## 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 200µA to 5A
Ohms=6 ranges from one tenth of Ohm to 100MΩ
Reactance=1 range from 0 to 10MΩ
Capacity=6 ranges from 0 to 500pF and from 0 to 0·5µF 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 Shunts 25/50/100A

PRICE **£18.50**

**ACCESSORIES**

| | |
|---|---|
| Transistor tester | £11·00 |
| Electronic voltmeter | £18·00 |
| Ampclamp | £11·95 |
| Temperature probe | £11·95 |
| Guass meter | £11·95 |
| Signal Injector | £5·95 |
| Phase Sequence | £5·95 |
| EHT Probe | £5·95 |
| Shunts 25/50/100A | £4·50 |

## NEW SINCLAIR PROJECT 80

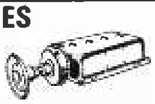
| | |
|---|---|
| Stereo Pre-Amplifier | £11·95 |
| Audio Filter Unit | £6·95 |
| 2Z40 15 watt Amplifier | £5·45 |
| 2Z60 25 watt Amplifier | £6·95 |
| PZ5 Mod. for 1 on 2 Z40 | £4·98 |
| PZ6 Mod. (S Tab) 1 on 2 Z40 | £7·98 |
| PZ8 Mod. (S Tab) 1 on 2 Z60 | £7·98 |
| TRANSFORMER FOR PZ8 | £3·95 |
| NEW FM TUNER | £11·95 |
| STEREO DECODER | £7·45 |

All items post paid.

## 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.


## SPECIAL PURCHASES
**UHF TV TUNERS**
**CHANNELS 21 TO 64**
Brand new transistorised geared tuners for 625 line Receiver IF output. **£2·50** post 20p.



## PUSHBUTTON UHF TV TUNER
New purchase of 4 button transistorised uhf tuner. **£3.50** + post 20p.

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.

## FIBRE OPTICS
0·01 diam. Mono Filament **£5·50** per 100 metre reel.
0·13 diam. 64 Fibres Sheathed. **£1·00** per metre.
SPRAYS 15mm. diam. Mares Tails. **£9·50**

## 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, **65p** each.
Complete with knobs.

## MARRIOT TAPE HEADS
4 TRACK MONO or 2 TRACK STEREO. '17' High Impedance **£2·50.** '18' Medium Impedance **£3·50.** '36' **£5·00.** R730/E73 2 track mono Record/Erase, low imp. **75p** pair. Erase Heads for '17', '18' and '36' **£1·00.** '63' 2 track mono Hi imp, **£1·75.** '43' Erase Head for '63' **75p.** (Post etc., 15p any quantity.)

## EXCLUSIVE DECCA KELLY SPEAKERS

12 watt speaker Tweeter systems. 8in. Bass/Midrobe and Melinex Domed HF radiator plus crossover **£12·50** per pair of systems (carr./pkg. 40p) or built into veneered cabinets, size 18×12×6½in. **£19·50** pair (carr. £1).

## JOSTY KITS NOW IN STOCK
Latest stock lists
Ref 11 on request

## 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.

**ALWAYS BARGAINS FOR CALLERS**

# 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
144 Burnt Oak Broadway, Burnt Oak, Edgware 01-952 7402
190-194 Station Road, Harrow, Middlesex 01-863 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 shew) Min. Order £1.00 please: Post 10p.

## 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 £p | 12/29 £p | 30/99 £p |
|---|---|---|---|
| SN7400N | 0·20 | 0·18 | 0·16 |
| SN7401N | 0·20 | 0·18 | 0·16 |
| SN7401AN | 0·38 | 0·38 | 0·33 |
| SN7402N | 0·20 | 0·18 | 0·16 |
| SN7403N | 0·20 | 0·18 | 0·16 |
| SN7403AN | 0·38 | 0·38 | 0·33 |
| SN7404N | 0·24 | 0·21 | 0·18 |
| SN7405N | 0·20 | 0·18 | 0·18 |
| SN7405AN | 0·44 | 0·44 | 0·38 |
| SN7406N | 0·40 | 0·38 | 0·35 |
| SN7407N | 0·40 | 0·38 | 0·35 |
| SN7408N | 0·25 | 0·22 | 0·18 |
| SN7409N | 0·33 | 0·33 | 0·28 |
| SN7409AN | 0·44 | 0·44 | 0·38 |
| SN7410N | 0·20 | 0·18 | 0·16 |
| SN7411N | 0·25 | 0·23 | 0·21 |
| SN7412N | 0·28 | 0·28 | 0·25 |
| SN7412AN | 0·38 | 0·38 | 0·33 |
| SN7413N | 0·30 | 0·27 | 0·25 |
| SN7414N | 0·72 | 0·72 | 0·63 |
| SN7416N | 0·30 | 0·27 | 0·25 |
| SN7417N | 0·30 | 0·27 | 0·25 |
| SN7420N | 0·20 | 0·18 | 0·16 |
| SN7422N | 0·28 | 0·28 | 0·25 |
| SN7422AN | 0·38 | 0·38 | 0·33 |
| SN7423N | 0·37 | 0·34 | 0·32 |
| SN7425N | 0·37 | 0·37 | 0·32 |
| SN7427N | 0·37 | 0·37 | 0·32 |
| SN7428N | 0·43 | 0·43 | 0·37 |
| SN7430N | 0·20 | 0·18 | 0·16 |
| SN7432N | 0·37 | 0·37 | 0·32 |
| SN7433N | 0·43 | 0·43 | 0·38 |
| SN7433AN | 0·57 | 0·57 | 0·50 |
| SN7437N | 0·43 | 0·43 | 0·37 |
| SN7438N | 0·43 | 0·43 | 0·37 |
| SN7438AN | 0·57 | 0·57 | 0·50 |
| SN7440N | 0·20 | 0·18 | 0·16 |
| SN7441AN | 0·85 | 0·79 | 0·73 |
| SN7442N | 0·85 | 0·79 | 0·73 |
| SN7443N | 1·50 | 1·27 | 1·13 |
| SN7444N | 1·50 | 1·27 | 1·13 |
| SN7445N | 2·16 | 2·16 | 1·89 |
| SN7446N | 2·16 | 2·16 | 1·89 |
| SN7447AN | 1·80 | 1·80 | 1·57 |

| Type | 1/11 £p | 12/29 £p | 30/99 £p |
|---|---|---|---|
| SN7448N | 1·50 | 1·27 | 1·13 |
| SN7450N | 0·20 | 0·18 | 0·16 |
| SN7451N | 0·20 | 0·18 | 0·16 |
| SN7453N | 0·20 | 0·18 | 0·18 |
| SN7454N | 0·20 | 0·18 | 0·16 |
| SN7460N | 0·20 | 0·18 | 0·16 |
| SN7470N | 0·33 | 0·30 | 0·27 |
| SN7472N | 0·30 | 0·38 | 0·34 |
| SN7473N | 0·44 | 0·41 | 0·37 |
| SN7474N | 0·48 | 0·48 | 0·42 |
| SN7475N | 0·59 | 0·55 | 0·51 |
| SN7476N | 0·45 | 0·38 | 0·32 |
| SN7480N | 0·80 | 0·70 | 0·50 |
| SN7481N | 1·25 | 1·10 | 0·95 |
| SN7482N | 0·87 | 0·80 | 0·72 |
| SN7483N | 1·20 | 1·10 | 1·00 |
| SN7485N | 1·87 | 1·87 | 1·63 |
| SN7486N | 0·50 | 0·50 | 0·44 |
| SN7489N | 4·32 | 4·32 | 3·78 |
| SN7490N | 0·75 | 0·70 | 0·63 |
| SN7491AN | 1·10 | 1·00 | 0·90 |
| SN7492N | 0·75 | 0·70 | 0·63 |
| SN7493N | 0·75 | 0·70 | 0·63 |
| SN7494N | 0·85 | 0·80 | 0·75 |
| SN7495N | 0·85 | 0·80 | 0·75 |
| SN7496N | 1·00 | 0·90 | 0·83 |
| SN74100N | 2·10 | 1·89 | 1·89 |
| SN74104N | 0·60 | 0·53 | 0·45 |
| SN74105N | 0·60 | 0·53 | 0·45 |
| SN74107N | 0·51 | 0·51 | 0·45 |
| SN74110N | 0·57 | 0·57 | 0·50 |
| SN74111N | 0·88 | 0·88 | 0·75 |
| SN74116N | 2·18 | 2·18 | 1·89 |
| SN74118N | 1·00 | 0·90 | 0·83 |
| SN74119N | 1·92 | 1·92 | 1·68 |
| SN74120N | 1·05 | 1·05 | 0·92 |
| SN74121N | 0·57 | 0·57 | 0·50 |
| SN74122N | 0·80 | 0·80 | 0·70 |
| SN74123N | 1·44 | 1·44 | 1·26 |
| SN74125N | 0·69 | 0·69 | 0·60 |
| SN74126N | 0·69 | 0·69 | 0·60 |
| SN74132N | 0·72 | 0·72 | 0·63 |
| SN74136N | 0·63 | 0·63 | 0·55 |

| Type | 1/11 £p | 12/29 £p | 30/99 £p |
|---|---|---|---|
| SN74141N | 1·00 | 0·90 | 0·80 |
| SN74142N | 2·88 | 2·88 | 2·52 |
| SN74145N | 1·44 | 1·44 | 1·26 |
| SN74147N | 2·30 | 2·30 | 1·83 |
| SN74148N | 2·01 | 2·01 | 1·63 |
| SN74150N | 2·30 | 2·30 | 2·01 |
| SN74151N | 1·15 | 1·15 | 1·00 |
| SN74153N | 1·09 | 1·09 | 0·95 |
| SN74154N | 2·30 | 2·30 | 2·01 |
| SN74155N | 1·15 | 1·15 | 1·00 |
| SN74156N | 1·09 | 1·09 | 1·00 |
| SN74157N | 1·09 | 1·09 | 0·95 |
| SN74159N | 2·44 | 2·44 | 2·14 |
| SN74160N | 1·58 | 1·58 | 1·38 |
| SN74161N | 1·58 | 1·58 | 1·38 |
| SN74162N | 1·58 | 1·58 | 1·38 |
| SN74163N | 1·58 | 1·58 | 1·38 |
| SN74164N | 2·01 | 2·01 | 1·76 |
| SN74165N | 2·01 | 2·01 | 1·76 |
| SN74166N | 2·18 | 2·16 | 1·89 |
| SN74167N | 4·10 | 4·10 | 3·59 |
| SN74170N | 2·88 | 2·88 | 2·52 |
| SN74172N | 5·78 | 5·76 | 5·04 |
| SN74173N | 1·66 | 1·66 | 1·45 |
| SN74174N | 1·80 | 1·80 | 1·57 |
| SN74175N | 1·29 | 1·29 | 1·13 |
| SN74176N | 1·44 | 1·44 | 1·26 |
| SN74177N | 1·44 | 1·44 | 1·26 |
| SN74180N | 1·44 | 1·44 | 1·26 |
| SN74181N | 5·18 | 5·18 | 4·53 |
| SN74182N | 1·44 | 1·44 | 1·26 |
| SN74184N | 2·16 | 2·16 | 1·89 |
| SN74185AN | 2·16 | 2·16 | 1·89 |
| SN74188N | 6·48 | 6·48 | 5·67 |
| SN74190N | 2·30 | 2·30 | 2·01 |
| SN74191N | 2·30 | 2·30 | 2·01 |
| SN74192N | 2·30 | 2·30 | 2·01 |
| SN74193N | 2·30 | 2·30 | 2·01 |
| SN74194N | 1·72 | 1·72 | 1·51 |
| SN74195N | 1·44 | 1·44 | 1·26 |
| SN74196N | 1·58 | 1·58 | 1·38 |
| SN74197N | 1·58 | 1·58 | 1·38 |
| SN74198N | 3·18 | 3·18 | 2·77 |
| SN74199N | 2·88 | 2·80 | 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 36, 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 | BCY32 85p | CIO6D 55p | OC44 18p | ZTX300 14p | 2N3771 1·75 |
| AC128 20p | BCY39 1·00 | GET111 55p | OC45 18p | ZTX302 18p | 2N3773 2·25 |
| AC187 20p | BCY55 2·50 | GET115 75p | OC71 15p | ZTX500 15p | 2N3790 2·25 |
| ACY17 35p | BCY70 15p | GET880 55p | OC72 25p | 2G301 40p | 2N3919 35p |
| ACY39 65p | BCY71 20p | LM309K 1·87 | OC77 55p | 2N697 15p | 2N3866 75p |
| AD149 50p | BCY72 13p | MAT121 25p | OC81 28p | 2N706 10p | 2N3903 15p |
| AD161 38p | BD124 80p | MJE340 50p | OC83 25p | 2N930 20p | 2N4002 14p |
| AD162 38p | BD131 45p | MJE520 85p | OC140 65p | 2N987 45p | 2N4126 15p |
| AF117 20p | BF115 22p | MJE3055 75p | OC170 25p | 2N1132 25p | 2N4871 35p |
| AF118 50p | BF180 33p | MPF105 40p | OC200 55p | 2N1304 22p | 2N5457 38p |
| AF139 33p | BF194 13p | NKT217 45p | OC202 90p | 2N1613 20p | 2S001 3·00 |
| AF186 40p | BFX13 25p | NKT404 60p | OCP71 1·00 | 2N1671 1·00 | 2S026 8·90 |
| AF239 44p | BFX34 55p | OA5 60p | ORP12 55p | 2N2147 75p | 2S303 70p |
| ASY27 30p | BFX88 22p | OA81 10p | ORP60 45p | 2N2160 69p | 40250 45p |
| BA115 10p | BFY50 20p | OA200 8p | P346A 20p | 2N2926 10p | 40361 45p |
| BAX13 5p | BFY51 20p | OA202 10p | TIL209 25p | 2N3053 20p | 40362 40p |
| BC107 15p | BFY64 45p | OC16 85p | TIP29A 49p | 2N3054 45p | 40408 50p |
| BC108 15p | BFY90 75p | OC20 1·25 | TIP30A 58p | 2N3055 45p | 40486 75p |
| BC109 15p | BLY36 6·25 | OC28 65p | TIP31A 61p | 2N3440 50p | 40636 1·00 |
| BC109C 14p | BSX20 15p | OC35 55p | TIP41A 74p | 2N3442 1·10 | 40430 85p |
| BC113 16p | BU105 2·20 | | TIP42A 90p | 2N3525 80p | |
| BC147 12p | BY100 15p | | TIS43 28p | 2N3614 59p | |
| BC169C 14p | BY127 15p | | V405A 25p | 2N3702 11p | |

## TRIACS Stnd. mounting with accessories

**3 AMP RANGE**

| Type | P.I.V. | Price Each 1-11 |
|---|---|---|
| SC35A | 100v | 80p |
| SC35B | 200v | 85p |
| SC35D | 400v | 90p |
| SC35E | 500v | £1·20 |

**6 AMP RANGE**

| | | |
|---|---|---|
| SC40A | 100v | 90p |
| SC40B | 200v | 95p |
| SC40D | 400v | £1·20 |
| SC40E | 500v | £1·50 |

**10 AMP RANGE**

SC45A 100v £1·95

| | | |
|---|---|---|
| SC45B | 200v | £1·15 |
| SC45D | 400v | £1·45 |
| SC45E | 500v | £1·85 |

**15 AMP RANGE**

| | | |
|---|---|---|
| SC50A | 100v | £1·45 |
| SC50B | 200v | £1·65 |
| SC50D | 400v | £1·95 |
| SC50E | 500v | £2·25 |

**TRIACS** Additional Types

40430 TRIAC (T066) 85p
40669 TRIAC (Plastic) 90p
40486 TRIAC (T05) 75p

3 Amp T048 — 15 Amp T048

## SILICON CONTROLLED RECTIFIERS

Type 1-11

**ONE AMP (T05) P.I.V.**

| | | |
|---|---|---|
| CRS 1/05AF | 50v | 30p |
| CRS 1/10AF | 100v | 30p |
| CRS 1/20AF | 200v | 35p |
| CRS 1/40AF | 400v | 45p |
| CRS 1/60AF | 600v | 55p |

**THREE AMP (T048)**

| | | |
|---|---|---|
| CRS 3/05AF | 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 | 85p |
| CRS 7/600 | 600v | 95p |

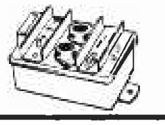
**SIXTEEN AMP (T043)**

| | | |
|---|---|---|
| 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 AMTROM

—EVERYTHING SUPPLIED

| Model No. | | |
|---|---|---|
| 310 | Radio control receiver | 3·29 |
| 300 | 4-channel R/C transmitter | 8·81 |
| 345 | Superhet R/C receiver | 6·01 |
| 65 | Simple transistor tester | 1·60 |
| 115 | 8 watt Amplifier | 4·50 |
| 120 | 12 watt amplifier | 4·73 |
| 125 | Stereo control unit | 8·81 |
| 130 | Mono control unit | 4·18 |
| 605 | Power supply for 115 | 5·31 |
| 610 | Power supply for 120 | 5·31 |
| 615 | Power supply for 2 x 120 | 8·64 |
| 230 | AM/FM aerial amplifier | 3·29 |
| 240 | Auto packing light | 8·90 |
| 275 | Mic. preamplifier | 8·98 |
| 570S | LF generator 10Hz-1mHz | 21·45 |
| 575S | Sq. wave generator 20Hz-20Khz | 19·77 |
| 590 | SWR meter | 9·47 |
| 630 | STAB Power supply 6-12v 0·25-0-1A | 9·24 |
| 690 | DC motor speed Gov. | 3·31 |
| 700 | Electronic Chaffinch | 7·92 |
| 760 | Acoustic switch | 12·57 |
| 780 | Metal Detector (electronics only) | 10·91 |
| 790 | Capacitive Burglar alarm | 7·92 |
| 835 | Guitar preamp. | 4·99 |
| 840 | Delay car alarm | 6·99 |
| 875 | CAP. Discharge Ignition for car engine (-Ve Earth) | 13·99 |
| 80 | Scope Calibrator | 2·65 |
| 255 | Level indicator | 6·98 |
| 525 | 120-160mHz VHF timer | 11·31 |
| 715 | Photo cell switch | 8·97 |
| 795 | Electronic continuity tester | 4·97 |
| 860 | Photo timer | 15·51 |
| 235 | Acoustic Alarm for driver | 8·61 |
| 465 | Quartz XTAL checker | 9·90 |
| 220 | Signal Injector | 2·30 |
| 390 | Vox | 15·50 |
| 432 | Testakit | 19·30 |
| 670 | Buffer Battery Charger | 8·55 |
| 885 | Capacitive Contact Alarm | 8·25 |
| 850 | Electronic Keyer | 18·75 |
| 820 | Electronic Digital Clock | 58·50 |



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/packg 30p.
**8 TRACK CAR STEREO** (— Earth) with speakers, in pods and fixings £12·50 carr/packg 40p.
**PORTABLE BATTERY CASSETTE TAPE PLAYER** £7·25
**CAR LIGHTER PLUG and ADAPTOR** for all cassette and radio 6/7½/9 volt output (state width) £1·95 each.
**ROTEL STEREOPHONES** RH630 £6·80; RH700 £10·25; RH430 £4·14.
**WEIN W500 BATTERY/MAINS CASSETTE RECORDER £12·75**
**PORTABLE CASSETTE TAPE** Player—for car or carry around. £7·25 carr/packg 20p.

**HANIMAX BC808 POCKET CALCULATOR** WITH % KEY £28·95.
**HANIMAX BC811M** Memory Version £33·75
★**BC807** % key £22·95.
★**BCM850** % key and Memory £33·95.
★**MAINS UNIT** £3·25 EXTRA.
**STEREO COMPACT RECORD PLAYER** 2×7 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**

| | | |
|---|---|---|
| B025/05 | 50 PIV | 16p |
| B025/10 | 100 PIV | 18p |

¼ x ¼ x ⅛" dia.

**½ AMP 1-11 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 |

⅜H x ½L x $\frac{5}{16}$" dia.

**1 AMP P.I.V.**

| | | |
|---|---|---|
| B1/05 | 50v | 25p |
| B1/10 | 100v | 25p |
| B1/20 | 200v | 28p |
| B1/60 | 600v | 30p |

⅜H x ½L x $\frac{5}{16}$" dia.

**1 AMP P.I.V.**

| | | |
|---|---|---|
| W005 | 50v | 29p |
| W01 | 100v | 30p |
| W02 | 200v | 32p |
| W06 | 600v | 35p |

⅜ x ⅜" Tubular

**2 AMPS P.I.V.**

| | | |
|---|---|---|
| B2/05 | 50v | 35p |
| B2/10 | 100v | 40p |
| B2/20 | 200v | 45p |
| B2/60 | 600v | 50p |
| B2/100 | 1000v | 55p |

⅜H x ⅜L x $\frac{5}{16}$" dia.

**4 AMPS P.I.V.**

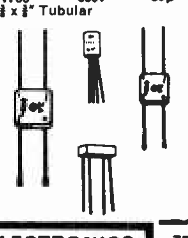
| | | |
|---|---|---|
| B4/100 | 100v | 55p |
| B4/200 | 200v | 59p |
| B4/400 | 400v | 65p |
| B4/600 | 600v | 75p |
| B4/800 | 800v | £1·00 |

⅜H x ½L x $\frac{5}{16}$" dia.

**6 AMPS P.I.V.**

| | | |
|---|---|---|
| B6/05 | 50v | 65p |
| B6/10 | 100v | 70p |
| B6/20 | 200v | 80p |
| B6/40 | 400v | 90p |
| B6/6x0 | 600v | £1·00 |

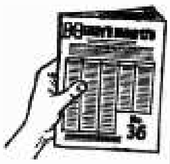
⅜H x ½L x $\frac{5}{16}$" dia.



All prices correct at time of press
10% VAT to be added to all orders (UK only)
Export & UK Manufacturers/Colleges supplied.
E.&O.E.

## FREE BOOKLET

All types of Transistors
Rectifiers—Bridges
SCR's—Triacs
Integrated Circuits
F.E.T.—Light Devices



OVER 1500 DIFFERENT DEVICES
ENTIRELY NEW 1974 EDITION
More Devices ★ New Prices ★ New Ranges ★
This is a must for all Semi-conductor Users. (Ask for booklet No. 36.)
SENO FOR YOUR FREE COPY TOOAY

**TBA800 5 WATT IC**
Suitable alternative to SL403D 5/30 volt operated. 8/16 OHM 5 watt output. With circuits and data £1·50.

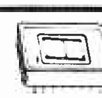
**STROBE TUBE**
**ZFT4A.** Suitable for Dec. '73 Pract. Electronics £3·00

| | |
|---|---|
| ST2 (D32) DIAC | 25p |
| CRS1/40 SCR | 45p |
| ZFT4 | £3·50 |
| ZFT8 | £4·00 |

**Sinclair IC12**
with circuits and data. 6 watt IC with printed circuit board. 28 volt. operated, £2·00

**Ultrasonic Transducers**
Operate at 40Khz up to 100 yds. Ideal remote switching and signalling. Complete with data transmitter and receiver new I.C circuits. Per pair £5·90.
TA960 with socket £1·80

**ZN414 IC**
Integrated circuit radio as featured by many magazines (PW Jan. 73 Reprint Ref. No. 19 for 10p). £1·20.



**3015F 7 SEG.**
I.C. size complete with data price £1·70 each (digital clock circuits ref. No. 31, 15p).

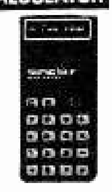
**SINCLAIR SPECIAL OFFER**
Stereo 60 Pre-amplifier—for use with most small amplifiers. Exclusive offer £6·75.

**PP9 ELIMINATOR KIT**
Complete module kit 9v. 100mA output £1·95, p. & p. 25p.

**TIL209 LED 24p ea. 22p ea. per 10**

## BUILD YOURSELF A POCKET CALCULATOR

A complete kit, packaged in a polystyrene container and taking about 3 hours to assemble—that's the Sinclair Cambridge pocket calculator from Henry's. Some of the many features include Intertace chip, thick-film resistor pack, printed circuit board, electronic components pack. Size 4⅜" long x 2" wide x $\frac{11}{16}$" deep.
Free of charge with the kit for the more advanced technologist is a 32-page booklet explaining how to calculate Logs, Tangents, Sines etc.



## SPECIAL OFFER

**Price £13·60 + VAT** Also available assembled ready to use £19·90 + VAT.

**LIVING SOUND LOW NOISE TOP QUALITY CASSETTES MADE BY EMI TAPES LTD TO INTERNATIONAL STANDARDS ESPECIALLY FOR HENRY'S. ALL POST PAID LESS THAN ⅓ REC. PRICES. COMPLETE WITH LIBRARY CASES.**

| | 3 for | 6 for | 10 for | 25 for |
|---|---|---|---|---|
| C 60 | £1·10 | £1·98 | £3·00 | £7·40 |
| C 90 | £1·40 | £2·80 | £4·60 | £11·25 |
| C 120 | £1·80 | £3·45 | £5·50 | £13·45 |

Quantity and trade enquiries invited.

**LEARN A LANGUAGE**—complete with phrase book German—French—Spanish—Italian £1·36 per course £5 for any 4.

## A SELECTION OF INTERESTING ITEMS

| | | |
|---|---|---|
| 3025 | Compact transistor tester | £6·95 p & p 15p |
| Q4002 | Photoelectric system | £13·70 |
| E1310 | Stereo mag. cart. preamp. | £4·90 p & p 25p |
| Easiphone D1201 | telephone amplifier | £7·50 p & p 25p |
| D1203 | Teleamp. with PU coil | £4·95 p & p 20p |
| LL1 | Door intercomm. and chime | £8·40 p & p 25p |
| US50 | Ultrasonic Switch transmitter/receiver | £12·75 |
| 1 Kw | Dimmer/controller | £3·00 p & p 10p |
| 9" Twin spring unit | For Reverbs | £3·36 p & p 15p |
| 16" Twin spring unit | For Reverbs | £6·85 p & p 25p |
| VHF 105 | Aircraft Band Convertor | £4·50 p & p 15p |
| B2005 | 4 Ch. mic. mixer | £4·20 p & p 15p |
| B2004 | 2 ch. Stereo mixer | £6·75 p & p 15p |
| PK3 kit. | Etch your own printed circuits | £1·95 p & p 20p. |
| C3041 | 1-250 MHz | £4·25 |
| C3043 | 50H 1-300 MHz | £5·75 |

**Henry's RADIO LIMITED**
EDGWARE ROAD, W2

ELECTRONICS FOR EVERY PURPOSE
*See facing page for addresses*

**ZENER DIODES**
400 m/w **BZY88/BZX83.** From 3·3 volt—33 volts 10p each.
1·3 watts 5% Miniature Tubulars **IN4700** series. From 3·3 volt—33 volt 18p each.
10 watts. Stnd. Mounting. ZS series 6·8 volts—100 volts 5% 40p each.

**SILICON RECTIFIERS**
1 amp series IN4001 to IN4007. From 8p ea
1·5 amp PL4001 to PL4007 from 8p ea
3 amp PL7001/IN5400 From 14p ea
Send for full list 36.

# G. F. MILWARD

# ELECTRONIC COMPONENTS

Wholesale/Retail: **369 Alum Rock Road, Birmingham B8 3DR.** Tel. 021-327 2339

# HALF PRICE OFFER! LIMITED PERIOD ONLY!

## RESIST COATED PRINTED CIRCUIT BOARD

| BOARD SIZE | FIBRE GLASS | | | | | | | | | | | | PAPER | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/32"—1 oz | | | | 1/32"—2 oz | | | | 1/16"—1 oz | | | | 1/16"—1 oz | |
| | Single Sided | | Double Sided | | Single Sided | | Double Sided | | Single Sided | | Double Sided | | Single Sided | |
| | Positive | Negative | Positive | Negative | Positive | Negative | Positive | Negative | Positive | Negative | Positive | Negative | Positive | Negative |
| 75mm × 100mm | 14p | 12p | 15p | 13p | 8p | 8p | 8p | 8p | 16p | 15p | 14p | 13p | 8p | 8p |
| 100mm × 150mm | 27p | 24p | 29p | 26p | 15p | 14p | 19p | 15p | 33p | 30p | 29p | 26p | 15p | 14p |
| 150mm × 200mm | 53p | 48p | 56p | 51p | 30p | 27p | 37p | 30p | 66p | 60p | 60p | 54p | 30p | 27p |
| 200mm × 250mm | 88p | 80p | 92p | 84p | 51p | 45p | 63p | 51p | £1·10 | £1·00 | £1.02 | 92p | 51p | 45p |
| 250mm × 250mm | £1·10 | £1·00 | £1·15 | £1·05 | 65p | 55p | 80p | 65p | £1·38 | £1·25 | £1·30 | £1·15 | 65p | 55p |
| 12" × 6" | 80p | 70p | 85p | 75p | 55p | 45p | 65p | 55p | £1·00 | 90p | £1·10 | £1·00 | 55p | 45p |
| 12" × 12" | £1·60 | £1·40 | £1·65 | £1·45 | £1·05 | 85p | £1·25 | £1·05 | £1·95 | £1·75 | £2·10 | £1·90 | £1·05 | 85p |

## *EXTRA DISCOUNTS!*

*ORDER 25 SHEETS OF ANY ONE TYPE—DEDUCT 20%*
*ORDER 100 SHEETS OF ANY ONE TYPE—DEDUCT 30%*

*IF ABOVE SIZES DO NOT MATCH YOUR REQUIREMENTS, ASK FOR QUOTE—CUT TO YOUR SIZE.*
*THIS IS AN OFFER THAT YOU CANNOT AFFORD TO MISS! ACT NOW!*

## SMALL ELECTROLYTICS

| Ref. No. | Capacity | Voltage | Price |
|---|---|---|---|
| H8/2A | 3·3μF | 25V | 4p |
| H8/3 | 3μF | 50V | 4p |
| H8/3A | 4μF | 50V | 4p |
| H8/4 | 4·7μF | 25V | 4p |
| H8/5 | 5μF | 10V | 4p |
| H8/6A | 10μF | 10V | 4p |
| H8/7 | 10μF | 70V | 4p |
| H8/8A | 16μF | 16V | 4p |
| H8/9 | 20μF | 6V | 2p |
| H8/9A | 20μF | 70V | 4p |
| H8/10 | 22μF | 50V | 4p |
| H8/11 | 25μF | 12V | 4p |
| H8/11A | 24μF | 275V | 4p |
| H8/12 | 32μF | 15V | 4p |
| H8/12A | 30μF | 10V | 4p |
| H8/13A | 32μF | 50V | 4p |
| H8/14 | 40μF | 25V | 5p |
| H8/14A | 40μF | 16V | 4p |
| H8/15 | 47μF | 50V | 4p |
| H8/15A | 40μF | 35V | 4p |
| H7/1A | 50μF | 10V | 4p |
| H7/2A | 64μF | 2·5V | 2p |
| H7/4 | 64μF | 15V | 4p |

| Ref. No. | Capacity | Voltage | Price |
|---|---|---|---|
| H7/5 | 80μF | 16V | 4p |
| H7/8 | 125μF | 16V | 5p |
| H7/8A | 100μF | 35V | 6p |
| H7/9 | 100μF | 63V | 6p |
| H7/9A | 125μF | 4V | 4p |
| H7/10 | 125μF | 25V | 6p |
| H7/10A | 160μF | 265V | 3p |
| H7/11 | 160μF | 25V | 6p |
| H7/11A | 150μF | 10V | 5p |
| H7/13A | 200μF | 25V | 8p |
| H7/14 | 220μF | 50V | 10p |
| H7/14A | 220μF | 16V | 6p |
| H7/15 | 220μF | 25V | 5p |
| H7/15A | 220μF | 35V | 10p |
| H6/1A | 250μF | 4V | 3p |
| H6/2 | 250μF | 25V | 3p |
| H6/3A | 320μF | 2·5V | 3p |
| H6/4 | 320μF | 10V | 4p |
| H6/4A | 330μF | 16V | 5p |
| H6/5 | 330μF | 25V | 10p |
| H6/5A | 330μF | 35V | 15p |
| H6/8A | 470μF | 35V | 20p |

## MULLARD ELECTROLYTIC CAPACITORS

**071 and 072 series**

| Type No. | Working Voltage Vdc. | Capacitance μF | Max. Ripple Current at 50°C | Weight | Price |
|---|---|---|---|---|---|
| 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 | 1½oz | 22p |
| 072 15752 | 16 | 7500 + 7500 | 10·5 amps | 3oz | 37p |
| 072 15113 | 16 | 11000 + 11000 | 13·8 amps | 4½oz | 49p |
| 071 16472 | 25 | 4700 | 5·4 amps | 1½oz | 22p |
| 072 16502 | 25 | 5000 + 5000 | 9·6 amps | 3½oz | 37p |
| 072 16752 | 25 | 7500 + 7500 | 12·6 amps | 4½oz | 49p |
| 071 18681 | 63 | 680 | 2·1 amps | 1oz | 15p |

**106 and 107 series**

| Type No. | Working Voltage Vdc. | Capacitance μF | Max. Ripple Current at 50°C | Weight | Price |
|---|---|---|---|---|---|
| 106 16223 | 25 | 22000 | 17 amps | 10oz | £1·12 |
| 106 17103 | 40 | 10000 | 12 amps | 7½oz | 94p |
| 107 10222 | 100 | 2200 | 10 amps | 5½oz | 74p |

| Type No. | Voltage | Capacitance | Weight | Price |
|---|---|---|---|---|
| 102 15163 | 16 | 16000 | 8oz | 40p |
| 104 90003 | 20 | 39000 | 16oz | 50p |
| 102 16802 | 25 | 8000 | 7oz | 50p |
| 104 90001 | 45 | 20000 | 16oz | £1·00 |

A further 10% discount on lots of 100 of any one type.

*Please calculate the weight of your order and include appropriate postage.*

| Not over | Ordinary Parcels | Not over | Ordinary Parcels |
|---|---|---|---|
| | | 12lb | 53p |
| 2lb | 23p | 14lb | 58p |
| 4lb | 30p | 16lb | 63p |
| 6lb | 36p | 18lb | 68p |
| 8lb | 42p | 20lb | 73p |
| 10lb | 48p | 22lb | 78p |

**REMEMBER! ALL GOODS PLUS 10% V.A.T.**

**G. F. MILWARD, Drayton Bassett, Tamworth, Staffs.** Postage (minimum) per order 20p.

**TEKTRONIX 545B** Oscilloscopes. From As New to well used condition. Main frame. Prices from **£225.**
**TEKTRONIX 502A** Oscilloscopes. Brand New. Guaranteed. P.O.A.
**HEWLETT PACKARD** Oscilloscopes type 175A Dual 50MHz. **£225.**

**CONSTANT VOLTAGE TRANSFORMERS**
1 Kilowatt etc.
S.A.E. with requirements.

**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 13¼ × 9¼ × 19in. Price **£70** each. Carriage £1·50.

**AMERICAN SWEEP GENERATOR** type TRM 3 15 to 400 MHZ. **£300.**

**AMERICAN AM GENERATOR** type 497. 4 to 400 MHZ. Supplied with leads, etc., for 240V 50 HZ operation **£35.**

**12" LONG PERSISTANCE TUBES**
Ideal for SSTV; educational purposes. Type 12DP7A. Connections, voltages etc. Brand New Boxed **£7·50** each including carriage and VAT.

**SPECIAL 40 MHZ SCOPE SOLARTRON CD1212 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.

**SINGLE TRACE 40 MHZ PLUG-INS** for CD1212 oscilloscopes now available at £25 ea. P. & P. 75p.

**SOLARTRON PRECISION LABORATORY**
Oscilloscope type CD643. DC-15MHz. 5in. Flat face tube. **£45** each.

**SOLARTRON CD 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 dbs. 5in. m rror 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.

**E.H.T. TRANSFORMERS,** e.g. 5KV at 0.125 Amps and others. All 240 volts input.
**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 **£3·75** 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** 2½ Watt. Brand new, 5; 10; 50; 250; ohms; 1; 2·5; 10; 25; 50K at **15p** ea.

**STANDARD** 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.

**RELIANCE 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.

**RELAYS**

Varley VP4 Plastic covers 4 pole c/o. 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.

**FANTASTIC VALUE**
Miniature Transformer. Standard 240V input. 3Volt 1·amp output. Brand New. **65p** ea. P & P 15p. Discount for quantity.

Large quantity LT, HT, EHT transformers and chokes.

Vast quantity of good quality components
—NO PASSING TRADE—so we offer
**3 LBS. of ELECTRONIC GOODIES**
for **£1·50 post paid.**

**CRYSTALS.** Colour 4.43MHz. Brand New. **£1·25** ea. P. & P. 10p.

**£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 ½ and ¼ watt etc., many high stabs. All brand new. Fine value at **50p** per pack. P. & P. 27p.

**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.

**Replacement TUBES** for **COSSOR** 1035 Mk 1, 2 & 2A & **COSSOR** 1049 Mk 1, 2 & 3. Used—guaranteed. **£3** ea. P. & P. 37p.

**C.R.T.'s** 5" type CV1385/ACR13. Brand new with spec. sheet. **63p** ea. P. & P. 35p.

Modern Version of VCR 138. Flat faced. Side connectors PDA. **£2·50** ea. P & P 37p.

**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.
**BECKMAN 10 TURN DIALS ONLY.** Brand new **£2·25** ea. P. & P. 10p.

**ELECTROSTATIC VOLTMETERS** from 0–300 Volts to 0–10KV. S.A.E. with your requirements.

**DECADE DIAL UP SWITCH—5 DIGIT.** Complete with escutcheon. Black with white figures. Size 4in. long × 1in. high × 1⅛in. deep. Ex-Plessey. **£1·40** each. P. & P. 15p.

**LIGHT EMITTING DIODES** (Red) from Hewlett-Packard. Brand New **38p** ea. Information **5p.** Holders **1p.**

**FIBRE-GLASS PRINTED CIRCUIT BOARD.** Brand New. Single or Double sided. Any size **1½p** per sq.in. Postage **10p** per order.

**METERS.** Ernest Turner. Model 402. 100 micro amps. BRAND NEW. Lousy scale—hence **£2·25** ea. P. & P. 25p.

**METERS by SIFAM** type M 42. 25–0–25 micro amp. Scaled 25–0–25 green; 250–0–250 red; linear. As new. **£3·50** ea. 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.

**BLOCK PAPER CAPACITORS AVAILABLE.** S.A.E. with requirements.

**PHOTOCELL** equivalent OCP 71, **13p** ea.
**MULLARD OCP70 10p** each.

**EX-MINISTRY** CT436 Double Beam Oscilloscope DC–6 megs. Max Sensitivity 10mv/cm. Small compact. Size 10 × 10 × 16in. Suitable for Colour TV Servicing. Price **£85** each including copy of manual.

**SOLARTRON** D 300 range Oscilloscope Single Beam. DC to 6 megs. Price **£25** each.

**MARCONI** TF1331 Double Beam Oscilloscope DC–15 MHZ. Sensitivity 50 mv/cm. 5 in. flat face tube. TB 0·1 micro sec/per cm to 0·02 micro sec/per cm with expansion. Complete with copy of manual **£120.**

**HARTLEY** 13A Double Beam Oscilloscope TB 2 c/s –750 kc/s. Band width 5·5mcs. Sensitivity 33 Mv/cm. Calibration markers 100kc/s and 1 Mc/s. **£25** each. With accessories **£27·50** ea.

**12 in. DISPLAY UNITS**
S.A.E. for details.

**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.

DON'T FORGET YOUR MANUALS
S.A.E. WITH REQUIREMENTS

**WIDE RANGE WOBBULATOR**
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.)**

Buy it with Access

# CHILTMEAD LTD

**7/9 ARTHUR ROAD, READING, BERKS. (rear Tech. College, Kings Road) Tel.: Reading 582605/65916**

# 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 27½p** P & P 16½p 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. Price of each instrument is independent of the number of ways. Please phone for latest details of cable.

**£2.75** P & P 38½p per instrument

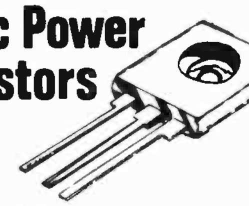
**EXTENSION TELEPHONES**
71½p each p.p. 27½p. £1.37½ for 2 p.p. 55p. These phones are extensions and do not contain bells.

## New X-Hatch

**Our new, vastly improved Mark Two Cross-Hatch Generator is now available. Essential for alignment of colour guns on all TV receivers.** Featuring plug-in ICs and a more sensitive sync. pick-up circuit. The case is virtually unbreakable—ideal for the engineer's toolbox—and only measures 3" X 5¼" X 3".

Ready built unit only **£10·92** Complete kit **£8·72**
**(includes VAT and P & P, but no batteries)**

## 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.

| | 1-12 | 13-25 | 26-50 |
|---|---|---|---|
| RANGE 1 VCE. Min. 15 HFE. Min. 15 | | | |
| 40 Watt | 22p | 20p | 18p |
| 90 Watt | 26½p | 24½p | 22p |
| RANGE 2VCE. Min. 40 | | | |
| RANGE 2VCE. Min. 40 HFE. Min. 40 | | | |
| 40 Watt | 33p | 31p | 29p |
| 90 Watt | 38½p | 36½p | 33p |

**High-speed magnetic counters**
4 digit (non-reset) 4" X 1" X 1" 33p P & P 5p

**INTEGRATED CIRCUITS**
We stock a large range of I.Cs 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.
Pocket Size **15p.** Wall Chart **18p.**

**LOW COST DUAL IN LINE I.C. SOCKETS**
14 pin type at **16½p** 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.

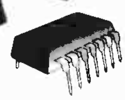
**2 LBS in weight for £1·10**
Post and Packing 27½p.

## Tested and Guaranteed Paks

| | | | |
|---|---|---|---|
| B79 | 4 | 1N4007 Sil. Rec. diodes. 1,000 PIV lamp plastic | 55p |
| B81 | 10 | Reed Switches 1" long ⅛" dia. High speed P.O. type | 55p |
| H35 | 100 | Mixed Diodes, Germ. Gold bonded etc. Marked and Unmarked | 55p |
| ·38 | 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 |
| 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 |

## 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 |
| B83 | 200 | Transistors, manufacturers rejects, AF, RF, sil and germ. | 55p |
| H26 | 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 |
| H67 | 10 | 3819 N Channel FET's plastic case type | 55p |

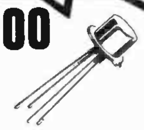


## LM380 AUDIO IC

We have just received a large consignment of LM380 ICs. These are specially selected to a higher grade and are marked with the number SL60745. This **fantastic** little 3watt audio IC only requires two capacitors and two potentiometers to make an amplifier with volume and tone control. The quality is good and has to be heard to be believed.

Our special price **£1·10** ea complete with data and projects book

## 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 27½p

## 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**

## 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 nomal coil ignition system.

**£1·10 each**

## UHF TV Tuner Units

**Brand new by a famous manufacturer**
**Data supplied £2.75**

Please send me the FREE Bi-Pre-Pak Catalogue.

ALL PRICES INCLUDE 10% VAT

NAME . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

ADDRESS . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

MINIMUM ORDER 50p. CASH WITH ORDER PLEASE. Add 15p post and packing per order. OVERSEAS ADD EXTRA FOR POSTAGE.

**Buy these goods with Access.**

**BI-PRE-PAK LTD**
Co Reg No 820919
Dept.B . 222-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX.
TELEPHONE: SOUTHEND (0702) 46344.

# C. T. ELECTRONICS

## NOW AT 267 AND 270 ACTON LANE, LONDON W.4

Now open. Our New Components Shop. These premises are very much larger and will enable us to have greater stocks than we already have. Having all the components under one roof will now guarantee you speedier service on the counter, and on the mail order side. We have an enormous range of components to choose from. If you are having problems getting your components then come along. We are open from 9.30 a.m. through till 6.0 p.m. Monday to Saturday. The nearest Underground is Chiswick Park, and there are no parking restrictions

## SEMICONDUCTORS

| | |
|---|---|
| AC107 | 35p |
| AC125 | 25p |
| AC126 | 25p |
| AC127 | 27p |
| AC128 | 28p |
| AC176 | 27p |
| ACY17 | 25p |
| ACY18 | 30p |
| ACY19 | 30p |
| ACY20 | 25p |
| ACY39 | 55p |
| ACY21 | 30p |
| AD140 | 60p |
| AD149 | 65p |
| AD161 | 40p |
| AD162 | 40p |
| ADZ11 | £1·80 |
| AF114 | 25p |
| AF115 | 25p |
| AF116 | 25p |
| AF117 | 25p |
| AF118 | 60p |
| AF172 | 30p |
| ASY28 | 30p |
| ASZ21 | 60p |
| BA102 | 33p |
| BA112 | 50p |
| BA114 | 18p |
| BA156 | 15p |
| BC107 | 12p |
| BC108 | 12p |
| BC109 | 12p |
| BC147 | 12p |
| BC148 | 12p |
| BC149 | 12p |
| BC153 | 15p |
| BC157 | 14p |
| BC158 | 15p |
| BC169C | 14p |
| BC182 | 14p |
| BC183 | 14p |
| BC184 | 14p |
| BC212 | 14p |
| BC213 | 14p |
| BC214 | 14p |
| BC000 | 12p |
| BCY30 | 40p |
| BCY31 | 55p |
| BCY32 | 95p |
| BCY33 | 45p |
| BCY34 | 60p |
| BCY38 | 65p |
| BCY39 | £1·00 |
| BCY55 | £1·60 |
| BCY70 | 22p |
| BCY71 | 22p |

| | |
|---|---|
| BCY72 | 25p |
| BD121 | 75p |
| BD123 | 75p |
| BD124 | 80p |
| BD131 | 75p |
| BD132 | 75p |
| BD153 | 75p |
| BD156 | 75p |
| BDY11 | £1·40 |
| BDY17 | £1·60 |
| BDY19 | £1·95 |
| BF152 | 20p |
| BF194 | 14p |
| BF195 | 15p |
| BFX29 | 30p |
| BFX84 | 30p |
| BFX85 | 30p |
| BFX86 | 30p |
| BFX88 | 30p |
| BFY10 | 35p |
| BFY44 | 50p |
| BFY50 | 25p |
| BFY51 | 25p |
| BFY52 | 25p |
| BFY53 | 25p |
| BFY90 | 66p |
| BSW63 | 65p |
| BSW68 | 80p |
| BSY95A | 12p |
| C111 | 50p |
| C426 | 40p |
| BY100 | 15p |
| BY126 | 20p |
| BY127 | 20p |
| BY164 | 65p |
| IS100 | 15p |
| IS103 | 20p |
| MJ340 | 55p |
| MJ481 | 95p |
| MJ2801 | £1·25 |
| MJ2901 | £2·20 |
| MJE340 | 50p |
| MJE370 | 75p |
| MJE371 | 90p |
| MJE520 | 65p |
| MJE2955 | £1·95 |
| MJE3055 | 85p |
| MM1613 | 43p |
| MM1712 | 60p |
| MPF102 | 45p |
| MPF103 (2N5457) | 35p |
| MPF104 (2N5458) | 35p |
| MPF105 (2N5459) | 40p |

| | |
|---|---|
| MPSA06 | 35p |
| MPSA16 | 30p |
| MPSA56 | 35p |
| MPSU06 | 75p |
| MPSU56 | 70p |
| NKT135 | 35p |
| NKT222 | 25p |
| NKT401 | 85p |
| NKT404 | 80p |
| NKT773 | 30p |
| NKT774 | 25p |
| OA5 | 20p |
| OA10 | 20p |
| OA47 | 10p |
| OA70 | 12p |
| OA79 | 12p |
| OA81 | 10p |
| OA90 | 10p |
| OA91 | 10p |
| OA200 | 10p |
| OA202 | 10p |
| OA210 | 35p |
| OA211 | 36p |
| OC16 | 90p |
| OC19 | 85p |
| OC22 | 55p |
| OC26 | 65p |
| OC28 | 65p |
| OC35 | 60p |
| OC36 | 65p |
| OC42 | 40p |
| OC44 | 20p |
| OC45 | 20p |
| OC70 | 15p |
| OC71 | 17p |
| OC72 | 20p |
| OC75 | 25p |
| OC76 | 25p |
| OC77 | 40p |
| OC81 | 25p |
| OC83 | 25p |
| OC84 | 25p |
| OC139 | 30p |
| OC140 | 30p |
| OC170 | 25p |
| OC171 | 30p |
| OC200 | 50p |
| OC201 | 60p |
| OC202 | 75p |
| TIP29A | 49p |
| TIP30A | 58p |
| TIP31A | 62p |
| TIP32A | 74p |
| TIP33A | £1·05 |
| TIP34A | £1·55 |

| | |
|---|---|
| TIP35A | £3·35 |
| TIP36A | £2·65 |
| TIP41A | 75p |
| TIP42A | 90p |
| TIP29B | 58p |
| TIP30B | 66p |
| TIP31B | 70p |
| TIP32B | 82p |
| TIP33B | £1·12 |
| TIP34B | £1·68 |
| TIP35B | £2·81 |
| TIP36B | £3·64 |
| TIP41B | 83p |
| TIP42B | 98p |
| TIP29C | 71p |
| TIP30C | 78p |
| TIP31C | 85p |
| TIP32C | £1·05 |
| TIP33C | £1·30 |
| TIP34C | £1·90 |
| TIP35C | £3·20 |
| TIP36C | £4·10 |
| TIP41C | 95p |
| TIP42C | £1·10 |
| TIS50 | 40p |
| ZTX107 | 15p |
| ZTX300 | 15p |
| ZTX500 | 16p |
| ZTX501 | 20p |
| ZTX504 | 50p |
| ZTX531 | 30p |
| ZTX550 | 25p |
| IN659 | 8p |
| IN914 | 8p |
| IN916 | 8p |
| IN4001 | 8p |
| IN4002 | 9p |
| IN4003 | 9p |
| IN4004 | 10p |
| IN4005 | 12p |
| IN4006 | 15p |
| IN4007 | 18p |
| IN4148 | 7p |
| 2N696 | 25p |
| 2N697 | 20p |
| 2N698 | 25p |
| 2N706 | 12p |
| 2N706A | 12p |
| 2N708 | 15p |
| 2N930 | 20p |
| 2N1132 | 25p |
| 2N1302 | 16p |
| 2N1303 | 16p |
| 2N1304 | 25p |
| 2N1305 | 25p |
| 2N1306 | 25p |
| 2N1307 | 25p |

| | |
|---|---|
| 2N1308 | 25p |
| 2N1309 | 25p |
| 2N1613 | 25p |
| 2N1711 | 25p |
| 2N2147 | 70p |
| 2N2160 | 65p |
| 2N2217 | 25p |
| 2N2218 | 25p |
| 2N2219 | 25p |
| 2N2222 | 20p |
| 2N2222A | 25p |
| 2N2368 | 70p |
| 2N2640 | 50p |
| 2N2846 | £1·50 |
| 2N2904 | 25p |
| 2N2905 | 25p |
| 2N2906 | 25p |
| 2N2907 | 25p |
| 2N2926 | 12p |
| 2N3053 | 25p |
| 2N3054 | 65p |
| 2N3055 | 50p |
| 2N3232 | 70p |
| 2N3525 | 95p |
| 2N3702 | 14p |
| 2N3703 | 12p |
| 2N3074 | 12p |
| 2N3705 | 12p |
| 2N3706 | 12p |
| 2N3707 | 12p |
| 2N3708 | 12p |
| 2N3709 | 12p |
| 2N3771 | £2·70 |
| 2N3772 | £2·75 |
| 2N3773 | £2·95 |
| 2N3819 | 35p |
| 2N3820 | 55p |
| 2N3866 | 85p |
| 2N3904 | 22p |
| 2N3905 | 25p |
| 2N4058 | 12p |
| 2N4059 | 12p |
| 2N4060 | 12p |
| 2N4061 | 12p |
| 2N4126 | 17p |
| 2N4286 | 15p |
| 2N4287 | 15p |
| 2N4288 | 15p |
| 2N4289 | 15p |
| 2N4290 | 15p |
| 2N4444 | £1·90 |
| 2N4871 | 35p |
| 2N4920 | 60p |
| 2N5191 | 96p |
| 2N5194 | £1·10 |
| 40360 | 50p |
| 40361 | 50p |
| 40362 | 55p |

QTY. DISCOUNTS: 12+ 10%; 25+ 15%; 100+ 20%

### S.C.R.s

| | |
|---|---|
| CRS1/05 | 40p |
| CRS1/10 | 56p |
| CRS1/20 | 60p |
| CRS1/40 | 65p |
| CRS1/60 | 90p |
| CRS3/10 | 62p |
| CRS3/20 | 62p |
| CRS3/40 | 90p |
| CRS7/400 | £1·00 |
| CRS16/100 | 85p |
| CRS16/200 | 90p |
| CRS16/600 | £1·60 |
| C106B | 45p |
| C106D | 70p |
| 40669 | 90p |
| TIC44 | 35p |
| 2N4444 | £1·90 |
| BT10/500A | 90p |

### BRIDGE RECTIFIERS

| | |
|---|---|
| W02 1A 200V | 38p |
| BY164 1·4A 200V | 57p |
| MDA952/2 6A 100V | 80p |

### ZENER DIODES

BZY88 Series 400mW 3·3V-33V, 5% .... 11p
1·5W range ..... 25p
10W range ...... 45p

### L.E.D.

| | |
|---|---|
| TIL209 | 28p |
| HP5082 | 28p |
| MA2032R | 25p |

### L.D.R.

ORP12 .......... 60p

NE555 Timer .... 90p

### TRIACS

| | |
|---|---|
| TXL228B 8A 400V | 95p |
| SC40D | £1·40 |
| SC40E | £1·65 |
| SC45D | £1·70 |
| SC45E | £2·10 |
| SC50D | £2·42 |
| SC50E | £2·70 |
| DIAC | 25p |

### LINEAR I.C.s

| | |
|---|---|
| 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./TO99 | 45p |
| 741C Op Amp 8/14 D.I.L./TO99 | 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 |
| SN76023 6w audio with circuit | £1·75 |

## ★★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. 1,000-50p ea. 10,000-40p ea.

**3 CORE PVC INSULATED MAINS CABLE,** GREY ML6650. 3x7/0·2mm Price 100m-£4·50. 1000m-£35. 10,000m-£330.

**0·47mfd. 50V MYLAR FILM CAPACITOR.** Size 1" x 0·35" x 0·65" P.C. Mount. Price 100-4p ea. 1000-3p ea.

**240V. A.C. SOLENOID.** Reversible operation; twin coil. Size approx. 2¾ x 1½ x 1¾in. 90p ea.

30 unmarked OC71 transistors £1·00
25 Unmarked 250mW Zenerdiode, 4·7V, 5·1V, 6·2V, 7·5, 9·1V, 10V. Measured and tested. £1·00
Please state voltage required.
50 GE Diode OA47 equivalent. £1·00

**TRANSFORMER:** DOUGLAS PRI, 0, 115, 200, 220 240 SEC. 25-0-25-0-6V, 2½A, £4·50 + 50p p.p.

**TRANSFORMER**
PRI. 0, 115, 160, 205, 225, 245. SEC. 35-0-35, 1·2A £4·50 + 50p. p.p.

**MULLARD TUBULAR CERAMIC UHF TRIMMERS (PROFESSIONAL)**
Type 092 0·8-2·2p
801 0·8-2·2p
991 0·5-1·3p
Price 10p ea.

QUANTITY DISCOUNTS PLEASE TELEPHONE

1000pF Feedthrough capacitor 5p ea.
Miniature tubular P.C. trimmers
3·5-13pF
6-30pF 10p ea.
4p c/o Varley 700Ω relay 50p ea.

**TO3 VOLTAGE REGULATORS**
L005 5V 650mA
L036 12V 500mA
L037 15V 450mA £1·60 ea.

## METAL BOXES

**ALUMINIUM BOXES IDEAL FOR VEROBOARD WITH BASE AND P.K. SCREWS**

| Type | Long | Wide | High | Price |
|---|---|---|---|---|
| AB7 | 2¾" | 5¼" | 1½" | 50p |
| AB8 | 4" | 4" | 1½" | 50p |
| AB9 | 4" | 2¾" | 1½" | 50p |
| AB10 | 4" | 5¼" | 1½" | 50p |
| AB11 | 4" | 2½" | 2" | 60p |
| AB12 | 3" | 2" | 1" | 44p |
| AB13 | 6" | 4" | 2" | 70p |
| AB14 | 7" | 5" | 2½" | 84p |
| AB15 | 8" | 6" | 3" | £1·08 |
| AB16 | 10" | 7" | 3" | £1·22 |
| AB17 | 10" | 4½" | 3" | £1·00 |
| AB18 | 12" | 5" | 3" | £1·20 |
| AB19 | 12" | 8" | 3" | £1·60 |

**ALUMINIUM BOXES WITH SLOPING TOP PANEL—IDEAL FOR PRE-AMPS, ETC., USING SLIDER CONTROLS**
AB20 8" Long 9" Wide 3½" High at back 2" High at front 6" Slope to front With P.K.Screws .......£2·00
AB21 As above but 10" long ................£2·20
AB22 As above but 12" long ................£2·40

**V41 VU METER** £2·50
The V41 is calibrated −20 to +3 and 0-100%, making it suitable for use as a recording level meter or as a power output indicator.
**Sensitivity:** 130 μA. **Internal resistance:** 600 ohms. **Dimensions:** 40 x 40 x 29 mm.

**ALSO STOCKED**
Electrolytic Capacitors Mullard, Sprague, Lorlin etc. Polyester. Polystyrene, Silver Mica Capacitors, etc. Resistors ⅛W-10Watt. Potentiometers; carbon. wirewound, Preset, Rectilinear multiturn. Antex Soldering Irons switches, rotary, slide, toggle, etc. Cable, veroboard.

**VEROBOARD**

| | 0·1 | 0·15 |
|---|---|---|
| 2½ × 3¾ | 32p | 23p |
| 2½ × 5 | 35p | 35p |
| 3¾ × 3¾ | 35p | 35p |
| 3¾ × 5 | 40p | 41p |
| 17 × 2½ | £1·05 | 79p |
| 17 × 3¾ | £1·43 | £1·12 |
| 17 × 5 | £1·84 | — |
| PIN INS. TOOL | 72p | 72p |
| SP.F. CUTTER | 52p | 52p |
| 100 PINS SS | 30p | 30p |
| 100 PINS DS | 30p | 30p |
| 500 PINS SS | £1·20 | £1·20 |
| 500 PINS DS | £1·20 | £1·20 |

Prices Correct June 12

**NEW SERIES TRANSISTOR DATA BOOKS**
1. DTA3 USA Band 3 Transistor Characteristics. 2N21—2N6269 all numbers.
2. THT Thyristor, Triac, Diac, Put, UJT's.
3. DT15 Japanese Transistor Characteristics. 2SA, 2SB, 2SC, 2SD numbers.
4. DVT Diode, Comparison Tables.
5. Band 1. Transistor Characteristics. European numbers AC, AF, BC, BF, etc.
6. TVT. Transistor Equivalent Tables.
All books contain pin connections and semi-conductor outlines.
PRICE. £1·10 per book. £6 per 6 books inc. post.

**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.

## DIGITAL INTEGRATED CIRCUITS

| | |
|---|---|
| SN7400 | 20p |
| SN7401 | 20p |
| SN7402 | 20p |
| SN7403 | 20p |
| SN7404 | 20p |
| SN7405 | 20p |
| SN7406 | 30p |
| SN7407 | 30p |
| SN7408 | 20p |
| SN7409 | 45p |
| SN7410 | 20p |
| SN7411 | 23p |
| SN7412 | 42p |
| SN7413 | 30p |
| SN7416 | 30p |
| SN7417 | 30p |
| SN7420 | 20p |
| SN7422 | 48p |
| SN7423 | 48p |
| SN7425 | 48p |
| SN7427 | 42p |

| | |
|---|---|
| SN7428 | 50p |
| SN7430 | 20p |
| SN7432 | 42p |
| SN7433 | 70p |
| SN7437 | 65p |
| SN7438 | 65p |
| SN7440 | 20p |
| SN7441AN | 75p |
| SN7442 | 75p |
| SN7443 | £1·00 |
| SN7445 | £2·00 |
| SN7446 | £2·00 |
| SN7447 | £1·75 |
| SN7448 | £1·75 |
| SN7450 | 20p |
| SN7451 | 20p |
| SN4753 | 20p |
| SN7454 | 20p |
| SN7460 | 20p |
| SN7470 | 30p |
| SN7472 | 30p |

| | |
|---|---|
| SN7473 | 40p |
| SN7474 | 40p |
| SN7475 | 55p |
| SN7476 | 45p |
| SN7480 | 80p |
| SN7481 | £1·25 |
| SN7482 | 87p |
| SN7483 | £1·00 |
| SN7484 | 90p |
| SN7486 | 45p |
| SN7490 | 75p |
| SN7491AN | £1·00 |
| SN7492 | 75p |
| SN7493 | 75p |
| SN7494 | 80p |
| SN7495 | 80p |
| SN7496 | £1·00 |
| SN7497 | £6·25 |
| SN74100 | £2·50 |
| SN74104 | £1·45 |
| SN74105 | £1·00 |

| | |
|---|---|
| SN74107 | 55p |
| SN74110 | 80p |
| SN74118 | £1·00 |
| SN74119 | £1·90 |
| SN74121 | 65p |
| SN74122 | £1·35 |
| SN74123 | £2·70 |
| SN74141 | £1·00 |
| SN74145 | £1·50 |
| SN74150 | £3·35 |
| SN74151 | £1·10 |
| SN74153 | £1·35 |
| SN74154 | £2·00 |
| SN74155 | £1·55 |
| SN74156 | £1·55 |
| SN74157 | £1·80 |
| SN74160 | £2·60 |
| SN74161 | £2·60 |
| SN74162 | £3·40 |
| SN74163 | £3·40 |
| SN74164 | £2·75 |
| SN74165 | £4·00 |
| SN74166 | £4·00 |

| | |
|---|---|
| SN74167 | £6·25 |
| SN74170 | £4·10 |
| SN74174 | £2·00 |
| SN74175 | £1·35 |
| SN74176 | £1·60 |
| SN74177 | £1·60 |
| SN74180 | £1·55 |
| SN74181 | £7·00 |
| SN74182 | £2·00 |
| SN74184 | £2·45 |
| SN74185A | £2·40 |
| SN74190 | £1·95 |
| 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 |

# AUDIO ACCESSORY SHOP, 17 TURNHAM GREEN TERRACE, CHISWICK W.4

### MICROPHONES

PRICES INC. VAT

| | | |
|---|---|---|
| CM10 | Crystal Lapel Microphone with Lead and Plug | 60p |
| CM20 | General purpose Crystal Microphone | £1·20 |
| CM73 | Crystal Stick Microphone with Switch Lead and Plug | £2·20 |
| CO92 | Omni Directional Capacitor Microphone with built in Preamplifier, Cable and Windshield | £14·00 |
| CO96 | Cardioid Capacitor Microphone as above, both types with Switch, both 600 ohms | £18·00 |
| DD1 | Cassette Dynamic Microphone with Plugs for signal and stop/start. 200 ohms | £2·20 |
| DD5 | Electret Paging Microphone, on table stand with gooseneck and switch, 600 ohms | £14·00 |
| DD6 | Lavalier Microphone with Windshield; Lavalier Cord, 6 metres Cable. 600 ohms/50 k | £11·20 |
| DM18HL | Dual Impedance Dynamic Microphone with desk stand. 600 ohms/50 k | £10·50 |
| DM73 | Omni Directional Dynamic Microphone with desk stand. 6 metres Cable and Plug. 50 k. ohms | £10·00 |
| DM81 | Remote Dynamic Microphone, Cassette type with Plugs. 200 ohms | £1·80 |
| DM82 | Remote Cassette Cardioid Microphone with Plugs, 200 ohms | £2·40 |
| DM94 | Omni Directional Dynamic Microphone with Slide on Windshield and Switch. 50 k | £9·50 |
| DM614 | Pencil Type Dyanmic Microphone with Cable. Lavalier Cord and Base. 50 k | £3·20 |
| PROM5 | Lavalier Capacitor Microphone with Tie Clip. 5.8 metres Cable. 600 ohms | £16·00 |
| PROM10 | Omni Directional Capacitor Microphone with 6 metres Cable. 600 ohms | £30·00 |
| PROM20 | Uni-Directional Capacitor Microphone with 6 metres Cable. 600 ohms | £32·00 |
| PROM25 | Capacitor Boom Arm Microphone with Arm, two Windshields, Cable. 600 ohms | £34·60 |
| UD50HL | Cardioid Dual Impedance Microphone with Switch, 6 metres Cables and Plug. 600 ohms/50 k | £12·00 |
| 200C | Slim Line Crystal Microphone with Switch, Cable and Connector | £3·80 |

### TWEETERS

PRICES INC. VAT

| | | |
|---|---|---|
| CT5 | Cone Tweeter. Freq. 3000-15000 HZ. Cross-over freq. 3000 HZ. Imp. 8 ohms. Suitable for systems up to 10 watts RMS | £1·60 |
| CT10/8 | Pressure Unit Type Tweeter. Freq. 1500-16000 HZ. Crossover freq. 3000 HZ. Imp. 8 ohms. Suitable for systems up to 20 watts RMS | £2·60 |
| CT10/16 | As above but 16 ohms | £2·60 |
| DT33 | Dome Tweeter. Freq. 2000-18000 HZ. Crossover freq. 3000 HZ. Imp. 8 ohms. Suitable for systems up to 40 watts | £5·70 |
| FF27 | Dome Tweeter. Freq. 2000-20000 HZ. Crossover freq. 3000 HZ. Imp. 8 ohms. Suitable for systems up to 30 watts RMS | £4·80 |
| FF28 | Horn Tweeter. Freq. 3000-20000 HZ. Crossover freq. 3000 HZ. Imp. 8 ohms. Suitable for systems up to 20 watts RMS | £8·20 |
| HT15 | Horn Tweeter Freq. 2000-18000 HZ. Crossover freq. 3000 HZ. Imp. 16 ohms. Suitable for systems up to 30 watts RMS | £4·00 |
| HT21 | Horn Tweeter. Freq. 2500-20000 HZ. Crossover freq. 3000 HZ. Imp. 8 ohms. Suitable for systems up to 40 watts RMS | £6·20 |
| MHT10 | Horn Tweeter. Freq. 2000-18000 HZ. Crossover freq. 3000 HZ. Imp. 8 ohms. Suitable for systems up to 30 watts RMS | £4·00 |

### CROSSOVERS

PRICES INC. VAT

| | | |
|---|---|---|
| CN23 | 2 Way Crossover Network. Imp. 3 ohms. Crossover 3000 HZ. Suitable up to 15 watts RMS | £1·25 |
| FF5 | 3 Way Crossover Network. Imp. 8 ohms. Crossover freqs. 1000 and 5000 HZ. Suitable up to 25 watts RMS | £3·30 |
| FF30 | 3 Way Crossover Network. Imp. 8 ohms. Crossover freqs. 1000 and 5000 HZ. Suitable up to to 25 watts RMS | £6·80 |
| SN75 | 2 Way Crossover Network. Imp. 8 ohms. Crossover 3000 HZ. Suitable for systems up to 15 watts RMS | £3·80 |

### CASSETTES

PRICES INC. VAT

| | C60 | C90 | C120 |
|---|---|---|---|
| BASF LH | 88p | £1·21 | £1·78 |
| MEMOREX | | | |
| MROX2 Oxide | 99p | £1·32 | £1·76 |
| CROX2 | £1·47 | £1·91 | — |
| PHILLIPS | 85p | £1·19 | £1·75 |

QTY Discounts 12-10%. 24-15%. 36-20%. 60-25%.

**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.

**TEAK VENEERED SPEAKER CABINETS**

| For | Size | Price |
|---|---|---|
| 8 × 5in. Speaker | 9¼×13¼×5¾ | £3·50 |
| 8in. + Tweeter | 7¾×11¾×5¼ | £5·00 |
| 13×8in. | 10½×17×6 | £5·75 |
| 13×8in.+Tweeter | 12×18¼×8¾ | £7·50 |
| 12in.+Tweeter | 15¾×18×8¾ | £9·00 |

### VALVE AMPLIFIERS

PRICES INC. VAT

Robust units suitable for most PA/Disco uses.

| | | |
|---|---|---|
| 5 watt | 2 Inputs, Vol, Treble, Bass Controls | £12·50 |
| 15 watt | 4 inputs. Vol, Treble, Bass Controls | £24·50 |
| 30 watt | 4 inputs, Vol, Treble, Bass Controls | £29·50 |
| 50 watt | 4 inputs, Vol. Treble, Bass Controls | £36·25 |
| 150 watt | 4 inputs with separate vol. controls plus master vol., treble, bass | £75·90 |
| 500 watt | 4 inputs each with independant vol, treble and bass controls plus overall master vol. control | £124·50 |

### MICROPHONE MIXERS

PRICES INC. VAT

| | | |
|---|---|---|
| FF1 | 4 Channel Mono Mixer and Preamplifier with individual slide controls. Battery operated | £26·00 |
| FF10 | 7 Channel Stereo Mixer and Preamplifier with individual slide controls. Battery operated | £34·00 |
| FF11 | Stereo Frequency Controller and Preamplifier, uses five slide controls. Battery operated | £34·00 |

**All mail order and enquiries to 270 Acton Lane Tel: 01-994 6275**

# Marshall's

Everything you need is in our New Catalogue available now price 20pence
(100 pages of prices and data)
Call in and see us 9–5.30 Mon–Fri
9–5.00 Sat
Trade and export enquiries welcome

A. Marshall (London) Limited
42 Cricklewood Broadway London NW2 3HD Telephone 01-452 0161 Telex 21492
& 65 Bath Street Glasgow G2 2BX Telephone 041-332 4133

## Popular Semiconductors

| Type | Price |
|---|---|
| 2N456 | 0·75 |
| 2N456A | 0·75 |
| 2N457A | 1·35 |
| 2N490 | 3·16 |
| 2N491 | 3·58 |
| 2N492 | 3·89 |
| 2N493 | 4·20 |
| 2N696 | 0·15 |
| 2N697 | 0·15 |
| 2N698 | 0·25 |
| 2N699 | 0·29 |
| 2N706 | 0·16 |
| 2N706A | 0·18 |
| 2N708 | 0·14 |
| 2N709 | 0·38 |
| 2N711 | 0·30 |
| 2N718 | 0·21 |
| 2N718A | 0·49 |
| 2N720 | 0·50 |
| 2N721 | 0·55 |
| 2N914 | 0·22 |
| 2N916 | 0·41 |
| 2N918 | 0·47 |
| 2N929 | 0·30 |
| 2N1302 | 0·19 |
| 2N1303 | 0·19 |
| 2N1304 | 0·24 |
| 2N1305 | 0·24 |
| 2N1306 | 0·31 |
| 2N1307 | 0·22 |
| 2N1308 | 0·25 |
| 2N1309 | 0·36 |
| 2N1671 | 1·44 |
| 2N1671A | 1·54 |
| 2N1871B | 1·72 |
| 2N1671C | 4·32 |
| 2N1711 | 0·45 |
| 2N1907 | 5·50 |
| 2N2102 | 0·50 |
| 2N2147 | 0·70 |
| 2N2148 | 0·94 |
| 2N2160 | 0·60 |
| 2N2192 | 0·40 |
| 2N2192A | 0·40 |
| 2N2913 | 0·40 |
| 2N2193A | 0·61 |
| 2N2194 | 0·73 |
| 2N2194A | 0·30 |
| 2N2218A | 0·60 |
| 2N2219 | 0·45 |
| 2N2219A | 0·60 |
| 2N2220 | 0·45 |
| 2N2221 | 0·41 |
| 2N2221A | 0·40 |
| 2N2222 | 0·40 |
| 2N2222A | 0·50 |
| 2N2368 | 0·31 |
| 2N2369 | 0·37 |
| 2N2369 | 0·41 |
| 2N2646 | 0·77 |
| 2N2647 | 1·12 |
| 2N2904 | 0·55 |
| 2N2904A | 0·70 |
| 2N2905 | 0·48 |
| 2N2905A | 0·50 |
| 2N2906 | 0·31 |
| 2N2906A | 0·37 |
| 2N2907 | 0·40 |
| 2N2907A | 0·45 |
| 2N2926 | 0·11 |
| 2N3053 | 0·32 |
| 2N3054 | 0·60 |
| 2N3055 | 0·75 |
| 2N3390 | 0·26 |
| 2N3391 | 0·23 |
| 2N3391A | 0·29 |
| 2N3392 | 0·13 |
| 2N3393 | 0·13 |
| 2N3394 | 0·13 |
| 2N3402 | 0·18 |
| 2N3403 | 0·19 |
| 2N3440 | 0·59 |
| 2N3441 | 0·97 |
| 2N3442 | 1·69 |
| 2N3414 | 0·10 |
| 2N3415 | 0·10 |
| 2N3416 | 0·15 |
| 2N3417 | 0·21 |
| 2N3638 | 0·15 |
| 2N3638A | 0·15 |
| 2N3639 | 0·27 |
| 2N3641 | 0·17 |
| 2N3702 | 0·11 |
| 2N3703 | 0·12 |
| 2N3704 | 0·14 |
| 2N3705 | 0·12 |
| 2N3706 | 0·09 |
| 2N3707 | 0·13 |
| 2N3708 | 0·70 |
| 2N3709 | 0·11 |
| 2N3710 | 0·12 |
| 2N3711 | 0·11 |
| 2N3712 | 0·96 |
| 2N3713 | 1·20 |
| 2N3714 | 1·33 |
| 2N3715 | 1·50 |
| 2N3716 | 1·80 |
| 2N3771 | 2·20 |
| 2N3772 | 1·80 |
| 2N3773 | 2·65 |
| 2N3779 | 3·15 |
| 2N3790 | 2·40 |
| 2N3791 | 2·35 |
| 2N3792 | 2·69 |
| 2N3794 | 0·10 |
| 2N3819 | 0·37 |
| 2N3820 | 0·38 |
| 2N3823 | 1·42 |
| 2N3900 | 0·21 |
| 2N3901 | 0·32 |
| 2N3903 | 0·24 |
| 2N3904 | 0·27 |
| 2N3905 | 0·24 |

| Type | Price |
|---|---|
| 2N3906 | 0·27 |
| 2N4036 | 0·63 |
| 2N4037 | 0·42 |
| 2N4058 | 0·16 |
| 2N4059 | 0·09 |
| 2N4060 | 0·11 |
| 2N4061 | 0·11 |
| 2N4062 | 0·11 |
| 2N4126 | 0·20 |
| 2N4289 | 0·13 |
| 2N4919 | 0·84 |
| 2N4920 | 0·99 |
| 2N4921 | 0·73 |
| 2N4922 | 0·84 |
| 2N4923 | 0·83 |
| 2N5172 | 0·12 |
| 2N5174 | 0·22 |
| 2N5175 | 0·26 |
| 2N5176 | 0·32 |
| 2N5190 | 0·92 |
| 2N5191 | 0·95 |
| 2N5192 | 1·24 |
| 2N5195 | 1·46 |
| 2N5245 | 0·43 |
| 2N5457 | 0·49 |
| 2N5458 | 0·45 |
| 2N5459 | 0·49 |
| 40361 | 0·48 |
| 40362 | 0·50 |
| 40363 | 0·61 |
| 40389 | 0·46 |
| 40394 | 0·56 |
| 40395 | 0·65 |
| 40406 | 0·44 |
| 40407 | 0·33 |
| 40408 | 0·50 |
| 40409 | 0·52 |
| 40410 | 0·52 |
| 40411 | 2·25 |
| 40414 | 3·55 |
| 40430 | 0·85 |
| 40583 | 0·23 |
| 40601 | 0·67 |
| 40602 | 0·46 |
| 40603 | 0·53 |
| 40604 | 0·56 |
| 40636 | 1·10 |
| 40669 | 1·00 |
| 40673 | 0·70 |
| AC107 | 0·25 |
| AC113 | 0·16 |
| AC117 | 0·20 |
| AC126 | 0·25 |
| AC127 | 0·25 |
| AC128 | 0·25 |
| AC151V | 0·14 |
| AC152V | 0·17 |
| AC153 | 0·25 |
| AC153K | 0·25 |
| AC154 | 0·20 |
| AC176 | 0·18 |
| AC176K | 0·25 |
| AC187K | 0·23 |
| AC188K | 0·34 |
| ACY18 | 0·24 |
| ACY19 | 0·27 |
| ACY20 | 0·22 |
| ACY21 | 0·26 |
| ACY28 | 0·20 |
| ACY30 | 0·42 |
| AD142 | 0·50 |
| AD143 | 0·45 |
| AD149V | 0·66 |
| AD150 | 0·63 |
| AD161 | 0·45 |
| AD162 | 0·45 |
| AD161 } | pr |
| AD162 } | 1·05 |
| AF109R | 0·40 |
| AF115 | 0·24 |
| AF116 | 0·25 |
| AF117 | 0·20 |
| AF118 | 0·50 |
| AF124 | 0·24 |
| AF125 | 0·20 |
| AF126 | 0·19 |
| AF127 | 0·20 |
| AF139 | 0·39 |
| AF170 | 0·25 |
| AF172 | 0·25 |
| AF178 | 0·55 |
| AF179 | 0·65 |
| AF180 | 0·50 |
| AF186 | 0·40 |
| AF200 | 0·35 |
| AF239 | 0·51 |
| AF240 | 0·72 |
| AF279 | 0·54 |
| AF280 | 0·54 |
| AL102 | 0·75 |
| AL103 | 0·70 |
| BC107 | 0·16 |
| BC108 | 0·15 |
| BC109 | 0·19 |
| BC113 | 0·13 |
| BC115 | 0·15 |
| BC116 | 0·15 |
| BC116A | 0·18 |
| BC117 | 0·21 |
| BC118 | 0·11 |
| BC119 | 0·29 |
| BC121 | 0·23 |
| BC125 | 0·15 |
| BC126 | 0·20 |
| BC132 | 0·30 |
| BC134 | 0·11 |
| BC135 | 0·11 |
| BC136 | 0·15 |
| BC137 | 0·15 |
| BC138 | 0·24 |
| BC140 | 0·34 |
| BC141 | 0·29 |
| BC142 | 0·23 |

| Type | Price |
|---|---|
| BC143 | 0·21 |
| BC145 | 0·21 |
| BC147 | 0·12 |
| BC148 | 0·13 |
| BC149 | 0·12 |
| BC153 | 0·18 |
| BC154 | 0·18 |
| BC157 | 0·14 |
| BC158 | 0·13 |
| BC159 | 0·14 |
| BC160 | 0·37 |
| BC167B | 0·13 |
| BC168B | 0·13 |
| BC168C | 0·11 |
| BC169B | 0·13 |
| BC169C | 0·13 |
| BC170 | 0·11 |
| BC171 | 0·13 |
| BC172 | 0·11 |
| BC182 | 0·12 |
| BC182L | 0·12 |
| BC183 | 0.09 |
| BC183L | 0·09 |
| BC184 | 0·11 |
| BC184L | 0·11 |
| BC186 | 0·25 |
| BC187 | 0·27 |
| BC207 | 0·12 |
| BC208 | 0·11 |
| BC212K | 0·10 |
| BC212L | 0·16 |
| BC214L | 0·21 |
| BC237 | 0·09 |
| BC238 | 0·09 |
| BC239 | 0·09 |
| BC251 | 0·20 |
| BC252 | 0·18 |
| BC253 | 0·23 |
| BC257 | 0·09 |
| BC258 | 0·09 |
| BC259 | 0·13 |
| BC261 | 0·20 |
| BC262 | 0·18 |
| BC263 | 0·23 |
| BC300 | 2·12 |
| BC301 | 0·34 |
| BC302 | 0·29 |
| BC303 | 0.54 |
| BC307 | 0·10 |
| BC307A | 0·10 |
| BC308 | 0·09 |
| BC308A | 0·12 |
| BC308B | 0·09 |
| BC309 | 0·10 |
| BC309A | 0·10 |
| BC309B | 0·10 |
| BC237 | 0·21 |
| BC238 | 0·19 |
| BC337 | 0·19 |
| BC338 | 0·19 |
| BCY30 | 0·43 |
| BCY31 | 0·52 |
| BCY32 | 1·15 |
| BCY33 | 0·34 |
| BCY34 | 0·37 |
| BCY38 | 0·53 |
| BCY39 | 1·05 |
| BCY40 | 0·87 |
| BCY42 | 0·15 |
| BCY58 | 0·21 |
| BCY59 | 0·22 |
| BCY70 | 0·17 |
| BCY71 | 0·22 |
| BCY72 | 0·13 |
| BCY87 | 3·54 |
| BCY88 | 2·42 |
| BCY89 | 0·97 |
| BD115 | 0·75 |
| BD116 | 0·75 |
| BD121 | 0·75 |
| BD123 | 0·32 |
| BD124 | 0·67 |
| BD131 | 0·40 |
| BD132 | 0·50 |
| BD135 | 0·43 |
| BD136 | 0·49 |
| BD137 | 0·55 |
| BD138 | 0·63 |
| BD139 | 0·71 |
| BD140 | 0·87 |
| BDY20 | 1·05 |
| BF115 | 0·25 |
| BF116 | 0·23 |
| BF117 | 0·43 |
| BF119 | 0·58 |
| BF121 | 0·25 |
| BF123 | 0·27 |
| BF125 | 0·25 |
| BF152 | 0·20 |
| BF153 | 0·21 |
| BF154 | 0·16 |
| BF158 | 0·23 |
| BF159 | 0·27 |
| BF160 | 0·23 |
| BF161 | 0·42 |
| BF163 | 0·32 |
| BF166 | 0·32 |
| BF167 | 0·21 |
| BF173 | 0·24 |
| BF177 | 0·29 |
| BF178 | 0·35 |
| BF179 | 0·43 |
| BF180 | 0·35 |
| BF181 | 0·34 |
| BF182 | 0·40 |
| BF183 | 0·40 |
| BF184 | 0·30 |
| BF185 | 0·17 |
| BF194 | 0·16 |
| BF195 | 0·17 |
| BF196 | 0·15 |
| BF197 | 0·15 |
| BF198 | 0·18 |
| BF199 | 0·18 |
| BF200 | 0·40 |
| BF225J | 0·19 |
| BF237 | 0·22 |
| BF238 | 0·22 |

| Type | Price |
|---|---|
| BF244 | 0·16 |
| BF245 | 0·33 |
| BF246 | 0·43 |
| BF247 | 0·23 |
| BF254 | 0·16 |
| BF255 | 0·17 |
| BF257 | 0·46 |
| BF258 | 0·59 |
| BF259 | 0·55 |
| BFS21A | 2·30 |
| BFS28 | 0·92 |
| BFS61 | 0·27 |
| BFS98 | 0·20 |
| BFX29 | 0·30 |
| BFX30 | 0·25 |
| BFX44 | 0·33 |
| BFX63 | 2·48 |
| BFX68 | 0·30 |
| BFX84 | 0·24 |
| BFX85 | 0·30 |
| BFX87 | 0·28 |
| BFX88 | 0·25 |
| BFX89 | 0·45 |
| BFY18 | 0·35 |
| BFY19 | 0·35 |
| BFY20 | 0·50 |
| BFY29 | 0·40 |
| BFY50 | 0·23 |
| BFY51 | 0·19 |
| BFY52 | 0·21 |
| BFY53 | 0·16 |
| BFY90 | 0·60 |
| BRY39 | 0·48 |
| BU104 | 1·42 |
| BU105 | 2·25 |
| C106A | 0·46 |
| C106B | 0·55 |
| C106D | 0·65 |
| C106E | 0·43 |
| CA3020A | 1·80 |
| CA3046 | 0·70 |
| CA3048 | 2·11 |
| CA3089E | 1·96 |
| CA3090Q | 4·23 |
| LM301A | 0·48 |
| LM304A | 2·03 |
| LM309K | 1·88 |
| LM702C | 0·75 |
| LM709T099 | 0·48 |
| 8DIL | 0·38 |
| 14DIL | 0·33 |
| LM723C | 0·75 |
| LM741T099 | 0·40 |
| 8DIL | 0·46 |
| 14DIL | 0·38 |
| LM747 | 1·00 |
| LM748 8DIL | 0·60 |
| 14DIL | 0·73 |
| MC1303p | 1·26 |
| MC1310 | 2·92 |
| MC1458CP1 | 0·79 |
| MJ480 | 0·90 |
| MJ481 | 1·14 |
| MJ490 | 0·98 |
| MJ491 | 1·38 |
| MJE340 | 0·42 |
| MJE2955 | 1·12 |
| MJE3055 | 0·68 |
| MP8111 | 0·32 |
| MP8112 | 0·40 |
| MP8113 | 0·47 |
| MPF102 | 0·39 |
| MPSA05 | 0·25 |
| MPSA06 | 0·26 |
| MPSA55 | 0·26 |
| MPSA56 | 0·27 |
| NE555V | 0·90 |
| NE560 | 4·48 |
| NE561 | 4·48 |
| NE565A | 4·48 |
| OC23 | 0·56 |
| OC28 | 0·76 |
| OC35 | 0·60 |
| OC42 | 0·35 |
| OC45 | 0·32 |
| OC71 | 0·12 |
| OC72 | 0·13 |
| OC81 | 0·20 |
| OC83 | 0·20 |
| ORP12 | 0·50 |
| SC350 | 1·68 |
| SC360 | 1·46 |
| SC40D | 1·89 |
| SC41D | 1·32 |
| SC45D | 1·89 |
| SC46D | 1·96 |
| SC50D | 2·60 |
| SC51D | 2·39 |
| SL414A | 1·80 |
| SL623 | 4·59 |
| TAA263 | 0·70 |
| TAA350 | 2·10 |
| TAA621 | 2·03 |
| TAA661B | 1·32 |
| TAD100 | 1·50 |
| Filter | 0·70 |
| TBA271 | 0·64 |
| TBA641B | 2·25 |
| TBA800 | 1·50 |
| TBA810 | 1·50 |
| TIL209 | 0·35 |
| TIP29A | 0·49 |
| TIP30A | 0·58 |
| TIP31A | 0·62 |
| TIP32A | 0·74 |
| TIP33A | 1·01 |
| TIP34A | 1·51 |
| TIP35A | 2·90 |
| TIP36A | 3·70 |
| TIP41A | 0·79 |
| TIP42A | 0·90 |
| TIP2955 | 0·93 |
| TIP3055 | 0·60 |
| ZTX300 | 0·12 |
| ZTX302 | 0·20 |
| ZTX500 | 0·15 |
| ZTX502 | 0·17 |
| ZTX503 | 0·21 |

**New from Siemens**
7 segment 4 digit Clock Display Liquid Crystal Type AN 4132 complete with data. From stock now. Price £13.00 complete with holder. Ideal for battery operated Quartz clock using two of the latest CMOS ICs from Solid State Scientific. 15v battery operated, minimum of discrete components required. Send SAE for details.

**Seven Segment Read Out**
Minitron 3015F £1·55
DL707 Litronix £2·35
All data in our new catalogue price 20p

**Printed Circuit Marker Pen**
DALO 33PC – complete with instructions. No masking! No mess! Red or blue. Price 87p

400mW Zeners 3·3v to 43v
New low price 11p each £8·20 for 100

A large selection of heatsinks for all types of transistors from Redpoint, in stock now.
TO5–6p TO18–7p
6W1–6" x 4" undrilled £1·00
4W1–4" x 4" undrilled £0·80
2W1–2" x 4" undrilled £0·45

| Resistors Power W | Tol | Price | Tantalum Bead Caps Value | Price |
|---|---|---|---|---|
| 1/8 | 5% | 1p | 1/35v | 14p |
| 1/4 | 5% | 1·5p | 22/35v | 14p |
| 1/2 | 5% | 2p | 47/35v | 14p |
| 1 | 10% | 2·5p | 1μ/35v | 14p |
| 2 | 10% | 6p | 2·2/35v | 14p |
| 2½ | 5% | 7p | 4·7/35v | 18p |
| 5 | 5% | 9p | 2·2/16v | 14p |
| 10 | 5% | 10p | | |

**Veroboard Largest stockist**

| | Copper ·15 | Copper ·1 | Plain ·1 | Plain ·15 |
|---|---|---|---|---|
| 2·5x3¾ | 20 | 28 | – | 14 |
| 2·5x5 | 30 | 30 | – | 14 |
| 3¾x3¾ | 30 | 30 | – | – |
| 3¾x5 | 35 | 34 | – | 24 |
| 2½x17 | 67 | 89 | – | 49 |
| 3¾x17 | 95 | 1·21 | 76 | 69 |

trade or retail supplied

**Thermistors**
Mullard E299DD Series 12½p
E298ED Series 10p
Neg temp Coef VA1000 Series 20p
R53 £1·20
Full details of ranges in our catalogue 20p

**Equivalents Books**
Transistors 90p
IC's 70p

| Veropins | ·1 | ·15 |
|---|---|---|
| 36pcs | 24 | 24 |
| 200pcs | 89 | 92 |

Face Cutter 46p
Insertion Tools 64p

**VAT**
Please include 10% Vat with all orders
Prices quoted are all exclusive of Vat

**Post and Package**
15p postage and package charges
Prices correct at July 1974

## Integrated Circuits

Each month we will show a different range of i.c.'s which are kept in stock.

### TTL (SN 7400 Series)

| Type | Price £ | Type | Price £ | Type | Price £ | Type | Price £ |
|---|---|---|---|---|---|---|---|
| SN7400 | 16p | SN7437 | 35p | SN7483 | £1·20 | SN74154 | £1·66 |
| SN7401 | 16p | SN7438 | 35p | SN7484 | 95p | SN74155 | £1·55 |
| SN7401AN | 38p | SN7440 | 16p | SN7485 | £1·58 | SN74157 | £1·09 |
| SN7402 | 16p | SN7441 | 85p | SN7486 | 45p | SN74160 | £1·58 |
| SN7403 | 16p | SN7442 | 85p | SN7490 | 65p | SN74161 | £1·58 |
| SN7404 | 24p | SN7445 | £1·59 | SN7491 | £1·10 | SN74162 | £1·58 |
| SN7405 | 24p | SN7446 | £2 | SN7492 | 75p | SN74164 | £2·01 |
| SN7406 | 45p | SN7447 | £1·30 | SN7493 | 65p | SN74165 | £2·01 |
| SN7407 | 45p | SN7448 | £1·50 | SN7494 | 85p | SN74167 | £4·10 |
| SN7408 | 25p | SN7450 | 16p | SN7495 | 80p | SN74174 | £1·80 |
| SN7409 | 33p | SN7451 | 16p | SN7496 | £1·00 | SN74175 | £1·29 |
| SN7410 | 16p | SN7453 | 16p | SN74100 | £2·16 | SN74176 | £1·74 |
| SN7411 | 25p | SN7454 | 16p | SN74107 | 43p | SN74180 | £1·44 |
| SN7412 | 28p | SN7460 | 20p | SN74118 | £1·00 | SN74181 | £5·18 |
| SN7413 | 50p | SN7470 | 30p | SN74119 | £1·92 | SN74190 | £1·95 |
| SN7416 | 45p | SN7472 | 38p | SN74121 | 57p | SN74191 | £1·95 |
| SN7417 | 30p | SN7473 | 44p | SN74122 | 80p | SN74192 | £2·05 |
| SN7420 | 20p | SN7474 | 48p | SN74123 | 72p | SN74193 | £2·30 |
| SN7423 | 37p | SN7475 | 59p | SN74141 | £1·00 | SN74196 | £1·58 |
| SN7425 | 37p | SN7476 | 45p | SN74145 | £1·44 | SN74197 | £1·58 |
| SN7427 | 45p | SN7480 | 75p | SN74150 | £1·44 | SN74198 | £3·16 |
| SN7430 | 16p | SN7481 | £1·25 | SN74151 | £1·10 | SN74199 | £2·88 |
| SN7432 | 45p | SN7482 | 87p | SN74153 | £1·09 | | |

## Diodes & Rectifiers

| PIV | 50 | 100 | 200 | 400 | 600 | 800 | 1000 |
|---|---|---|---|---|---|---|---|
| 1·5 | 0·08 | 0·09 | 0·10 | 0·11 | 0·12 | 0·15 | 0·20 |
| 3 | 0·15 | 0·17 | 0·20 | 0·22 | 0·25 | 0·27 | 0·20 |
| 10 | — | 0·35 | 0·40 | 0·47 | 0·56 | — | — |
| 35 | 0·84 | 9·92 | 1·18 | 2·15 | 2·52 | 3·65 | 4·20 |

**CATHODE STUD ONLY**
IN3766 (35 amp 800 pv) £3·65 IN3768 (35 amp 1000 pv) £4·20

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| IN34A | 0·10 | BA141 | 0·17 | BY237 | 0·12½ | OA79 | 0·07 |
| IN914 | 0·07 | BA142 | 0·17 | BYZ10 | 0·35 | OA81 | 0·08 |
| IN916 | 0·07 | BA144 | 0·12 | BYZ11 | 0·32 | OA85 | 0·10 |
| AA119 | 0·07 | BA145 | 0·17 | BYZ12 | 0·30 | OA90 | 0·07 |
| AA129 | 0·15 | BA154 | 0·12 | OA9 | 0·10 | OA91 | 0·07 |
| BA100 | 0·15 | BY100 | 0·15 | OA10 | 0·23 | OA95 | 0·07 |
| BA102 | 0·25 | BY126 | 0·15 | OA47 | 0·07½ | OA200 | 0·07 |
| BA110 | 0·25 | BY127 | 0·17½ | OA70 | 0·07½ | OA202 | 0·10 |
| BA115 | 0·07 | BY140 | 1·00 | OA73 | 0·10 | OA210 | 0·27½ |

## Bridge Rectifiers

| | Plastic 1A | 2A | 4A | 6A | Metal—Professional quality 5A | 15A | 25A | 50A |
|---|---|---|---|---|---|---|---|---|
| 50 | 0·24 | 0·32 | 0·60 | 0·62 | 2·22 | 2·64 | 3·36 | 12·30 |
| 100 | 0·36 | 0·37 | 0·70 | 0·75 | 2·24 | 3·00 | 3·60 | 12·36 |
| 200 | 0·30 | 0·41 | 0·75 | 0·80 | 2·82 | 3·78 | 4·32 | 14·40 |
| 400 | 0·36 | 0·45 | 0·85 | 1·10 | 3·72 | 4·20 | 5·40 | 16·38 |
| 600 | 0·40 | 0·52 | 0·95 | 1·25 | | | | |

## AB Potentiometers–carbon

**Rotary type 45**
Singles (Log and linear) 15 pence
Single switched (Log and linear) 21 pence
Doubles (Log and linear) 38 pence
**Slider type 58**
Singles (Log and linear) 30 pence
Doubles (Log and linear) 50 pence
**Presets** (Please specify vertical or horizontal)
0·1 watt 6 pence
0·2 watt 6 pence
0·3 watt 7½ pence

***STOP PRESS!!***
PIHER RESISTORS & POTS IN STOCK SOON

## Kellner Construction Kits

**We are the sole distributors in U.K.**

| | |
|---|---|
| ES3 3 watt Mono Transistor Amplifier Kit | £4·08 |
| ES15 15 watt Hi-Fi Transistor Amplifier Kit (two for stereo) with Tone Control and Pre-Amp | £13·20 |
| ES30 30 watt Mono Hi-Fi Power Amplifier | £9·20 |
| ES50 50 watt Mono Hi-Fi Power Amplifier | £4·53 |
| EV5 Distortion Compensator Pre-Amplifier | £4·00 |
| AV7 Aerial Amplifier. LW, SW, MW, VHF, T/V Channels 2-12 | £2·04 |
| UH870 FM Transmitter Kit. 65mHz-145mHz. A GPO Licence is required | £2·79 |
| MUE7 Short Wave and VHF Receiver Kit. Companion to UH870 25mHz-150mHz | £3·22 |
| UH870 25mHz-150mHz | £3·22 |
| EW18 Electronic Dice Kit | £6·53 |
| EW20 Electronic Dice with Sensor Button | £7·79 |
| ST800 Strobe Light Kit. 120W/S | £7·86 |
| LO1000 Psychedelic Light Control, single channel | £7·00 |
| LO350 Psychedelic Light Control, three channel | £13·50 |
| NT15 Power Supply—4 to 30V, 1·5W | £7·46 |
| NT85 Professional Stabilized Power Supply, 5 to 70V, 2A | £12·53 |
| O800 800W Light Dimmer Speed Control | £2·98 |
| WT7 Aircraft Communication Tuner. 110-130mHz. Built and aligned | £15·46 |
| WT9 Transmitter VFO for 2 meters (14mHz-140mHz). Built and aligned | £15·46 |

**All prices plus 10% VAT and plus 15p post and packing.**
**All kits with easy to follow instructions and covered by a full guarantee.**

Full range of Carbon and Wirewound resistors available.

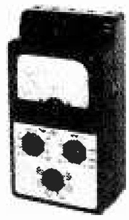
Post and Packing 15p per order. Europe 25p. Commonwealth (Air) 65p. (Min.)

# Z & I AERO SERVICES LTD.

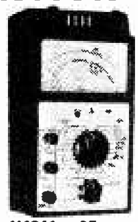
THE MANAGEMENT ANNOUNCES WITH REGRET THAT DUE TO RISING COSTS AND STAFF SHORTAGES OUR MAIL ORDER SERVICE WILL HAVE TO BE CURTAILED. NO MAIL ORDERS WILL BE ACCEPTED BELOW £5.00 PLUS VAT, I.E. £5.50 VAT PAID. OUR EQUIPMENT WILL STILL BE AVAILABLE TO PERSONAL CALLERS ONLY AT OUR RETAIL BRANCH, 85 TOTTENHAM 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% £10.25
**U4313;** 31-ranges AC/DC Volts and Amps. Sensitivity 20.000 o.p.v./2.000 o.p.v., Accuracy 1.5/2.5% £12.50

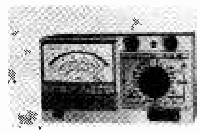


**U435;** 30-ranges. AC/DC Volts and Amps. Sensitivity 20.000 / 2.000 o.p.v. Accuracy 2.5/4% £8.75

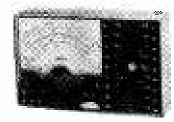


**U4341;** 27-range multimeter, with AC/DC voltage and current coverage *plus* transistor tester giving current gain measurements from 10 to 350. Sensitivity 16.700/3.300 o.p.v. Accuracy 2.5/4% £10.50

**U4324;** 32 ranges. AC/DC Volts and Amps. Sensitivity 20.000/4.000 o.p.v. Accuracy 2.5/4% £9.25



**U4317.** 42-ranges AC/DC Volts and Amps. Sensitivity 20.000/4.000 o.p.v. Mirror scale. Transistorized high-speed trigger protection. Mirror scale. Accuracy 1.5/2.5%. £16.50



**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% £7.70

OUR CATALOGUE OF VALVES, SEMICONDUCTORS AND TEST EQUIPMENT IS AVAILABLE: PLEASE SEND 0.15p FOR YOUR COPY.

*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

---

A REASONABLE INCOME, GOOD SICKNESS AND PENSION SCHEMES — AND THE WELFARE STATE, OF COURSE.

# But are they enough?

There are sometimes circumstances when assistance just can't be provided by any of them—especially if it's needed in a hurry—and particularly if it's needed for your wife—or your child.

The EEIBA can give immediate help or comfort to people (or their dependants) who are, or have been, in the electrical and electronics industries and whose circumstances are changed by illness, accident, or old age. Help in the form of an automatic invalid chair, a Patient Operated Selector Mechanism, a sewing machine for a disabled person, an artificial kidney, a cooker for a pensioner, a flat for an elderly person.

A donation of as little as £1 a year from you goes a long way. Can you be sure you won't be the next to need help from the EEIBA?

If it were your colleague in need wouldn't **you** like to help?

EE IBA

**The Electrical and Electronics Industries Benevolent Association**
8 Station Parade
Balham High Road, London SW12 9BH
Telephone: 01-673 0131-2

305P5

---

## 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.

Bg

# SERVICE TRADING CO

## VARIABLE VOLTAGE TRANSFORMERS

Carriage extra

INPUT 230 v. A.C. 50/60
OUTPUT VARIABLE 0/260 v. A.C.
BRAND NEW. All types.

| | |
|---|---|
| 200W (1 Amp) | £9·00 |
| 0·5 KVA (Max. 2½ Amp) | £10·00 |
| 1 KVA (Max. 5 Amp) | £14·70 |
| 2 KVA (Max. 10 Amp) | £28·10 |
| 3 KVA (Max. 15 Amp) | £31·25 |
| 4 KVA (Max. 20 Amp) | £72·50 |
| (Max. 37.5 Amp) | £102·50 |
| 1 Amp OPEN TYPE (Panel Mounting) | £9·00 |

### L.T. TRANSFORMERS

All primaries 220-240 volts.

| Type No. | Sec. Taps | Price | Post |
|---|---|---|---|
| 1 | 30, 32, 34, 36 v. at 5 amps. | £6·90 | 45p |
| 2 | 30, 40, 50 v. at 5 amps. | £9·15 | 60p |
| 3 | 10, 17, 18 v. at 10 amps. | £7·20 | 50p |
| 4 | 6, 12 v. at 20 amps. | £8·60 | 60p |
| 5 | 17, 18, 20 v. at 20 amps. | £9·15 | 60p |
| 6 | 6, 12, 20 v. at 20 amps. | £8·65 | 60p |
| 7 | 12, 20, 24 v. at 10 amps. | £6·75 | 50p |
| 8 | 4, 6, 24, 32 v. at 12 amps. | £8·60 | 60p |
| 9 | 6 and 12 v. at 10 amps. | £4·30 | 40p |

**Large selection of other types in stock, phone for details.**

## VOLTAGE CHANGING TRANSFORMER

M.f. to highest W.D. spec. Auto wound, and tapped 0-130, 160-200-250 at least 2KVA. Can also be used as 230-240V. input, 115V. out for U.S.A. equipment, or reverse to obtain 240V. from 115V. The ideal transformer for making up solid state constant voltage unit, by use of taps the following voltages may be obtained: 30-40-50-70-90 Volts at 10 amps. Weight 40 lbs., length 260 mm., height 190 mm., width 230 mm. In original maker's wooden case, **£8·00**, carr. £1.

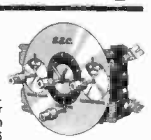
## 300 VA ISOLATING TRANSFORMER

115/230–230/230 volts. Screened. Primary two separate 0–115 volts for 115 or 230 volts. Secondary two 115 volts at 150 VA each for 115 or 230 volts output. Can be used in series or parallel connections. Fully tropicalised. Length 13.5 cm. Width 11 cm. Height 13.5 cm. Weight 15 lb. SPECIAL OFFER PRICE Only **£5.00**. Carr. 80p.

## VENNER TIME SWITCH TYPE MSQP

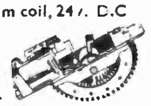
200/250 Volt 2-ON/2-OFF every 24 hours at any manually pre-set time. 20 amp contacts. Fitted die-cast case. Tested and in good condition **£4·75** Post 25p.

## A.C. MAINS TIMER UNIT



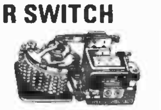
Based on an electric clock, with 25 amp. single-pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders. Lights. Electric Blankets. etc. Attractive satin copper finish. Size 135 mm X 130 mm X 60 mm. Price **£2·00**. Post 20p. (Total inc. VAT & Post **£2·42**).

## UNISELECTOR SWITCHES—NEW



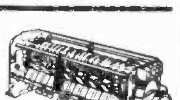
**4 BANK 25 WAY FULL WIPER** 25 ohm coil, 24 v. D.C operation **£6·90**. Post 30p.
**8 BANK 25 WAY FULL WIPER** 25 ohm coil, 24 v. D.C. **£7.90**. Post 30p.
**8 BANK 25 WAY FULL WIPER** 24 v. D.C. operation **£9·50**. Post 40p.

## MINIATURE UNISELECTOR SWITCH



2 Bank. 12 position. 24 volt D.C. operation. full wiper with ancillary contacts. NEW Price **£2·50** Post 20p. As above but with 5 Bank. 12 position. Price **£3·50** Post 20p.

## PROGRAMME TIMERS



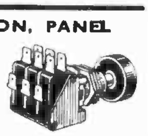
230/240 Volt A.C. 15 RPM Motors. Each cam operates a c/o micro switch. Ideal for lighting effects, animated displays etc. Ex equipment tested.

| | |
|---|---|
| 4 cam model | £2·50 post 30p. |
| 6 cam model | £3·25 post 30p. |
| 12 cam model | £4·00 post 35p. |
| 6 cam model 3 RPM | £3·25 post 30p. |

## VERY SPECIAL OFFER

**Miniature Roller Micro Switch.** 5 amp c/o contacts. Mfg. BONNELLA. NEW. Price 10 for **£1·50**. Post 10p. (Min order 10.)
As above without roller. 20 for **£2.00**. Post 10p. (Min. order 20.)

## 'HONEYWELL' PUSH BUTTON, PANEL MOUNTING MICRO SWITCH ASSEMBLY



Each bank comprises of a change-over rated at 10 amps 240 volt A.C. Black knob 1 in. dia. Fixing hole ⅜ in. Prices: 1-bank **30p**, 2-bank **40p**, 3-bank **50p**. (Illustrated) inc. P. & P. Special quotes for quantities.

## 24 VOLT DC SOLENOIDS

**UNIT** containing: 1 heavy duty solenoid approx. 25 lb. pull at 1 in. travel. 2 solenoids of approx. 1 lb. pull at ¼ in. travel. 6 solenoids of approx. 4 oz. pull at ¼ in. travel. Plus 1 24V D.C. 1 heavy duty 1 make relay. Price: **£2·50**. Post 60p. **ABSOLUTE BARGAIN.**

## POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
**25 WATT** 10, 25, 100, 150, 500, 1k ohm. **£1·15** Post 10p.
**50 WATT** 1, 5, 10, 25, 50, 100, 250, 500, 1·5k ohm **£1·60**. Post 10p.
**100 WATT** 1/5/10/25/50/100/250/500/1k/1·5k/2·5k/3·5k/5k ohm **£2·35**. Post 15p.
**Black SilverSkirted knob calibrated in Nos. 1-9. 1½ in. dia brass bush. Ideal for above Rheostats, 22p ea.**

## STROBE! STROBE! STROBE!

FOUR EASY TO BUILD KITS USING XENON WHITE LIGHT FLASH TUBES, SOLID STATE TIMING + TRIGGERING CIRCUITS, PROVISION FOR EXTERNAL TRIGGERING. 230-250v. A.C. OPERATION.

**EXPERIMENTERS "ECONOMY" KIT**
Adjustable 1 to 30 Flash per sec. All electronic components including Xenon Tube + Instructions **£6·30**. Post 30p.

**INDUSTRIAL KIT**
Ideally suitable for schools, laboratories etc. Roller tin printed circuit. Adjustable 1-80 f.p.s., approx. ½ output of Hy-Lyght. Price **£14·00**. Post 50p.

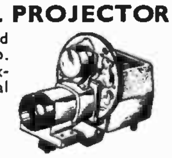
**HY-LITE STROBE Mk IV**
Designed for use in large rooms, halls and utilizes a silica tube, printed circuit. Speed adjustable 1-20 f.p.s. Light output greater than many (so called 4 Joule) strobes. Price **£14·00**. Post 50p.

**'SUPER' HY-LIGHT KIT**
Approx. 4 times the light output of our well proven Hy-Lyght strobe.
Variable speed from 1-13 flash per sec.
Reactor control circuit producing an intense white light. **ONLY £22·00**. Post 75p.

**ATTRACTIVE, ROBUST, FULLY VENTILATED METAL CASE** for the Super Hy-Lyght Kit including reflector. **£8·00**. Post 60p.

**FOR HY-LYGHT STROBE** incl. reflector, **£5·75**. Post 25p.

## COLOUR WHEEL PROJECTOR



Complete with oil filled colour wheel. 100 watt lamp. 200/240V AC. Features extremely efficient optical system. **£18·50**. Post 50p.

**1 R.P.M. MOTOR and COLOUR WHEEL**
200/240 volt A.C. 1 r.p.m. motor, and wheel **£5.60**. Post 40p. (Motor not available separately.)
**6 INCH COLOUR WHEEL ONLY.** Price **£4.50**. Post 30p.

**BIG BLACK LIGHT**
400 Watt. Mercury vapour ultra violet lamp. Extremely compact and powerful source of u.v. Innumerable industrial applications also ideal for stage, display, discos etc. P.F. ballast is essential with these bulbs. Price of matched ballast and bulb **£16·00**. Post £1. Spare bulb **£7·00**. Post 40p.

**BLACK LIGHT FLUORESCENT U.V. TUBES**
4ft. 40 watt. Price **£5·50**. Post 30p. 2ft. 20 watt **£4·25**. Post 25p. (For use in stan bi-pin fittings.) MINI 12in. 8 watt **£1·60**. Post 15p. 9in. 6 watt **£1·30**. Post 15p. Complete ballast unit and holders for either 9" or 12" tube. **£1·70**. Post 25p. (9in. x 12in. measures approx.).

## High Visibility Panel Mounting LED'S

·25 inch mounting, ·16 inch lens. Typical parameters 2 volt 20 m.a. all types. Supplied complete with snap in mountings and data. Red 4 for **£1·00**, Green 3 for **£1·00**, Yellow 3 for **£1·00**. Post 5p. (Min. order **£1·00**.)

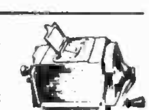
## LED READOUTS

7 series l/h DP ⅓" high characters. 14-pin D.C.L. Available in red or green. **£1·65**, post 10p: 4 for **£6·00** post paid.

## GENERAL ELECTRIC POWER-GLAS TRIACS

10 amp. Glass passivated plastic Triac. Latest device from U.S.A. Long term reliability. Type SC 146E 10 amp. 500PIV. **£1·30**. Post 5p. (Inclusive of data and application sheet) suitable Diac **18p**.

## INSULATION TESTERS (NEW)



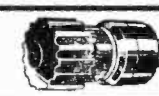
Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8 in., W. 4 in., H. 6 in., weight 6 lb.
**500 VOLTS**, 500 megohms **£28·00**. Post 60p.
**1,000 VOLTS**, 1,000 megohms **£34·00**. Post 60p.

**VAT**

All prices are subject to **8% VAT.** (8p in the £)

To all orders add 8% VAT to total value of goods including carriage/packaging.

## INSULATED TERMINALS



Available in black, red, white, yellow, blue and green. New **12p** each incl. P & P. Minimum order 6.

## RELAYS

SIEMENS PLESSEY, etc. MINIATURE RELAYS

| 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|
| 58 | 5-9 | 6 c/o | 80p | 700 | 20-30 | 6 c/o | 80p |
| 150 | 4-9 | 2 c/o | 70p* | 2500 | 36-45 | 6 M | 60p* |
| 185 | 8-12 | 6 M | 60p* | 2400 | 30-48 | 4 c/o | 60p |
| 308 | 9-14 | 4 c/o | 75p* | 2500 | 31-43 | 2 c/o HD | 60p* |
| 700 | 16-24 | 4M2B | 60p* | 9000 | 40-70 | 2 c/o | 60p* |
| 700 | 16-24 | 4 c/o | 80p* | 15k | 85-110 | 6 M | 60p |

(1) Coil ohms; (2) Working d.c. volts; (3) Contacts; (4) Price HD=Heavy Duty. All Post Paid. (*Including Base)

**6 VOLT D.C.** 1 make con. **35p**. Post 5p.

**9 VOLT D.C. RELAY**
3 c/o 5 amp contacts. 70 ohm coil **75p**. Post 5p.

**12 VOLT D.C. RELAY**
3 c/o 5 amp contacts 120 ohm coil **75p**. Post 5p.

**24 VOLT D.C.** 3 c/o 600 ohm coil **75p**. Post 5p.
2 HD c/o 700 ohm coil **75p**. Post 5p.
4 c/o 300 ohm coil **85p**. Post 5p.

**100 VOLT A.C.**
2 c/o sealed type, octal base **£1·00**. Post 10p.

**24 VOLT A.C.**
Mfg. by ITT. 2 h.d. c/o contacts. **55p**. Post 5p.

**240 VOLT A.C. RELAY ITT**
240V. A.C. heavy duty c/o contacts. Octal plug in base. Price **75p**. Post 5p.

**DIAMOND H, Heavy Duty Relay**
230/240V A.C. 2 c/o contacts 25 amp RES at 250v A.C. Price **£2·00**. Post 10p.

**HEAVY DUTY SEALED RELAY**
110 Volt 2 c/o 20 amp contacts. **£1·25**. Post 10p.

**220/240 VOLT AC RELAY**
3 c/o 5 amp cont. Sealed. incl 11-pin base. **£1.25**. Post 10p.

**CLARE-ELLIOT Type RP 7641 G8**
Miniature relay. 675 ohm coil. 24 volt D.C. 2 c/o. **70p**. Post Paid.

## DRY REED RELAYS

M.f.g. by ERG 12 volt D.C. encapsulated.
Single c/o **65p**. Post Paid. Two c/o **85p**. Post Paid.
**STC** 280 ohm coil 6/12 V D.C. 3 make contacts metal shrouded **60p**. Post Paid. Large range of other types available.

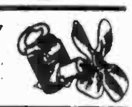
## BLOWER UNIT

200-240 Volt A.C. **BLOWER UNIT** Precision German built. Dynamically balanced, quiet, continuously rated, reversible motor. Consumption 60mA. Size 120mm. dia. x 60mm. deep. Price **£3·00**. Post 30p.

## PRECISION CENTRIFUGAL BLOWER

Mfg. Airflow Developments Ltd., Heavy Duty, continuously rated, smooth running, 230/240v A.C. motor. Size: 16 X 14 cm. (case only), OAL 15 cm. Aperture 6 X 6 cm. **£6.50**. Post 50p.

## 230V FAN ASSEMBLY



Continuously rated, special sealed bearing, removable aluminium blades. Price **£1·00**. Post 20p.

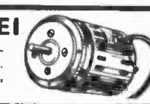
## 240 V A.C. SOLENOID OPERATED FLUID VALVE

Rated 1 p.s.i. will handle up to 7 p.s.i. Forged brass body, stainless steel core and spring. ⅛ in. b.s.p. inlet/outlet. Precision made. British mfg. PRICE: **£1·75**. Post 25p. Special quotation for quantity. NEW in original packing.

## FOOT SWITCH

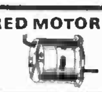
Suitable for Motors, Drills, etc., etc. 5 amp. 250 Volt. Price **75p**. Post 15p.

## A.C. MOTOR M.fg. AEI



Smooth running, powerful, continuously rated, reversible motor. 230/250V. A.C., 50 cycle 1/50th H.P., 0·25 amp. 900 r.p.m. **£3·50**. Post 30p.

## 230/240V SYNCHRONOUS GEARED MOTOR



Manufactured by either Sangamo, Haydon or Smith. Built-in gearbox. 2 RPH, 3 RPH, 6 RPH, 12 RPH. Price **90p**. Post 10p.

## PARVALUX TYPE SD2. 200/250 VOLT A.C. D.C. HIGH SPEED MOTOR

Speed 9,000 r.p.m. approx. or 3,200 r.p.m. if used with built-in governor, or variable speed over a wide range if used in conjunction with our Dimmer Switch. illustrated below. PRICE: **£2·00**. Post 35p.

## 600 WATT DIMMER SWITCH

Easily fitted. Fully guaranteed by makers. Will control up to 600 watts of all lighting except fluorescent at mains voltage. Complete with simple instructions. **£2·75**. Post 25p.

## METERS NEW! 2¼in. FLUSH ROUND

available as D.C. Amps 1, 5, 10, 15, 20 or A.C. Amps 1, 5, 10, 15, 20. Both types **£2·00**. Post 15p.
**VOLTMETER** 0-300V. A.C. **£2·00**. Post 15p.

*ALL MAIL ORDERS, ALSO CALLERS AT:*
57 BRIDGMAN ROAD, CHISWICK, LONDON, W4 5BB. Phone: 01-995 1560
*Closed Saturdays.*

**SERVICE TRADING CO.**
SHOWROOMS NOW OPEN
AMPLE PARKING

*PERSONAL CALLERS ONLY*
9 LITTLE NEWPORT STREET, LONDON, WC2H 7JJ.
*Tel.: 01-437 0576*

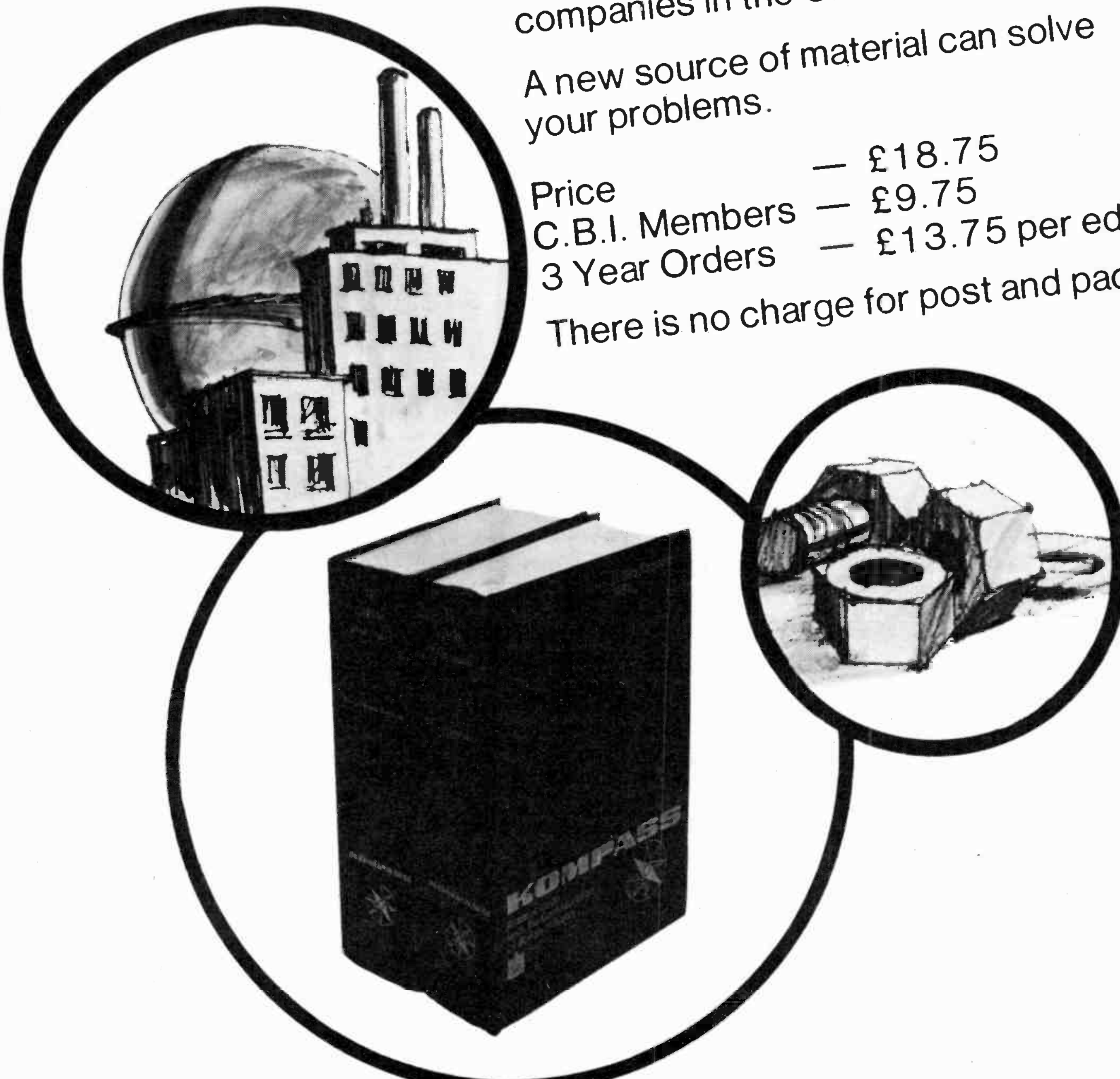
# WHO SUPPLIES

U.K. Kompass lists 33,000 products and services from 28,000 of the leading companies in the United Kingdom.

A new source of material can solve your problems.

Price — £18.75
C.B.I. Members — £9.75
3 Year Orders — £13.75 per edition

There is no charge for post and packing




**Order your copy now.**

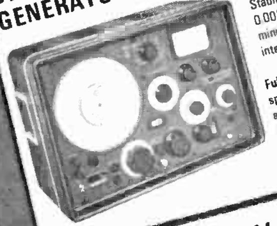
## KOMPASS PUBLISHERS LTD

**R.A.C. House, Lansdowne Road, Croydon CR9 2HE.**
**Tel: 01-686 2262**

## FABULOUS Marconi

**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**

**£245**

## ADVANCE T.V. DOT AND CROSS HATCH GENERATOR SG73

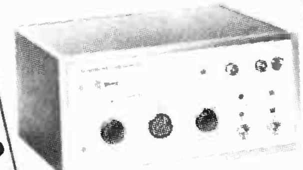
Output in form of modulated signal at VHF and UHF at level suitable for aerial sockets of receiver.
Two Ranges
Band III-on fundamental (MOD)
Band IV & V On Harmonics (—MOD)
Modulation 405 Lines or 625 Lines

**£49·50 EX-DEMONSTRATION BRAND NEW**

**ADD 8% VAT TO ALL PRICES**

## ADVANCE SQUARE WAVE GENERATOR SG21

**Frequency Range 9Kc/s to 100Mc/s, Rise time less than 1nS Ex-Demonstration. New condition in manufacturer's original carton.**

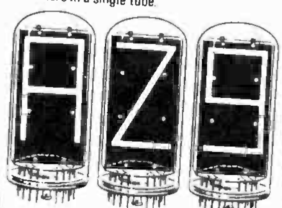


9Kc/s to 100Mc/s continuously variable.
Accuracy ±4%, +1% F.S.
MAIN OUTPUT 20mV–1V into 50 ohm external termination continuously variable.
Accuracy ±5%.
Maximum output on open circuit 2V.
RISE TIME less than 1nS up to 500mV.
TRIGGER OUTPUT
0.2, 0.4, 1.0, 2.0V into 50 ohm external termination maximum output on open circuit 4V.
Rise time nominally 1.5nS.
Fall time nominally 3.5nS.
Size: 11inW, 5½inH, 9inD.
Wt. 7.1 lb.
**LAST LISTED PRICE £95**

**OUR PRICE £45. P/P £1·50.**
**Also available SG21A 100Kc/s–30Mc/s.**

## ALPHANUMERIC NIXIE TUBES B7971

The Alphanumeric NIXIE tube has the ability to display all the letters of the alphabet, numerals 0 thru 9 and special characters in a single tube.

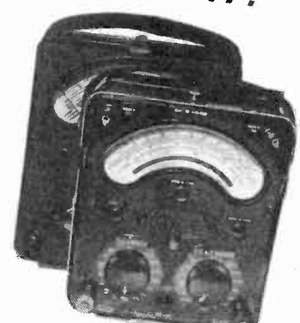


From the standpoint of both readability and electrical characteristics, the Alphanumeric NIXIE tube provides many unique benefits including
★ All DC operation ★ Uniform, continuous line characters of equal height
★ Memory with simple solid state drive circuits ★ Readability in high ambient light . . . 200 footlamberts brightness
★ Long life with no loss of brightness
★ Character height 2½ins.

**Price only 99p each plus 16p**

**JUST ARRIVED NIXIE TUBES NUMERIC ONLY. PHONE FOR DETAILS LARGE QUANTITIES**

## HERE! NOW! FOR IMMEDIATE DELIVERY!



**AVO's 7 & No. 1 (Similar to No. 9)**
**Fully tested and checked, guaranteed 12 months with one free calibration.**
**AVO MODEL**
**7X, £26.00**
**8X, £33.00**
Test Set No. 1 panclimatic Avo similar to specifications of model 9. **£37.00**
**Leads and batteries extra.**
**Leather cases for above £3·50.**
**Ever-ready case enables the meter to be used while in its case £5.**
***Please note: X stands for fully tropicalised, splash-proof and mu-metal shield.**

## Computers & Accessories

### MEMORY DRUMS— *SAVE OVER 50% ON ORIGINAL COST*

Sperry Floating Head J101 Memory System
* 256 Data Tracks
* 1000 bits/inch
* 8 Megabits
* Speed 3000 rpm
* Access time 10 millisec.
* Data transfer rate 1.65 megabits/sec.
* Recording bit density 1050 bpi
* Complete with electronics for interfacing to DEC PDP8

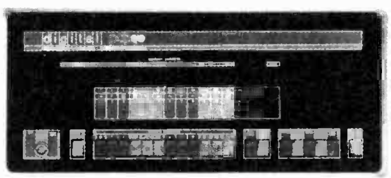
Vermont 1004 Memory Drum
* 128 Data Tracks
* 650 bits/inch
* 4.4 Megabits
* Speed 3000 rpm

**RING NOW FOR LATEST ON BRAND NEW DRUMS OR EX-DEMONSTRATION MODELS**

**WIDE RANGE OF SPARES FOR THE FOLLOWING COMPUTERS ICI 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.

### Little used DEC PDP8 systems available for immediate delivery at special prices as a result of cancelled project



PDP8E 12K Processor complete with
Facit 4001 High Speed Reader (500 cps)
Data Dynamics BRPE 114 Punch (110 cps)
ASR33 Teletype
Sperry J101 8 megabit Memory Drum
Line Printer
Rack-mounted in double cabinet

PDP8E 4K Processor complete with
Facit 4001 High Speed Reader (500 cps)
Data Dynamics BRPE 114 Punch (110 cps)
ASR33 Teletype
Complete in cabinet

***A PHONE CALL CAN SAVE YOU A BOMB! RING NOW FOR PRICE!***

### SUBSTANTIAL SAVINGS FROM LIST PRICE OF THIS DEC MINI COMPUTER

PDP8I 8K Processor
Facit High Speed Reader
ASR33 Teletype

**£1,950**

### 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 $\frac{11}{16}$", $\frac{7}{8}$" tape. Synchronous, parallel-wire input. **£145**

### WELMEC 7 & 8 HOLE ELECTRO-MECHANICAL PUNCHES & READER

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 Transporters AMPEX TM4, TM2, TM7, FR300, IBM 7330, POTTER. From **£89.00.**

### TAPE READERS

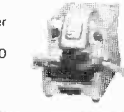


Photo-electric Readers for all colour paper tapes up to 1 in.
ICL Type 2640 (250 cps), Elliott T2/94 (250 cps), Elliott D4/42 (500–1,000 cps).
Available with full warranty.
Prices from **£220.**

### HEWLETT PACKARD DIGITAL RECORDER MODEL 565A

Data Entry, parallel to 11 columns. Print speed 5 lines per second. **PRICE £85·00.**

### OSCILLOSCOPE CT 436

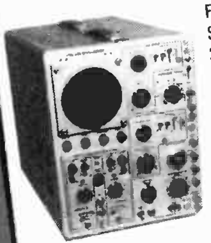
**Commercial Designation Solarton CD1014.**

General Purpose Dual Beam DC-6MHz flat faced double gun cathode ray tube operating at 1.6kV. The time base velocity is continuously variable between 1cm/usec, and 1cm/sec.
TIME BASE Free running or triggered from positive or negative pulses. Sweep speed 1cm/usec to 1cm/sec.
Synchronisation: positive or negative going internal from either channel or external continuous waves.
Internal 3mm P/P.
External 100mVP/P.
Sensitivity 100mV/cm, maximum on Y2 amplifier 1mV/cm.
Size 9½" X 11½" X 15". Wt. 25 lb.
PRICE: **£69·50.**

# BONANZA!

LIMITED QUANTITY

## TEKTRONIX WIDE-RANGE OSCILLOSCOPES



THE WORLD FAMOUS 545 Series DC to 30MHz range. Can be used to operate with Tektronix letter series plug-in unit for virtually any application.

Fantastic value at **£175** (Main Frame only)

Tektronix 545 complete with CA Double Beam Time Base **£235**

Also available:
TEKTRONIX 545A with CA plug-in **£255**
TEKTRONIX 535 with CA plug-in **£175**

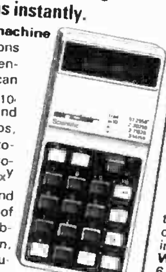
ALSO 545B £295 limited quantity

## INCREDIBLE SOLARTRON OFFERS!


Digital Voltmeters Type LM1420 **£195**
Type 1420.2 **£235**
Type 1420.2BC (Remote Ranging) **£325**
Type 1420.2BM (DC + Wide Band Mean AC Sensing DVM) **£395**
Wide Range of spares for Solartron Data Loggers Compact 1 and Series 2.

## SPECIAL OFFER

**The Sinclair Scientific. Logs, trig and arithmetic. All at the touch of a button. At last there's a pocket calculator which gives you log and trig functions instantly.**



**Full 12-function machine**
With the functions available on the scientific keyboard, you can handle directly $\log_{10}$, $\text{antilog}_{10}$, sin and arcsin, cos and arccos, tan and arctan, automatic squaring, automatic doubling, $x^y$ (including square and other roots), plus, of course, addition, subtraction, multiplication, division and any calculations based on them.
**7-digit scientific notation, 200-decade range. Reverse Polish logic and 25-hour battery life.**
**Send for further information. £45**

## NEW "Strobette" STROBOSCOPE–TACHOMETER

What is "Strobette"? "Strobette" is a complete combined Stroboscope–Tachometer available at a remarkable price. It's a stroboscope because it is capable of optically stopping, or slowing, any moving object while the object is in motion. And it's a tachometer since it can measure the speed, or rate of motion, of a rotating or moving object. "Strobette" is a tool, analyser, measuring device, fault detector for engineers, technicians, inspectors, teachers.
**WIDE RANGE:** Stroboscope—200 to 6,000 flashes per minute. Tachometer—200 to 6,000 RPM. **ACCURACY:** 3% or better. **CIRCUITRY:** 100% solid state. **BEAM ANGLE:** 80°. **CALIBRATION:** At 3,600 FPM against any known synchronous speed—7200, 3600, 1800, etc. **FLASH DURATION:** Approximately 10 to 25 microseconds. **LIGHT COLOUR:** Xenon white 500°K. **COMPACT, LIGHTWEIGHT:** Can be carried in tool box, weighs only 27 oz. **EASY TO USE:** One on-off switch and one dial.

**ONLY £49.50**

## Power Supplies

### Portable Power Supply

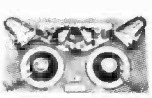
+ 7 Volts — 0–7 Volts at 1.5 Amps. Solid State Stabilised, four outputs. High limit + or — 10 Volt at 1 Amp. Low limit + or — 5.6 Volt at 2 Amp. Incredible Savings. Cost over £25 to produce.

**PRICE: £12·50**

## 7-TRACK DIGITAL MAGNETIC TAPE STORAGE DECK

These machines, originally ex-computer, are multi-track recording units, ideal for data storage. Record and Replay Heads encased in one common unit. Low resistance heads. Frequency response approximately 0 Kc/s to 50 Kc/s. Bit density 557 b.p.i. ½ in. 10½ in. spools. 230 V to 380V. Capstan motor speed 1,500 r.p.m. 48 V DC rewind motors complete with vacuum assembly. Finished in brush aluminium and matt black. Size 27 in. × 26 in. × 8 in. Weight 90 lbs. **NEW LOW PRICE £55.**

## RCA 301 TAPE DECK MODEL 381



**PRICE £25**

*Technical Data.* ½" wide Magnetic Tape. Power supplies: Input 208-230V AC 60 c/s. Single phase Magnetic recording head, read/write and erase. Seven channels each head. Speed 30"/sec. forward or reverse. 90"/sec. during rewind. The recording density of 333 characters per inch is maintained, thus giving the nominal read and write rate of 10,000 characters per second. Maximum diameter of 8" tape reel. Accommodates 1200ft. of Magnetic Tape, which gives a minimum of 1,150ft. available for recording.

## 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. | £2·00 |
| 500 | 0.1 | Beckman | S. | £2·50 |
| 500 | 1·0 | Relcon | HEL107-10 | £2·25 |
| 1K | | Relcon | HEL0710 | £2·25 |
| 2K | 0·5 | Beckman | SA1101 | £3·00 |
| 2K | 0·25 | Beckman | 7216 | £3·00 |
| 2K | | Reliance | GPM15 | £2·00 |
| 2K | | General Controls | GPA15/4 | £2·00 |
| 5K | | Relcon | 07–10 | £2·50 |
| 5K | | Colvern | CLR2503 | £3·00 |
| 10K | 0·1 | Beckman X | A. | £3·50 |
| 15K | | Colvern | CLR2402 | £3·00 |
| 25K | 0·5 | Helipot | SAJ337 | £3·00 |
| 29K | 0·05 | Beckman | SA1244 | £4·50 |
| 30K | 0·1 | Beckman | A.88 | £3·50 |
| 30K | 0·5 | Beckman | SA1692 | £3·00 |
| 50K | | Reliance | 07·10 | £2·25 |
| 50K | | | 07·5 | £2·25 |
| 50K | 0·5 | Beckman | A. | £3·00 |
| 100K | 0·1 | Beckman | A. | £3·50 |
| 100K | | Colvern | 2501 | £2·25 |
| 298K | 0·1 | Beckman | 8A3902 | £3·50 |
| 300K | 0·1 | Beckman | A. | £3·50 |

### THREE TURN 780° ROTATION

| Res Ohms | Linearity Per cent | Manufacturers | Model | Price |
|---|---|---|---|---|
| 25Ω | | 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. | £3·00 |
| 50K | 0·5 | Beckman | C.S. | £1·75 |

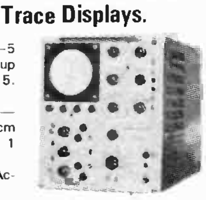
### FIFTEEN TURN 5400° ROTATION

| Res Ohms | Linearity Per cent | Manufacturers | Model | Price |
|---|---|---|---|---|
| 25K/25K | | Beckman B | 10 watts | £6·50 |
| 46K/46K | | Beckman B | 10 watts | £6·50 |

## 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.**

## Solartron C.T. 484 oscilloscope. DC–40 MHz. 3% accuracy. Dual Trace Displays.



**TIME BASE.** 100 nanosecs/cm—5 secs/cm or continuously variable up to 12 secs/cm. Sweep expansion x 5. Accuracy: ± 3%.
**X AMPLIFIER.** Bandwidth: D.C.—150 Kc/s. Sensitivity: 200 mV/cm and 1 V/cm. Input Impedance: 1 M.ohm 40 pF.
**INTERNAL CALIBRATOR.** Accuracy: ± 3%.
**DUAL TRACE Y AMPLIFIER.** Bandwidth: D.C.—24 Mc/s. Rise Time: 14 nanosecs. Sensitivity: 50 mV/cm. Input Impedance: 1 M.ohm 26pF. Measuring Accuracy: ± 5% direct. ± 3% with calibrator.
**WIDE BAND Y AMPLIFIER PLUG ALSO AVAILABLE.** Bandwidth: D.C.—40 Mc/s. Rise Time: 8 nanosecs. Sensitivity: 50 mV/cm—50V/cm. Input Impedance: 1 m.ohm 22pF. Measuring Accuracy: ± 5% direct. ± 3% with calibrator. P.O.A.

**£149.50**

## MINITRON

K.G.M. Type 3015F 7 Segment display showing figures 0–9 plus decimal point. Character pf 9mm height. In 16 DIL case.
**NEW LOW PRICE £1·25**
SN7447N BCD Decoder Driver **£1·00.**

## AC CLAMP VOLTAMMETER

Clamp-on Voltammeter is used for measurements of AC voltages and currents without breaking circuits.
**Specification**
Measurement ranges:—Current 10–25–100–250–500 Amps. Voltage 300, 600 V. Accuracy 4%. Scale length 60mm. Overall dimensions 283×94×36mm. Weight 1.5 lbs.

**£10·50**

## Stop Press

**VERY LATEST TEKTRONIX** 100MHz Dual Trace Oscilloscope 465.
Listed at over £1000. **Our Price £775.**
**TEKTRONIX 453A** Listed at over £1300.
**Special Offer this month £795.**

**Carriage and packing charge extra on all items unless otherwise stated.**

**Please note: all instruments offered are second-hand and tested and guaranteed 12 months unless otherwise stated.**

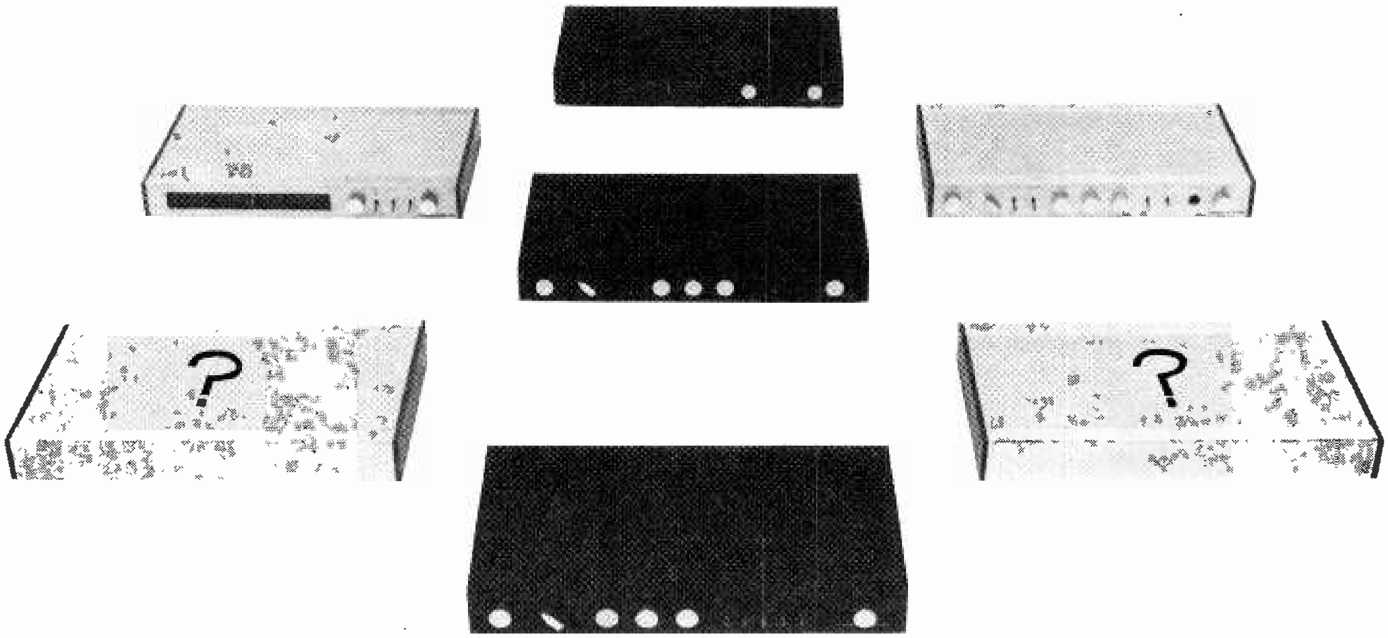
**ADD 8% VAT TO ALL PRICES**

# ELECTRONIC BROKERS LIMITED

**49–53 Pancras Road, London NW1 2QB. Telephone 01-837 7781**

**PROMPT DESPATCH MAIL ORDER. CALLERS WELCOME MON–FRI 9 A.M. to 5.30 P.M.**

# Cambridge Audio need more of the best people to build more of the best audio products




In the past eighteen months we've introduced many new products. Firstly, an advanced stereo tuner employing new techniques and the latest integrated circuits. Next was a mark two version of the well reviewed and widely acclaimed P50 amplifier. For higher power requirements we built the P110 amplifier currently regarded by many as the finest British amplifier available at any price. On the export side the T75x, P70x and P140x have proved remarkably successful and have already established the Cambridge. name for outstanding performance, quality and good looks in many new overseas markets. This April we showed the all-new Cambridge Audio P60 Stereo Amplifier. This unit incorporates many features not found on any amplifier built anywhere in the world. Audio enthusiasts and music lovers alike appreciated all the new features that we had engineered and we are certain this amplifier will soon become our most popular product, possibly even a world classic. And there's a lot more to come from Cambridge Audio – new products, new ideas. But to speed our programme we need more really good people – you perhaps.

**Vacancies exist for technically capable personnel in many areas of the company. Applicants should be audio enthusiasts above all else and as highly qualified as possible. Work may be based in London or St. Ives. Apply to the Chief Engineer, Cambridge Audio at the address below giving full personal particulars.**

Cambridge Audio

for people who listen to music

Cambridge Audio Limited
The River Mill
St. Ives
Huntingdon PE17 4EP
Telephone St. Ives 62901

I don't need a job but I would like details of your products please.
Name.
Address

WW84

# APPOINTMENTS VACANT

**DISPLAYED APPOINTMENTS VACANT:** £4.68 per single col. centimetre (min. 3cm).
**LINE advertisements (run-on):** 66p per line (approx. 7 words), minimum two lines.
**BOX NUMBERS:** 30p extra. (Replies should be addressed to the Box number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London, S.E.1.)
**PHONE: Allan Petters on 01-261 8508 or 01-261 8423.**
*Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.*

**Advertisements accepted up to 12 noon Tuesday, August 20th for the September issue subject to space being available.**

# Opportunities in Electronics

## Train to be an Electronics Technician

If you are 16-20 years old and would like a career in Electronics, our special 3 year training scheme provides the opportunity you are looking for.

We are offering you the opportunity to become an Electronics Technician in a fast expanding industry with an ever increasing demand for those with the ability to understand the practical workings of complex electronic equipment.

Our scheme includes well paid employment whilst training and day release to attend college to study for the City and Guilds Electronics Technician Certificate.

In addition to a practical interest in electronics you will require 'O' levels or CSE Grades in Maths, Physics and English.

Telephone, or write to the Training Officer,
G & E Bradley Ltd.,
Electral House,
Neasden Lane, N.W.10.
01-450 7811.

**BRADLEY electronics**
**A LUCAS COMPANY** 3970

# Senior audio visual technician

Kodak Limited has a vacancy for a Senior Audio Visual Technician in the presentation section of the A/V Production Unit which is based at Ruislip.

He will be primarily responsible for the assessment and organisation of equipment servicing, and participate in testing, servicing and developing special items. He will be involved in the design of A/V presentation areas and the judgment of presentation standards both technically and aesthetically.

Aged between 25 and 40, he must have a sound practical knowledge of relevant electronics and mechanics and have experience of workshop practice and organisation. He must have the ability to work on his own initiative with imagination. A background knowledge of photography and sound reproduction would be an advantage. A current driving licence is essential as the job entails occasional travel within the U.K., sometimes at short notice. In return we offer a good starting salary and excellent employee benefits.

Please write giving details of experience and salary to:

**Personnel Manager, Kodak Limited, Victoria Road, Ruislip, Middlesex, HA4 0QJ.**

Kodak

(3941

# ELECTRONIC VACANCIES

Engineers
Draughtsmen ● 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**
(95

# 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 Radiocommunications, 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 £1,567 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 £2,054, rising to a maximum of £2,622 at age 25 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 (L526), MRSD/ET17, Room 643, Armour House, St. Martin's-le-Grand, London EC1A 1AR.

**Post Office Telecommunications**

193

# Communications Instructors and Supervisors

## Saudi Arabia (Jeddah)

Saudi Arabian Airlines, a member of IATA, is a fast expanding corporation and now requires the following men:

## INSTRUCTORS

### Telephone

to train Saudi students in theoretical and practical maintenance of telephone exchanges, equipment and circuitry. Other duties will include on-the-job training, planning courses, instructing pupils from initial to final stages, assisting the Communications Maintenance Department in their overall activities, particularly in the area of circuit and system planning and budgeting for future training needs in conjunction with other Course Instructors.
Applicants should have at least 5 years' experience in the practice and instruction of telephone technical communications.

### Teleprinter

to train Saudi students in theoretical and practical maintenance of teleprinter equipment and circuitry. Other duties, qualifications and experience will be as above, but in the field of teleprinters. In addition, applicants will be required to set up procedures for routine maintenance, also major check procedures and to set acceptable standards of criteria for equipment used.

### Radio

To train local students in the practical and theoretical maintenance of radio equipment. He will teach basic electronics, physics, chemistry and the repair of KHV, VHF, single side band, public address systems, etc.
Applicants should have a good standard of education at least 5 years' experience in the practice and instruction of radio technical telecommunications.

## SUPERVISORS

### Technical Services

To supervise the installation, maintenance and repair of Saudia radio trans-ceiving, video and public address systems and associated equipment and circuitry. He will also assist the Staff Manager in the planning, engineering and cost estimating of new equipment and prepare provisioning recommendations for spares, etc.
Applicants should have certified training and 4–6 years' shop experience in the maintenance and overhaul of a wide variety of electronic communications equipment (i.e: HF, VHF, UHF).

### Teleprinter

To supervise the installation, maintenance and repair of Saudia teleprinter equipment and associated circuitry. He will also assist the Staff Manager in the planning, engineering and cost estimating of new facilities and prepare provisioning recommendations for spares, etc. He will conduct on-the-job training of Saudi nationals.
Applicants should have certified training and 4–6 years' experience in the shop repair and overhaul of a wide variety of teleprinter equipment.

Commencing Salaries will be £5,622 per annum and benefits include free and reduced rate air travel, and relocation expenses.

Please apply with full personal and career details to Mr. A. Dannenberg, Manager of Employment, Saudi Arabian Airlines, c/o TWA Inc., 101 Champs-Elysées, 75008, Paris, France.

**saudia**
SAUDI ARABIAN AIRLINES

13930

# NEW HEBRIDES

## SENIOR RADIO TECHNICIAN

Required by the Condominium Radio Department to maintain transmitting and receiving equipment for postal, inter-island and domestic services, local and overseas shipping, aircraft, and broadcasting studios—housed in the Radio Station and at our stations.

Candidates must have HNC plus at least five years experience of maintaining telecommunications equipment including side band telephone/teleprinter circuits and telex equipment. Candidates with ONC or City and Guilds with appropriate experience may also be considered. The ability to speak and read French is desirable but not essential. Initial tour 3 yrs. Some touring involved. **Salary in the Scale £3,269 to £4,024 p.a. Gratuity 20% total salary drawn. There is no local income tax in New Hebrides at present.**

Other Benefits include: Free return air passages, subsidised housing, generous leave on full pay, free medical attention, education allowances and holiday visit passages.

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/730852/WF.**

[3932

# RADIO AND TELEVISION ENGINEERING

## SOUTH AFRICA

A major television manufacturer is extending its activity in South Africa to take advantage of the introduction of colour television due to occur next year, and wishes to strengthen its team by the addition of:—

## CHIEF TEST EQUIPMENT ENGINEER (TELEVISION)

who will head up a small department developing and maintaining test equipment for colour TV production. Salary c. £5,000.

## DEVELOPMENT ENGINEER (RADIO)

responsible to the Chief Engineer, but able to work on his own initiative, on radio development work. Salary c. £4,000.

Qualifications, although desirable, are not essential, the requirement being for practical engineers with both the ability and experience to make a genuine contribution to the engineering team.

Write in the first instance, giving full details of experience and background to:

**Box number: WW 3937**

# *Field service Engineers*

Ansamatic Ltd require men with an electronics background and experience of bench or field service.

Vacancies exist in Leeds and several S.E. England territories.

We offer a satisfying career with your own personal company vehicle and responsibility for your area.

Commencing salaries are up to £2,250 depending upon qualifications and experience and for ambitious men, there are prospects of fast promotion to supervisory grades.

To find out more contact:
J. N. Ground
Ansamatic Ltd
Viatron House
928 High Road
London N12 9SL
Tel: 01-446 2451

**ANSAMATIC**
*telephone answering systems*

3974

**IRELAND**

# TECHNICAL OFFICERS

## (VHF Radio/Radar)

required in the Radio Service of the Department of Transport and Power.

**Salary: £1,945-£3,035. Entry up to £2,484** possible. Non-contributory pension. Widows and Orphans pension scheme.

**Maximum age-limit:** 50 years

**Essential:**

(a) Technician Engineering Diploma Course in Telecommunications and Electronics of Kevin Street College of Technology, or equivalent,

or

(b) City and Guilds Course 271 (formerly 300). Advanced Studies in Telecommunications and Electronics, or equivalent,

or

(c) Maintenance experience in one or more of: Radio Communications, Radio Navigational Aids, Radar Digital Equipment.

All candidates will be expected to display a sound theoretical and practical knowledge of electronics.

Candidates other than those eligible under (c) above, must have adequate practical experience in the maintenance of electronic equipment.

It is intended to make at least 10 appointments from this competition.

**CLOSING DATE: 5th SEPTEMBER 1974**

For application forms and more details write to the Secretary (1/B), Civil Service Commission, 45 Upper O'Connell Street, Dublin 1, Ireland.

[3939

# Electronic Development Engineers

## E. London £2,000-£3,000

The Submarine Systems Division of STC is the world's largest supplier of submarine cable systems. We are also the technological leaders of this field and our business is growing rapidly.

Repeaters are placed every few miles in a submarine cable system to boost the signals. Once laid they must work continuously for at least 25 years without maintenance. To achieve this reliability they must be designed and manufactured to the highest standards.

We are now developing a new generation of cable systems capable of handling television signals and telecommunications traffic. For this we require **experienced engineers** to develop wideband (analogue) amplifiers, filter networks and supervisory circuits, to specify and design special testing methods and apparatus, and for performance planning.

Opportunities exist for them to assist in the overseas commissioning and laying of new systems.

We are looking for graduate or similarly qualified electronic engineers with at least two years experience in the design and development of advanced analogue circuits or similar equipment.

Starting salaries will be between £2,000 and £3,000, depending on qualifications and experience, and the Company offers good fringe benefits.

For an information pack on the work of our Submarine Systems Division, conditions of service, and an application form, please phone David Stenhouse on 01-476 1401, or write to him at:
*Standard Telephones and Cables Limited, (WW 15/8) Henley Rd., N. Woolwich, London E16.*

**Standard Telephones and Cables Limited**
A British Company of ITT

3968

---

# BBC

## Equipment Department

have vacancies for Senior Laboratory Technicians to work on the test and commissioning of newly manufactured equipment and systems to BBC design. The equipment employs both digital and analogue techniques over the frequency range d.c. to 1000 MHz. Applicants should preferably be qualified to HNC or C & G. Full Technological Certificate level in appropriate subjects.

Starting salary will be in the range £2,040 to £2,250 and rise by annual increments of £105 to £2565, plus cost of living Threshold Payments currently £104 p.a.

Suitably qualified Senior Technicians progress to Engineering Technician whose salary maximum is £2,940. The posts are pensionable, based at Chiswick, within easy reach by tube (Gunnersbury or Acton Town Station) and road (M4, North and South Circular).

For Application Forms please write to the Engineering Recruitment Officer, British Broadcasting Corporation, Broadcasting House, London W1A 1AA quoting reference 74.E.4056/WW. Closing date for completed application forms 14 days after publication.

[3976

---

UNIVERSITY OF SOUTHAMPTON

# Electronics Technician

required by Physics Department to assist in a programme of balloon borne X and gamma ray astronomy. The work involves development of electronic systems for long duration flights at very high altitudes.

The appointment requires a versatile man able to take responsibility for the operation of equipment on field trials and prepared to undertake a limited amount of foreign travel. Candidates should have broad experience with the construction or maintenance of radio communication systems or be able to show a high standard of up-to-date constructional ability. HNC or equivalent qualification desirable, but considerable relevant experience with a minimum qualification at ONC would be considered.

The appointment, which is initially for two years, will be made at Grade 5 (non-established) on the salary scale £2,007—£2,382 per annum.

Applications, giving details of age, qualifications and experience and the names of two referees should be sent by **30 August 1974** to the Deputy Secretary's Section, The University, Southampton SO9 5NH, quoting reference WW 264/T.

[3964

---

# DATEK SYSTEMS LIMITED

The company has vacancies at Senior, Junior and Trainee levels in its Test Department to work on small digital systems used in phototypesetting. The man for the senior position will probably be HNC or degree level, but more importantly will have at least 5 years experience in electronics with emphasis on digital systems. Potential leadership ability in the test environment would be valuable. The Junior and Trainee will ideally be capable of achieving O.N.C. level but above all must have an active interest in electronics.

**Telephone:**
**Mr. PIYASENA**
**01-904 0061**

[3961

# Making a career in Electronics is a fine time to think about Graphic Art

Mention Crosfield Electronics to anyone in the graphic arts or printing industry and you're liable to hear some pretty interesting stories. Like the one about our electronic scanners in colour reproduction, our industrial cameras/enlargers, our computers, electro mechanical systems, and the fact that our Magnascan was the first digital enlarging colour scanner to be marketed in the world.

And that's just a beginning.

If you'd like to join the electronic leaders in the graphic arts and printing field, are interested in the potential of perhaps living and working abroad, see if one of these positions fits your ambitions.

## Installation Service Engineers

For experienced electronic engineers capable of applying their experience to a wide range of industrial applications, there are quite a few interesting positions open.

There's the chance to travel abroad extensively providing a complete installation and back-up service for complex colour scanner/separators in trade houses. Young men at least 22 years old with experience in computers, radar/fixed/variable pulse techniques will also be considered.

## Test Engineers

Practical electronic engineers with experience on systems testing and finite equipment will be interested in these positions. A minimum of HNC electrical engineering and practical interest in constantly changing technology is essential. A knowledge of analogue and digital techniques is desirable.

These positions would suit engineers between 22 and 35 years old with at least 3–5 years industrial experience.

## Technicians

Successful technicians with ONC or equivalent qualifications will get a tremendous amount of experience at the bench testing electronic sub assemblies, and repairing, modifying and testing relevant design specifications. Excellent opportunities for College or University graduates, or young technicians with some industrial experience behind them.

Salaries will be according to qualifications and experience, and we offer excellent company benefits.

**If you're interested in any of these positions phone or write to: J. Phillips, Crosfield Electronics Ltd., 766 Holloway Road, London N.19. Tel: 01-272 7766.**

CROSFIELD ELECTRONICS LIMITED

1967 1972 1973

3963

---

**LBC NEWS**

LBC have vacancies for Audio Maintenance Engineers. Applicants should have experience in the maintenance and testing of broadcast equipment.

The positions will involve shift work. Salaries in accordance with ACTT/ABS agreement.

**LBC,**
**Communications House,**
**Gough Square,**
**London, EC4**

3958

---

**Coláiste na hollscoile Gaillimh**

(University College, Galway)

**Department of Physiology**

# PHYSIOLOGY TECHNICIAN

to maintain physiological apparatus. The post requires some Electronics, Metalwork & Telecommunications. City & Guilds qualification in Physics, Electronics or Telecommunications required or equivalent.

Salary Scale—£1,851—£2,163 (4 x £78)

Applications to Professor of Physiology from whom further particulars may be obtained.

[3951

---

**ANTARCTIC EXPEDITION**

# Wireless Operator Mechanics

required immediately for British stations in Antarctica.

Applicants, preferably single and aged 22-30, should have experience of maintaining and operating SSB transmitters, and receivers. Teleprinter experience desirable.

Salary from £1,688 per annum, all found overseas. Low income tax. Bonus for satisfactory service.

Applications to:

**BRITISH ANTARCTIC SURVEY,**
**30 Gillingham Street,**
**London, SW1V 1HY.**
**Tel: (01) 834 3687.**

[3947

## NORTHAMPTON COLLEGE OF TECHNOLOGY

### Department of Engineering

# LECTURER I

## TELECOMMUNICATIONS

To teach Telecommunication Technician course students, with specialist knowledge in Telephony. Applicants should possess appropriate qualifications and have suitable industrial experience. Applicants will be expected to commence duties on 1st September, 1974, or as soon as possible thereafter.

Salary Scale £1,800—£2,874, according to experience and qualifications.

Forms of application and further particulars may be obtained from the Chief Administrative Officer, Northampton College of Technology, St. George's Avenue, Northampton, NN2 6JB, telephone 34286, to whom completed applications should be returned by the 26 August.

[3971

**THE LONDON HOSPITAL (WHITECHAPEL) LONDON, E1 1BB**

# Electronics Technician

required for the Department, of Medical Physics. Duties will include routine maintenance of electronic equipment, including the SL-75 10 Mev Linear Accelerator, and participation in research and development. Minimum qualification ONC or equivalent. Some experience in electronics essential. Day release for further study will be allowed.

Further information may be obtained from Mr. P. Bennett, Chief Physics Technician, at the above address, tlephone 01-247 5454 ext. 158. Please write or telephone David High, at the above address, telephone 01-247 5454 ext. 388 for application form.

[3973

## LONDON BOROUGH OF HARROW

# TECHNICIAN

**Up to £2,103***

A Technician/Engineer in Television and Sound is required for a post in the Film and Television Department. Duties will include the technical operation and routine maintenance of a C.C.T.V. Studio requiring electronic and mechanical skills and knowledge in the television field. Relevant City and Guilds or H.N.C. Qualifications are desirable and further in service training will be considered.

*Plus threshold payment

Application forms from the Harrow College of Technology and Art, Northwick Park, Watford Road, Harrow, Middlesex, HA2 3TT. Telephone 01-864 4411 Ext. 31.

[3977

# 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-Services 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

mi

MARCONI INSTRUMENTS LTD,
Longacres, St. Albans, Herts
Tel: St. Albans 59292
Luton Airport, Luton, Beds
Tel: Luton 33866

A GEC-Marconi Electronics Company

THE QUEEN'S AWARD TO INDUSTRY 1971

94

eastern electricity

**CHILTERNS GROUP**

# Second Engineer (Telecommunications)

Applications are invited for the position of Second Engineer in the Telecommunications Section of the Group Engineer's Department, based at Bedford, to lead a team of engineers engaged on installation, preventive maintenance and fault location on a wide range of telecommunications apparatus.

Applicants should preferably be qualified to at least HNC standard and must have had experience with VHF, fixed and mobile radio equipment and automatic telephone exchanges. Experience with digital alarm and telemetry systems would be an added advantage.

Salary: £2,775 to £4,000 per annum plus £90 per annum allowance. In accordance with the NJB Threshold Agreement a further £104–£125 is also payable as a supplement to salary.

**Applications in writing should be sent to The Manager, Chilterns Group, Eastern Electricity, Prebend Street, Bedford, so as to be received by 22nd August, 1974.**

13946

# SERVICE ENGINEER EXTRAORDINARY NEEDED

Experience of digital pulse techniques very valuable. Post relates to field service of advanced pulse height analysis systems. Exciting challenge, good prospects and pay.

*Please reply in confidence to:—*

**Managing Director,**
**INTERTECHNIQUE LIMITED**
**Cottrell House**
**53-56 Wembley Hill Road**
**Wembley, HA9 8BE.**

[3948

---

SOUND TECHNIQUES

require a

# TECHNICAL ENGINEER

to look after the day to day running of the equipment at their Chelsea Recording Studio.

The successful applicant will be part of a closely knit professional team and be expected to work without supervision and use his own initiative.

Salary is by negotiation and after a probationary period will include a profit sharing bonus and non-contributory pension scheme.

Applicants, who should preferably be working in a multi-track recording studio environment at present, should send a full resume of their career to date to

**JOHN WOOD**
**SOUND TECHNIQUES LIMITED**
**46A OLD CHURCH STREET**
**LONDON S.W.3.**

All applications will be treated in the strictest confidence.

[3959

---

# TECHNICIAN

with electronics experience, for interesting and varied work connected with children's heart disease. Grading according to experience and qualifications.

Write with details to:

**Consultant-in-Charge,**
**Department of Clinical Physiology,**
**The Hospital for Sick Children,**
**Great Ormond Street,**
**London, W.C.1.**

[3978

---

## MARCONI INSTRUMENTS LIMITED

# ELECTRONIC TECHNICIANS

are required to work on calibration, fault-finding and testing of telecommunications measuring instruments. The work is varied and will enable technicians with experience of r.f. circuits to broaden their knowledge of the latest techniques employed in the electronics and telecommunications industries by bringing them into contact with a wide range of the most advanced measuring instruments embracing all frequencies up to u.h.f.

Entrants may be graded as Test Technicians, Senior Test Technicians or Technician Engineers according to experience and qualifications. Our production and servicing programme, geared to our recognised export achievement, provides employment combined with prospects of advancement, not only within these grades, but into other technical and supervisory posts within the Company at St. Albans and Luton.

Salaries are attractive and conditions excellent. A Pension Scheme includes substantial life assurance cover provided by the Company. Assistance with removal may also be given in appropriate cases. Please write or telephone, quoting reference WW748, for application form to:

Mr. P. Elsip,
Personnel Officer,
Marconi Instruments Ltd,
Longacres, St. Albans, Herts.
Tel: St. Albans 59292

THE QUEEN'S AWARD TO INDUSTRY 1971

Member of GEC-Marconi Electronics

3980

---

## Avery-Hardoll

*Manufacturers of Meter Pumps for Petrol and Fuelling Equipment for Aircraft, require two*

# TECHNICAL SERVICE ENGINEERS

One to be resident in Wiltshire and the other in West Yorkshire. The successful candidates will have reached ONC in electrics or electronics and preferably have had experience in electromechanical servicing.

The duties are concerned with the commissioning, diagnosis of faults, and rectification of electronic equipment associated with liquid flow measuring devices, mainly on readout and control.

Permanent staff position with a Company car, four weeks' holiday after one year of service, contributory pension scheme, etc.

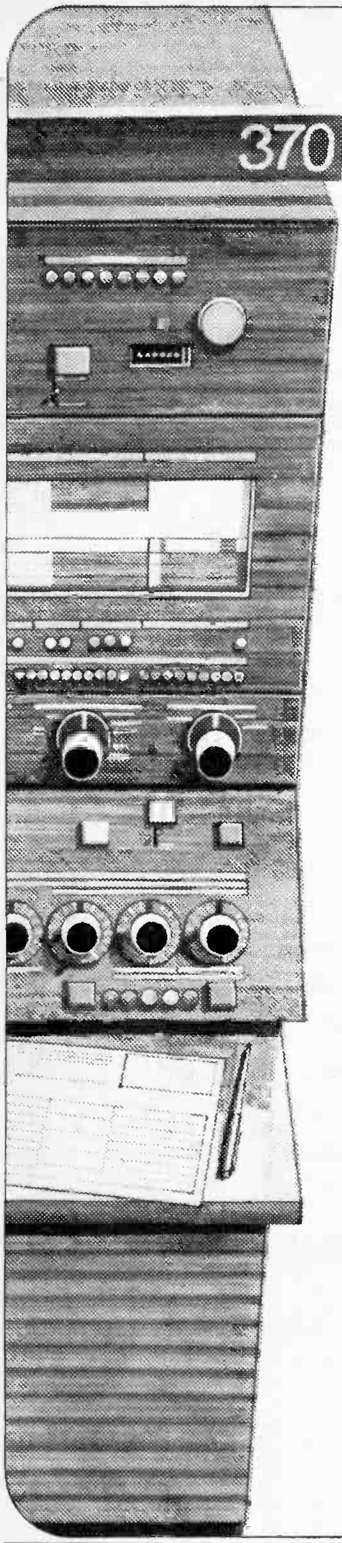
Please apply in writing, giving brief details of experience to date, to:

**Personnel Manager,**
**Avery-Hardoll Ltd.,**
**Downley Road,**
**Havant, Hants.**

AVERY

A member of the Avery Group

3949




## Customer Engineers

# Even computers need a little understanding

Computers may make life more simple, but they're pretty complex themselves, and sometimes they need the understanding of a trained Customer Engineer to sort out their problems.

IBM's expanding sales and the continuous development of new, more sophisticated systems means that we need more Customer Engineers. Men like you who already have a knowledge of electronics and are looking for a place in the front line of computer technology.

We'll give you the sort of training it takes to service and maintain our medium and large-scale systems. An on-going training matched to IBM's evolving range of computer products, to keep your expertise right up to the minute.

In addition to electronics knowledge, to ONC/HNC qualification level (or equivalent), you'll need a logical approach to mechanical problems and the ability to get on well with people at all levels in a wide range of businesses.

In return we'll start you on a good salary, with the best big-company benefits, and the prospects you'd expect from IBM – where promotion is on merit.

Find out more about the opportunities in Computer Servicing with IBM in **the London area** by writing today with brief details of career to date to: Anne Dare, IBM United Kingdom Limited,
389 Chiswick High Road,
London W4 4AL, quoting
ref: WW/92275.

**IBM**

[3926

**UNIVERSITY OF THE WITWARTERSRAND,**

**Johannesburg, South Africa**

**EDUCATIONAL TECHNOLOGY UNIT**

The Unit is building a broadcast colour television complex. The following vacancies exist:

### (a) Head of Television Engineering

Senior Engineers currently involved in colour broadcasting and who hold appropriate qualifications are invited to apply. Experience with all forms of studio equipment and operational procedures is necessary and some proven organized ability could be advantageous.

### (b) Assistant to the Head of Television Engineering

Applications are invited from people who have had several years experience in broadcast colour television. The successful applicant would probably be of assistant engineer or engineer grade in the UK broadcast industry.

Salary for both posts will depend on qualifications and experience.

Interested persons should obtain the information sheet relating to these posts from Miss J. Lloyd, London Representative, University of the Witwatersrand, London Office, Chichester House, 278 High Holborn London WC1, England with whom applications should be lodged not later than 30th August, 1974. An airmail copy should be sent to the Registrar, University of the Witwatersrand, Jan Smuts Avenue, Johannesburg, South Africa.

Interviews will be conducted in mid-September.

[3967

# TECHNICAL DEVELOPMENT MANAGER
## HIGH VACUUM TECHNOLOGY

A Physics Graduate, aged about 40, is required to head a technical group engaged in high voltage, high vacuum technology.

The Group will evaluate developments and, as appropriate, will introduce innovations to manufacturing processes which have, in part being current for some 25 years. The Manager may initially secure a detailed appreciation of the problem areas through secondment for a period of six months to an associated U.S. Company.

This is a challenging appointment, and there are opportunities for further advancement within the organisation. Location is North West London.

Please reply giving full personal and career details to **Position Number AKT 4495, Austin Knight Limited, London, W1A 1DS.**

Applications are forwarded to the client concerned, therefore companies in which you are not interested should be listed in a covering letter to the Position Number Supervisor. [3945

**LEWISHAM HEALTH DISTRICT**

### Electronic and Biomedical Technician Grade II

This is a new post based at Lewisham Hospital. The successful candidate will be responsible to the Group Engineer for maintenance of Electronic and Biomedical Equipment.

H.N.D. in Electronics and experience of Medical Electronics required.

Salary scale £2,040-£2,661 p.a. plus £126 London Weighting Allowance.

Applications to Group Engineer, Yeomanry House, Bromley Road, Catford, S.E.6.

[3931

# 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 ..........................................

..........................................

.......................................... WW 12/8

lansdowne Appointments Register

97

---

**LOUGHBOROUGH CONSULTANTS LIMITED**
**Electronics Development Group**

Applications are invited for a number of posts in the Electronics Development Group. The work will be concerned with the design, development and manufacture of sophisticated electronic measuring equipment.

The Group has contracts for the supply of prototype and special purpose equipment in the automotive, aeronautical, shipping, railway and general industrial fields.

The posts will have starting salaries from £2,007 upwards depending upon experience and qualifications.

Applications giving the usual personal details and an account of the applicants career to date should be sent to:

**Dr. D. J. Spikins, Managing Director, Loughborough Consultants Limited, University of Technology, Loughborough, Leicestershire LE11 3TU** [3960

---

**UNIVERSITY OF SUSSEX**
**SCHOOL OF APPLIED SCIENCES**

## ELECTRONICS ENGINEER

### (Technician Grade V)

Experienced electronics engineer required to be responsible for the servicing of equipment within the Materials Science Division. Duties also include some development work on projects associated with the research programmes being carried out in the Laboratories.

In the near future, it is anticipated that the successful candidate will have the opportunity of becoming fully involved in the operation of the University's Electron Microscopy Service Suite for which additional training (if necessary) would be given.

Salary on scale £2,007 - £2,383 per annum. Applications giving full details of age, qualifications and experience should be sent to the Laboratory Superintendent, School of Applied Sciences, University of Sussex, Brighton BN1 9QT.

[3936

---

# Electronic/ Communications Engineer

Rank Xerox is a name linked with the future. Currently we're engaged in the development of new and existing machines and communications equipment, including our telecopier. There is currently in hand an extensive programme of work on products which are destined to be among the most significant ever produced by the Company.

We have a requirement for an engineer to participate in the design of a new business system. They will work within a small team on the design and development of circuitry, which could involve very high frequencies.

Applicants should be qualified to honours degree level with 3 years' experience in the electronics industry, preferably in the telecommunications field. Experience in the design and development of solid state circuitry at very high frequencies and digital circuitry would be an advantage.

The Company offers above average salaries and fringe benefits including generous assistance with relocation expenses where appropriate.

**Please write or telephone to Alan Preston, Rank Xerox Limited, P.O. Box 17, Bessemer Road, Welwyn Garden City, Herts. Tel. Welwyn Garden 28177.**

3962

RANK XEROX
ENGINEERING GROUP

---

# RADIO OFFICERS

Do you have PMG I, PMG II, MPT 2 years operating experience?

Possession of one of these qualifies you for consideration for a Radio Officer post with composite signals organisation.

On satisfactory completion of a 7-month specialist training course, successful applicants are paid on a scale rising to £3,096 pa; commencing salary according to age—25 years and over £2,245 pa. During training salary also by age, 25 years and over £1,724 pa 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 UK residents up to 35 years of age (40 years if exceptionally well qualified) will be considered.

Full details from:

**Recruitment Officer,**
**Government Communications Headquarters,**
**Room A/1105, Priors Road, Oakley,**
**Cheltenham, Glos GL52 5AJ**
**Telephone Cheltenham 21491 Ext 2270**

[92

## ARTICLES FOR SALE Cont.

**GLASS FIBRE P.C. KITS**
**SIMPLE, PRECISION, CUT-STRIP PROCESS**
For amateurs, laboratories and industry: one-off's, prototypes on single-sided 1 oz board. Draw circuit layout on resist with pen, pencil, etc. Cut and strip unwanted resist. Add water and p.c.b. to pre-packed etching chemicals. All materials supplied in standard kits, e.g. 3 off 3"×4" £2.25; 2 of 4"×6" £3.00; 2 off 4.5"×4.5" £2.50; 1 off 4.5"×8" £2.25; P & P 12p.
**GLASS FIBRE P.C. BOARDS**
1 oz copper in widths up to 8". Single-sided: 2p per 3 sq in. Double-sided: 1p per sq in. No cutting charge. P & P 10p per sq ft.
**BARGAIN PACK**
Double-sided 2 sq ft £1.00; P & P 20p. No small pieces.
**KELTRONIX LTD**
15 Barra St., Glasgow G20 0AX
041-946 1600 [3818

**BUILDING or PURCHASING an AUDIO MIXER**
pre-amp, autofade, V.U. or audio monitor, V.E. mixer, driver or power supply etc . . . First consult:
**PARTRIDGE ELECTRONICS**
Ref. W.W.
21-25 Hart Road, Benfleet, Essex
Established 23 years [43

**ENAMELLED COPPER WIRE**

| S.W.G. | 1lb reel | ½lb reel |
|---|---|---|
| 10 to 14 | £1.90 | £1.05 |
| 15 to 19 | £2.00 | £1.10 |
| 20 to 24 | £2.05 | £1.15 |
| 25 to 29 | £2.10 | £1.20 |
| 30 to 34 | £2.20 | £1.28 |
| 35 to 40 | £2.35 | £1.35 |

All the above prices are inclusive in U.K.
**INDUSTRIAL SUPPLIES**
102 Parswood Rd., Withington, Manchester 20
Telephone 061-224 3553 [85

**CARBON FILM RESISTORS—E12 SERIES**
High Stab. ¼W OR ½W 5%. 1p. 75p/100, £5·50/1000 (22Ω-1MΩ).
**RESISTOR KITS** 22Ω-1MΩ E12 SERIES
10E12 KIT 10 of each value (Total of 570) ¼W, £3·65; ½W, £3·85; .25E12 KIT 25 of each value (Total of 1425) ¼W, £8·35; ½W, £8·45.
METAL FILM KITS ALSO AVAILABLE
**CATALOGUE No. 3 (Approx. 2000 Parts) 15p.**
C.W.O. P. & P. 10p on orders under £5. Overseas at cost.
**B.H. COMPONENT FACTORS LTD**
Dept. WW, 61 Cheddington Road, PITSTONE,
Nr. Leighton Buzzard, Beds. LU7 9AQ
Cheddington (0296) 668446 (3

## SITUATIONS VACANT

BRAZIL United Nations Association International service need Telecommunications engineer interested in teaching. Living allowance and air fares paid. Contact U.N.A.I.S. 93, Albert Embankment, S.E.1. Telephone 735 4431. [3957

CITY importers require electronic engineers to service radio and audio equipment.
Interesting work, good wages and prospects. L/Vs, hours 9am-5pm. 5 day week.
Ring Secretary 253-8031. [3935

ELECTRONIC EXPERIENCE WANTED. Engineers, technicians or testers required to assist teams preparing electronic equipment manuals. Writing experience preferable but not essential. Interesting work on sites in London and Home Counties. Excellent remuneration around £3,000 p.a. (more for specialised digital knowledge). Box No. WW 3979.

HI-FI 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

## ARTICLES FOR SALE

AARVAK ELECTRONICS, 3-channel sound-light converters, from £18. Strobes, £25. Rainbow Strobes, £132.—98A West Green Road (Side Door), London N15 5NS. 01-800 8656. [23

BUILD IT in a DEWBOX quality plastic cabinet 2 in. x 2½ in. x any length. D.E.W. Ltd. (W.), Ringwood Rd., Fernwood, Dorset. S.A.E. for leaflet. Write now—Right now. [76

COLOUR T.V.'s—Bush CTV25 displayed working £90+VAT. Large discounts for 3-up. Non-workers available. Rediffusion wired Mono T.V.'s all screen sizes, new condition. Sumiks, 1532 Pershore Road, Birmingham, 30. Tel. 021-458 2208. [12

COLOUR UHF and TV SPARES. Colour and UHF lists available on request. 625 TV. If unit, suitable for Hi-Fi amp or tape recording, £6.75, P/P 35p. Bush CTV25 colour, new power units complete, incl. mains TX, Electrolytics, rectifiers, etc., £2.50, carr. 80p. New convergence panels plus yoke and blue lat., £3.85, P/P 40p. New Philips single standard convergence panels complete, incl. 16 controls, coils, P.B. switches, leads and yoke £5.00, P/P 40p. 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 35p. Mullard or Plessey Blue Laterals, 75p P/P 20p. BRC 3000 type Scan Coils, £2.00, P/P 40p. Delay Lines DL20, £3.50. DL1E, DL1, £1.50, P/P 25p. Lum. Delay Lines, 50p, P/P 15p. EHT Colour Quadrupler for Bush Murphy CTV 25 111/174 series, £8.25, P/P 35p. EHT Colour Tripler ITT TH25/1TH suitable most sets, £2.00, P/P 25p. KB CVC1 Dual Stand. convergence panels complete incl. 22 controls, £3.75, P/P 35p. CRT Base Panel, £1.75, P/P 15p. Makers Colour surplus/salvaged Philips G8 panels part complete; Decoder, £2.50, IF incl. 5 modules, £2.25. 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 35p. CRT Base 75p, P/P 20p. B9D valve bases 10p, P/P 6p. VARI-CAP 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 transistorised, £4.95. All tuners P/P 35p. 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, £1.00. 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. Mullard 110° mono scan coils, new, suitable all standard Philips, Stella, Pye, Ekco, Ferranti, Invicta, £2.00, P/P 35p. Large selection LOPTs. FOPTs available for most popular makes. PYE/LABGEAR transistd. Masthead UHF Booster, £5 75. Power Unit, £4.65 P/P 30p or Setback battery operated UHF Booster, £4.65 P/P 30p. 200+200+100 Microfarad 350v Electrolytic, £1.00 P/P 20p. 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

HALLICRAFTERS RBX-2 receiver 130-210 MHz £50. Receiver 88 2-20MHz accurate tuning £20 with power pack and spares. Receiver R10 tuning around 3,000MHz £20 with power unit. Other items from 25p to £20. SAE list. JDR, Roydonbury, Harlow CM19 5DU. Tel (Daytime) Roydon 3343. [3950

LADDERS 8ft 10in closed—21ft extended, £23.54, delivered. Home Sales Ladder Centre (WW2), Haldane (North) Halesfield (1) Telford, Shropshire. Tel: 0952-586644. [23

MIROR Aluminising, optical filters and components, vacuum coatings. Frew-Smith Optics, 94 Main Street, Prestwick, Ayrshire. Tel. 0292 70003. [3886

MULLARD Ferrite cores LA3 50p. LA4 75p, LA2100 50p. Enquiries invited for other ferrites rings, beads, rods etc. Mc Murdo PP10 edge plugs Ex brand new equipment 12p. Also 10 way PS10 sockets Ex brand new equipment 14p. Covers for sockets with cable clamps and screws 3p each. Mc Murdo B11A relay sockets Ex new equipment 10p each 100 for £7.00. 1000 for £50. Very large quantities of all above components Ex stock. Also available large quantities of polyester, ceramic, polystyrene and electrolytic capacitors, relays, key switches etc. Add 8% VAT to all orders, mail order only. Xeroza Radio, 1 East Street, Bishop's Tawton, Devon. [3955

OWN the best 48 page components catalogue around! For only 50p post free. Box No. WW 3952.

SCAN coils type KV9P1 by Choomosen suitable for 1" vidicons as used in ITC video range £11.50 post free Dixon Technical, 3 Soho Square, London. W.1. [3965

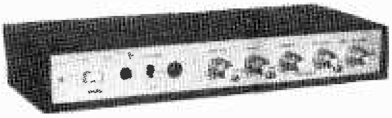
Classifieds continued on p. 85

**Guide to Broadcasting Stations**
**17th Edition**
A new edition of a title which has sold more than 250,000 copies. The bulk of the book is devoted to lists of stations broadcasting in the long, medium, short and v.h.f. bands in both frequency and geographical and alphabetical order. The book also contains useful information on radio receivers, aerials and earth, propagation, signal identification and reception reports.
1973 206 pp., illustrated
0 592 00081 75p

**Illustrations in Applied Network Theory**
**F. E. Rogers**
A hundred numerical and algebraic illustrations designed to exemplify practical circuit problems and introduce, in analysis, principles consistent with studies of synthesis that may be pursued later.
1973 240 pp., illustrated
0 408 70425 X cased £5.00
0 408 70426 8 limp £2.50
Obtainable through any bookseller or from
**The Butterworth Group**
88 Kingsway, London WC2B 6AB
Showroom: 4–5 Bell Yard, WC2.

**SINTEL** 234500
Calculator Keyboard (to order)—Ideal for C500, suitable for CT5001 . . . . . . . . . . £6.00+8% VAT=£6.48
CT5001 (while stocks last) . . . . . . . £3.50+8% VAT=£3.78
MK50250N Alarm Clock IC . . . . . . . £6.90+8% VAT=£7.45
SP352 2 digits .55" . . . . . . . . . . . . . £4.00+8% VAT=£4.32
DL707R Litronix .3" 7 seg. LED . . . . £1.70+8% VAT=£1.83
NO P&P CHARGE—Data and circuits supplied with orders. Send 4½p for our new price list which includes special prices for MK50250N with LEDs, Minitrons or SP352s.
SINTEL, 53c ASTON STREET, OXFORD.

**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 | £2.15 |
| PACK 4. SUNDRIES | pp 15p | £2.50 |
| PACK 5. SWITCHES | pp 15p | £1.00 |
| PACK 6. CONTROLS | pp 15p | £1.45 |
| PACK 7. SEMICONDUCTORS | pp 15p | £8.25 |
| PACK 8. TRANSFORMER | pp 30p | £6.95 |
| PACK 9. P.C. BOARD | pp 15p | £2.50 |
| PACK 10. CHASSIS | pp 25p | £3.00 |
| PACK 11. CABLES & LEADS | pp 15p | 40p |
| PACK 12. TEAK CABINET | pp 37p | £3.00 |

*POST EXTRA* *VAT EXTRA*
*NOW ON DEMONSTRATION*

**TELERADIO HI FI**
PRINTED CIRCUITS AVAILABLE
W.W. F.M. TUNER (Apr–May 74) set . . . . . . . . . . £2.50
LINSLEY-HOOD Class A. Ampl. 10W . . . . . . . . . . 50p
LINSLEY-HOOD D.C. Coupled 75W . . . . . . . . . . £1.00
POP/WIRELESS F.M. TUNER (CRATA) . . . . . . . . . £1.00
BAILEY-QUILTER Pre-Amp. . . . . . . . . . . . . . . . £1.00
TOSHIBA Pre-Amp. . . . . . . . . . . . . . . . . . . . . 75p
QUADRAPHONIC SYSTEM
Components also available for most above designs.
S.A.E. for further information
**TELERADIO ELECTRONICS**
325–7, FORE ST., LONDON, N9 OPE
01-807 3719 (Closed Thursdays)

# Wilmslow Audio

***THE firm for speakers!***

| | |
|---|---|
| Baker Group 25, 3, 8 or 15 ohm | £7.75 |
| Baker Group 35, 3, 8 or 15 ohm | £8.50 |
| Baker Deluxe, 8 or 15 ohm | £10.75 |
| Baker Major, 3, 8 or 15 ohm | £8.50 |
| Baker Regent, 8 or 15 ohm | £7.75 |
| Baker Superb, 8 or 15 ohm | £14.50 |
| Celestion PST8 (for Unilex) | £2.55 |
| Celestion MH 1000 horn, 8 or 15 ohm | £10.95 |
| EMI 13 × 8, 3, 8 or 15 ohm | £2.25 |
| EMI 13 × 8, 150 d/c 3, 8 or 15 ohm | £2.50 |
| EMI 13 × 8, 450 t/tw 3, 8 or 15 ohm | £3.75 |
| EMI 13 × 8, 350, 8 or 15 ohm | £8.25 |
| EMI 13 × 8, 20 watt bass | £6.60 |
| EMI 2¼" tweeter 8 ohm | .65 |
| EMI 8 × 5, 10 watt, d/c, roll/s 8 ohm | £2.50 |
| Elac 59RM 109 15 ohm, 59RM 114 8 ohm | £2.80 |
| Elac 6½" d/cone, roll/s 8 ohm | £3.50 |
| Elac TW4 4" tweeter | £1.21 |
| Fane Pop 15 watt 12" | £4.80 |
| Fane Pop 25/2 25 watt 12" | £6.95 |
| Fane Pop 40, 10" 40 watt | £8.50 |
| Fane Pop 50 watt, 12" | £11.00 |
| Fane Pop 55, 12" 60 watt | £12.50 |
| Fane Pop 60 watt, 15" | £13.00 |
| Fane Pop 100 watt, 18" | £22.50 |
| Fane Crescendo 12A or B, 8 or 15 ohm | £29.00 |
| Fane Crescendo 15, 8 or 15 ohm | £36.00 |
| Fane Crescendo 18, 8 or 15 ohm | £49.95 |
| Fane 807T 8" d/c, roll/s, 8 or 15 ohm | £3.85 |
| Fane 801T 8" d/c, roll/s, 8 ohm | £7.00 |
| Goodmans 8P 8 or 15 ohm | £5.00 |
| Goodmans 10P 8 or 15 ohm | £5.30 |
| Goodmans 12P 8 or 15 ohm | £12.95 |
| Goodmans 12P-D 8 or 15 ohm | £16.75 |
| Goodmans 12P-G 8 or 15 ohm | £15.75 |
| Goodmans Audiom 100 8 or 15 ohm | £12.00 |
| Goodmans Axent 100 8 ohm | £7.25 |
| Goodmans Axiom 401 8 or 15 ohm | £17.25 |
| Goodmans Twinaxiom 8" 8 or 15 ohm | £8.25 |
| Goodmans Twinaxiom 10" 8 or 15 ohm | £9.00 |
| Kef T27 | £5.25 |
| Kef T15 | £6.00 |
| Kef B110 | £7.00 |
| Kef B200 | £8.00 |
| Kef B139 | £12.75 |
| Kef DN8 | £2.00 |
| Kef DN12 | £4.50 |
| Kef DN13 | £2.75 |
| Richard Allan CG8T 8" d/c roll/s | £6.35 |
| STC4001G super tweeter | £6.19 |
| Wharfedale Super 10RS/DD 8 ohm | £9.80 |
| Fane 701 twin ribbon horn | £23.00 |
| Baker Major Module each | £10.75 |
| Fane Model One each | £9.90 |
| Goodmans DIN 20 4 ohm each | £9.75 |
| Helme XLK25 (pair) | £22.00 |
| Helme XLK30 (pair) | £14.95 |
| Helme XLK50 (pair) | £39.95 |
| Kefkit 2 each | £23.50 |
| Kefkit 3 each | £34.00 |
| Peerless 3–15 (3 sp. system) each | £15.00 |
| Richard Allan Twinkit each | £8.25 |
| Richard Allan Triple 8 each | £13.00 |
| Richard Allan Triple each | £18.50 |
| Richard Allan Super Triple each | £21.50 |
| Wharfedale Linton 2 kit (pair) | £19.25 |
| Wharfedale Glendale 3 kit (pair) | £34.50 |
| Wharfedale Dovedale 3 kit (pair) | £52.50 |

**PRICES INCLUDE VAT**

Cabinets for PA and HiFi, wadding, vynair, etc.

Send stamp for free booklet "Choosing a Speaker".

**FREE with orders over £7—"HiFi loudspeaker enclosures" book.**

**All units guaranteed new and perfect.**

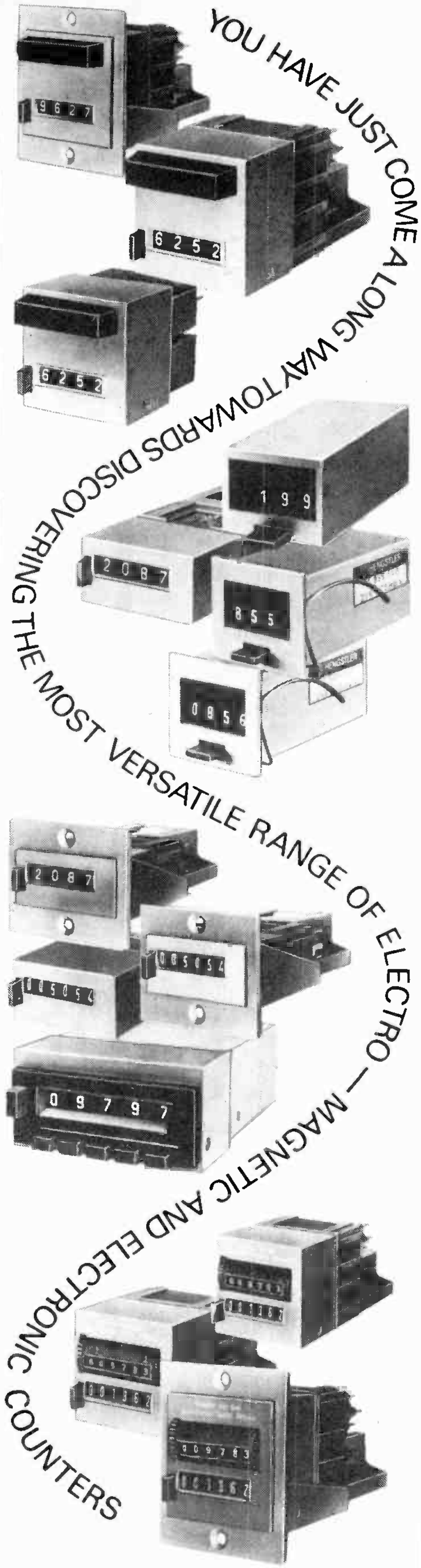
Prompt despatch.

Carriage: Speakers 38p each, tweeters and crossovers 20p each, kits 75p each (pair £1.50).

## WILMSLOW AUDIO

**Dept WW**
**Swan Works, Bank Square, Wilmslow, Cheshire SK9 1HF Tel. Wilmslow 29599**
**(Discount HiFi, PA and Radio at 10 Swan St, Wilmslow.)**

WW—015 FOR FURTHER DETAILS




# HENGSTLER

Manufacturers of counters and counting systems

HENGSTLER GB LIMITED,
NAZEING NEW ROAD,
BROXBOURNE, HERTS, EN10 6SX.
TELEPHONE: HODDESDON 68451
TELEX: LONDON 263243

WW—036 FOR FURTHER DETAILS

# 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-Receivers and one **COLLINS** Receiver all fully tuneable 2 to 30 m/cs 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 HC-150 POINT-TO-POINT STRIP RADIO HF RECEIVERS** 2/30 m/cs. Ten fully tuneable channels to 0·5 kcs with synthesisers. Single and diversity reception on ISB, DSB, SSB with 4 sub-bands to each channel. Full details and prices on application.

## HIGHEST QUALITY 19" RACK MOUNTING CABINETS & RACKS

**CABINETS**

| Our Ref. | Height in inches | Width in inches | Depth in inches | Rack Panel Space in ins. | Price |
|---|---|---|---|---|---|
| CD | 69 | 21 | 13 | 68 | £10·00 |
| CL | 30 | 60 | 36 | 42 | £12·50 |
| CR | 69 | 30 | 20 | — | £24·00 |
| DM | 70 | 20 | 26 | 138 | £21·00 |
| FA | 85 | 22 | 36 | 160 | £22·00 no sides |
| FB | 74 | 21 | 22 | 70 | £18·00 |
| FC | 52 | 25 | 22 | 47 | £17·00 |
| FD | 40 | 22 | 24 | 72 | £14·00 |
| FE | 72 | 22 | 21 | 68 | £18·00 |
| FG | 11 | 19 | 18 | 10 | £11·00 |
| FH | 15 | 21 | 17 | 11 | £12·00 |
| FJ | 15 | 21 | 15 | 12 | £12·00 |
| FN | 70 | 24 | 20 | 68 | £17·00 |
| FL | 84 | 22 | 17 | 80 | £21·00 |
| FM | 70 | 72 | 27 | 120 | £20·00 |
| FP | 76 | 22 | 18 | 70 | £18·00 |

Also Consoles, twin and multi-way Cabinets.

**OPEN RACKS**

| Our Ref. | Height in inches | Channel Depth | Rack Panel Space | Base | Price |
|---|---|---|---|---|---|
| RF | 85 | 3 | 79 | 15 | £11·00 |
| RG | 57 | 2 | 51 | 14 | £9·00 |

**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.**

| | |
|---|---|
| ★ 400 channel Pulse Height Spectrum Analyzers | P.U.R. |
| ★ Racal SA 21 and SA 52 Counters | £30·00 |
| ★ Airmec 245 L.F.150 watt Oscillators | £30·00 |
| ★ Solartron CD 1015 Oscilloscopes | £40·00 |
| ★ Eddystone Receiver Cabinets | £12·00 |
| ★ Solartron 5/25000 cyc. Oscillators | £24·00 |
| ★ Dawe 630 Phase Meters | £22·50 |
| ★ Southern Inst. 1800 F.M. Meters | £24·00 |
| ★ Belling Lee T.V. Relay Equipment | P.U.R |
| ★ Addo 5/8 track Tape Punches | £48·00 |
| ★ Tally 5/8 track Tape Readers | £48·00 |
| ★ 80 column Card Hand Punches | £40·00 |
| ★ 75 foot sectional self supporting Towers | £300·00 |
| ★ Auto Electric Carillon Chimes | £250·00 |
| ★ CV-157 Hoffman ISB/SSB Converters | £95·00 |
| ★ 10 foot Triangular Lattice Mast Sections 6 inch sides | £12·00 |
| ★ Ditto 15 foot with 15 inch sides | £29·00 |
| ★ Casella Assmann Electric Hygrometers | £24·00 |
| ★ Racal MA-150 Synthesisers | £95·00 |

We have a varied assortment of industrial and professional Cathode Ray Tubes available. List on request.

| | |
|---|---|
| ★ Racal MA-250 Decade Generators | £125·00 |
| ★ Racal RA-98 S.S.B./D.S,B. Adaptors | £75·00 |
| ★ Avo Geiger Counters, new | £8·00 |
| ★ Servomex 2KVA Voltage Regulators | £44·00 |
| ★ Double Co-axial Blowers 6×6 220 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 m/cs Yagi Beams | £6·00 |
| ★ Haynes 500 watt 230 v./115v. Isolation Transformers | £9·00 |
| ★ Muirhead D.888 Analysers | £80·00 |
| ★ Laboratory Radio Interference Filters | £2·00 |
| ★ Cawkell Type 1471 Variable Filters | £70·00 |
| ★ 54in. dia. Meteorological Balloons | £2·00 |
| ★ Flann Microwave Attenuators 4/12 GMC | £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-600
1" and ½" 14 and 7 tracks 4 speeds Transistorised

**MINCOM**

CMP-100
¼" ½" 1" 7 tracks 6 speeds

**E.M.I.**

TD-1
¼" 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.

**Prices on Application**
**PLEASE ADD V.A.T. TO ABOVE**

## P. HARRIS
**ORGANFORD — DORSET**
**BH16 6ER**
**BOURNEMOUTH-65051**

# EX-COMPUTER STABILISED POWER SUPPLIES

**RECONDITIONED, TESTED AND GUARANTEED**

Ripple <10mV. Over-voltage protection 120-130v. 50 c/s input. Stepdown transformer to suit about **£3.**
Post & Packing **£1·70**

5-6v. 8A. **£12** 5-6v. 16A. **£16**
5-6v. 12A. **£14**

**PAPST FANS** 4½ x 4½ x 2in. 100 cfm. **£3·50** (30p).

**PAPST FANS** 6in. dia. x 2 3/16in. deep Type 7576 **£5·00** (30p).

**TRANSISTORS** p & p 10p
BC107/8/9 BC147/8/9 BC157/8/9 al 9p
BF180 **25p** BF182/3/ **40p** BF184 **17p** BF187 **13p**
BFW10 **55p** BF336 **35p** 741 8 DIL **34p**

**ELECTROLYTICS**
12,000µ 100v, 5 x 2½ dia **£1** (25p)
30,000µ 25v **65p** (20p)
4000µ 70v., 3,600µ 40v., 4½×2in. dia. **55p** (15p)
10,000µ 35v. 5,000µ 35v., **40p** (12p)
4,000µ 100v., 4½×2½ **55p** (22p)

**EX-COMPUTER PC PANELS** 2 x 4in. 25 boards for **£1** (30p).
QH Bulbs, 12v. 55w. .......... **50p** (7p)
250 Mixed Resistors .......... **60p** (13p)
250 Mixed Capacitors .......... **60p** (11p)
200 SI Planar Diodes .......... **50p** (8p)
Microswitches .......... 8 for **50p** (10p)
Min. Glass Neons .......... 8 for **50p** (7p)

*Postage and package shown in brackets*

**Please add 8% VAT to TOTAL**

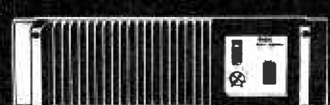
## KEYTRONICS
Mail Order only.

**44 EARLS COURT ROAD, LONDON, W.8**
**01-478 8499**

---

## Grampian

'SERIES 7' — *Studio Monitor Version*
*One of the world's finest Amplifiers.*



**GRAMPIAN REPRODUCERS LIMITED**
Hanworth Trading Estate, Feltham, Middlesex.
Telephone: 01 894 9141.

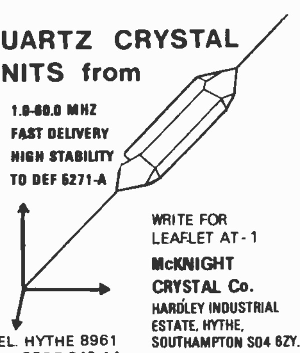
---

## 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

---

## QUARTZ CRYSTAL UNITS from



- 1.0-60.0 MHZ
- FAST DELIVERY
- HIGH STABILITY
- TO DEF 5271-A

WRITE FOR LEAFLET AT-1
**McKNIGHT CRYSTAL Co.**
HARDLEY INDUSTRIAL ESTATE, HYTHE, SOUTHAMPTON SO4 6ZY.
TEL. HYTHE 8961
STD CODE 042 14

---

## KJB printed circuits
K J BENTLEY & PARTNERS LIMITED
18 GREENACRES ROAD, OLDHAM
061 624 0939

---

## 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 capability | 2 A/2.5 A<br>110 V/125 V D.C.~<br>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

WW—023 FOR FURTHER DETAILS

---

**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

---

**WE PURCHASE ALL FORMS OF ELECTRONIC EQUIPMENT AND COMPONENTS, ETC.**
**SPOT CASH**
**CHILTMEAD LTD.**
**7, 9, 11 Arthur Road, Reading, Berks.** **Tel: 582 605**

---


**THE ONLY COMPREHENSIVE RANGE OF RECORD MAINTENANCE EQUIPMENT IN THE WORLD!**

Send P.O. 15p (plus 4p postage) for 48 page booklet providing all necessary information on Record Care.

**CECIL E. WATTS LIMITED**
Darby House
Sunbury-on-Thames, Middx.

---

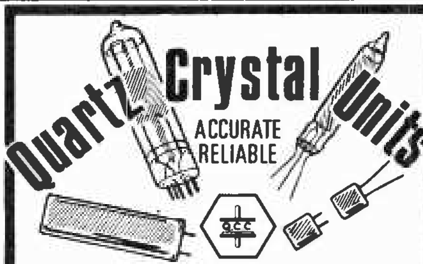
## EXPRESS
Prototype Printed Circuits
Fastest in London Area
Also medium production runs, call-offs, etc.
**Electronic & Mechanical Sub-Assembly Co. Ltd,**
**Highfield House, West Kingsdown, Nr. Sevenoaks, Kent.**
**Tel: West Kingsdown 2344**

---

## SYNTHESISER SOUNDS SUPREME
**BY DEWTRON—THE UP-FRONT PEOPLE**
YOU can build professional standard synth. equipment from our modules if you can read and solder! E.g. pitch-to-voltage enables your creation to play itself from sound of voice, sax, clarinet, guitar etc. Send 15p NOW for full catalogue. 10 years experience from—
**D.E.W. LTD.,**
**254 Ringwood Road, Ferndown, Dorset.**

---

## 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

---

**COLOUR TV's**
Bush CTV 25 displayed working **£90** plus VAT
Large discount for 3 up non-workers available. Rediffusion used Mono TV's all screen sizes, new condition.
**SUMIKS**
**1532 Pershore Road, Birmingham 30**
**Tel: 021 458 2208**

---

**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**

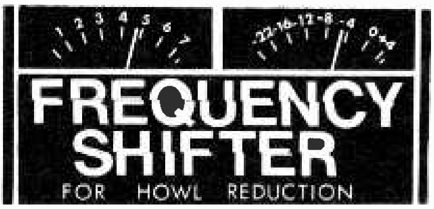
## PEAK PROGRAM METERS TO BS4297

**also 200KHz version for high speed copying.**

Drive circuit. 35 x 80mm. for 1mA L.H. zero meter to BBC ED1477. Gold 8-way edge con supplied.

| | | 4 off | 10 off | 50 off |
|---|---|---|---|---|
| Complete kit | **£10.00** | **£9.50** | **£9.00** | **£8.50** |
| Built and aligned | **£14.00** | **£13.30** | **£12.60** | **£11.90** |

ERNEST TURNER PPM meters. scalings 1/7 OR-22/+4. Type 642. 71 x 56mm **£10·90**: 643. 102 x 79mm **£12·90**.
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 imperceptible on both speech and music.

SHIFTERS IN BOXES with overload 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 600 ohm | 20 or 600 ohm BAL |
| **PRICE** | **£58.00** | **£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

# TEXAS INSTRUMENTS. SEMICONDUCTOR CIRCUIT DESIGN VOL. III

**by B. Norris Price £5·25**

**THE TRANSISTOR & DIODE DATA BOOK FOR DESIGN ENGINEERS VOL. I** by Texas Instruments. Price £2·25

**MOTOROLA SEMICONDUCTORS EUROPEAN CONSUMER DEVICES** Price £4·25

**SEMICONDUCTOR DEVICES TESTING & EVALUATION** by C. E. Jowett Price £5·25

**FET APPLICATIONS HANDBOOK** by J. Eimbinder. Price £2·00

**SOLID-STATE HOBBY CIRCUITS MANUAL** by RCA. Price £1·15

**ELECTRONICS: A HANDBOOK FOR ENGINEERS & SCIENTISTS** by G. H. Olsen. Price £7·25

**TELECOMMUNICATIONS** by J. Brown. Price £3·20

**DIGITAL ELECTRONIC CIRCUITS & SYSTEMS** by N. M. Morris. Price £2·40

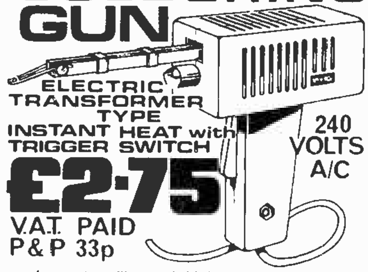
**MICROPHONES: DESIGN & APPLICATION** by L. Burroughs. Price £10·00

**THE MAZDA BOOK OF PAL RECEIVER SERVICING** by D. J. Seal. Price £4·00

★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.*

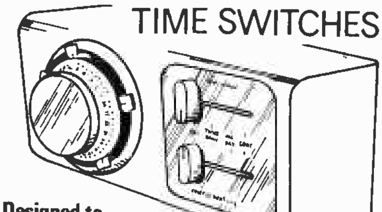
## SOLDERING GUN




**£2·75**
V.A.T. PAID
P & P 33p

New surplus stock as illustrated. AC 240 volts. Input power 100VA. Instant heat at touch of trigger switch in handle. Constructed in robust plastic casing with work light in front and 4′ × 3-core cable.

## PROGRAMME TIME SWITCHES



**Designed to switch central heating and hot water on/off twice a day. Suitable for any electrical appliance up to 3 amps 240 volts A.C.**

**£5·50** P&P 28p
VAT paid.

New surplus stock as illustrated. Size 7″ × 4″ × 3″
Smiths Time Switch with 24-hour dial which is simple to set to switch on/off twice per day at any times required. Also fitted with two lever switches which can be set to operate two circuits which can each be set to operate on Time Switch twice per day, all day, continuous, or off. Mounted in robust white plastic casing. Drilled for fixing on back supplied with wiring instructions. Ideal for shop lighting and many other applications.
**SAE FOR CATALOGUE WITH MANY OTHER BARGAINS TO**
**C. W. WHEELHOUSE & SON**
**9/13 BELL ROAD, HOUNSLOW. PHONE 01-570 3501.**

**Classifieds continued from p.82**
**Articles for Sale Continued**

STUDIO sound control desk needs attention to wiring and mechanical construction. Consists of "Marconi" faders, units and amplifiers. Approx. size 4½′ x 5′ x 2½′. Also:—"Ampex" 14 channel tape deck. £350.00 o.n.o. for more details write to:—S. Whitaker, Flat 2, 224 Bramhall Lane, Davenport, Stockport, Cheshire. [3953

SUPERB Instrument Cases by Bazelli, manufactured from heavy duty PVC faced steel, choice of 174 types. Send for free list. Brazelli Instrument Cases, Dept. 22, St. Wilfrids, Foundry Lane, Halton, LA2 6LT, near Lancaster. [3646

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

VALVES, large stocks, 1930 to 1974, many obsolete types. S.A.E. for quotation. List, 10p. Cox Radio The Parade, East Wittering, Sussex, West Wittering 2023. [3890

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. [21

### ARTICLES WANTED

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

### BOOKS, INSTRUCTIONS, ETC.

COMMERCIAL RADIO INFORMATION Bulletin. Packed with facts on the IBA local radio stations, Radio Luxembourg and the offshore stations. Send 20p for sample copy or £1.50 for 10 issues to Commercial Radio News Agency, 67-69 Chancery Lane, London WC2A 1AF. [3443

### CAPACITY AVAILABLE

AIRTRONICS LTD., for Coil Winding—large or small production runs. Also PC Boards Assemplies. Suppliers to P.O., M.O.D., etc. Export enquiries welcomed. 3a Walerand Road, London, SE13 7PE. Tel. 01-852 1706. [61

BATCH Production Wiring and Assembly to sample or drawings. Deane Electricals, 19B Station Parade, Ealing Common, London, W.5. Tel: 01-992 8976. [20

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, E9 6AB. Tel. 01-985 7057. [14

DESIGN, development, repair, test and small production of electronic equipment. Specialist in production of printed circuit assemblies. YOUNG Electronics Ltd., 54 Lawford Road, London, NW5 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 3966.

SMALL Batch Production, wiring assembly, to sample or drawings. Specialist in printed circuit assemblies. D. & D. Electronics, 2 Bishopsfield, Harlow, Essex. Harlow 33018. [17

### COURSES

RADIO AMATEUR well planned postal course. Details from Electronic Publications, 53 Warren Court, Westcliffe Rd., Southport, Lancs. [16

RADIO and Radar M.P.T. and C.G.L.I. Courses. Write: Principal, Nautical College, Fleetwood, FY7 8JZ. [25

### 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 Rx5s, 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

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

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

### SERVICE AND REPAIRS

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

### VALVES WANTED

WE buy new valves, transistors and clean new components, large or small quantities, all details, quotation by return.—Walton's, 55 Worcester St., Wolverhampton. [62

### RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

TWO pair walkie talkies' "GEC COURIER" complete with xtals require attention. Minus carying straps. £24 pair o.n.o. Phone 01-303 6231. [3954

### NEW GRAM AND SOUND EQUIPMENT

GLASGOW HI FI, Recorders, Video, Communications Reciever always available we buy sell and exchange for photographic equipment. Victor Morris Audio Visual Ltd., 340 Argyle Street, Glasgow, G.2; 31 Sauchiehall Street, Glasgow, G.1; 8/10 Glassford Street, Glasgow, G.2. Tel. 041-221 8958.

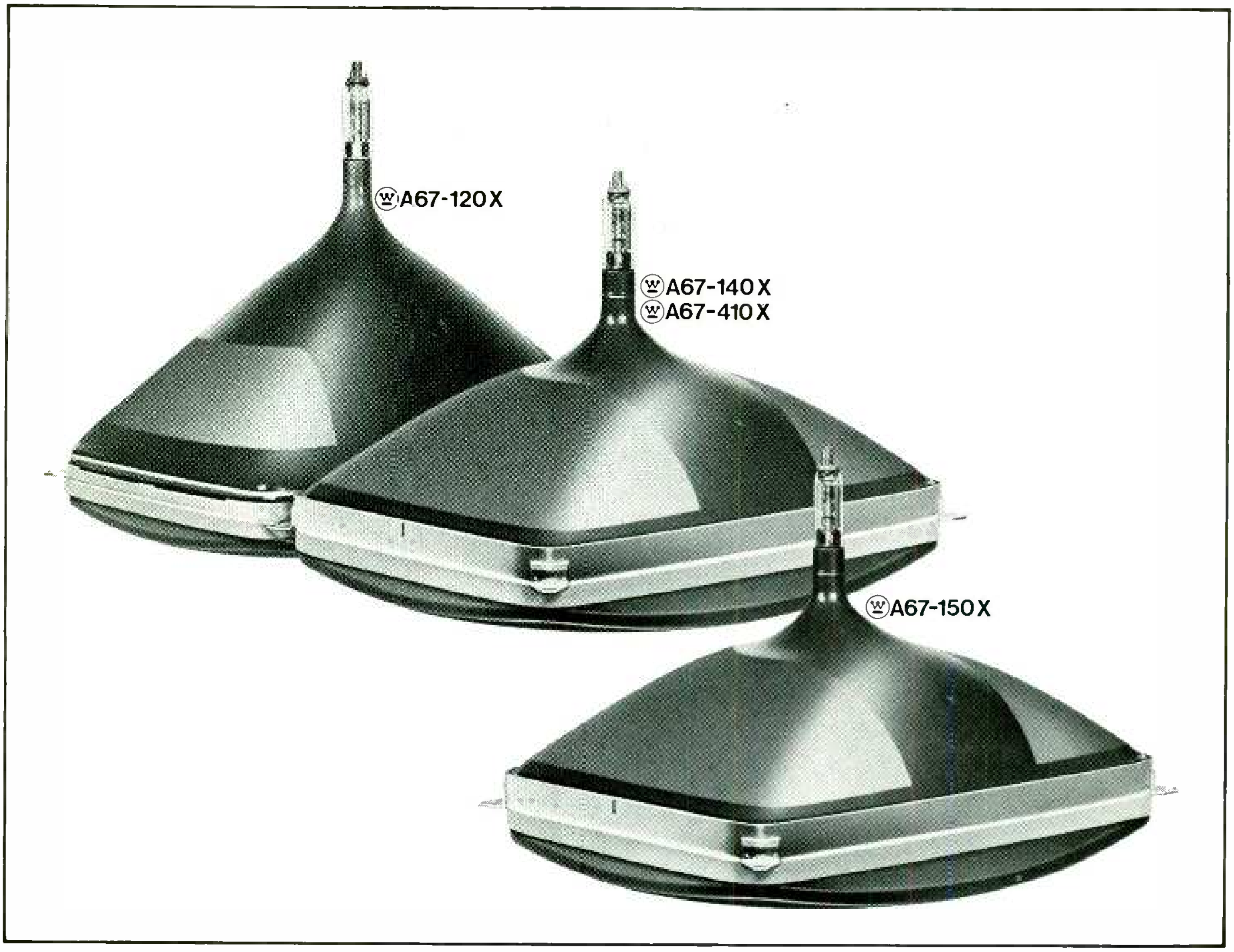
**FOR CLASSIFIEDS RING ALLAN PETTERS 01-261 8508/8423**

# INDEX TO ADVERTISERS

## Appointments Vacant Advertisements appear on pages 70-82



Printed in Great Britain by Hazells Offset Ltd., Leigh Road, Slough, Bucks., and Published by the Proprietors I.P.C. Electrical-Electronic Press Ltd., Dorset House, Stamford St., London, SE1 9LU telephone 01·261 8000. *Wireless World* can be obtained abroad from the following: Australia and New Zealand: Gordon & Gotch Ltd. India: A. H. Wheeler & Co. Canada: The Wm. Dawson Subscription Service, Ltd. Gordon & Gotch Ltd. South Africa: Central News Agency Ltd.: William Dawson & Sons (S.A.) Ltd. United States: Eastern News Co., 306 West 11th Street, New York 14. CONDITIONS OF SALE AND SUPPLY. This periodical is sold subject to the following conditions namely that it shall not without the written consent of the publishers first given be lent re-sold, hired out or otherwise disposed of by way of Trade at a price in excess of the recommended maximum price shown on the cover, and that it shall not be lent, re-sold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.




# 3 sizes...4 solutions

Four Westinghouse 67 cm diagonal TV colour tubes. Each one directly responding to the requirements of the European market.

In 1971 we came out with the 90° A67-120X to meet set manufacturers' need for a 67 cm diag. tube. 1972 saw widespread construction of the "slim-line" set and we responded with the 10 cm shorter profile 110° A67-140X.

This year an improved version of this tube is available – the A67-410X. Its "fast-on" technology for solid-state circuitry permits European viewers to obtain a full colour image within 4–5 sec. following switch-on of their receiver.

And recently, owing to the employment by many manufacturers of a narrow neck system, we've introduced the compatible 110° narrow neck A67-150X.

All proving that at Westinghouse we make a point of developing finer products to match the dynamic needs of the industries we serve. Here in Europe and throughout the world.

For further information on these tubes and the many hundreds of other precision devices for industrial and defense application, please write or call:

Electronic Tube Division,
Westinghouse Electric S.A. No.1
Curfew Yard, Thames Street, Windsor
Berks. Phone: 63392.

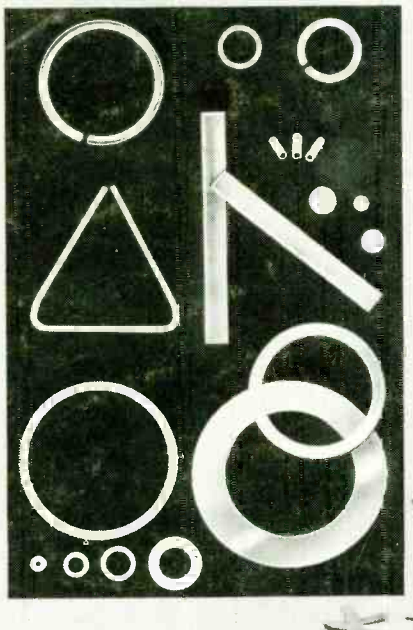
**Westinghouse helps make it happen**

# Multicore Solder preforms, a little something for automatic processes.

## Multicore Preforms.

Multicore precision made solder preforms come in virtually any shape or size. Rings, washers, discs, pellets, and lengths of solder tape – in most soft solder alloys. Designed, with or without flux cores, to make the most of automatic soldering processes, a solder preform is simple and accurate to use. It's just positioned between the parts to be soldered and the temperature of the metal surfaces raised to about 50°C above the melting temperature of the solder. The solder preform does the rest. Heating techniques can include gas flame, hot plate, oven conveyor, induction coils, resistance/electrode soldering, hot gas and infra-red.

Multicore Solder Preforms just get on with the job. Automatically.

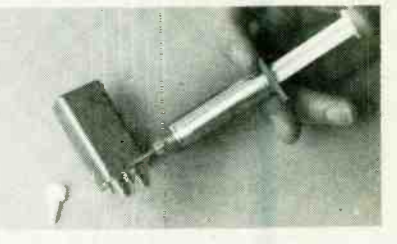


## Our Solder Creams, something else again...

New Multicore Solder Creams are designed for electronics assembly where quality is vital. Like manufacturing diodes, for instance, or making a tuner chassis, or soldering thick-film circuits.

A finely graded solder alloy powder in a thixotropic organic vehicle. It's often quicker, cheaper, easier and more reliable than other soldering techniques. It's different. It doesn't spit or need stirring. It can be applied by syringe, automatic dispenser or screen printing – giving instant soldering with good spread, strong joints with low contact angles. It can act as a temporary adhesive during assembly and the clear colour flux residue – without solder globules – simplifies inspection.

There are three types of Multicore Solder Cream – one of them may be just what you've been looking for.

Approved USA Federal Specification QQ-S-571E

| Multicore Product Ref. | XM 27330 | XM 27298 | XM 27328 |
|---|---|---|---|
| Alloy Composition | 62/36/2 Sn/Pb/Ag | 60/40 Sn/Pb | 96/4 Sn/Ag |
| Melting Point or Liquidus °C | 179 | 188 | 221 |
| Recommended Flow Temperature °C | 239 | 250 | 280 |
| Typical Application | Low Melting Point Soldering of silver and gold-plated surfaces | General purpose joints requiring high quality solder cream | Higher temperature resistant joints. Lead free. Higher joint strength than Sn/Pb |

*On Qualified Products List of U.S.A. Defense Supply Agency*


Ersin Multicore 5 core solder

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.