# wireless world

JANUARY 1975 25p

## Electronics and oil
## Silent stereo switch

| | | | |
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| Australia | 80 Cents | Malaysia | M$ 2.60 |
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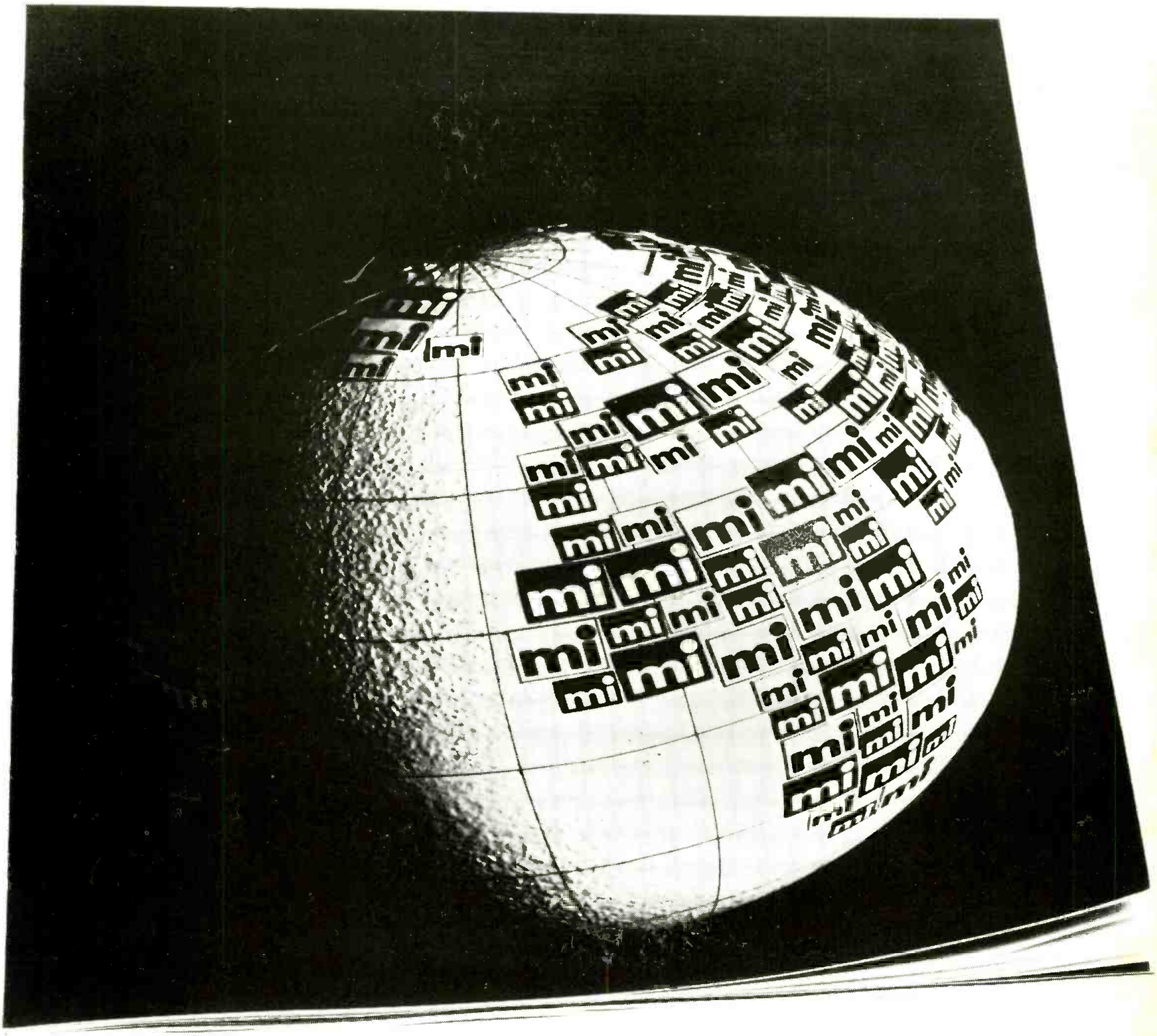
| Italy | L. 700 | | |



# Cover Story

Some Marconi Instruments are designed to be mobile. Others are not – but do a lot of travelling all the same. In fact, nearly three-quarters of **mi**'s total sales stem from export orders.

So there are plenty of people in Milwaukee or Mannheim or Melbourne or Montevideo who are just as discerning about Marconi Instruments as you are. And they're equally enthusiastic about **mi** service, too. We've service organisations in New Jersey, Munich, Paris and a whole lot of other places to see to that.

There are **mi** distributors and representatives in more than 60 countries throughout the world and we have 14 associated companies in Africa, the Middle, Near and Far East, North and South America and Europe.

**mi**, then, doesn't only cover all the intricacies of planning and producing some of the world's finest electronic testing and measuring instruments .....

It covers the world, as well.

## mi: THE INTERNATIONALISTS

MARCONI INSTRUMENTS LIMITED

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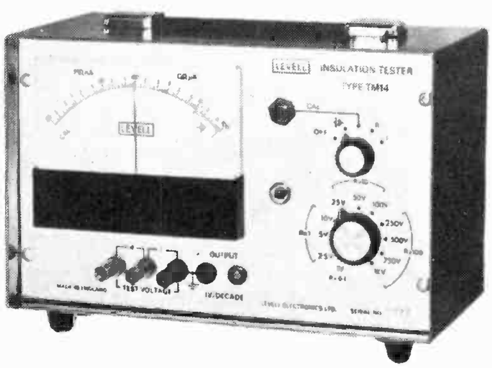
A GEC–Marconi Electronics company.

# LOW COST TESTERS

LEVELL

PORTABLE INSTRUMENTS

## INSULATION TESTER




A logarithmic scale covering 6 decades is used to display either insulation resistance or leakage current at a fixed stabilised test voltage. The current available is limited to a maximum value of 3mA for safety and capacitors are automatically discharged when the instrument is switched off or to the CAL condition. The instrument operates from a 9V internal battery.

### RESISTANCE RANGES

10M Ω to 10T Ω ($10^{13}$ Ω) at 250V, 500V, 750V and 1kV.
1M Ω to 1T Ω at 25V, 50V and 100V.
100k Ω to 100G Ω at 2.5V, 5V and 10V.
10k Ω to 10G Ω at 1V.
Accuracy ±15% +800 Ω on 6 decade logarithmic scale.
Accuracy of test voltages ±3% ±50mV at scale centre.
Fall of test voltages < 2% at 10μA and < 20% at 100μA.
Short circuit current between 500μA and 3mA.

### CURRENT RANGE

100pA to 100μA on 6 decade logarithmic scale.
Accuracy of current measurement ±15% of indicated value.
Input voltage drop is approximately 20mV at 100pA, 200mV at 100nA and 400mV at 100μA.
Maximum safe continuous overload is 50mA.

### MEASUREMENT TIME

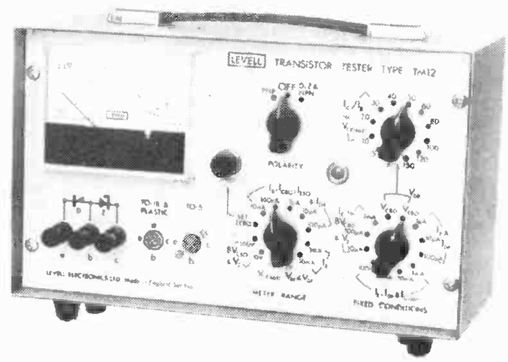
< 3s for resistance on all ranges relative to CAL position.
< 10s for resistance of 10G Ω across 1μF on 50V to 500V.
Discharge time to 1% is 0.1s per μF on CAL position.

### RECORDER OUTPUT

1V per decade ±2% with zero output at scale centre.
Maximum output ±3V. Output resistance 1k Ω.

type TM14 **£80**

## TRANSISTOR TESTER




Tests bipolar transistors, diodes and zener diodes. Measures leakage down to 0.5 nA at 2V to 150V. Current gains are checked from 1μA to 100mA. Breakdown voltages up to 100V are measured at 10μA, 100μA and 1mA. Collector to emitter saturation voltage is measured at 1mA, 10mA, 30mA and 100mA for $I_C/I_B$ ratios of 10, 20, 30. The instrument is powered by a 9V battery.

### TRANSISTOR RANGES (PNP OR NPN)

$I_{CBO}$ & $I_{EBO}$: 10nA, 100nA, 1μA, 10μA and 100μA f.s.d. acc. ±2% f.s.d. ±1% at voltages of 2V, 5V, 10V, 20V, 30V, 40V, 50V, 60V, 80V, 100V, 120V, and 150V acc. ±3% ±100mV up to 10μA with fall at 100μA < 5%+250mV.

$BV_{CBO}$: 10V or 100V f.s.d. acc ±2% f.s.d. ±1% at currents of 10μA, 100μA and 1mA ±20%.

$I_B$: 10nA, 100nA, 1μA . . . 10mA f.s.d. acc. ±2% f.s.d. ±1% at fixed $I_E$ of 1μA, 10μA, 100μA, 1mA, 10mA, 30mA, and 100mA acc. ±1%.

$h_{FE}$: 3 inverse scales of 2000 to 100, 400 to 30 and 100 to 10 convert $I_B$ into $h_{FE}$ readings.

$V_{BE}$: 1V f.s.d. acc. ±20mV measured at conditions on $h_{FE}$ test.

$V_{CE(sat)}$: 1V f.s.d. acc. ±20mV at collector currents of 1mA, 10mA, 30mA and 100mA with $I_C/I_B$ selected at 10, 20 or 30 acc. ±20%.

### DIODE & ZENER DIODE RANGES

$I_{DR}$: As $I_{EBO}$ transistor ranges.

$V_Z$: Breakdown ranges as $BV_{CBO}$ for transistors.

$V_{DF}$: 1V f.s.d. acc. ±20mV at $I_{DF}$ of 1μA, 10μA, 100μA, 1mA, 10mA, 30mA and 100mA.

type TM12 **£80**

**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.

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Who else but the Italians could have produced the most sophisticated range of mixing and fading facilities ever offered in such a beautifully designed range of equipment.

Yet still apply the most precise and exacting manufacturing standards to provide the operational stability and reliability such complex electronics demand.

This is why we are able to guarantee all Goodmans/Galactron equipment for three years.

And your guarantee will be signed personally by the quality controller who tests it before it leaves the factory in Italy.

**Galactron Mk 10**
**Stereo Integrated Amplifier**

A remarkably compact pre and power amp combination with 90 watts RMS per channel. Features 5 mixable stereo inputs, 5 plug-in-modules—two of which can be cross-faded by slide potentiometer.

**Galactron Mk 16**
**Stereo/Quad Amplifier**

No comparable equipment has all these 3 functions. 5 inputs, independently mixable and equalised by plug-in modules. Twin graphic equalisers having 10 filters each (±16dB) at octave intervals from 32Hz to 16kHz. Plug-in quadrophonic decoder panels for discrete and matrix systems allied to 4 output level controls.

**Galactron Mk 100**
**Stereo Power Amplifier**

Originally designed as a monitor amp for recording studios, the Mk 100 is designed for use with the Mk 16 preamplifier. 100 watts RMS per channel output.

Full facts and figures are available from Goodmans Loudspeakers Limited, Downley Road, Havant, Hants.

THORN
A member of The Thorn Group

**Goodmans**
**GALACTRON**

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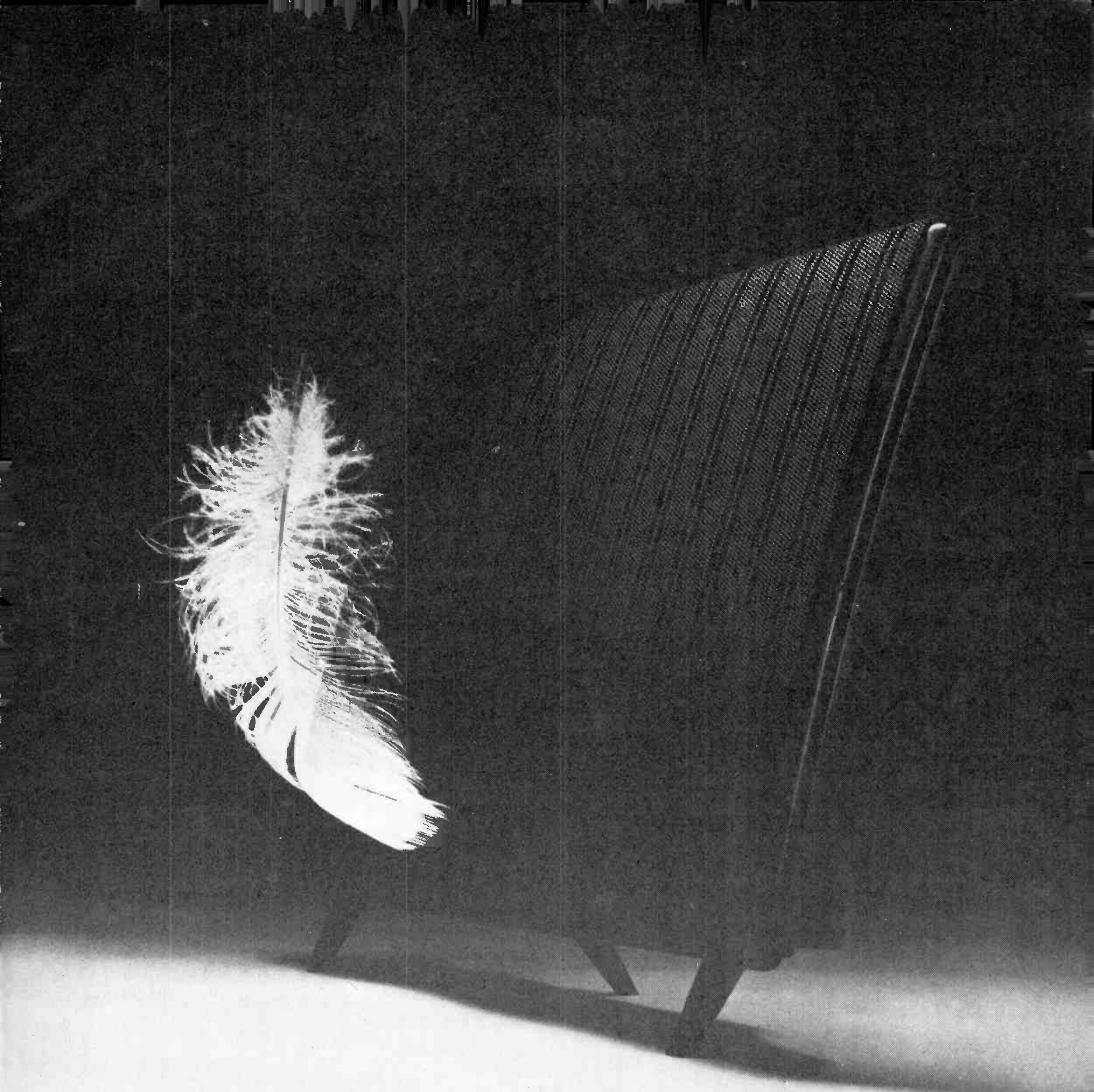

**50/70 watt all silicon amplifier with built-in 5-way mixer using F.E.T.'s.**

# SOUND SENSE = VORTEXION

VORTEXION Design and manufacture public address equipment to meet a range of specific requirements for AIRPORTS, HOTELS, THEATRES, GOVERNMENT AUTHORITIES, LOCAL AUTHORITIES, SUPERMARKETS, SCHOOLS, SPORTING COMPLEXES, POP GROUPS AND THE LOCAL VILLAGE HALL.

The high fidelity amplifier illustrated has bass cut controls on each of the three low impedance balanced line microphone stages and a high impedance gram stage with bass and treble controls, plus the usual line or tape input. All the input stages are protected against overload by back to back low self capacity diodes and all use F.E.T.'s for low noise, low intermodulation distortion and freedom from radio breakthrough.

A voltage stabilised supply is used for the pre-amplifiers making it independent of mains supply fluctuations and another stabilised supply for the driver stages is arranged to cut off when the output is overloaded or over temperature. The output is 75 % efficient and 100 V balanced line or 8-16 ohms output are selected by means of a rear panel switch which has a locking plate indicating the output impedance selected.

The mixer section has an additional emitter follower output for driving a slave amplifier, phones or tape recorder, output 0.3 V out on 600 ohms upwards.

**50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4-WAY MIXER** using the circuit of our reliable 100 Watt Amplifier with its elaborate protection against short and overload, etc. To this is allied our latest development of F.E.T. Mixer Amplifier, again fully protected against overload and radio breakthrough. The mixer is arranged for 2-30/60 Ω balanced line microphones, 1-HiZ gram input and 1-auxiliary input followed by bass and treble controls. 100 volt balanced line output OR 5-15 Ω and 100 volt line.

**100 WATT ALL SILICON AMPLIFIER.** A high quality amplifier with 8 ohms-15 ohms or 100 volt line output for A.C. Mains. Protection is given for short and open circuit output over driving and over temperature. Input 0.4 V on 100 K ohms.

**THE 100 WATT MIXER AMPLIFIER** with specification as above is here combined with a 4-channel F.E.T. mixer. 2-30/60 Ω balanced microphone inputs, 1-HiZ gram input and 1-auxiliary input with tone controls and mounted in a standard robust stove enamelled steel case. A stabilised voltage supply feeds the tone controls and pre amps, compensating for a mains voltage drop of over 25 % and the output transistor biasing compensates for a wide range of voltage and temperature. Also available in rack panel form.

**20/30 WATT MIXER AMPLIFIER.** High fidelity all silicon model with F.E.T. input stages to reduce intermodulation distortion to a fraction of normal transistor input circuits. Standard model 1-low mic. balanced input and HiZ gram. Outputs available 8/15 ohms OR 100 volt line.

**CP50 AMPLIFIER.** An all silicon transistor 50 watt amplifier for mains and 12 volt battery operation, charging its own battery and automatically going to battery if mains fail. Protected inputs, and overload and short circuit protected outputs for 8 ohms-15 ohms and 100 volt line. Bass and treble controls fitted.

Models available with 1 gram and 2 low mic. inputs, 1 gram and 3 low mic. inputs or 4 low mic. inputs.

**200 WATT AMPLIFIER.** Can deliver its full audio power at any frequency in the range of 30 c/s-20 Kc/s. Can be used to drive mechanical devices for which power is 120 watts on continuous sine wave. Input 1 mW 600 ohms. Output 100-120 V or 200-240 V. Additional matching transformers for other impedances are available.

**F.E.T. MIXERS and PPM's.** Various types of mixers available. 3, 4, 6 and 8 channel with Peak Programme Meter. 4, 6, 8 and 10 Way Mixers. Twin 3, 4 and 5 channel Stereo, also twin 4 and 5 channel Stereo with 2 PPM's.

# VORTEXION

**Vortexion Ltd., 257-263 The Broadway, Wimbledon, SW19 1SF.**
**Telephone: 01-542 2814 and 01-542 6242/3/4.**
**Telegrams: "Vortexion London SW19"**

For further information and technical leaflets write to Vortexion

Name

Address

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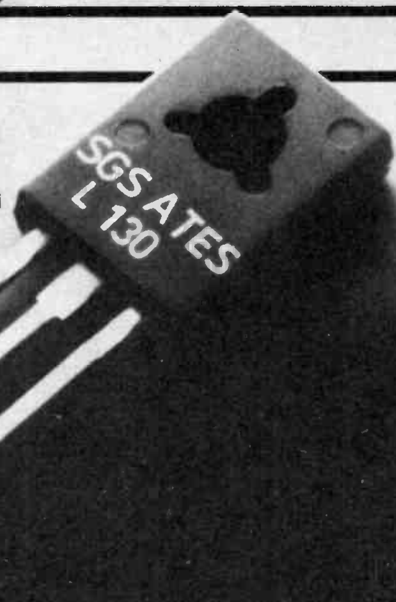
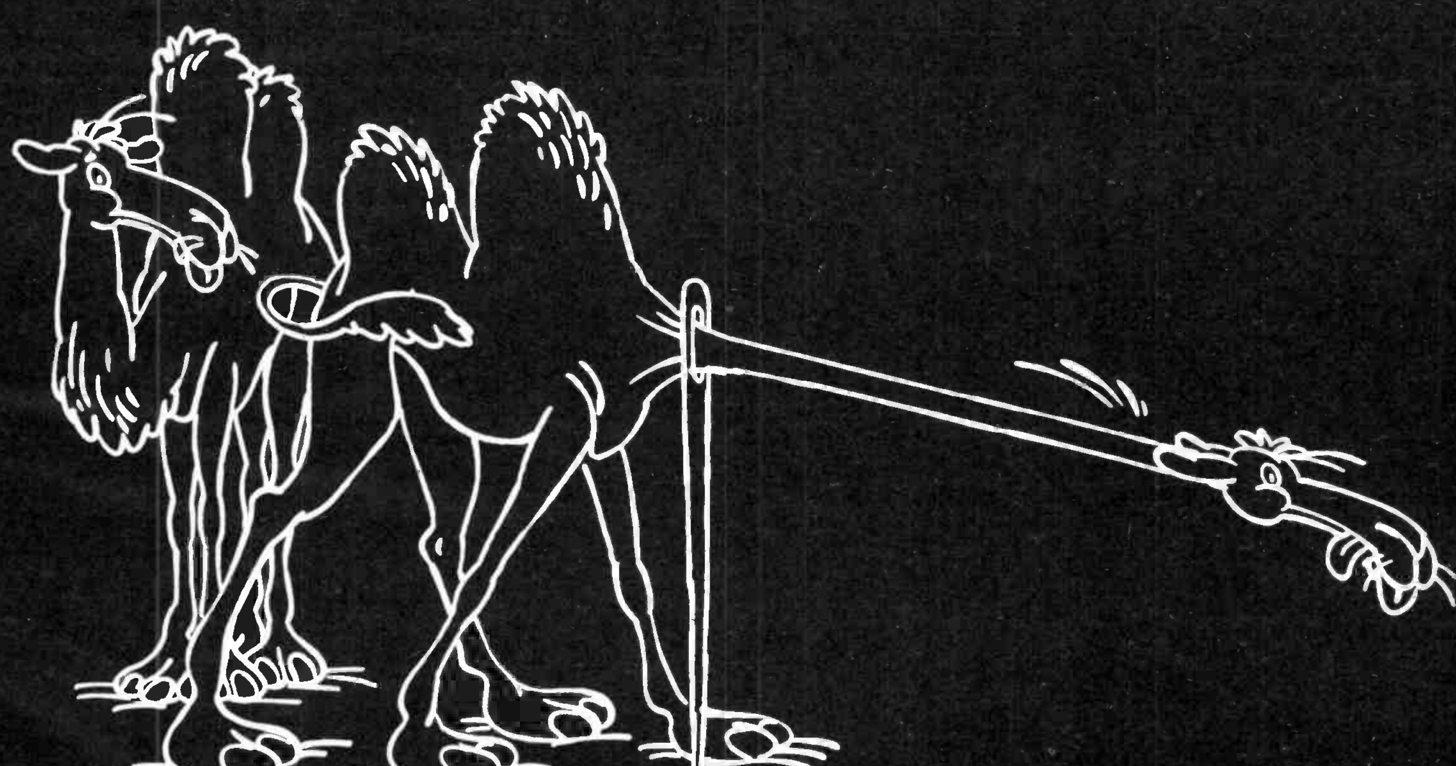
updating from

SGS ATES

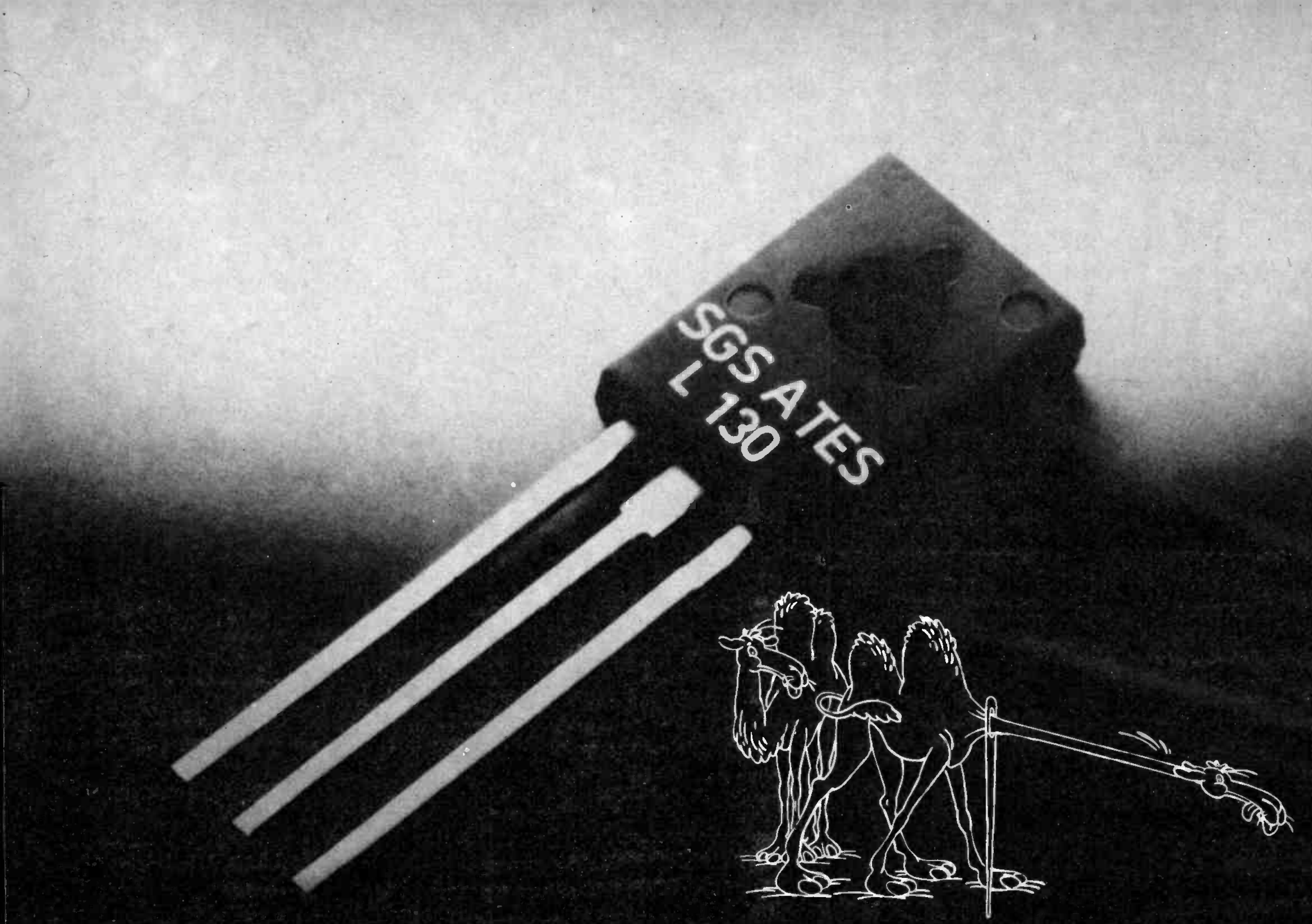
# PLASTIC VOLTAGE REGULATORS




## A regular and constant output



## whatever the input




# Bestselling voltage regulators now in plastic

Following the sweeping success of SGS-ATES' integrated fixed voltage regulators in TO-3 metal can, these circuits are now also available, ex stock, in SOT 32 plastic package.
Designated L129, L130 and L131, they are suitable for low cost applications in professional, industrial and consumer equipment requiring compact components with low/medium output current, such as
- desk calculators
- video displays
- computer peripherals
- touch tuning and remote control for TV sets
- TV subsystems, such as video IF, sound IF, sync and chroma stages

A particularly interesting area of application is in local regulation systems. The main advantages of this circuit technique over traditional single point regulation are the reduction in common ground and inter-circuit coupling, high noise immunity and the elimination of problems due to line voltage drops.

Special features of the circuits include
- tight tolerance on the output voltage
- load regulation less than 1%
- ripple rejection 60 dB typical
- internal overload protection
- short circuit protection

The L129, L130 and L131 are designed to operate in the -20 °C to +85 °C temperature range. For the standard operating temperature range, 0 °C to +70 °C, these plastic voltage regulators are available with type numbers TDA1405, 1412 and 1415.

| -20° to +85 °C | $V_o$ | $I_o$ reg. typical | 0° to +70 °C |
|---|---|---|---|
| L 129 | 5V | 850 mA | TDA 1405 |
| L 130 | 12V | 720 mA | TDA 1412 |
| L 131 | 15V | 600 mA | TDA 1415 |

SGS ATES
(United Kingdom) Ltd.

Distributors in the UK: Distronic Ltd., Harlow, 02796-32947 - Electronic Component Supplies Ltd., Windsor, 07535-68101 - Hawnt Electronics Ltd., Birmingham, 021-3594301 - ITT Electronic Services, Harlow, 02796-26777 - REL Equipment & Components Ltd., Hitchen, 0462-50551 - Quamdon Electronics Ltd., Derby, 32651.

# You could easily make our 12-speed chart recorder faster than you thought possible.

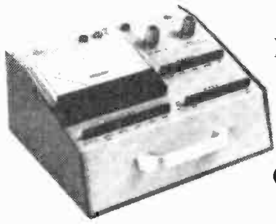
Send away for our 12-speed, 10" chart recorder kit—the IR-18M. And you'll receive a very clear, easy to understand instruction manual with it. Which explains every single step. To make light work of assembly and provide you with a high quality chart recorder a lot quicker than you thought.

And just look what you'll be getting. Multi-speed capability. With fast, pushbutton switch selection of speeds from 5 seconds per inch to 200 minutes per inch. To give you all the versatility you need.

You'll also get two input ranges, giving accurate voltage measurements of 1 millivolt and 10 millivolts full scale. Excellent repeatability. And a full scale pen response time of one second—comparing favourably with many much higher priced recorders. Take a look at the 1G-18 Solid State Sine-Square Wave Generator kit too. Outputs from 1Hz to 100KHz are available using repeatable switch selection.

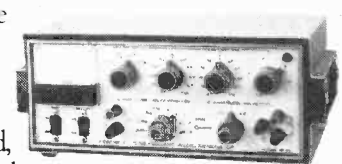
And its sine and square wave outputs are available simultaneously. With less than 0.1% sine wave distortion. And less than 50 ns square wave rise time.

And, for quick accurate testing of diodes, FETs, transistors, SCRs and triacs, there's the IT-121 Tester kit.



You can see these and other Heathkit electronic kits at the London Heathkit Centre, 233 Tottenham Court Road. Or at our showroom in Bristol Road, Gloucester.

Otherwise just clip the coupon and we'll send you the complete Heathkit catalogue.



Faster than you thought possible.

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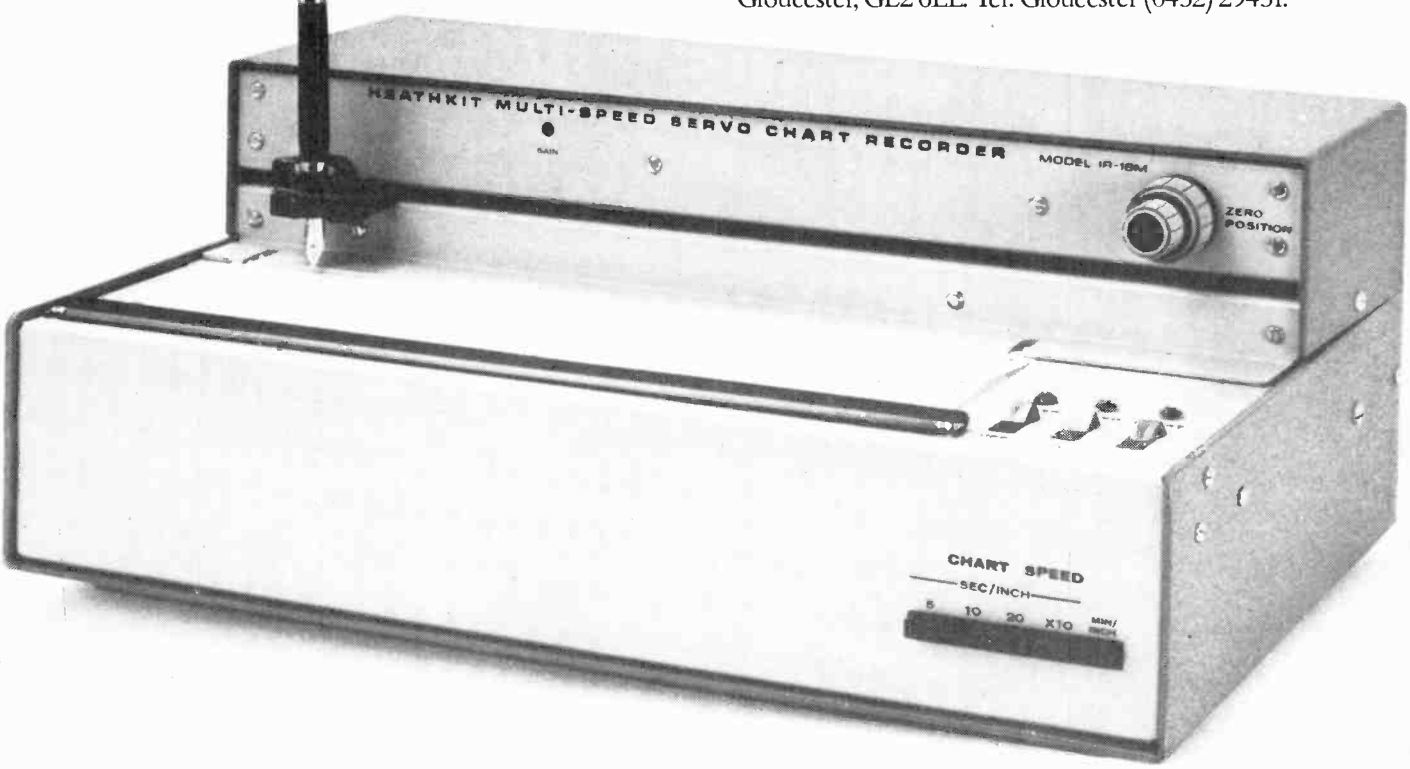


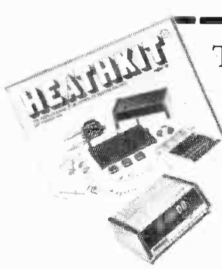


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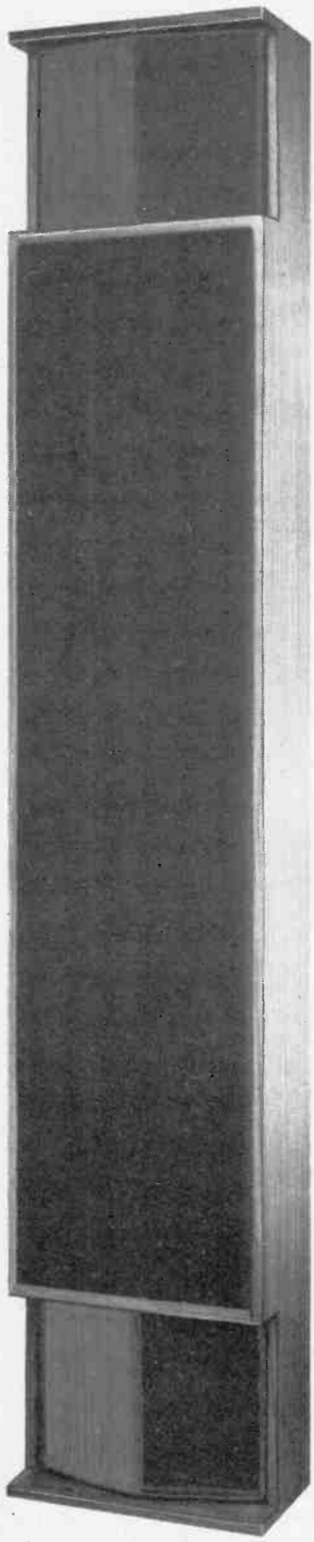
# audix

SOUND SYSTEMS AND ELECTRONICS

# A NEW SERIES OF HIGH PERFORMANCE COLUMN LOUDSPEAKERS

CL 750/H2 75 watts
Theatre Column



CL 300/H2 30 watts

CL 200/H2 20 watts

CL 120/H2 12 watts

A new exciting range of column loudspeakers, designed to combine excellent sound reproduction with good appearance and reasonable price. Cabinets are manufactured from heavy gauge afrormosia timber and are fitted with matched high quality driver units and 100 volt line transformers. The frequency response of the larger columns is maintained to the upper end of the audio spectrum by high frequency driver units, mounted in separate acoustic chambers. A forest green vynair grille completes the assembly and semi concealed brackets permit rapid installation.

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AUDIX LIMITED · STANSTED · ESSEX CM24 8HS
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(4 lines) (STD 0279)

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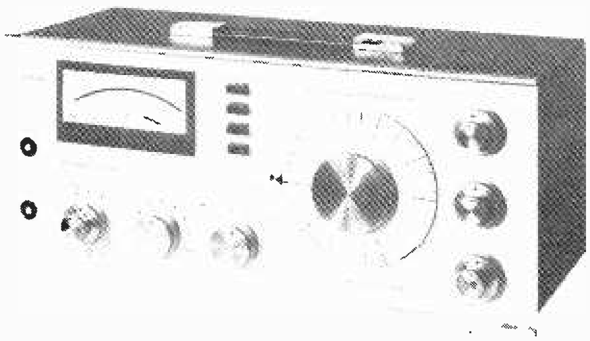
# RADFORD

## AUDIO MEASURING INSTRUMENTS



## LOW DISTORTION OSCILLATOR SERIES 3

A continuously variable frequency laboratory oscillator with a range 10Hz–100kHz, having virtually zero distortion over the audio frequency band with a fast settling time.

| | |
|---|---|
| Specification: | |
| Frequency range: | 10Hz–100kHz (4 bands) |
| Output voltage: | 10 volts r.m.s. max. |
| Output source resistance: | 150 ohms unbalanced (optional 150 ohms unbalanced. plus 150/600 ohms balanced/floating) |
| Output attenuation: | 0–100dB (eight, 10dB steps plus 0–20dB variable) |
| Output attenuation accuracy: | 1% |
| Sine wave distortion: | Less than 0.002% 10Hz–10kHz (typically below noise of measuring instrument) |
| Square wave rise and fall time: | 40/60 n.secs. |
| Monitor output meter: | Scaled 0–3, 0–10, and dBV. |
| Mains input: | 110V/130V, 220V/240V |
| Size: | 17" (43cm) × 7" (18cm) high × 8¾" (22cm) deep |

Price: 150 ohms unbalanced output: £250
150/600 unbalanced/balanced floating output: £300

## DISTORTION MEASURING SET, SERIES 3

*(illustrated above)*

A sensitive instrument with high input impedance for the measurement of total harmonic distortion. Designed for speedy and accurate use. Capable of measuring distortion products down to 0.001%. Direct reading from calibrated meter scale.

| | |
|---|---|
| Specification: | |
| Frequency range: | 5Hz–50kHz (4 bands) |
| Distortion range (f.s.d.): | 0.01%–100% (9 ranges) |
| Input voltage measurement range: | 50mv–60V (3 ranges) |
| Input resistance: | 47K ohms on all ranges |
| High pass filter: | 12dB/octave below 500Hz |
| Power requirement: | 2 × PP9. included. |
| Size: | 17" (43cm) × 7" (18cm) high × 8¾" (22cm) deep |
| Price: | £200 |

*Now available in reasonable delivery time*

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**Bristol BS3 2HZ**
**Telephone 0272 662301**

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Miniature and sub-miniature lamps are Vitality's speciality and the range available is one of the most comprehensive in Europe.

Write for the Vitality catalogue for full details on the range and application notes, or phone us if you have a special requirement for conventional or unusual environments, wherever a light source is needed for illumination, reference, indication or warning.

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VB31

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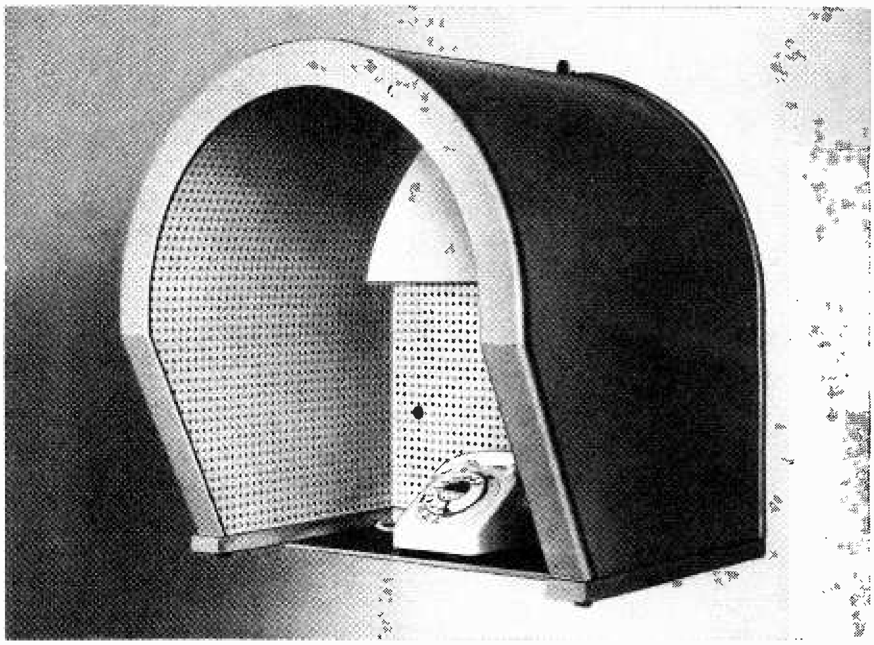
# Whiteley

## Acoustic Hoods



These strongly made hoods for both outdoor and indoor use are designed to specifications which meet Post Office approval. Suitable for desk, shelf or wall mounting, they are available with or without internal light fittings and doors if required.

**WHITELEY ELECTRICAL RADIO CO. LTD.,** Mansfield, Notts, England. Tel. Mansfield 24762. London Office: 109 Kingsway, W.C.2. Tel. 01-405 3074

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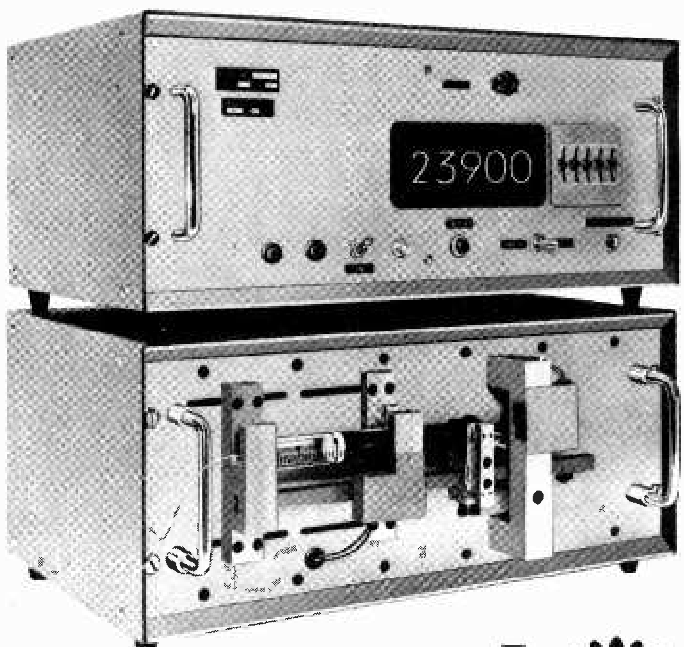
# Digitize that Fluid Input

McLennan Engineering are pioneering in the field of digitized liquid delivery. The equipment illustrated is suitable for medical, veterinary, chemical and general laboratory applications.




**DIGITAL SYRINGE TYPE DS110**

Fluid pulse 1·0 or 10 micro litres
Number of pulses presettable from 1–50,000
Pulse rate 400Hz–1 Hz or ·01 Hz in the case of frequency divider model
Digital 'fluid delivered' display monitors output at all times
External B.C.D. signals can programme the number of pulses
Remote multiple syringe facility
High reliability. Drive designed around Impex stepper motor system.

**OTHER ITEMS MANUFACTURED BY McLENNAN ENGINEERING INCLUDE:**

Digital and analogue servo systems
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If you have a problem in any of the above fields we shall be pleased to discuss your special requirements. Please get in touch – it costs nothing to talk.

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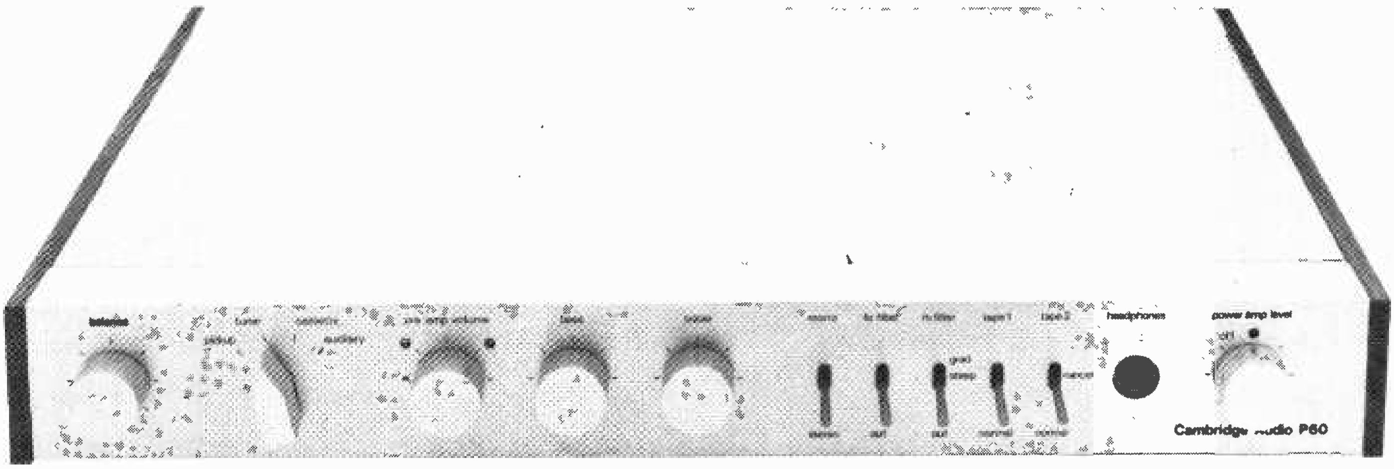
# A WORLD FIRST* FROM CAMBRIDGE AUDIO



## THE NEW P60 INTEGRATED STEREO AMPLIFIER

Low profile design only 2″ high.
Recording with or without tone correction.
*Peak level indicator for tape recording.
Suitable for continual high power operation.
Dual independent tape operation.
*Light Emitting Diodes for level monitoring in main and pre-amplifiers.
Toroidal mains transformer.
Facilities for three tape recorders.
*Separate main and pre-amp gain controls.
Fully protected output stages.
RIAA phono correction unaffected by cartridge inductance.
Ultra low distortion circuits.
*New tape monitoring, A-B and A-B-C facilities.
International state-of-the-art circuitry from Cambridge Audio in Britain.

*To the best of our knowledge these features have never been included in a comparable amplifier hitherto.

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# the image makers

## Potentiometric Recorders


### SE3300 Series

A versatile series of recorders and modules for all applications of potentiometric recording. Single and two pen versions. A choice of writing mechanisms. Input modules for differing sensitivity requirements and many add on function modules eg. AC true RMS, integrating module, etc. Build up from a simple single channel unit to a complex 8 channel dot recorder!

Two new models for A3 operation to be announced shortly!

## X – Y Recorders

### SE225 Mk II

A general purpose X – Y recorder with a good specification at a realistic price. Choice of sensitivity configuration giving a maximum 0.05V/cm on an A4 chart. A compact unit with many features and a specification to equal more expensive recorders. Time base unit gives added versatility and there is also a chart adaptors available.

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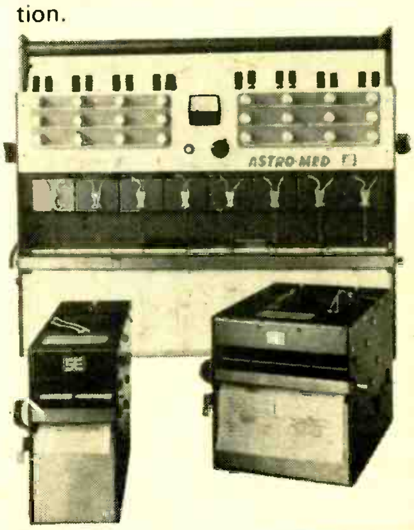
Economical direct write units. Single double, triple channel recorders with vertical or horizontal chart travel. Frequency response to 100Hz Sensitivities 10mV/mm choice of chart speeds; full 50mm pen travel; available in OEM or cased configurations.

## Super 8

Superlative performance from this eight channel pen recorder. Unique variable drive from 0.25 to 100mm/sec. Frequency response to 100 Hz; Sensitivity 10mV/mm; channel width full 50 mm: OEM configuration.

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- Competitive prices.


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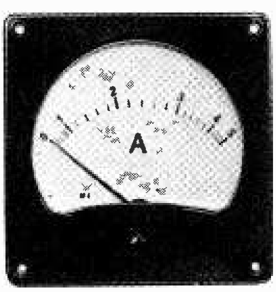
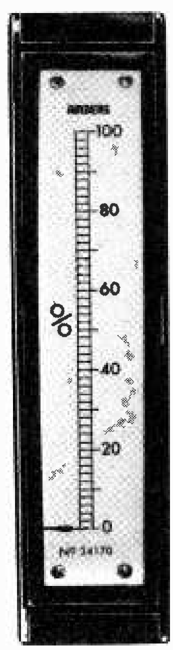
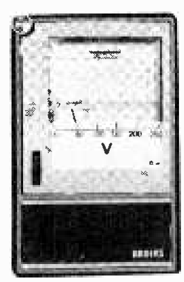
Popular models and ranges are stocked in depth while a specially equipped instrument department enables swift production of non-standard ranges and scales, to suit individual customer requirements, in large or small quantities.



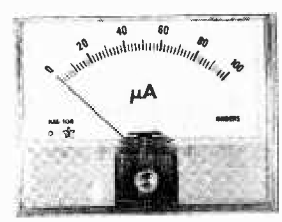

Vulcan Moving Iron. 4 models, 1·5", 1·8", 2·7", 3·7" scales. Voltmeters, ammeters and motor starting meters.




Profile 350 edgewise 4·3" scale. DC moving coil and AC moving coil rectified. Horizontal or vertical mounting.

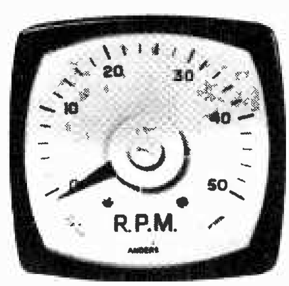



Recorders 60 or 120 mm. charts. Non-ink marking. DC moving coil and AC rectified.




Kestrel Clear Front. 7 models, 1·3" – 5·25" scales. DC moving coil, AC moving coil rectified, AC moving iron.


Regal·Range 100° flattened arc. 2 models 2.5" and 3.2" scales. Taut band. DC moving coil and AC moving coil rectified.




Stafford Long Scale 240°. 6 models, 3·5"—11·5" scales. DC moving coil, AC moving coil rectified, AC moving iron. Also 98° scale.


Lancaster Long Scale 240°. 2 models, 4", 5·5" scales. DC moving coil and AC moving coil rectified.

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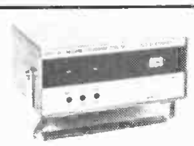
# RCS

## CRYSTAL FREQUENCY STANDARD



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OUTPUTS 1MHz, 100KHz, 10KHz
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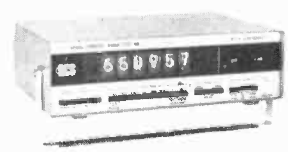

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STABILITY 1 part in $10^6$
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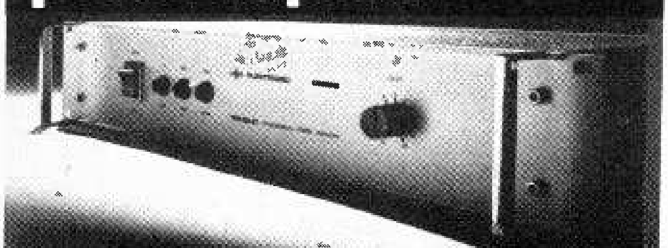
## integrated circuit power amplifier



TPA 50 - D Specification

| | |
|---|---|
| Power Output | 100 watts rms into 4 ohms<br>65 watts rms into 15 ohms |
| Freq Response | ±0·1dB 20Hz to 20KHz into 15 ohms. -1dB at 150KHz |
| Total harmonic distortion | Less than 0·04% at all levels up to 50 watts rms into 15 ohms |
| Input sensitivity | OdBm |
| Noise | -100dB |
| Rise time | 2 u seconds |
| Price | £59 plus V.A.T. |

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

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## Spectrum Analyser Module ST858

**SPECIFICATION: Frequency range** 10 MHz to 850 MHz in two calibrated ranges **Sensitivity** Better than 50 mv for 0.5V per cm **Resolution** Better than 25 KHz. **Dispersion** From less than 1 MHz to 400 MHz variable **Input** Via 50 ohm BNC connector on front panel **Output 1** Coax cable for connection to Y input on scope **Output 2** Coax cable for connection to sync. input on scope **Power requirements** 240 volts AC 50 Hz 10 watts. (Other voltages and frequencies available as required) **Size** Width 11in (28cm.) Height 4.375in. (11.2cm.) Depth 8.5in. (21.6cm.) **Nett weight** 7.5lbs (3.4 Kg) **Gross weight** 10lbs (4.5 Kg.)

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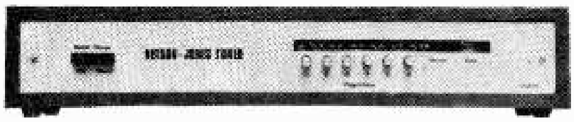
# THE NEW NELSON-JONES FM TUNER



## 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.

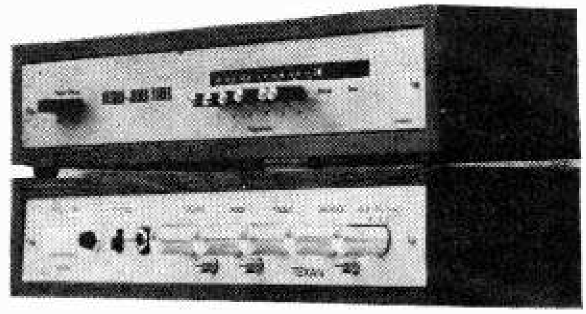
Typ. Specn: 20 dB quieting 0.75uV. Image rejection —70dB.I.F. Rejection —85 dB

Basic tuner module prices start as low as **£12.31**, with **complete** kits starting at **£26.95** (mono) + P.P. 65p. 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 details 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 **£7.02** when bought with a **complete** N-J tuner kit or **£8.29** if bought separately (P.P. 21p.)

**PLEASE NOTE.** Existing tuners are readily convertible and kits/parts are available for this purpose.

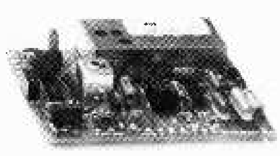
**TEXAN AMPLIFIER.** We have designed the tuner case and metalwork to match the Texan amplifier (see photograph). Complete designer approved Texan kits are available at **£30.78** plus P.P. 65p including Teak Sleeve.



## NEW LOW COST STEREO TUNER Available as basic or complete kits

Basic stereo tuner **£15** post free.
Basic mono tuner **£12** post free.
6 position push button units with integral pots **£2.92**.

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



*VAT at 8% is included in all prices*

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.)

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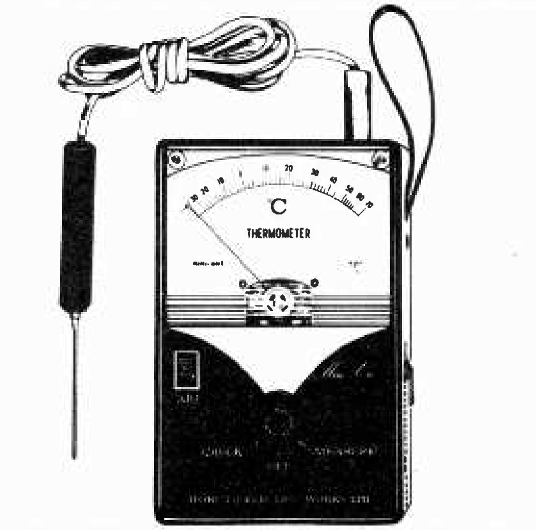


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**TAKES UP ALMOST NO BENCH SPACE.**

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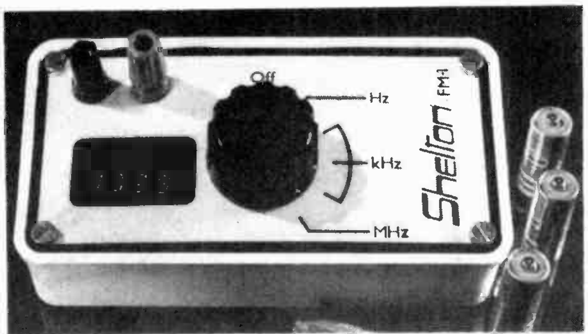
**Mains PSU available which fits inside ready drilled case.**




* Also: FX-1 FREQUENCY MULTIPLIER (X 60,X 100) —see last month's W.W. **£29.50** *

## MINIATURE BATTERY FREQUENCY METER FM-1

**FOUR-DIGIT MEMORY DISPLAY**
**FIVE RANGES**
**4 ppm CRYSTAL**
**SIZE $6\frac{1}{4} \times 3\frac{1}{4} \times 2\frac{3}{4}$ in —including knob and terminals**

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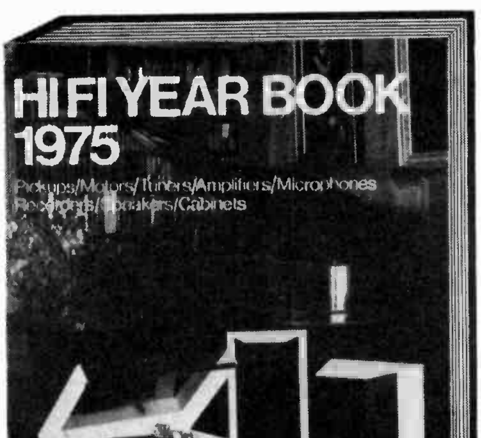


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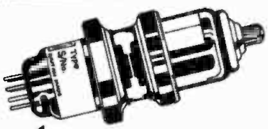
# AEL



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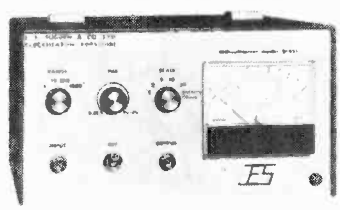
## J E S AUDIO INSTRUMENTATION



Illustrated the Si 451 Millivoltmeter — pk-pk or RMS calibration with variable control for relative measurements. 40 calibrated ranges **£42.50**

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

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Low distortion Oscillator.
Sine — Square — RIAA

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# hurst ELECTRONICS

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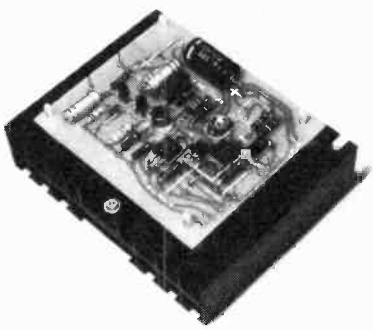
Telephone: 01-567 0424

## HE 100 100 WATT POWER AMP MODULE



- ★ Includes large black anodised heatsink—no further heat-sinks required.
- ★ Top grade glass-fibre P.C.B.
- ★ Uses high quality components.
- ★ Fully protected—short/open circuit proof.
- ★ Only 5 external connections.
- ★ Fully guaranteed.

### TECHNICAL SPECIFICATIONS

| | |
|---|---|
| ★ Power output | : 106W. R.M.S. into 8Ω |
| ★ Distortion | : 0.8% at full O/P. Typ. 0.4% |
| ★ Frequency response | : 15 Hz–23 kHz |
| ★ Signal to noise | : Better than – 96dB |
| ★ Input sensitivity | : 0dB (0.775V) |
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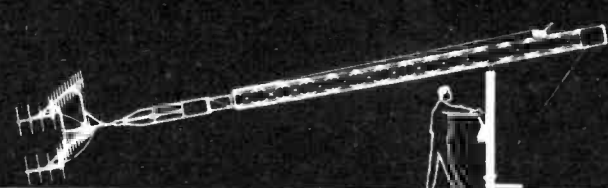

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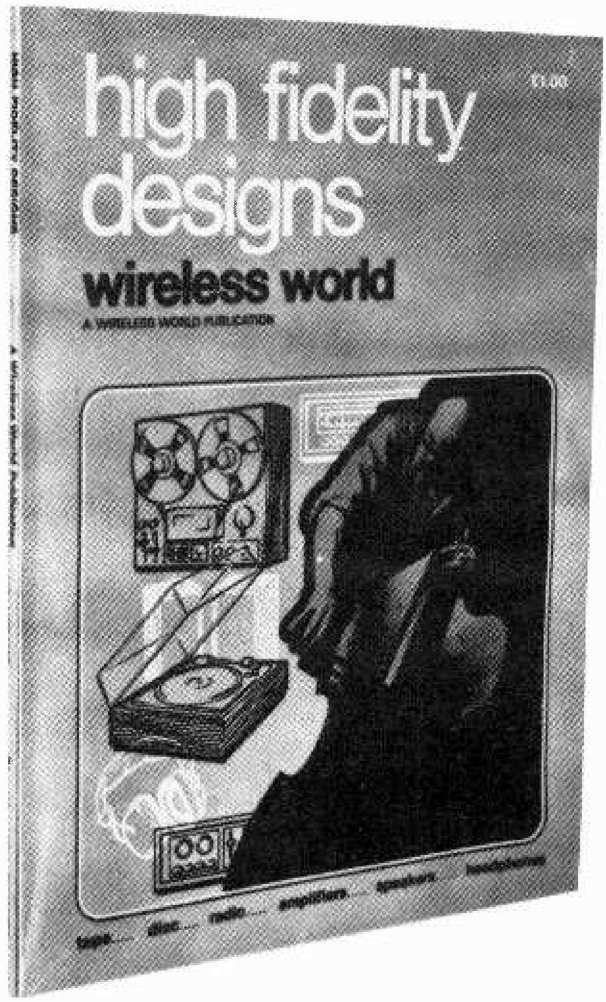


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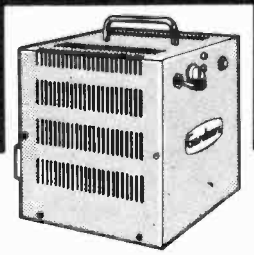

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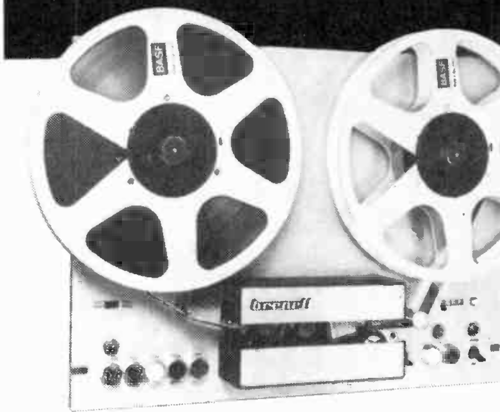

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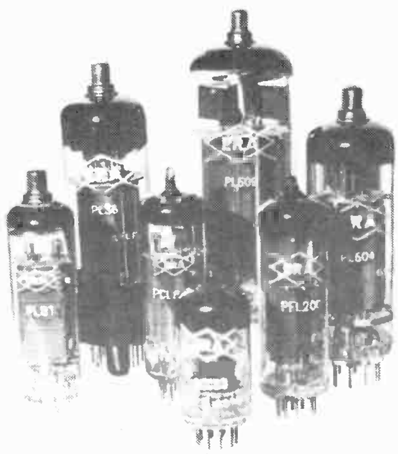

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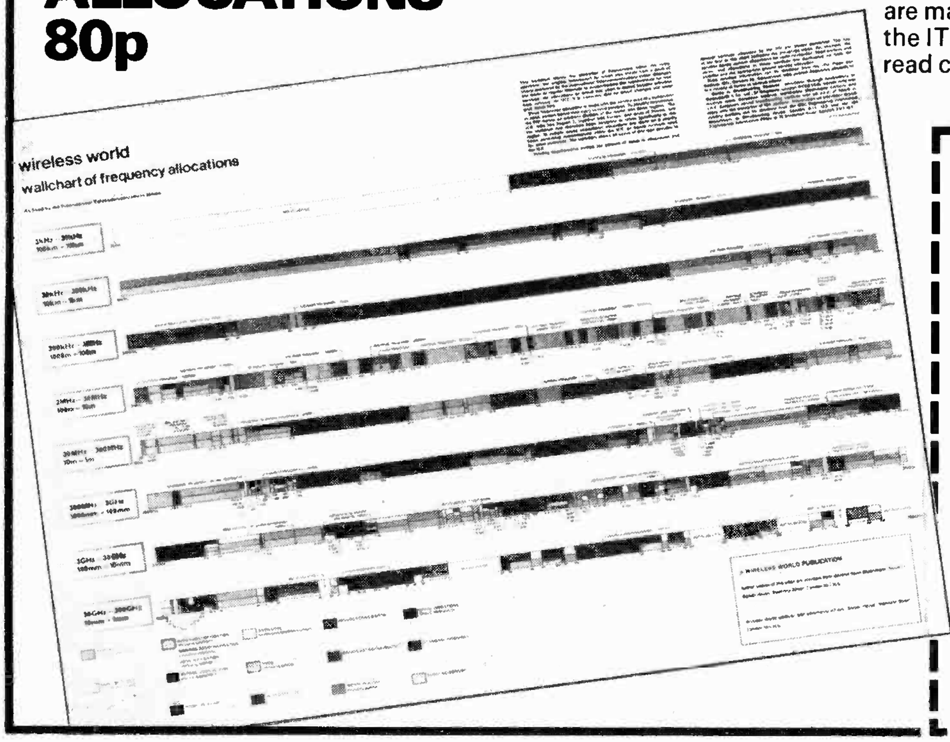


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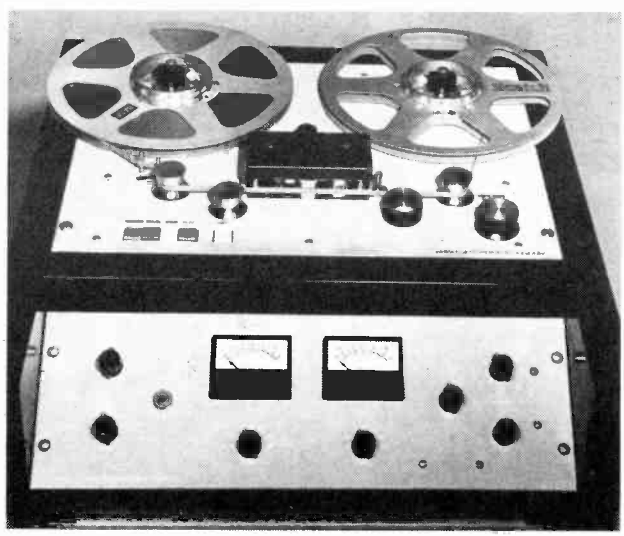

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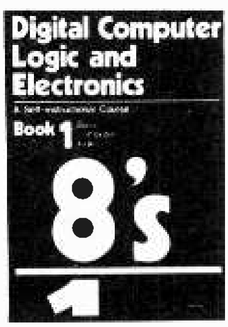


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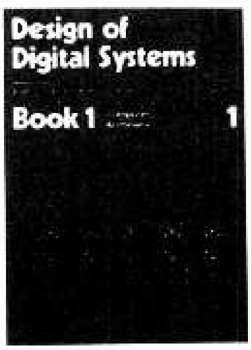


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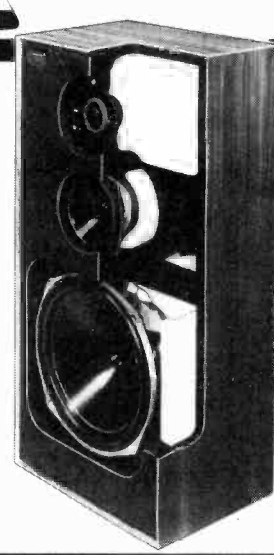

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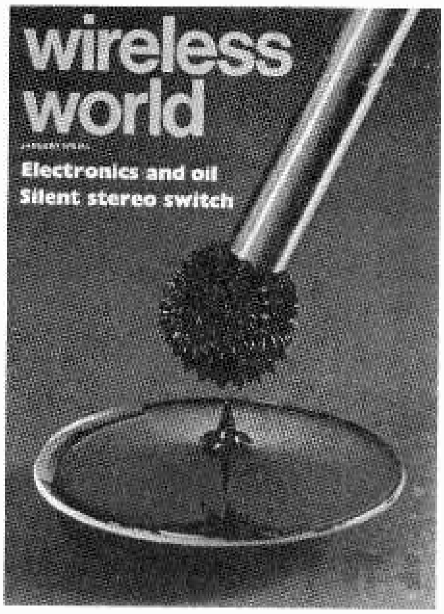


**This month's front cover** picture, from Philips Research Laboratories, shows an oil with extremely finely distributed iron oxide in suspension being attracted to the end of a rod magnet.

## Contents



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## Sharing the spectrum

In the next two years the Annan Committee will be deliberating on the future of broadcasting in the UK. No doubt it will consider the amount and variety of broadcasting that we should have—bearing in mind the new channels in the broadcasting frequency bands that are likely to become available. But there ought to be another committee, with a wider brief, advising Annan on the amount of broadcasting usage of the radio spectrum there should be in relation to the needs of other users. Of course, the block allocations of frequencies for broadcasting, communications etc. are decided by international agreements, but there is still room for manoeuvre by individual national governments. For example the section of the v.h.f. band 87.5 to 100MHz is internationally allocated to broadcasting, but within the UK the section 97.6 to 102.1MHz is at present occupied by Home Office mobile radio users (the fire, ambulance and police services).

The new channels for broadcasting will be available for both sound and television. The mobile radio users mentioned above will be cleared from the 97.6 to 100MHz section, allowing one more national sound broadcasting network to be set up. Furthermore, the BBC, pointing to the even higher frequencies used for v.h.f. sound broadcasting in other countries, has said that "further clearance to 104MHz is most desirable". This would entail moving out the v.h.f. military communications at present in the section 102.6 to 104MHz. In television there is, of course, spectrum space available for a fourth national u.h.f. network (sometimes incorrectly called a "channel"), the use of which has yet to be decided; and when the present 405-line transmissions in bands 1 and 3 are shut down there will be room here for two more networks of near national coverage or a large number of local television stations. In general the broadcasters' attitude seems to be "we keep what we hold" but the BBC has publicly shown itself to be sensitive about the wasteful duplication of its sound (m.f./l.f. and v.h.f.) and television (v.h.f. and u.h.f.) programmes, which can only be justified on historical grounds and the laudable desire to keep faith with certain groups of listeners and viewers.

It is, of course, mainly the mobile radio manufacturers and users who are interested in these v.h.f. and u.h.f. parts of the spectrum. They are very much aware that in the USA the FCC has recently made available 115MHz of additional space for mobile users in the 900MHz bands. A bold suggestion from one British company is that the broadcasters might be prepared to surrender some of bands 1 and 3 "in exchange for the extended band 2".

The greatest problem of any spectrum advisory committee would be how to weigh against each other the requirements for spectrum space of very different types of users. How is society's need for entertainment, for example, to be balanced against society's need for telecommunications? Such value judgements are in fact already being made because they are implicit in the existing frequency allocations. But they are made under the influence of politicking by interested parties and to this extent it is doubtful if they reflect the true needs of society.

# Classifying f.e.ts

## "A unified view of the f.e.t. jungle"

by B. L. Hart

*North East London Polytechnic*

A field effect transistor (f.e.t.) is a semiconductor device in which the flow of charge carriers in a "channel" between two terminals, designated source and drain, is controlled by a transverse field resulting from the application of a potential difference between one of these terminals and a third, control, terminal known as the gate. This definition is a convenient starting point and can be extended to include those devices having two gates. The manner in which the control function is achieved, without the requirement of significant d.c. input power, permits a division of f.e.ts into two basic categories, each of which can be further sub-divided.

### Junction-gate f.e.t.

The voltage applied to the reverse-biased p-n junction associated with the gate terminal determines the thickness of the junction depletion layers and this alters the effective dimensions of the conducting channel. The conducting channel may be p-type or n-type material. The jugfet is also known as a j.fet, p-n f.e.t., and sometimes, confusingly, just f.e.t.

### Insulated-gate f.e.t.

The voltage applied to the gate terminal determines the charge induced in a semiconductor material which is electrically insulated from the gate. The induced charge can either establish a conducting channel where none existed before, which is the case with the p- and n-channel "enhancement-mode" devices, or modulate the conductivity of an already existing or built-in channel. This is the case with the p- and n-channel "depletion mode" devices.

Early igfets were made using established bipolar integrated-circuit processing technology and, as a result, had a metal gate and an oxide insulator. This led to the description most (metal oxide semiconductor transistor) or mosfet. Although metal and oxide are not always used mosfet has tended to be used interchangeably with igfet as a generic description of this device type. Cisfet (conductor, insulator, semiconductor) is, arguably, the best description of this group but because of past usage the former terms are unlikely to be displaced.

### General d.c. description

The pear-shaped symbol, shown at (a) opposite, represents an f.e.t. of unspecified type; the arrows represent the sign convention for positive $I_{DS}$, $V_{DS}$, $V_{GS}$. The relevant family of $|I_{DS}|$ versus $|V_{DS}|$ characteristics is shown at (b), opposite. It is apparent that $|I_{DS}| \approx 0$ at $V_{GS}=V_\gamma$; $V_\gamma$ is thus a cut-in, cut-off, or a threshold-of-conduction voltage. For the jugfet, $V_\gamma$ is usually known as pinch-off voltage and written $V_P$, whilst for the igfet $V_\gamma$ is normally referred to as the threshold voltage and written $V_T$. The form $|I_{DS}| \approx 0$, is used because $V_\gamma$ is often conveniently measured at some specified low leakage current level of a few μA.

When $|V_{DS}|<|V_{GS}-V_\gamma|$, the f.e.t. operates in the pre-pinch-off, triode, ohmic, or voltage saturation region. For $|V_{DS}|>|V_{GS}-V_\gamma|$, the f.e.t. operates in the pinch-off, constant-current, current-saturation, or pentode region and since the curves are parallel to the $V_{DS}$ axis we can write an expression for $I_{DS}$ which does not involve $V_{DS}$:

$$I_{DS}=\lambda(V_{GS}-V_\gamma)^2$$

in which $\lambda$ is a device parameter dependent on material type, doping level, and geometry. The polarities of the quantities in this relationship for the six possible types of f.e.t. are given in the accompanying table.

| Device type | Carrier type | $\lambda$ | $I_{DS}$ | $V_{DS}$ | $V_{GS}$ | $V_\gamma$ |
|---|---|---|---|---|---|---|
| n-channel enhancement igfet | electron | + | + | + | + | + |
| n-channel depletion igfet | electron | + | + | + | +/− | − |
| n-channel jugfet | electron | + | + | + | − | − |
| p-channel jugfet | hole | − | − | − | + | + |
| p-channel depletion igfet | hole | − | − | − | +/− | + |
| p-channel enhancement igfet | hole | − | − | − | − | − |

The device d.c. relationship with appropriate parameter signs is the basis of the f.e.t. classification chart opposite, which links the transfer characteristic with symbolic representation and a simple cross-section of device construction. Note that the device is only on and in the pinch-off mode for that part of the $I_{DS}$, $V_{GS}$ parabola which has a positive slope.

The symbols shown, though not used in all f.e.t. literature, are strongly recommended because they permit instant recognition of device type without supplementary explanation. A thick continuous line connecting s and d indicates that for $V_{GS}=0$ $|I_{DS}|=|I_{DSS}|>0$. All devices so drawn are termed depletion f.e.ts. In some texts depletion-mode igfets are referred to as normally-on or depletion/enhancement devices, but this can be confusing and is not recommended. A thick broken line connecting s and d indicates that for $V_{GS}=0$, $|I_{DS}| \approx 0$; as a result such a device has been referred to as a normally-off igfet.

A horizontal arrow connected to a perpendicular line section indicates a p-n junction. The direction of the arrow is from p to n. Thus, an n-channel jugfet has a p-type gate. In the case of a p-channel enhancement igfet the arrow points from the p-type induced channel to the n-type substrate.

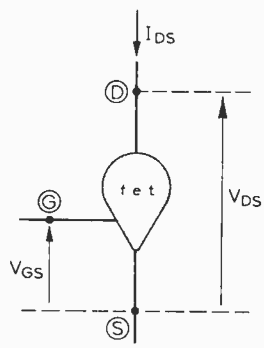
The horizontal section of the gate terminal is on the same level as the source. The igfet gate has a vertical section isolated from the rest of the device to emphasise the insulated nature of the terminal. The substrate, shown as b for bulk on the symbol, is sometimes internally connected to the source and in such cases the substrate is often not shown. When the substrate terminal is at the disposal of the circuit design engineer it must be connected to a potential which ensures that both the drain-substrate and source-substrate junctions never become forward biased. For n-channel igfets this is often, conveniently, the most negative potential in the circuit whilst for p-channel types the most positive potential in the circuit is appropriate.

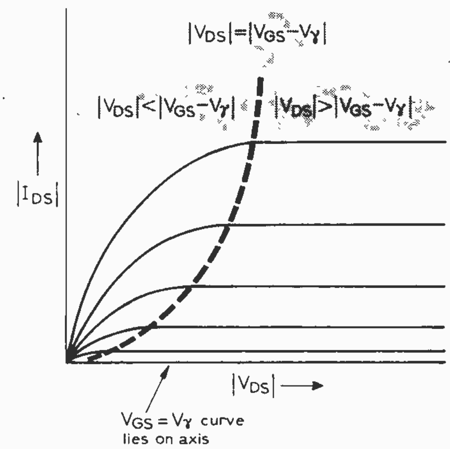
*Fig. 1. (a) F.e.t. of unspecified type, (b) Drain-source characteristics for (a).*

*Fig. 2. F.e.t. classification chart showing device inter-relationships.*

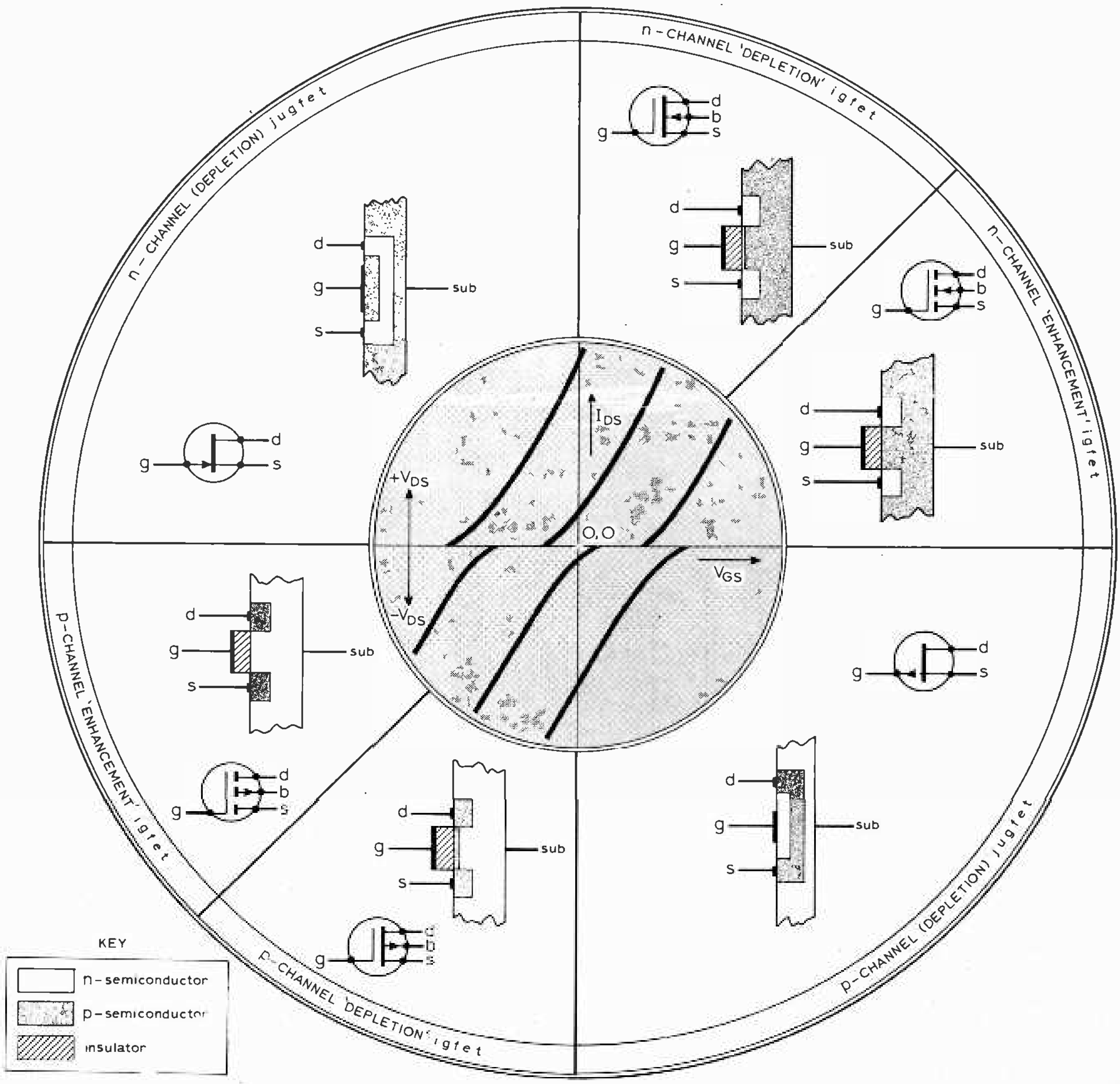
*Transfer characteristics refer to "pinch-off" region. Channel type, whether initially "built-in", or induced always has the same polarity as the semiconductor material in contact with the source terminal.*

(a)

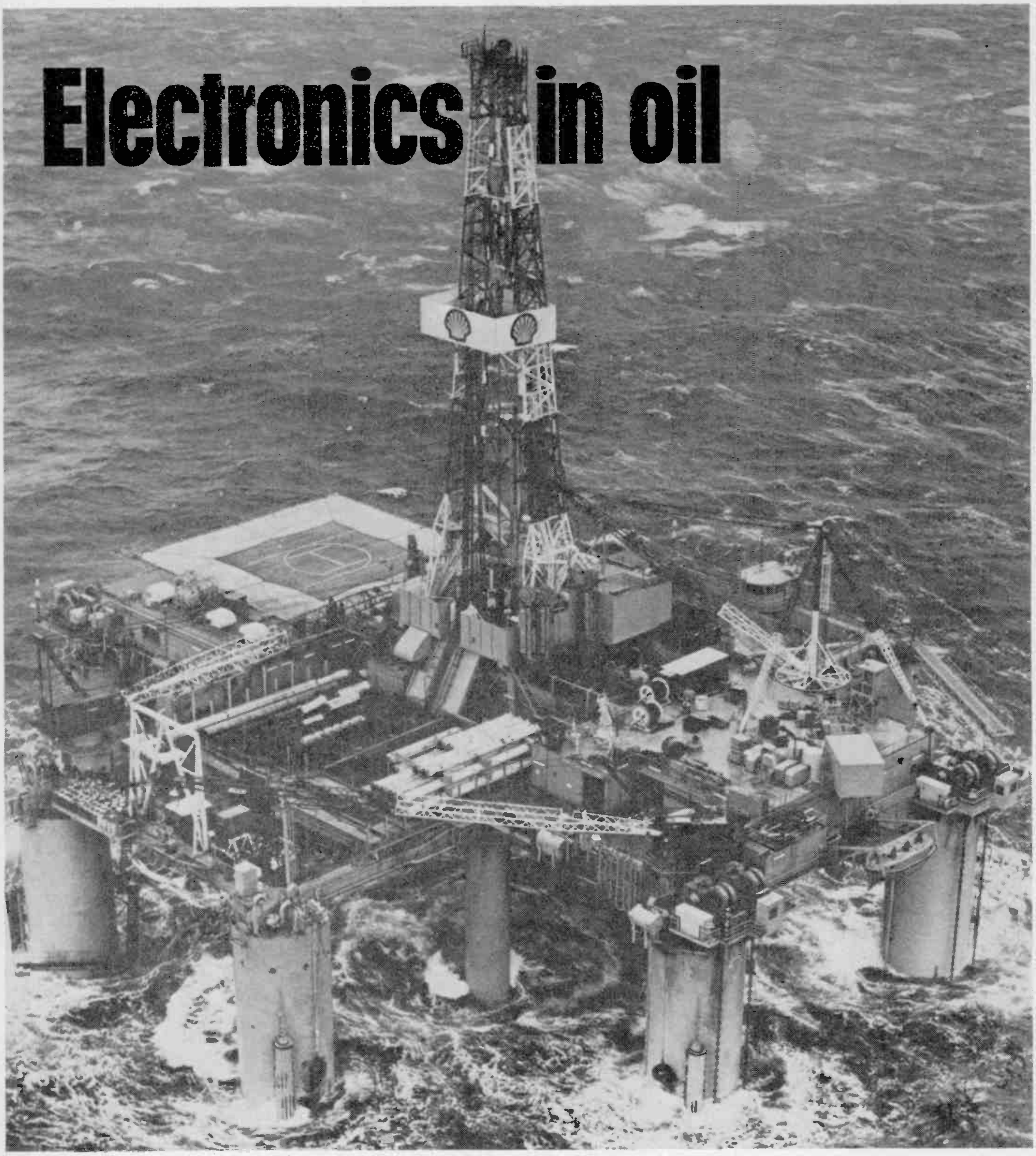

IDS
D
G
fet
VDS
VGS
S


|VDS|=|VGS−Vγ|
|VDS|<|VGS−Vγ|
|VDS|>|VGS−Vγ|
|IDS|
|VDS|
VGS = Vγ curve
lies on axis

(b)


n−CHANNEL 'DEPLETION' igfet
n−CHANNEL 'ENHANCEMENT' igfet
p−CHANNEL (DEPLETION) jugfet
p−CHANNEL 'DEPLETION' igfet
p−CHANNEL 'ENHANCEMENT' igfet
n−CHANNEL (DEPLETION) jugfet
d
b
s
g
sub
IDS
+VDS
−VDS
O,O
VGS
KEY
n−semiconductor
p−semiconductor
insulator

# Electronics in oil



by W. E. Anderton
*Assistant Editor, Wireless World*

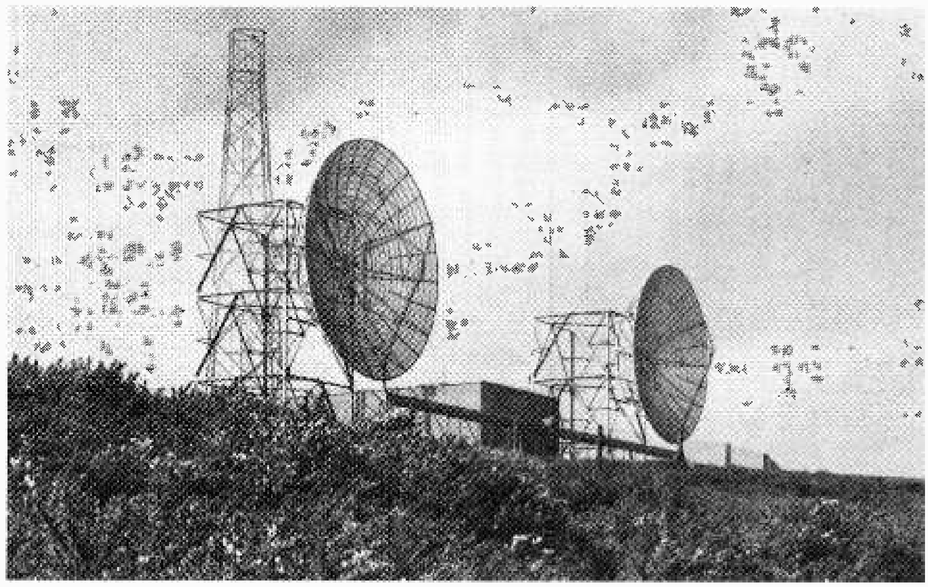
**A survey of the electronic systems used in the search for and recovery of oil under the sea—communications, telemetry, navigation and data collection with a brief look at special developments such as dynamic stationing of vessels and the national data buoy.**

Before we look at the role played by electronics and communications and how these systems are achieved, the scene must be set to reveal what conditions have encouraged the growth of the special and vital systems now in use for the discovery and recovery of undersea oil.

The type of drilling installation used (platforms, barges or ships on which drilling rigs are mounted) depends upon the depth of the sea and possible storm conditions. A jack-up unit—so called because the drilling platform is jacked up on legs (which rest on the sea bed) to above the water level—is normally used in less than 200ft of water. This type of installation is highly stable but can be moved only in calm seas and wasted time in waiting for these conditions may therefore run into several weeks. In deeper water, which will be typical of most future UK offshore operations, a floating installation will have to be employed, either a drill ship or a semi-submersible. A drill ship is fitted with a rig which operates through an aperture in the middle of the vessel or, in some cases over the ship's side. A semi-submersible, as the name suggests, has submerged pontoons which support the working deck well above wave level.

Floating installations are normally anchored to the sea bed, although dynamic

*Tropospheric scatter aerials at Brimmond Hill which serve the B.P. platforms in the Forties Field (Marconi Communication Systems photograph).*



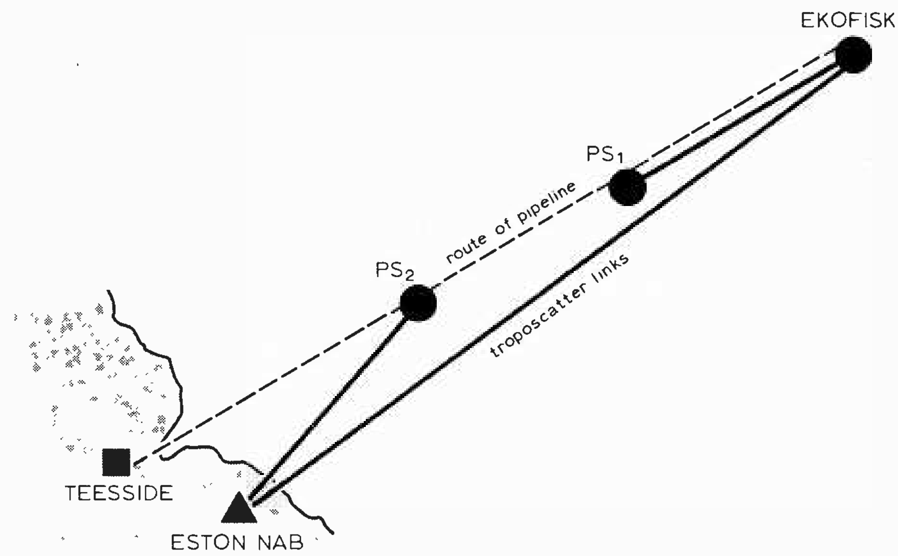



*Fig. 1. Tropospheric scatter link from the Phillips Group field production facilities at Ekofisk to the crude oil terminal facilities at Teesside (PS—pumping station).*

positioning (explained in detail later) by propellors appropriately oriented to counter the effects of wind and current is now used. However, in the waters around Scotland, where very high waves and winds may occur, keeping the platform in position is a major problem whatever method is employed.

Of the installations now available, only the semi-submersible can operate in Scottish waters during the winter months, and then only with difficulty; drill ships are less able to smooth out wave-induced vertical rig movements and can operate only during the summer season. To help overcome these difficulties, a new generation of large semi-submersibles is being built and the number of exploration installations at work in the UK sector of the North Sea is now about 25.

To put the cost of these operations into this background perspective, the new generation of installations will cost about £10m each to build, and with the associated supply boats, helicopters, etc, as much as £20,000 per day to operate. To drill a 10,000-ft well in 60 days, a company would have to lay out more than £1M.

In the North Sea, the ratio of successful wells to wells drilled is reasonably good (about one to six) but the ratio of commercially viable wells is only 1 to 20 or less, so that £10M–£30M may have to be spent on a drilling before a commercial oilfield is discovered. Luck enters into it as well. Some licensees may spend this sum of money and still find nothing. Finding a field is just the end of the beginning and two or three more wells at least have to be drilled to determine whether or not the field is commercial.

The cost rises rapidly in proportion to the water depth. In deep water (e.g. the 500 or 600 feet of water off the Shetlands), it could rise to more than £40M. No platform has yet been constructed in such a depth of water anywhere in the world, and, although it is technically feasible, the immense cost has prompted a search for alternative methods. An entirely new field of technology is therefore emerging encompassing such developments as completing the well under water (without the need for a fixed platform) by remote controls, or using two-man submarines fitted with remotely operated arms, or a diving bell which locks onto a capsule enclosing the wellhead, so enabling the technician to work as if on land.

### Communications

In the beginning, both needs and available facilities were simple—a straightforward radiotelephone link. Now the main service is provided by independent-sideband equipment which caters for the simultaneous transmission of radioteleprinter on upper-sideband and radiotelephony on lower-sideband operating through special Post Office terminals at Humber and Stonehaven for rigs in the North Sea.

The radiotelephone and teleprinter are the two main types of communication link between the oil rig and the shore. A typical system supplied by Marconi Marine consists of independent-sideband or upper-sideband only installations. The former permits simultaneous operation of both radiotelephone (l.s.b.) and teleprinter (u.s.b.) while the latter system allows both types of transmission but requires switching from one to the other.

Frequency shift keying is a modulation method used for teleprinter operation. For the mark/space teleprinter code an audio tone is deflected from "side to side". The teleprinter however generates positive or negative d.c. for transmission and requires the same for reception. To convert from d.c. into frequency shift keyed audio tones and vice versa, a voice frequency telegraph unit is required. Automatic high-speed telegraphy, particularly when used for data telex transmission requires the highest standard of accuracy possible. The Post Office's specification W6652 calls for the fitting of single-path error correction equipment. A technique for satisfying this condition effectively doubles up on the normal teleprinter code to provide a "checking" signal with which the required signal can be compared. The result is a substantial improvement in accuracy on noisy transmission/reception paths. Tropospheric scatter systems also play a large part in rig-to-shore communication, explained in detail later.

Most communications from the oil rig to its supply vessels are carried out via v.h.f. links, but while rig to ship communication requires frequency modulated v.h.f., rig to helicopter radiotelephony requires amplitude modulated v.h.f. Usually only one or two channels in the band 121–123MHz are necessary.

### Microwave systems

Telemetry systems provide vital information on the status of the pipeline, on supply, demand and product quality, providing control at any point. On land, telemetry information is generally carried over a conventional telephone circuit by connection into the local network, or provided by a special cable or radio-relay system. The communication link is vital, particularly in an emergency and the cable system must provide alternative routing and the radio relay system include independent standby equipment. Conventional relay links provide a solution to communication problems so long as the platform is within "line-of-sight".

Oversea paths are generally engineered with vertically spaced antennas to provide a diversity system, whereby when one antenna receives a low signal, the other is brought into use. The permissible offshore distance is thus dependent upon the available shore height and antenna spacing, the facility for both being strictly limited on most platforms because of the additional loading and hazard that the antennas present to helicopters. Whether the operating frequency is in the v.h.f., u.h.f., or s.h.f. band, the limit range for antenna heights of 30 to 60m will be 30 to 50km, a shore height of 300m extending the range to 80 to 100km.

Many offshore developments of which the North Sea is a particularly interesting example, are well in excess of the line-of-sight limit and the signal diffracted beyond the horizon is rapidly attenuated. As the diffraction loss becomes prohibitive in terms of effective radiated power, the scattered signal takes over. To provide the required service, typical data error rates must be in the order of not more than 1 in $10^5$ for 99.99 per cent of the time.

North Sea scatter communications operate in the 2.5GHz band.[1] Six- and nine-metre paraboloids give gains of 41.5 and 45dB respectively, which with 1kW amplifiers produce effective radiated powers of 10 to 30MW. With modern uncooled parametric amplifiers having noise figures of 2dB, quadruple diversity receivers with i.f. combining and threshold extension techniques, an f.m. threshold of −140dB or better is achieved. A path loss of 250dB can be tolerated before the error rate becomes significant, corresponding to a range of 300km with the required 99.99 per cent circuit availability.

There is one outstanding problem affecting both radio relay and scatter communication links particularly relevant to the North Sea, the phenomenon of ducting. For short periods of time, signals far beyond the horizon may exceed the free-space value; the normally insignificant over-shoot to other stations may assume levels of serious interference. The distance between stations operating on the same frequency must ensure protection against both the scattered and the ducted signals.

Although the communication bands are very wide, the large number of users and the wide-band transmissions involved call for maximum economy in channel allocations. Thus many radio-relay systems carrying television and telephony traffic have a bandwidth of 30MHz, as wide as the whole h.f. band. The use of frequency diversity for both the line-of-sight and scatter links, occupying two channels for the same traffic, is being discouraged in favour of space diversity.

The scatter system often uses two antennas at each end, providing four physical paths. The two transmitters must be identified by the respective receivers by virtue of their different frequencies or, with single frequency links, the polarization of the two transmissions.

One of the latest troposcatter links is being established between the North East field called Ekofisk and the coastline near Teesside. The system provides for two 40ft dish antennas to be erected on the 800ft hill at Eston Nab along the coast just south of Teesside, with feedhorn arrays angled towards Ekofisk and towards one of two pumping stations, 70 miles off the coast. Similarly at Ekofisk, two 30ft dish aerials will be built with feedhorn arrays towards Eston Nab and towards the other pumping station, 70 miles from Ekofisk. Two 20-ft dishes will be installed at Pumping Station I and two 12-ft dishes at Pumping Station II both sited along the piping line. Each dish antenna will have two dual polarized feedhorns to provide for quadruple diversity operation—dual space and dual polarization techniques combined to provide four separate radio paths without using additional frequencies.

The main link is to provide a basis for 72 telephone or telegraphy channels, while the pumping stations' links will carry 12 channels with a capacity of 24. Both major stations will operate at 1kW transmitter power but the links with Pumping Station II will have 2W output from Eston Nab and 2W on the return path. Transmitted power from Ekofisk to Pumping Station I will be 20W.

## Accuracy in navigation

Marine seismic surveys are the commonest method of initiating exploration for offshore oil or gas fields which are indicated by certain geological formations. Sound waves are transmitted through the water and sea-bed and the reflections are recorded and analyzed to give a picture of the geological structure. The most favourable sites to drill and the depth at which prospective reservoir rocks are expected to occur are indicated by this picture, taken in conjunction with any other available information such as data on regional geology.

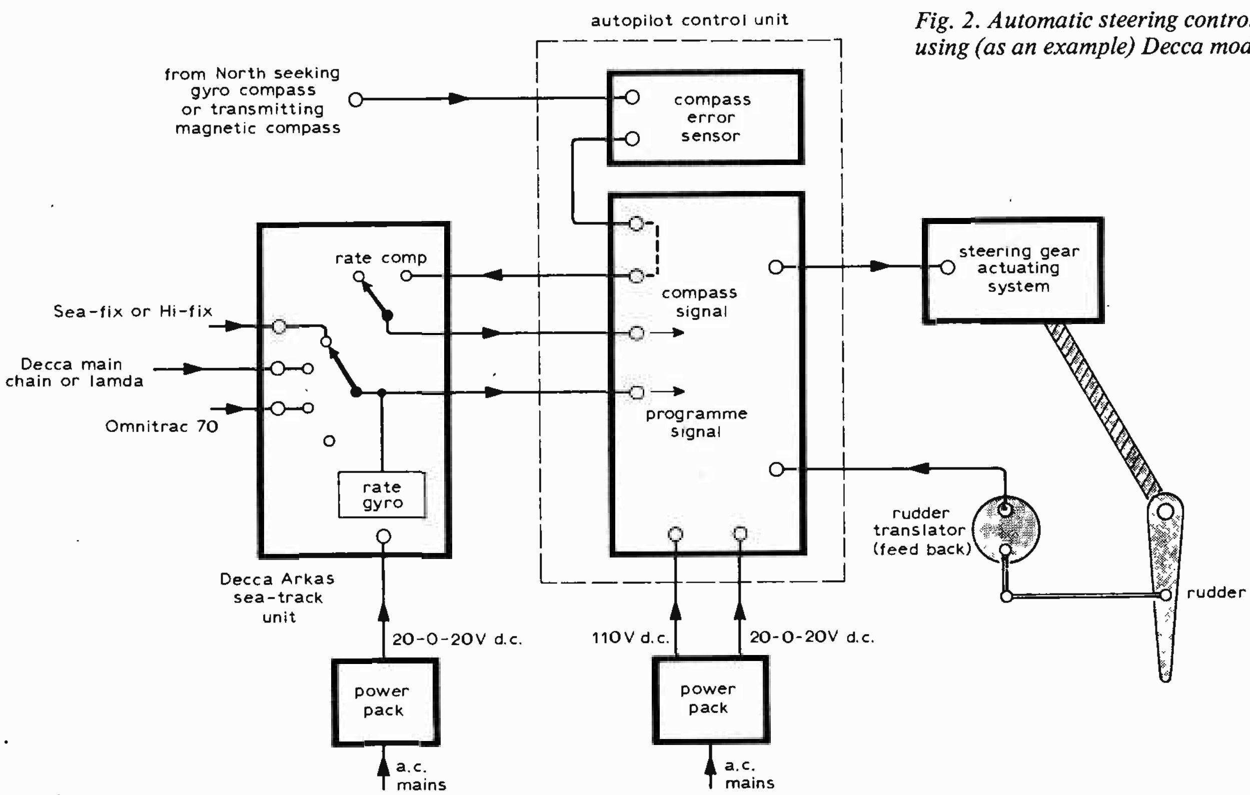



*Fig. 2. Automatic steering control system using (as an example) Decca modules.*

During the survey procedure it is essential that the area surveyed should be fixed and marked accurately, hence use has to be made of an accurate navigational system so that the survey ships know where they are, coupled with an equally accurate underwater system to define the limits of the area surveyed and to enable ships and drilling rigs to return to the same spot each time.[2]

Accurate navigation when reasonably close to the land can be obtained by a radio hyperbolic or ranging system. There are a number of such systems on the market, but in the North Sea surveys are often carried out using the Decca Survey Hi-Fix system. The present system consists of three shore stations working in the band 1700 to 2000kHz. All three use the same frequency and transmit one after another. Receivers on board the survey ships measure the phase difference of the received continuous wave from two of the stations and so position themselves on a hyperbola. Then a further hyperbola is obtained using the third station and one of those already used. Where the two curves intersect is the ship's position. Hi-Fix has a range of about 150 miles and will produce a position accurate to within two metres under optimum conditions. Decca Survey have just developed an even more accurate system, known as Hi-Fix 6. This consists of up to six stations on-shore, all employing the same frequency.

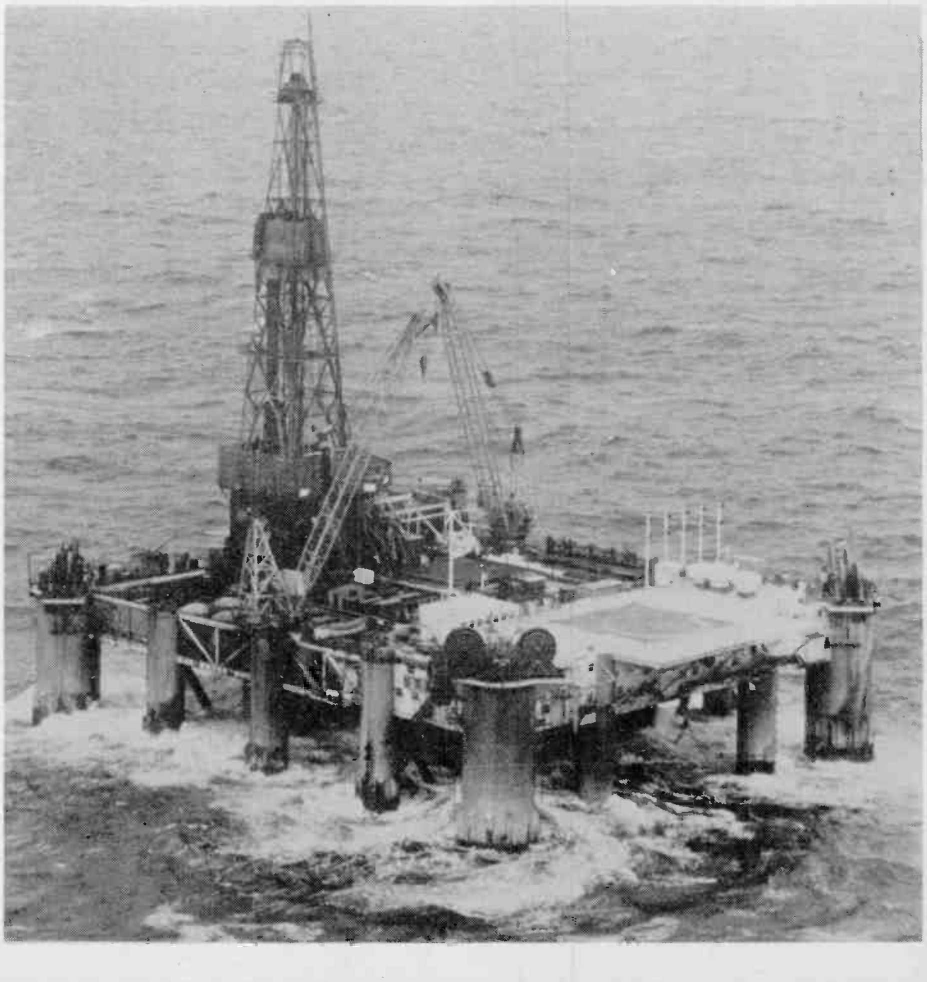
For underwater fixing some form of transducer that can be activated by a ship's sonar is used. Such a system is particularly valuable when working at the limit of a radio hyperbolic system. Two or more transponders may be laid on the sea floor in known positions and ships interrogate them with their sonars. The transponders are triggered off and transmit return pulses. By measuring the time between the transmission of a pulse of energy and the reception of the transponder's return and noting the bearing on which the transmission was made, the ship's bearing and distance from the transponder can be deduced and thus the ship's position. By using more than one transponder a check can be made and an accurate position found. The transponders have a life of three to three and a half years and can be laid permanently in selected positions as navigational beacons, either for use when surveying or for positioning rigs or platforms.

To obtain an overall picture of the seabed the sonars used usually project their beams sideways and downwards and scan the bottom as their parent ship moves along. They will produce contour maps of the seabed and will show up such things as cables, wrecks, pipelines and areas of rock.

A hydrographic sonar, designed by the Admiralty Research Laboratory is being developed by Marconi Space and Defence Systems and is capable of producing both horizontal and vertical plan views of the seabed. The depth of objects on the seabed can be determined to an accuracy of within two feet to ranges of 200 yards.

**Rig manoeuvres**

It is possible to manoeuvre a drilling rig or ship into position without human interven-



tion, thereby increasing the accuracy of manoeuvres. A system made by Decca Survey and known as Dynafix uses shore stations up to 40 miles distant and processes their signals in such a way that they are used to operate specially fitted manoeuvring propellers.

Dynamic positioning of a drilling, whereby the vessel is held in position over the well without the use of anchors, was first used in drilling for oil in deep water early in 1972. This was achieved by Sedco 445, a drillship designed to Shell specifications and equipped to conduct world-wide drilling operations in water depths of about 2000 feet. Dynamic positioning enables the drillship to hold its position despite wind, waves and tides. Eleven sideways-acting propellers and two main screws are controlled by two computers in keeping the ship over the hole while drilling takes place.

The method and systems were pioneered in the United States by the Shell Oil Company. Its work with dynamic positioning began in 1961 when it participated in the development of a manually controlled drillship. In the same year it developed the first automatically controlled dynamic positioning system in the core drilling vessel Eureka.

Sedco 445 provides laboratory space for drilling, electrical logging, mud logging, diving, petroleum engineering, and geological and management services, all of which are designed to be independent of shore support. However, for emergency supplies, timely re-stocking, personnel access and safety stand-by the drilling unit is provided with a helicopter deck and will be accompanied by a large crew-standby boat and a work boat. Two acoustic reference systems measure vessel's position with respect to beacons at the wellhead. As a backup and for use during certain operations, two tiltmeters are used either on a taut line to bottom over the side or on a guideline. Two gyro compasses measure heading for control. Two anemometers measure wind velocity and direction with respect to the ship and permit the control system to command an immediate and opposite thrust.

To assure the highest reliability complete backup equipment is provided throughout the dynamic stationing system. Two Honeywell computers are used; while only one of them at a time is issuing commands to the thrusters, both are continuously receiving data from position and environment sensing instruments, comparing them for validity, performing the control calculations and checking each other. Control automatically transfers to the standby computer on failure of the operating unit.

The computer's thrust commands are sent to thyristor modules which provide variable voltage d.c. power to reversible speed standard traction motors.

Sedco 445 can be navigated by satellite.[3] Conventional navigational positioning systems use stationary wave patterns generated by fixed, land-based, radio transmitting stations, and have an accuracy of about 25 to 50 metres. However, they are limited to a range of about 200 miles from shore.

The Navy Navigation Satellite System (NNSS) consisting of orbiting satellites and accompanying ground facilities was made available for non-military use in 1967. NNSS enables work to be carried out quickly and conveniently—the vessel Lady Glorita using satellite navigation as its prime positioning system was able to carry out a seismic survey off Guyana in only four days, whereas the setting up of a conventional positioning system could have taken more than a month of expensive preparation. On a *moving* ship, given an accurate knowledge of the vessel's true speed and course, an accuracy of about 100 metres can be obtained, with the added advantage of not being limited to a range of 200 miles from the shore.

The equipment needed to operate satellite navigation is portable and self-contained aboard ship. It consists basically of two radio receivers, a small computer equipped with teletype print-out facilities and a reference oscillator. The system measures the v.h.f. radio signals transmitted from one of the orbiting satellites and, using the Doppler principle, computes the latitude and longitude of the signal receiver. NNSS has five satellites orbiting the earth at an altitude of about 600 miles. They travel at a speed of about 16,500 miles per hour. The satellites are in polar orbit and their orbit planes are at angles of about 45° from each other.

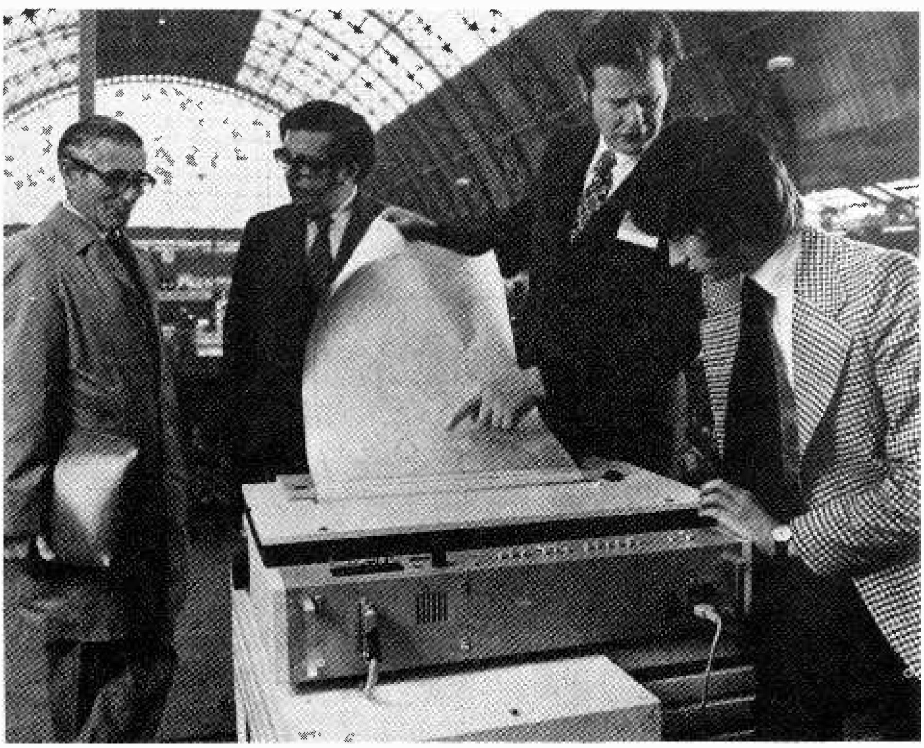
Each satellite is transmitting continuously two related stable frequencies at 150 and 400MHz, while every two minutes it gives an accurate time check and its orbital position at that time. A ship with the necessary receiving equipment can compare the signal it receives from the satellites with the shipboard oscillator, which is fixed to a frequency slightly offset from the one transmitted by the satellite. The shipboard receiver measures the Doppler frequency by observing the changing relationship between the incoming frequency and the stable reference.

Satellite navigation is still in development. At its present state, it is unlikely to be used as the sole or primary means of navigational positioning except for cases such as seismic ships on roving commission. However, when combined with sonar Doppler into an integrated navigation system and used in shallow water, satellite navigation has shown that it has great potential for location fixing offshore work in the oil industry. (An article on satellite navigation by the NNSS will be published in the February issue.)

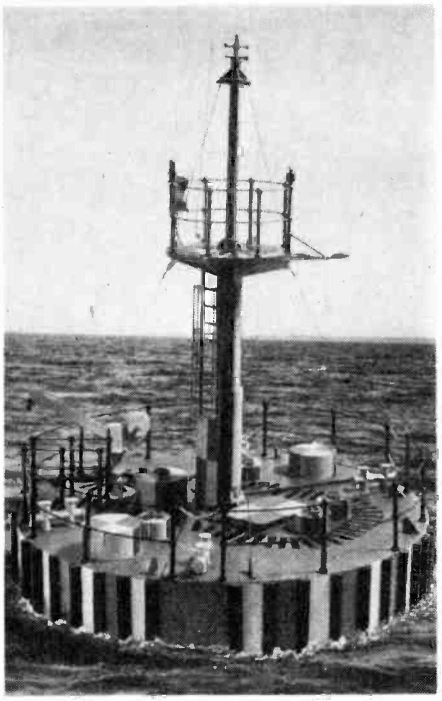
### New weather buoy

The national Data Collection Buoy, presently being manufactured by the Seatek consortium, is to be placed on station in the North Sea in summer 1975.

The 7.6-metre-diameter wave-riding welded steel buoy is to act as a development platform for oceanographic and meteorological sensors. These include air temperature, barometric pressure, wind speed and direction, humidity, rainfall and visibility. Sea-bed pressure instruments, connected to the buoy by cable, are included in the range of oceanographic sensors, and these will help produce storm surge warnings. Other sensors include acoustic and electromagnetic current meters near the ocean surface, and current speed and direction monitors at three sub-surface positions. One hundred



*Reception of worldwide weather chart transmissions of the international meteorological services demonstrated by the EMI Weatherfax system at the 1974 Offshore International Exhibition, London.*



*Artist's impression of the UK national data buoy D.B.1.*

data channels are provided, some 50 being used by the initial suite of sensors. Measurements can be made at any time within the one-hour cycle, and then stored ready for the hourly transmission. A 1MHz temperature compensated crystal oscillator provides not only the high accuracy clock (ten seconds per year) for automatic control but also a basic input to synthesize all frequencies required within the transmitter.

A six-watt transmitter at 4163.5kHz feeds a ten-metre whip antenna and is used in conjunction with space-diversity reception at Lowestoft. The A9J emission is a modification of the Piccolo system with one audio tone per decimal digit.

A slow morse call sign (2NI02) precedes a synchronizing signal, followed by three sequential scans of the data channels. Each channel uses three decimal digits to provide 0.1% resolution and each digit is transmitted as a tone lasting 300ms.

Every third hour an additional 20-minute transmission of buoy heave, pitch, roll and compass data provides high-frequency wave information. A fuel supply of 400kg of propane on the buoy will last two years and the data handling equipment is designed to operate unattended for at least six months, but the oceanographic sensors may require more frequent visits due to fouling by marine growths.

**Under-sea production**

Research into the development of deep sea production facilities is being pressed forward in parallel with progress in drilling techniques in the deep oceans. Such facilities can either be on the sea floor or on the surface. Oil companies are exploring both routes in seeking solutions to the problems involved. The objective involved with the surface method when oil is found in commercial quantities is to get the oil from the well to the surface as simply as possible, put it through production facilities on the surface and transport it away by tanker. This technique calls for man-controlled, remotely actuated devices, using electronic tools where necessary and embodying the means to feed continuous data on what is happening below back to the surface. If problems occur however there must be human access to the seat of the trouble—either by miniature submarines with mechanical arms or, dependent on depth, divers.

If large oilfields are found in very deep water far from shore, floating storage will have to be provided. A concept envisaged by the Shell companies is the use of a huge floating tube, the shape of a fisherman's float, suspended vertically in the water and with a storage capacity of perhaps 300,000 barrels (about 40,000 tons), linked by lines to the wellheads on the ocean floor. In very deep water, dynamic stationing equipment similar to that installed in the "445" would keep it in position.

A programme to build a complete oil-field on the seabed without any surface platforms and in deeper water than any existing wells is under way at Lockheed Petroleum Services. Several major oil companies are financing the programme. This gives a good indication of their interest in the project which is pioneering a range of subsea equipment to extract oil in up to 3,000ft of water. This is eight times deeper than any present oil well and yet is within a water depth where surveys indicate there could be major petroleum reserves in several areas throughout the world including the North Sea. A well-head on the sea floor is enclosed in a dry one-atmosphere, steel cellar which houses the equipment normally carried on surface platforms. It is serviced by engineers who travel to it in a one-atmosphere capsule from a surface support vessel. The capsule docks with the seabed cellar and engineers open a hatch to gain access and carry out their work in shirt-sleeve conditions with fresh air and electrical power supplied by umbilical cable from a surface support vessel. Lockheed is developing the system.

As a final note and with the sort of developments just mentioned in mind, there still remains a market of over £2,000M in production wells and transportation over the next ten years and also on the many offshore and on land services associated with the oil business. Although much of the initial demand of the oil industry has been met by American and European suppliers, the United Kingdom's offshore oil business is a vast and expanding market that will stretch into the 1990s, and Britain now has not only the opportunity of rising to self-sufficiency in fossil fuels by the 1980s but also to evaluate the opportunities and establish itself as a major world supplier of products and services to the offshore industry. A report is due for publication in March by Industrial Market Research Ltd, London, containing up-to-date information on product and service opportunities in North Sea oil developments.


**References**

1. Anderson, E. W., "Microwave Communication Systems for the Offshore Oil and Gas Industry", *Mariner*, July/Aug. 1973, p.8–10.
2. Marriott, J., "Accuracy and instrumentation in offshore oil developments", Offshore International Exhibition and Conference publication, Oct. 1974.
3. "Satellite navigation", *Shell Magazine*. Vol. L11, No. 749, p.109, 110.


# News of the Month

## ITU first l.f./m.f. conference session

Further to the news item published in our December 1974 issue, the following is a summary of the conclusions reached by the first session of the regional administrative l.f./m.f. broadcasting conference which was "to prepare the technical and operational criteria which will serve as a basis for the preparation by the Second Session . . . of frequency assignment plans for the l.f./m.f. broadcasting bands in Regions 1 and 3".

For ground-wave propagation, the curves of the International Radio Consultative Committee Recommendation 368-2, which cover propagation at low and medium frequencies for different values of ground conductivity, were adopted by the conference. The conference decided that any new frequency plan should be based on the continued use of double sideband amplitude modulation with full carrier and rejected proposals for a reduced value of modulation bandwidth. Similarly, proposals to base planning on high degrees of signal compression, thereby improving protection against interference, were rejected by the conference because of the allegedly adverse effect upon reception quality. No upper limit on the radiated power of individual transmitters has been recommended but use should be made of directional antennae to reduce power in those cases where assignment incompatibilities cannot be resolved by any other means.

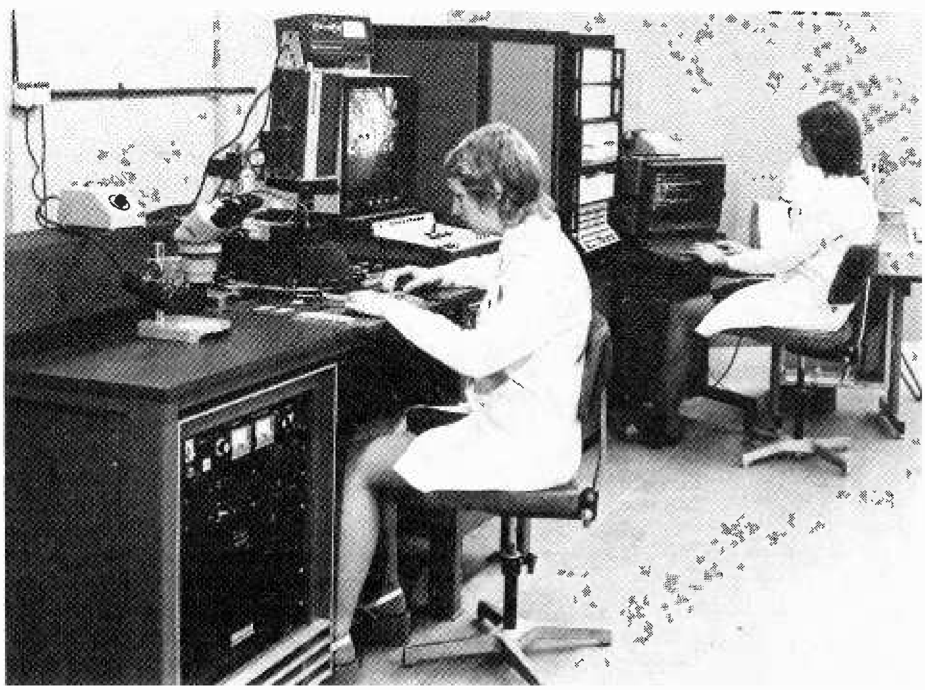
The conference decided that for most purposes a protection ratio of 30dB against interference from other transmitters operating in the same channel should be adopted. A consensus was quickly reached that the channel spacing should be uniform throughout the whole of Regions 1 and 3 and that the carrier frequencies should be integral multiples of the channel spacing. The revised channelling in the m.f. band will start with a carrier frequency of 531kHz and proceed in 9kHz steps up to the highest channel with a carrier frequency of 1602kHz. The l.f. band remains unchanged with its present 9kHz channelling and carrier frequencies which are not integral multiples of the channel spacing.

## Liquid crystals for electron observation

A simple technique has been developed for the observation of electron pulses flowing through an integrated circuit. The technique employs liquid crystals. Conventional i.c. test equipment determines whether an i.c. is functioning properly but is of little value in determining exactly why and where it has failed. With the new technique, developed by RCA, it is possible to observe where the electron flow has been interrupted at a defect. This is made possible by the normally clear liquid crystal which reflects or refracts light when stimulated by an electric current.

A drop of nematic liquid crystal is placed on the surface of the i.c. so that all the rod-like molecules align in the same direction. The i.c. is placed in a conventional microscope and illuminated by light passed through a set of polarizers arranged so that none of the light reaches the microscope's eyepiece under normal conditions. However, when the i.c. is operating, the refractive index changes caused by the electrons' electric fields allow light to pass through the polarizers and, in effect, give the viewer a "live" picture of the pulses or signals flowing in the i.c. The circuits can be examined at various speeds and at normal operating voltages—eight to ten volts for m.o.s. circuits and as low as two or three volts for bipolars.

*Laser system installed at the Beckman Instruments, Glenrothes, Scotland factory for resistance and functional trimming of their d.i.p. resistor networks, ladder networks and hybrid microcircuits.*



## Paging the dead

A news release we recently received indicated that paging equipment installed at the South Essex Crematorium has contributed towards the efficiency of the organization. According to Multitone Electric, "the smooth operation of a crematorium in every detail is imperative by the very nature of the function which it discharges . . . At the South Essex Crematorium there was an additional problem in that the administrative offices are situated at the entrance to the grounds, some distance from the crematory itself. The new Multitone paging system has made things very much easier, however, "by ensuring that all key staff can be contacted immediately wherever they are". It is envisaged that the next application of radio paging will be its use by mediums to take some of the routine hard work out of their endeavours.

## Quadraphonic cassettes

Although details had not reached this office at the time of going to press, we have heard that BASF has been experimenting with the duplication of quadraphonic cassettes. Unfortunately none of the output from the German duplicating plant appears in the UK so it is unlikely that such cassettes will be offered for sale here, unless one of our own duplicators follows suit.

It is believed that the extra information is recorded on the standard track format, but matrix encoded using the SQ system. Although such an arrangement is perfectly feasible, it is possible that the phase stability of the cassette recording process may have to be of an order higher than most average domestic machines to achieve acceptable decoding. Should the recordings be of such a type, standard add-on decoders, or those built-in to amplifiers may prove quite suitable for use with this type of recording. Further details will be published as they become available.

## New communications device

A control unit has recently been introduced which dispenses with space-wasting racks of switching and exchange equipment and condenses what would normally be a roomful of equipment into a space no larger than a small filing cabinet. The unit, MFC, was announced by Pye Business Communications as a new master control unit for its M100 speech intercom.

The MFC allows almost limitless expansion of M100 intercom systems while no conventional exchange or switching is required. The calling station initiates a pulse sequence which is in turn decoded by the receiving station. The control unit is constructed on a "plug-in" card principle, station capacity being decided by the number of cards employed.

When a call is initiated, the system memory is interrogated to confirm the availability of the required station and to evaluate the fastest method of connection. Should the called number be engaged, the system is able to keep trying the number every six seconds for up to 90s to obtain a connection, or even arrange for it to call you back later. Extra features include automatic call transfer, three callers on line at once, connection to public address or pocket paging systems and the calling of all stations at once for emergency use.

## Parrot power

After decades of experience, the engineers and researchers at Austral Standard Cables Pty, Sydney, Australia, could perhaps be excused for believing they had overcome almost every conceivable environmental challenge that could confront the industry. The sad truth is that the ASC people recently have been given the bird. Over several years they successfully wrestled with problems of cable moisture permeation, submarine cable protection, electrical interference, assorted "gremlin-inspired" technical difficulties and termite attacks. The termites were beaten when they introduced nylon-sheathed cable. Now another menace has arisen in Western Australia. "Iron beaks" have been pecking through cables (Integral Bearer Cables) at Mt Newman, W.A., causing shorts and interference within a mining company's domestic communications network. ASC supplied most of the cable when this private telephone system was commissioned in 1968 and since then has met substantial orders for extension and upgrading of the network. The system's radiotelephone signals link both the Newman township and mine to the PMG exchange at Port Hedland, 265 miles to the northwest.

In such a communications complex, any pests which mutilate part of the network obviously are unwelcome. The birds have concentrated on a relatively small stretch of line. They land on the bearer wire, bend under and peck right through the polythene-sheathed cable. The ASC planners in Melbourne don't claim to have a quick remedy for the problem, but have suggested that brass tape may stop the birds. It has been urged that for ease of handling and installation poly-sheathed cable be lashed on site to the bearer wire with brass tape. If that doesn't stop the parrots, ASC's engineering services may be in for some overtime.

## Colour TV examination

The Radio, Television and Electronics Examination Board is introducing a certificate of competence in colour television servicing. The qualification has been established in response to demand from the industry to provide a recognized certificate in this field which is issued on passing a comprehensive practical test. It is open to those who have already established themselves in the servicing of colour television receivers, who hold a recognized technical qualification and who have had a minimum of one year's full time gainful experience. The award will take the form of a certificate and personal identity card issued by the Board.

The examination is a problem-solving exercise in which the candidate has to identify the problem and obtain the relevant test information. There is a limit on time (five faults in two hours) and the candidate is required to work on more than one type of receiver, designated in advance. Setting up of pre-set controls also forms part of the test. In addition to the practical assessment, a short written test is concerned with safety and installation. The practical test involves fault-finding to component level and the candidate is to state correctly the symptom, the fault area, the stage and the component.

## TV deliveries down

Deliveries to UK distributors of UK made and imported colour television receivers reached 153,000 in September—a 41% decrease on September 1973 (259,000), according to the latest statistics compiled by the British Radio Equipment Manufacturers' Association. This brought the total for the first nine months to 1,638,000, a fall of 18% compared with the same period of 1973 (2,005,000). The share of imports of colour sets has fallen in the January to September period to 21% from 25% during the same period in 1973.

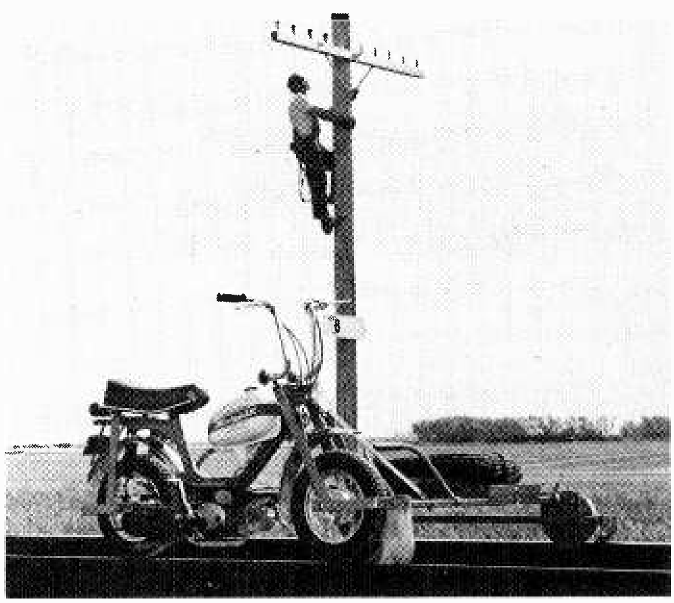
Total monochrome television deliveries for September of 72,000 brought the total for the year to 611,000, a fall of 44% compared with January to September 1973 (1,084,000). These figures are details of deliveries of UK made and imported deliveries, including those to rental and relay companies.

## Briefly

**The journal you like.** More and more people are reading *Wireless World*. At the time of going to press the estimated circulation for 1974 was an average of 65,723 copies per month (to be confirmed by the Audit Bureau of Circulations). This was 5,000 up on the 1973 figure of 60,528 per month.

**RTS Hon. Sec. retires.** The retirement of Charles Marshall as honorary secretary of the Royal Television Society was recently marked at a society luncheon in London. Mr Marshall who is head of public relations at Mullard had held the post for 13 years.

*Something new in telecommunications maintenance—a "Tra-k-art" has been introduced by Canadian Pacific Rail. It is a 48cc motorcycle and sidecar adapted to run on a railway track*



# Circuit Ideas

## Control of a binary counter for division by one or two

This circuit provides a method of switching division by two into or out of a stream of clock pulses. The output is in phase with the input, and free from spikes due to race problems, which may occur with conventional gating methods. Only one D-type flip-flop and one inverter are used.

The logic circuit is shown below; action is as follows.

*Control low; input low*

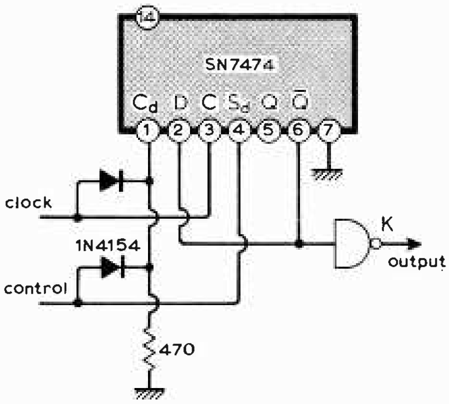
$C_d$, $S_d$ both low, Q and Q both forced high.

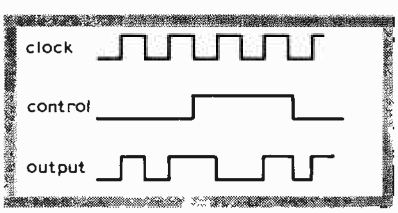
*Control low, input high*

$C_d$ high; $\overline{Q}$ goes low (complement of Q).

*Control high*

$C_d$ and $S_d$ are both high. At the positive edge of the clock, the D input is transferred to Q. This is the normal connection for division by two, using a D flip-flop. An inverter is added to restore the phase. Note that K≠Q in the divide by one mode, since Q is held up, by $S_d$ low. Hence the use of the inverter.

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Ottawa.

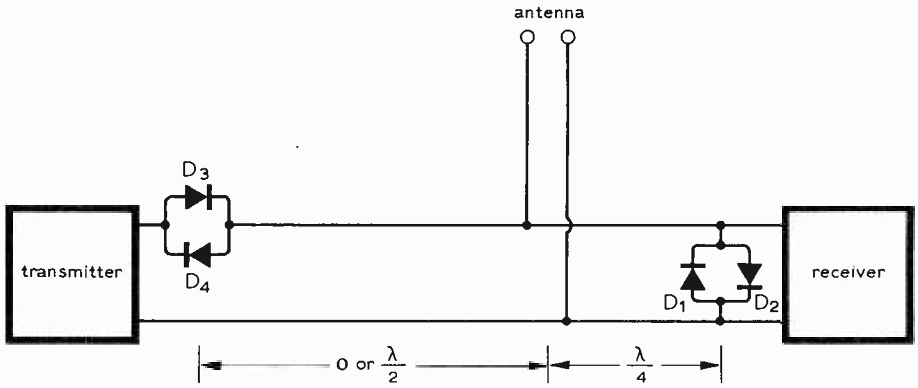
## Passive solid-state antenna switch

A lot of antenna switch schemes have appeared in the past, but all used complicated tuned circuits and lots of diodes, or vacuum tubes that required high-voltage supplies. This circuit uses only two pairs of silicon diodes, one pair ($D_1$ and $D_2$) which effectively shorts the receiver input during transmission, and the other ($D_3$ and $D_4$) which disconnects the transmitter during reception.

Because of the high power from the transmitter, $D_3$ and $D_4$ conduct, and the power flows towards the antenna. Likewise, $D_1$ and $D_2$ in the receiving branch also conduct and put a short circuit across the line at the receiver (only 0.6 volts appear across $D_1$ and $D_2$), thereby protecting the input circuits of the receiver. As the short circuit is a quarter wavelength from the T-junction, the impedance in parallel with the antenna line at the junction is very high and does not affect the power travelling toward the antenna.

During reception, the impedance at the T-junction looking toward the transmitter is infinite because there is an open circuit half-a-wavelength away caused by non-conducting $D_3$ and $D_4$. Looking toward the receiver there is a matched line, so all the power from the antenna goes into the receiver. The diodes are high-frequency switching diodes with current ratings depending on the transmitter power. The line is the same as the one used to feed the antenna.

Alejandro Lieber, LU1 FCR,
Edinburgh.



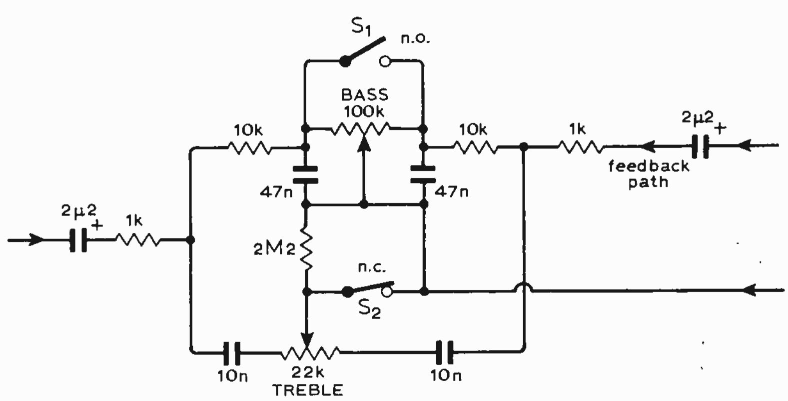

## Click-free switching for audio filters

It's often required in mixing consoles and other audio equipment to be able to insert a correction network for comparison purposes without producing transients or changes of level. The diagram shows how this can be achieved with a familiar Baxandall network, though of course the idea is applicable to other filters.

With $S_1$ open and $S_2$ closed, the circuit functions normally, but if the switch positions are simultaneously reversed, the response remains flat, regardless of the positions of the pots. The centre-frequency gain remains unchanged since the network is symmetrical and, furthermore, phase shift is unaltered.

The main value of this type of switching, however, is that with the controls in the flat position, there is no transient interruption of the signal, and with no d.c. in the network, no clicks either.

J. S. Wilson,
Amersham,
Bucks.



# Charge-coupled devices

## 2—Techniques for making two-, three- and four-phase devices

by John Mavor
*University of Edinburgh*

In part 1 of this series of articles, the charge-coupled device concept was examined in relation to the simplest device embodiment; the three-phase single-level metallization structure (Fig. 1). Although c.c.d. structures are conceptually simple and essentially compatible with standard m.o.s. transistor processing, they do have an Achilles' heel. For acceptably high charge-transfer efficiency to be obtained, the formation of the very narrow inter-electrode gaps (gate-to-gate spacings) must be produced.

Another important limitation to the simple, single-level metallization c.c.d., caused by the existence of the gaps, is that of stability and, ultimately, its long-term reliability.

For efficient transfer of charge carriers in c.c.ds, it was shown in part 1 that the silicon surface, just below the silicon-silicon dioxide interface, must be completely depleted between adjacent gates. Now for the silicon surface to be depleted, a voltage of a correct magnitude and polarity for repelling the substrate majority carriers must be applied across the insulator. For a given oxide thickness, a higher-doped substrate (with more majority carriers) will require a larger applied gate voltage than with lower doping (less majority carriers). For lightly-doped substrates of 20Ωcm (~ $10^{15}/cm^3$) about 10V is required to allow a depletion layer depth into the silicon of 1μm. Because complete depletion is required between electrodes for good efficiency the gap length (*t* in Fig. 1) must be less than 3μm in practice.

For integrated-circuit processing using conventional photolithography, 3-μm gaps are possible but not always easily reproducible with high yield in a production environment. As the device yield will suffer, fabrication cost will inevitably rise. The problem of producing narrow gaps results in the increased probability of alignment errors in connection with masking. Also the masks which are used to define the gaps must be kept particularly clean and replaced frequently to avoid bad definition of the gaps. However, although the masks may be in good order, it is necessary to use a careful photoresist-etching step to actually produce the narrow metal gaps.

Although single-level metal c.c.ds with acceptable yields may be fabricated, their performance may vary either after encapsulation or during life tests. For gaps of 3μm or less, the substrate surface potential in the gap region is determined mainly by the fringing fields caused by the gate potentials. However, any charge present in the gaps, which could vary in location and size, will cause a second-order variation in device performance. This charge is due mainly to

- the "fixed", positive, surface-state charge, $Q_{SS}$, which exists just within the oxide near the silicon-silicon dioxide interface
- a charge component due to the "fast" surface states, $N_{SS}$. Their density varies with the size of the depletion region. These states have a major effect on the dynamic transfer of charge in the c.c.d, and
- any contaminant ions (usually sodium) which may be mobile within the gate insulator.

Any variation in location or size of these charge contributions will result in potential barriers and wells being formed in this region, Fig. 2. Although a value of gate-to-substrate voltage can usually be chosen to reduce charge loss owing to this variation, the required bias voltage for this condition to occur will change with time. Thus, c.c.ds with even partly exposed gate oxides have inherently unstable operating characteristics.

### Oxide growth conditions

Processing investigations on single-level metallization structures have produced satisfactory gate insulator growth conditions to reduce instabilities. Although more elaborate gapless techniques have been developed to improve c.c.d. performance and produce stable devices suitable for systems applications, great care must be exercised whenever the gate insulator (oxide) is grown. Some of the steps which are normally taken in a c.c.d. process are

—The use of particular crystal-orientation substrates to reduce the minimum obtainable values of $Q_{SS}$ and $N_{SS}$.
—Stringent cleaning procedures to prepare the surface of the substrate, prior to oxidation.
—Furnace tubes are either double walled, or are steamed out continuously to prevent ionic contamination.
—The use of specific growth conditions to provide low $Q_{SS}$ and $N_{SS}$ values, e.g. "dry" thermal oxide grown at 1050°C. Conditions should be achieved for which both $Q_{SS}$ and $N_{SS}$ are at minimum values.
—Following oxide growth, a high temperature step in an inert atmosphere (say nitrogen), plus a low

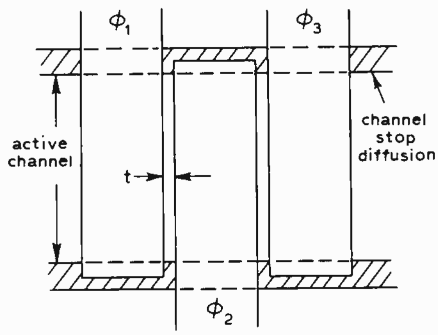



*Fig. 1. Plan view of three-phase, single-level metal c.c.d. showing channel-stop diffusions. Difficulty in obtaining reproducible electrode gap width (t) of less than 3μm led to the "resistive sea" modification of Fig. 4.*

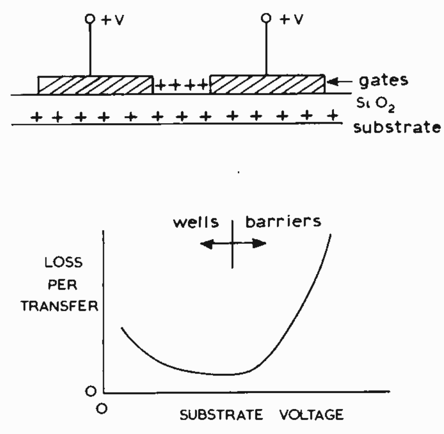



*Fig. 2. Variation in size or location of change in the electrode gaps (t in Fig. 1) forms potential barriers or wells. Charge loss can be minimized by suitable choice of substrate voltage, but required value changes with time.*

temperature (450°C) anneal; the former to reduce $Q_{SS}$, the latter to minimize $N_{SS}$.
—A phosphorus gettering step is often used to reduce the mobility of any mobile ions present in the gate insulator.
—Oxides are sometimes grown with a trace of HCl present, so that the contamination ion concentration is reduced.

### Channel confinement

To avoid the loss of the signal charge which has been introduced into the c.c.d. depletion regions, it is necessary to introduce a barrier to the charge around the periphery of the clocked gates. Two methods are immediately available from integrated circuit technology.

**Thick oxide isolation.** In m.o.s. fabrication a thick oxide called the "field" is used to prevent the formation of parasitic transistors. The field oxide is normally deposited by chemical vapour deposition, and is typically 1-μm thickness. For the c.c.d. example, if the gates are taken over the edge of the field and down on to a thin oxide well, then c.c.d. action will only occur within the confines of the well. The two main disadvantages of this isolation method are that an extra processing step is required to deposit the field oxide, and that the thin gate metal required for the production of narrow inter-electrode gaps can easily break at the corners of the step in the oxide between the thick and thin transition.

**Channel-stop diffusion.** When a highly doped ring of diffusion surrounds, but just underneath, the periphery of the c.c.d. gate area proper, then no charge loss can occur (see Fig. 1). For an n-type substrate, the $n^+$ doped-up edge of the c.c.d., owing to the channel stop, cannot support a depletion region which would otherwise cause charge loss.

The disadvantage of this technique is that an additional diffusion must be made; however, no field oxide is required. Fig. 3 shows the basic processing steps used to fabricate a simple p-channel c.c.d. A further processing step is usually used to passivate the device, by coating the aluminium transfer electrodes with a vapour-deposited silicon oxide—Fig. 3(c).

### N versus P-channel c.c.ds

Charge-coupled devices—formed on n-type substrates, already studied in part 1, have certain disadvantages over the performance of p-types, for a given gate arrangement.

For p-channel, n-type substrate, devices, the channel must always be maintained in depletion. Otherwise the signal minority carrier charge, which is only located in the depletion region wells, will be lost. n-channel devices have a built-in surface depletion region owing to the positive $Q_{SS}$ charge which is located in the gate insulator (see Fig. 2). The $Q_{SS}$ charge tends to enhance the surface charge level in p-channel devices but deplete the surface in n-types.

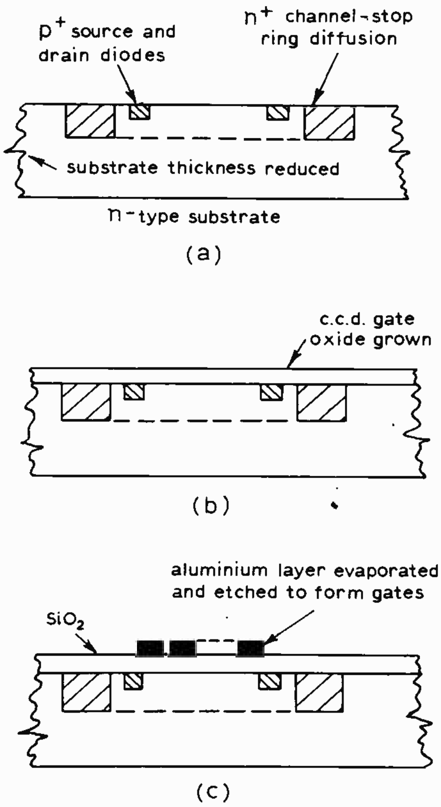



*Fig. 3. Basic single-level metal c.c.d. process steps: (a) drain, source and channel-stop diffusions, (b) gate-oxide grown, and (c) aluminium layer evaporated and etched to form individual gates.*

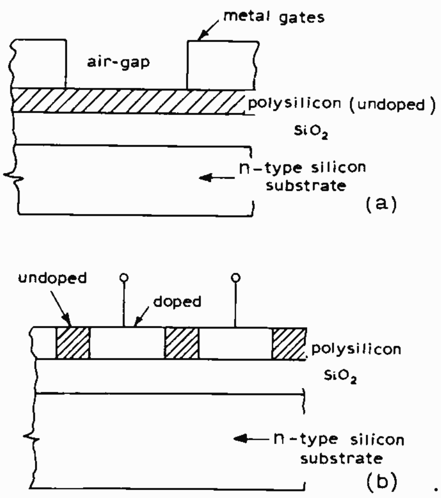



*Fig. 4. Two alternative c.c.d. structures to Fig. 1, for metal gates (a) or polysilicon gates (b).*

Carrier mobility in an n-type substrate is higher than for p-types. This means that the ultimate speed limitation on an n-channel c.c.d. is inherently higher than for a p-channel device.

Finally, a p-channel device has a higher $V_T$ than an n-channel device. This is an important consideration for both on-chip and also commercially available clock generators.

### Modifications to single-level metal structure

Both an increased stability of the c.c.d. structure, and a reduction in the need for narrow gaps can be achieved by using the "resistive sea" process modification[1,2] which comes in several forms. For example Fig. 4(a), useful for metal gates, and Fig. 4(b), useful for polysilicon gates. The polysilicon is lightly doped or used as grown (undoped). However, its conductance is higher than the gate insulator so that it acts effectively as a conductor, and helps to stabilize the surface potential against variations in charge within the insulator.

An advantage of this process is that the inter-electrode gap can be increased substantially for the same operating performance of a narrow gap structure. However, the high-resistance conductor and the distributed, associated gate capacitance, makes the gap look like an electrical $RC$ transmission line. The characteristic delay associated with this equivalent circuit for the gap may severely limit the high frequency performance, even though the doping level of the polysilicon has been increased to reduce the delay to a practical minimum. This resistance between the gates presents an increased differential loading on the pulse generators which are driving the c.c.d.

### Gapless c.c.d. structures

The solution to the instability problem, coupled with increased performance, can be achieved by using overlapping, or gapless gate techniques. There is usually also a slight easing of the alignment tolerances. The penalty to pay, normally, is a multi-level gate arrangement which involves a more involved processing schedule. Fig. 5(a) shows how a three-phase, improved c.c.d. can be fabricated using doped polysilicon to produce a gapless gate arrangement[3]. Each gate overlaps, or is overlapped by, the next gate. A similar approach to this for the formation of the gates can be used to form a four-phase c.c.d. (see later). In this structure, the gates can be made by evaporated metal, and/or polysilicon gates[4,5].

### Two-phase c.c.ds

The main attractions of a c.c.d. which can be operated by a two-phase clock are the simplified clocking arrangement, and for a given gate length, a two-phase structure may take up less area. Directionality of charge flow can be obtained by a variety of techniques.

**Stepped-oxide structure.** Frequently the two levels of conductors (gates) are produced by a stepped-oxide structure[6,7], Fig. 6(a), or by the two-phase clocking of a four-phase c.c.d.[8], which has been fabricated with a deposited oxide and a thermally grown oxide, Fig. 6(b). These structures have the effect of producing gates with alternatively high, then low gate capacitances. Consequently, when the maximum value of the gate voltage on each phase is equal, then the size of the depletion regions (or the well depths) will have two values owing to the different gate insulator fields. This results in charge always propagating in one direction.

Essentially, the main disadvantage of a two-phase structure is that the charge-carrying capability, otherwise known as the dynamic range, is reduced for the same gate voltage size as in a three-phase structure. For a gate voltage, $V_g$, the charge-carrying capability, $Q$, of a c.c.d. can be written[9]

$$Q=C\,(V_G-V_T)$$

per unit gate area, where $C \propto 1/t$ is the capacitance per unit area of an oxide of thickness, $t$. $V_T$ is the threshold voltage for the m.o.s. capacitor formed by a c.c.d. gate, its oxide and the substrate beneath it. It can easily be seen from this equation, that the charge-carrying capability increases by either increasing the gate voltage, or reducing the gate-oxide thickness. Notice that if charge is introduced into the oxide (see Fig. 6(e)) $V_T$ will change its value, and so will the charge-handling capacity of the c.c.d.

**Ion-implanted barriers**. The complex processing of a two-level metallization technique can be eliminated by using a implanted barrier to achieve directionality[10], Fig. 6(c). This technique has two potential advantages over other two-phase c.c.d. structures in that it provides a fairly large dynamic range and the length of a shift-register bit is just larger than two gate lengths (say< 20μm). However, using ion-implanted substrates does not solve the requirement for an overlapping gate arrangement to achieve high charge transfer efficiency.

**D.C. offset voltage**. Asymmetry in the depletion region depths can be obtained by using two-level clock amplitudes across a single-level metallization structure. However, rather than having to generate this clock pulse train, it is easier to have each of two clock phases connected to consecutive pairs of gates, but incorporating a d.c. bias to one gate of each pair, Fig. 6(d).

**Fixed oxide charge**. When additional charge is introduced into the oxide of an m.o.s. capacitor the threshold voltage is altered. For a single-level metallization c.c.d. structure, when a charge is introduced into the insulator of alternate gates, the depletion regions will be different under consecutive gates. This will result in two-phase operation, when pairs of gates—each pair having a corresponding insulator region with, and without introduced charge—are clocked.

Additional charge may be introduced conveniently when the gate insulator comprises two insulators, Fig. 6(e), having different conductivities, e.g. silicon nitride covering silicon dioxide (m.n.o.s.). When pulsed with a voltage, the m.n.o.s. capacitor threshold voltage changes[11] in value and sign under certain conditions. This shift in threshold voltage is due to charge which accumulates at the nitride-oxide interface owing to tunnelling currents through the very thin ($\sim 50 \times 10^{-10}$m gate oxide). The charge density should remain constant at the interface for many years when the applied insulator

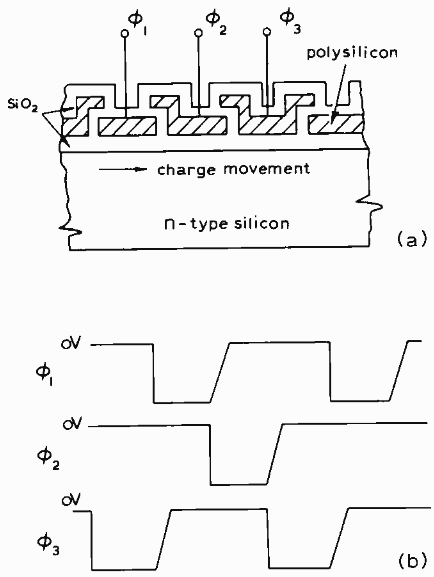



*Fig. 5. Gap problem is avoided in this gapless technique, at the expense of more complicated processing. This can also be applied to four-phase devices.*

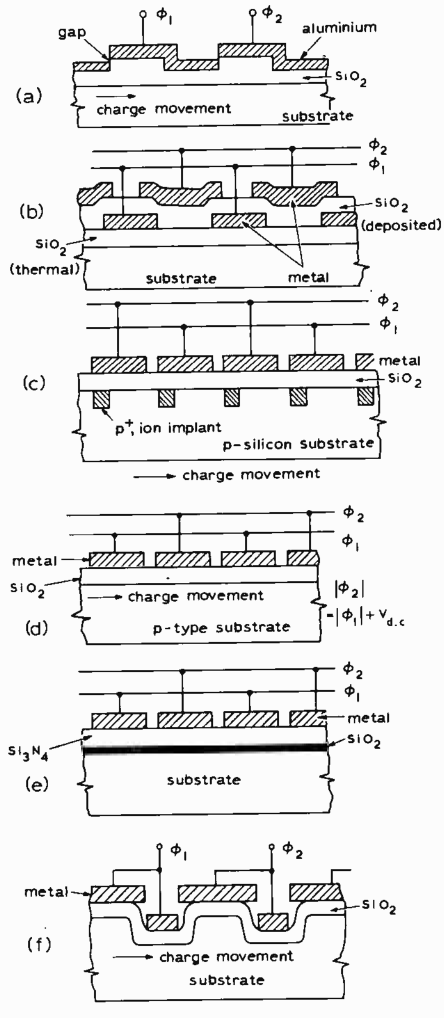



*Fig. 6. Two-phase c.c.d. structures: stepped oxide (a), deposited oxide (b), ion implant (c), d.c. offset (d), m.n.o.s. (e), and profiled silicon (f).*

voltages remain at normal c.c.d. clock levels[12] (< 20 V).

This m.n.o.s. technique has been used to form a single-phase c.c.d.[13], by introducing two levels of charge into the gate insulator. The device performance can be electrically programmed.

**Profiled substrates**. The necessary small lateral spacing between gate electrodes can be achieved by etching holes, say, 0.2 to 0.3-μm deep in the silicon substrate, Fig. 6(f). Metal, evaporated during some stage of the process, will form breaks at the discontinuity in silicon surface levels. Two- or three-phase devices can be made by this technique[6] by selectively connecting the multi-level gates.

### Four-phase c.c.ds

Superior clocking performance can be achieved using four-phase c.c.ds[3,4] (Fig. 7). They employ two-level conductor arrangements, which provide all the advantages of a sealed channel technology. Four gates are used to form one bit of a c.c.d. analogue shift register. (This is also the area required for some two-phase devices.) The four-phase structure, being symmetrical, is thus electrically bidirectional and when the clock pulse train is reversed, the signal charge will propagate back along the c.c.d.

To understand the reason for this action, it is helpful to visualize the signal charge as being transferred along the device in a series of depletion-region wells, under the control of gate potential. Given a choice, signal charge will start to fill the deeper adjacent well. In three- and four-phase structures, which are both symmetrical in design, the direction of signal charge propagation is determined solely by the clocking sequence. Correct clocking operation for three-phase devices requires one phase being switched off slowly, as the next gate phase is switched on. Polarity of the clock pulses is also important, and depends on whether the substrate is p- or n-type.

### Fabrication of four-phase c.c.ds

**Silicon gates.** Four-phase devices are often made using basically a standard silicon-gate m.o.s. process. The gate structure avoids critical mask-alignment problems by using an overlapping gate arrangement, Fig. 7(b):

- The gate oxide is thermally grown under stringent conditions for low $Q_{SS}$ and $N_{SS}$.
- A polysilicon layer is then formed on the top of the oxide and doped to achieve low resistance gates.
- The doped polysilicon layer is etched to form individual gates.
- The slices are then placed again in an oxidation furnace to form a top insulator.
- Then aluminium is evaporated over the surface of the oxide and selectively etched to form the overlapping gates.

A further layer of polysilicon could be used to replace the aluminium (see Fig. 5). This last-mentioned gate structure is particularly useful for imaging applications, because the polysilicon gates are transparent (200-nm thick), whereas metal gates of practical thickness would reflect light.

**Anodized aluminium.** In one process[5], c.c.ds are made by anodizing first-level aluminium gates, which are first evaporated on a thermal oxide. The oxide of aluminium, which is formed over the surface of the aluminium, provides the insulation between the two-levels of the metal gates—see Fig. 7(a). Anodization is performed at temperatures which will not affect the previously evaporated aluminium gates. A deposited oxide, at say 400°C, could also be used to form the intergate insulator. Alternatively, a refractory metal that forms a controllable, good quality grown oxide could be used. Molybdenum is a possibility, but its oxide is fairly uncontrollable in thickness.

Fig. 7(c) shows the normal clocking arrangement for a four-phase n-channel device. Signal charge resides in turn in the depletion region under each of the four gates. An alternative and most useful arrangement is called double clocking: Fig. 7(d). This is possible where the gate oxide under each gate is the same thickness and the gate areas are similar. The advantages of this clocking sequence are:

—The clocks are on for twice the normal duration, therefore twice the normal amount of charge can be propagated, leading to a larger dynamic range than normal.

—Efficiency increased because the area under an electrode is without carriers for a shorter time than normal.

—The possibility of simpler clocking because each pair of clocks, e.g. $\Phi_1$ and $\Phi_3$, $\Phi_2$ and $\Phi_4$ are mirror images.

—The clock breakthrough can be significantly reduced because of the mirrored clocks.

## Buried-channel c.c.ds

**Basic device.** Surface-channel c.c.ds suffer from the fact that charge moves at the surface of the silicon, in intimate contact with the fast surface states. Unfortunately, the density of these states cannot be reduced beyond a certain minimum value, and interaction with these states is a major contribution to the charge transfer efficiency. In a buried-channel device[14, 15], Fig. 8, the depletion region well starts to form below the surface, within the bulk of the semiconductor. The shape and location of the depletion region, and, consequently, where the signal charge resides, is determined by several factors: the doping level and profile of the substrate; the oxide thickness; and the applied voltage. Because the charge is made to move within the semiconductor, only bulk trapping centres affect $\eta_T$ (these are normally at a low density as compared to $N_{SS}$ surface values). The carriers can move at higher velocities within the bulk because the bulk mobility is larger than the surface, inversion layer value. However, the charge handling capacity of the buried-channel c.c.d. is lower than the surface version, owing to the larger effective distance of the charges to its gate electrode.

**Construction.** Buried-channel devices are usually made on n-type silicon layers on top of p-type substrates. the n-type layer is usually either ion-implanted with an n-type dopant, or epitaxially grown in an r.f. reactor.

The gate arrangements for buried-channel devices are usually three- or four-phase schemes which have been described earlier. Fig. 8 shows a simple buried-channel c.c.d. with a three-phase gate arrangement. Four-phase devices can in some circumstances be driven by sine-wave clocks at 5 or 6 volts peak-to-peak. This development is most significant for the advanced high-frequency applications of c.c.ds.

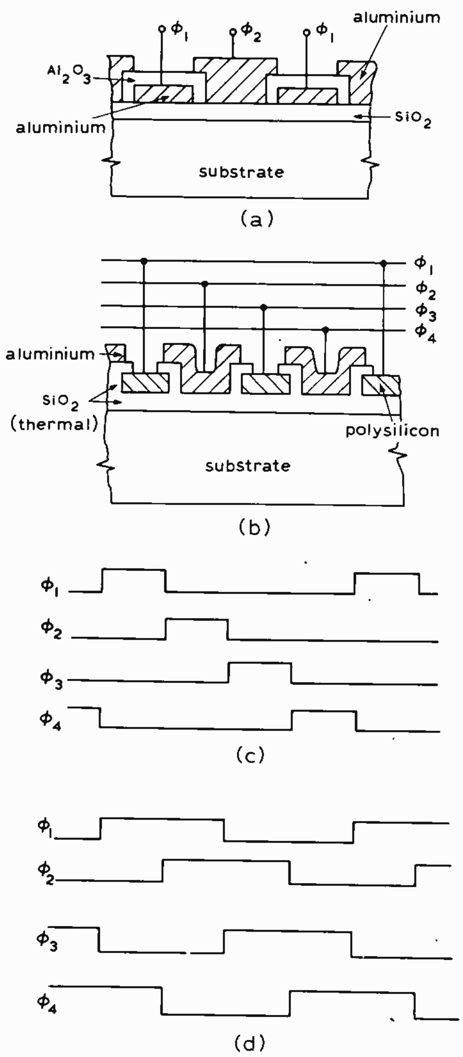



*Fig. 7. Four-phase overlapping-gate c.c.ds can have anodized aluminium gates (a), or polysilicon ones (b)—especially useful in imaging devices because of their transparency. Double clocking (d) allows twice the charge to be propagated and increases efficiency over normal clocking (c).*

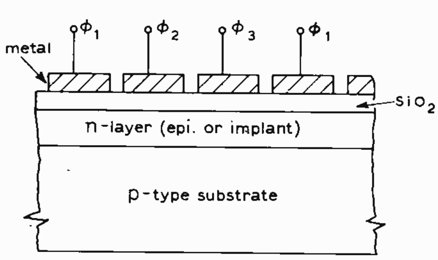



*Fig. 8. In buried n-channel c.c.ds, carriers can move faster within the bulk because mobility is larger than the surface value.*

## Testing

At the end of the fabrication process, the finished slice contains perhaps hundreds of potentially working c.c.ds and m.o.s.ts. Before the wafer is scribed-up to produce individual chips, the circuits are d.c. tested. A test computer is often used to control the current and voltage sources used in the test, set the test limits on the detectors, and store the test data in a memory which can be read-out at a later time.

The parameters which are usually monitored to determine the d.c. performance of the chip, and thus the probability that the circuits will work under dynamic conditions, are simple continuity tests (forward biasing diode junctions); the gate oxide breakdown voltage(usually measured on the clock phases); a test to establish if any shorts exist between clock phase lines, and the source and drain diode reverse leakage. A c.c.d. chip which fails any of these d.c. tests is rejected by inking the offending device with the prober "inker" and removing it after the slice is scribed.

## Chip cost and yields

The chip cost calculation has basically three components:

- wafer processing cost—including labour and overheads;
- yield—proportional to the number of photoresist-masking steps required to fabricate the silicon slice, and
- area per bit required for a particular structure, which is a function of the number of bits in the device.

As the fabrication cost of a chip, and therefore the c.c.d. cost, depends exponentially on the chip area it is necessary to aim for a square layout. This has led to making c.c.d. shift registers, with many bits, in a serpentine shape and in some cases to serial-parallel-serial memory layouts[16].

## Future developments

The commercial future of c.c.ds largely depends on the degree of process compatibility with existing standard m.o.s. processes; especially silicon-gate m.o.s. devices. The applications areas where this is particularly relevant is in the mass-memory market, where the cost per bit is a crucial parameter and high yields are essential. However, there will undoubtedly be applications, especially in the specialized military system area, where high component costs can be tolerated and therefore where non-standard processes are acceptable. A full treatment of the progress of c.c.ds in penetrating specific application areas will appear in later parts of this series.

As regards future developments in

c.c.d. technology, new techniques for producing sub-micron inter-electrode gaps, such as by electron-beam lithography, will undoubtedly have an important influence on device structures and therefore result in improved performance. Another possibility is fabricating devices in materials other than silicon. Silicon technology is established; and the processes for growing stable oxides and making good diodes is well understood.

However, materials exist which potentially offer improved c.c.d. performance, if a suitable technology based around the new material existed. A prime example is gallium arsenide. It has a mobility about four times higher than for silicon. Thus, c.c.ds based on gallium arsenide should have a significant speed advantage. Its optical properties compared with silicon make it an interesting proposition for imaging applications. However, before gallium arsenide devices become widely available the cost of the starting material will have to drop substantially, and the high surface state density, which occurs with this material, will have to be reduced by further research.

## References


1. Kim, C. K. and Snow, E. H. *Appl. Phys. Lett.*, vol. 20, 1972, p. 514.
2. Mifune, T. et al., Proceedings of the 4th Conference on Solid State Devices: Supplement to *J. Japanese Soc. of Appl. Phys.*, vol. 42, 1973, p. 207.
3. Sequin, C. H. et al., IEEE International Solid-State Circuits Conference, Dig. Tech. Papers, 1974, p. 24.
4. Engeler, W. E. et al., *Appl. Phys. Lett.*, vol. 17. 1970, p. 469.
5. Collins, D. R. et al., *J. Electrochem. Soc.*, 1973, p. 521.
6. Berglund, C. N. et al., *Appl. Phys. Lett.*, vol. 20, 1972, p. 413.
7. Baker, I. M. et al., British Patent Application, 51950/72.
8. Kahng, D. and Nicollian, E. H. US Patent 3651349.
9. Boyle, W. S. and Smith, G. E. *Bell System Techn. J.*, 1970, p. 587.
10. Krambeck, R. H. et al., *Appl. Phys. Lett.*, vol. 19, 1971, p. 520.
11. Frohman-Bentchkowsky, D. and Lenzlinger, M. *J. Apply. Phys.*, vol. 40, 1969, pp 3307.
12. Salama, C. A. T. *Electronics Lett.*, vol. 8, 1972, p. 21.
13. Gelberger, P. P. and Salama, C. A. T. *Proc. IEEE*, 1972, p. 721.
14. Walden, R. H. et al., *Bell System Techn. J.*, 1972, p. 1635.
15. Esser, L. J. M. *Electronics Lett.*, vol. 8, 1972, p. 620.
16. Windle, D. J. et al., *New Electronics*, vol. 7, 1974, p. 18.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**Instrumentation in Oceanography**
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**BIRMINGHAM**

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# Letters to the Editor

## "SETTLING TIME" IN AUDIO AMPLIFIERS

In an earlier article in your pages[1] I noted that there appeared to be a relationship between the tonal quality of an audio amplifier and the type of transient response of the amplifier following a step function input under reactive load conditions. This was more noticeable with complex l.s. systems, which might be presumed to offer more highly reactive load impedances at certain parts of the frequency spectrum, than with simple l.s. configurations.

Shortly afterwards there appeared the now celebrated paper by Dr Otala[2] which looked at the problem of the transient behaviour of audio amplifiers on a formal basis, and drew attention to the possibility of transient intermodulation phenomena when the rate of change of the input waveform applied to a feedback amplifier exceeded the possible rate of change of the feedback voltage (or current).

Recent work in the field of high-quality operational amplifiers has led to the widespread adoption and specification of the parameter "settling time" as a measure of the transient performance of such amplifiers under specified load conditions. This is defined as the time which elapses between the application at the input of the amplifier of a notionally ideal step function, and the "settling" of the output signal at a level which is, and remains, within some specified error band about its final output voltage.

I would like to suggest the extension of this concept to the field of audio amplifiers, as a means of defining the transient performance, partly because it is a readily visible and measurable thing—as an examination of the published "square wave" oscillographs in normal amplifier reviews will readily confirm—but principally because the argument suggests itself that when the output of an amplifier has "settled", steady state conditions, as defined by conventional t.h.d. and intermodulation distortion characteristics, must surely apply.

Following this argument, I would like to suggest, therefore, that the target for good-quality audio amplifier design should be that t.h.d. should be, and remain, below 0.1% within the useful audio spectrum and the whole of the output power range, and also that the transient performance of the amplifier, under the anticipated "worst-case" reactive load condition, should be such that the output voltage settles within an appropriate error band (a realistic figure is probably ±0.5%) within a time which is short in relation to the highest frequency signal the amplifier is likely to be called upon to handle; 5 microseconds seems an appropriate value.

(If an input *CR* lag network is incorporated at the input of the amplifier, as part of the design, to limit the possible rate of change of the input voltage waveform—which may well be a prudent thing to do—the true settling time may be less than the apparent rise time, but can be derived from the difference between the measured rise time and that predictable from the effect of the input *RC* network.)

Apart from the questions which this hypothesis may raise in respect of the performance of available audio amplifier designs, it also raises a query as to the desirability in use of steep cut audio filters, which not only produce an increase in settling time when used, but also—demonstrably—will introduce colouration on a "white noise" signal, perhaps for this very reason.

J. L. Linsley Hood,
Taunton,
Somerset.


**References**

1. Linsley Hood, J. L. *Wireless World,* June 1970, p. 280.
2. Otala, M. *Trans. I.E.E.E.*, AU-18, pp. 234–239.


## REDUCING AMPLIFIER DISTORTION

In his article in the October issue (page 367) Mr Sandman states that "In Fig. 1 the undistorted part of the output $V_{in}R_2/R_1$ balances off at the junction of $R_1$ and $R_2$ to produce zero voltage, the only voltage to appear at this point being proportional to the distortion".

This statement is not strictly accurate. In Fig. 1, and in other circuits, the amplifier input is connected to the junction of $R_1$ and $R_2$. It is obvious, therefore, that the undistorted component of voltage at this point cannot be zero. If it were, the amplifier would have no input and could produce no output. If $A$ is large the voltage approximates to $V_{in}R_2/AR_1$; it may well be that this is small compared with the distorted voltage fed back, but it can never be zero.

Referring again to Fig. 1, there is a point in the circuit at which the undistorted component of signal does balance to zero, to leave only a distorted component. This point is not at the junction of $R_1$ and $R_2$, but is along $R_2$ between the input and output of the amplifier $A$. To obtain a true balance to zero it is necessary to connect the input of $A_2$ in Fig. 2 to a tapping point on $R_2$ instead of to the input of $A_1$. This point on $R_2$ is critically dependent on the gain of $A_1$, however, and precise adjustment is needed to obtain the proper condition. As long as $A_1$ is high enough, therefore, it is probable that Mr Sandman's non-critical arrangement is better in practice.

There is no mention in Mr Sandman's references to the work of W. Baggally ("Distortion cancellation in audio amplifiers", *The Wireless Engineer and Experimental Wireless*, August 1933, page 413). I referred to this in my letter in the April 1973 issue of *Wireless World*, page 192. In Baggally's scheme a phase-reversing main amplifier had a resistance with an adjustable tapping connected between its input and output. A non-phase-reversing amplifier was fed from this tapping and its output applied to the input to the main amplifier. Critical adjustments of tapping point and of subsidiary amplifier gain were required, which is probably why the circuit never achieved popularity.

W. T. Cocking,
Ewell, Surrey.

*Mr Sandman replies:*

The part of the article "It cannot be too strongly stressed . . ." (page 367) deals with the definition of distortion which I employ. Distortion includes frequency, amplitude, phase and non-linear distortion.

I am sure it is common ground that the output can be split up into two parts, undistorted

$$\left(V_{in}\frac{R_2}{R_1}\right)$$

and distorted $V_D$.

It follows that $V_{in}$ and $V_{in}R_2/R_1$ balance off to zero at the input to $A_1$ and $A_2$ and that the voltage at this point is the distortion ($V_D$) attenuated by $R_1$ and $R_2$ (a small voltage). This attenuation is compensated by the gain of amplifier $R_1'$, $R_2'$ and $A_2$ to produce $V_D'$ (the error take-off voltage as I now define it) which is taken off the output appearing across $R_L$.

If Mr Cocking were to build Fig. 11 incorporating the corrections in *Wireless World*, November 1974, page 454, I am sure his doubts would be laid to rest.

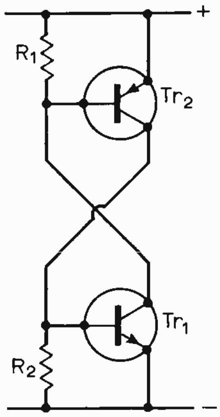
Mr Baggally's scheme falls down on both the principles of "non-interaction" and "rigidity of interconnection".

## CIRCUIT DIAGRAM LAYOUT

The article by Mr Amos on circuit diagram layout (November issue) was certainly welcome in these days of atrocities typified by his Fig. 9.

While agreeing with most of his recommendations, the golden rule I like to follow is to draw everything that is more positive "northwards" of everything that is negative, so that travelling from the bottom to the top of the paper each conductor is in order of potential above earth. This makes it easier to understand the circuit once one has recognized it.

Therefore I totally abhor Mr Amos's Fig. 6 which, although it may be "clearly a multivibrator", is not easy to understand. I suggest the following drawing is preferable:




The crossover is preserved and so are the polarities. Caution is still needed, however, or, like Mr Amos, one might miss the fact that this *never was* a multivibrator, but is a bistable which self-destructs when triggered!
David Williams,
London SE12.

Speaking as one who earns his daily bread in a world of circuit diagrams I must say I entirely agree with the admirable basic aims set out in your November 1974 editorial and the opening paragraph of Mr Amos's article on layout of circuit diagrams in the same issue.

However, I feel Mr Amos has missed the point in attempting to lay down standard circuit diagram patterns for every type of circuit. Since there are already countless different circuit configurations and new circuits are being designed every day, you can never hope to achieve a standard pattern for every circuit. The aim should be to assist a complete stranger to learn the function of a particular circuit configuration; if someone who is already familiar with the circuit can instantly stamp it with the name "Colpitts oscillator" (or whatever) then so much the better, but that should be a secondary aim.

I therefore suggest four basic rules for a good circuit diagram should be, in order of priority:

(i) current flow vertically downwards;

(ii) signal flow from left to right and top to bottom;

(iii) minimize the number of bends in connecting lines;

(iv) minimize the number of crossings of connecting lines.

I place (iii) above (iv) because a line is fairly easy to follow if it is straight, even if it does cross several others in its path.

In my experience, when one encounters a totally unfamiliar circuit configuration rule (i) is fundamental in attempting to understand its function. Fortunately nowadays most circuits are drawn to this convention, which enables one to visualize small voltage changes as "up or down" and to keep a clear track of the various inversions a signal undergoes.

By this argument, Fig. 5 in the article is preferable to Fig. 6, contrary to Mr Amos's conclusions. Being able to stamp Fig. 6 with the name "multivibrator" does not help one to understand its operation, since it is unusual in that both transistors are on (or off) simultaneously.
Paul V. J. Adkins,
Braintree, Essex.

*Mr Amos replies:*
I am glad that Mr Williams welcomed my article in general and I like his redraw of the multivibrator circuit. I am puzzled, however, by his final sentence which seems to imply that a multivibrator cannot be bistable. In fact electronic circuitry bristles with bistable multivibrators usually abbreviated nowadays to just bistables. I take Mr Williams's point about my Fig. 6; I have perhaps oversimplified this in order to emphasize my argument. In a practical version of the circuit current-limiting resistors are necessary.

Mr Adkins also advocates the "current downwards" approach in circuit diagram layout and I think this has much to commend it in digital circuits. My article was, however, chiefly devoted to analogue circuits as I made clear in my first paragraph and here I think it is preferable to aim at preserving the standard pattern for well-used circuits no matter what the direction of standing currents. This is also the view of BSI as made clear in Section B2 of the Guiding Principles of BS3939.

## TRACKING FILTERS

I was very interested in the article in your October issue by Messrs Knott and Unsworth, particularly in their implementation of the technique of 50Hz rejection with modern methods and their analysis of the performance of the filter.

One of the earliest examples of this method was described in 1953 by Beard and Skomal[1]. They used a switched capacitor storage system to reject 60Hz interference in a model of a geophysical prospecting situation.

The technique has also been widely used for rejecting all signals (as well as those from mains) which are not locked to the store switching rate. Three papers which have probably not received the credit they deserve, because of inaccessability, are by G. Suryan[2,3,4]. He used a synchronous magnetic store and his analysis showed clearly its behaviour as a comb filter.

A switched capacitor store was introduced by me for rejecting 50Hz, and all other signals not locked to the switching cycle, in 1951 and described more fully in 1953[5]. Although the electronics are obsolete the account of the method may be of interest because it outlines some of the precautions against stray capacitances and capacitor leakage which are needed if a stored waveform is to retain its shape. This technique has now become a standard method of examination in man for delay of conduction in diseased nerves. Also it is used for examining transmission in the auditory pathway in children who cannot communicate.

The technique is now usually implemented by purely digital methods, but there may still be a use for capacitor stores in special purpose applications. So it seems well worthwhile emphasizing the more general applications of a system such as that described by Knott and Unsworth. It can be easily used to extract the response of any system which can be stimulated at a fixed time in relation to the store switching cycle. Also, with digital switching, the occurrence of store switching cycles and locked stimuli may be irregular, if this is an advantage.
G. D. Dawson,
Department of Physiology,
University College London.


**References**

1. Beard, C. I. and Skomal, E. N. RC memory commutator for signal to noise improvement, *Rev.Sci.Instr.* Vol. 24, 276–280, 1953.
2. Suryan, G. A new method of integration of weak nuclear magnetic resonance signals, *Physical Review*, Vol. 80, 119, 1950.
3. Suryan, G. The synchronous magnetic recorder and its applications, Part 1 theory, *J. of the Indian Institute of Science*, Vol. 35, No. 3, 1953.
4. Suryan, G. The synchronous magnetic recorder and its applications, Part 2 experimental, *J. of the Indian Institute of Science*, Vol. 35, No. 3, 1953.
5. Dawson, G. D. A summation technique for the detection of small evoked potentials, *EEG Clin. Neurophysiol.*, Vol. 6, 65–84, 1954.


## QUADRAPHONIC QUANDARY

It would be pointless to make a *technical* reply to Mr Bauer's letter (September 1974) which concludes that it is sufficient for the producer and recording director to make and approve the SQ record and so "the various mathematical and philosophical arguments about quadraphony, therefore, become inconsequential".

How delightful! Quadraphony equals SQ. All controversial problems may now be set aside.
B. J. Shelley,
Rome,
Italy.

## AMPLIFIER CLAIMS

I have just noticed an advertisement in your May 1974 issue, placed by Radford Audio Ltd. I wish to make some comments on some of their claims, as they have made some very bold statements which I doubt would stand the scrutiny of the Trade Descriptions Act.

First, their statement, "We believe no other amplifier in the world can match the specifications of the HD250". I don't believe that they have checked other makers' equipment from, say, the USA or Japan. There are several pre-amps and main amps made in both these countries that will equal it and better it by an easy margin—if the Radford specs are written in the same manner. They are not properly defined.

Secondly, to say distortion (pre-amp) is zero is a very bold statement, to say the least. According to the IHF method of measurement, the only true distortion figure to quote is what is called total harmonic distortion (t.h.d.) which is defined as including noise hum, all spurious and harmonics of the frequency being measured. Incidentally many British makers seem to "loophole" their way round amplifier distortion these days by stating only harmonic distortion, let alone which one! The reason for including noise is that all amplifying circuits add some noise which was not there on the original signal fed in, thereby distorting the original. (This I know is a hypothetical case.) So let's have a look at their case—making many assumptions. That the phono has a sensitivity of 2mV at 1kHz and the nominal output from the pre-amp is 1 volt, then the lowest distortion with reference to this can only be about 0.03%, not zero. The disc noise is given as −83dBV bandwidth limited to 23kHz, but with respect to what! The generally accepted method of quoting noise in Japan is on a wide band measurement up to 1MHz and against a nominal 2.2mV at 1kHz sensitivity, and for auxiliary or other high level inputs a reference of 150mV is used. Likewise whose "A" weighting do they mean? Overload margin of "disc" input is quoted at 40dB; nothing marvellous. I could find other points to grumble about in this advertisement.

Tim de Paravicini,
Lux Corporation,
Osaka, Japan.

*Reply from Radford Audio Ltd:*
Mr Paravicini's comments are a little inconsistent and misleading. Am I to understand that our current advertisements for the HD250 amplifier would not stand the scrutiny of the Trade Descriptions Act because the performance specification extracts appear too good to be true? If so, then how can it be that several pre-amplifiers and power amplifiers in USA and Japan "will equal it and better it by an easy margin"?

The phrase from our advertisement "We believe that no other amplifier in the world can match the specification of the HD250" is mis-quoted by him as "We believe no other amplifier in the world can match the specifications of the HD250". Mr Paravicini's plural specification is taken to mean "some specification details". The word "specification" (singular) means the totality of all specification detail. This includes visual presentation, engineering design, quality of manufacture, servicability, facilities and functions available, flexibility in use, performance characteristics, etc. Mr Paravicini appears to have become enmeshed by his loose reading and colloquial popular hi-fi jargon.

In the advertisement it quite clearly states that the performance details quoted are extracts, and the specification is therefore not complete. In it readers are invited to write for a 12-page leaflet which describes the design details of the HD250, together with a complete specification. It is not possible or desirable to give a complete specification in an advertisement. Nor is it expected that our potential customers will purchase amplifiers by just reading the advertisement, or even after studying the leaflet, but only after hearing and comparing the HD250 with other amplifiers in the dealer's showroom.

The fact that we believe that the specification of the HD250 cannot be matched by any other *integrated* amplifier does not make it a claim or a fact. Nevertheless it is reasonable to expect that we have done some work to justify our opinion. Our belief is based on measurements carried out on amplifiers available in this country, and in America with similar test equipment and under similar conditions of test, and not by studying manufacturers' literature. Mr Paravicini compares the performance details of the HD250 quoted with unspecified separate pre-amplifiers and power amplifiers. Although it is generally accepted that it is not possible to obtain some performance parameters as good in integrated amplifiers as in separate pre-amplifiers and power amplifiers it does not alter the fact that we know of no other pre-amplifier with a better overall performance characteristic than the pre-amplifier section of the HD250 (the pre-amplifier section of the HD250 is now also available as a separate unit, namely the ZD22 Pre-amplifier Control Unit).

Concerning distortion. We do not claim that the harmonic distortion of the pre-amplifier section is an unqualified zero as he states. In general text we say that the distortion is "virtually zero" or qualified as in the advertisement "cannot be identified or measured as it is below inherent circuit noise".

The IHF method of specifying total residual background under dynamic conditions of distortion measurement as "total harmonic distortion" makes sense generally as this is what distortion measuring sets measure. If, however, after rejection of the fundamental test frequency by the d.m.s. there are no measurable or observable harmonics left—just the static inherent noise of the equipment under test plus measuring equipment noise if any—then to specify this residual as "total harmonic distortion" is nonsense in any language. When the IHF test specification was drafted such a condition was probably not envisaged. If the total harmonic distortion products generated by an amplifier at the working signal level do not add to the static inherent noise background, then the harmonic distortion can surely be said to be "virtually zero". In the disc amplifier referred to, the harmonic distortion cannot be measured or detected at working signal level or even at 20dB above. It will be appreciated that distortion levels below 0.01% are largely academic in practical amplifiers for sound reproduction, but this does not prevent engineers from designing better and better amplifiers. The virtual elimination of harmonic distortion in audio amplifiers up to output stage clipping level is a logical target of development.

It is conventional when making distortion measurements with a d.m.s. to display the residual output, after fundamental rejection, on one trace of an oscilloscope and the fundamental on the other. This enables an assessment to be made of the harmonic distortion structure, the character and energy content of noise, crossover spikes, and spurious responses. The contribution of hum can be ascertained by using a 1kHz test signal with the 500Hz filter.

I am baffled by the statement that "British manufacturers seem to 'loop hole' their way around amplifier distortion by stating only harmonic distortion, let alone which one". One could gather from this remark that British engineers have a crafty way of eliminating hum, noise and a dominant second harmonic and quoting only a lower amplitude third harmonic. British manufacturers, in common with American and Japanese manufacturers, use conventional total harmonic distortion measuring equipment in development and do not generally use wave analyzers. As my company has supplied this type of equipment to the major audio manufacturers in this country (and the rest of the world) I am aware of the situation.

The "A" weighting characteristic is incorporated in standard noise measuring equipment and is also used by professional audio engineers in broadcast and recording studios. It was formulated to simulate the subjective hearing response in order to obtain significant noise figures. A bandwidth of 1MHz for audio and acoustical noise measurement is unrelated and misleading.

The 40dB disc overload margin is said to be "nothing marvellous". In itself it may not be extraordinary but if it is taken in conjuction with a noise level near the theoretical minimum and a "virtually zero" distortion at +20dB above operating level and an RIAA accuracy of ±0.2dB then that *is* something. In the HD250 sales leaflet it clearly states that the signal-to-noise ratio is greater than 83dB measured with a noise bandwidth of 23kHz when used with a 5mV output cartridge (1mV/cm/s at reference velocity of 5 cm/s). This figure is considerably better than in any other amplifier we have tested.

I am unable to appreciate the object of Mr Paravicini's letter. Is it intended to be a general tilt at British manufacturers? Is he worried about the advanced state of British audio and acoustical technology—or is it just "I am the greatest"?

A. H. Radford,
Radford Audio Ltd,
Bristol.

# Weather satellites ground station—3

## Conclusion of this series with the display electronics described in full

by G. R. Kennedy

The block diagram of the picture display system is shown in Fig. 22.

The scheme of operations is as follows. Assume an input signal from a tape recording of an APT satellite signal at a moment when the signal is in the peak white between picture condition. The signal clock rate is determined by the limiters feeding the phase-lock loop, which locks on to the input signal rate. The phase-lock loop v.c.o. will then follow the apparent input clock rate, within the tracking range limits, and hence take account of tape-recorder wow and flutter. The *X* ramp generator takes the p.l.l. v.c.o. frequency and produces a step-function ramp from the buffered square wave signal locked to the input rate. Hence the *X* ramp also takes account of tape-recorder speed errors. It should be borne in mind that a step-function ramp generator for the *X* axis is superior to an analogue integrator ramp generator, for the former takes account of signal rate/phase changes cycle by cycle with the input signal, whereas the integrator sums the effect and due to the large time constant, may be lagging or leading the input-signal rate by flyback. This would give a ragged edge to the picture, and displacement of picture details.

The dividers count down the clock rate in synchronism with any rate changes and accurately trigger the flyback of the *X* ramp generator.

The start-sync circuit is quiescent during most of the satellite signal sequence. When the 300Hz tone occurs, the circuit resets the decade counters in the divide chain to nine and the divide-by-12 counter to zero at the beginning of one of the 12.5ms black level periods in the five-second phasing period after the 300Hz tone. After 12 cycles of the signal frequency the divide-by-12 circuit changes state and sets the decade counters to zero, which resets the *X* ramp generator. The 12 cycles of the signal frequency delay the flyback

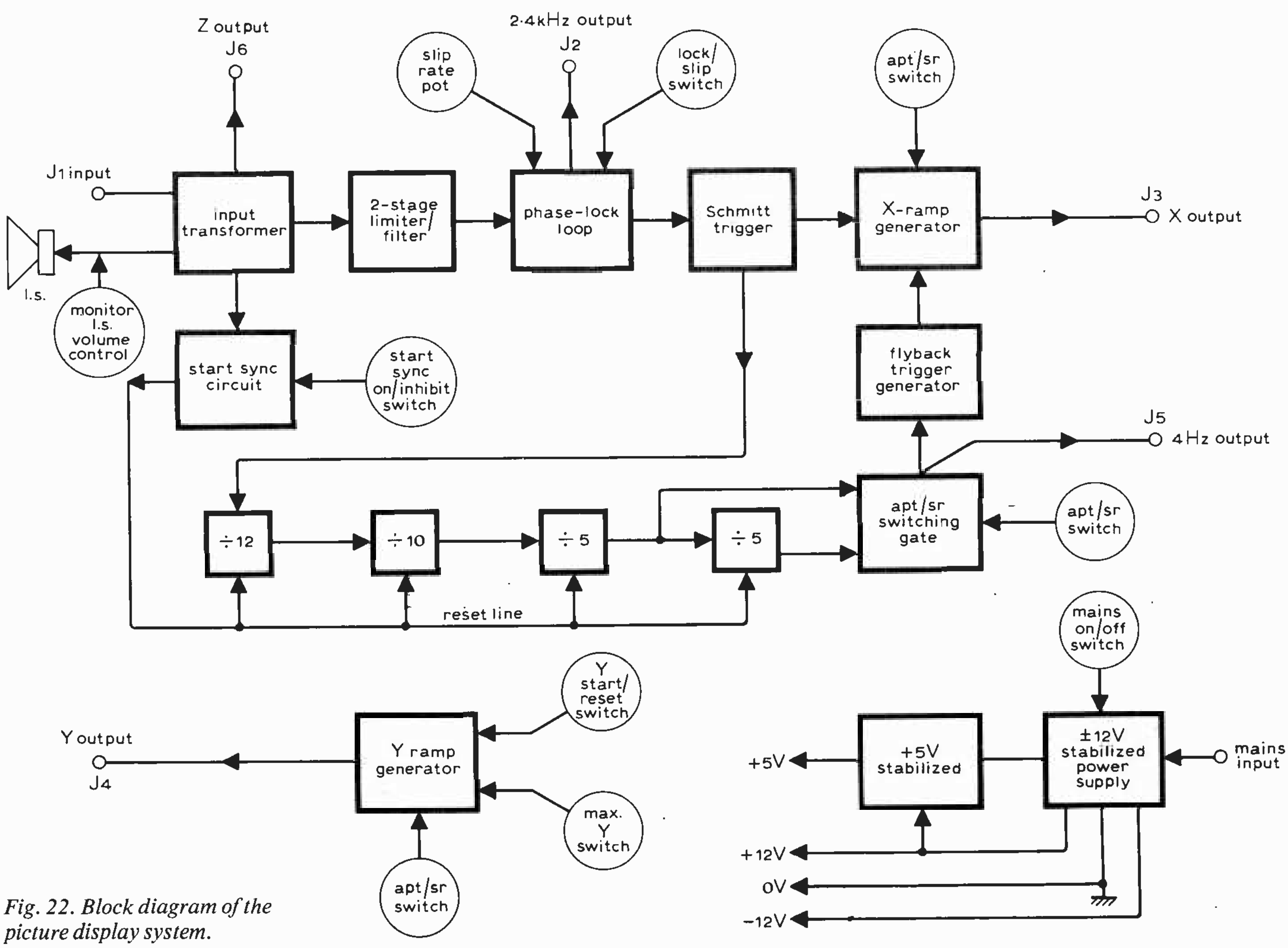



*Fig. 22. Block diagram of the picture display system.*

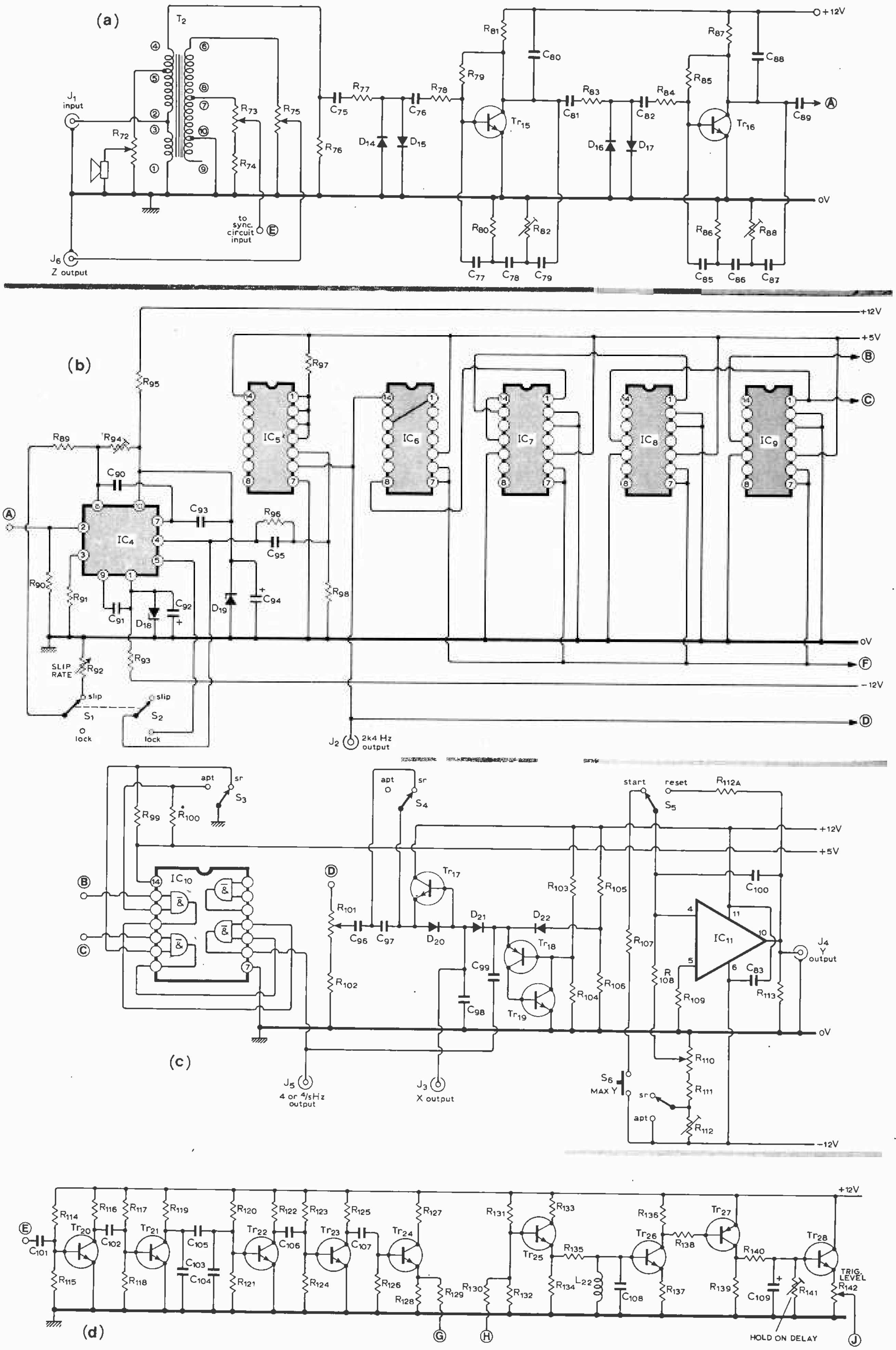



*Fig. 23. Display electronics (a) input and limiter/filter stages (b) phase lock loop and divider stages (c) switching gate and ramp generators (d1) start synchronizing circuit.*

(and start) of the $X$ ramp by six ms or so. This forces the $X$ ramp to approximately midway through successive black periods in the phasing sequence and centres the picture $X$ scan lines so that there is a white border down each side of the displayed picture. The sync circuit keeps the reset line at logic low during the rest of the picture, until it sees more than 1.5 seconds of 300Hz, whence the forcing action occurs again. The chances of the picture containing more than a few milliseconds of 300Hz waveform are remote, but the sync circuit can be manually inhibited, if so required.

In the case of SR pictures such as sent by NOAA-2 there is no interpicture period —the sequence runs continuously—and it is convenient to manually phase the picture for either visible or infra-red picture on the left-hand side, using the lock/slip and slip-rate controls. These unlock the phase-lock loop v.c.o. and allow the p.l.l. output frequency to lag the satellite sub-carrier frequency. In practice it is a matter of moments to manually phase up the picture by observing the picture formation, and by slipping the desired picture border to the left-hand side. The lock position is then selected, and the picture will stay phased. Using the proposed circuit, it would be relatively easy to detect the 23.3ms, 300Hz burst in the NOAA-2 sequence which precedes each IR and visible picture line scan. As it stands, the burst is too short for the circuit to respond, but by switching in increased gain for the SR position, forcing of the counters could be carried out. Also, the 600Hz burst every 30 seconds preceding an i.r. picture line scan could be detected using a 600Hz filter, and the display phased automatically for left-hand IR pictures. For SR pictures, which run continuously during a pass, the $Y$ ramp generator is switched to run much slower than for APT pictures. The rate can be set by a preset potentiometer on the APT/SR switch to set the picture to the correct Index of Co-operation. It is for this reason that an analogue integrator is used for the $Y$ axis ramp generator, and not a step scan generator.

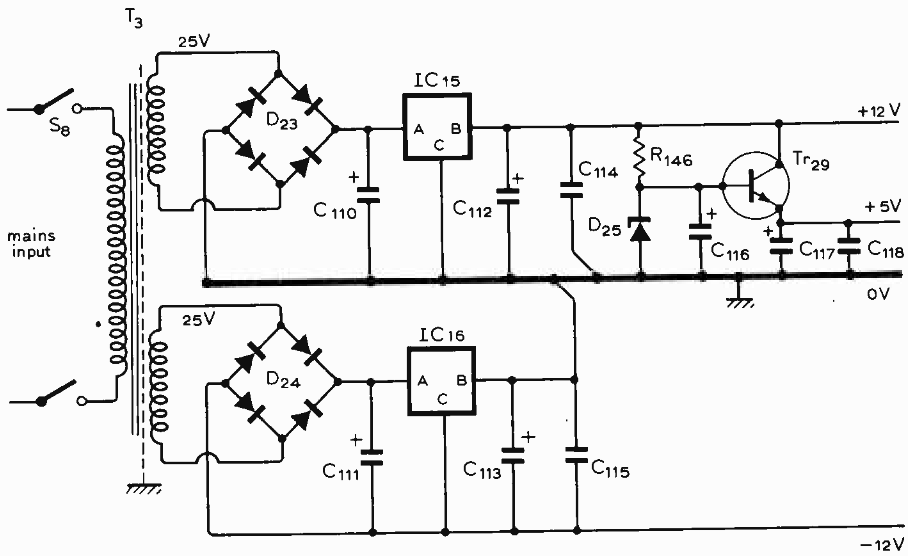



*Fig. 24. Display electronics power supplies.*

The complete display circuit is shown in Figs. 23, 24.

**Input stage:** the input transformer $T_2$ is a multi-tapped standard speaker isolating transformer. The number shown refers to the tag number on this transformer. The outputs to the monitor loudspeaker, the sync circuit and to the $Z$ axis output socket are variable by simple resistive coupling using potentiometers $R_{72}$, $R_{73}$, $R_{75}$. The voltage to the limiter is increased by auto-transformer action to double the input level. Shielding of the input transformer from any stray mains fields, particularly from the power supply transformer is essential to reduce 50 or 100Hz patterning on the displayed picture.

**Limiter/filter stage:** two similar limiters are used in series[7]. The input waveform is clipped on each half cycle by the opposed diodes $D_{14}$ through $D_{17}$ and amplified and filtered by $Tr_{15}$ and $Tr_{16}$. The filter networks of $C_{77}$, $C_{78}$, $C_{79}$, $R_{80}$, $R_{82}$ and $C_{85}$, $C_{86}$, $C_{87}$, $R_{86}$, $R_{88}$ are simple 180° phase-shift lead networks across the amplifier transistors. For the simple circuit shown, and taking single values for $R$ and $C$, the filter frequency is very approximately given by

$$f \approx 1/2\pi RC\sqrt{10}$$

**Phase-lock loop:** an integrated circuit low frequency p.l.l. is used (Signetics NE565A). The usual detected output in unused, and the v.c.o. is $RC$ coupled to the following buffer stage. To avoid feedthrough problems, and for simplicity the circuit has its own ± 5 volt supplies derived from the ± 12V rails. The working point of the input is set by the bias resistors $R_{90}$ and $R_{91}$.

The unlocked idle frequency is set by $C_{91}$ and ten-turn trimming pot $R_{94}$. The internal v.c.o. output connection at pin 4 and the internal p.s.d. connection at pin 5 are broken and brought out to the lock/slip switch, which closes the servo loop for locked operation and opens it for slipping the picture sync. In the latter state the resistive loading of $R_{89}$ and $R_{92}$ are sufficient to alter the v.c.o. frequency.

**Schmitt trigger:** as mentioned earlier, a gate or emitter follower could perform as well as the Schmitt trigger. The purpose of the stage is to buffer the p.l.l. output and

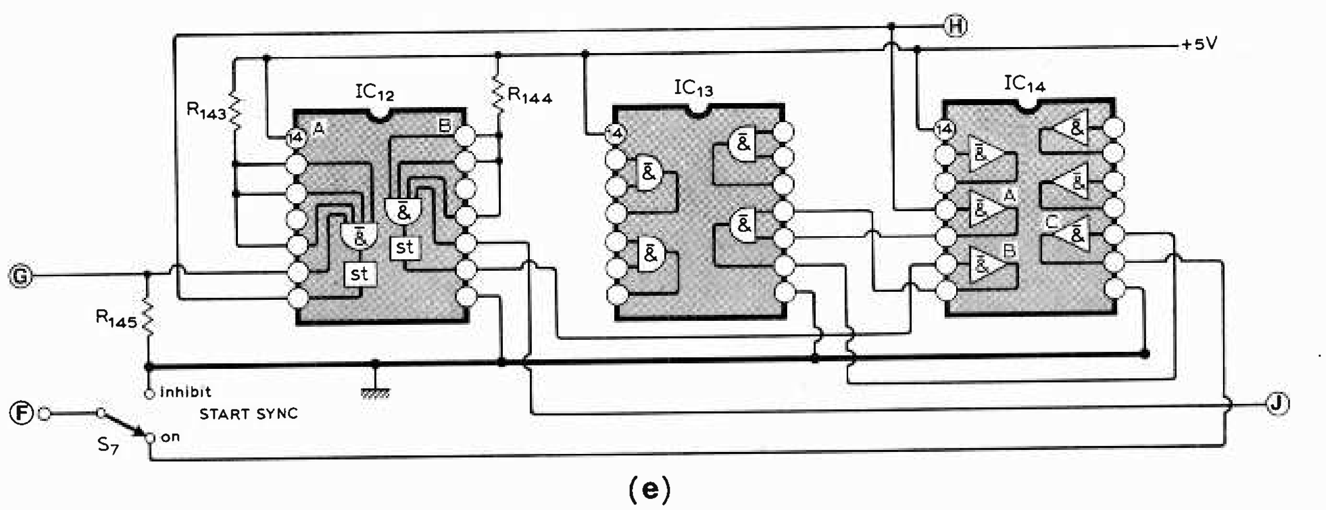



*Fig. 23 (cont.) Display electronics (e) start synchronizing circuit.*

allow fan-out to the ramp generator and dividers. The use of a digital i.c. gives a guaranteed and precise logic level output, and the dual nature of the NAND Schmitt trigger on the chip used allows for further development work.

***X* Ramp generator:** The staircase ramp generator $Tr_{17}$, $D_{20}$, $C_{97}$, $C_{98}$ is a standard diode transistor pump. The step rise per input pulse of $V_{in}$ is given by

$$V_0 = \frac{V_{in}\,C_{97}}{C_{97}+C_{98}}$$

assuming no loading of $C_{98}$. As it stands, the output across $C_{98}$ is at very high impedance, and unless driving a high impedance device such as an oscilloscope amplifier, must be buffered. A simple f.e.t. source follower is suitable.

**Flyback trigger:** The voltage on ramp generator capacitor $C_{98}$ is coupled via diode $D_{21}$ to the complementary pair $Tr_{18}$, $Tr_{19}$. In the quiescent state the anode of $D_{22}$ is held at +8.7 volts, $D_{22}$ is forward biased and $D_{21}$ is reverse biased, since the ramp on $C_{98}$ does not approach 8 volts. Diode $D_{21}$ is a silicon diode and does not present any appreciable discharge path to $C_{98}$. Transistors $Tr_{18}$ and $Tr_{19}$ are off, since the 8.2V at $Tr_{18}$ base due to potential divider $R_{103}$, $R_{104}$ is insufficient to forward bias $Tr_{18}$ base/emitter diode with the forward conduction potential of $D_{22}$ in series. When a positive trigger pulse arrives at $C_{99}$ from the flyback trigger generator $D_{22}$ cuts off, $D_{21}$ remains cut off, $Tr_{18}$ and $Tr_{19}$ turn on and $D_{21}$ conducts forwards. Capacitor $C_{98}$ is rapidly discharged to the level of the sum of the forward bias potentials of $D_{21}$, $Tr_{18}$ and $Tr_{19}$. When no further charge is transferred through $C_{99}$ the circuit returns to its former state.

**Divider stage:** the divider stage comprises four NAND digital i.c. counter chips: a divide-by-12; a decade counter; an identical counter connected for divide-by-five; and a further divide-by-five counter. All the counters have two input NAND gates for zero setting, and the decade counters have also a two input NAND gate for binary coded decimal nine setting. The divide by 12 zero reset line and the decade counter nine reset line are taken to the output of the start sync stage. The line

NAND GATE TRUTH TABLE

| a | b | c |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 0 |

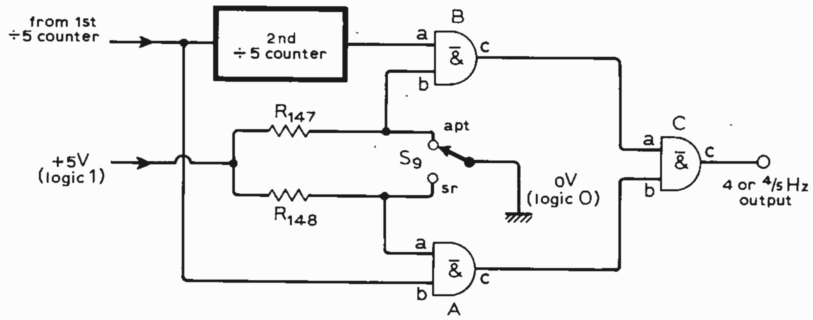



*Fig. 25. APT/SR switching logic.*

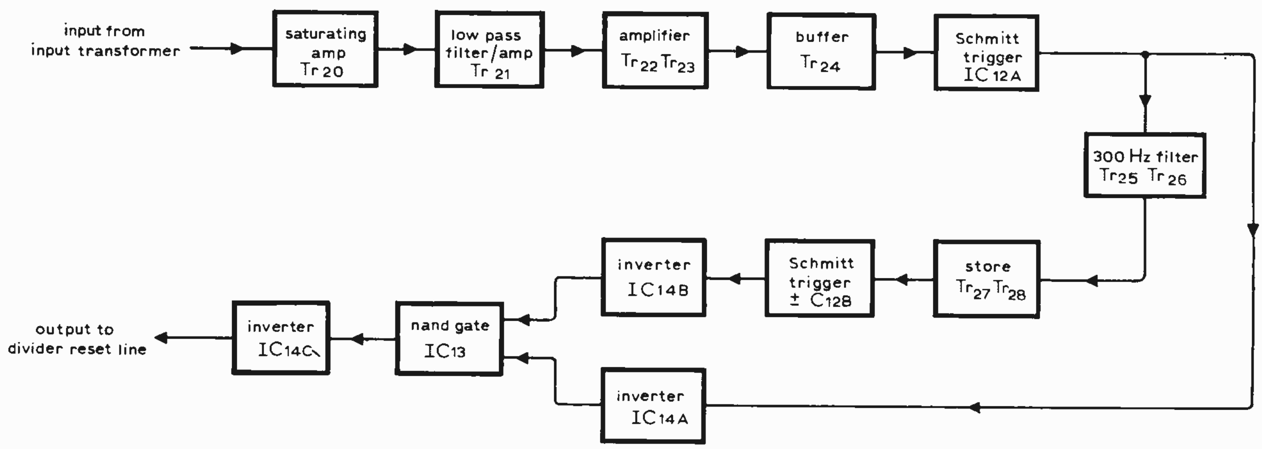



*Fig. 26. Start sync circuit block diagram.*

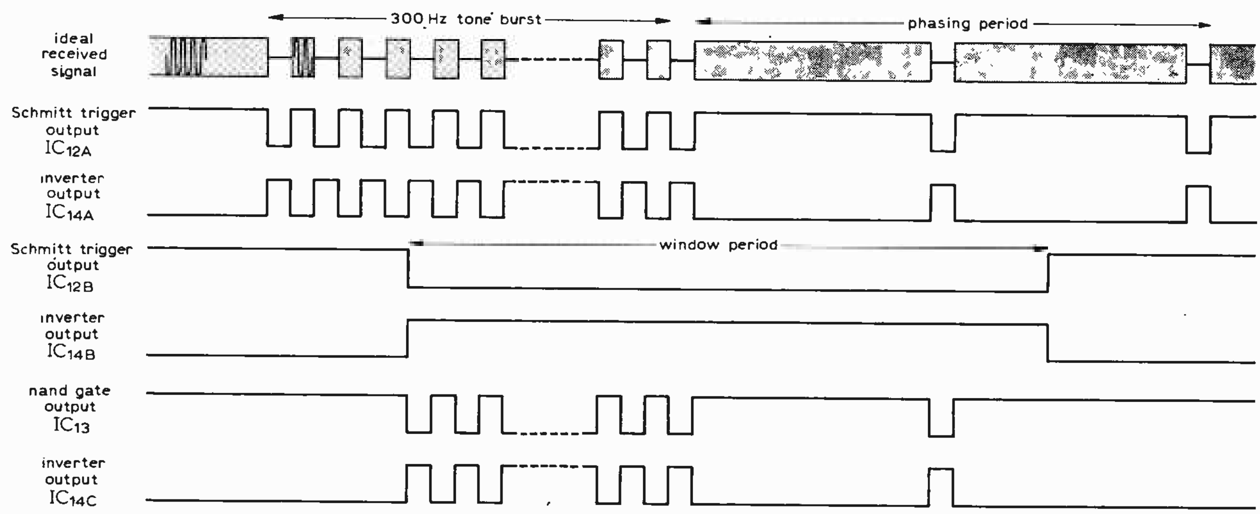



*Fig. 27. Start sync circuit waveforms.*

is normally held at logic zero, and the counters count conventionally.

**APT/SR switching gate:** the APT/SR switch circuit is shown separately in Fig. 25. Three two-input NAND gates are used, A, B and C. The input to the final divide-by-5 counter is fed in parallel to gate A. The output of the divide-by-5 counter is fed to gate B, and the outputs of the gates feed gate C. Both of the second unused inputs of gates A and B are held at logic 1 by a direct connection through $R_{147}$ or $R_{148}$, but can be set to logic O by the APT/SR switch. If any NAND gate input is held at zero, no gate transmission can take place, and the output remains high. Hence, whichever gate is not held at zero conducts, and transmits the square wave input to the output, in inverted state. Since one gate is always held off at logic 1 output, gate C always toggles with the output of the other input gate, and inverts that output, returning the sign of the signal to that at the circuit input.

**Start sync circuit:** the block diagram of the start sync circuit is shown in Fig. 26, and the relevant waveforms in Fig. 27. Referring to the circuit Fig. 23(d), the input is taken from the input transformer via a potentiometer $R_{73}$ and $C_{101}$. Transistor $Tr_{20}$ forms a high gain saturated amplifier detector. The pi filter $C_{103}$, $C_{104}$, $C_{105}$ removes the bulk of the 2.4kHz sub-carrier, and further amplification by $Tr_{22}$ and $Tr_{23}$ clips the detected signal to rapid transitions between high and low.

This signal is buffered by $Tr_{24}$ and is converted to precise logic levels by Schmitt trigger $IC_{12A}$. The Schmitt trigger output is fed in parallel to an inverter $IC_{14A}$, one of six inverters on an inverter chip i.c., and to a 300Hz filter at $Tr_{25}$, $Tr_{26}$. Components $L_{22}$ and $C_{108}$ are a circuit resonant at 300Hz of low $Q$ due to the shunting effect of $R_{134}$, $R_{135}$ and $R_{137}$ through $Tr_{26}$ base/emitter diode. Transistor $Tr_{26}$ collector drives the high gain p-n-p transistor amplifier $Tr_{27}$, which in turn feeds the capacitor $C_{109}$. When the potential at $Tr_{26}$ base rises due to a 300Hz tone, $Tr_{26}$ switches on, which switches $Tr_{27}$, which charges $C_{109}$ by the potential due to the collector current of $Tr_{27}$ through $R_{139}$.

The potential rises on $C_{109}$ at a rate determined by its capacity, shunting components $R_{139}$, $R_{140}$, $R_{141}$ and $R_{142}$, and by the length of the 300Hz burst. Hence the effect of the 300Hz burst is stored by $C_{109}$. Transistor $Tr_{28}$ emitter follows the charge rise on $C_{109}$ and depending on the value of potentiometer $R_{142}$, triggers Schmitt trigger $IC_{12B}$, the second half of a dual Schmitt i.c. chip. This Schmitt output is inverted by $IC_{14B}$, and the resultant signal applied to the second input of NAND gate $IC_{13}$, together with the inverted output of Schmitt trigger $IC_{12A}$. Due to the fact that Schmitt $IC_{12A}$ output is normally high, and hence its inverted signal is normally low, NAND gate $IC_{13}$ is normally disabled. When the input due to $IC_{12B}$ via $IC_{14B}$ goes high after a 300Hz burst, a window is created when gate $IC_{13}$ can respond to its input from Schmitt trigger $IC_{12A}$, carrying detected signal information.

For the window period, the length of which depends on the length of burst the setting of the storage capacitor shunt $R_{14}$, and the Schmitt trigger lever $R_{142}$, the NAND gate responds to the detected signal information. The period after the 300Hz burst contains the 12.5ms black pulses, and the gate goes low during these periods. The inverted output of the gate through inverter $IC_{14C}$ therefore goes high. This output is connected to the divider chain counter reset line, and forces reset during the black periods within the 300Hz store window. In practice, at the beginning of the window period, the 300Hz tone will still be running, since it is three seconds long, and the reset line will be activated for several of the 300Hz cycles. However, the counter will respond, as far as the picture display is concerned, to the last forced reset only.

**Y ramp generator:** the vertical ramp is generated by a conventional operational amplifier integrator, $IC_{11}$. The feedback integrating capacitor $C_{100}$ is shunted by a low resistance $R_{112A}$ during reset via switch $S_5$. The integrator potential is derived from the negative rail by dividers $R_{110}$, $R_{111}$ for APT and $R_{110}$, $R_{111}$, $R_{112}$ for SR, selected by switching. Both inputs are biased by resistors $R_{108}$ and $R_{109}$ Switch $S_6$ is opened to allow linear integration of the potential on $R_{110}$ wiper, with an optional negative potential being switched into the inverting input by $S_6$ to set the integrator to maximum ramp voltage. The vertical output is taken across load $R_{113}$ to earth. As the circuit stands it is manually controlled. The addition of gate control from the start sync circuit could be arranged relatively easily to automate the start/reset cycle.

**Stabilized power supplies:** the main stabilized power supply uses integrated circuit stabilizers. Two supplies are used and combined to give $\pm$12V at 0.5A. The rail is fed to a simple series transistor stabilizer, comprising an n-p-n power transistor $Tr_{29}$ with base potential stabilized by $R_{146}$ zener diode $D_{25}$ and is decoupled by $C_{116}$ (Fig. 24).

## Display device

The obvious display for the preceding circuitry is an oscilloscope. The basic requirements are: $Z$ axis modulation capability; $X$ axis input capability with stable d.c. coupled amplifier; $Y$ axis stable d.c. coupled amplifier; small spot size; short persistence c.r.t. phosphor for photography, or long persistence for direct viewing; hum free supplies; and capability of disabling the beam blanking.

## Display system operation

The display must first be set for $X$, $Y$ and $Z$ range limits. The $X$ ramp is continuously available for setting up, as are the $Y$ limits using S and S. On the oscilloscope the $Z$ axis is the most difficult to set, due to the generally coarse controls for brightness on most oscilloscopes. The inter-picture maximum brightness signal is useful for setting this level, but the overall dynamic range, as determined by $R_{75}$, is a matter of trial and error. Once set, the tape may be run until the 300Hz tone is heard on the monitor in the case of APT signals. The oscilloscope camera shutter, if used, can then be opened, and $S_5$ switched to start. After the picture period, when the interpicture tone is heard, the shutter is closed and $S_5$ switched to reset. In the case of SR pictures, as outlined earlier, the picture must be viewed, or a slave display arranged so that phasing can be carried out manually with the lock/slip switch $S_{1,2}$. The simplest way to set up the correct Index of Co-operation for the SR pictures is to count the telemetry "teeth" which occur every 25 lines, and to apply the empirical relationship

$$\frac{\text{width of actual picture (centimetres)}}{\text{telemetry "teeth" per centimetre}} = 2.6$$

Lastly, two practical points when using an oscilloscope for display can be useful. It may well be found that the $X$-axis amplifier is too insensitive for the generated $X$-ramp. One solution is to transpose the $X$ and $Y$-axis outputs from the display electronics, since many oscilloscopes have a higher $Y$ input sensitivity than $X$ sensitivity, and the $Y$ output of the display unit delivers a 0 to +11 volt ramp. Secondly, if the oscilloscope has a stable and accurate trigger circuit, the display unit step-derived ramp may be omitted and the oscilloscope internal timebase used to generate the $X$ ramp. In this case, the 4 or 4/5Hz output is coupled to the oscilloscope external trigger input and the timebase speed adjusted to suit.

## Appendix

**Capture and lock range for the Signetics NE565 phase lock loop.** If the external frequency determining components at pins 8 and 9 (Fig. 19, Part 2) are $R_{53}$ and $C_{67}$ respectively:

free running frequency $f_o \approx 1.2/4R_{53}C_{67}$.

When the p.s.d. is in the limiting mode ($V_m \gg$200mV pp) the lock range is given by $2\omega_L = 2K_o K_d A\theta_d$

where $K_o$ is the v.c.o. conversion gain, $K_d$ is the p.s.d. gain, $A$ is the amplifier gain and $\theta_d$ is the maximum phase error for loop lock.

For the NE565 typical values are

$K_o = \frac{50 f_o}{V_{cc}}$ where $V_{cc}$ is the *total* voltage supply to the circuit, $K_d = \frac{1.4}{\pi}$ volts/radian, A = 1.4 and $Q_d = \pi/2$ radians. Hence $f_L \approx \omega_L/2\pi \approx 8 f_o/V_{cc}$ Hz either side of the centre frequency or a total range of $2f_L \approx 16 f_o/V_{cc}$ Hz.

The capture range is given approximately by $2\,\omega_c \approx 2\sqrt{\frac{\omega L}{\tau}}$

where $\omega_L$ is the one sided lock range $\omega_L = 2\pi f_L$, and $\omega_C = 2\pi f_C$ and $\tau$ is the time constant of the loop filter. $\tau = RC$ (C is the external filter capacitor on pin 7) with R = 3.6kΩ (internally on the chip).

$$\text{Re-writing, } f_c \approx \pm \frac{1}{2\pi}\sqrt{\left(\frac{2\pi f_L}{\tau}\right)}$$

$$= \pm\left[\frac{1}{2\pi}\sqrt{\left(\frac{16\pi f_0}{\tau V_{cc}}\right)}\right]$$

Hz either side of centre or a total capture range of

$$f_c \approx \left[\frac{1}{\pi}\sqrt{\left(\frac{16\pi f_0}{\tau V_{cc}}\right)}\right]$$

This approximation works well over narrow capture ranges when $f_c < f_L/3$ but becomes too large as $f_c \to f_L$.

## Components list

**Resistors—R**

| | | | | | |
|---|---|---|---|---|---|
| Fig. 23(a) | 72 | 1k | | 111 | 15k |
| | 73 | 5k | | 112 | 100k |
| | 74 | 33k | | 112A | 100 |
| | 75 | 5k | | 113 | 10k |
| | 76 | 10k | (d) | 114 | 100k |
| | 77 | 10k | | 115 | 1k |
| | 78 | 10k | | 116 | 4.7k |
| | 79 | 330k | | 117 | 100k |
| | 80 | 10k | | 118 | 1k |
| | 81 | 1.5k | | 119 | 4.7k |
| | 82 | 10k | | 120 | 100k |
| | 83 | 10k | | 121 | 2.2k |
| | 84 | 15k | | 122 | 5.6k |
| | 85 | 470k | | 123 | 100k |
| | 86 | 10k | | 124 | 10k |
| | 87 | 1k | | 125 | 3.3k |
| | 88 | 10k | | 126 | 220k |
| (b) | 89 | 47k | | 127 | 100 |
| | 90 | 330 | | 128 | 1k |
| | 91 | 330 | | 129 | 2.2k |
| | 92 | 1M | | 130 | 10k |
| | 93 | 150 | | 131 | 100k |
| | 94 | 5k | | 132 | 100k |
| | 95 | 150 | | 133 | 100 |
| | 96 | 2.2k | | 134 | 1k |
| | 97 | 470 | | 135 | 1.7k |
| | 98 | 1k | | 136 | 1.8k |
| (c) | 99 | 330k | | 137 | 1k |
| | 100 | 330k | | 138 | 100k |
| | 101 | 5k | | 139 | 470k |
| | 102 | 10k | | 140 | 10k |
| | 103 | 470 | | 141 | 250k |
| | 104 | 1k | | 142 | 5k |
| | 105 | | | 143 | 470 |
| | 106 | 1k | | 144 | 470 |
| | 107 | 1k | | 145 | 1k |
| | 108 | 510k | Fig. 24 | 146 | 560, |
| | 109 | 510k | Fig. 25 | 147 | 33k |
| | 110 | 500, ten turn | | 148 | 33k |

**Capacitors—C**

Numbers 83 and 84 are not included.

| | | |
|---|---|---|
| Fig. 23(a) | 75 | 50n |
| | 76 | 50n |
| | 77 | 1.8p |
| | 78 | 1.8p |
| | 79 | 1.8p |
| | 80 | 470p |
| | 81 | 50n |
| | 82 | 50n |
| | 85 | 1.8p |
| | 86 | 1.8p |
| | 87 | 1.8p |
| | 88 | 470p |
| | 89 | 50n |
| (b) | 90 | 1n |
| | 91 | 32n |
| | 92 | 150μ/15V |
| | 93 | 100n |
| | 94 | 150μ/15V |
| | 95 | 47p |
| (c) | 96 | 470p |
| | 97 | 147p |
| | 98 | 1.25μ |
| | 99 | 680n |
| | 100 | 6.8, mylar |
| | 83 | 10n |
| (d) | 101 | 100n |
| | 102 | 10n |
| | 103 | 220n |
| | 104 | 1μ |
| | 105 | 0.68μ |
| | 106 | 150n |
| | 107 | 680n |
| | 108 | 320n |
| | 109 | 10μ/25V |
| Fig. 24 | 110 | 10,000μ/30V |
| | 111 | 10,000μ/30V |
| | 112 | 400μ/35V |
| | 113 | 400μ/35V |
| | 114 | 10n |
| | 115 | 10n |
| | 116 | 10μ/30V |
| | 117 | 400μ/35V |
| | 118 | 10n |

**Diodes—D**

| | | |
|---|---|---|
| Fig. 23(a) | 14 | GEX34 |
| | 15 | GEX34 |
| | 16 | GEX34 |
| | 17 | GEX34 |
| (b) | 18 | MR56 |
| | 19 | MR56 |
| (c) | 20 | 1N4001 |
| | 21 | 1N4001 |
| | 22 | 1N4001 |
| Fig. 24 | 23 | REL65 |
| | 24 | REL65 |
| | 25 | MR51 |

**Inductor—L**

| | | |
|---|---|---|
| Fig. 23(d) | 22 | 500mH |

**Transistors—Tr**

| | | |
|---|---|---|
| Fig. 23(a) | 15 | 2N2926 |
| | 16 | 2N2926 |
| (c) | 17 | 2N2926 |
| | 18 | 2N726 |
| | 19 | 2N706 |
| (d) | 20 | 2N2926 |
| | 21 | 2N2926 |
| | 22 | 2N2926 |
| | 23 | 2N2926 |
| | 24 | 2N2926 |
| | 25 | 2N2926 |
| | 26 | 2N2926 |
| | 27 | 2N2926 |
| | 28 | 2N2926 |
| Fig. 24 | 29 | 2N3054 |

**Integrated circuits—IC**

| | | |
|---|---|---|
| Fig.23(b) | 4 | NE565A |
| | 5 | SN7413N |
| | 6 | SN7492N |
| | 7 | SN7490N |
| | 8 | SN7490N |
| | 9 | SN7490N |
| (c) | 10 | SN7400N |
| | 11 | SN72741N |
| (d) | 12 | SN7413N |
| | 13 | SN7400N |
| | 14 | SN7404N |
| integrated stabilizer | 15 | MVR-12V |
| integrated stabilizer | 16 | MVR-12V |

**Transformers—T**

| | | |
|---|---|---|
| Fig. 23(a) | 2 | RS Components Ltd, universal speaker isolating transformer. Ratios w.r.t. i/p on pins 2 and 3. pin 5—1.375:1 pin 4—2.0:1 pin 6—1.575:1 pins 7 and 8—0.475:1 |
| Fig. 24 | 3 | 30V rectifier transformer. |

**Author's biography**

Gerry Kennedy is a Higher Scientific Officer with the Science Research Council at the Appleton Laboratory, Chilbolton Observatory. His private project was started in the Falkland Islands with Nimbus 3 ice cover pictures. This work was continued on his return to the UK to encompass more recent satellites. He is a radio amateur with the call signs VP8LZ and G30GK.

**Corrections to Part 1**

p.437, column 2, last line—diodes 3 to 13 (not 5 to 12).
p.438, column 1, line 2—$D_7$ (not $D_4$)
line 11—$R_7$ (not $R_2$)
line 24—$R_8$ (not $R_5$)
p.439, column 1, line 15—$Tr_2$ (not $Tr_1$)
column 3, line 32—$L_5$ (not $L_{10}$)
p.440, components $R_7$—1M (not 111)
$C_{12}$—1000 (not 1)
$Tr_2$—MS175TB (not 11S-1757B)

**Corrections to Part 2**

p.488 col. 3 line 15—for $R_5$ read $R_{57}$, line 16 for $C_3$ read $C_{69}$, line 18 for $C_6$ read $C_{70}$, line 19 for $C_4$ read $C_{71}$, line 22 for $C_4$ read $C_{71}$.
p.489 picture is upside down and back-to-front.
p.490 components list $R_{70}$ is 250k.

**Acknowledgement**

The author would like to thank the Reverend Dr Paul Sollom OSB, of Douai Abbey for his encouragement and helpful advice, also NOAA for data supplied periodically and NASA for making the whole project possible.

**References**

7. Sollom, "Just Look at the Weather", *Radio Communication*, Radio Society of Great Britain, vol. 47, No. 12, Dec. 1971, p.823.

# The monostable . . . doth give us pause

## Introducing set 19 of Circards

by J. Carruthers, J. H. Evans, J. Kinsler and P. Williams

*Paisley College of Technology*

Not quite the words of Hamlet, but delay is one outstanding property of the monostable circuit. De Bono, in *The Mechanism of Mind*, could be describing another function of the circuit when he writes, "a short-term memory is just a way of extending the influence of an event beyond the real time of its occurrence along the dimension of time", e.g. a monostable will accept a transition at its input and respond with an output pulse, but for a finite time. A more formal description of the monostable (sometimes called a one-shot) circuit is having one stable state in which it remains until triggered by an external signal into a quasi-stable state, where it remains for a time determined by circuit parameters and subsequently returns to its stable state. This basic action allows the monostable to be used for a variety of purposes such as lengthening, delaying and regenerating pulses, sequential timing and delay applications and frequency division.

The nature of the monostable circuits can be widely different because they can be designed using n-p-n and p-n-p bipolar transistors (in cross-coupled emitter-coupled and complementary modes), field-effect transistors, operational amplifiers, discrete and integrated-circuit logic gates, as well as purpose-designed monostable integrated circuits.

A very common type of monostable uses a cross-coupled configuration which can be thought of as being a modification of a symmetrical bistable where one resistive coupling is replaced by a capacitive coupling. Two can either be connected between the collector of a normally-off transistor to the base of a normally-on transistor, or between the collector of a normally-on transistor and the base of a normally-off transistor. Fig. 1 shows a circuit of the first type and Fig. 2 the associated current and voltage waveforms.

Transistor $Tr_2$ is in a stable on state, until triggered, due to the base drive supplied through $R_2$. Transistor $Tr_1$ is held in a stable off state as $R_4$ is connected to $Tr_2$ collector which is at the low saturation value of $v_{ce2}$ and $R_3$ is returned to the negative $V_{BB}$ rail. When a positive-going trigger pulse is applied to $Tr_1$ base via $C_1$ this transistor turns on causing its collector voltage to fall to almost zero.

Because the charge on $C_2$ cannot change instantaneously, this negative-going transition is passed to $Tr_2$ base which switches off. The transistors remain in these states while the charge on $C_2$ changes via $R_2$ causing $v_{be2}$ to rise exponentially towards $+V_{CC}$. When $v_{be2}$ passes through zero and rises positively to a value depending on the type of transistor used, which causes base current to flow in $Tr_2$, this transistor begins

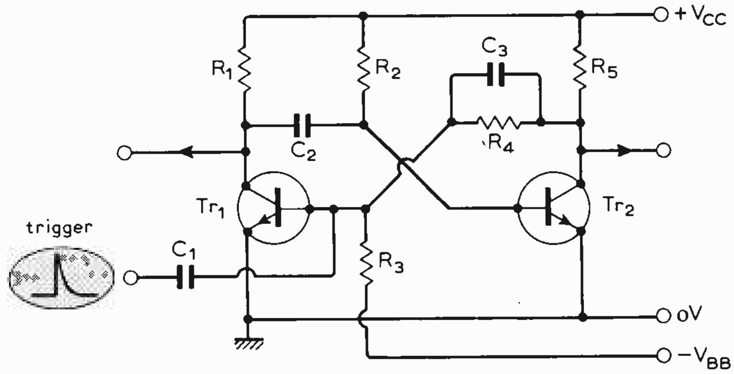



*Fig. 1. A common monostable can be thought of as a bistable circuit with one resistive coupling replaced by a capacitative coupling. Two can be connected as shown.*

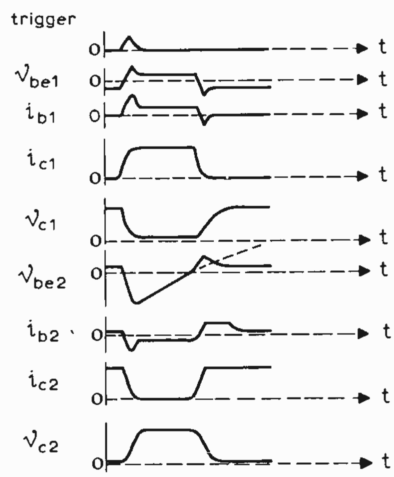



*Fig. 2. Waveforms associated with circuit of Fig. 1.*

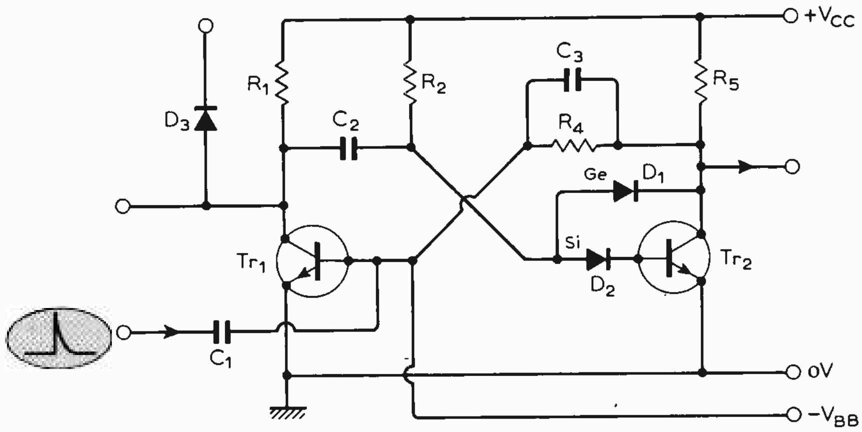



*Fig. 3. Switching speed of Fig. 1 circuit is improved by preventing saturation with diodes $D_1$ and $D_2$. Clamping diode $D_3$ reduces recovery time by connection to a supply less than $V_{cc}$.*

to turn on. The resulting fall in $V_{C2}$ is coupled to $Tr_1$ base via $C_3$, $Tr_1$ beginning to turn off; the regenerative feedback via $C_2$ and $C_3$ causes the circuit to restore to its stable state of $Tr_1$ off and $Tr_2$ on, the capacitor $C_2$ recharging through $R_1$.

The switching speed of this kind of circuit can be improved by using higher speed switching transistors in a non-saturating circuit. To prevent saturation, germanium diode $D_1$ and silicon diode $D_2$ can be added as shown in Fig. 3. When $Tr_2$ begins to turn on, to return the circuit to its stable state, $D_1$ will be reverse-biased until $v_{C2}$ falls below $(v_{be2} + v_{D2})$ causing the excessive base drive current, which would otherwise saturate $Tr_2$, to be diverted through $D_1$. Two series-connected germanium diodes can be used in place of the silicon diode $D_2$. The waveform at $Tr_1$ collector can have a slow recovery time, especially when driving capacitive loads, and this can be reduced by the addition of the clamping diode $D_3$ returned to a supply $V_A < V_{CC}$. The output voltage $v_{C1}$ attempts to rise towards a higher value with $D_3$ present but becomes clamped at $(V_A + V_{D3})$ when $D_3$ conducts.

Another method of reducing the recovery time is to include an emitter follower between $R_1$ and $C_2$ of Fig. 1, as shown in Fig. 4. As $C_2$ is charged to almost the supply rail voltage, the emitter of $Tr_3$ is normally close to $+V_{CC}$. The input trigger pulse switches the circuit to its quasi-stable state and as the charge on $C_2$ changes, the emitter voltage of $Tr_3$ rises above its base voltage ($v_{C1}$ on) cutting the transistor off. When $Tr_2$ again begins to conduct, the circuit returns to its stable state with $C_2$ being rapidly recharged by the emitter current of $Tr_3$.

The output from $Tr_1$ collector can be made to more closely approach a rectangular pulse by the inclusion of an isolation diode $D_4$ as shown in Fig. 5. When $Tr_1$ is on the collector current flows through $R_1$ and $R_7$ in parallel and a faster recovery time is achieved by making $R_7 < R_1$ so that when $Tr_1$ switches off $D_4$ is reverse biased and $C_2$ recharges more rapidly, through $R_7$, than in the circuit shown in Fig. 1. Other methods of triggering this type of monostable include negative pulses to either $Tr_1$ collector or $Tr_2$ base or positive pulses to the base of another transistor having its collector and emitter respectively connected to $Tr_1$ collector and emitter.

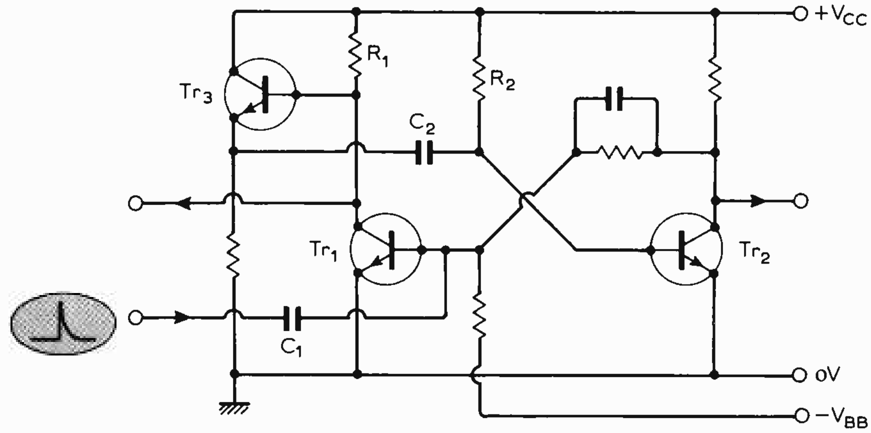



*Fig. 4. Recovery time can also be reduced with an emitter follower between $R_1$ and $C_2$ of Fig. 1.*

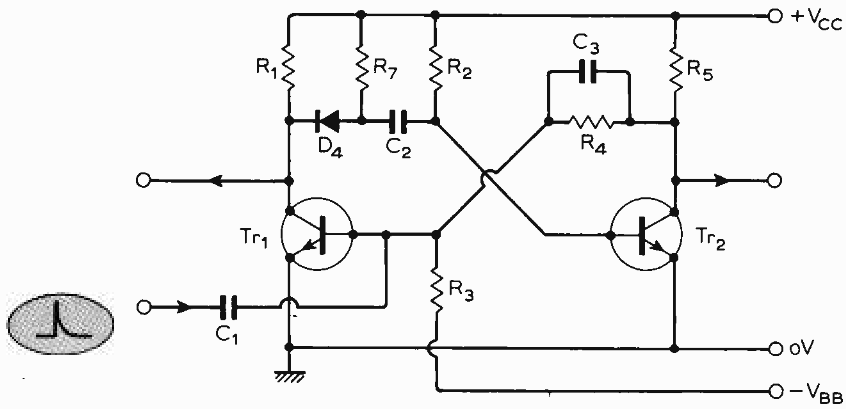



*Fig. 5. Output from $Tr_1$ is made more rectangular by isolation diode $D_4$ and by making $R_7 < R_1$.*

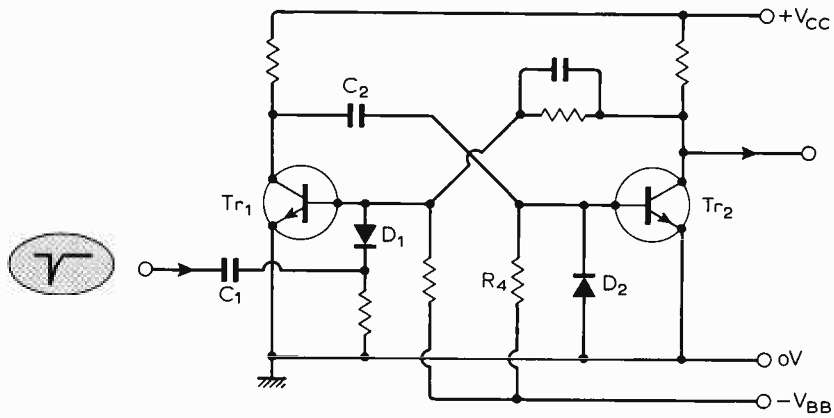



*Fig. 6. In this variant of the cross-coupled monostable, $Tr_1$ is normally on and $Tr_2$ normally off. Note trigger is of opposite polarity. Circuit has much faster recovery time.*

Another form of the cross-coupled monostable is shown in Fig. 6, the major difference compared with the foregoing circuits being that $Tr_1$ is on and $Tr_2$ is off in the stable state. This is achieved by correct choice of the potential-dividing chain and by $D_2$ being forward-biased via $R_4$, holding the base-emitter junction of $Tr_2$ reverse-biased. A negative-going input trigger pulse causes $Tr_1$ to switch off and hence $Tr_2$ to switch on and to remain in that state as $C_2$ charges, part of the charging current being base drive to $Tr_2$. Diode $D_2$ is reverse-biased in this quasi-stable state which ends when the base drive to $Tr_2$ has fallen to a level which will not maintain conduction. Transistor $Tr_2$ then switches off causing $Tr_1$ to return to the stable on state. No output is taken from $Tr_1$ collector as a load at that point significantly changes the off time of $Tr_2$. This circuit has a much faster recovery time than the previous ones discussed.

A cross-coupled monostable which besides producing a time-constant-dependent output pulse may provide one due to the input pulse duration is shown in Fig. 7. In the stable state $Tr_1$ is on and $Tr_2$ is off, so when a short-duration trigger pulse is applied via $D_1$ the circuit remains in its quasi-stable state for a time determined largely by $C_1R_3$. However, when a long input pulse is applied, $Tr_1$ will remain off until the input is removed even if $C_1$ completes its discharge during that interval.

Fig. 8 shows an emitter-coupled monostable where $Tr_2$ is on and $Tr_1$ is off in the stable state. Compared with the cross-coupled circuits, this type has the advantages of only using a single supply and providing an output which is taken from a point having no internal coupling. When a negative-going trigger pulse is applied to $Tr_1$ collector via $C_1$ it is coupled to the base of $Tr_2$ which switches off. The emitter voltage falls allowing $Tr_1$ to switch on for a time determined by that required for $C_2$ to discharge sufficiently to allow $Tr_2$ to begin to conduct. The emitter voltage then rises, causing $Tr_1$ to begin to switch off, and the resulting rise in $Tr_1$ collector voltage is coupled to $Tr_2$ base which switches on, and $Tr_1$ switches off to regain the stable state. Due to the presence of $R_4$, the output voltage swing does not approach $V_{CC}$ and the recovery time is not very fast, as $R_3$ should be greater than $R_6$ to ensure the correct switching action. Recovery time can be improved by the

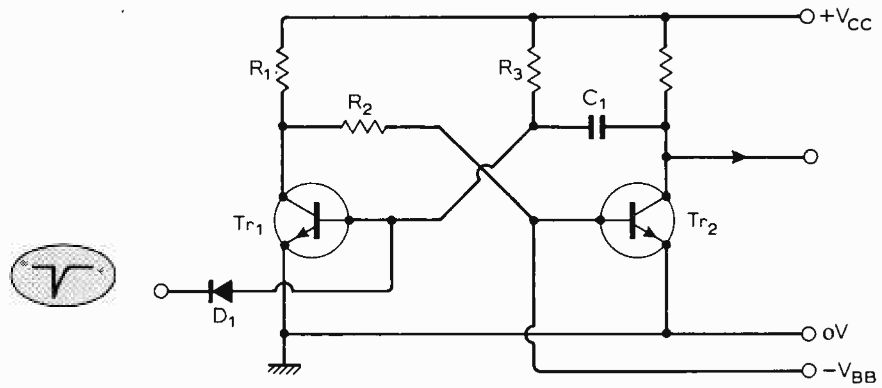



*Fig. 7. This circuit produces an output pulse dependent on input pulse duration.*

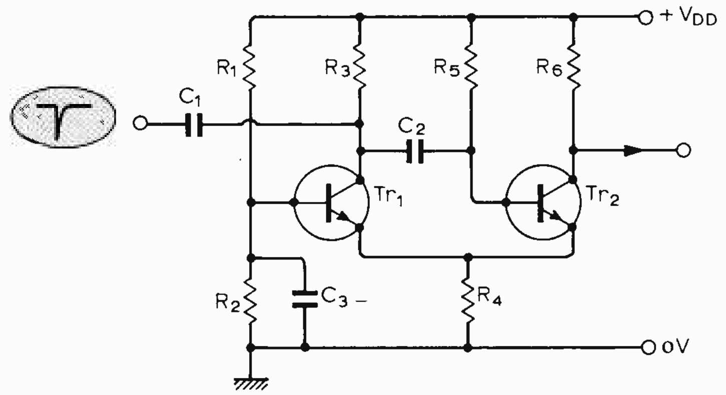
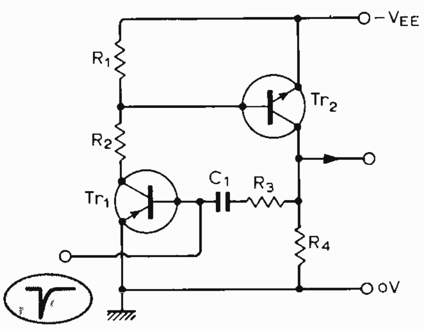
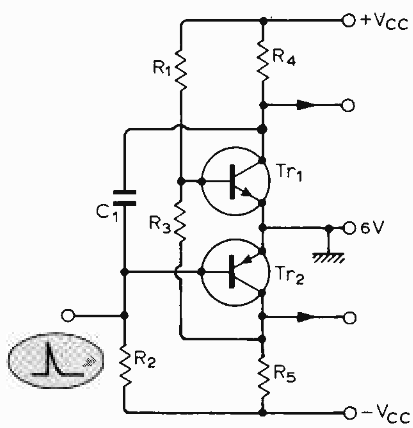



*Fig. 8. Emitter-coupled circuit needs only one supply line and gives a more isolated output.*




*Complementary transistors enable both transistors to be normally off (Fig. 9, above) or normally on (Fig. 10, right). Opposite-polarity outputs are available from Fig. 10.*

addition of an emitter follower as was done in Fig. 4.

A monostable using a complementary pair of transistors, having both transistors off in the stable state, is shown in Fig. 9. A negative-going trigger pulse applied to $Tr_1$ base causes this p-n-p transistor to switch on, its collector current in $R_1$ and $R_2$ causing the base of $Tr_2$ to go positive causing this n-p-n transistor to switch on also. The resulting collector current in $R_4$ causes the output voltage to go negative and this change is coupled to $Tr_1$ base through $C_1$ causing $Tr_1$ and hence $Tr_2$ to be switched hard on. In this quasi-stable state $C_1$ charges through $R_3$ and $Tr_2$ towards $-V_{EE}$ and when the charging current is insufficient to maintain conduction in $Tr_1$ this transistor switches off, as does $Tr_2$ and the circuit returns to its stable state.

Fig. 10 shows a complementary monostable in which both transistors are on in the stable state, and which provides a pair of opposite-polarity outputs simultaneously. A positive-going trigger pulse applied to $Tr_2$ base turns both transistors off and after $C_1$ charges sufficiently, through $R_2$ and $R_4$, both transistors return to the stable on state regeneratively.

*These and other types of monostable circuits are discussed in Circards, set 19, together with component values for tested circuits—see next column.*

## Titles of cards in set 19 of Circards (available shortly)

1 discrete-component monostables
2 complementary circuits
3 op-amp/comparator types
4 t.t.l.-gate monostables
5 compensated c.m.o.s. circuits
6 emitter-coupled monostables
7 voltage-controlled monostables
8 long-delay circuits
9 dual monostable applications
10 high duty-cycle types

## 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 × 127mm (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 plastic 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. The Circard concept was outlined more fully in the October 1972 issue of *Wireless World*, pp. 469/70.

## 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 counters
15 pulse modulators
16 current-differencing amplifiers—signal processing
17 c.d.as—signal generation
18 c.d.as—measurement and detection

# Meetings

**LONDON**

2nd and 3rd. IEE—"The why and how of telephone exchanges". Christmas holiday lecture by C. A. May at 14.30 at Savoy Pl., WC2.

6th. IEE—"Flat diaphragm loudspeakers" by J. W. Manger at 17.30 at Savoy Pl., WC2.

7th. IEE—"Protection performance as affected by the use of capacitor voltage transformers" by M. A. Hughes at 17.30 at Savoy Pl., WC2.

8th. IEE—Discussion on "Processor architecture for telecommunication switching" at 17.30 at Savoy Pl., WC2.

8th. IERE—"Train control developments on British Rail" by J. W. Birkby at 18.00 at 9 Bedford Sq., WC1.

8th. BKSTS—"The Turpin Colorflex system" by Gerry Turpin at 20.30 at NFT2, National Film Theatre, South Bank, Waterloo, SE1.

13th. IEE/IERE—"A review of electron microscopy" by Dr V. E. Cosslett at 17.30 at Savoy Pl., WC2.

14th. IEE—Colloquium on "Applications of active, digital and passive filters" at 10.30 at Savoy Pl., WC2.

14th. AES—"Practical design of magnetic heads" by Robert B. Dyer at 19.15 at the IEE, Savoy Pl., WC2.

15th. IEE—"Charge-coupled devices and their application" by D. Burt at 17.30 at Savoy Pl., WC2.

15th. IERE/RINav.—Colloquium on "Advances in airborne equipment for navigation and flight control" at 10.30 at the Royal Aeronautical Society, 4 Hamilton Pl., W1.

15th. IERE—"Good quality reception from medium-wave broadcasting" by Dr R. C. V. Macario at 18.00 at 9 Bedford Sq., WC1.

15th. I.Phys.—One-day meeting on "Surface effects on semiconductor devices" at 10.00 at Imperial College, SW7.

21st. IEE—Colloquium on "Standardization in geographically distributed control and telemetry systems" at 14.30 at Savoy Pl., WC2.

21st. IEE/IERE—"Designing machines for people" by Dr C. R. Evans at 17.30 at Savoy Pl., WC2.

22nd. IERE—Colloquium on "Thermionic emission devices" at 9 Bedford Sq., WC1.

22nd. IEE—"How to see in the dark" by Dr R. M. Hodgson at 18.30 at Savoy Pl., WC2.

23rd. IEE—"Control of distributed parameter systems" by Prof. P. C. Parks at 17.30 at Savoy Pl., WC2.

27th. IEE—"Digital systems for sound programme transmission" by J. W. H. O'Clarey at 17.30 at Savoy Pl., WC2.

28th. IEE—"The design of precision coaxial power meters" by Dr A. E. Fantom at 17.30 at Savoy Pl., WC2.

28th. IEE—"The ESRO orbital test satellite" by Dr P. Bartholome at 17.30 at Savoy Pl., WC2.

29th. IEE/IERE—"Sensing, sizing and sorting of cells: the laser sorter" by D. F. Capellaro at 17.30 at Savoy Pl., WC2.

29th. IERE—"Speech engineering" by Dr A. J. Fourcin at 18.00 at the Haldane Theatre, Wolfson House, Stephensons Way, NW1.

**BIRMINGHAM**

15th. IERE/RTS—"The status of British broadcasting" by C. B. B. Wood at 19.00 at the A.T.V. Centre, Broad Street.

22nd. SERT—"Liquid crystal displays and their applications" by G. P. Stenning at 19.00 at the Byng Kenrick Suite of the University of Aston, Gosta Green.

**BRIGHTON**

9th. SERT—"Principles of video tape recording" by R. A. Bravery and K. G. A. Whittington at 19.45 at the TV Studio, Sussex University.

**CHATHAM**

21st. IERE—"Quadraphonics" by Dr K. Barker at 19.00 at the Lecture Theatre 18, Medway and Maidstone College of Technology, Maidstone Road.

**CHELMSFORD**

15th. IEE—"C-MOS and its applications" by R. Henderson at 18.30 at the King Edward VI Grammar School, Broomfield Road.

**HALTON**

16th. IEE/R.Ae.S.—"Radar and meteorology" by Prof. E. Shearman at 19.30 at Kermode Hall, R.A.F. Halton, Bucks.

**LEATHERHEAD**

15th. IEE—"Man-made, God-made" by Prof. E. R. Laithwaite at 19.30 at C.E.R.L. Offices, Kelvin Avenue.

**LLANDAFF**

15th. SERT—"The Pye 110° colour chassis" by P. E. Gibbs at 19.15 at Llandaff College of Technology.

**MANCHESTER**

23rd. SERT—"Mobile radio equipment" by M. Howard at 19.30 at the Granada Building, College of Building, Hardman Street.

**MORDEN**

29th. IEE—"Developments in superconductivity techniques" by J. A. Baylis at 19.00 at Merton Technical College, Morden Park, London Road.

**READING**

6th. SERT—"Colour television" at 19.30 at The Technical College.

20th. IEE—"Concorde systems design" by H. Hill at 19.30 at the University, Whiteknights Park.

23rd. IERE—"Optoelectronic devices" by M. Miller at 19.30 at the J. J. Thomson Physical Laboratory, University of Reading, Whiteknights Park.

**SALISBURY**

27th. SERT—"TEC, ERB and the technical engineer" by A. J. Kenward at 19.30 at Salisbury College of Technology.

**SOUTHAMPTON**

22nd. SERT—"Philips video tape recorder" by R. Adams at 19.00 at the College of Technology, East Park Terrace.

*Tickets are required for some meetings: readers are advised therefore to check with the society concerned.*

## Wireless World lectures

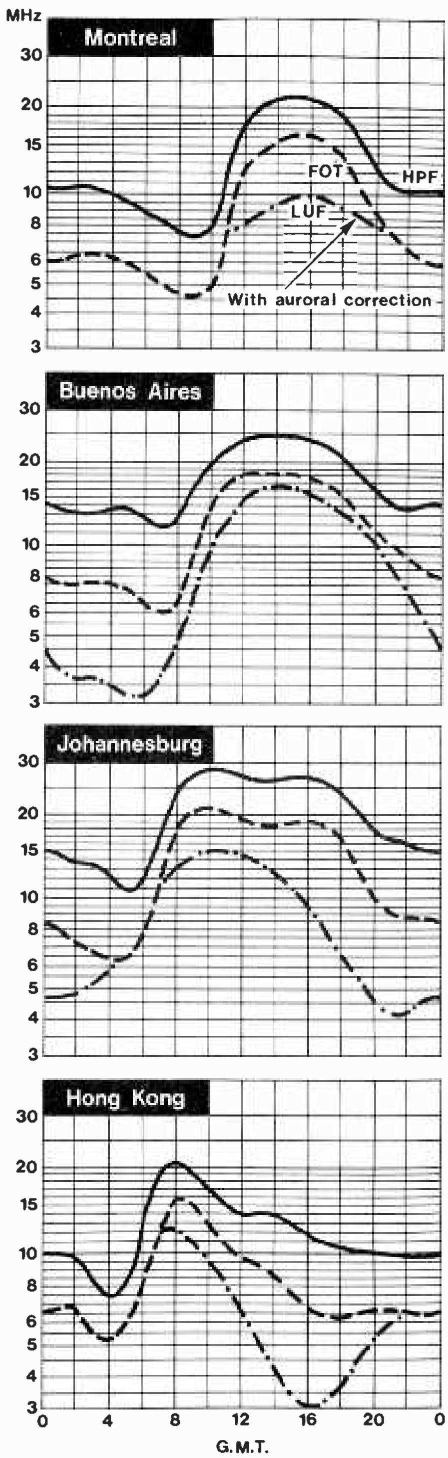
H. W. Barnard, who was editor of our journal from 1965 until 1973, has been approached several times by societies, clubs and other organizations in the field of radio and electronics to address their members. With 48 years experience of *W.W.*, he is in a unique position to give a picture of the development of communications, broadcasting and the growth of "electronics" and it occurs to us that many other people would like to listen to an illustrated talk on this most fascinating subject.

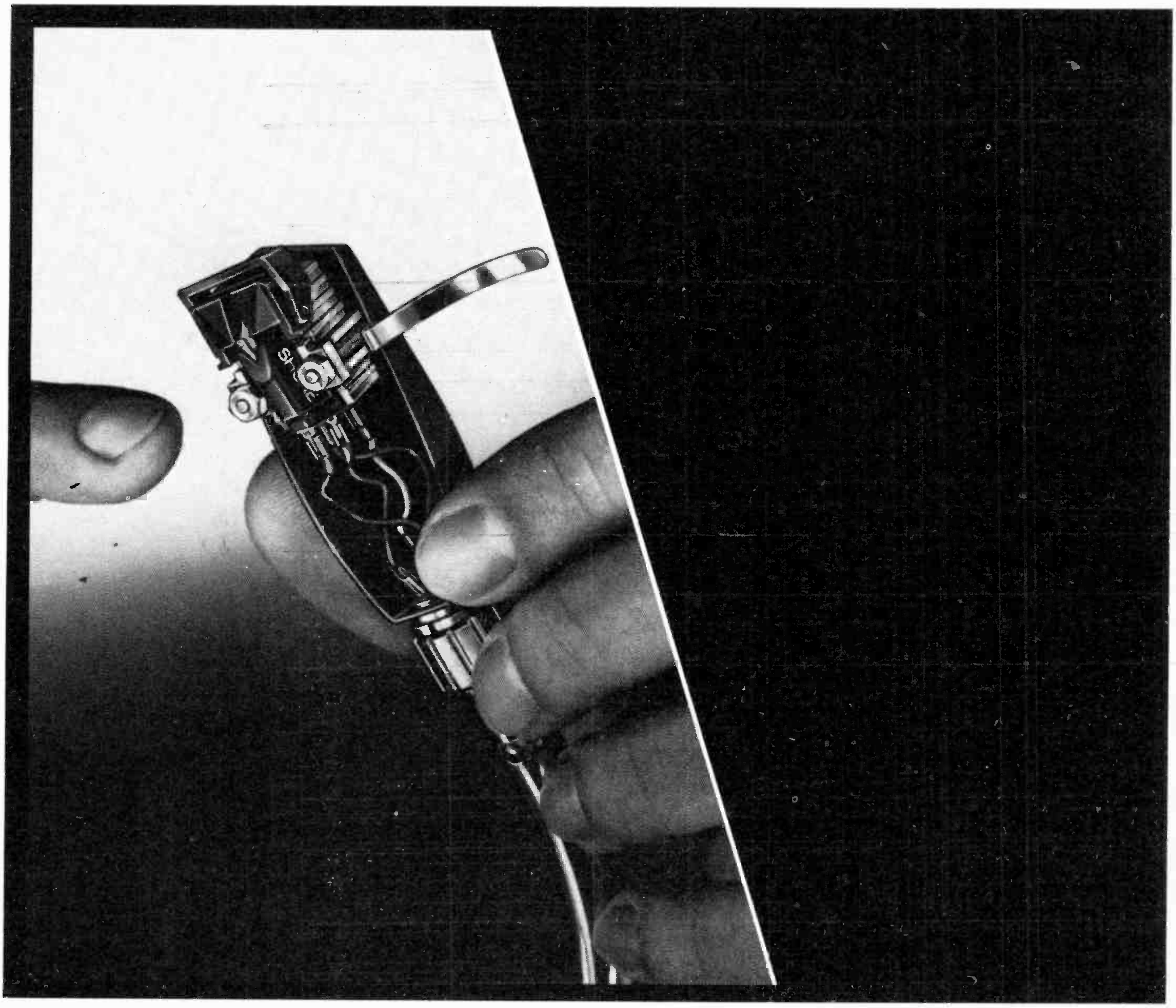
If, therefore, secretaries of such bodies would like to write to us, we will try to arrange for Mr Barnard to give a lecture.

# HF predictions

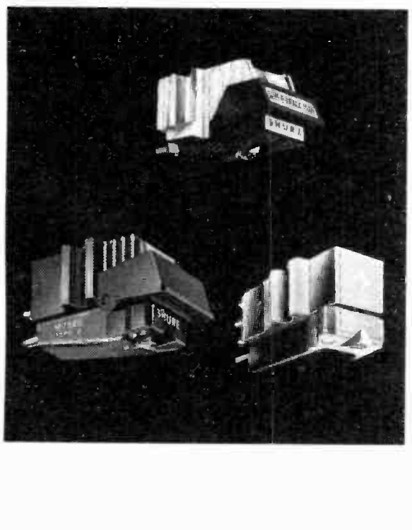
Solar Index is now less than 10 and will remain so throughout the year with the end of the current sunspot cycle expected in August. As their number decreases sunspots tend to concentrate at low solar latitudes, then when the number increases the new spots appear at high solar latitudes. Minima are therefore used to mark the duration of a cycle as they are much more clearly defined than maxima.

A year of poor communication conditions can be expected especially during summer months as HPFs and FOTs will be at their very lowest.









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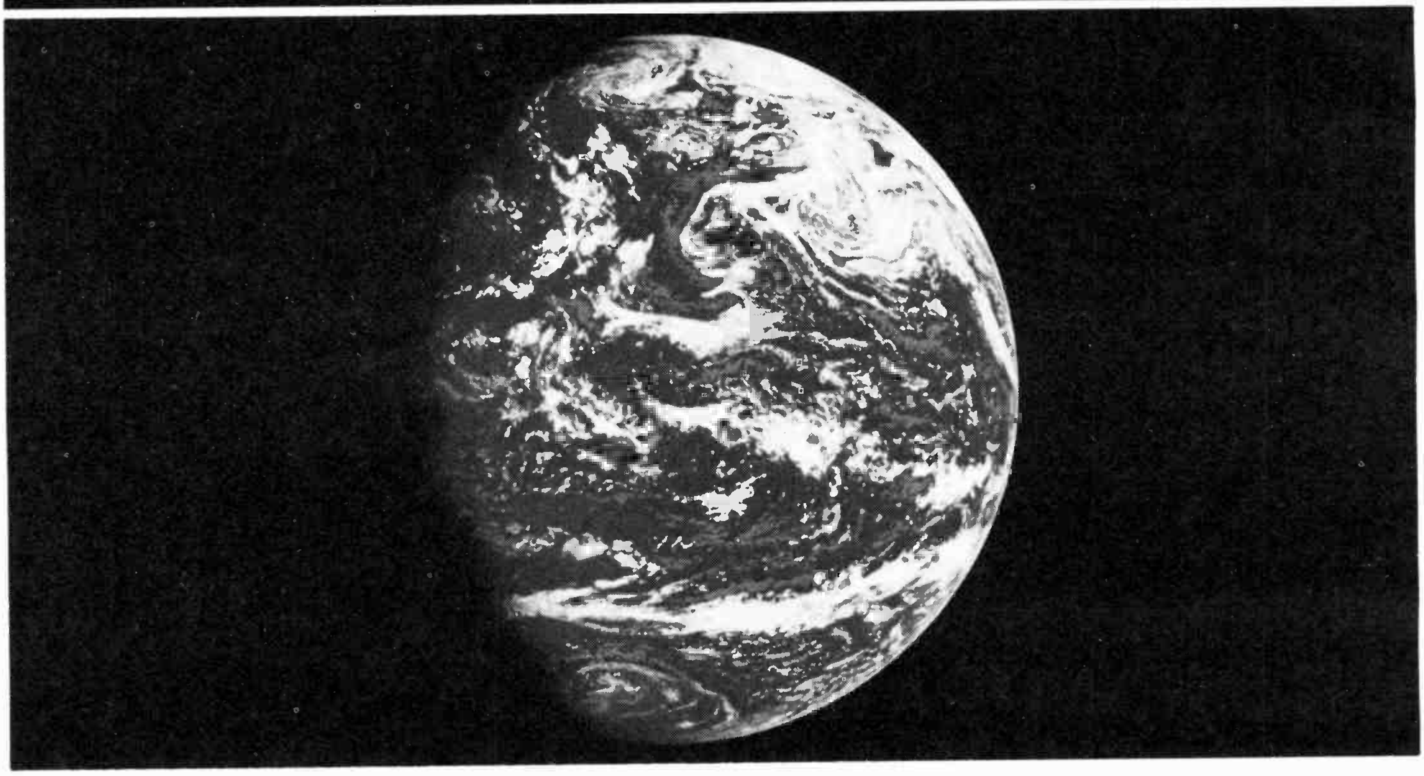

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LAP 84

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# Silent switch for stereo-pair comparisons

by K. Moulana, B.Sc.
*University of Surrey/BBC Research Department*

**Design and printed circuit construction details are given for an f.e.t. electronic switch designed to meet stringent requirements.**

During the course of a project the need arose for a silent switch with the following specification: an on/off ratio greater than 70dB; a switching time as fast as possible without introducing any audible transients; remote control switching facility by means of a single, mechanically silent on/off switch; output clipping level not less than +10dBm into 600 ohms; overall unity gain into 600 ohms; an input impedance greater than 50kΩ over the frequency range 30Hz to 15kHz; output impedance of 600 ohms ±2% over the above frequency range; amplitude/frequency response ±0.2dB over the above frequency range; hum and noise not greater than −70dBm over a 15kHz bandwidth and a total harmonic distortion not greater than 0.5% and void of high order harmonics.

A preliminary survey showed that a unit satisfying the above requirements was not readily available on the market and, therefore, one had to be designed. However, before the actual design procedure which was adopted is outlined, a brief study of the underlying requirements may serve as a useful introduction.

When a programme is switched by mechanical means, transients of two different kinds are transmitted through the system. The first type is caused by the rapid change in the d.c. at the point of switching which of course leads to an audible thump. The second and less objectionable variety is the result of terminating an a.c. signal when its waveform is not passing through zero.

In order to eliminate transients caused by changes in d.c. levels, either the signal carrying part of the circuit must be electrically isolated from the switching section, or measures must be taken to ensure that the d.c. biasing potentials remain unchanged at the instant of switching.

In the past, the majority of transient free switches employed a light-sensitive resistance as the signal carrying element, and the luminance of a lamp to control the degree of attenuation required. The main disadvantage of light-operated switches is that they are not fast enough, because an incandescent lamp has a decaying luminance after the current through it has been stopped. In fact, the decay rate is inversely proportional to the normal standing current through the lamp; even with low current lamps the decay time is too long. Up to now, such switches have, in addition, suffered from poor on/off ratios whenever small size, low current and hence low power lamps have been used. It should be pointed out that in recent years light emitting diodes have also been used instead of incandescent lamps.

The other group of silent switches or electronic attenuators often used may be conveniently classified under the heading of d.c. modulators. Such circuits are essentially amplitude modulators under various disguises. The programme signal is injected into the otherwise carrier input and a d.c. potential is used instead of the modulation signal to control the amplitude of the programme. Basically, these circuits make excellent electronic attenuators over a finite range, and with additional refinements high on/off ratio switches can be designed. Unfortunately, the use of the above technique to achieve the desired specification would have resulted in a fairly complex circuit unless integrated circuits were employed. Furthermore, during the designing stages (two years ago) the author could not find any i.c. modulator or attenuator that would meet the requirements. Therefore, the only feasible alternative was to use an f.e.t. as a voltage controlled resistor which in fact constitutes the basis of the present design.

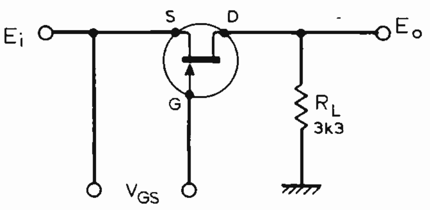



*Fig. 1. An f.e.t. used as a voltage controlled resistor.*

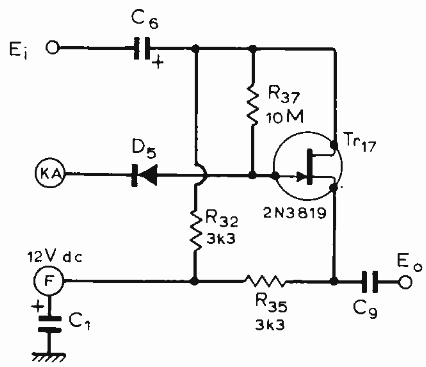



*Fig. 2. Biasing arrangement for a symmetrical junction f.e.t.*

If an f.e.t. is biased near the origin of its output characteristics, the channel behaves like a pure resistance whose value is a function of the gate voltage. In other words, the device becomes a voltage controlled resistor. With suitable circuit arrangements, this property can be put to use as the basis of a transient free switch.

Essentially, an f.e.t. is used in conjunction with a resistance to form a voltage controlled potential divider shown in Fig. 1. When the f.e.t. is conducting, $V_{GS}$ is zero and the channel resistance, $r_{DS}$, is a minimum and therefore:

$$\frac{E_o\,(on)}{E_i}=\frac{R_L}{R_L+r_{DS}\,min.}$$

If $V_{GS}$ is greater or equal to the pinch-off voltage of the f.e.t, $r_{DS}$ becomes a maximum and thus:

$$\frac{E_o\,(off)}{E_i}=\frac{R_L}{R_L+r_{DS}\,max.}$$

For a 2N3819 junction f.e.t., $r_{DS}$ (min) and $r_{DS}$ (max) are of the order of 100Ω and 10MΩ respectively. If $R_L$ is set at 3.3kΩ, an on/off ratio of 70dB is achieved for the voltage controlled potential divider.

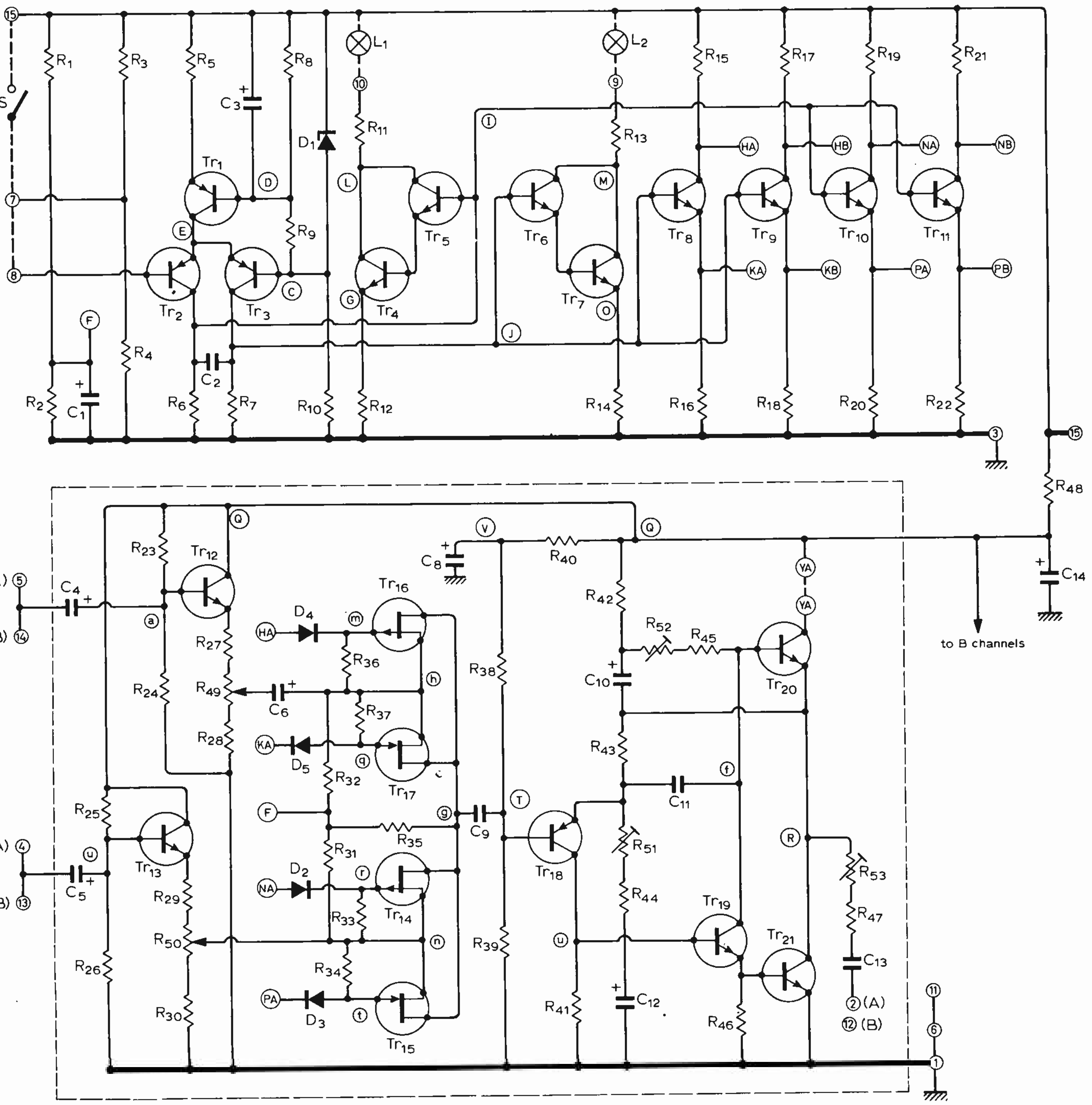
Let us now consider the biasing arrangement for the f.e.t. If the device is biased at the origin of the output characteristics, the a.c. signal will swing symmetrically about that point, implying that the output characteristics of the f.e.t. must be symmetrical about the origin over the working range required. A symmetrical junction f.e.t. fulfils this requirement for small excursions about the origin of its characteristics.

Fig. 2 shows the basis of the biasing arrangement for a symmetrical junction f.e.t. The source and drain are both held at 12V through $R_{32}$ and $R_{35}$ because the drain current is zero. When point KA is open circuited or at 12V, $V_{GS}$ becomes zero because the current through $R_{37}$ is zero, and the f.e.t. is switched on. The function of $D_5$ is to protect the gate against excessive forward bias. Taking KA to a voltage greater than the pinch-off voltage of the device, switches the f.e.t. off. In the actual circuit, point KA is in fact taken to earth.

So far as signal transmission is concerned, point F should ideally be at a.c. earth. In practice, the resistive path between F and true earth must be very small in comparison to $R_{32}$ at the lowest frequency of interest, because the two form a potential divider between the input and true earth, and hence a fraction of the a.c. signal always present at the input leaks through to the output via $R_{35}$ thus reducing the on/off ratio. In the actual circuit, a 5000μF capacitor couples F to earth giving a theoretical leakage factor of about −70dB at 40Hz.

Using a single f.e.t., signals of the order of −30dBm can be passed without exceeding the distortion limit when the device is conducting. For larger swings, the incremental value of the channel resistance will no longer be the same as its d.c. resistance. In other words, the channel resistance will change during the actual a.c. cycle which of course leads to distortion. The effect can be minimized by using two complementary f.e.ts in parallel so that the change in the channel resistance of one is compensated by the other hence reducing changes in the total resistance during the a.c. cycle. The complementary changes in resistance is due to the fact while one f.e.t. is forward biased, the other is reversed biased and the incremental value of the channel resistances are in the opposite sense for the two biasing

*Fig. 3. Complete circuit for one channel of a stereo pair. Parts enclosed in the broken line are repeated for the B channels. Points marked with identical letters are connected together. Circled numbers refer to pin connections and operating voltages as shown in the table of voltages.*



modes. The use of a complementary pair of f.e.ts was found to increase the signal handling capability by some 20dB.

Fig. 3 shows the complete circuit of the stereo silent switch. Transistors $Tr_{14}$ and $Tr_{15}$ form the switching elements for the A channel of a stereo pair, while $Tr_{16}$ and $Tr_{17}$ serve the A channel of a second stereo pair. The circuit for the B channels is identical to that enclosed by the broken lines. Resistances $R_{31}$, $R_{32}$ and $R_{35}$ maintain the drains and sources of the four f.e.ts at about 12V. Resistor $R_{35}$ also acts as the a.c. load for both A channels. When points HA and KA are at about 12V, f.e.ts $Tr_{16}$ and $Tr_{17}$ are switched on, and the signal present at their sources is developed across $R_{35}$. When point HA is at 24V and KA is at zero volts, $V_{GS}$ for both $Tr_{16}$ and $Tr_{17}$ becomes greater than their corresponding pinch-off voltages and, therefore, they are both switched off. Furthermore, at any given time if $Tr_{16}$ and $Tr_{17}$ are conducting, $Tr_{14}$ and $Tr_{15}$ will be cut off and vice versa. Therefore, the signal developed across $R_{35}$ is either that belonging to the A channel of one stereo pair or the corresponding signal of the other stereo pair. The advantage of this arrangement is that only one subsequent amplifier (consisting of $Tr_{18}$ to $Tr_{21}$) is required for two independent channels. However, the required d.c. switching for f.e.ts $Tr_{16}$ and $Tr_{17}$ is done by means of the phase splitter $Tr_8$ which itself is driven by the differential amplifier consisting of transistors $Tr_1$, $Tr_2$ and $Tr_3$. When $Tr_{16}$ and $Tr_{17}$ are on, $Tr_{14}$ and $Tr_{15}$ should be off and; therefore, points NA and PA are driven by the phase splitter $Tr_{10}$ which is in turn driven in opposition to $Tr_8$ by the differential amplifier.

The remaining a.c. carrying part of the circuit is fairly straightforward. The two input signals present on the bases of transistors $Tr_{12}$ and $Tr_{13}$ are attenuated by 20dB before entering the switching elements in order to reduce harmonic distortion. The switching mode ensures that only one of the two input signals appears across $R_{35}$. The amplifier that follows the switching elements compensates for the initial 20dB attenuation and therefore maintains the overall unity gain required. The amplifier proper is of the class A push-pull variety, the operation of which has been explained frequently in the literature.

The d.c. switching and indicating section was designed to operate by means of a single on/off switch $S$, which could also be paralleled with a second on/off switch to facilitate remote control switching. The differential output state of the amplifier $Tr_1$ to $Tr_3$ is governed by switch $S$, provided the base of $Tr_2$ is connected to the junction of $R_3$ and $R_4$. This corresponds to linking pins 7 and 8 on the printed circuit board. Alternatively, the switching could be done by an external d.c. signal of about 4–5 volts negative with respect to the 24V supply rail. In that case, the switching voltage should be applied directly to the base of $Tr_2$ with pins 7 and 8 isolated from each other. The magnitude of this switching voltage was chosen with t.t.l. compatibility in mind.

Lamps $L_1$ and $L_2$ are indicators for the

## Component list

**Resistors:** 1/8W, ± 2% unless otherwise stated.

| | | | | | |
|---|---|---|---|---|---|
| $R_1$ & $R_2$ | 10kΩ | $R_{23}$ | 150kΩ | $R_{39}$ | 560kΩ ± 5% |
| $R_3$ | 30kΩ | $R_{24}$ | 330kΩ ± 5% | $R_{40}$ | 220kΩ |
| $R_4$ | 82kΩ | $R_{25}$ | 150kΩ | $R_{41}$ | 27kΩ |
| $R_5$ | 1.5kΩ | $R_{26}$ | 330kΩ ± 5% | $R_{42}$ | 100kΩ |
| $R_6$ & $R_7$ | 15kΩ | $R_{27}$ | 4.7kΩ | $R_{43}$ | 47kΩ |
| $R_8$ | 10kΩ | $R_{28}$ | 680Ω | $R_{44}$ | 2.2kΩ |
| $R_9$ | 5.6kΩ | $R_{29}$ | 4.7kΩ | $R_{45}$ | 18kΩ |
| $R_{10}$ | 3.9kΩ | $R_{30}$ | 680Ω | $R_{46}$ | 100kΩ |
| $R_{11}$ | ½W,160Ω ± 5% | $R_{31}$ & $R_{32}$ | 3.3kΩ | $R_{47}$ | 560Ω |
| $R_{12}$ | 1W,270Ω ± 5% | $R_{33}$ & $R_{34}$ | 10MΩ ± 10% | $R_{48}$ | 27Ω |
| $R_{13}$ | ½W,160Ω ± 5% | $R_{35}$ | 3.3kΩ | $R_{49}$ & $R_{50}$ | 470Ω ± 10% |
| $R_{14}$ | 1W,270Ω ± 5% | $R_{36}$ & $R_{37}$ | 10MΩ ± 10% | $R_{51}$ | 1kΩ ± 10% |
| $R_{15}$–$R_{22}$ | 120kΩ | $R_{38}$ | 680kΩ ± 5% | $R_{52}$ | 100kΩ ± 10% |
| | | | | $R_{53}$ | 100Ω ± 10% |

**Capacitors:**

| | | | | | |
|---|---|---|---|---|---|
| $C_1$ | 5000μF/12V | $C_6$ & $C_7$ | 50μF/12V | $C_{11}$ | 33pF |
| $C_2$ | 1μF | $C_8$ | 4μF/25V | $C_{12}$ | 50μF/12V |
| $C_3$ | 30μF/6V | $C_9$ | 1μF | $C_{13}$ | 100μF/25V |
| $C_4$ & $C_5$ | 4μF/25V | $C_{10}$ | 10μF/12V | $C_{14}$ | 500μF/25V |

**Semiconductors:**

| | | | | | |
|---|---|---|---|---|---|
| $D_1$ | BZY88, C3V3 | $Tr_5$ & $Tr_6$ | 2N930 | $Tr_{16}$ | 2N3820 |
| $D_2$–$D_5$ | 1N916 | $Tr_7$ | 2N2219A | $Tr_{17}$ | 2N3819 |
| | | $Tr_8$–$Tr_{13}$ | 2N930 | $Tr_{18}$ | 2N3702 |
| $Tr_1$–$Tr_3$ | 2N3702 | $Tr_{14}$ | 2N3820 | $Tr_{19}$–$Tr_{21}$ | 2N930 |
| $Tr_4$ | 2N2219A | $Tr_{15}$ | 2N3819 | | |

**Lamps**

| | |
|---|---|
| $L_1$ & $L_2$ | 6V, 40mA |

two stereo-pair programmes. When $S$ is open, $L_1$ lights and signals present at input pins 4 and 13 pass through to the output pins 2 and 12 respectively. Conversely, the closed position of the switch corresponds to $L_2$ lighting and the signals at pins 5 and 14 appearing at output pins 2 and 12 respectively.

Finally, the 1μF capacitor $C_2$ is used to reduce the change-over speed at the output of the differential amplifier. In this way, transients otherwise generated by rapid switching of the a.c. signals are subjectively eliminated. Note that this capacitor alone determines the switching speed of the complete unit.

### Construction

All components of the stereo silent switch except the two lamps and switch $S$ are mounted on a printed circuit board shown in Fig. 4. The corresponding component layout is outlined in Fig. 5 which is immediately followed by relevant explanatory notes and the line-up procedure.

During assembly, it should be observed that the capacitor $C_2$ is not in physical contact with the resistor $R_{12}$ because the latter generates a certain amount of heat.

The length of the wires connecting switch $S$ to the circuit are not critical. In fact, the circuit operates satisfactorily with remote control wires ten meters long. However, should the casing of switch $S$ chosen be connected to any one of its pins, measures must be taken to eliminate the possibility of an inadvertent contact between the casing of that switch and earth. Otherwise, either a short circuit is created across the d.c. supply line, or a 21V reverse bias will be imposed across the base to emitter junction of $Tr_3$.

### Operating voltages

| Point | $S$ open | | $S$ closed |
|---|---|---|---|
| *1, 3, 6 & 11* | | 0 Volts | |
| *7* | 17.6 | | 24.0 |
| *8* | 17.6 | | 24.0 |
| *9* | 24.0 | | 17.8 |
| *10* | 17.8 | | 24.0 |
| *15* | | 24.0 | |
| C | | 20.8 | |
| D | | 21.9 | |
| E | 18.3 | | 21.4 |
| F | | 11.8 | |
| G | 10.7 | | 0 |
| HA & HB | 23.7 | | 12.4 |
| I | 11.9 | | 0 |
| J | 0 | | 11.9 |
| KA & KB | 0.14 | | 11.4 |
| L | 11.4 | | 24.0 |
| M | 24.0 | | 11.4 |
| NA & NB | 12.4 | | 23.7 |
| O | 0 | | 10.7 |
| PA & PB | 11.4 | | 0.14 |
| Q | | 23.0 | |
| R | | 11.5 | |
| T | | 8.8 | |
| U | | 1.14 | |
| V | | 19.4 | |
| a | | 14.8 | |
| f | | 12.1 | |
| g | | 11.8 | |
| h | | 11.8 | |
| m | 23.4 | | 12.3 |
| n | | 11.8 | |
| q | 0.43 | | 10 |
| r | 12.3 | | 23.4 |
| t | 10 | | 0.43 |
| u | | 14.7 | |

### Performance tests

Objectively, the unit meets the required specification initially outlined. Total harmonic distortion, for example, is in fact less than 0.2% from 30Hz to 15kHz for an output level of +10dBm into 600Ω. The distortion is predominantly second harmonic and its magnitude decreases with reduction in the output level.

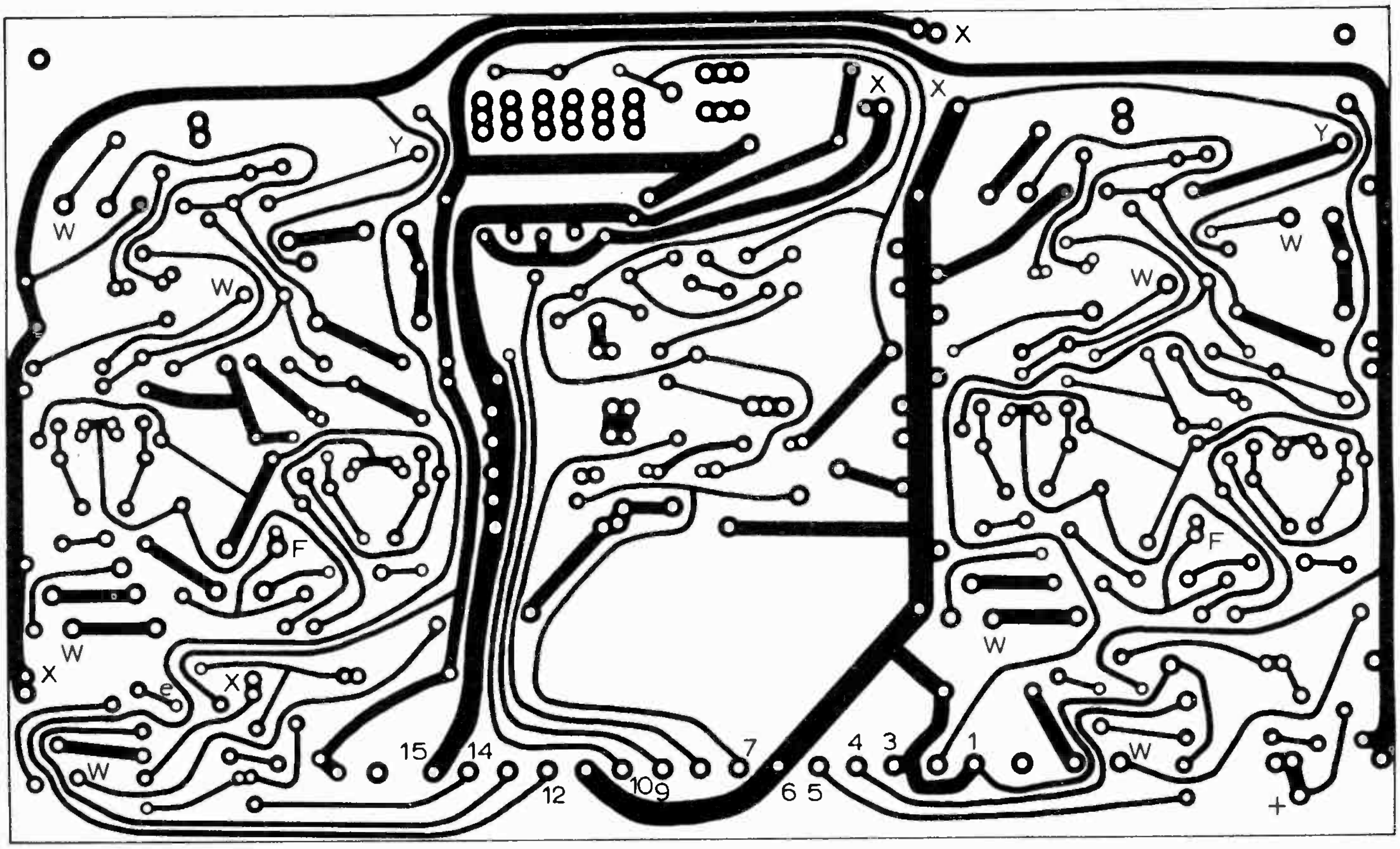



*Fig. 4. Printed circuit layout of silent switch.*

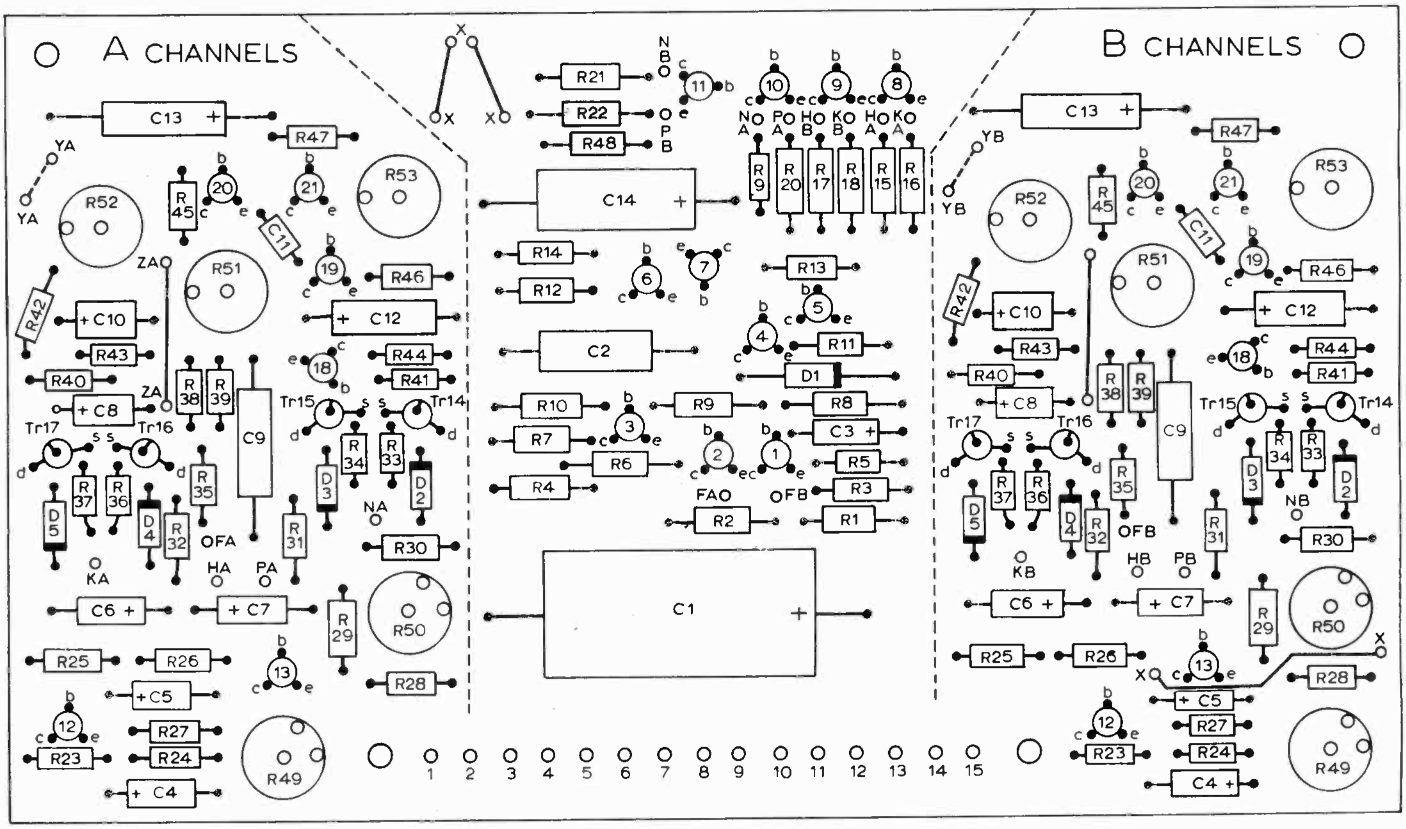



*Fig. 5. Printed circuit component layout.*

The d.c. switching and indicating section components are placed in the middle of the board. Components belonging to the signal carrying parts of the circuit are positioned to the left and right of the board for the A and B channels respectively.

**External Connections.** Connect points marked X to each other as indicated. DO NOT connect points Y at this stage. Connect the following:

HA to HA, KA to KA, NA to NA, PA to PA, FA to FA, ZA to ZA, etc.

**Line-up Procedure.** With no signal applied, connect an ammeter between points YA. Adjust $R_2$ so that the ammeter reads 12mA. Remove the ammeter and connect points YA together. Set $R_{53}$ to obtain an output impedance of 600Ω. Terminate the output (pin 2) with a 600Ω load. Apply a 1kHz, −10dBm signal (via a 100μF capacitor with its positive end connected to the circuit) to either end of $C_9$. Adjust $R_{51}$ to obtain +10dBm at the output. Connect pins 7 and 8 together. Apply a 1kHz, +10dBm signal to pin 4 (the input). Adjust $R_{50}$ so that the output is at +10dBm. Apply a 1kHz, +10dBm signal to pin 5. Close switch $S$ (see circuit diagram). Adjust $R_{49}$ so that the output is also at + dBm.

Repeat the same procedure for the B channels.

Pins 1 to 15 are laid out for connection to a Painton 15 pole plug type 73/10/1501/10.

$Tr_{20}$ and $Tr_{21}$ should be matched.

The switching speed of the unit was measured in terms of a parameter called parameter implies "Fade-in" as well as time taken for the output level of the switch to change by 60dB. Note that the parameter implies "Fade-in" as well as "Fade-out". This mode of measurement was adopted in preference to the other criteria generally used because it is subjectively meaningful and compatible with the properties of human hearing as well as other parameters in acoustical engineering. The justification generally accepted is that a 60dB reduction in the sound pressure level of a programme makes it inaudible under average conditions. A figure of 25ms $\pm$ 20% was obtained as the Fade-Time of the silent switch.

Subjectively, the switching was found to be free from transients for all programme materials including pure tone. Nevertheless, in order to investigate the subjective detectability of the actual transition, the same programme was fed to both inputs and the switch was operated so as to create a momentary interruption. The degree of the impairment caused by the transition was then judged by a few observers experienced in sound quality evaluations. It was found that the detectability of the transition was dependent on the programme used and the relative instant at which the switch was actuated. For speech and music if the change-over was made during the momentary silences of the programme, then the transition was not noticeable. However, if switching was done during the existence of a continuous passage, then the interruption was found to be noticeable but quite acceptable. The same judgment was also passed when continuous signals such as pink noise or pure tone were used.

Two units were manufactured, both of which were in continual daily use for about 14 months with satisfactory performance. The few problems encountered during this period were minor ones and their corresponding remedies have already been mentioned.

It is perhaps worth mentioning that during the designing stages, attempts were made to add electronic fading facility to the unit. Unfortunately, it was found that using f.e.ts as the fading element, realization of a unit capable of low distortion performance during an entire fade, in addition to high on/off and signal to noise ratios, was not really possible. However, the author has since designed a four-channel modulation type electronic fader, the details of which will hopefully be published soon!

**Acknowledgement**

The above paper presents an engineering aspect of a Ph.D. project financed by the University of Surrey but carried out at the BBC Research Department. I would like to thank both bodies for making this rather unusual but most productive arrangement possible.

# Literature Received

### APPLICATION NOTES

We have received a copy of the 256-page Sescosem linear i.c. application manual, Vol. 1, *Les amplificateurs operationnels*. The manual is published in French only. There are companion volumes on voltage regulators and active filters. Editions Radio, 9 rue Jacob, 75006 Paris, France. .. WW417

A Precision Monolithics leaflet on the realization of a high-speed, eight-bit a-d converter is available from Bourns (Trimpot) Ltd, Hodford House, 17/27 High Street, Hounslow, Middlesex TW3 1TE. WW418

The British Standards Institution have recently published BS5102, "Phenolic resin bonded paper laminated sheets for electrical applications," which gives requirements for six types of sheet material and test methods. Copies are available at £4 from BSI Sales Department, 101 Pentonville Road, London N1 9ND.

A chart has been prepared by ERMA to provide information on the correct way to crimp a variety of r.f. connectors, using ERMA hand crimping tools. ERMA Ltd, Mount Pleasant, Alperton, Wembley, Middlesex. .................. WW419

A bulletin (No. 2) is available from Qantex on the recovery of phase-encoded digital signals on magnetic tape in the ANSI four-track, ¼-in, 1600 bits per inch format. North Atlantic Industries Inc, Qantex Division, 200 Terminal Drive, Plainview, NY, USA. .................. WW420

GIM have sent us a copy of their application note on the AY-5-9100 microcircuit for use in push-button telephone systems. The publication provides circuit information on the use of the i.c. in mains diallers, line-powered instruments, re-dialling and card-reading telephones and repertory diallers. General Instrument Microelectronics Ltd, 57–61 Mortimer Street, London W1N 7TD. .............. WW421

### EQUIPMENT

A brochure is available describing the interfaces produced to enable Datalab 900 transient recorders to work with computers, punches, typewriters and other peripherals. Data Laboratories Ltd, 28 Wates Way, Mitcham, Surrey CR4 4HR. ........ WW408

Descriptions of paging systems, both loop and radio types, are contained in a publication from Sales Office, Multitone Electric Company Ltd, Underwood Street, London N1. .......... WW409

We have received a leaflet on the Nea Lindberg 1kVA static inverter, which provides a 50Hz, 220V sinusoidal output at up to 4.6A from 20–30V d.c. Efficiency is 75%. Avel-Lindbert Ltd, South Ockendon, Essex. ...................... WW410

Teradyne have produced a book entitled "High-volume testing for electronic device users" which is mainly concerned with the use of Teradyne automatic test equipment in the inspection of devices and assemblies. The publication costs £1 from Teradyne Ltd, Clive House, 12 Queens Road, Weybridge, Surrey.

A brochure on the CILCOM 1600 system for the conversion of magnetic tape computer output into a film record (COM for Computer Output onto Microfilm) has been sent to us by UCC/Computer Instrumentation Ltd, School Lane, Chandler's Ford, Eastleigh, Hants. ................. WW411

The 1974/75 brochure of Pickering pickup cartridges is now available. The brochures are published in two editions, with six languages in each, and are obtainable from Highgate Acoustics, 38 Jamestown Road, London NW1 7EJ. ............... WW412

We have received a brochure on the range of equipment marketed by Telephone Rentals, which includes telephones, data communications, staff location, time control, production control and fire and security equipment. Telephone Rentals Ltd, 197 Knightsbridge, London SW7 1RL. .... WW413

Ship-borne and shore station radio-telephone equipment is described in a brochure (RF-201M) sent to us by Harris Corporation, 1680 University Avenue, Rochester, New York. Specifications of six basic models are included. .................... WW414

SE Labs have published the latest in a series of Complete Guides, this time to oscillographs, ultraviolet and other types. SE Labs (EMI) Ltd, North Feltham Trading Estate, Feltham, Middlesex TW14 0TD. .......................... WW415

Labgear have published a brochure on television and f.m. radio reception equipment, v.h.f./u.h.f. distribution equipment and television test instrumentation. Labgear Ltd, Abbey Walk, Cambridge CB1 2RQ. ............................ WW416

### PASSIVE DEVICES

Beckman have produced a 12-page booklet describing their range of Resnet resistor networks in various packages. Beckman Instruments Ltd, Components International, Queensgate, Glenrothes, Fife, Scotland ............................. WW406

Sprague have produced a wall-chart which gives brief details of a range of aluminium electrolytic capacitors. Sprague World Trade Corporation, Färberstrasse 6, 8008 Zürich, Switzerland. . WW407

### ACTIVE DEVICES

Mullard have sent us a copy of their newly published 1974/75 data book. Valves, c.r.ts, semiconductors, resistors, capacitors, i.cs and assemblies for entertainment purposes are briefly described. The publication is available from booksellers or from Technical Press Ltd, Freeland, Oxford 0X7 2AP at 40p.

Microwave Associates Ltd have sent us three leaflets, on a Gunn diode local oscillator for a 9470MHz centre frequency (MA87635), the MA7701C series of tunnel diode detectors and a range of p-i-n diodes (Bulletin 4306). Available from Microwave Associates, Dunstable, Beds. ..................................... WW401

Siliconix have sent us their latest short-form catalogue, which includes information on junction f.e.ts and dual-gate mosfets, a 3½-digit a-to-d converter, a triple op-amp and new driver gates. Siliconix Ltd, 30A High Street, Thatcham, Newbury, Berks RG13 4JG. ........................... WW402

ITT have produced a booklet on m.o.s. devices entitled "Everything you wanted to know about m.o.s". It explains the pros and cons of the process and there is a glossary. ITT also have their new short-form semiconductor catalogue. ITT Semiconductors, Footscray, Sidcup, Kent.

Booklet ............................. WW403

Catalogue ........................... WW404

A wall-chart from RCA presents mechanical and electrical information on their range of linear integrated circuits and includes a cross-reference between the RCA products and twelve other types. There is a list of application notes. RCA Ltd, Solid-state—Europe, Sunbury-on-Thames, Middlesex. ................................. WW405

### GENERAL

The "Handbook of Electrical Connectors" has been published by Pye Connectors Ltd, Hitchin Street, Biggleswade, Beds. It is a loose-leaf folder in which is collected all the information on Pye's various types of connector, including the printed-circuit variety. .............................. WW422

The solenoids in the Magnetic Devices range are described in a short-form catalogue which gives salient mechanical and performance information. Magnetic Devices Ltd, Exning Road, Newmarket, Suffolk. ............................. WW423

A catalogue of small mechanical components and p.c.b. furniture is published by Dieter Assman Electronics Ltd, Victoria Works, Water Lane, Watford, Herts. The company markets the products of the German Assman KG company. No price list is provided. ........................ WW424

# Research Notes

## Enter the white hole

If a black hole in astronomy is a star which has collapsed to nothing then a white hole is the reverse, that is, matter which suddenly appears at a point in space. While there is no observational evidence that such a thing happens it is always of interest to astronomers to theorize about such things. Three Indian astronomers have been doing so. They conclude that the appearance of a white hole would be marked by a great burst of radiation, mostly at very short wavelengths (X-rays and gamma rays). The radiation is not very different from what is actually observed from certain types of galaxy, so the possibility that white holes exist in reality as well as in theory is open.

*Nature*, Oct. 18, 1974, vol. 251, p.590.

## Thermistor-stabilized oscillators

Low-distortion RC oscillators in which lamps or thermistors are used to stabilize the level of oscillation tend to suffer from "amplitude bounce". Any small disturbance to the circuit, such as the manipulation of a tuning control, causes the amplitude to jump about. Usually the effect dies away but in bad cases the bounce continues indefinitely, so that the output of the oscillator becomes an amplitude-modulated sine wave.

It has been known for a long time that bounce is an inherent property of low-distortion oscillators and gets worse as the distortion of the maintaining amplifier is reduced. (Some commercial oscillators can be operated in two modes: a low-distortion mode for use when purity of waveform is important and a "fast-settling" mode for such work as measuring frequency responses where bounce is a nuisance.) In a thorough analysis, P. L. Taylor of the University of Salford shows that even a small amount of amplifier distortion (0.1% third harmonic) damps the bounce by a large factor (16) compared with the ideal case of a distortionless amplifier. Bounce in practice is less than predicted by simple theory, probably because the usual assumption that the temperature is uniform throughout the thermistor bead is in practice invalid. Non-uniformity changes the effective thermal time constant, which is an important quantity in the bounce equation.

Distortion is caused by the thermistor itself heating and cooling a little during each half-cycle of oscillation. The distortion is worst at the lower frequencies (0.1% at 10Hz in a typical circuit). The distortion can be reduced (at the expense of increased bounce) by putting resistance in series with the thermistor.

*Proc. I.E.E.*, Aug., 1973, vol. 120, no. 8.

## Power from ocean waves

An Edinburgh scientist says that if the energy in the Atlantic waves which approach Britain's western shores could be extracted along a frontage of a few hundred kilometres it would be enough to supply the present power needs of these islands.

Most proposals for extracting energy from sea waves make use of the up-and-down boat-bobbing movement as the wave passes a floating object. This, however, does not extract the maximum amount of energy, because the particle motion in the wave itself is not up and down but circular. A mechanism has been tested in the laboratory which makes use of the circular motion. It has rollers of egg-shaped cross-section which rotate, turning first one way then the other as the wave passes. A floating breakwater containing these structures should extract nearly all the wave energy, leaving calm water on the shoreward side.

The intermittent flow of wave energy poses problems in conversion to steady electrical supplies. One possibility is to use the waves to drive, first, a pump which would build up a head of liquid then allow the liquid to escape steadily, driving a turbo-generator. Development of the idea is to be supported by a government grant.

Dept. of Mechanical Engineering, Univ. of Edinburgh.

## First binary pulsar

The big radio telescope at Arecibo, Puerto Rico, has discovered a pulsar which is one partner in a double star, the other being an ordinary star. The ordinary star has not yet been detected, but its presence is deduced from the way in which the pulsar's period is Doppler-shifted every few hours, as it moves away from the earth then towards the earth in a highly elliptical orbit.

This discovery is of interest for the light it may cast on supernova explosions. Pulsars are currently thought to be neutron stars, small, very dense objects which may well be all that is left of a supernova. The fact that a normal star might have continued to exist in close proximity to a supernova in this present example lends support to the idea that the X-ray-emitting binaries recently discovered are also made up of supernova remnants.

## Watching high-speed transistors in slow motion

The scanning electron microscope has been used for some years to image transistors in operation. Changes in the potential of the transistor surface affect the electron beam and are therefore visible on the microscope's "TV screen". The University College of North Wales, Bangor, has a method of "strobing" its scanning electron microscope at up to 10GHz, making it possible to "freeze" high-speed events in the transistor under examination.

## Sunspots, Jupiter, and earthquakes

1982 should be a bumper year for sunspots —and earthquakes. So say J. Gribbin and S. Plagemann ("The Jupiter Effect," Macmillan, London). The basic idea is that the number of sunspots is affected by the gravitational pull of the planets on the sun; this is increased when two or more planets are in line. In 1982 all the planets will be in line, for the first time in 179 years. Sunspots are known to affect the climate on earth, and the authors argue that this in turn will produce a slight perturbation of the earth's rotation and trigger off any incipient earthquakes.

Meanwhile, astronomers and radio-propagation experts will be checking up on another sunspot relationship just reported by G. M. Brown of the University College of Wales, Aberystwyth. Solar activity produces ionospheric currents which interfere with the horizontal component of the earth's magnetic field. The field on a normal "quiet" day goes through a minimum at about 11.00 hours local time. However, there are also "abnormal quiet days" when the effect takes place at some quite different time. Examination of magnetic records for England (which go back to 1885) shows that these abnormal quiet days go through a cycle like the sunspots, but with a maximum which occurs at sunspot minimum. What is more to the point, for ionospheric predictions, is that the "AQD" count seems to be a good measure of the intensity of the sunspot maximum which will follow it, in about six years.

*Nature*, Oct. 18, 1974, vol. 251, p.594.

*If a ship fitted with this Koden radio buoy sinks, the buoy surfaces and transmits a distress signal for over 48 hours.*

# Computer monitoring of TV signals

## An experimental digital system for the monitoring of unmanned television transmitters.

by J. Schaffer, B.Sc., A.R.C.S.

*Decca Radio and Television Ltd*
*(formerly Independent Broadcasting Authority)*

Present methods of monitoring the quality of a television signal are almost invariably based on measurements of Insertion Test Signals (ITS). These signals are inserted into the field blanking interval of the signal, and usually accompany it from point of origin (studio) to destination (domestic TV receiver).

Over recent years the forms of the ITS have been agreed both nationally and internationally, and are shown in Fig. 1. Certain technical quality parameters based on the ITS are listed in Table 1.

Practical techniques for measuring the quality parameters may be divided into two categories—manual and automatic. Manual methods use oscilloscopes with special graticules for the measurement of white bar tilt and 2T pulse *K* factors; for differential phase and gain, vectorscopes or special purpose measuring instruments are used. Manual measurement of non-linearity is made with a differentiating filter acting upon the staircase waveform backed by a high gain amplifier[1,2].

Automatic measuring methods may be sub-divided into the usual two categories of analogue and digital. There are now available automatic analogue machines[3,4], which evaluate many of the parameters listed in Table 1. It is expected that automatic methods will predominate as more automatic correcting and control equipment is brought into service. The output signals (direct voltages) from these analogue machines are used to raise alarms or to actuate local control equipment should any of the quality parameters fall outside certain pre-set limits. In addition, the analogue outputs may be converted into digital form by a digital voltmeter and the digitized data telemetered to a central control room. At the control room the received data may be used merely for record purposes, or to decide whether

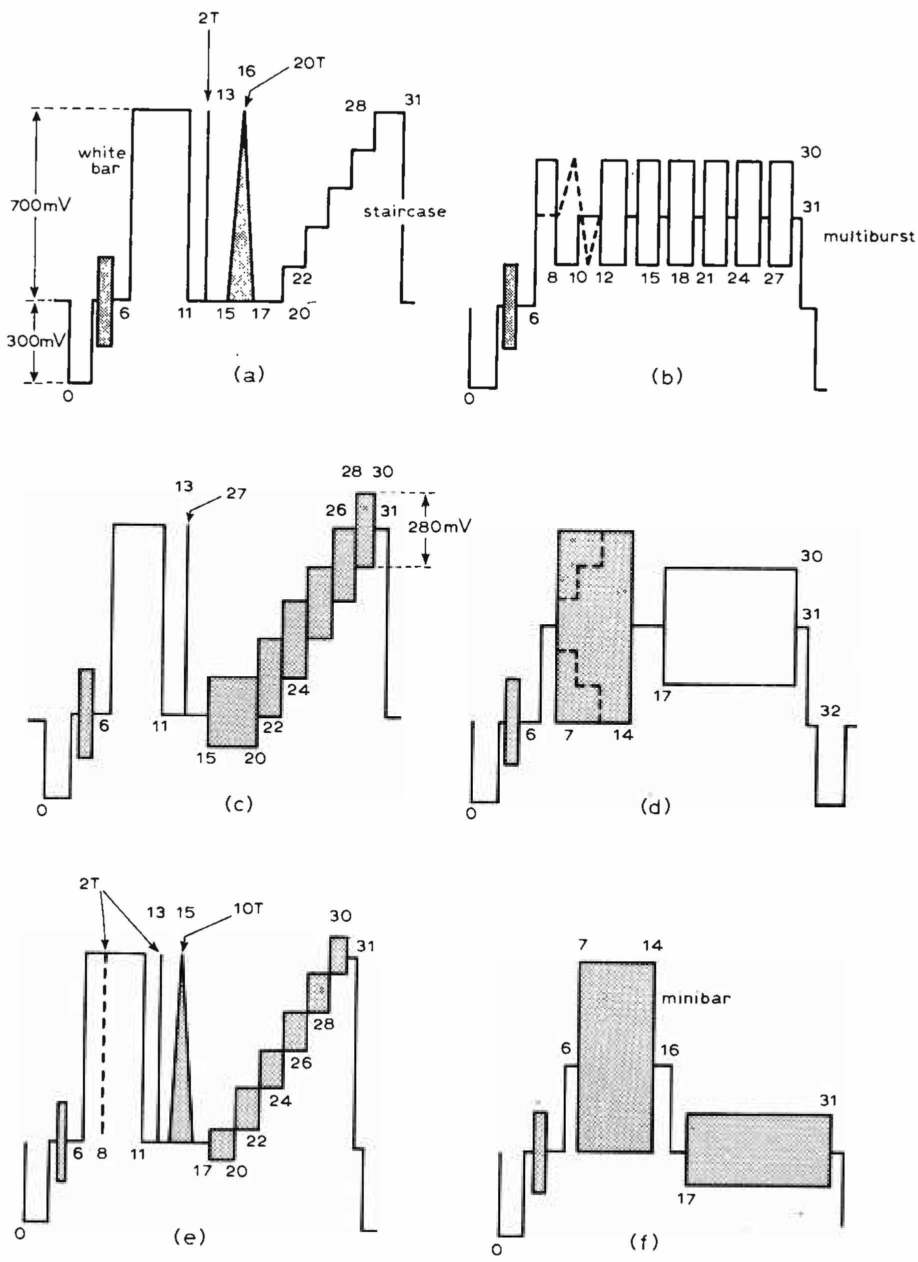



*Fig. 1. International Test Line Signals a, b, c and d, inserted on lines 17, 18, 330 and 331. The National Test Line Signals a and b are inserted on lines 19 and 32, and lines 20 and 335.*

**Table 1**

| Quality Parameter | Waveform Used |
|---|---|
| Insertion gain | White bar |
| White bar tilt | White bar |
| Pulse to Bar K factor | White bar and 2T pulse |
| Non-linearity | Staircase |
| Differential gain | Staircase with super-imposed sub-carrier |
| Differential phase | Staircase with super-imposed sub-carrier |
| Chrominance luminance delay | 10T or 20T pulse |
| Chrominance luminance cross talk | Mini bar |
| Chrominance luminance gain | Mini bar |

remote control equipment should be actuated.

As far as is known there are no digital machines commercially available at present. There is, however, an experimental digital system, developed by the Independent Broadcasting Authority, which is being used to monitor unmanned television transmitters. This system has been undergoing field tests since November 1972 at the Lichfield control and monitoring centre of the Independent Broadcasting Authority[5].

In its mode of operation, off-air signals are received at the monitoring centre from the unmanned transmitters in the vicinity, each transmitter being serviced in turn. After the received signal has been amplified and demodulated by a high-quality receiver, the ITS is extracted and applied to a fast sample-and-hold circuit backed by a fast analogue-to-digital converter. Evaluation of the quality parameters from the resulting digital data is performed by a general purpose digital computer. Results of the field tests show that good agreement is obtained with both manual measurements and with automatic analogue measurements. The off-air system of monitoring has the advantage that the main capital cost is concentrated at one location—the monitoring and control centre—giving a lower overall cost than a monitoring system using automatic measuring machines at each unmanned site.

Generally the signal-to-noise ratios met in off-air monitoring are poor compared to those met in on-site monitoring. Consequently the computer programmes which derive the quality parameters have been designed to operate in conditions of high noise by using averaging techniques to improve the signal to noise ratio[6].

In passing it is worth noting that the relatively poor noise performance of analogue machines prevents their use in similar off-air monitoring systems.

Although the field tests have shown that adequate performance is obtained with off-air signals received at Lichfield, it was envisaged that cases would occur where the received signal-to-noise ratios would be too low for the system to operate, particularly where the unmanned station and the monitoring and control centre were located in hilly areas, or in conditions of severe co-channel interference.

To cover such cases the Independent Broadcasting Authority initiated the development of a digital telemetry system which could be dovetailed with the off-air monitoring system, using, as far as possible, common digital hardware and software. The function of the digital telemetry system would be to transmit measurements made at the "difficult" sites back to the monitoring and control centres using either the public switched telephone network or private telephone lines.

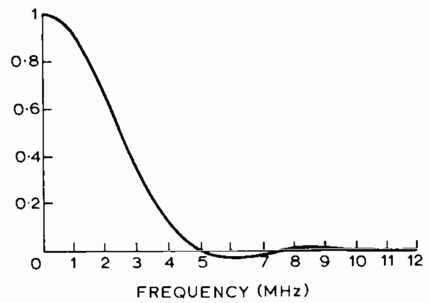



*Fig. 3. Spectrum of the 2T pulse.*

## Design of the digital telemetry system

An important factor in the design of the telemetry system is the need to minimize the cost of the measuring equipment installed at the sites to be monitored. Consequently it would seem that only the simplest measurements and processes should be undertaken on-site, with the bulk of the data processing carried out by the relatively expensive equipment at the monitoring and control centre. Unfortunately, it is found that this strategy dictates long data transmisssion times and a slow system response.

This can be seen by taking as an example the measurement of r.m.s. noise. To obtain a good estimate of noise about 200 samples need to be taken at a nominally constant part of the television waveform (preferably during the "quiet line"). If these samples are digitized by an eight-bit analogue-to-digital converter, the total number of bits equals 1,600, and the time taken to transmit these bits over a 50-baud (bits per second) channel is 32 seconds. Coupled with the transmission time of the ITS data, which would be at least as long, it is seen that the total data transmission time is in the order of minutes. This time may be reduced if, instead of transmitting raw data, a small amount of digital processing is performed upon the data prior to transmission. A block diagram of a measuring system, incorporating the above ideas, is shown in Fig. 2.

Circuit design was begun using read-only memories (ROMs) to determine sample timings and random access memories (RAMs) to hold the data prior to transmission—data processing was carried out by an adder/subtractor unit made up in t.t.l. It was soon realized that the design was merely reproducing, at a high cost, circuitry that was already available in commercial microcomputers, and the original development policy was abandoned, subsequent development being based on the use of a microcomputer containing a single chip four-bit central processing unit.

The need for cheapness also limits the performance of the analogue-to-digital converter employed. Some converters are able to convert in fractions of a microsecond and form the heart of equipments such as DICE[7]. Unfortunately these fast converters are too expensive for this application and a cheaper, slow converter was used, which converts to eight bits in about 12 microseconds. Using a slow converter means that only a small number of samples can be taken in the 64-microsecond duration of each insertion test signal.

In practice, programming the microcomputer is simplified if only one sample is taken during each ITS, i.e., a sample rate of 25Hz or 50Hz. At this point it may be well to recall the well-known Sampling Theorem which states that a band limited signal may be reproduced, without error, from samples taken at a rate of at least twice the bandwidth of the signal. Sampling at field or picture rate would therefore apparently limit the bandwidth of the measurements to either 12.5Hz or 25Hz. This limitation is overcome by employing strobing techniques identical to those used in sampling oscilloscopes[8], wherein the sample timing is advanced, between samples, by an amount not greater than half the period of the maximum frequency contained in the signal.

## Measurement theory

**Luminance parameters.** Sufficient samples need to be taken at various points along the ITS to provide the required data for calculating the luminance quality parameters: white bar amplitude, white bar tilt, 2T pulse response, and luminance non-linearity.

Measurement of white bar height and tilt requires four samples to be taken at appropriate points along the waveform. The accuracy of measurement is limited by the quantization errors of the analogue-to-digital converter, and may be estimated as follows. If the input signal is 1 volt peak to peak and it occupies, say, 0.7 of the full range of an eight-bit analogue-to-digital converter (thus allowing for a possible 3dB increase in input signal level without overloading the converter), then the picture component would span $0.7 \times 0.7 \times 255 = 125$ quantization levels where the number 255 corresponds to the highest level of an eight-bit converter ($=2^8-1$). The measuring error for each sample due to quantization is $\pm\frac{1}{2}$ level; therefore the maximum error in bar height is $\pm 1$ level since two measurements are used to evaluate the white bar height. The

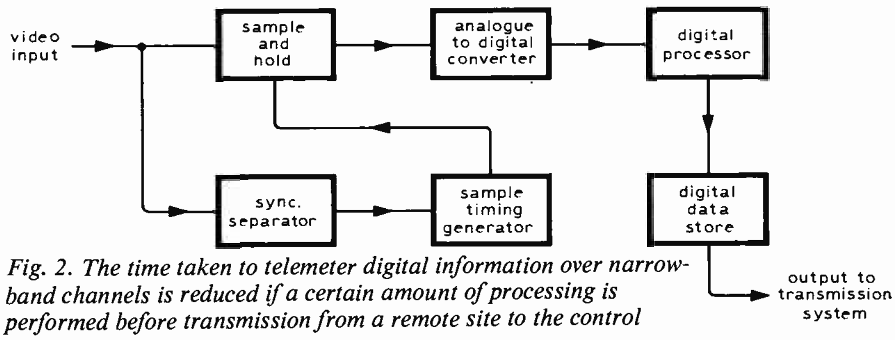



*Fig. 2. The time taken to telemeter digital information over narrow-band channels is reduced if a certain amount of processing is performed before transmission from a remote site to the control centre.*

fractional error is $\pm 1$ in 125 or about $\pm 0.8\%$. Error in tilt measurement expressed as a percentage of white bar height is likewise $\pm 0.8\%$ maximum. These errors are usually quite acceptable for most television measuring purposes. In the case of luminance linearity, measured on the staircase, the situation is somewhat worse. Each staircase riser height is approximately 25 quantum levels and the error of $\pm 1$ level corresponds to an error in the measurement of luminance linearity of 8%, a performance which is not satisfactory. Improved accuracy may be obtained by adding small amounts of noise to the signal and averaging over many samples[6] or by superimposing sub-carrier on the staircase and averaging over four, or multiples of four fields.

For the 2T pulse, samples need to be taken at timing intervals short enough to permit the pulse to be reconstituted from the samples according to the Sampling Theorem. In Fig. 3 is shown the spectrum of the 2T pulse, from which it is seen that there is little energy beyond 5.0MHz, implying that the sample intervals should not exceed 100 nanoseconds.

As mentioned above, strobing techniques are used to obtain these short timing intervals, the samples, which in real time repeat at picture intervals (40 milliseconds), being advanced by the required sampling intervals until the whole of the 2T pulse is covered. For reasons associated with the evaluation of the colour components of the Insertion Test Signal, the timing increments are derived from 13.5MHz oscillator giving a minimum timing increment of 74.1 nanoseconds and a bandwidth of 6.75MHz. The total number of pulses used for strobing the 2T pulse is 27, covering 2 microseconds, including a half microsecond allowance for timing errors in the location of the 2T pulse. In a similar manner, by strobing the line sync. pulse it is possible to measure sync., pulse amplitude, duration and rise times.

**Colour components.** At first glance the use of strobing techniques for evaluating chrominance data appears to be invalidated by the changes in sub-carrier phase which occur from field to field. Fortunately in the case of the PAL system these phase changes may be put to good use. It can be shown[9] that the phase of the sub-carrier component of the Insertion Test Signal, when referred to the preceding line sync. pulse, varies from field to field in multiples of 90 degrees. Taking line 19 as reference, the relative phases are:

| Line No. | 19 | 332 | 19 | 332 | 19 | 332 | 19 | 332 |
|---|---|---|---|---|---|---|---|---|
| Phase | 0 | 90.3 | 270 | 0.3 | 180 | 270.3 | 90 | 180.3 |

and so on, repeating in an eight-field sequence.

Suppose the amplitude of the Insertion Test Signal at a time relative to line sync. in given by:

$$v = v_L + v_c \sin(2\pi f_{sc} t + \phi),$$

where $f_{sc}$ is the sub-carrier frequency, $v_L$ is the luminance amplitude, $2v_c$ is the peak to peak sub-carrier amplitude, and $\phi$ is an arbitrary phase angle. Then it follows that the amplitudes of four consecutive samples, taken at picture rate, have the values:—

$$v_n = v_L + v_c \sin\theta$$
$$v_{n+1} = v_L - v_c \cos\theta$$
$$v_{n+2} = v_L - v_c \sin\theta$$
$$v_{n+3} = v_L + v_c \cos\theta,$$
$$\text{where } \theta = 2\pi f_{sc} t + \phi.$$

In these equations it is assumed that samples are confined to either odd or even fields; the method may therefore be applied directly to the International Insertion Test Signals which differ on odd and even fields. (It is also possible that future UK practice will be to use insertion signals from different origins on odd and even fields.) The amplitude and phase of the sub-carrier and the luminance amplitude may be easily derived from these samples by forming the variables:

$$v_I = v_n - v_{n+2} = 2v_c \sin\phi,$$
$$v_Q = v_{n+3} - v_{n+1} = 2v_c \cos\phi,$$
$$v_T = v_n + v_{n+1} + v_{n+2} + v_{n+3} = 4v_L,$$
$$\text{giving } v_L = v_T/4, \tan\theta = v_I/v_Q,$$
$$v_c = \tfrac{1}{2}\sqrt{v_I^2 + v_Q^2}.$$

When evaluating chrominance-luminance delay the 10T pulse is strobed, groups of four phase samples being taken at each sampling point. The microcomputer is programmed to calculate the values of $v_I$, $v_Q$ and $v_T$, and it is these values which are telemetered. At the monitoring and control centre, the luminance amplitude $v_L$ and the chrominance amplitude $v_C$ are first evaluated. The values of $v_L$ and $v_C$ are then filtered in identical digital filters, in order to reduce noise and quantization errors and the luminance and chrominance 10T pulses are reconstituted according to the Sampling Theorem. A further computer algorithm then evaluates the relative delay between the two 10T pulses.

Unfortunately when evaluating differential gain and phase from the staircase waveform, the above equations when used directly, result in excessive quantization errors. With an eight-bit a-d.c. the 140-millivolt peak to peak sub-carrier superimposed on the staircase waveform spans approximately 25 quantum levels. The maximum quantization error in either $v_I$ and $v_Q$ is 1 quantum level corresponding to an amplitude error of 4% and a possible error in differential gain of 8%. Maximum phase errors are about 1/25 of a radian or $2\frac{1}{2}°$ approx., resulting in a possible error in differential phase of 5°.

A method has been devised which reduces these quantization errors by a process of summing a multiple of samples at each staircase level. At each staircase level, the sampling point is progressed along the sine wave by a small angle $e$, the values of $v_I$ at each sampling point being added together to give a total $S$; likewise the values of $v_Q$ are added together to give a total $C$. If for each staircase step a total of $n$ groups of four-phase samples are taken, it can be shown by summing sine and cosine series that

$$S = 2v_c \sin\left(\theta + \left[\frac{n-1}{2}\right]e\right).\frac{\sin ne/2}{\sin e/2}.$$

$$C = 2v_c \cos\left(\theta + \left[\frac{n-1}{2}\right]e\right).\frac{\sin ne/2}{\sin e/2}$$

The relative sub-carrier phase and amplitude are again easily evaluated from $S$ and $C$.

The luminance value $L$ is equal to the sum of the sample values divided by $4n$. In these sums quantization errors tend to cancel whereas the signal components reinforce. Although it has not been found possible to evaluate the errors theoretically, practical errors are approximately 1 degree in differential phase, 2% for differential gain, and 1% for luminance non-linearity. These values apply for $n=8$ corresponding to 32 samples being taken at each staircase level.

The required phase progression $e$ is automatically obtained by deriving the sample timings from a 13.5 MHz oscillator, the output of which is divided by 864 to line frequency, and locked to the line synchronizing pulses. The resulting value of $e$ is equal to $-5.3°$. Other timing oscillator frequencies are possible, $\frac{\sin ne/2}{\sin e/2}$ should not be small and that the division ratio to line frequency should be easy to realize in practice.

The analysis of the staircase waveform requires a well-defined sequence of sample timings. On a given step, a set of four-phase samples is taken at a constant time relative to the preceding line sync. pulse; the sample timing is then advanced by three cycles of the 13.5 MHz oscillator and another set of four-phase samples taken and so on until a total of $n$ four-phase samples have been taken. The sample timing is then advanced to the next staircase step and the process repeated. The timing of each group of $4n$ samples is made constant relative to the staircase risers, so that transients associated with staircase transitions, or tilt across the steps, affect each group of readings equally. Consequently in the above formulae the value of $\theta$ varies with the step number, and correction angles must be applied when evaluating differential phase. The values of the correcting angles are given by $\theta n = 2\pi f_{sc} nT$. where $T$ is the time separation between the steps (4.00 microseconds) and $n$ is the step number (1 to 5) whence

| $\theta_1$ | $\theta_2$ | $\theta_3$ | $\theta_4$ | $\theta_5$ |
|---|---|---|---|---|
| −84.4 | +11.2 | −73.2 | +22.4 | −62.1 |

Another group of colour measurements often required is the amplitude, position, and rise and fall times of the colour burst envelope. The phase sequence of the colour burst differs from that of the Insertion Test Signals by virtue of the phase alternation which is inherent in the PAL system, and it is not possible to use the above method without modification. It can be shown[10] that the phase of the colour burst, relative to line sync, on a given line and the corresponding line in the next field takes one of two phases 180° apart. Quadrature phases are only obtained when the samples are taken on pairs of lines half a field apart, for example lines 19 and 175. The sub-carrier amplitude may be evaluated from samples taken on these lines using the previous formula and by strobing the sampling point through the colour burst the required information may be obtained.

**Noise measurement.** Signal-to-r.m.s.-noise ratio is an important measure of signal quality. As indicated previously, about 200 samples taken at a nominally constant part of the signal, are required to obtain a good statistical estimate of the noise. It is of course possible to programme the microcomputer to compute the r.m.s. value of the samples directly, but the relatively complex squaring programme involved in this computation may be avoided by making use of a relationship[11] between the mean square $P$ and the mean deviation from the mean $d$, possessed by Gaussian (normal) noise:

$$d^2 = \frac{2}{\pi}P.$$

Using this relationship it may be shown[12] that the signal-to-noise ratio ($S/N$) in dB is given by:

$$(S/N) = 20\log_{10}\frac{(2.B.m)}{(\pi.S_m)},$$

Where $B$ is the white bar amplitude and $S_m$ is the telemetered noise word formed by adding the magnitudes of the differences between consecutive noise samples for a total of $m+1$ samples.

For an eight-bit analogue-to-digital converter this method of noise measurement is accurate for signal-to-noise ratios less than approximately 49dB.

## Hardware

A block diagram of experimental equipment operating according to the above concepts in shown in Fig. 4. The video signal is clamped and applied to the input of the sample and hold circuit. Timing information from the microcomputer is compared, in a ten-bit comparator, with the state of a divide-by-1,024 counter driven by 13.5 MHz crystal oscillator. When coincidence occurs a pulse is generated which, after gating by the output of a second comparator, actuates the sample and hold circuit. The second comparator ensures that sampling occurs only during the line selected by the microcomputer. Synchronism between the sequence of operations within the microcomputer and the television waveform is maintained by the line 3/316 signals applied to the microcomputer.

The microcomputer itself, as used in the experimental equipment consists of a single-chip four-bit central processing unit, four ROM and four RAM packages and about 30 t.t.l. packages which are used for control purposes. The ROMs have a total capacity of 1,024 programme steps and the total RAM capacity is 1,280 bits.

## Programming the microcomputer

As a first experimental application of these ideas, it was decided to programme the microcomputer to analyze the staircase waveform. The flow diagram of this programme is shown in Fig. 5, which is seen to consist of a main programme and a measuring subroutine labelled LABA. The main programme after defining the starting time for the scan at black level jumps to the measuring subroutine LABA.

On rejoining the main programme after completing sub-routine LABA the process is repeated for the next step and so on, until the five steps are scanned. At this point the processed measuring data are held in the RAM store and would, in the final system, be read out into the telemetry channel. However in the present experimental system the data are read out directly onto paper tape using a routine labelled PUNCH.

The heart of the staircase programme is the sub-routine LABA. This routine organizes the arithmetic operations made upon the digital measurements in accordance with the foregoing equations. On entering the routine the sample counter is incremented, followed by a test to determine whether the sample count is a multiple of four. If so the sample timing counter is incremented by three which results in the sample timing being advanced by three cycles of the 13.5MHz oscillator for each group of four samples. A test for the presence of the line three signal on an input line of the computer follows.

If the line three signal is not present the microcomputer enters a sub-loop which it can leave only on the presence of the line three signal. The latest timing information as determined by the state of the timing counter is then entered on to the ten output lines which are connected to the timing comparator in the measuring circuitry.

At this point in the programme, a delay is inserted which ensures that the a.-d.c. data accepted is derived from a sample taken at the new sampling time. The amount of delay required is estimated by dividing the c.p.u. instruction cycle time (which for this microcomputer is approximately ten microseconds) by the difference between the times that the sample timing data are outputted ($T_1$) and the timing ($T_2$) of the sample in line 19. The time difference between line three and line 19 corresponds to 102 instruction cycles: 16 instruction cycles are taken up between the detection of line three and $T_1$, and the delay must therefore be at least 86 instruction cycles. In practice the delay is made up by traversing a loop of 32 instruction cycles five times, giving a total delay of 160—well in excess of the required delay. It is permissible to waste programme time in this way since there is room for approximately 4,000 instructions in the 40 millisecond interval between samples, whereas only 50 are used in the present programme.

After the a.-d.c. output has been accepted, one of six RAM locations con-

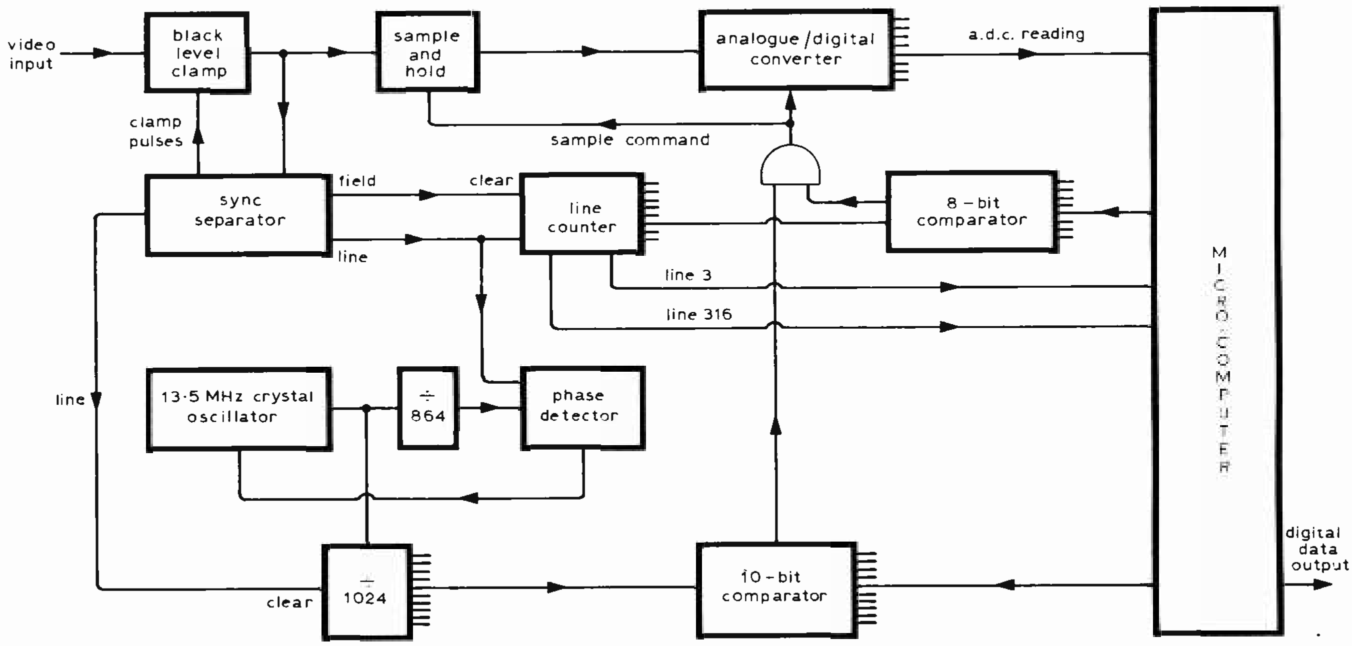
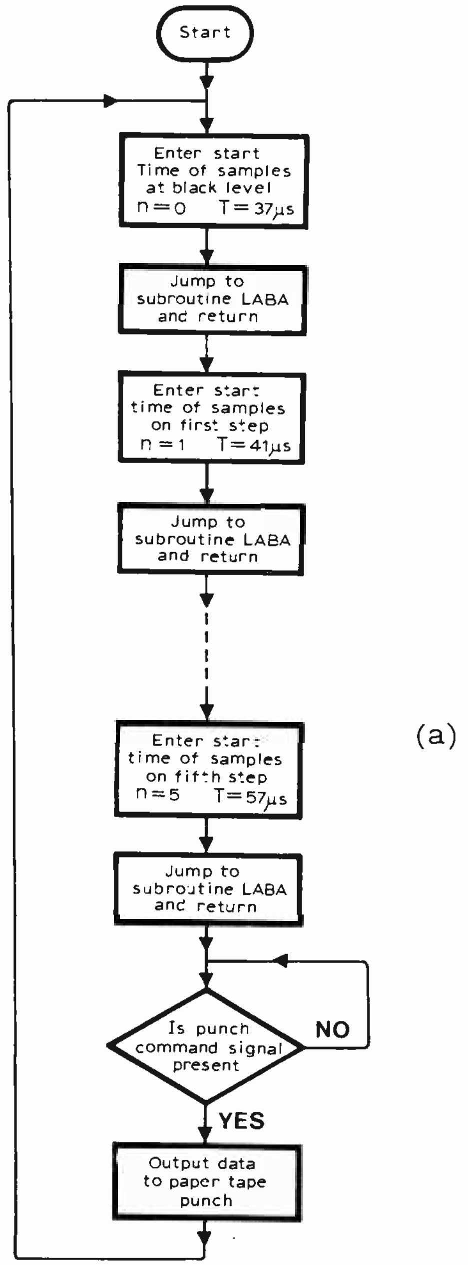



*Fig. 4. Measurement, timing and processing system used at the remote site.*



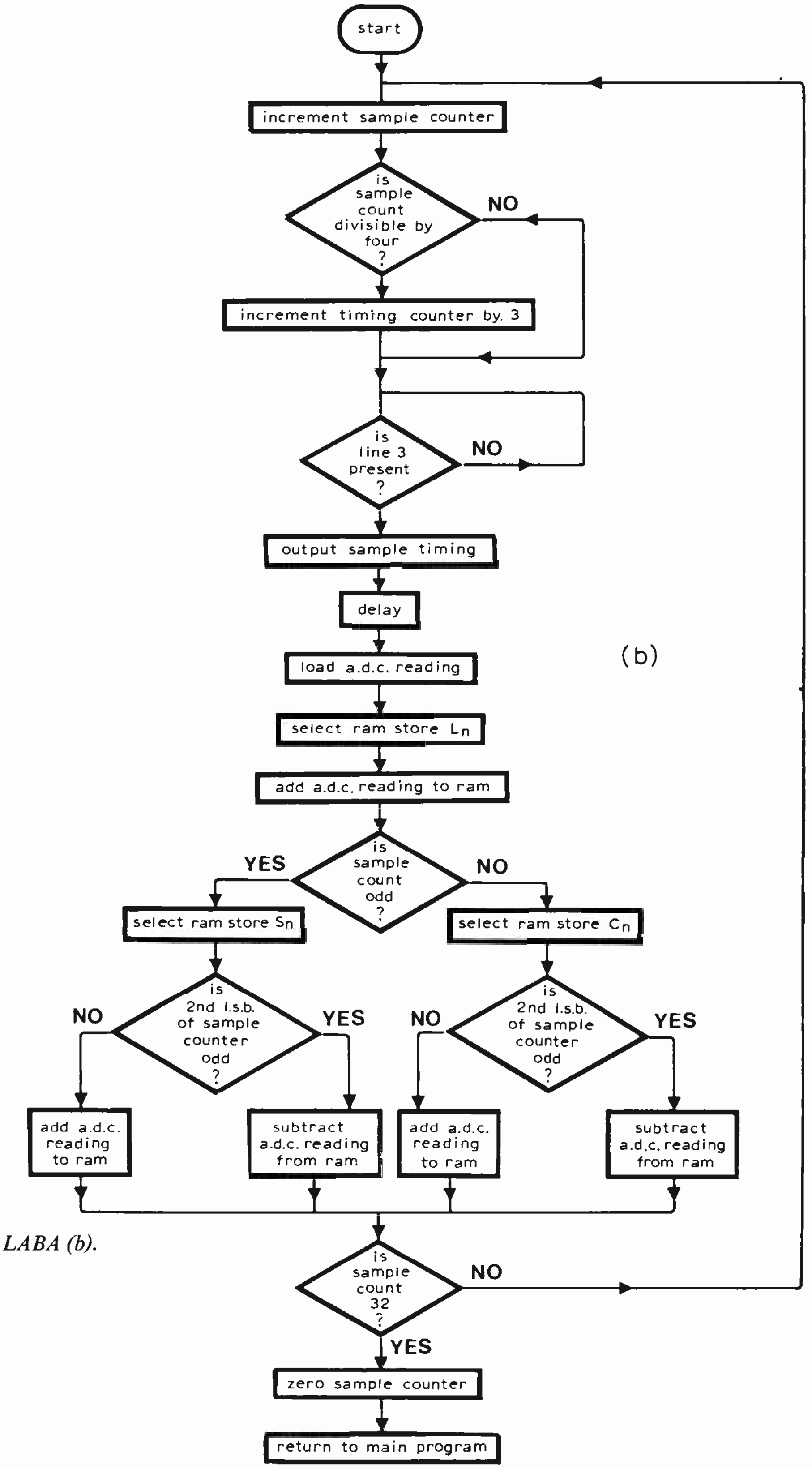




*Fig. 5. The main programme (a) and sub-routine LABA (b).*

taining the luminance totals is addressed according to the step being sampled ($n=0$ to 5) and the a.-d.c. reading added to the contents of this RAM location.

Next follows an algorithm for evaluating the chrominance data. A test which operates on the least significant bit of the sample counter determines whether to address the $S_n$ or $C_n$ RAM location. A further test on the second least significant bit of the sample counter determines whether the a.-d.c. reading is to be added or subtracted from the RAM store addressed.

Finally a test is made to check whether the samples taken total 32. If so the main programme is rejoined after zeroing the sample counter. In the subroutine LABA there are two nested subroutines LABT and LABS, which respectively add and subtract the a.-d.c. readings from the appropriate RAM locations. These subroutines are necessary, for although the c.p.u. possesses add and subtract machine instructions which occupy single instruction cycles, these instructions operate only on four-bit words, whereas in this application, to prevent overflow, 16-bit words are used. That 16-bit words are required may be seen by considering the contents of the luminance store when sampling the fifth staircase step. Peak white corresponds to a quantum level of about 180, giving for the total luminance content, 32 × 180 or 5760, which in binary notation becomes the 13-bit word 1011010000000. The basic word length of the c.p.u. is four bits and any arithmetic operation on a 13-bit word must necessarily involve four operations in cascade giving a working word length of 16 bits.

For chrominance measurements the 140-millivolt peak-to-peak chrominance amplitude on the staircase for the UK signal corresponds to 25 quantum levels, giving possible maximum values $S$ and $C$ of approximately 25 × 32 or 800, which in binary notation becomes the ten-bit word 1100100000. A difficulty now arises because the values of $S$ and $C$ may be negative and a sign bit must be added. Further, if the higher level of subcarrier for the international test signal is taken into account, and a one-bit margin against overflow is allowed the total number of bits required for the chrominance values $S$ and $C$ also equals 13. The net result is that both luminance and chrominance working word lengths are 16 bits long.

The subtraction operation in the c.p.u. uses two's-complement arithmetic requiring the 16-bit $S$ and $C$ words to be interpreted in the following way. The 16th most significant bit (sign bit), if zero, signifies a positive number, with the remaining 15 bits regarded as a normally weighted binary number. If the sign bit is unity the number is negative, the magnitude of the number being equal to the binary complement of the remaining 15 bits plus one.

The next step in programming is to transform the flow diagram into a series of instructions using the instruction set belonging to the c.p.u. The c.p.u. here used has a set of 45 instructions, examples of which are:

ADD —Adds two four-bit numbers with carry
SUB —Subtracts two four-bit numbers with borrow
INC A—Increment contents of register A
LD X —Loads contents of register X into the accumulator

Completion of this stage of programming results in a series of machine instructions which are next translated into machine code. This translation is simple, since each member of the instruction set corresponds to a unique eight-bit machine code word. In machine code the programme consists of a sequence of eight-bit words; it is these words which are written in order into the Read Only Memory (ROM).

The task of programming the microcomputer is eased by using assembler and simulator programmes designed by the microcomputer manufacturer. With these programmes, which are accessed via computer time-sharing services, the microcomputer programmes may be checked for correct operation prior to entering them into the ROM, thereby decreasing the cost and time of programming. A product of the assembler programme is a paper-tape which contains the microcomputer programme as a sequence of machine code instructions. This tape is used in a special machine to programme the ROM automatically.

## Results

Measurements made with the staircase programme may be taken to indicate the performance of the monitor based on this work since it involves appreciable on-site processing of the raw data and produces three quality parameters.

A single read-out from the staircase programme consists of 18 measurements made up of six sets of values $L_n$, $S_n$, $C_n$, where $n$ varies from 0 to 5. On paper tape these values are recorded as 36 words, each word having a length of eight bits.

**TABLE 2**

| Col 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| $n$ | $L_n$ | $S_n$ | $C_n$ | $R_n$ | $A_n$ | $\theta$ | $\theta'$ | $\theta_n$ | $\theta_r$ |
| 0 | 1829 | −8.7 | −184 | — | 204 | +25.3 | 0 | 0 | 0 |
| 1 | 2579 | −176 | +111 | 750 | 208 | −57.8 | −83.1 | +84.4 | +1.3 |
| 2 | 3330 | +121 | +165 | 751 | 205 | +36.2 | +10.9 | −11.2 | −0.3 |
| 3 | 4075 | +153 | −140 | 745 | 207 | −47.5 | −72.8 | +73.2 | +0.4 |
| 4 | 4818 | −155 | −139 | 743 | 208 | +48.1 | +22.8 | −22.4 | +0.4 |
| 5 | 5555 | −124 | +167 | 737 | 208 | −36.6 | −61.9 | +62.1 | +0.2 |

**TABLE 3**

| Col 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| $n$ | $L_n$ | $S_n$ | $C_n$ | $R_n$ | $A_n$ | $\theta$ | $\theta'$ | $\theta_n$ | $\theta_r$ | $\theta_r'$ |
| 0 | 1819 | −162 | +61 | — | 173 | −69.4 | 0 | 0 | 0 | 0 |
| 1 | 2452 | +79 | +153 | 633 | 172 | +27.3 | +96.7 | +84.4 | +181.1 | +1.1 |
| 2 | 3078 | +145 | −93 | 626 | 172 | −57.6 | +11.8 | −11.2 | +0.6 | +0.6 |
| 3 | 3700 | −107 | −137 | 622 | 174 | +38.0 | +107.4 | +73.2 | +180.6 | +0.6 |
| 4 | 4327 | −125 | +120 | 627 | 173 | −46.2 | +23.2 | −22.4 | +0.8 | +0.8 |
| 5 | 4949 | +131 | +112 | 622 | 172 | +49.5 | +118.9 | +62.1 | 181.0 | +1.0 |

A typical set as read off from paper tape and converted to decimal notation is shown in Table 2. In column four of this table are evaluated the relative riser amplitudes, and in columns five and six the chrominance amplitude and phase. After normalizing to the phase at black level and correcting by $\theta_n$ the final phase is shown in column nine.

Non-linearity is given by

$$NL = 100\,\frac{(R_{MAX} - R_{MIN})}{R_{MAX}} \text{ per cent}$$
$$= 1.9\%.$$

Differential gain is given by the largest in magnitude of

$$100\,\frac{(A_n - A_0)}{A_0} \text{ per cent}$$
$$= 2.0\%$$

Differential phase is the largest in magnitude of $\theta_r$

$$= +1.3°.$$

To give an idea of the repeatability of the measurements, results from the same signal measured at a level of −1.5dB are given in Table 3.

These results give

NL = 1.8%
Differential gain = +0.6% or −0.6%
Differential phase = +1.1°.

In evaluating differential phase in this case, an additional correction had to be made in column ten to compensate for the 180° ambiguity in the evaluation of arctangents. This correction is not always necessary but depends on the particular point in the eight-field sequence at which the summations of $S$ and $C$ commence.

Tables 2 and 3 show that the maximum difference in phase at each staircase step between these two sets of measurements is 0.9°, which is typical of results obtained.

Detailed measurements to determine the accuracy of the monitor in the presence of random noise have not been made. However it is expected that the effects of random noise will be reduced in the same manner as quantum noise, and the accuracy will not be significantly impaired for signal-to-random-noise ratios exceeding about 46dB.

## Acknowledgement

This work was carried out whilst the author was employed by the Independent Broadcasting Authority, and the author wishes to thank the Director of Engineering of the Independent Broadcasting Authority for permission to publish this article. The author also wishes to acknowledge the important contribution made by Mr John Moore (formerly of the IBA now of Sumlock Anita Ltd) in producing the original programmes.

## References

1. Savage, D. C. and Carter, D. A. Application of insertion test signals techniques to television chain operation, Proceedings of the Joint Conference on Television Measuring Techniques, May 1970, IERE.
2. Robinson, K. W. and Heinzl, J. J. Measurement of non-linear distortion on the video signal, *Marconi Instrumentation*, May 1972.
3. Shelley, I. J. and Williamson-Noble, G. E. Automatic measurement of insertion test signals, Joint Conference on Television Measuring Techniques, May 1970.
4. Provisional specification EMC-44 for insertion test signal analysis system PM5578, Philips Electrical Ltd.
5. McKenzie, G. A. Experiments with a computer in a television control and monitoring centre, *IBC Conference Publication* No. 68.
6. Vivian, R. H. Some methods of automatic analysis of television test signals, *IBA Technical Review* No. 1, Sept. 1972.
7. "DICE" *IBA Technical Review* No. 3, June 1973.
8. Grove, W. M. A new DC-4000MC sampling 'scope plug in with signal feed through capability, *Hewlett Packard Journal*, April 1964.
9. Schaffer, J. The phase of colour test signals, IBA Internal Report No. 4/70, Oct. 1970.
10. Schaffer, J. Identification of PAL phase sequences, IBA Automation and Control Section Design Note DN/11/71.
11. Weatherburn, C. E. A first course in mathematical statistics, page 27.
12. Schaffer, J. Computer simulation of a television digital noise meter, IBA Technical Memorandum No. 1/73 April 1973.

# Twin voltage stabilized power supply

## A simple high-quality practical design

by J. L. Linsley Hood

The classical series voltage stabilizer system using thermionic valves is shown in Fig. 1, and most transistor operated stabilized supply circuits are simple derivatives of this, of the form shown in Fig. 2. In both cases the h.t. output voltage is varied by altering the setting of $R_1$. Among the snags of this arrangement is the fact that the lowest output voltage at which the stabilized output can be obtained is roughly equal to the reference voltage $V_{ref}$.

If a stable negative reference voltage is available, the circuit can be rearranged as shown in Fig. 3, to give an output variable down to 0V. The performance of the stabilizer arrangement in this circuit has also been upgraded by including a monolithic op. amp. integrated circuit in the control loop, and a conventional "constant current" current limiting circuit has been included in the form of $Tr_3$. With some form of Darlington transistor arrangement as $Tr_1$, this type of circuit forms the basic layout of the bulk of normal stabilizer arrangements.

However, as it stands, this circuit arrangement suffers from three significant drawbacks. These are: (1) the forward bias applied to the series pass transistor, $Tr_1$, cannot be greater than the input-to-output voltage drop less the base-emitter potential(s) of $Tr_1$. Consequently, the value of $R_1$ must be kept fairly low if adequate base bias current is to be provided for $Tr_1$, which lowers the loop gain and increases the quiescent dissipation in $Tr_2$. Also, since at higher currents there will be some ripple on the input supply voltage, the forward minimum voltage drop must in fact be larger than simple calculations would suggest if output ripple is to be avoided; (2) since the operation of the current limit circuit is to "steal" the base current from $Tr_1$, and this current must flow in the output circuit, this sets the lower limit at which the short-circuit output current can be set; (3) under short-circuit conditions, the portion of the stabilizer which provides the high loop gain is removed from useful participation in the operation of the circuit, and in consequence, the output current under these conditions is much less well stabilized than when the circuit is acting as a voltage controlled arrangement.

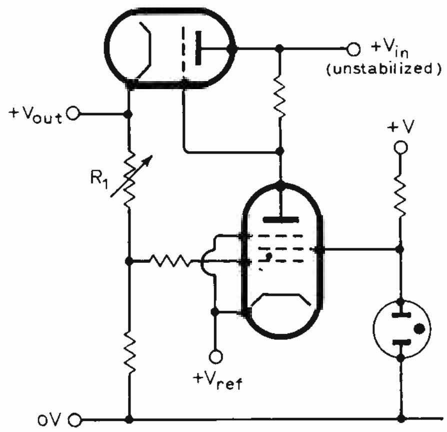



*Fig. 1. Traditional "series" valve voltage stabilizer.*

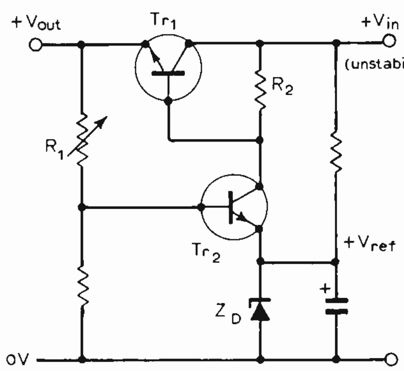



*Fig. 2. Conventional transistor voltage stabilizer circuit derived from Fig. 1.*

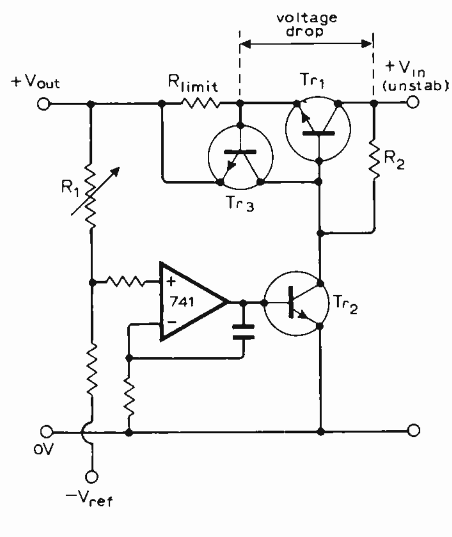



*Fig. 3. Improved transistor stabilized supply with current limiting circuitry and op-amp to increase loop gain.*

These snags can be removed if the circuit is rearranged as shown in Fig. 4. In this the forward bias of the pass transistor $Tr_1$ is obtained from the zero volts line, and is, in consequence, the whole of the input supply potential. Also, the amplifier transistor, $Tr_2$, now is required to pass current only when the load current requires it, and the static dissipation of the device is consequently much less. (The use of the pass transistor in this mode is probably due to Owen[1].) As before, an operational amplifier is used to increase the

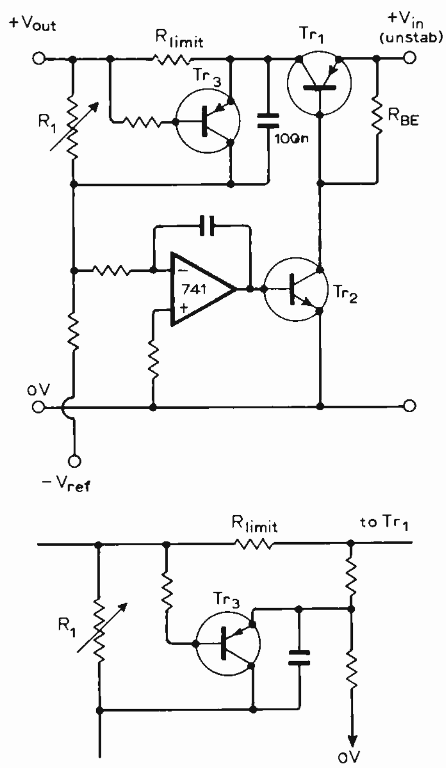



*Fig. 4. Rearranged stabilizing circuit with $Tr_3$ and op-amp inverted. The circuit of $Tr_3$ is rearranged below to give re-entrant current limiting.*

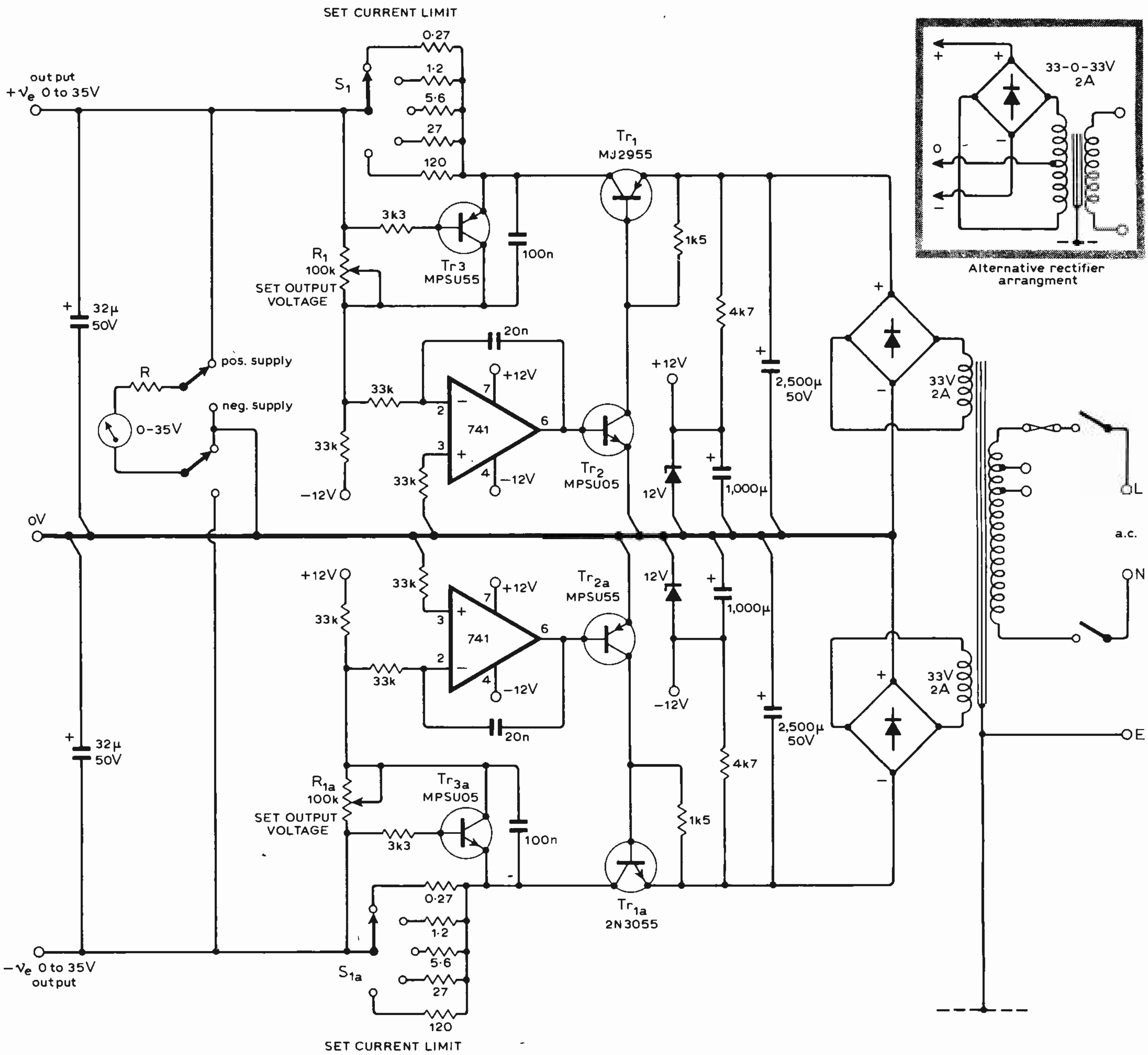



*Fig. 5. Twin stabilized d.c. power supply. Capacitors of 0.1µF may be connected across the transformer secondaries if r.f. modulation hum is found. Switches $S_1$, $S_2$ and the two voltage adjustment potentiometers may be ganged.*

low frequency loop gain, but this time in a shunt feedback mode.

Transistor $Tr_3$ is used to give a "constant current" limiting effect, but this time by effectively bypassing the voltage adjustment potentiometer, and causing the circuit to voltage regulate at a sufficiently lower voltage that the load current reduces to the required limit value. By this means, the voltage regulator circuit is in operation all the time and the output performance is not degraded under "current limit" conditions. The capacitor across $Tr_3$ serves to limit the gain of this device at h.f. and prevent loop oscillation due to the increased circuit gain when this transistor comes into operation.

Because of the very high open loop gain of the 741 at low frequencies, where no negative feedback is applied to it, the d.c. output voltage is extremely stable and shows none of the low frequency "noise" excursions to which simple stabilizer circuits are normally prone. In fact the performance is probably limited mainly by the quality of the negative reference line.

This circuit arrangement has been embodied in a twin output (positive and negative lines (bench stabilized supply, of which the circuit is shown in Fig. 5. Although, in principle, the two supplies could be quite independent, and use identical circuits, because of my interest in audio amplifier circuits which have a split (+ and −) supply, I have chosen the arrangement in which the input (+ and −) supply is used to provide the two 12-volt lines which power the 741s and provide the positive and negative reference rails. For economy in knobs on the front of the box I have also ganged the two voltage adjustment potentiometers and the current limit switches.

The measured performance of the prototype is as follows.

**Output voltage** 0–35 volts, positive and negative
**Output current** 2 amps max
**Load regulation** ≈2 mV. No load to full load
**Output hum, noise and ripple** approx. 150µV, not significantly affected by load
**Limit currents** (nom.) 5mA, 20mA, 100mA, 500mA and 2A

Adequate heat sinks should, of course, be used for the pass transistors $Tr_1$ and $Tr_{1a}$, and the output voltage sensing (the "live" ends of $R_1$ and $R_{1a}$) should be taken from a point as close to the output terminals of the supply as possible. In practice, since the voltage control potentiometer will be mounted on the instrument front panel this is an easy requirement to satisfy. The small value output electrolytics are used to bypass

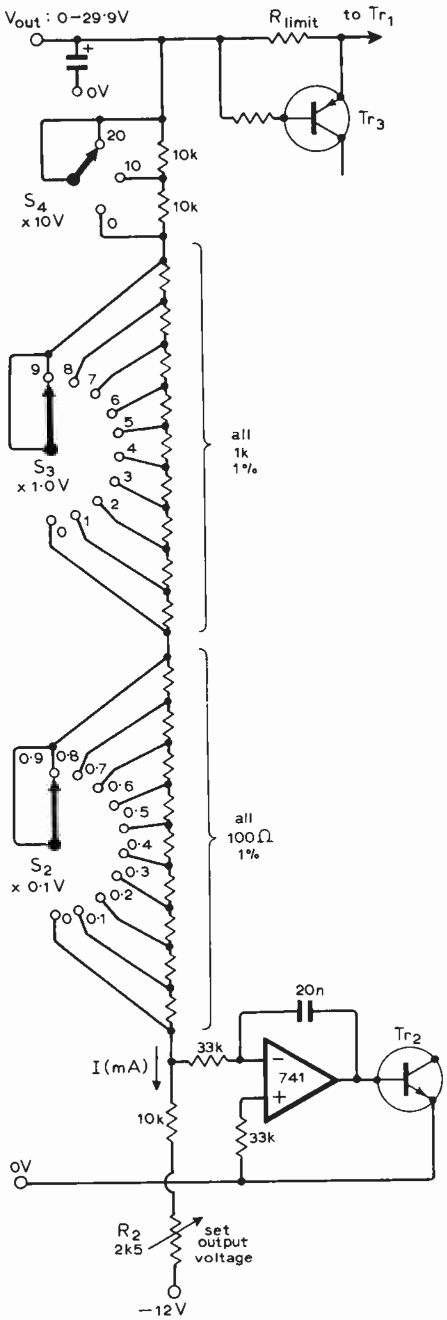



*Fig. 6. Circuit configuration to give precise switched output voltages.*

any h.f. noise and to assist in avoiding loop instability. Their stored energy should not be an embarrassment under short circuit conditions.

An interesting further possibility exists in the case of any supply circuit having a negative reference voltage line, and that is as shown in Fig. 6. If the current drawn from the reference supply is set to be precisely 1mA, by means of the preset $R_2$, the output voltage can be adjusted in 0.1-, 1-, and 10-volt increments by the switches $S_2$, $S_3$ and $S_4$, with the output voltage as accurately set as the precision of the resistors allows.

### Reference

Owen, T. R. E., "Circuit Ideas" *Wireless World*, May 1971, p234.

# Teletext receivers

Engineers are now turning their minds to the design of receivers for Teletext, the unified Ceefax/Oracle system of information display now being experimentally transmitted (November issue, p.441). B. S. Barnaby of GEC and G. O. Crowther of Mullard presented a paper at the International Broadcasting Convention in London on the receiver techniques needed to take advantage of the transmissions, pointing out that the design philosophy that is eventually adopted will have been decided by economic factors, and that if it is not found possible to bring the cost of the extra circuitry down to an acceptable level then Teletext will probably not succeed. They also recognize that large-scale integration will play a vital part in this exercise, though it seems likely that even larger-scale integration, bringing the cost down further still, will have to wait until the system has been accepted before semiconductor companies will feel impelled to spend several million pounds on the development.

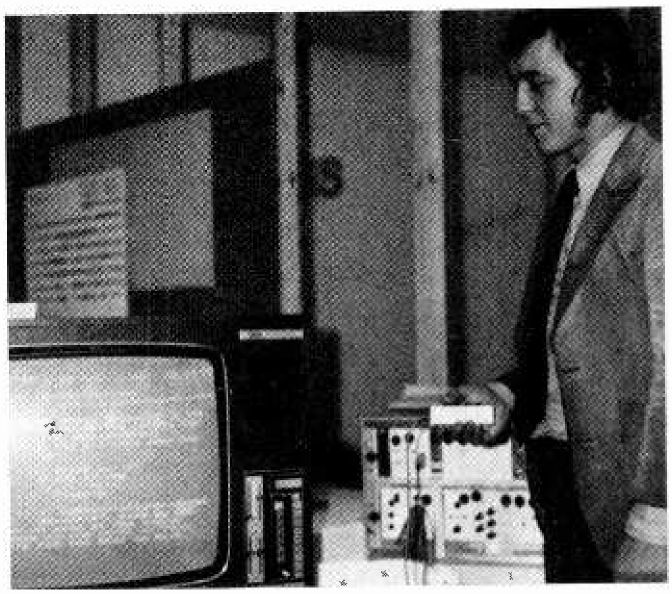
Two possibilities exist: an add-on unit, with a tuner, i.f. and modulator, to feed the aerial socket of a receiver; and a combined television/Teletext receiver. With the former, one is not restricted to the television channel being used; while the latter, though cheaper, is a little restrictive.

The memory part of the circuit is, perhaps, the thorniest problem, and two techniques are considered—the shift-register and RAM, both of the large-scale m.o.s. type. The shift-register is a possibility, even though there is no random access, as transmission and use of the digital information is serial in form, as is shift-register operation. The authors conclude that the RAM offers the best chance of success in both cost and ease of access, although the standard RAM does have binary organization, which is a slight disadvantage. The dynamic type of "refreshed" memory is acceptable with the information flow presented to it.

The data acquisition part of the decoder, which consists of instructions for the display character ROM and address information, will possibly be realized in the t.t.l. family of devices, because the data clock rate—nearly 7MHz—is a little high for m.o.s. techniques. The user, incidentally, will be able to select the required page number by means of either a thumbwheel switch or a calculator-type keyboard. It seems probable that some sort of remote control device (ultrasonic?) would eventually be used.

The display section uses the coded signals to produce the video character signals and the timing. The character-memory, which produces characters in response to the transmitted instructions, is a "read-only" type (ROM), in the m.o.s. technique. Characters are on a 7 × 5 matrix, and the rather restricted character-forming facilities can be improved, at no expense in bandwidth, by using raster interlace to "fill in the corners". Upper- and lower-case characters can be generated, but a lower-cost, upper-case-only ROM gives a slight cost reduction. Timing circuits are in large-scale m.o.s. modules.

The test transmissions are to last two years, and one hopes that manufacturers will have the next generation of l.s.i. circuits well considered before the end of this period, because the smaller-scale devices now available could lead to an overall decoder cost of up to £150, depending on whether "combined" receivers or add-on units are used.



*The BBC "Ceefax" information display system was publicly demonstrated for the first time on our Audio Fair stand. A* Wireless World *staff member, Mike Sagin, demonstrates the equipment: the decoder can be seen in the centre. This is a BBC laboratory prototype—much larger than a commercial unit will be.*

# World of Amateur Radio

## Oscar 7 up and working

The seventh amateur-radio space satellite, Oscar 7, was successfully launched into orbit on November 15, exactly 25 months after the launching of Oscar 6 which is still functioning, although to a restricted timetable. The new satellite—by far the most ambitious of the series—carries two linear repeaters: one (built in West Germany) that accepts signals on 432.125 to 432.175MHz and retransmits them on 145.975 to 145.925MHz; the other provides a similar service to Oscar 6, accepting signals in the 144MHz band and re-transmitting them on 29.4 to 29.5MHz. The two transposers operate on alternate days. The anticipated 2304MHz beacon could not be carried (apparently it proved impossible for the Americans to obtain permission to use this frequency in space) but it carries beacons on 29.50, 145.98 and 435.10MHz. A feature of the new satellite is the use of circularly-polarized aerials for 144 and 432MHz. The orbit is very similar to that of Oscar 6 (sun synchronous).

## The president from Wales

When, on January 17 at Cardiff Castle, Cyril Parsons, GW8NP, formally takes over the insignia of president of the Radio Society of Great Britain he not only makes history as the first person with a "GW" (Wales) callsign to hold this office but is likely to find that, figuratively at least, the chain is not growing any lighter. For amateur radio, both in the UK and in many other parts of the world, is going through a period of uneasy change at a time when rapid inflation is undoubtedly pressing hard on many long-established societies. Although financially the RSGB has had two good years, undoubtedly costs are rising at a pace that is difficult to match with subscriptions; like many London-based societies there are persistent suggestions that a move to the provinces might reduce running costs. Again, amateur radio itself is increasingly subject to pressure to expand by making it ever easier to become an operator, yet experience has shown that where licences are easy to obtain they are valued less and tend to result in a form of Citizens Band approach to the hobby.

But in Cyril Parsons the national society will have as president someone who while clearly accepting that the hobby must be ready to change, does so from the viewpoint of one with a knowledge of experimental radio stretching back more than 50 years to the time when at the age of 14 he obtained (through a guardian as was then necessary) an "Experimental Receiving Licence" and soon progressed from a crystal receiver with loose-coupled aerial to a more sophisticated three-valve receiver using French R valves. By the end of the twenties an early interest in high-quality reproduction was reflected in constructing experimental moving-coil loudspeakers that did away with the need for an output transformer by winding 4000-ohm speech coils (centre-tapped) and with a machined steel pot wound with wire capable of taking the necessary two amps to excite the gap.

Then, after an interval in which motorcycles and hydroplane racing played a part, Cyril Parsons came back to radio experimentation in 1934 with the call 2BPN, becoming GW8NP in February 1937. He was one of the considerable number of pre-war amateurs who joined the RAF Civilian Wireless Reserve in 1938 and was mobilised just before the outbreak of war in September 1939. He served as a Staff Signals Officer, retaining his interest in the Air Force for more than ten years after the war in the Royal Auxiliary Air Force with such units as No 3615 Fighter Control Radar, finally stepping down with the rank of Hon. Wing Commander and the Air Efficiency Award and Bar. From 1946 he was also again very active in amateur radio.

Cyril Parsons takes office at a time when there are a record number of over 20,000 licensed amateurs in the UK but with mode and band rivalries hardening and signs of differences of opinion between those with Class A and Class B licences. While by European standards the numbers here are large, there are today over 400,000 amateurs (about three-quarters of them in code-free categories) in Japan with an average age of 22 years. In the United States there are some 250,000 licensed operators (about 180,000 'active' stations) but with a growing belief that the FCC is shortly to introduce a new structure giving more facilities to code-free categories, including operating rights above 29MHz. American amateurs are still puzzled at the recent unexpected decision of FCC to waive logging requirements.

A difficult maze for the new president to find his way through.

## Commonwealth microwave record?

Murray Willis, ZL2THW, and Neil Lambert, ZL2TGC, established on August 12, 1974 a New Zealand record for 3.3GHz of 144 miles. This is 46 miles better than the current UK band record and may well be a Commonwealth record. Equipment at both ends was a CV237 feeding a 3ft dish aerial and using f.m. (transmitter power 60mW) with signals "59" both ways.

From New Zealand's *Break-in* also comes news that a 28.17 MHz beacon station (ZL2MHF) is being installed by the very active Upper Hutt branch of NZART on Mount Climie. This follows an approach some time ago by the RSGB enquiring whether a ten-metre beacon could be installed in New Zealand to help propagation studies. There are over 20 v.h.f. beacons in Region 3.

## Amateur television

The experiment of holding the 1974 British Amateur Television Club's convention at Rugby was a qualified success, with some disappointment in the attendance of about 100 members for what was a most interesting day. Among the demonstrations were those of the BATC "outside-broadcast" vehicle "Monoculus", microwave and fibre optic experimental equipment, low-definition television and slow-scan television. Bob Roberts, G6NR, continues at president with Don Reid taking over as chairman from Malcolm Sparrow.

An experimental, low-definition, mechanical television system by D. C. Hodges, G6MXY/T, uses 30 lines at the high rate of 50 pictures/second (to allow the use of standard monitors) based on a Nipkow disc running at 3000rpm.

## In brief

Almost 6,000 people attended the 1974 ARRA amateur radio exhibition at the Granby Halls, Leicester . . . The RSGB Education Committee is presenting one of the Christmas holiday lecture demonstrations at the Science Museum. This will be at 11am and 3pm on Saturday, January 4. Ticket applications to J. D. Freeborn, Lecture Service, Science Museum, South Kensington, London SW7 2DD . . . During the period May 16 to October 10 the Australian amateur VK3CZ heard on 1.8MHz a number of North and South American amateurs but the only European amateur heard was the Czech station OK1DOK (August 6) although the German commercial station DHJ (commonly used as a Top Band "DX beacon") was heard on many occasions . . . The March and District Amateur Radio Society emerged as overall winner of the 1974 VHF National Field Day. This was held under extremely bad weather conditions but nevertheless attracted 115 entries for operation on 70, 144, 432 and 1296MHz. Runners-up were Southampton RSGB Group . . . M. Hawkins of Chelmsford won the 1974 Direction Finding Contest as the first to locate three 1.8MHz hidden transmitters . . . The RSGB affiliated societies contest is being held on January 11 to 12 (a changed date) . . . Quote from Don Keith, WA4BDW: "So long as we depend on the publicly-owned frequencies for amateur radio's very existence we had better make sure the public knows who we are and what we do."

PAT HAWKER, G3VA

# New Products

## Mini oscilloscope

A miniature battery/mains-powered oscilloscope, the A1010, measures only 5.5 × 13.5 × 19cm. The *y* amplifier has a 10MHz bandwidth, a 10mV/division sensitivity and the pre-amp stage can be isolated for use in conjunction with the external sweep input. The input attenuator is switched to give × 1, × 10 and × 100 with a maximum input of 350V a.c./d.c. The timebase is continuously variable on each of three switched ranges from 1μs to 1s/division. Built-in batteries provide four hours' operation before recharging is necessary, which takes place automatically when the instrument is powered from external 240/110V a.c. or 12V d.c. supplies. Lawtronics Ltd, 139 High Street, Edenbridge, Kent TN8 5AX.
**WW313 for further details**

## Sweep generator

The model 7271 linear/logarithmic sweep generator offers sine, square, triangle, pulse and ramp waveforms over the range 0.0001Hz to 20MHz. The sweep width is set by two controls—one for start frequency and the other for stop, over a three-decade range. The internal sweep generator, having a range of sweep times from 1000s to 100ns, may be triggered manually or externally. The pulse generator has variable pulse width and repetition rate which can be set independently. Several choices of d.c. offset, for vertical positioning of the waveform, are offered as well as a voltage-controlled offset for remote control. Dana Electronics Ltd, Collingdon Street, Luton, Beds.
**WW306 for further details**

## Optical transmission system

A fibre-optic data transmission system comprising an emitter, lightguide, and receiver is capable of transmitting a 16-bit digital word or one analogue signal with a 12-bit accuracy. With an additional multiplexer, 16 analogue signals may be transmitted at the same accuracy. Plug-in p.c. cards are also available to expand the transmission capacity in steps of 32 bits up to a maximum of 320 bits. The system, which is noise immune, can operate over distances up to 100 metres. Triskelion AG, Leimatt 1, 6317-Oberwil/ZG, Switzerland.
**WW305 for further details**

## Function generator

The latest function generator from the Heath/Schlumberger range of assembled instruments is the SG-1271. The instrument will provide sine, square, or triangle waveforms over the frequency range 0.1Hz to 1MHz. Frequency selection is by means of six variable ranges. The output delivers a 10V peak-to-peak signal into a 50 ohm load. A calibrated step attenuator adjusts from 0 to 50dB in 10dB steps with a variable attenuator providing up to 20dB attenuation in each step. Frequency accuracy for the generator is ± 3% with waveform symmetry within 10%. Heath (Gloucester) Ltd, Bristol Road, Gloucester, GL2 6EE.
**WW302 for further details**

## Static-protection aids

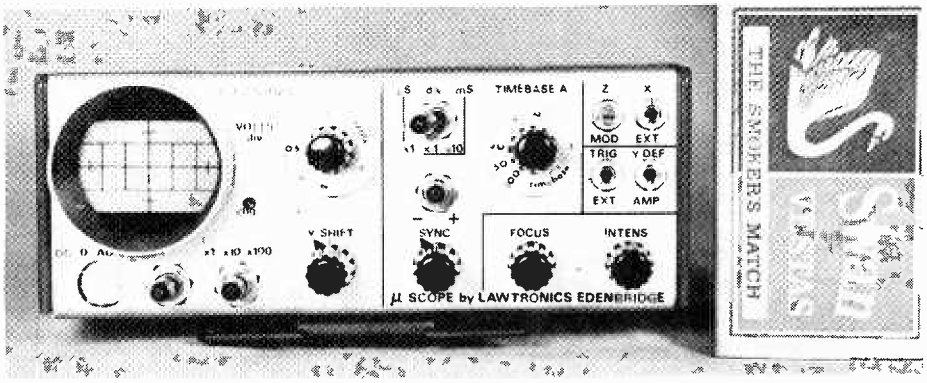
A range of materials and accessories for the handling of devices sensitive to electrostatic-discharge damage is available from Semicomps Ltd. The range, which is constructed from electrically conductive material, includes items such as aprons, wrist straps, shoes and stool covers. The material is also available in 4ft × 8ft sheet form for bench tops and foam sheets for shorting component leads. Semicomps Ltd, Northfield Industrial Estate, Beresford Avenue, Wembley, Middx.
**WW303 for further details**

## Pushbutton potentiometer

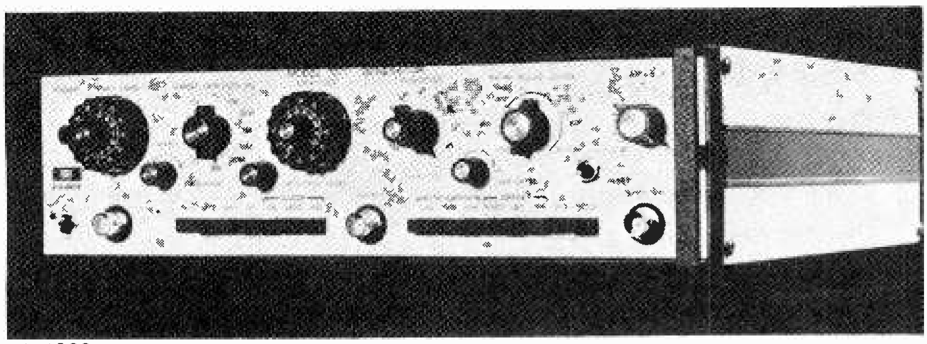
A potentiometer, known as the 3680 knobpot, combines an incremental decade resistance-element with a digital display and pushbutton section in one package. Ratings for the device are a temperature coefficient of 100 p.p.m./°C, resistance tolerance of ± 1.0%, resolution of ± 0.1% and a power rating of 2W. Bourns Trimpot Ltd, Hodford House, 17/27 High Street, Hounslow, Middx.
**WW307 for further details**

## Surge suppressor

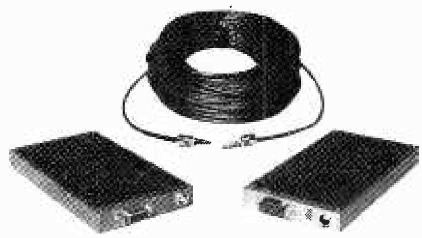
A voltage-dependent resistor has been developed by Mullard for the suppression of mains-borne transients. The resistor, type 2322 594 53912, is made from zinc-oxide and has a higher degree of non-linearity than the usual silicon-carbide-based components. Whereas the current through silicon-carbide components is proportional to the fifth power of the applied voltage, this figure becomes the



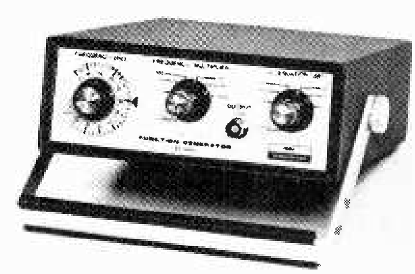

WW313



WW300



WW305



WW302

35th power for zinc-oxide types. In normal operating conditions with a 240V a.c. supply the zinc-oxide v.d.r. dissipates a few milliwatts, an increasing voltage causes a rapidly falling resistance to effectively short circuit the transient. Under surge conditions the v.d.r. can pass currents of 100A. Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD.
**WW301 for further details**

## Multiplying oscilloscope

In addition to a full range of facilities, the Philips PM3265 dual-trace oscilloscope possesses a multiplying mode in which signals from both amplifiers are multiplied and displayed on one trace, the other displaying one of the original signals. The multiplying bandwidth is 100MHz, which means that power products in high-speed logic circuitry can be displayed. Bandwidth of the *y* amplifiers is 150MHz at 5mV per cm and operating modes are A, B, chopped, alternate, added or multiplied. The horizontal deflection is by a delayed time-base, the delaying and delayed sweeps appearing apparently together, although, in fact, on alternate sweeps. Triggering, in a variety of modes, is workable with a signal up to 300MHz. A 8×10cm screen is provided, the 20kV accelerating potential making for a bright, sharp trace, which is stable with variations in beam current. Pye Unicam Ltd, York Street, Cambridge CB1 2PX.
**WW315 for further details**

## Instrument modules

A recently introduced instrument module system from Metrowatt comprises basic frame sizes ranging from volumes of 300 c.c. up to housings of 3500 or 10,000 c.c. Most of the frames are divided into two subframes. The upper frame accepts the display movement and offers a variety of control layouts. There is also a choice of lower frames for various battery sizes and types. Blank circuit cards are available for all frame sizes together with ancillary components such as battery connectors, jacks and safety switches. Metrowatt UK Ltd, York House, Stevenage Road, Hitchin, Herts SG4 9DY.
**WW308 for further details**

## Peak-reading voltmeter

The Semikron peak-reading storage voltmeter will read the maximum transient voltages on a line in any given period. The transients to be measured are selectable by filters for duration and amplitude. The instrument has six voltage ranges from 30 to 10,000V and an input impedance of 10MΩ. A minimum pulse width is selectable from 1, 10 or 100μs and a selectable storage time from 1 to 20s and infinity. The voltmeter is mains or battery powered with an automatic-charge circuit for the latter. An automatic reset facility is provided, so that if the meter is connected to a suitable recorder the voltmeter will give a history of supply variations. Semikron UK Ltd, Brewhouse Lane, Hertford.
**WW312 for further details**

## Optical tachometer

Using the Power Instruments optical tachometer it is possible to take measurements up to two feet away from a revolving mechanism. The instrument uses the principle of a collimated beam and a high-speed response phototransistor. A small piece of reflective tape is attached to the rotating component, and the instrument receives only its own light to provide a reading. The instrument is self-calibrating from any fluorescent light operating from 50 or 60Hz. Four ranges, from 0 to 30,000 r.p.m., are provided on the tachometer which has a claimed accuracy of $1\frac{1}{2}$% of f.s.d. The instrument is battery powered and measures approximately $5 \times 7\frac{1}{2} \times 2\frac{1}{2}$in with a 24in probe cable. Electronic Brokers Ltd, 49/53 Pancras Road, London NW1.
**WW300 for further details**

## Moisture-proof switch

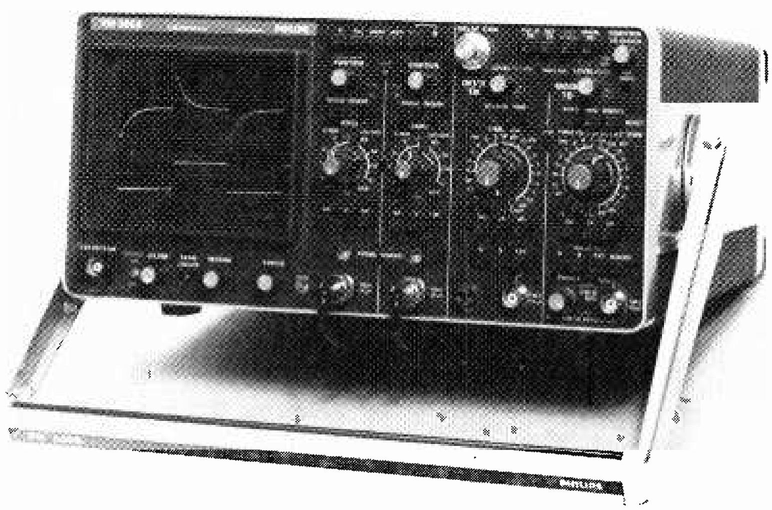
A moisture-proof switch called the E7240A, is rated at 10.1A, 186W, 115/250V a.c., and is claimed to operate immersed in water. The switch measures approximately $1 \times \frac{7}{8} \times \frac{1}{3}$in with 10in, 14-gauge leads. The one-off price is £0.60 from Cherry Electrical Products UK Ltd, Lattimore Road, St Albans, Herts.
**WW309 for further details**

## Frequency-to-voltage converter

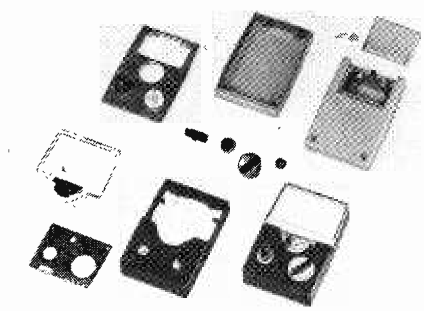
Teledyne Philbrick have introduced a 10kHz frequency-to-voltage converter. The device, which is known as the 4714, has a 1mV to 10V output directly proportional to a 1Hz to 10kHz input frequency. A non-linearity of 0.08% of f.s. in four decade ranges is claimed for the device which is priced at £19.75 one off, from Teledyne Philbrick, Heathrow House, Bath Road, Cranford, Hounslow, Middx.
**WW310 for further details**

## Miniature power supply

A d.c. power supply in a d.i.l. package provides outputs of 5 or 12V at 1W. The total volume of the package, which fits into a standard i.c. socket, is 0.3 cubic in. Isolation is provided and the source is short-circuit proof with an automatic reset. TI Supply, 165 Bath Road, Slough, Bucks SL1 4AD.
**WW311 for further details**



WW315



WW308


WW312

# Audio fair new products

## Three-head cassette deck

Teac showed an unexpected new model of a three-head cassette tape deck at the Audio Fair. Designated the A-850 this machine is placed upright, thus occupying only the depth of a shelf. Three d.c. motors provide forward drive and fast wind functions via logic-controlled solenoid operation. In common with Sony and Nakamichi, dual capstans are used to improve control of the tape across the heads. Dolby noise reduction is included and calibration controls and a built-in test oscillator provide the flexibility to get the best out of all tapes. Separate three-position bias and equalization switches, a peak-reading facility for the VU meters and full microphone/line mixing are included among the facilities. Price will be about £400. Acoustico Enterprises Ltd, Unit 7, Space Waye, North Feltham Trading Estate, Feltham, Middlesex TW14 0TZ.

**WW327 for further details**

## Omal loudspeaker

The Omal TL6 "monitor" loudspeaker is designed to leave the listener with many options as to the kind of loudspeaker used. Using five drive units, with mid-range and h.f. units in both the front and rear, it is possible to operate in the forward-radiating mode or in the "omnidirectional" mode by adjustment of the level controls.

In the bass region there is a choice of mode brought about by mechanically operated flaps which alter the loading of the bass unit, from a quarter-wave design to either a distributed port or damped labyrinth.

Crossover frequencies are 400Hz and 5kHz using 12 and 18dB/octave slopes. Mid- and high-frequency unit controls are switched with constant-resistance and Zobel impedance correction networks. Sensitivity in the direct mode, all controls set level, is quoted as 80dBA/watt. Distortion is claimed to be less than 1% above 65Hz for 90dB s.p.l. (at 1kHz). Maximum amplifier rating should be 20 watts (into 8Ω) and maximum power handling figure is 50 watts. Ambionic Sound Reproducers Ltd, Omal House, North Circular Road, London NW10 7UF.

**WW320 for further details**

## Belt-drive turntable

With much of the emphasis on direct-drive turntables at the top end of the market, it is unusual to see a competitive new belt-drive turntable. Sansui showed such a product, the SR-313, and claim that it can out-perform many types of direct-drive units. Complete with tone-arm, the SC-38 induced magnet cartridge, plinth and cover, the unit offers the following manufacturer's specification. Signal-to-noise ratios: >50dB, frequency response: 20Hz–20kHz, ±3dB, wow and flutter: <0.06% w.r.m.s. Approximate price is £142.86 plus v.a.t. Vernitron Ltd, Thornhill, Southampton.

**WW323 for further details**

## Professional CD-4 demodulator

A new high-performance CD-4 demodulator for professional use was demonstrated by JVC. Designated CD4-1000, it features lower distortion and improved signal-to-noise than the consumer model. The carrier-channel circuitry has been improved by use of a "crosstalk-cancelling" circuit; the a.n.r.s. circuit has been upgraded to the standard of the recording circuit. Two switched filters are included—one giving a 3dB loss at 18Hz, the other giving a 6dB loss at 10kHz, with a slope of 6dB/octave. Harmonic distortion quoted for the baseband channels is 0.03% (1kHz). No distortion figures are issued for the carrier channels. Baseband amplitude frequency response can extend to 20kHz (−3dB). Victor Company of Japan Ltd, 1, 4-chome, Nihonbashi-Honcho, Chuo-ku, Tokyo 103.

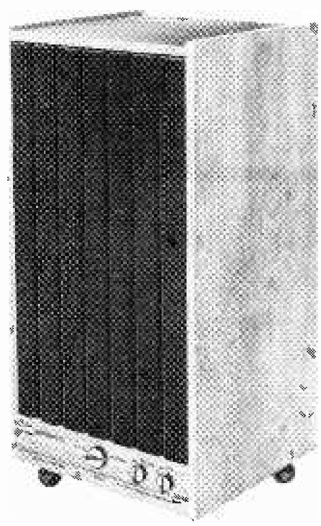
**WW324 for further details**

## Dolby cartridge recorder

The 3M Company made quite a showing with a new range of equipment selected from the American Wollensak range. The first is an eight-track cartridge recorder, designated the Wollensak 8075 and is unique in as much as it is the first Dolby cartridge machine to be marketed in the UK.

In addition, a cassette deck based on the well-known Wollensak mechanism was shown, the model 4766. Again, this machine has Dolby noise reduction, plus a claimed wow and flutter of 0.07% w.r.m.s., twin VU meters and peak overload indicators. 3M United Kingdom Ltd, 3M House, Wigmore Street, London W1A 1ET.

**WW321 for further details (8075)**
**WW322 for further details (4766)**



WW320

WW327

WW323

## Mini loudspeaker

An interesting design produced by Technics is the SB30 loudspeaker system. This consists of one full-range 9cm loudspeaker mounted in a closed cabinet measuring only 10.3 × 18.1 × 12.7cm. Maximum input power to the nominal 8Ω unit is 20W and 1W will produce 86dB at a distance of 1m on axis. The weight of each speaker is 1.5kg and the claimed frequency range is 50Hz to 20kHz, no limits being specified, however. Price is £15 each plus v.a.t. National Panasonic (UK) Ltd, 107–109 Whitby Road, Slough, Berks, SL1 3DR.
**WW328 for further details**

## New valve amplifiers

One of the most surprising new products at Olympia was the Lux MQ-80 valve stereo power amplifier from Lux (perhaps not so surprising on reflection). A twin triode tube 6336A is used per channel at the output stage in a push-pull circuit. The output transformer in each output has bifilar windings to ensure maximum coupling with no leakage inductance. The transformer design also permits a claimed frequency response extending up to 200kHz. Main specifications are: Power output: 40W (8Ω, each channel, both driven); t.h.d.: below 0.5%; frequency response: 10Hz to 60kHz (−1dB); damping factor: 15 (8Ω load); residual noise: below 0.5mW. Price £398 plus v.a.t.

Associated with this power amplifier is the Lux 35/II valve pre-amplifier (£298+ v.a.t.). Howland West Ltd, 3–5 Eden Grove, London N7 8EQ.
(Howland West state that they do not keep these models as stock items but will order on request.)
**WW329 for further details**

## Calibration cartridge

Wilmex, distributors of Stanton cartridges, showed the model 681 EEE which is claimed to represent a "state of the art" standard in magnetic cartridges. The stylus tip is a low mass (two-thirds the mass of its predecessor) nude diamond, 0.2 × 0.7 mil elliptical type. Frequency response: 10Hz–12kHz, ±0.5dB, overall, 10Hz–22kHz. Nominal output for 5cm/s recorded velocity: 3.5mV ± 2dB, channel separation: 35dB, tracking force: 0.75–1.5g, total cartridge mass: 5.5g. Wilmex Ltd, Import Division, Compton House, New Malden, Surrey KT3 4DE.
**WW326 for further details**

## New Brahms speaker systems

An enclosure added to the Brahms range of loudspeakers is the SAL 3000, a design which incorporates an 8in bass unit with an aluminium voice coil and rubber-roll suspension. It has a one-inch dome high-frequency unit mounted in a cabinet which measures 48 × 27 × 25cm. Power handling is rated at 30W and nominal impedance is 4–8Ω. Each cabinet weighs 9.5kg and teak or walnut is the choice of cabinet finishes. The manufacturers claim a good stereo image and a flat response to 22kHz. Price is £29.50 each plus v.a.t.

The new Windsor loudspeaker system also has two units but the bass unit is a 10in neoprene doped cone mounted in a larger cabinet measuring 61 × 33 × 28cm. Finishes are also similar and the price £34 each plus v.a.t. Brahms also had a new range of German loudspeakers manufactured by Schilling on view at Olympia, which is due for release during January. These are similar in operating principle to the Sonab surround sound loudspeakers and the range consists of four models which range in price from £31.93 to £95.81 plus v.a.t. Brahms Manufacturing and Development Co, Unit E, Rochester Airport, Maidstone Road, Rochester, Kent ME1 3QJ.
**WW325 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.**

## Switching power-transistors

Three new series of switching transistors from Sescosem are constructed using the triple-diffused technology and have ratings for $V_{CEO\ (sus)}$ from 90 to 500V at maximum collector currents from 15A to 30A.
**WW350 for further details** Sescosem

## Quad opto-isolator

The 1LQ74 is a quad opto-isolator in a 16-pin d.i.l. package. Each channel has a typical isolation resistance of 100MΩ and a minimum breakdown voltage of 1500V. The coupler costs £2.87 for one-off and £1.65 for 1,000-off quantities.
**WW351 for further details** Jermyn

## 80V op-amp

An op-amp designated the HA2-2645-5 is capable of operating from ±40V power rails. The device, which incorporates an output current limiter, will deliver an output swing of up to ±35V at ±10mA with a bandwidth of 4MHz. Offset voltage is typically 2mV and offset voltage drift is typically 15μV/°C. The op-amp costs £2.65 in 100+ quantities.
**WW352 for further details** Memec

## Step-recovery diodes

The 5082-0800 series of step-recovery diodes has been designed for use in high- and low-order harmonic generators. The diodes have typical outputs of 0.3W from 10 to 20GHz and 6W from 3 to 5GHz. Junction capacitance for the two ranges is 0.1pF minimum and 3.5pF maximum respectively. Transition times range from 50ps to 250ps.
**WW353 for further details Hewlett Packard**

## Buffer register

The AMI S1709 buffer register contains 13 parallel-in/parallel-out shift registers plus the control logic necessary to achieve a first-in/first-out memory configuration. External control signals allow cascading of several register arrays and the device may operate with independent input and output data rates. The S1709 is supplied in a 24-pin d.i.l. package and costs £8.69 for 100+ quantities.
**WW354 for further details GDS**

## Liquid-crystal driver

A b.c.d.-to-seven segment latch/decoder/driver called the MC14543 is designed for use with liquid-crystal readouts. The device is constructed using c.m.o.s. and offers direct l.e.d. driving capability, latch storage of code and readout blanking on all unpermitted combinations.
**WW355 for further details Lock**

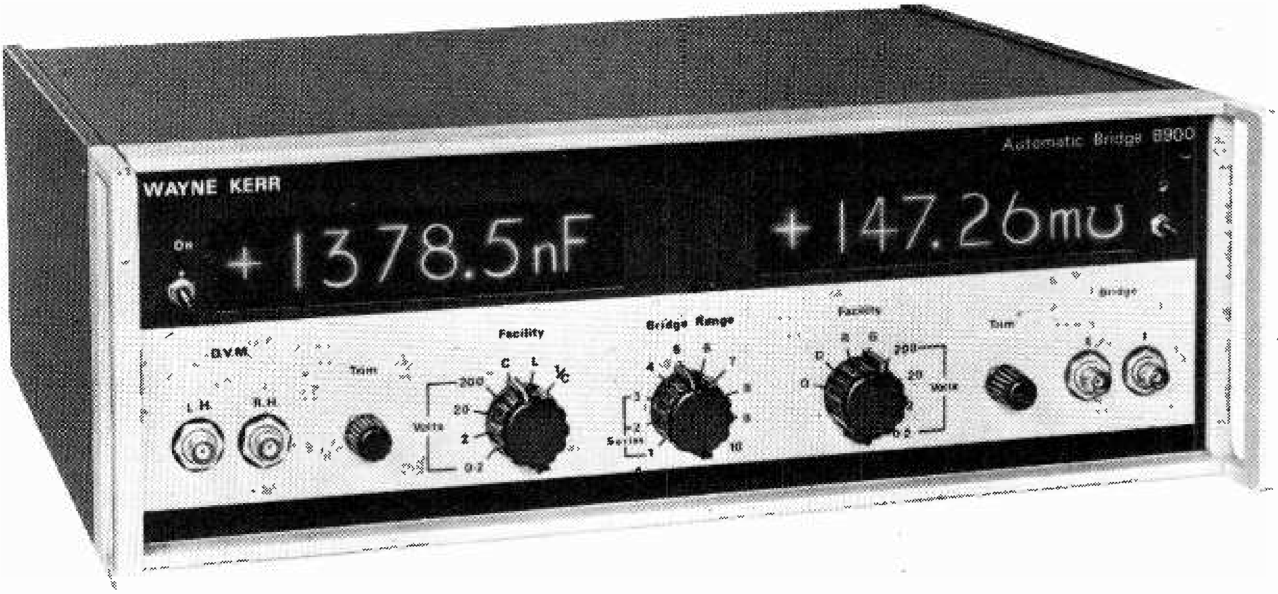
## Suppliers

**Hewlett-Packard Ltd**, 224 Bath Road, Slough, Berks SL1 4DS.
**GDS (Sales) Ltd**, Michaelmas House, Salt Hill, Bath Road, Slough, Berks.
**Lock Distribution**, Neville Street, Middleton Road, Oldham, Lancs OL9 6LF.
**Memec Ltd**, The Firs, Whitchurch, Aylesbury, Bucks.
**Jermyn Distribution**, Sevenoaks, Kent.
**Sescosem**, 50 rue Jean Pierre, Timbaud, BP120, 92403 Coubevoie, France.

## Semiconductor service

Amateur constructors and servicing technicians can now obtain small quantities of semiconductor devices at manufacturers' list prices from the distributor Semicomps through a new service started by its subsidiary SCS Components. The range available includes all discrete and integrated semiconductors from Mullard, Motorola, Signetics, General Instrument (Microelectronics), G.I. (UK), Ferranti, RCA, Monsanto, and Mostek. Data sheets are free on request. Passive components from Mullard, Seatronics and Centralab will be added to the range later. A catalogue is available free. SCS Components is at 5c Northfield Industrial Estate, Beresford Avenue, Wembley, Middlesex, HA0 1SD, telephone 01-903 3168.

# New automatic digital bridge from Wayne Kerr

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WW—129 FOR FURTHER DETAILS

## TTL 74 SERIES INTEGRATED CIRCUITS

| | | | | | |
|---|---|---|---|---|---|
| 7400 | 14p | 7432 | 37p | 7486 | 41p |
| 7401 | 16p | 7437 | 37p | 7489 | 340p |
| 7402 | 16p | 7440 | 20p | 7490 | 52p |
| 7403 | 22p | 7441 | 75p | 7492 | 68p |
| 7404 | 18p | 7442 | 70p | 7493 | 55p |
| 7405 | 25p | 7445 | 216p | 74100 | 200p |
| 7406 | 42p | 7447 | 95p | 74107 | 45p |
| 7407 | 42p | 7448 | 120p | 74121 | 34p |
| 7408 | 20p | 7450 | 20p | 74122 | 76p |
| 7409 | 28p | 7451 | 20p | 74141 | 85p |
| 7410 | 16p | 7460 | 20p | 74142 | 280p |
| 7412 | 30p | 7470 | 30p | 74145 | 150p |
| 7413 | 28p | 7472 | 30p | 74160 | 160p |
| 7414 | 90p | 7473 | 36p | 74161 | 160p |
| 7416 | 33p | 7474 | 34p | 74184 | 225p |
| 7417 | 36p | 7475 | 52p | 74185 | 225p |
| 7420 | 16p | 7476 | 37p | 74190 | 220p |
| 7422 | 25p | 7480 | 65p | 74191 | 220p |
| 7425 | 37p | 7482 | 87p | 74192 | 220p |
| 7427 | 37p | 7483 | 120p | 74193 | 220p |
| 7430 | 16p | 7485 | 187p | | |

## LINEAR ICs

| | | |
|---|---|---|
| CA3046 | Transistor Array | 55p |
| LM301 | Op. Amp. with external compensation | 40p |
| LM307 | Op. Amp. with internal compensation | 50p |
| MFC6040 | Electronic Attenuator | 90p |
| MFC8070 | Zero Voltage Switch | 161p |
| NE536 | FET Op. Amp. | 192p |
| NE555 | Timer 2µS to 2 hours | 55p |
| NE556 | Dual 555 Timer | 120p |
| NE560 | High Phase Locked Loop | 290p |
| NE562 | High Phase Locked Loop with AM Demod | 290p |
| NE562 | High Phase Locked Loop with Vco | 290p |
| NE565 | Precision Phase Locked Loop | 290p |
| NE566 | Function Generator | 200p |
| NE567 | Tone Decoder | 250p |
| 709 | Op. Am. with external compensation | 26p |
| 710 | Differential Voltage Comparator | 47p |
| 741 | Op. Am. with internal compensation | 28p |
| 747 | Dual 741 | 70p |
| 748 | Op. Amp. with external compensation | 38p |
| ICL8038 | Voltage-Controlled Oscillator | 290p |

## BRIDGE RECTIFIERS

| | 50V | 100V | 400V | 600V |
|---|---|---|---|---|
| 250mA | 16p | — | — | — |
| 1 Amp | 20p | 21p | 24p | 25p |
| 2 Amp | 30p | 35p | 45p | 48p |
| 4 Amp | 47p | 48p | 60p | 70p |
| 6 Amp | 55p | 60p | 78p | 98p |

## SCR—THYRISTORS

| | 50V | 100V | 400V | 600V |
|---|---|---|---|---|
| 1 Amp | 42p | 48p | 60p | 78p |
| 3 Amp | 43p | 49p | 78p | 100p |
| 7 Amp | — | 80p | 84p | 115p |
| 16 Amp | — | 82p | 98p | — |

Other
C106D 45p. 2N3525 91p. 2N4444 185p.

## TRIACS

| | 100V | 400V | 500V |
|---|---|---|---|
| 3 Amp | 85p | 99p | 120p |
| 6 Amp | 88p | 120p | 150p |
| 10 Amp | 109p | 154p | 185p |
| 16 Amp | 145p | 180p | 200p |

Other
40430 90p. 40486 75p.
40669 95p.
DIAC ST2. For use with above triacs 21p.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AC125 | 11p | BC136 | 17p | BD131 | 40p | BFX88 | 24p | OC74 | 30p | 2N1304/5 | 21p | 2N4058 | 15p |
| AC126 | 11p | BC137 | 17p | BD132 | 45p | BFY50 | 14p | OC81 | 12p | 2N1306/7 | 28p | 2N4059 | 10p |
| AC127 | 11p | BC138 | 17p | BD153 | 65p | BFY51 | 14p | OC82 | 12p | 2N1308/9 | 28p | 2N4060 | 13p |
| AC128 | 11p | BC142 | 35p | BD156 | 60p | BFY52 | 14p | OC83 | 18p | 2N1613 | 20p | 40360 | 35p |
| AC141 | 18p | BC143 | 35p | BDY60 | 75p | BSX19 | 16p | OC84 | 18p | 2N1711 | 20p | 40361 | 38p |
| AC142 | 18p | BC147 | 7p | BDY61 | 65p | BSX20 | 16p | OC200 | 50p | 2N2218 | 21p | 40362 | 38p |
| AC176 | 11p | BC148 | 7p | BF115 | 22p | BSX21 | 22p | OC201 | 50p | 2N2219 | 20p | 40409 | 50p |
| AC187 | 12p | BC149C | 8p | BF167 | 23p | BU105 | 220p | TIP41A | 70p | 2N2220 | 19p | 40410 | 50p |
| AC188 | 11p | BC157 | 14p | BF170 | 23p | MJ490 | 95p | TIP42A | 88p | 2N2221 | 20p | 40411 | 200p |
| AD140 | 48p | BC158 | 12p | BF173 | 25p | MJ491 | 136p | ZTX107 | 12p | 2N2222 | 20p | 40594 | 65p |
| AD142 | 55p | BC159 | 14p | BF177 | 28p | MJE340 | 45p | ZTX108 | 10p | 2N2369 | 14p | 40595 | 75p |
| AD143 | 50p | BC169C | 12p | BF178 | 28p | MJE370 | 72p | ZTX109 | 13p | 2N2484 | 30p | 40600 | 69p |
| AD149 | 43p | BC171 | 12p | BF179 | 33p | MJE371 | 84p | ZTX300 | 14p | 2N2904 | 20p | FETs | |
| AD161 | 36p | BC177 | 18p | BF180 | 33p | MJE520 | 68p | ZTX301 | 14p | 2N2905 | 19p | BF244 | 36p |
| AD162 | 36p | BC178 | 17p | BF181 | 33p | MJE521 | 80p | ZTX302 | 18p | 2N2906 | 20p | MPF102 | 31p |
| AF114 | 13p | BC179 | 18p | BF182 | 33p | MJE2955 | 99p | ZTX303 | 15p | 2N2926RB | 7p | MPF103 | 31p |
| AF115 | 13p | BC182 | 10p | BF184 | 22p | MJE3055 | 65p | ZTX304 | 24p | 2N29260 | 8p | MPF104 | 31p |
| AF116 | 13p | BC183 | 10p | BF185 | 22p | MPSA12 | 50p | ZTX500 | 15p | 2N2926YG | 9p | MPF105 | 31p |
| AF117 | 13p | BC184 | 11p | BF194 | 11p | MPSA06 | 30p | ZTX501 | 15p | 2N3053 | 18p | 2N3819 | 20p |
| AF118 | 50p | BC212 | 11p | BF195 | 12p | MPSA56 | 32p | ZTX502 | 19p | 2N3054 | 45p | 2N3820 | 57p |
| AF121 | 33p | BC213 | 10p | BF196 | 14p | MPSU06 | 62p | ZTX503 | 45p | 2N3055 | 40p | 2N3B23 | 60p |
| AF124 | 30p | BC214 | 14p | BF197 | 15p | MPSU56 | 78p | 2N404 | 28p | 2N3441 | 80p | 2N5457 | 31p |
| AF125 | 30p | BC237 | 12p | BF200 | 32p | OC26 | 40p | 2N696 | 15p | 2N3442 | 140p | 2N5458 | 31p |
| AF126 | 30p | BC238 | 11p | BF257 | 32p | OC28 | 55p | 2N697 | 13p | 2N3702/3 | 11p | 2N5459 | 31p |
| AF127 | 30p | BC239 | 12p | BFR39 | 30p | OC35 | 48p | 2N698 | 30p | 2N3704/5 | 11p | MOSFETs | |
| AF139 | 33p | BC307 | 11p | BFR40 | 30p | OC36 | 52p | 2N706 | 12p | 2N3705/6 | 10p | 3N140 | 85p |
| AF181 | 45p | BC308 | 11p | BFR41 | 30p | OC41 | 15p | 2N708 | 18p | 2N3707 | 11p | 3N141 | 75p |
| AF186 | 40p | BC309 | 12p | BFR79 | 30p | OC42 | 15p | 2N914 | 18p | 2N3708/9 | 9p | 40603 | 58p |
| AF239 | 38p | BCY70 | 18p | BFR80 | 30p | OC44 | 11p | 2N918 | 40p | 2N3771 | 170p | 40673 | 80p |
| BC107 | 9p | BCY71 | 22p | BFR81 | 30p | OC45 | 11p | 2N929 | 20p | 2N3772 | 180p | UJTs | |
| BC108 | 9p | BD115 | 55p | BFX29 | 30p | OC70 | 11p | 2N930 | 18p | 2N3773 | 240p | TIS43 | 26p |
| BC109 | 10p | BD121 | 100p | BFX30 | 30p | OC71 | 11p | 2N1131 | 18p | 2N3866 | 70p | 2N2160 | 80p |
| BC115 | 20p | BD123 | 100p | BFX84 | 26p | OC72 | 11p | 2N1132 | 18p | 2N3903/4 | 15p | 2N2646 | 34p |
| BC135 | 17p | BD124 | 65p | BFX87 | 20p | OC73 | 50p | 2N1302/3 | 17p | 2N3905/6 | 15p | 2N4871 | 31p |

## SIGNAL DIODES

| | |
|---|---|
| BA100 | 10p |
| BAX13 | 5p |
| BAX16 | 6p |
| OA47 | 7p |
| OA70 | 9p |
| OA79 | 10p |
| OA81 | 8p |
| OA85 | 10p |
| OA90 | 7p |
| OA91 | 7p |
| OA95 | 7p |
| OA200 | 8p |
| OA202 | 10p |
| 1N914 | 4p |
| 1N916 | 6p |
| 1N4148 | 4p |

## RECTIFIER DIODES

| | |
|---|---|
| BY100 | 15p |
| BY126 | 12p |
| BY127 | 12p |
| BY133 | 15p |
| BYZ10 | 38p |
| BYZ11 | 35p |
| BYZ12 | 33p |
| BYZ13 | 38p |
| 1N4001 | 5p |
| 1N4004 | 6p |
| 1N4007 | 7p |
| PL4004 | 10p |
| PL7004 | 20p |

LED
TIL209 18p

## ZENER DIODES

3.3V to 33V

| | |
|---|---|
| 400mW | 9p |
| 1.3W | 18p |
| 1.5W | 25p |
| 10W | 40p |
| 20W | 65p |

## OTHER DIODES

Tunnel
AEY11 50p
Varicap
BA145 15p
BA148 13p

## SPECIAL OFFERS FOR POPULAR TRANSISTORS

| | 100+ | 500+ |
|---|---|---|
| AC 126 | 9p | 8p |
| AC 127 | 9p | 8p |
| AC 128 | 9p | 8p |
| AC 128/AC 176 m.p. | 18p | 16p |
| AC 176 | 9p | 8p |
| AC 187 | 10p | 9p |
| AC 188 | 9p | 8p |
| AF 114 | 11p | 10p |
| AF 115 | 11p | 10p |
| AF 117 | 11p | 10p |
| BC 109C | 9p | 8½p |
| BC 147B | 6p | 5p |
| BC 148B | 6p | 5p |
| BC 149C | 7p | 6p |
| 2N 2926 (TO-106) R B O | 6p | 5p |
| 2N 2926 (TO-106) G Y | 7p | 6p |

The above offers are for a limited period only AND subject to present stocks being available.

## TGS GAS SENSOR

Semiconductor 200p
Data Sheet 10p

## OPTO-ELECTRONICS

Photo-Transistors
OCP70 50p
OCP71 65p
2N5777 50p

Light Dependent Resistors
ORP12 50p
ORP60 55p
ORP61 55p

Light Emitting Diodes (LED)
Red 18p Green 35p Yellow 40p
Seven Segment Displays
3015F (Filament) 120p MAN-3M (LED) 120p

## Fixed o/p +Ve Voltage Regulators

1A (Plastic)

| | |
|---|---|
| MC7805 5V | 140p |
| MC7812 12V | 140p |
| MC7815 15V | 140p |
| MC7818 18V | 140p |
| MC7824 24V | 140p |

## Variable o/p Voltage Regulator

ML723 2V to 37V . 55p

## ACCESSORIES

DIL SOCKETS
8 pin 12p, 14 pin 13p,
16 pin 14p.
Mica Washers + 2 Bushes (TO3 or TO66) 5p

Data Sheets on advertised I.C.s 10p each

## AUDIO & RADIO ICS

| | | |
|---|---|---|
| CA3048 | Four Independent Amplifiers | 230p |
| CA3089 | FM IF Amplifier | 250p |
| CA3090 | FM Stereo Multiplex Decoder | 300p |
| LM377 | 2W/Channel Stereo Amp | 300p |
| LM380 | 2 Watt Amplifier | 140p |
| LM381 | Stereo Pre-amplifier | 200p |
| MC1304 | FM Stereo Multiplex Decoder | 170p |
| MC1307 | FM Stereo Multiplex Decoder | 145p |
| MC1310 | Coilless FM Multiplex Decoder | 245p |
| MC1312 | Four Channel SQ Decoder | 220p |
| MFC4000 | ¼Watt Audio Amplifier | 50p |
| TBA800 | 5 Watt Audio Amplifier | 100p |
| TBA810 | 7 Watt Audio Amplifier | 125p |
| TBA820 | 2 Watt Audio Amplifier | 80p |
| ZN414 | TRF Radio Receiver | 110p |

## QUANTITY PRICES

| | 50/99 | 100+ |
|---|---|---|
| 555 | 48p | 40p |
| 723 | 48p | 40p |
| 741 | 26p | 25p |
| 7490 | 47p | 43p |
| 2N3819 | 19p | 18p |

Low Profile DIL sockets by Texas

| | 50/99 | 100+ |
|---|---|---|
| 8 PIN | 11p | 10p |
| 14 PIN | 12p | 11p |
| 16 PIN | 13p | 12p |

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CD4009AE Hex Inverter/Buffer 120p
CD4011AE Quad 2 I/p Nand Gate 50p
CD4012AE Dual 4 I/p Nand Gate 50p
CD4013AE Dual 'D' Flip-Flop ..120p
CD4017AE Decade Counter/ Divider............300p
CD4018AE Divide by N Pre-settable Counter 300p
CD4027AE Dual J-K Flip-Flop 170p
CD4028AE BCDto Decimal Decoder ........270p
CD4047AE Monostable Multi-vibrator ........185p

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# TRANSISTORS

| Type | Price (£) | Type | Price (£) | Type | Price (£) | Type | Price (£) | Type | Price (£) | Type | Price (£) | Type | Price (£) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | BD115 | 0·65 | BF273 | 0·16 | BUY79 | 2·85 | ZXT313 | 0·12 | 2N3794 | 0·20 |
| | | | | BD123 | 0·98 | BF336 | 0·35 | C106F | 0·43 | ZTX500 | 0·17 | 2N3819 | 0·35 |
| AC107 | 0·35 | BC119 | 0·29 | BD124 | 0·80 | BF337 | 0·35 | C111E | 0·56 | ZTX502 | 0·17 | 2N3820 | 0·49 |
| AC117 | 0·24 | BC125 | 0·22 | BD130Y | 1·42 | BF485 | 0·46 | CRS1/40 | 0·45 | ZTX504 | 0·42 | 2N3823 | 1·45 |
| AC126 | 0·25 | BC125B | 0·25 | BD131 | 0·45 | BF459 | 0·57 | CRS3/40 | 0·55 | ZTX602 | 0·24 | 2N3866 | 1·70 |
| AC127 | 0·25 | BC126 | 0·20 | BD132 | 0·50 | BF596 | 0·70 | D40N1 | 0·45 | 2N525 | 0·86 | 2N3877 | 0 25 |
| AC128 | 0·25 | BC132 | 0·15 | BD135 | 0·40 | BF597 | 0·15 | E1222 | 0·55 | 2N696 | 0·23 | 2N3904 | 0·16 |
| AC141 | 0·26 | BC134 | 0·20 | BD136 | 0·46 | BFR41 | 0·30 | E5024 | 0·20 | 2N697 | 0·15 | 2N3905 | 0·18 |
| AC141K | 0·27 | BC135 | 0·15 | BD137 | 0·48 | BFR61 | 0·30 | ME6001 | 0·16 | 2N706 | 0·12 | 2N3906 | 0·15 |
| AC142K | 0·19 | BC136 | 0·20 | BD138 | 0·50 | BFT43 | 0·55 | ME6002 | 0·17 | 2N706A | 0·15 | 2N4032 | 0·31 |
| AC151 | 0·24 | BC137 | 0·20 | BD139 | 0·55 | BFW10 | 0·55 | ME8001 | 0·18 | 2N708 | 0·35 | 2N4036 | 0·52 |
| AC152 | 0·25 | BC138 | 0·20 | BD140 | 0·62 | BFW11 | 0·55 | MJE340 | 0·68 | 2N744 | 0·30 | 2N4046 | 0·35 |
| AC153K | 0·28 | BC142 | 0·30 | BD144 | 2·19 | BFW16A | 1·70 | MJE341 | 0·72 | 2N914 | 0·19 | 2N4058 | 0·17 |
| AC154 | 0·20 | BC143 | 0·35 | BD145 | 0·75 | BFW30 | 1·38 | MJE370 | 0·65 | 2N916 | 0·20 | 2N4123 | 0·13 |
| AC176 | 0·25 | BC147B | 0.13 | BD163 | 0·67 | BFW59 | 0·19 | MJE520 | 0·85 | 2N918 | 0·42 | 2N4124 | 0·15 |
| AC187 | 0·25 | BC148 | 0·12 | BD183 | 0·56 | BFW60 | 0·20 | MJE521 | 0·95 | 2N930 | 0·35 | 2N4126 | 0·20 |
| AC187K | 0·25 | BC149 | 0·14 | BD234 | 0·75 | BFW90 | 0·28 | MJE2955 | 1·20 | 2N1304 | 0·21 | 2N4236 | 1·90 |
| AC188 | 0·25 | BC152 | 0·25 | BD519 | 0·76 | BFX16 | 2·25 | MJE3055 | 0·74 | 2N1305 | 0·21 | 2N4248 | 0·12 |
| AC188K | 0·26 | BC153 | 0·20 | BD520 | 0·76 | BFX29 | 0·30 | MM721 | 0·70 | 2N1306 | 0·31 | 2N4284 | 0·19 |
| AC193K | 0·30 | BC154 | 0·20 | BDX18 | 1·45 | BFX30 | 0·35 | MPF102 | 0·40 | 2N1307 | 0·22 | 2N4286 | 0·19 |
| AC194K | 0·32 | BC157 | 0·15 | BDX32 | 2·55 | BFX84 | 0·25 | MPSA05 | 0·47 | 2N1308 | 0·26 | 2N4288 | 0·13 |
| AC728 | 0·25 | BC158 | 0·13 | BDY16A | 0·38 | BFX85 | 0·26 | MPSA55 | 0·50 | 2N1309 | 0·36 | 2N4289 | 0·20 |
| ACY39 | 0·68 | BC159 | 0·15 | BDY18 | 1·78 | BFX86 | 0·26 | MPS6566 | 0·21 | 2N1613 | 0·34 | 2N4290 | 0·14 |
| AD140 | 0·50 | BC161 | 0·48 | BDY20 | 0·99 | BFX87 | 0·28 | MPSU05 | 0·66 | 2N1711 | 0·45 | 2N4291 | 0·18 |
| AD142 | 0·52 | BC167B | 0·15 | BF115 | 0·20 | BFX88 | 0·24 | MPSU06 | 0·76 | 2N1890 | 0·45 | 2N4292 | 0·20 |
| AD143 | 0·51 | BC168B | 0·13 | BF117 | 0·45 | BFY18 | 0·53 | MPSU55 | 1 26 | 2N1893 | 0·48 | 2N4871 | 0·24 |
| AD149 | 0·50 | BC169C | 0·13 | BF120 | 0·55 | BFY40 | 0·40 | MPSU56 | 1·26 | 2N2102 | 0·31 | 2N4902 | 1·30 |
| AD161 | 0·48 | BC170 | 0·15 | BF121 | 0·25 | BFY41 | 0·43 | OC26 | 0·38 | 2N2217 | 0·36 | 2N5042 | 1·05 |
| AD162 | 0·48 | BC171 | 0·15 | BF123 | 0·28 | BFY50 | 0·25 | OC28 | 0·65 | 2N2218 | 0·60 | 2N5060 | 0·32 |
| AF114 | 0·25 | BC172 | 0·14 | BF125 | 0·25 | BFY51 | 0·23 | DC35 | 0·50 | 2N2219 | 0·50 | 2N5061 | 0·35 |
| AF115 | 0·25 | BC173 | 0·20 | BF127 | 0·30 | BFY52 | 0·23 | OC36 | 0·55 | 2N2221A | 0·41 | 2N5064 | 0·45 |
| AF116 | 0·25 | BC176 | 0·22 | BF158 | 0·25 | BFY57 | 0·32 | OC42 | 0·35 | 2N2222A | 0·50 | 2N5087 | 0·32 |
| AF117 | 0·20 | BC177 | 0·20 | BF159 | 0·27 | BFY64 | 0·42 | OC44 | 0·15 | 2N2369A | 0·42 | 2N5294 | 0·35 |
| AF118 | 0·50 | BC178 | 0·20 | BF160 | 0·22 | BFY72 | 0·31 | OC45 | 0·15 | 2N2401 | 0·60 | 2N5296 | 0·37 |
| AF121 | 0·30 | BC178B | 0·22 | BF161 | 0·45 | BFY90 | 0·70 | OC70 | 0·15 | 2N2484 | 0·41 | 2N5298 | 0·38 |
| AF124 | 0·25 | BC179 | 0·20 | BF162 | 0·45 | BLY15A | 0·79 | OC71 | 0·15 | 2N2570 | 0·18 | 2N5322 | 0·85 |
| AF125 | 0·20 | BC179B | 0·21 | BF163 | 0·45 | BPX25 | 1·65 | OC72 | 0·15 | 2N2646 | 0·53 | 2N5449 | 1·90 |
| AF126 | 0·20 | BC182L | 0·11 | BF167 | 0·25 | BPX29 | 1·60 | OC73 | 0·51 | 2N2712 | 0·12 | 2N5457 | 0·30 |
| AF127 | 0·20 | BC183 | 0·11 | BF173 | 0·25 | BPX52 | 1·90 | OC75 | 0·25 | 2N2904 | 0·22 | 2N5458 | 0·35 |
| AF139 | 0·35 | BC183K | 0·12 | BF177 | 0·30 | BRC4443 | 0·60 | OC81 | 0·25 | 2N2904A | 0·26 | 2N5494 | 1·85 |
| AF147 | 0·35 | BC183L | 0·11 | BF178 | 0·33 | BRY39 | 0·42 | OC81D | 0·30 | 2N2905 | 0·72 | 2N5496 | 2·05 |
| AF149 | 0·45 | BC184L | 0·13 | BF179 | 0·33 | BR101 | 0·35 | OC139 | 0·28 | 2N2905A | 0·73 | 2N6027 | 0·65 |
| AF178 | 0·55 | BC186 | 0·25 | BF180 | 0·35 | BSW64 | 0·38 | OC140 | 0·30 | 2N2926G | 0·13 | 2N6178 | 0·71 |
| AF179 | 0·60 | BC187 | 0·25 | BF181 | 0·33 | BSX19 | 0·13 | OC170 | 0·25 | 2N2926Y | 0·12 | 2N6180 | 0·78 |
| AF180 | 0·55 | BC208 | 0·12 | BF182 | 0·44 | BSX20 | 0·19 | DC171 | 0·30 | 2N29260 | 0·12 | 2SC643A | 1·36 |
| AF181 | 0·50 | BC212L | 0·12 | BF183 | 0·44 | BSX76 | 0·15 | OCP71 | 0·43 | 2N3019 | 0·75 | 2SC1172Y | 2·80 |
| AF186 | 0·40 | BC213L | 0·12 | BF184 | 0·26 | BSX82 | 0·52 | ON188 | 2·19 | 2N3053 | 0·21 | 3N140 | 1·21 |
| AF239 | 0·40 | BC214L | 0·15 | BF185 | 0·26 | BSY19 | 0·52 | ON236A | 0·65 | 2N3054 | 0·55 | 40250 | 0·60 |
| AF279 | 0·84 | BC238 | 0·10 | BF194 | 0·15 | BSY41 | 0·22 | ORP12 | 0·55 | 2N3055 | 0·60 | 40327 | 0·67 |
| AL100 | 1·10 | BC261A | 0·28 | BF195 | 0·15 | BSY54 | 0·50 | R2008B | 2·05 | 2N3133 | 0·54 | 40361 | 0·48 |
| AL102 | 1·10 | BC262A | 0·18 | BF196 | 0·15 | BSY56 | 0·80 | R2010B | 2·10 | 2N3134 | 0·60 | 40362 | 0·50 |
| AL103 | 1·10 | BC263B | 0·25 | BF197 | 0·17 | BSY65 | 0·15 | TAG3/400 | 1·54 | 2N3232 | 1·32 | 40429 | 0·80 |
| AL113 | 0·95 | BC267 | 0·16 | BF198 | 0·20 | BSY78 | 0·40 | TIC44 | 0·24 | 2N3235 | 1·10 | 40439 | 2·67 |
| AU103 | 1·40 | BC268C | 0·14 | BF199 | 0·25 | BSY91 | 0·28 | TIC46 | 0·44 | 2N3254 | 0·28 | AC128/ | |
| AU110 | 1·40 | BC294 | 0·27 | BF200 | 0·35 | BT101/300 | 1·05 | TIC47 | 0·58 | 2N3323 | 0·48 | AC176 | 0·52 |
| AU113 | 1·70 | BC300 | 0·58 | BF218 | 0·35 | BT101/500 | 1·15 | TIC29A | 0·49 | 2N3391A | 0·23 | AC141K/ | |
| BC107 | 0·12 | BC301 | 0·35 | BF222 | 1·08 | BT102/300 | 1·02 | TIP30A | 0·58 | 2N3702 | 0·13 | AC142K | 0·56 |
| BC107A | 0·13 | BC303 | 0·60 | BF224J | 0·15 | BT102/500 | 1·12 | TIP31A | 0·65 | 2N3703 | 0·15 | AC187/ | |
| BC107B | 0·14 | BC307B | 0·12 | BF240 | 0·20 | BT106 | 1·18 | TIP32A | 0·67 | 2N3704 | 0·15 | AC188 | 0·60 |
| BC108 | 0·12 | BC308A | 0·10 | BF241 | 0·20 | BU105/02 | 1·95 | TIP33A | 0·99 | 2N3705 | 0·11 | AC187K/ | |
| BC108B | 0·13 | BC309 | 0·15 | BF244 | 0·18 | BU108 | 3·25 | TIP34A | 1·73 | 2N3706 | 0·10 | | |
| BC108C | 0·14 | BC323 | 0·38 | BF254 | 0·45 | BU126 | 1·93 | TIP41A | 0·80 | 2N3707 | 0·13 | AC188K | 0·61 |
| BC109 | 0·13 | BC377 | 0·22 | BF255 | 0·45 | BU204 | 1·98 | TIP42A | 0·91 | 2N3715 | 2·30 | AC193K/ | |
| BC109C | 0·14 | BC441 | 1·10 | BF256 | 0·45 | BU205 | 1·98 | TIS43 | 0·30 | 2N3724 | 0·72 | AC194K | 0·71 |
| BC113 | 0·13 | BC461 | 1·58 | BF257 | 0·49 | BU207 | 3·00 | TIS73 | 1·36 | 2N3739 | 1·18 | AD161/ | |
| BC114 | 0·20 | BCY33 | 0·36 | BF258 | 0·66 | BU208 | 3·15 | ZTX109 | 0·12 | 2N3771 | 1·70 | | |
| BC115 | 0·20 | BCY42 | 0·16 | BF259 | 0·93 | BU209 | 2·55 | ZTX300 | 0·16 | 2N3772 | 1·90 | AD162 | 0·95 |
| BC116 | 0·20 | BCY71 | 0·22 | BF262 | 0·70 | BUY77 | 2·50 | ZTX304 | 0·22 | 2N3773 | 2·90 | BC142/ | |
| BC117 | 0·20 | BCY88 | 2·42 | BF263 | 0·70 | BUY78 | 2·55 | ZTX310 | 0·10 | 2N3790 | 4·15 | BC143 | 0·70 |

## DIODES

| Type | Price (£) |
|---|---|
| AA113 | 0·15 |
| AA119 | 0·09 |
| AA129 | 0·20 |
| AA143 | 0·10 |
| AAZ13 | 0·30 |
| BA100 | 0·50 |
| BA102 | 0·25 |
| BA110U | 0·30 |
| BA115 | 0·12 |
| BA141 | 0·17 |
| BA145 | 0·17 |
| BA148 | 0·17 |
| BA154 | 0·13 |
| BA155 | 0·16 |
| BA156 | 0·15 |
| BA147 | 0·25 |
| BAX13 | 0·06 |
| BAX16 | 0·07 |
| BB103 | 0·25 |
| BB104 | 0·45 |
| BB105B | 0·45 |
| BB105G | 0·35 |
| BR100 | 0·50 |
| BY100 | 0·15 |
| BY103 | 0·22 |
| BY126 | 0·16 |
| BY127 | 0·17 |
| BY133 | 0·23 |
| BY140 | 1·40 |
| BY164 | 0·55 |
| BY176 | 1·00 |
| BY179 | 0·70 |
| BY206 | 0·31 |
| BYX10 | 0·15 |
| OA47 | 0·07 |
| OA81 | 0·12 |
| OA90 | 0·08 |
| OA91 | 0·07 |
| OA95 | 0·07 |
| OA200 | 0·10 |
| OA202 | 0·10 |
| OA210 | 0·29 |
| IN914 | 0·07 |
| IN916 | 0110 |
| IN4001 | 0·05 |
| IN4002 | 0·06 |
| IN4003 | 0·07 |
| IN4004 | 0·08 |
| IN4005 | 0·09 |
| IN4006 | 0·11 |
| IN4007 | 0·14 |
| IN4148 | 0·05 |
| IN4448 | 0·10 |
| IN5400 | 0·15 |
| IN5401 | 0·17 |
| IN5402 | 0·20 |
| IN5403 | 0·22 |
| IN5404 | 0·25 |
| IN5404 | 0·27 |
| IN5406 | 0·30 |
| IN5407 | 0·34 |

## ZENERS

| | |
|---|---|
| 400mW 3-33V | 0·12 |
| 1W 3·3-68V | 0·18 |

## THYRISTORS, TRIACS AND TRIACS WITH TRIGGER

| IF VRM: | 50V | 100V | 200V | 400V | 600V |
|---|---|---|---|---|---|
| 3A | —/—/— | —/28/30 | —/34/36 | —/50/52 | —/66/70 |
| 4A | 26/—/— | 30/—/— | 38/—/— | 60/—/— | 75/—/— |
| 6A | 29/—/— | 33/44/46 | 42/56/58 | 68/80/84 | 80/100/105 |
| 8A | 32/—/— | 38/50/52 | 47/64/61 | 75/92/97 | 90/114/120 |
| 10A | 36/—/— | 42/60/63 | 51/74/78 | 84/104/109 | 100/128/13 |
| 16A | —/—/— | —/82/90 | —/88/95 | —/132/140 | —/175/185 |

**Notes:** All prices are in pence per unit. First price in each group is thyristor, second is triac, third is triac with trigger. Encapsulation depends on current rating and device type. Connection data supplied with each device. Quantity enquiries welcomed.

## INTEGRATED CIRCUITS

| Type | Price (£) | Type | Price (£) |
|---|---|---|---|
| CA3045 | 1·40 | TAA630Q | 3·29 |
| CA3046 | 0·70 | TAA630S | 3·29 |
| CA3065 | 1·90 | TAA700 | 3·30 |
| MC1307P | 1·90 | TAA840 | 1·64 |
| MC1310P | 2·94 | TAA861A | 0·49 |
| MC1327PQ | 1·01 | TAD100 | 1·42 |
| MC1330P | 0·76 | TBA120S | 0·99 |
| MC1351P | 0·75 | TBA240A | 1·10 |
| MC1352P | 0·72 | TBA480Q | 1·24 |
| MC1358PQ | 1·85 | TBA500 | 1·99 |
| | | TBA500Q | 2·00 |
| MC1496L | 0·87 | TBA510 | 1·99 |
| MC3051P | 0·58 | TBA520Q | 2·72 |
| MFC4000B | 0·43 | TBA530 | 1·98 |
| MFC4060A | 0·70 | TBA530Q | 1·99 |
| | | TBA540 | 2·20 |
| MFC6040 | 0·91 | TBA540Q | 2·21 |
| PA263 | 1·90 | TBA550Q | 3·29 |
| SL414A | 1·91 | TBA560C | 2·71 |
| SL901A | 2·60 | TBA560CQ | 2·72 |
| SL917B | 3·80 | | |
| SN76003N | 2·92 | TBA570 | 1·17 |
| SN76013N | 1·95 | TBA641 | 0·76 |
| SN76013ND | 1·72 | TBA673 | 1·80 |
| | | TBA700 | 1·90 |
| SN76023ND | 1·72 | TBA720Q | 2·20 |
| | | TBA750Q | 1·54 |
| SN76023N | 1·95 | TBA800 | 1·75 |
| SN76033N | 2·92 | TBA810AS | 1·75 |
| SN76530P | 1·05 | | |
| SN76533N | 1·20 | | |
| TAA300 | 1·46 | TBA920Q | 3·29 |
| TAA320 | 0·94 | TBA990 | 3·29 |
| TAA350 | 1·54 | TBA990Q | 3·29 |
| TAA435 | 0·85 | TCA270Q | 3·35 |
| TAA450 | 1·85 | ZN414 | 1·20 |
| TAA550 | 0·49 | | |
| TAA570 | 1·39 | u6A9951592 | ·52 |

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BC184L transistor **£5.90** 100, **£50.00** 1,000.
IN4148 diodes **£24.00** 1,000, **£98.00** 5,000 (1,000 minimum order).
8 x 5 in. 15Ω loudspeakers—ferrite magnet **50p** each (15p part postage on this item please).

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## RESISTORS

**CARBON FILM**
⅛W 1Ω to 1M : 5%, IM2 to 10M : 10% E12
¼W 1Ω to 10Ω : 5%, IM2 to 10M : 10% E12
1 1Ω to 910k : 5% E12 & E24 **1p** each.

**METAL OXIDE**
½W 10Ω to 1M : 2% E12 & E24 **4p** each

**WIREWOUND**
3W 0.22Ω, 0.27Ω, 0.33Ω, 0.47Ω : 10% **14p** each
1Ω to 270Ω : 5% E12 **12p** each

Other ranges stocked. See our catalogue for details.
E12: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, B2 and decades.
E24: 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and decades.

## POTENTIOMETERS

Rotary miniature carbon track ¼" spindle. Values available: 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M.
Log. signle-gang **16p.** Lin. single-gang (+1k) **16p**
Log. or Lin. single-gang with switch **33p**
Log. or Lin. dual-gang without switch **49p**
Slider 60mm track. Metal-cased: overall length 86.15mm less knob (6p extra).
Log. or Lin. single-gang 1k, 5k, 10k, 25k, 50k, 100k, **40p** each.
Log. or Lin. dual-gang 1k, 5k, 10k, 25k, 50k, 100k, **49p** each.
Presets: 0.1W vertical or Horizontal.
100Ω, 220Ω, 470Ω, 1k, 2k2, 4k7, 10k, 22k, 47k, 100k, 220k, 470k, 1M **7p** each.

## CAPACITORS

Sub-miniature
Axial lead electrolytic

| Mfd | V | Price | Mfd | V | Price | Mfd | V | Price |
|---|---|---|---|---|---|---|---|---|
| 1 | 63 | 6p | 68 | 6.3 | 6p | | | |
| 1.5 | 63 | 6p | 68 | 16 | 6p | | | |
| 2.2 | 63 | 6p | 68 | 63 | 14p | | | |
| 3.3 | 63 | 6p | 100 | 4 | 6p | | | |
| 4.7 | 63 | 6p | 100 | 10 | 6p | 470 | 6.3 | 6p |
| 6.8 | 40 | 6p | 100 | 25 | 6p | 470 | 10 | 14p |
| 6.8 | 63 | 6p | 100 | 40 | 6p | 470 | 25 | 16p |
| 10 | 25 | 6p | 100 | 63 | 16p | 470 | 40 | 25p |
| 10 | 63 | 6p | 150 | 6.3 | 6p | 680 | 6.3 | 14p |
| 15 | 16 | 6p | 150 | 16 | 6p | 680 | 16 | 16p |
| 15 | 40 | 6p | 150 | 25 | 6p | 680 | 25 | 25p |
| 15 | 63 | 6p | 150 | 40 | 14p | 680 | 40 | 28p |
| 22 | 10 | 6p | 150 | 63 | 16p | 1000 | 4 | 14p |
| 22 | 25 | 6p | 220 | 4 | 6p | 1000 | 10 | 16p |
| 22 | 63 | 6p | 220 | 10 | 6p | 1000 | 16 | 25p |
| 33 | 6.3 | 6p | 220 | 16 | 6p | 1000 | 25 | 28p |
| 33 | 16 | 6p | 220 | 25 | 14p | 1500 | 6.3 | 16p |
| 33 | 40 | 6p | 220 | 40 | 16p | 1500 | 10 | 25p |
| 47 | 4 | 6p | 220 | 63 | 25p | 1500 | 16 | 28p |
| 47 | 10 | 6p | 330 | 4 | 6p | 2200 | 6.3 | 25p |
| 47 | 25 | 6p | 330 | 10 | 6p | 2200 | 10 | 28p |
| 47 | 40 | 6p | 330 | 16 | 14p | 3300 | 6.3 | 28p |
| 47 | 63 | 6p | 330 | 63 | 28p | 4700 | 4 | 28p |

## SWITCHES

Rotary adjustable stop. 1 pole, 2 to 12 way; 2 pole, 2 to 6 way; 3 pole, 2 to 4 way; 4 pole, 2 or 3 way **36p** each.
Slide Sub-min. DPDT **9p**
Slide min. DPDT **13p**
Push to make non-locking SPST **14p**
Push-on, push-off locking DPDT 250V 4A **48p**
Rocker white DPST 250V 10A **40p**
Rotary mains DPST 250V 2A **20p**
Toggle with ON/OFF plate DPDT 250V 1.5A **25p**

**BCD OUTPUT SLIDE SWITCH**
Marks the end of the old-fashioned thumb-wheel switch. With 7-segment type read-out. Full details in our catalogue **£1.38**

## TRANSISTORS & DIODES

| | | | |
|---|---|---|---|
| AC127 | 18p | BFY52 | 20p |
| AC128 | 18p | BY126 | 13p |
| AC176 | 17p | BY127 | 13p |
| AD161/ | | BY164 | 49p |
| 162MP | 93p | BZY88 | |
| BA100 | 9p | series | 13p |
| BA145 | 22p | MPF102 | 36p |
| BC107 | 10p | OA91 | 6p |
| BC108 | 10p | OA200 | 7p |
| BC109 | 13p | OC71 | 20p |
| BC109C | 15p | SC146D | 88p |
| 8C142 | 23p | T1S43 | 28p |
| BC143 | 26p | WD05 | 30p |
| BC147 | 10p | WD4 | 33p |
| BC148 | 10p | 1N914 | 4p |
| BC149 | 12p | 1N4001 | 6p |
| BC168C | 12p | 1N4002 | 6½p |
| BC169C | 12p | 1N4003 | 7p |
| BC178 | 17p | 1N4004 | 7½p |
| BC182L | 10p | 1N4005 | 8p |
| BC183L | 12p | 1N4006 | 8½p |
| BC184L | 12p | 1N4007 | 9p |
| 8C212L | 14p | 1N4148 | 4p |
| BC213L | 15p | 2N1302 | 20p |
| BC214L | 18p | 2N1303 | 20p |
| BCY71 | 22p | 2N1304 | 30p |
| BD131 | 45p | 2N1711 | 24p |
| BD132 | 54p | 2N2219 | 25p |
| BD131/ | | 2N2646 | 45p |
| 8D132MP | | 2N2905 | 33p |
| | £1.20 | 2N2926 Or. | |
| BD135 | 36p | Ye. or Gn | 10p |
| BD139 | 49p | 2N3053 | 18p |
| BD140 | 69p | 2N3055 | 49p |
| BF258 | 35p | 2N3819 | 22p |
| BF259 | 25p | 2N5459 | 51p |
| BFX29 | 30p | 7400 | 17p |
| BFX30 | 33p | 7413 | 39p |
| BFX84 | 30p | 7447 | £1.10 |
| BFX85 | 36p | 7473 | 54p |
| BFX87 | 30p | 7474 | 45p |
| BFX88 | 25p | 7490 | 93p |
| BFY50 | 20p | 7493 | 93p |
| BFY51 | 22p | 74121 | 39p |

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2mcd ⅛" only **15p**
Panel mtg. clip **5p**
(Other colours and 7-seg. displays in our catalogue.)

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Our catalogue contains application circuits and data for all the above I.Cs and many more.

## DISCOUNTS

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## PLUGS AND SOCKETS

| DIN | PLUG | CHASSIS SOCKET |
|---|---|---|
| 2-pin | 8p | 6p |
| 3-pin | 9p | 7p |
| 4-pin | 10p | 7p |
| 5-pin A(180°) | 10p | 7p |
| 5-pin B(240°) | 10p | 7p |
| 6-pin | 10p | 9p |

## JACK PLUGS

2.5mm plastic barrel **9p**
2.5mm metal barrel **15p**
3.5mm plastic barrel **9p**
3.5mm metal barrel **15p**
¼in. std. mono plastic barrel **13p**
¼in. std. mono metal barrel **21p**
¼in. std. stereo plastic barrel **18p**
¼in. std. stereo metal barrel **30p**

## JACK CHASSIS SOCKETS

2.5mm open-type metal **9p**
3.5mm open-type metal **9p**
¼in. std. mono open-type metal **10p**
¼in. std. mono moulded with 2 break contacts **14p**
¼in. std. stereo open-type metal **15p**
¼in. std. stereo moulded with 3 break contacts **18p**

## PHONO

Plastic-topped plug **5p**
Screened plug **12p**
Chassis socket single **4p**
Chassis socket twin **6p**

## MAINS CONNECTORS

P360 3-pin 1.5A chassis plug with line socket **30p**
SA2190 3-pin 5A chassis plug **22p**
SA1862 Line socket for SA2190 **25p**
P437 3-pin 5A chassis socket with line plug **55p**

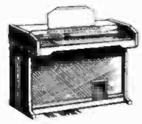
## TRANSFORMERS

LT700 min. output. Pri. 1k2; Sec. 5Ω 200mW **50p**
Sub-min mains 6–0–6V 100mA **95p**
12–0–12V 50mA **95p**
(Size both approx. 30×27×25mm)
Min. mains 0–6V 500mA, 0–6V 500mA **£1.36**
0–12V 250mA, 0–12V 250mA **£1.36**
0–20V 150mA, 0–20V 150mA **£1.36**
0–24V 125mA, 0–24V 125mA **£1.36**
Mains MT3AT: Sec: 12–15–20–24–30V 2A **£3.60**
Mains MT206AT: Sec: 0–15–20V 1A, 0–15–20V 1A **£3.98**

## ORGAN CONSTRUCTION

A Full-Scale Electronic Organ that you can build to your own specification.

*FULL CONSTRUCTIONAL DETAILS IN OUR LEAFLETS*



Leaflet MES 51: price **15p**, describes a fully polyphonic basic organ which can later be used as the basis of a large sophisticated instrument.
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A ready-built, tested and guaranteed digital master oscillator. Accurately generates the top 13 notes for your organ system and reduces the complete tuning of your organ to ONE SIMPLE adjustment. New design gives selectable C to C output ranges of (approx.) 4k to 8k (highest) or 2k to 4k or 1k to 2k, etc., right down to 16Hz to 32Hz! And this new compatible design is even smaller: only 3.5In.×3.7in., including gold-plated edge connexion.
DMO2T includes built-in variable depth and rate frequency shift tremulant.
DMO2 **£12.25** DMO2T **£14.25**
SAJ 110: 7-stage frequency divider in 14-pin DIL package. Sine or square wave input. Square wave output may be converted to saw-tooth. **£2.63** each or 6 for **£14.14** or 12 for **£25.**

## ORGAN COMPONENTS

Keyboards high quality, fully sprung.
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Sloping-front 61-note C to C **£20.35**
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*Reverberation driver module **£5.34**
*S.a.e. please, for full details: leaflet MES 24.
Gold-clad phosphor-bronze wire **30p** per yd.
Palladium earth bar **15p** per octave length
Contact blocks 2-make (GB2) **22p**
Stop tabs, rocker type, not engraved (white, red, grey or black) with DPDT switch **49p**

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We stock all parts for this brilliantly designed synthesiser. This includes all the PCBs, metalwork and drilled and printed front panel giving a truly professional finish. Authoritative opinions agree the ETI International Synthesiser is technically superior to most of today's models. Complete constructional details in our booklet, available shortly. S.a.e. please, for price lists and specification.
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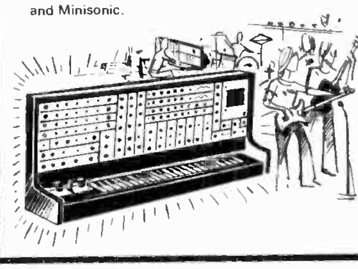

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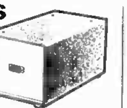
# TRANSFORMERS

## 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 | Open £ | £ | Post £ |
|---|---|---|---|---|---|
| 60 | 149 | 7·35 | 0·80 | 4·00 | 0·38 |
| 100 | 150 | 8·22 | 0·80 | 4·60 | 0·52 |
| 200 | 151 | 10·20 | 0·80 | 7·40 | 0·52 |
| 250 | 152 | 11·68 | 0·80 | 8·88 | 0·65 |
| 350 | 153 | 14·10 | 0·80 | 10·80 | 0·80 |
| 500 | 154 | 15·68 | 0·80 | 12·38 | 1·00 |
| 750 | 155 | 24·63 | 1·00 | 18·72 | 1·20 |
| 1000 | 156 | 32·19 | 1·00 | 26·50 | 1·20 |
| 1500 | 157 | 38·18 | 1·00 | 30·34 | O.A. |
| 2000 | 158 | 45·20 | 2·40 | 34·68 | O.A. |
| 3000 | 159 | 66·50 | 2·40 | 53·35 | 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 | 1·95 | 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 | 1·75 | 0·22 |
| 0-8-9 | 0-8-9 | 1000 | 1000 | 208 | 2·30 | 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 | 2·47 | 0·38 |
| 0-20 | 0-20 | 300 | 300 | 214 | 1·72 | 0·22 |
| 0-20 | — | 3500 | No Screen | 1116 | 3·00 | 0·40 |
| 20-12-0-12-20 | — | 700 (D.C.) | — | 221 | 2·31 | 0·30 |
| 0-15-20 | 0-15-20 | 1000 | 1000 | 206 | 3·22 | 0·38 |
| 0-15-27 | 0-15-27 | 500 | 500 | 203 | 2·73 | 0·38 |
| 0-15-27 | 0-15-27 | 1000 | 1000 | 204 | 3·52 | 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 | 1·38 | 0·22 |
| 1 | 0·5 | 213 | 1·58 | 0·22 |
| 2 | 1 | 71 | | 0·22 |
| 4 | 2 | 18 | 2·58 | 0·38 |
| 6 | 3 | 70 | 3·80 | 0·42 |
| 8 | 4 | 108 | 4·20 | 0·52 |
| 10 | 5 | 72 | 4·80 | 0·52 |
| 12 | 6 | 116 | 5·01 | 0·52 |
| 16 | 8 | 17 | 6·22 | 0·52 |
| 20 | 10 | 115 | 9·47 | 0·69 |
| 30 | 15 | 187 | 11·95 | 0·97 |
| 40 | 20 | 232 | 13·26 | 1·00 |
| 60 | 30 | 226 | 15·30 | 1·10 |

## 30 VOLTS

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

| AMPS | Ref. No. | Price £ | Post £ |
|---|---|---|---|
| 0·5 | 112 | 1·72 | 0·22 |
| 1 | 79 | 2·21 | 0·38 |
| 2 | 3 | 3·26 | 0·38 |
| 3 | 20 | 4·10 | 0·42 |
| 4 | 21 | 4·68 | 0·52 |
| 5 | 51 | 5·80 | 0·52 |
| 6 | 117 | 6·50 | 0·52 |
| 8 | 88 | 8·50 | 0·67 |
| 0 | 89 | 8·47 | 0·67 |

## 60 VOLTS

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

| AMPS | Ref. | Price | Post |
|---|---|---|---|
| 0·5 | 102 | 2·33 | 0·30 |
| 1 | 103 | 3·00 | 0·38 |
| 2 | 104 | 4·57 | 0·42 |
| 3 | 105 | 5·20 | 0·52 |
| 4 | 106 | 6·89 | 0·52 |
| 6 | 107 | 11·17 | 0·67 |
| 8 | 118 | 14·19 | 0·97 |
| 10 | 119 | 15·47 | 0·97 |

## 50 VOLTS

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

| AMPS | Ref. | Price | Post |
|---|---|---|---|
| 0·5 | 124 | 2·08 | 0·38 |
| 1 | 126 | 2·96 | 0·38 |
| 2 | 127 | 4·63 | 0·42 |
| 3 | 125 | 6·84 | 0·52 |
| 4 | 123 | 7·94 | 0·67 |
| 5 | 40 | 8·86 | 0·67 |
| 6 | 120 | 10·15 | 0·82 |
| 8 | 121 | 13·58 | 1·00 |
| 10 | 122 | 18·15 | 1·00 |
| 12 | 189 | 16·00 | 1·10 |

## 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!**
**Available shortly**
*Don't chance it!*
*isolate it!*

## "SPLASH PROOF" SAFETY TRANSFORMER

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

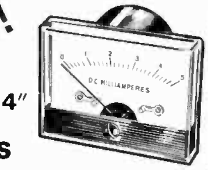
Housed in a tough Fibreglass case, with carrying handle. Complete with heavy duty 3-core power cable, splash proof outlet plug and socket, internal fuse. 110 Volt and 240 Volt versions available.

**PRICE £26·20**
**CARRIAGE £1·30**

## AUTO TRANSFORMERS

| VA (Watts) | Ref. No. | PRICE Cased £ | PRICE Plugs 2 & 3 pin £ | PRICE Open £ | Post £ |
|---|---|---|---|---|---|
| Tapped at 115, 220, 240 Volts | | | | | |
| 20 | 113 | 3·00 | 0·15 | 1·55 | 0·30 |
| Tapped at 115, 220, 240 Volts | | | | | |
| 150 | 4 | 5·80 | 0·15 | 3·98 | 0·39 |
| 200 | 65 | 6·40 | 0·15 | 4·50 | 0·40 |
| 300 | 66 | 7·27 | 0·15 | 5·28 | 0·52 |
| 500 | 67 | 9·99 | 0·15 | 8·29 | 0·67 |
| 750 | 83 | 12·56 | 0·75 | 9·76 | 0·82 |
| 1000 | 84 | 15·70 | 0·75 | 12·40 | 0·82 |
| 1500 | 93 | 19·88 | 0·75 | 16·58 | 1·50 |
| 2000 | 95 | 30·10 | 1·44 | 22·05 | 1·50 |
| 3000 | 73 | 43·58 | 1·90 | 32·00 | 1·90 |

## NEW! 2" AND 4" PANEL METERS

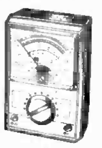



2": SIZE: 60mm Wide × 45mm High × 40mm Deep.
4": SIZE: 110mm Wide × 82mm High × 43mm Deep.

| 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" £3·15 Post 10p. Price 4" £3·95 Post 10p.
Lamps 55p per set.

## C1000 MULTI-METER



**Special Offer NOV. AND DEC. 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.

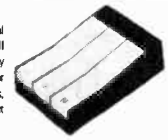
## MINIATURE NEONS

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. 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.

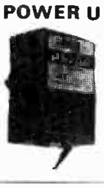
## BRIDGE RECTIFIERS

| 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

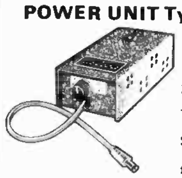
¼ watt at 70°C E 12 range 10Ω-1MΩ. 5% tol. above 470 KΩ 10% tol. at **95p** per 100.

## 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.

## C1001 MULTIMETER

Input Resistance 20,000 ohms per volt
Overload protection
250 ua movement, clear scale
Ranges—AC Volts 0–10, 50, 250, 1000V
DC Volts 0–5, 25, 125, 500, 2500V
DC Current 0–50 mA
Resistance 0–60 Kohms 0–6 Mohms
Decibels −20 to +22 db.
Carrying Case, Test Prods and Batteries included.
Size: 11·5 × 8·3 × 2·7 cm.
Price £9·85. Post 20p.

A.S.P. (Dept. WW1), SIMMONDS RD., WINCHEAP, CANTERBURY, KENT CT1 3RW Tel: Canterbury (0227) 52436

**PLEASE ADD 8% FOR VAT**

WW—120 FOR FURTHER DETAILS

# STEREO IC DECODER

**HIGH PERFORMANCE PHASE LOCKED LOOP**
**(as in 'W.W.' July '72)**

**MOTOROLA MC1310P EX STOCK DELIVERY**

**SPECIFICATION**

Separation: 40dB 50Hz-15kHz. 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 8% to all prices

**FI-COMP ELECTRONICS**
BURTON ROAD, EGGINTON, DERBY, DE6 6GY

# TELEVISION CAMERA KITS

Complete kits are available for both "Mullard" and "P.E." design. Each kit includes a comprehensive construction manual, and a completely FREE technical back-up service to ensure your success. VHF and UHF Modulator Kits also available to allow standard domestic T.V. to be used as monitor.

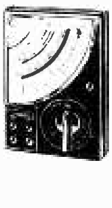
All parts available separately, including a wide range of lenses, vidicon tubes, special mains transformers and focus/scan coils. Also available P.W. tele-tennis game.

Send 5" × 7" S.A.E. for full details or come along for a demonstration and a chat with our technical staff.

**CROFTON ELECTRONICS**
**124 Colne Road, Twickenham, Middlesex TW2 6QS.**
**Tel. 01-898 1569. Telex 934642 Cadanac LDN.**

WW—105 FOR FURTHER DETAILS

# ASK LASKYS and make no mistake

## MODEL C7202EN

20,000 o.p.v. DC. 10,000 o.p.v. AC Mirror Scale. 5/25/50/250/500/1000/2500 V. DC. 10/50/100/500/1000 V. AC. DC Resistance x 10, x 1000 (30Ω centre scale) DC Current 50uA/2·5mA/250mA. –20 to +68 dB.
**OUR PRICE £6.50** P & P 30p

## MODEL C7208FM

30,000 opv DC. 15,000 opv AC. 6/3/15/60/300/600/1200 V. DC. 6/30/120/600/1200 V. AC. DC Resistance x 1, x 10, x 100, x 1000 (50Ω centre scale) DC Current 30uA/3/30/600mA. –20 to +63dB.
**OUR PRICE £8.95** P & P 30p

## KAMODEN HM720B FET VOM

Input impedence 10 Megohms. Ranges:– 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10 50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms
**OUR PRICE £21.00** 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 £52.00** P&P 50p

## 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 200 MULTIMETER KIT

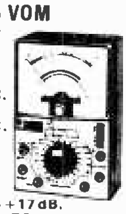
Build yourself a quality 20000 opv. multimeter and save money. Complete kit with meter scale, movement and rotary range selector ready mounted in cabinet. All parts, batteries, test prods and instructions. Ranges: 0/0.6/6/30/120/600/1200V D.C. 0/6/30/120 600/1200V A.C. Current: 0/0.6/6/60/600mA. Resistance: 0/10/100K/1/10 Meg ohms. Decibels: –20 to +63db. Size: 90 x 150 x 35mm
**OUR PRICE £7.95** P&P 30p.

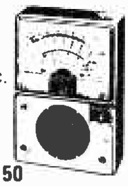
## U4323 MULTIMETER

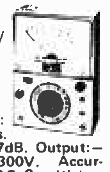
20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: x 10, x 100, x 1,000, x 10,000 (50Ω, 500Ω, 5kΩ, 50kΩ centre scale) Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.
**OUR PRICE £7.70** 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
Case for above £1.75

## 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 +17 dB.
**OUR PRICE £12.50** P&P 30p.

## 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.

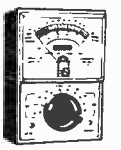
## HIOKI 750X VOLT-OHM-MILLIAMETER

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

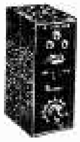
## TMK MODEL 117 FET ELECTRONIC VOLTMETER

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

## LB83 TRANSISTOR TESTER

Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.
**OUR PRICE £3.95** P&P 20p

## AUDIOTRONIC Model ATM1

Top value 1,000 opv pocket multimeter. 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

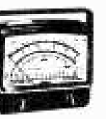
## LB4 TRANSISTOR TESTER

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.
**OUR PRICE £4.50** P&P 20p

## 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 £9.25** P&P 30p

## 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. Resistance: 10k/100k/1 Meg/10 Meg ohms. –20 to +81.5dB.
**OUR PRICE £12.50** P&P 20p

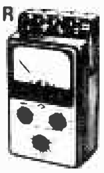
## TMK 100K LAB TESTER

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/10/100/2.5/10A. Resistance: 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

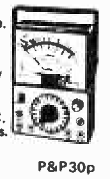
## AUDIOTRONIC Model ATM5

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

## 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 and carrying handle.
**OUR PRICE £17.50** P & P 40p

## U435 MULTIMETER

20,000opv. 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

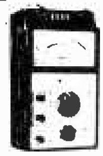
## HIOKI MODEL 700X

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

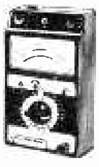
## 370WTR MULTIMETER

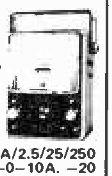
Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC. 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: –20 to +62dB.
**OUR PRICE £19.95** P&P 30p

## MODEL TH12

20,000 opv. Overload protection. Slide switch 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

## 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

## 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/1.5/6/15/150/60/600mA/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 £10.25** P&P 50p

## 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

## KAMODEN 72.200 Multitester

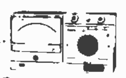
High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges:–0/.06/.3/3/30/120/600/1200V DC. 0/3/12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.
**OUR PRICE £22.50** P&P 30p

## HIOKI 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

## 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

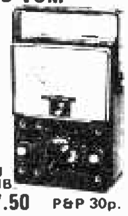
## U4317 MULTIMETER

High sensitivity instrument for field and laboratory work. Knife edge pointer, 86mm. mirror scale. Overload protection. 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 £16.50** P&P 40p

## MODEL PL436

20,000 opv DC. 8000 opv AC. Mirror scale 0/6/3/12/30/120/600V 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

## 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 £13.50** P&P 30p

## 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.

**ALL PRICES EXCLUDE VAT**

Also see following pages

## SWR METER Model SWR3

Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedence 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.

**OUR PRICE £4.25** 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.

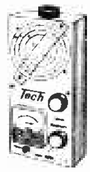
**OUR PRICE £43.00** Carr. paid

## 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

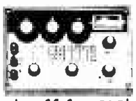
## MODEL TE15 GRID DIP METER



Transistorised. Operates as Grid Dip, Oscillator, Absorbtion Wave Meter and Oscillating Detector. Frequency range 440kHz–280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.

**OUR PRICE £17.50** P&P 30p

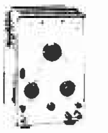
## TRANSISTORISED L.C.R. A.C. BR/8 MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Resistance: 6 ranges: 0.1 ohm-11.1 megohm ± 1% Inductance: 6 ranges: 1 microhenry-111 henries ± 2% Capacity: 6 ranges: 10pf-1110 mfd ± 2% Turns Ratio: 6 ranges: 1:1/1000-1:1110Q ± 1% Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 microamp meter indication. Size 7⅞" x 5" x 2"

**OUR PRICE £25.00** P&P 30p

## TE-20D RF SIGNAL GENERATOR



Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated. Variable R.F. attenuator audio output. Xtal socket for calibration. 220/240V a.c. Brand new with instructions. Size 140mm x 215mm x 170mm.

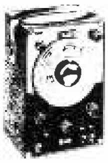
**OUR PRICE £17.50** P&P 50p

## TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedence 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.

**OUR PRICE £24.95** P&P 50p

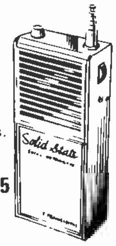
## ARF 300 AF/RF SIGNAL GENERATOR



All transistorised compact fully portable. AF sinewave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/ Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.

**OUR PRICE £37.50** P&P 50p

## WALKIE TALKIES



SKYFON NV7 Super low cost transmitter/receivers. 100MW with call buzzer and on/off volume control. 7 transistors. Telescopic rod antenna.

**OUR PRICE £28.95** per PAIR P.&P 50p.

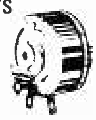
NOT LICENSABLE IN THE U.K.

## MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19-220,000Hz Sine Wave 19–100,000 Hz Square Wave. Output Sine or Square wave 10v. P. to P Size 180 x 90 x 90mm. Operation 220/240v. A.C.

**OUR PRICE £19.95** P&P 50p

## POWER RHEOSTATS



High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating.

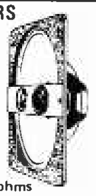
Single hole fixing. ¼" diameter shafts. Bulk quantities available.

**25 WATT*** 10/25/50/100/500/1000/2500 ohms. £1.15 P&P 10p

**50 WATT** 10/50/100/250/500/1500/5000 ohms. £1.62 P&P 10p

**100 WATT** 1/5/10/25/50/250/500/2500 ohms. £2.34 P&P 15p

## EMI LOUDSPEAKERS



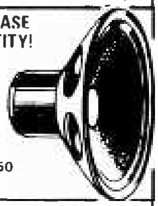
Model 350 13 x 8" with single tweeter/crossover. 20–20,000Hz. 15 watts RMS. Available 8 or 15 ohms.

**OUR PRICE £7.50** each P&P 37p

Model 450 13 x 8" with twin tweeter/crossover. 55–13,000Hz. 8 watts RMS. Available 8 or 15 ohms

**OUR PRICE £3.62** each P&P 35p

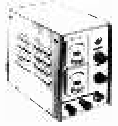
## SPECIAL PURCHASE LIMITED QUANTITY! Tannoy 12" DR/8 Bass Speakers



8 ohms. 30 watt. Heavy duty, ideal for Hi-Fi P.A. Group.

OUR PRICE £12.50 P&P 50p.

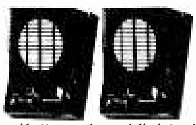
## PS200 Regulated POWER SUPPLY UNIT



Solid state. Variable output 5–20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.

**OUR PRICE £19.95** P&P 50p

## AUDIOTRONIC LE-102A INTERCOM



Beautifully made and finished in two tone ivory/buff, the LE-102A is useful in the home, office or shop and is suitable for use as baby alarm. Wall or desk mounting 57mm speaker/mic gives clear 2-way communication with on/off and volume control on master unit. Operates on 9V batt. Approx 60ft lead.

**OUR PRICE £3.95** P & P 30p

## TRITON 4318 PORTABLE 8 TRACK CARTRIDGE PLAYER WITH MW/LW RADIO

Will play 8 track stereo cartridge monaurally. Channel selector switch. Covers medium and long wave bands. Volume and tone controls. Earphone socket. Battery/Mains operation.

**OUR PRICE £11.95** P & P 50p

## EA41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar etc. and output to your amplifier. Volume control and depth of reverberation control. Beau walnut cabinet. 184 x 77 x 108mm.

**OUR PRICE £7.50** P&P 30p

## SPECIAL PURCHASES! RECORD DECK PACKAGE by Famous Manufacturer

GARRARD SP25 Mark 111 with G800 cartridge in luxurious plinth with cover

**OUR PRICE £13.95** P & P 75p

GARRARD SP25 Mark 111 Record deck fitted KS 40A cartridge

**OUR PRICE £9.95** P & P 50p

## LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.

**OUR PRICE £1.97** P&P 30p

## DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms. 20–12,000Hz. Complete with lead and plug.

**OUR PRICE £2.25** P&P 30p

## TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedence. Frequency response 25Hz–18kHz. Complete with cable and stereo jack plug.

**OUR PRICE £2.60** P&P 30p

## SDH8V MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedence. Frequency response 20Hz–18kHz. Complete with 10ft. coiled lead and jack plug.

**OUR PRICE £4.97** P&P 30p

## BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms.

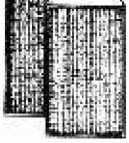
**OUR PRICE £5.95** P&P 30p

## HANIMEX HRC 3075 CASSETTE RADIO

Covers Medium and FM wavebands. Slider volume and tone controls. Battery/Mains operation. Will record direct from radio or through built in condenser microphone. Complete with batteries, earphone, and cassette.

**OUR PRICE £24·30** P & P 50p

## SPECIAL BARGAIN !! STEREOSOUND SPEAKERS



Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead.

**OUR PRICE £12.95** PAIR P&P 50p

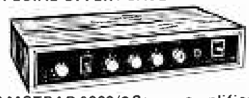
## FM TUNER CHASSIS

6 transistor high quality tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88–108MHz. Ready built, ready for use. Fantastic value for money.

**OUR PRICE £8.95** P&P 20p

Stereo Multiplex Adaptor £5 95 extra

## SPECIAL OFFER! SAVE OVER 50%



AMSTRAD 8000/2 Stereo amplifier 7 watts per channel rms. Inputs for tuner tape, phono. Headphone socket. List price £29.95.

**OUR PRICE £12.95** P & P 60p

## SPECIAL OFFER! CONVERT YOUR STEREO SYSTEM TO 4D SOUND FOR UNDER £16

Exclusive offer of GOODWIN 4-CHANNEL CONVERTER and a pair of AD15 10 watt 8 ohm bookshelf speakers enables you to add 4D sound to your existing system. Complete with simple connection details. Normal retail value £25.50.

**OUR PRICE £15.80** P & P £1.

GOODWIN CONVERTER available separately £3.95 P & P 50p.

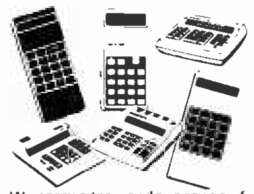
## Model A1018 FM TUNER

6 transistor high quality unit–3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88–108MHz. Powered by 9V battery.

**OUR PRICE £13.50** P&P 30p

Stereo multiplex adapter £5.95 extra.

## ELECTRONIC CALCULATORS



We carry a tremendous range of both pocket and desk calculators from as little as £9. Owing to the demand it is not possible to include them in this advertisement, so send for our latest price list or call into any branch.

## MINIATURE ORGAN MUSIC MASTER AM100

Spanning nearly two octaves, including semi-tones. This instrument will give hours of enjoyment to all the family. Beautifully finished. The Keyboard range can be adjusted to be in tune with any instrument. Operates from internal 9V battery. Fitted with on/off switch, vibrato switch, earphone socket and external 9V D.C. socket.

**OUR PRICE £7.95** P&P 50p.

## BINATONE DIGITAL CLOCK

Attractive ivory case. Large clear numbers for hours, minutes and seconds. A.C. 240V operation. Size approx. 6½ x 3 x 3½ inches.

**OUR PRICE £4.50** P&P 50p.

## SINCLAIR IC12 INTEGRATED CIRCUIT AMPLIFIER

complete with printed circuit mounting board.

**OUR PRICE £1.50** P & P 15p.

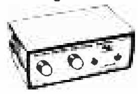
## SINCLAIR Project 80 Modules

| | | |
|---|---|---|
| Z40 Power Amp. | £5.95 | P & P 15p |
| Z60 Power Amp. | £7 45 | P & P 15p |
| Stereo 80 Pre-Amp | £13 95 | P & P 15p |
| Active Filter Unit | £7 45 | P & P 15p |
| FM Tuner | £13 95 | P & P 15p |
| Stereo Decoder | £8 95 | P & P 15p |
| PZ5 Power Supply | £5 95 | P & P 30p |
| PZ6 Power Supply | £8.95 | P & P 30p |
| PZ8 Power Supply | £8.45 | P & P 30p |
| Transformer for PZ8 | £4 05 | P & P 50p |
| IC 20 Stereo Amp. kit | £7.95 | P & P 15p |
| PZ20 Power Supply kit | £5 45 | P & P 30p |

## SINCLAIR Project 80 Packages

2xZ40/Stereo 80/PZ5 £28.60
2xZ40/Stereo 80/PZ6 £31.30
2xZ60/Stereo 80/PZ8 £33.55
P & P 35p each

## TE1021 Stereo Listening Station



For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on–off slide switch, stereo headphone socket.

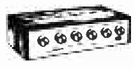
**OUR PRICE £2.25** P&P 15p

## AUDIOTRONIC LOW NOISE CASSETTES

| TYPE | 5 | 10 | 25 |
|---|---|---|---|
| C60 | £1.57 | £3.00 | £7.08 |
| C90 | £2.24 | £4.25 | £10.00 |
| C120 | £2.73 | £5.17 | £12.24 |

P&P 3p each. 10 and over Post Free

## MP7 MIXER-PREAMPLIFIER



5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.

**OUR PRICE £8.97** P&P 20p

## AUDIOTRONIC AHA101 Stereo Headphone Amplifier

All silicon, transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. INPUTS: 5mV and 100mV. OUTPUT: 50mV per channel.

**OUR PRICE £8.50** P&P 30p

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JOSTY KIT

WE ARE APPOINTED STOCKISTS AT Oxford Street, 42 & 257 Tottenham Court Road. 34 Lisle Street, 152, Fleet Street, 311 Edgware Road, CROYDON BIRMINGHAM KINGSTON LEICESTER NORTHAMPTON SOUTHEND TUNBRIDGE WELLS WOLVERHAMPTON branches, or by Mail Order.

All kits are complete with comprehensive easy to follow instructions and covered by full guarantee.

Post and Packing 15p per kit.

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| AF20 Mono amplifier | £5 61 |
| AF25 Mixer | £3 29 |
| AF30 Mono pre-amplifier | £3 20 |
| AF35 Emitter amplifier | £2 42 |
| AF80 0.5W mic. amplifier | £4 86 |
| AF305 Intercom | £7 67 |
| AF310 2 Mono Amplifier | £7 55 |
| M160 Multi-vibrator | £2 18 |
| M1302 Transistor tester | £8 33 |
| M191 VU Meter | £5 37 |
| M192 Stereo balance meter | £5 93 |
| LF380 Quadraphonic device. | £ 8 42 |
| AT5 Automatic light control | £3 75 |
| AT30 Photo cell switch unit | £ 6 68 |
| AT50 400W triac light dimmer/speed control | £5 18 |
| AT56 2,200W triac light dimmer/speed control | £6 75 |
| AT60 1 channel light control | £10 82 |
| AT65 3 channel light control | £16 52 |
| GU330 Tremolo unit | £8 10 |
| HF61 Diode detector | £3 87 |
| HF65 FM transmitter | £3 21 |
| HF75 FM receiver | £3 66 |
| HF310 FM tuner | £16 32 |
| HF325 Deluxe FM tuner | £26 33 |
| HF330 Decoder (HF310/325) | £10 55 |
| GP310 Stereo pre-amplifier for use with 2 x AF310 | £22 98 |
| GP312 Circuit board | £10 02 |
| GP304 Circuit board | £5 33 |
| HF380 lw/vhf aerial amplifier | £6 02 |
| HF395 broadband aerial amp. | £2 10 |
| NT10 Stabilised power supply 100mA, 9V | £6 27 |
| NT300 Stabilised p. supply | £13 16 |
| NT310 Power Supply 240 V AC or 2 x 18 V D C at 2 amps | £5 64 |
| NT305 Voltage converter | £5 64 |
| NT315 Power supply 240V AC to4,5/15V DC, 500mA | £12 06 |

**Amateur Electronics** by Josty-Kit, the professional book for the amateur – covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10 listed below.

**OUR PRICE £3.30** (No VAT) P&P 25p plus VAT.

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| AE1 100mW output stage | £1.55 |
| AE2 Pre-amplifier | £1 32 |
| AE3 Diode receiver | £2 05 |
| AE4 Flasher | £1.26 |
| AE5 Astable multi-vibrator | £1.14 |
| AE6 Monostable multi vibrator | £1 11 |
| AE7 RC generator | £1.08 |
| AE8 Bass filter | £1.05 |
| AE9 Treble filter | £1.05 |
| AE10 CCIR filter | £1.05 |

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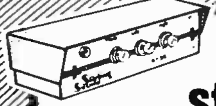
**ALL PRICES EXCLUDE VAT**

# BI-PRE-PAK

**SUPPLIERS OF SEMI-CONDUCTORS TO THE WORLD**



## 12 Watt stereo amp

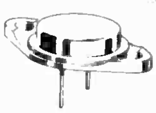
Only **£10** 45p p & p

SPECIAL OFFER LIMITED QUANTITY

**6 watt music power each channel**

This excellent little amplifier is of the latest integrated circuit design, and will work into 4, 8 or 16 ohm speakers. The reproduction is excellent for an amplifier of this size, only 8" X 3½" X 2". The case is made of chromed metal.

## Tested and Guaranteed Paks



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| B79 | 4 | 1N4007 Sil. Rec. diodes. 1,000 PIV lamp plastic | 50p |
| B81 | 10 | Reed Switches 1" long ⅛" dia. High speed P.O. type | 50p |
| H35 | 100 | Mixed Diodes, Germ. Gold bonded etc. Marked and Unmarked | 50p |
| H38 | 30 | Short lead Transistors. NPN Silicon Planar types | 50p |
| H41 | 2 | Power Transistors Comp. Pair BD 131/132 | 50p |
| H63 | 4 | 2N3055 Type NPN Sil. power transistors. Below spec. devices | 50p |
| H65 | 4 | 40361 Type NPN Sil. transistors TO-5 can comp. to H66 | 50p |
| H66 | 4 | 40362 Type PNP Sil. transistors TO-5 can comp. to H65 | 50p |
| H69 | 8 | Integrated circuits DTL data supplied. Mixed Types. Flip Flops, Gates, Hex Inverters, etc. | 50p |

## Unmarked Untested Paks

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|---|---|---|---|
| B1 | 50 | Germanium Transistors PNP, AF and RF. | 50p |
| B66 | 150 | Germanium Diodes Min. glass type | 50p |
| B86 | 100 | Sil. Diodes sub. min. IN914 and IN916 types | 50p |
| B83 | 200 | Transistors, manufacturers, rejects, AF, RF, sil and germ. | 50p |
| H26 | 40 | NPN Silicon Trans. 2N3707-11 range, low noise amp. | 50p |
| H34 | 15 | Power Transistors, PNP, Germ. NPN Silicon TO-3 Can. P & P 5p extra. | 50p |
| H67 | 10 | 3819 N Channel FET's plastic case type | 50p |
| H68 | 10 | Experimenters Pak of Integrated Circuits data supplied DTL & TTL some marked | 50p |

## 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.

**£1·00 each**

## Telephone dials

Standard Post Office type. Guaranteed in working order only **25p** + P&P 16p each

## Electronic Transistor Ignition £6.00

Complete Kit. P&P 11p

Now in kit form, we offer this "up-to-the-minute" electronic ignition system. Simple to make, full instructions supplied, with these outstanding features: transistor and conventional switchability, burglar-proof lock-up and automatic alarm, negative and positive compatibility.

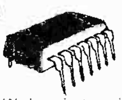
## New X-Hatch

**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 **£9·95** Complete kit **£7·95**

**(includes P & P, but no batteries)**

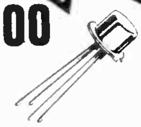
## LM380 AUDIO IC



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 **£1·00** 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.

## 8 RELAYS FOR £1·00

Various Types. Post & Packing 27p

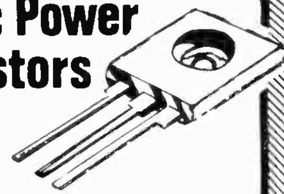
## UHF TV Tuner Units

**for 625 line channels 21 to 65**

**Brand new by a famous manufacturer**

**Data supplied £2·50**

## Plastic Power Transistors



**40 WATT SILICON**

| Type No. | Gain | VCE | Polarity | Price |
|---|---|---|---|---|
| 40N1 | 15 | 15 | NPN | 20p |
| 40N2 | 40 | 40 | NPN | 30p |
| 40P1 | 15 | 15 | PNP | 20p |
| 40P2 | 40 | 40 | PNP | 30p |

**90 WATT SILICON**

| Type No. | Gain | VCE | Polarity | Price |
|---|---|---|---|---|
| 90N1 | 15 | 15 | NPN | 25p |
| 90N2 | 40 | 40 | NPN | 35p |
| 90P1 | 15 | 15 | PNP | 25p |
| 90P2 | 40 | 40 | PNP | 35p |

**L.E.D's.** Complete with mounting grommet Red **25p** Green **40p**

**INTEGRATED CIRCUITS**

We stock a large range of I.Cs at very competitive prices. 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 **12p**. Wall Chart **18p**.

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# AMPLIFIER KITS OF *Distinction*

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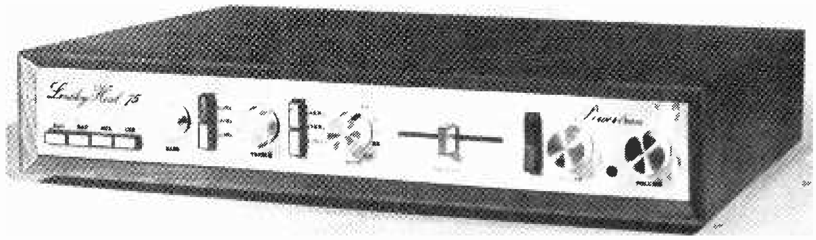
In Hi-Fi News there was published by Mr Linsley-Hood a series of four articles (November 1972–February 1973) and a subsequent follow-up article (April 1974) on a design for an amplifier of exceptional performance which has as its principal feature an ability to supply from a direct coupled fully protected output stage, power in excess of 75 watts whilst maintaining distortion at less than 0.01% even at very low power levels. The power amplifier is complemented by a pre-amplifier based on a discrete component operational amplifier referred to as the Liniac which is employed in the two most critical points of the system, namely the equalization stage and tone control stage, positions where most conventional designs run out of gain at the extremes of the frequency spectrum. Unusual features of the design are the variable transition frequencies of the tone controls and the variable slope of the scratch filter. There is a choice of four inputs, two equalized and two linear, each having independently adjustable signal level. The attractive slimline unit pictured has been made practical by highly compact PCBs and a specially designed Toroidal transformer.

## Hi-Fi News Linsley-Hood 75 W Amplifier Mk III Version (modifications as per Hi-Fi News April 1974)




Full circuit description in handbook (pack 15—price 30p)

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| 11 | Fibreglass printed-circuit board for power supply | £0.65 |
| 12 | Set of resistors, capacitors, secondary fuses, semiconductors for power supply | £3.50 |
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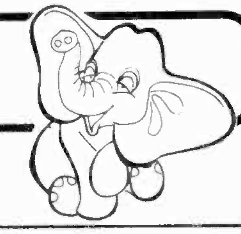

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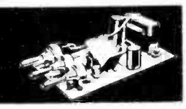

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| E1310 | Stereo 3–30mV mal cart 9 volt | £4.75 |
| FF3 | Stereo 3mV tape head 9 volt | £4.95 |
| 3402 | Stereo 5–20mV Mag. cart. mains | £5.95 |
| EQ25 | Mono 3–250mV Tape/cart/flat. 9 volt | £1.95 |

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| P500 9 volt 500mA | £3.20 | P12 4½–12 volt 0.4–1 amp | £7.15 |
| HC244R 3/6/7½/9 volt 400mA stabilised | £5.50 | SE101A 3/6/8/12 volt 1 amp stabilised | £12.75 |
| *P11 24 volt ½ amp | £3.30 | P1076 3/4½/6/7½/9/12 volt ½ amp | £4.20 |
| *P15 28 volt ½ amp | £3.30 | SE800A 1–15 volt 0–½A stabilised | £17.50 |
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| Audio filter unit | £6.95 |
| Z40 15 watt amplifier | £5.45 |
| Z60 25 watt amplifier | £6.95 |
| PZ5 power supplies for 1 or 2 Z40 | £4.98 |
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| Transformer for PZ8 | £3.95 |
| FM tuner | £11.95 |
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| IC20 power amp kit | £7.95 |
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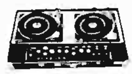

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pp 15p

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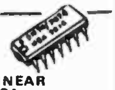

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|---|---|---|---|
| SN7400N | 0.16 | SN7492N | 0.70 |
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| SN7403N | 0.16 | SN7495N | 0.80 |
| SN7404N | 0.26 | SN7496N | 0.95 |
| SN7405N | 0.22 | SN7497N | 3.87 |
| SN7406N | 0.42 | SN74100N | 1.89 |
| SN7407N | 0.42 | SN74104N | 0.58 |
| SN7408N | 0.28 | SN74105N | 0.53 |
| SN7409N | 0.28 | SN74107N | 0.45 |
| SN7410N | 0.16 | SN74110N | 0.58 |
| SN7411N | 0.25 | SN74111N | 0.86 |
| SN7412N | 0.30 | SN74116N | 1.89 |
| SN7413N | 0.36 | SN74118N | 0.90 |
| SN7414N | 0.72 | SN74119N | 1.68 |
| SN7416N | 0.36 | SN74120N | 0.95 |
| SN7417N | 0.36 | SN74121N | 0.50 |
| SN7420N | 0.16 | SN74122N | 0.70 |
| SN7421N | 0.33 | SN74123N | 1.00 |
| SN7422N | 0.25 | SN74125N | 0.65 |
| SN7423N | 0.37 | SN74132N | 0.72 |
| SN7425N | 0.37 | SN74141N | 0.90 |
| SN7426N | 0.32 | SN74145N | 1.26 |
| SN7427N | 0.37 | SN74150N | 1.75 |
| SN7428N | 0.40 | SN74151N | 1.00 |
| SN7430N | 0.16 | SN74153N | 0.95 |
| SN7432N | 0.37 | SN74154N | 2.00 |
| SN7433N | 0.37 | SN74155N | 1.00 |
| SN7437N | 0.37 | SN74156N | 1.00 |
| SN7438N | 0.37 | SN74157N | 0.95 |
| SN7440N | 0.22 | SN74160N | 1.38 |
| SN7441AN | 0.92 | SN74161N | 1.38 |
| SN7442N | 0.79 | SN74162N | 1.38 |
| SN7443N | 1.27 | SN74163N | 1.38 |
| SN7444N | 1.27 | SN74164N | 1.76 |
| SN7445N | 1.60 | SN74165N | 1.76 |
| SN7446N | 1.89 | SN74166N | 1.60 |
| SN7447AN | 1.60 | SN74167N | 3.00 |
| SN7448N | 1.27 | SN74170N | 2.52 |
| SN7450N | 0.16 | SN74173N | 1.66 |
| SN7451N | 0.16 | SN74174N | 1.57 |
| SN7453N | 0.16 | SN74175N | 1.10 |
| SN7454N | 0.16 | SN74176N | 1.26 |
| SN7460N | 0.16 | SN74177N | 1.26 |
| SN7470N | 0.36 | SN74180N | 1.26 |
| SN7472N | 0.38 | SN74181N | 3.95 |
| SN7473N | 0.41 | SN74182N | 1.26 |
| SN7474N | 0.42 | SN74184N | 1.80 |
| SN7475N | 0.59 | SN74185N | 1.80 |
| SN7476N | 0.45 | SN74190N | 2.00 |
| SN7480N | 0.60 | SN74191N | 2.00 |
| SN7481N | 1.10 | SN74192N | 2.00 |
| SN7482N | 0.87 | SN74193N | 2.00 |
| SN7483N | 1.10 | SN74194N | 1.30 |
| SN7484N | 1.00 | SN74195N | 1.10 |
| SN7485N | 1.63 | SN74196N | 1.20 |
| SN7486N | 0.47 | SN74197N | 1.20 |
| SN7489N | 3.87 | SN74198N | 2.77 |
| SN7490N | 0.55 | SN74199N | 2.52 |
| SN7491AN | 1.00 | | |

**LINEAR**

| RCA | |
|---|---|
| CA3012 | 1.32 |
| CA3014 | 1.80 |
| CA3018 | 1.02 |
| CA3019 | 1.12 |
| CA3020 | 1.80 |
| CA3022 | 1.93 |
| CA3028A | 1.03 |
| CA3036 | 1.08 |
| CA3046 | 1.03 |
| CA3048 | 2.76 |
| CA3075 | 1.75 |
| CA3081 | 1.80 |
| CA3089E | 2.94 |
| CA3090Q | 5.40 |
| **Signetics** | |
| NE555 | 0.85 |
| NE560B | 5.00 |
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| NE567B | 3.50 |
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| MC1303L | 1.42 |
| MC1304P | 1.79 |
| MC1310P | 2.91 |
| MC1458CPI | 0.77 |
| MC1710CG | 0.60 |
| MFC4000P | 0.45 |
| MFC4010P | 0.55 |
| MFC6040P | 1.00 |
| **Others** | |
| TBA800 | 1.50 |
| SN76003N | 1.50 |
| SN72741P | 0.60 |
| SN72748P | 0.61 |
| 702C | 0.75 |
| 709C | 0.39 |
| 723C | 0.90 |
| 728C | 0.45 |
| 741C | 0.60 |
| 747C | 1.00 |
| ZN414 | 1.20 |
| 748C | 0.61 |
| LM309K | 2.00 |
| TAA960 | 1.75 |

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| AC128 | 0.15 | BU105 | 2.20 | V405A | 0.22 |
| AC187 | 0.21 | BY100 | 0.27 | ZTX108 | 0.08 |
| ACY17 | 0.40 | BY127 | 0.12 | ZTX300 | 0.13 |
| ACY39 | 0.78 | BYZ13 | 0.42 | ZTX302 | 0.18 |
| AD149 | 0.50 | C106D | 0.54 | ZTX500 | 0.13 |
| AD161 | 0.44 | GET111 | 0.72 | 2N697 | 0.16 |
| AD162 | 0.44 | GET115 | 0.90 | 2N706 | 0.12 |
| AF117 | 0.24 | GET880 | 0.60 | 2N930 | 0.18 |
| AF118 | 0.57 | LM309K | 2.00 | 2N987 | 0.42 |
| AF139 | 0.41 | MAT121 | 0.25 | 2N1132 | 0.24 |
| AF186 | 0.48 | MJE340 | 0.47 | 2N1304 | 0.28 |
| AF239 | 0.44 | MJE520 | 0.63 | 2N1613 | 0.21 |
| ASY27 | 0.33 | MJE3055 | 0.77 | 2N1671 | 1.20 |
| BA115 | 0.10 | MJE2955 | 1.27 | 2N2147 | 0.78 |
| BAX13 | 0.05 | MPF105 | 0.36 | 2N2160 | 0.78 |
| BC107 | 0.14 | NKT404 | 0.66 | 2N2926 | 0.12 |
| BC108 | 0.13 | OA5 | 0.72 | 2N3053 | 0.18 |
| BC109 | 0.14 | OA81 | 0.18 | 2N3054 | 0.48 |
| BC109C | 0.16 | OA200 | 0.08 | 2N3055 | 0.45 |
| BC113 | 0.15 | OA202 | 0.06 | 2N3440 | 0.58 |
| BC147 | 0.10 | OC28 | 0.66 | 2N3442 | 1.39 |
| BC148 | 0.08 | OC35 | 0.55 | 2N3525 | 0.91 |
| BC149 | 0.10 | OC36 | 0.60 | 2N3614 | 0.65 |
| BC169C | 0.15 | OC44 | 0.20 | 2N3702 | 0.11 |
| BC182 | 0.12 | OC45 | 0.20 | 2N3714 | 1.41 |
| BCY32 | 0.85 | OC71 | 0.18 | 2N3771 | 1.77 |
| BCT39 | 1.50 | OC72 | 0.28 | 2N3773 | 2.40 |
| 8CY55 | 2.64 | OC77 | 0.54 | 2N3790 | 2.10 |
| BCY70 | 0.18 | OC81 | 0.29 | 2N3819 | 0.38 |
| BCY71 | 0.22 | OC83 | 0.27 | 2N3886 | 0.72 |
| BCY72 | 0.12 | OC140 | 1.14 | 2N3903 | 0.15 |
| BD124 | 0.65 | OC170 | 0.30 | 2N4002 | 0.14 |
| BD131 | 0.42 | OC200 | 0.54 | 2N4126 | 0.15 |
| BF115 | 0.20 | OC202 | 0.90 | 2N4871 | 0.34 |
| BF180 | 0.36 | OCP71 | 1.20 | 2N5457 | 0.30 |
| BF194 | 0.10 | ORP12 | 0.60 | 2S303 | 0.60 |
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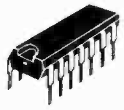

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| 74121 | £0·315 | £0·262 | £0·21 |
| 74122 | £0·45 | £0·375 | £0·30 |
| 74123 | £0·63 | £0·525 | £0·42 |
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| 74151 | £0·69 | £0·575 | £0·46 |
| 74153 | £0·69 | £0·575 | £0·46 |
| 74155 | £0·69 | £0·575 | £0·46 |
| 74156 | £0·69 | £0·575 | £0·46 |
| 74160 | £1·005 | £0·837 | £0·67 |
| 74161 | £1·005 | £0·837 | £0·67 |
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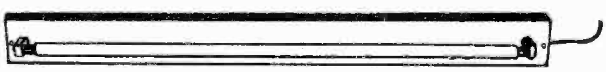
| BXY27 | Varacter Diode. "S" Band. Cut-off | 70GHz | **£1** |
| BXY28 | Varacter Diode. Cut-off | 100GHz | **£1** |
| BXY32 | Frequency Multiplier. "X" Band | 150GHz | **£1** |
| BXY35A/C | ditto | 25GHz | **£1** |
| BXY36C/D | ditto | 75GHz | **£1** |
| BXY37C/D | ditto | 100GHz | **£1** |
| BXY38C/E | ditto | 120GHz | **£1** |
| BXY39C/D | ditto | 150GHz | **£1** |
| BXY40D/E | ditto | 180GHz | **£1** |
| BXY41C/D/E | ditto | 200GHz | **£1** |

### 12 VOLT FLUORESCENT LIGHTING



| | | |
|---|---|---|
| Inverter transformers 13/15W (circuit included) | | **70p** |
| "Current economy" transistor (600 ma.) | | **50p** |
| "Maximum light" transistor (1·3A) | | **50p** |
| Resistors/capacitors to suit | | **15p** |
| Lampholders (long lead) (needed with cases) | Pair | **30p** |
| (short lead) | Pair | **20p** |
| White enamel case 21in (postage 30p) | | **70p** |
| Tube, 21in–13W | | **45p** |

(Note: tube only supplied if case ordered, to prevent postal damage).
13W fitting ready built and tested—including tube (postage 30p) **£3·75**
Post/packing, 25p per order except where shown.

### NEW! NEW! NEW! NEW!

An aerosol spray providing a convenient means of producing any number of copies of a printed circuit both simply and quickly.
Method: Spray copper laminate board with light sensitive spray. Cover with transparent film upon which circuit has been drawn. Expose to light. (No need to use ultra-violet.) Spray with developer, rinse and etch in normal manner.

Light sensitive aerosol spray **£1·00** plus
Developer and Etchant **50p** postage

Single-sided Copper-clad Fibreglass Board **75p** sq. ft.
Double-sided Copper-clad Fibreglass Board **£1·00** sq. ft.
Boards cut to any multiple of 6". Max. size 3' × 4'.

### 1,000,000 POTENTIOMETERS

We have bought a huge assortment of volume controls.

Pre-sets, sliders, etc. All are in manufacturer's original packing.

Manufacturing quantities of some types available.

Write or phone for details.

**Sample bag**
**100 mixed £2·50**

### ELECTROLYTIC CAPACITORS

Several thousand of each of the following types. Silly price to clear!

ALL NEW STOCK

| | |
|---|---|
| 5µf 10V | **35p** dozen |
| 10µf 10V | **35p** dozen |
| 50µf 10V | **35p** dozen |
| 100µf 10V | **35p** dozen |
| 330µf 16V | **45p** dozen |
| 330µf 25V | **60p** dozen |
| 330µf 35V | **80p** dozen |
| 2200µf 16V | **£1** dozen |
| 15000µf 25V | **50p** each |

### *HOBBY CORNER!*

### BRAN TUB ! ! !

- ★ **Resistors, Wire-wound and Carbon**
- ★ **Capacitors, Silver-mica, Paper, Ceramic, Polyester and Electrolytic**
- ★ **Controls, Volume, Pre-set, Carbon, Wire**
- ★ **Diodes, Silicon, Germanium, Zener**
- ★ **Transistors, Silicon, Germanium**

All the above are new and unused stock.
We have made up packs of 2lb gross weight, all are different in content, and contain a mixture of components from the above list. This is a fantastic, unrepeatable offer that will enable you to get a good stock of spares at a tiny fraction of normal price!
To make things even more interesting —TWENTY OF THESE BAGS ALSO CONTAIN A POUND NOTE! TWENTY CUSTOMERS WILL BE VERY PLEASED INDEED!
And the price that we are asking? Only **£1·50** including both postage and VAT!
Rush your order now! This offer is only made to reduce our surplus stock! It is unlikely that in these days of rising prices we shall ever be able to repeat!

**£1** — **100 ½ WATT RESISTORS, 100 CERAMIC CAPACITORS, 100 DIODES**
POSTAGE **25p** — PACK No. 1

**£1** — **100 RESISTORS, 100 CERAMIC CAPACITORS, 100 POLYSTYRENE CAPACITORS**
POSTAGE **25p** — PACK No. 2

**£1** — **100 RESISTORS, 100 CERAMIC CAPACITORS, 50 MULLARD POLYESTER CAPACITORS**
POSTAGE **25p** — PACK No. 4

**£1** — **20 ASSORTED UNUSED, MARKED, TESTED TRANSISTORS BC108 ETC.**
POSTAGE **25p** — PACK No. 5

**£1** — **1 TRANSISTORISED SIGNAL TRACER KIT, 1 TRANSISTORISED SIGNAL INJECTOR KIT**
POSTAGE **25p** — PACK No. 6

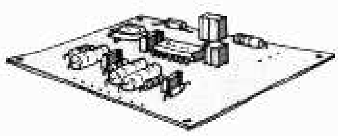
**£1** — **100 RESISTORS, 100 CAPACITORS (ASSORTED TYPES)**
POSTAGE **25p** — PACK No. 8

## REMEMBER! ALL GOODS PLUS 8% V.A.T.

**G. F. MILWARD, 369 Alum Rock Rd., Birmingham B8 3DR.** Postage (minimum) per order 25p.

# BI-PRE-PAK

## Audio Bargains

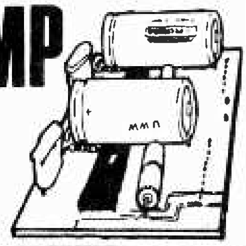


### STEREO DECODER £4.50

incl. P. & P.

Ready-built unit. ready for connection to the IF stages of existing FM Radio or Tuner. The very latest second-generation coilless integrated circuit design, operating on the phase locked loop system offering even better stereo separation. Only owing to our bulk-buying capacity are we able to offer this at the old price. **LED Stereo indicator lights available. RED @ 25p GREEN @ 40p.**

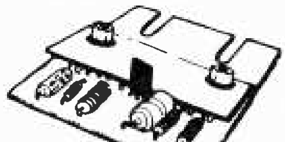
## 3 W R.M.S. I.C. AMP



**only £1.50** incl. P. & P. Order Code I.C.A. 1

**On P.C. Board with all components or 2 on one board for £2.60.** Order Code I.C.A. 1/S
These amps. are supplied with a free booklet on connecting up, specifications and easy to build projects using the I.C.A. 1

## 5W & 10W AMPS



**5W ONLY £1.80**
**10W ONLY £2.26**
incl. P. & P.

**These matchbox size amplifiers** have an exceptionally good tone and quality for the price. They are only 2¼" x 1¾". The 5W amp will run from a 12V car battery making it very suitable for portable voice reinforcement such as public functions. Two amplifiers are ideal for stereo. Complete connection details and treble, bass, volume and balance control circuit diagrams are supplied with each unit. Discounts are available for quantity orders. More details on request. **Cheapest in the U.K. Built and tested.**

## Now available for 5 & 10W AMPS

**Pre-assembled printed** circuit boards 2" x 3" available in stereo only. will fit ·15 edge connector.

**Stereo Pre-Amp 1 (Pre 1).** This unit is for use with low gain crystal or ceramic pick up cartridges. £1.10

**Stereo Pre-Amp 2 (Pre 2).** This unit is for use with magnetic pick-up cartridges £1.55

**Stereo Tone Control (STC).** This unit is an active tone control board and when used with the right potentiometers will give bass and treble boost and cut £1.10

**Instruction leaflet supplied with all units. Post and Packing included in Prices.**

**Please add VAT at current rate.**

I enclose £ .................................................... for
.............. Decoders/ ............ 3W Amps/ ............ 5W Amps
................. 10W Amps/ ..................... Stereo Pre-Amps 1
.............. Stereo Pre-Amps 2 ............... Stereo Tone Controls
(Please insert quantities and delete those not applicable)
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Address .......................................................
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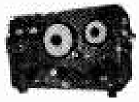
**BI-PRE-PAK** Co. Regn. No.820919
Dept 8 222/224 WEST ROAD, WESTCLIFF ON SEA, ESSEX SS0 9DF. TELEPHONE SOUTHEND (0702) 46344.

# P. F. RALFE

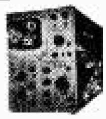
10 CHAPEL ST. LONOON NW1. Phone 01-723 8753

## SIGNAL GENERATORS



**MARCONI TF801D/1S.** 10-480 mHz P.O.A.
**MARCONI TF801B/2S.** 10-480 mHz **£225.**
**MARCONI TF144H** 10kHz—72 mHz P.O.A.
**MARCONI TF1370** RC Oscillator 10kHz-10mHz. Sine/Square.
**ROHDE & SCHWARZ SMAF** (illustrated) AM/FM 4-300 mHz.
**ROHDE & SCHWARZ SMLR** 15-30mHz power generator. P.O.A.
**RACAL/AIRMEC 201A.** 30kHz-30mHz. As new. P.O.A.
**ADVANCE SG21** VHF Square-wave generator 9kHz-100mHz. **£25.**

## OSCILLOSCOPES



**TEKTRONIX 555** (Late model) with two 'L' plug-ins and '21A' and '22A' plug-ins.
**TEKTRONIX 545A** with CA unit. DC-30mHz. Price only **£295·00.**
**TETRONIX 531** DC-15mHz with L type plug-in
**TETRONIX 535** DC-15mHz with L type plug-in
**ITT METRIX** miniature portable scope. DC-10mHz. Brand new. **£50.**
NB: Due to the fragile nature of CRTs we regret that these oscilloscopes cannot be despatched by post. Collection only or delivery could be arranged.

## MISCELLANEOUS TEST EQUIPMENT

**MARCONI TF1400S** double pulse generator with TM6600/S secondary pulse unit. **£105.**
**MARCONI TF791D** deviation meter. 4-1024mHz. 0-100kHz deviation.
**MARCONI TF1342** low-capacitance bridge 0·002pf-1,111pf. Resistance 1-1000M.ohm. **£85.**
**ROHDE & SCHWARZ** USVD calibrated receiver 280-4, 600mHz.
**ROHDE & SCHWARZ** A.F. Wave Analyser type FTA 0-20kHz plus log/lin AF meter incorporated. Excellent condition.
**ROHDE & SCHWARZ** URV milli-voltmeter BN10913 (late type) 1mV-10V. With 'T' type insertion unit, free probe and attenuator heads. 1kHz-1,600mHz. **£175.**
**COSSOR 1453** True RMS milli-voltmeter. Excellent. **£75.**
**ADVANCE PG54** Pulse generator. AS NEW.
**SOLARTRON EM1006** production-line resistance tolerance check-set. 0-15Mohm digital read-out.
**AIRMEC TYPE 210** modulation meter. Excellent condition.
**WAYNE KERR B521** LCR Bridge. Excellent condition. **£55.**
**EDDYSTONE 770R** VHF Receiver covering 19-165mHz. As mew. **£125**

**MUFFIN INSTRUMENT FANS**
Dimensions 4·5 x 4·5 x 1·5 ins. Very quiet running, precision fan specially designed for cooling electronic equipment, amplifiers etc. For 110V. AC operation—(practise is to run from split primary of mains transformer or use suitable mains dropper). CC only 11 Watts. List price over £10 each. Our price, in brand new condition, is **£3·50.**

**POLARAD Model SA84WA SPECTRUM ANALYSER**
10MHz-63GHz. I.F. Markers. Spectrum calibrator. Log/Lin scale. NB. This is not the instrument with the expensive TWT to replace. Supplied in full working, excellent condition. Guarantee.

**MANY TYPES** of RF plugs and sockets in stock:—
BNC plugs 50Ω. **30p.** BNC sockets 50Ω. **25p.** N. Type plugs 50Ω. **50p.** Burndept plugs. **40p.** Burndept sockets. **40p.** Miniature PYE. **20p.** Miniature sockets. **20p.**
All connectors are brand new. Immediate delivery. Please add appropriate postage.

**DURATRAK VARIACS** type 100L. 230V. AC Input. 0-230V. AC Output, at 8 amps. Brand new units, less control knobs. Price only **£15·00.** Carriage £1.

**MINI HELIPOTS**
500 Ω Beckman Linearity Tolerance 0.075% (10 Turn). 1K Ω Beckman Linearity Tolerance 0.25% (10 Turn). 20 Ω Colvern CLR 26/6310/9S (3 Turn). 5K Ω Colvern (10 Turn).

**AVO VALVE TESTERS**
Brief-case type 160. Full working condition throughout. **£65.**

**AERIAL CHANGE/OVER RELAYS**
of current manufacture designed especially for mobile equipments, coil voltage 12v., frequency up to 250 MHz at 50 watts. Small size only, 2 in. × ¾ in. Offered brand new. boxed. Price **£1·50,** inc. P.&P.

**RACAL/AIRMEC** VHF/UHF Millivoltmeter type 301A. Frequency range 50Hz-900mHz. Voltage range 300μV-3V in eight ranges. Co-axial input 50 and 75 ohms BNC connectors. DC Ranges 100μV-10V in ten ranges. Light-weight mains operated instrument in as new condition with handbooks. Other makes of voltmeter also available from stock.

**HEWLETT-PACKARD RF POWER METER**
Type 432A. Power range 1μW-10mW in 7 ranges. Frequency range 10mHz-10GHz. Automatic zeroing. With 478A co-ax mounts and carrying case. In excellent condition.

**HEWLETT PACKARD/ BOONTON TYPE 8900B**
Peak-power calibrator. Measures true peak power ±.6 db absolute. Frequency range 50-2000Mhz. RF power range 200mW peak, full-scale. RF Impedance 50 ohms. P.O.A.

**POLARAD MICROWAVE RECEIVER**
Model 'R' with tuning unit type RMT. Frequency range 4.2GHz-7.65GHz. AM/FM. In working condition. Price **£75.**

**PLEASE ADD 8% V.A.T. TO THE TOTAL AMOUNT WHEN ORDERING. INCORRECT AMOUNTS WILL CAUSE DELAY IN DESPATCH. THANK YOU.**

**REDIFON TELEPRINTER RELAY UNIT NO. 12:** ZA-41196 and power supply 200-250V a.c. Polarised relay type 3SEITR. 80-0-80V 25mA. Two stabilised valves CV 286. Centre Zero Meter 10-0-10. Size 8in. × 8in. × 8in. New condition. **£8.50.** Carr. 75p.

**AUTO TRANSFORMER:** 230V 50c/s, 1000 watts. Mounted in strong steel case 5in. × 6½in. × 7in. Bitumen impregnated. **£10** each, Carr. £1.

**TELEPRINTER TYPE 7B;** Pageprinter 24V d.c. power supply, speed 50 bauds per min. 'as new' cond. in original packing case, **£25** each; or second hand cond. (excellent order) no parts broken, **£15** each. Carriage either type £3·00.

**INSULATION TEST SET:** 0-10 kV negative, earth with amplifier provision for checking ionisation. 110/230V a.c. input. S/hand good cond. **£30** + £1 carr.

**BRIDGE MEGGER:** 250V. (Evershed Vignoles) series 2. **£30** each. Carr. £1.

**BRIDGE MEGGER:** 2,500V., series 1. **£30** each. Carr. £1.

**CRYSTAL TEST SET TYPE 193:** used for checking crystals in freq. range 3000-10,000KHz. Mains 230V 50Hz. Measures crystal current under oscillatory conditions and the equivalent resistance. Crystal freq. can be tested in conjunction with a freq. meter. **£17.50.** Carr. £1.50.

**TYPE 174/1 FREQUENCY SHIFT ADAPTOR** (Northern Radio Co.): Convert. mark and space frequencies from the output of one or two Receivers into d.c. pulses. Suitable to operate Teleprinters or similar devices. 110/220V. Further details on request, s.a.e. **£55** each. Carr. £1.50.

**TELEGRAPH TERMINAL UNIT (A.T.E.) TYPE TFS3:** Converts signals from Receivers into d.c. pulses. Complete with monitor. **£75** each. Carr. £2.

**MUIRHEAD PAMETRADA WAVE ANALYSER D-489-EM:** Primarily used for the analysis of complex vibration waveforms but will measure audio and power frequency waveforms from 19Hz-21KHz. Complete with power supply unit 230V 50Hz. Secondhand, good condition. **£90.** Carr. £3.

**FURZHILL SENSITIVE VALVE VOLTMETER V.200:** Freq. 10Hz-6MHz (can be used beyond 6MHz). Probe in circuit—voltage range 1mV-1kV in 6 decade ranges; full scale deflection 10mV, 100mV-1kV. Without probe 100µV-100V in 6 decade ranges; full scale deflection 1mV, 10mV-100V. Accuracy ±5%. **£30** each. Carr. £1.

**NOISE FIGURE METER TYPE 113A** (Magnetic AB, Sweden): **£125** each. Carr. £1.

**PRECISION PHASE DETECTOR TYPE 205:** Freq. 0.1-15MHz in 5 ranges. Variable time delay microseconds 0-0.1c, 115V input. **£55** each. Carr. £1.

**ROHDE & SCHWARZ HF MILLIVOLTMETER:** 30Hz-30MHz Type UVH, 1mV-1V in 7 ranges, 220V. **£75** each. Carr. £2.

**ROHDE & SCHWARZ VHF WATTMETER TYPE NAK:** with matching indicator, 30 watts, 200-470MHz. **£25** each. Post 70p.

**ADVANCE PULSE GENERATOR PG55: £40** each. Carr. £1.

**PHILLIPS VALVE VOLTMETER TYPE GM6014:** 1-300mV in 6 ranges, 70-20dB, probe 1000Hz-30MHz, 300mV maximum. **£35** each. Carr. £1.

**TF-1345/2 DIGITAL FREQUENCY COUNTER:** Range 10KHz-100MHz with extension units. Details on request, s.a.e. **£100.** Carr. £2.

**UHF MICROWAVE MILLIWATTMETER TYPE 14:** Direct reading, can be used to measure power from 100MHz upwards. F.S.D. on 4in. scale meter 2.5mW. **£40** each. Carr. £1.

**MARCONI HF SPECTRUM ANALYSER OA. 1094/3.** Further details on request. **£250** each. Carr. £5.

**Q METER:** 30MHz-200MHz. **£55.** Carr. £1.

**SIGNAL GENERATOR AIRMEC TYPE 701:** 30KHz-30MHz, 7 ranges. **£65.** Carr. £1.50.

**TF-1278/1 TRAVELLING TUBE WAVE AMPLIFIER: £125.** Carr. £2.

**BPL A.C. MILLIVOLTMETER TYPE VM.348-D Mk. 3:** 2 millivolts-2 volts, 6 ranges. **£30.** Carr. £1.

**WAYNE KERR WAVEFORM ANALYSER A.321:** Low scale 0-1200 c/s. High scale 1-20 Kc/s, 600 ohms. Harmonic level is 0-55 dB in 12 steps. **£75.** Carr. £1.50.

**SPECTRUM ANALYSER TYPE MW.69S** (Decca): Further details on request. **£200.**

**MARCONI DUAL TRACE UNIT TM-6456: £30.** Post 60p.

**AVO TRANSISTOR TESTER CT.446: £30.** Carr. £1.

**SIGNAL GENERATOR TS-403B/U (or URM-61A):** (Hewlett Packard). A portable, self-contained, general-purpose test equipment designed for use with radio and radar receivers and for other applications requiring small amounts of RF power such as measuring standing-wave ratios, antenna and transmission line characteristics, conversion gain, etc. Both the output freq. and power are indicated on direct-reading dials. 115V, AC, 50 c/s. Freq.—1800-4000 Mc/s. CW, FM, Modulated Pulse—40-4000 pulses per sec. Pulse Width—0.5-10 microsecs. Timing—Undelayed or delayed from 3-300 microsecs from external or internal pulse. Output—1 milliwatt max., 0 to —127 dB variable. Output Impedeance—50O. Price: **£120** each + £2 carr.

**H.V. TRANSFORMER:** 8000/8000. Output 300mA. rms. Size: 12in. × 12in. × 36in. 230V input. **£40.** Carr. £4.

**TELEPHONE CABLE:** (Twin) 1,300ft. on metal reel. **£7.50** per reel. Carr. £1

**FIRE-PROOF TELEPHONES: £25·00** each, carr. £1·50.

**TF.2000 A.F. SIGNAL SOURCE: £175·00,** carr. £1·00.

**POWER UNIT:** 110/230 volts a.c. input. 28 volts d.c. at 40 amps output. **£30·00** each, carr. £3·00.

**SMOOTHING UNIT** (for the above): **£10·00** each, carr. £2·00.

**X-BAND MODULATOR CALIBRATOR TYPE MC-4420-X:** Mnfr. James Scott. **£125** ea., Carr. £1.

**HP-766D DUAL DIRECTIONAL COUPLER:** 940-1975MHz. **£35** ea., 75p post.

**BACKWARD WAVE OSCILLATOR TYPE SE-215:** 6.3 heater, 105V Anode, 7.9mA. Mnfr. Watkins & Johnson. **£85** ea., Carr. £1.

**LISTS OF EQUIPMENT AVAILABLE: MOTORS; TELEPRINTERS; AR88 SPARES; TEST EQUIPMENT ETC.** Send 10p for above lists.

**ALL CARRIAGE QUOTES GIVEN ARE FOR 50 MILE RADIUS OF LONDON ONLY.**

**ALL U.K. ORDERS SUBJECT TO 8% VALUE ADDED TAX. THIS MUST BE ADDED TO THE TOTAL PRICE (including post or carriage).**

*If wishing to call at stores, please telephone for appointment.*

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*Phone: 01-808 9213 and Bedford 740605 (STD 0234).*

# QUADROPHONIC TAPE PLAYERS

**Tape Transports**
Brenell Mark V Series III Tape Decks mounted on Imhof Case IMP503/1915 size 21 in. wide x 19 in. front to back and 10 in. high overall including deck. This rugged unit can be purchased separately or fitted with the amplifiers described below. Others are available giving up to eight tracks. Price from **£118**

**Playback Pre-amplifiers**
A self-powered unit size 19 in. x 5¼ in. x 4½ in. deep with four plug-in low noise preamplifiers giving 1V output into 100 ohm line. Price **£32**

**Quad Power Amplifiers**
A complete amplifier size 7 in. x 10½ in. x 4 in. high with four plug-in power amplifiers each giving 8W RMS into 8 ohms from TIP31/32 output stage. 30V supply. Price **£37**

Tax and carriage extra

*Ask about tape controlled teaching equipment, with illuminated panel display, for typewriting and playing the piano or organ.*

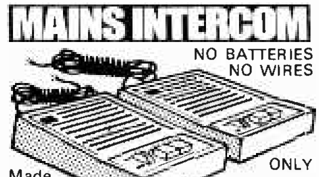
**DEIMOS LIMITED**
**Simmonds Road, Wincheap Industrial Estate, Canterbury, Kent.**
**Tel: 0227 68597**

NEW! AMERICAN STYLE CRADLE
**TELEPHONE AMPLIFIER**

ONLY **£11·95**

Latest transistorised Telephone Amplifier is completely automatic with detachable plug-in speaker. Placing the receiver on to the cradle activates a switch for immediate two-way conversation without holding the hand-set. Many people can listen at a time. Increase efficiency in office, shop, workshop. Perfect for "conference" calls: leaves the user's hands free to make notes, consult files. No long waiting. On/Off switch, volume control. Model with tape-recording facility £12·95. P. & P. 50p. C.W.O. 10-day price refund guarantee.

NEW IMPROVED
**MAINS INTERCOM**
NO BATTERIES NO WIRES

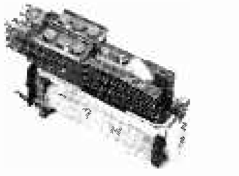


ONLY **£21·99** + VAT £1·76 per pair

Made to Brit. Safety & Telecom. Standards. Supplied with 3-core wire. Just plug into power socket. Ready for use. Crystal-clear communication from room to room. Operates over a ¼-mile range. On/Off switch. Vol. control. Useful as office intercom, baby alarm, invalids. No G.P.O. licence reqd. Full price ref. if returned in 10 days. 12 months' service guarantee. P. & P. 60p.

**WEST LONDON DIRECT SUPPLIES (W/W)**
**169 Kensington High Street, London W.8**

# *Wilkinsons* RELAYS



We have years of experience in building P.O. type 3000 and 600 relays to your own specification. Complete banks of contacts made to order and component parts also supplied. Very highest quality at competitive prices. Quotations by return. Specialists in export orders.

**ALL BEST BRITISH MAKES MOVING COIL DC METERS**

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|---|---|
| **2 INCH FLUSH SQUARE** | |
| 250 Microamp | £4.50 each |
| 15 Milliamp | £2.50 each |
| 25 Milliamp (scaled 100 & 200 Milliamp) | £2.50 each |
| 50–0–50 Amp | £1.00 each |
| 1 Volt | £3.50 each |
| 2 Volt | £3.50 each |
| 5 Volt | £3.50 each |
| 100 Volt | £4.50 each |
| **2 INCH FLUSH ROUND** | |
| 5 Amp | £2.50 each |
| 20 Volt | £2.50 each |
| 40 Volt | £2.50 each |
| **2½ INCH FLUSH ROUND** | |
| 200 Microamp | £3.50 each |
| 500 Microamp | £4.00 each |
| 5–0–5 Milliamp | £1.25 each |
| 10–0–10 Milliamp | £2.30 each |
| 15–0–15 Milliamp | £1.25 each |
| 100 Milliamp | £1.25 each |
| 400 Amp | £3.00 each |
| 500 Millivolt | £3.25 each |
| 120 Volts | £2.50 each |
| **3½ INCH FLUSH ROUND** | |
| 500 Microamp | £3.50 each |
| 2 Milliamp | £3.00 each |
| 500 Milliamp | £3.75 each |
| 500 Millivolt | £4.25 each |
| 50 Volt | £3.75 each |
| 100 Volt | £4.25 each |
| 120 Volt | £4.25 each |
| 200 Volt | £4.25 each |

All prices shown are carriage paid UK only but subject to VAT at the standard rate.
**WE ARE AREA STOCKISTS OF ALL STUART TURNER PUMPS. CENTRIFUGAL TYPES 10 AND 12 AVAILABLE NOW.**
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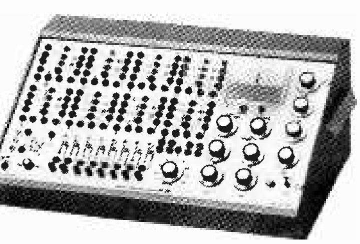
WW—066 FOR FURTHER DETAILS

# ANALOGUE & HYBRID COMPUTERS



**C60 FEATURES:**
Eight low drift, high gain, IC operational amplifiers. 1% accuracy. Automatic function selection and meter switching. A four quadrant variable multiplier. Individual pot-set facilities, built-in stabilised power supplies plus all of the features expected in our precision machines. Price **£475** complete with patching leads and instruction book.
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**PHYSICAL & ELECTRONIC LABORATORIES LTD.**
**MANUFACTURERS OF PRECISION ELECTRONIC INSTRUMENTS & COMPUTERS**
**28 Athenaeum Road, Whetstone, London N20. Tel. 01-445 7683**

WW—134 FOR FURTHER DETAILS

# VALVES

| Type | £ | Type | £ | Type | £ |
|---|---|---|---|---|---|
| A1065 | 1.25 | ECL80 | 0.55 | EZ80 | 0.30 |
| AR8 | 0.55 | ECL82 | 0.35 | EZ81 | 0.30 |
| ATP4 | 0.50 | ECL83 | 0.70 | GY501 | 0.75 |
| B12H | 3.00 | ECL86 | 0.50 | GZ34 | 0.70 |
| CY31 | 0.50 | EF36 | 0.65 | GZ37 | 1.00 |
| DAF96 | 0.50 | EF37A | 1.20 | KT66 | 2.50 |
| DF96 | 0.55 | EF40 | 0.75 | KT88 | 3.00 |
| DK96 | 0.55 | EF41 | 0.65 | MH4 | 0.75 |
| DL92 | 0.40 | EF80 | 0.30 | ML6 | 0.65 |
| DL96 | 0.60 | EF83 | 1.25 | OA2 | 0.45 |
| DY86/87 | 0.40 | EF85 | 0.35 | OB2 | 0.45 |
| DY802 | 0.45 | EF86 | 0.35 | PABC80 | 0.40 |
| E88CC/01 | 1.20 | EF89.. | 0.30 | PC97 | 0.50 |
| E180CC | 0.70 | EF91 | 0.45 | PC900 | 0.50 |
| E182CC | 1.25 | EF92 | 0.50 | PCC84 | 0.40 |
| EA50 | 0.40 | EF95 | 0.40 | PCC85 | 0.40 |
| EABC80 | 0.40 | EF183 | 0.35 | PCC88 | 0.60 |
| EAF42 | 0.75 | EF184 | 0.35 | PCC89 | 0.50 |
| EB91 | 0.30 | EFL200 | 0.75 | PCC189 | 0.60 |
| EBC33 | 1.00 | EL33 | 2.50 | PCF80 | 0.40 |
| EBC41 | 0.75 | EL34 | 0.70 | PCF82 | 0.40 |
| EBF80 | 0.40 | EL36 | 0.60 | PCF84 | 0.60 |
| EBF83 | 0.50 | EL41 | 0.80 | PCF86 | 0.60 |
| EBF89 | 0.40 | EL81 | 0.60 | PCF200 | 0.75 |
| EC52 | 0.35 | EL82 | 0.55 | PCF201 | 0.75 |
| ECC81 | 0.40 | EL84 | 0.30 | PCF801 | 0.55 |
| ECC82 | 0.35 | EL85 | 0.60 | PCF802 | 0.50 |
| ECC83 | 0.35 | EL86 | 0.45 | PCF805 | 0.90 |
| ECC84 | 0.35 | EL90 | 0.45 | PCF806 | 0.75 |
| ECC85 | 0.40 | EL504 | 0.80 | PCF808 | 0.90 |
| ECC86 | 0.90 | EM31 | 0.60 | PCH200 | 0.80 |
| ECC88 | 0.50 | EM80 | 0.55 | PCL81 | 0.55 |
| ECC189 | 0.70 | EM84 | 0.40 | PCL82 | 0.40 |
| ECF80 | 0.40 | EM87 | 1.00 | PCL83 | 0.65 |
| ECF82 | 0.40 | EY51 | 0.45 | PCL84 | 0.45 |
| ECF801 | 0.75 | EY81 | 0.45 | PCL86 | 0.50 |
| ECH42 | 0.80 | EY86 | 0.40 | PCL805 | 0.60 |
| ECH81 | 0.35 | EY88 | 0.50 | PFL200 | 0.70 |
| ECH83 | 0.45 | EZ40 | 0.70 | PFL200 | 0.70 |
| ECH84 | 0.45 | EZ41 | 0.75 | PL36 | 0.60 |
| | | | | PL81 | 0.50 |
| | | | | PL82 | 0.45 |
| | | | | PL83 | 0.45 |
| | | | | PL84 | 0.45 |
| | | | | PL504 | 0.80 |
| | | | | PL508 | 1.00 |

| Type | £ | Type | £ | Type | £ | Type | £ |
|---|---|---|---|---|---|---|---|
| PL509 | 1.35 | U191 | 0.75 | VR150/30 | 0.45 | 3D6 | 0.40 |
| PL802 | 0.95 | U801 | 0.75 | X66 | 0.65 | 3S4 | 0.40 |
| PY33 | 0.60 | UABC80 | 0.40 | Z800U | 2.70 | 3V4 | 0.85 |
| PY80 | 0.40 | UAF42 | 0.65 | Z801U | 2.70 | 5B/254M | 4.00 |
| PY81 | 0.40 | UBC41 | 0.60 | Z900T | 1.20 | 5B255M | 3.50 |
| PY82 | 0.40 | UBF80 | 0.40 | 1A3 | 0.55 | 5R4GY | 0.90 |
| PY83 | 0.40 | UBF89 | 0.40 | 1L4 | 0.25 | 5U4G | 0.50 |
| PY88 | 0.45 | UBL1 | 1.00 | 3A4 | 0.60 | 5V4G | 0.55 |
| PY500 | 1.00 | UBL21 | 0.70 | 1R5 | 0.40 | 5Y3GT | 0.55 |
| PY800 | 0.45 | UCC85 | 0.45 | 1S4 | 0.30 | 5Z3 | 0.80 |
| PY801 | 0.50 | UCF80 | 0.75 | 1T4 | 0.30 | 5Z4 | 0.80 |
| QQVO3-10 | 1.40 | UCH42 | 0.75 | 1X2A | 0.60 | 5Z4TG | 0.55 |
| QQVO6-40A | 8.00 | UCH81 | 0.45 | 1X2B | 0.75 | 6AB7 | 0.60 |
| QVO3-12 | 1.10 | UCL82 | 0.45 | 2D21 | 0.50 | 6AC7 | 0.60 |
| R19 | 0.60 | UCL83 | 0.65 | 2K25 | 9.00 | 6AH6 | 0.70 |
| SC1/400 | 3.00 | UF41 | 0.70 | | | | |
| SC1/600 | 5.00 | UF80 | 0.35 | | | | |
| SP61 | 0.75 | UF85 | 0.45 | | | | |
| TT21 | 5.00 | UF89 | 0.50 | | | | |
| U25 | 0.85 | UL41 | 0.70 | | | | |
| U26 | 0.75 | UL84 | 0.40 | | | | |
| U27 | 0.65 | UY41 | 0.45 | | | | |
| | | UY85 | 0.40 | | | | |
| | | VR105/30 | 0.45 | | | | |

**VAT 8% EXTRA**

| Type | £ | Type | £ | Type | £ |
|---|---|---|---|---|---|
| 6AK5 | 0.40 | 6C6 | 0.50 | 6L6G | 0.40 |
| 6AK8 | 0.40 | 6CB6 | 0.50 | 6L7G | 0.40 |
| 6AL5 | 0.30 | 6CH6 | 1.45 | 6SA7 | 0.50 |
| 6AL5 W | 0.55 | 6CL6 | 0.75 | 6SA7GT | 0.40 |
| 6AM6 | 0.45 | 6D6 | 0.55 | 6SC7GT | 0.40 |
| 6AN8 | 0.45 | 6EA8 | 0.85 | 6SG7 | 0.50 |
| 6AQ5 | 0.45 | 6F7 | 1.10 | 6SJ7 | 0.55 |
| 6AQ5W | 0.70 | 6F8G | 0.75 | 6SJ7GT | 0.35 |
| 6AS6 | 0.80 | 6F23 | 0.90 | 6SK7 | 0.55 |
| 6AT6 | 0.45 | 6F32 | 0.75 | 6SL7GT | 0.50 |
| 6AU6 | 0.40 | 6F33 | 3.50 | 6SN7GT | 0.55 |
| 6AV6 | 0.45 | 6H6 | 0.35 | 6SQ7 | 0.55 |
| 6AX4GT | 0.75 | 6J4WA | 1.25 | 6V6G | 0.15 |
| 6AX5GT | 1.00 | 6J5 | 0.65 | 6V6GT | 0.50 |
| 6B7 | 0.70 | 6J5GT | 0.50 | 6X4 | 0.40 |
| 6BA6 | 0.35 | 6J6 | 0.30 | 6X5G | 0.40 |
| 6BE6 | 0.40 | 6J7 | 0.60 | 6X5GT | 0.50 |
| 6BG6G | 0.90 | 6J7G | 0.40 | 6Y6G | 0.90 |
| 6BJ6 | 0.65 | 6K6GT | 0.80 | 6Z4 | 0.65 |
| 6BQ7A | 0.60 | 6K7 | 0.55 | 6-3OL2 | 0.90 |
| 6BR7 | 1.20 | 6K7G | 0.30 | 7B7 | 0.80 |
| 6BW6 | 1.00 | 6K8GT | 0.50 | 7Y4 | 0.80 |
| 6BW7 | 1.00 | 6K25 | 1.00 | 9D6 | 0.40 |
| 6C4 | 0.40 | 6L6 | 1.25 | 9D2 | 6.00 |
| | | | | 12AG | 0.55 |
| | | | | 12AT6 | 0.45 |
| | | | | 12AT7 | 0.40 |
| | | | | 12AU7 | 0.35 |
| | | | | 12AV6 | 0.50 |
| | | | | 12AX7 | 0.35 |
| | | | | 12BA6 | 0.45 |
| | | | | 12BE6 | 0.50 |
| | | | | 12BH7 | 0.50 |
| | | | | 12C8 | 0.55 |
| | | | | 12E1 | 3.50 |
| | | | | 12K5 | 1.10 |
| | | | | 12K7GT | 0.50 |
| | | | | 12K8GT | 0.70 |
| | | | | 12Q7GT | 0.70 |
| | | | | 12SA7GT | 0.70 |
| | | | | 12SG7 | 0.55 |
| | | | | 12SJ7 | 0.55 |
| | | | | 12Y4 | 0.40 |
| | | | | 14S7 | 1.00 |
| | | | | 19AQ5 | 0.65 |
| | | | | 19G3 | 8.00 |
| | | | | 19G6 | 6.60 |
| | | | | 19H5 | 14.00 |
| | | | | 20P3 | 0.60 |
| | | | | 20P4 | 1.10 |
| | | | | 25L6GT | 0.70 |
| | | | | 30C15 | 1.00 |
| | | | | 30C17 | 1.00 |
| | | | | 30C18 | 0.00 |

**COLOMOR**
THE VALVE WITH A GUARANTEE

| Type | £ | Type | £ |
|---|---|---|---|
| 30F5 | 1.00 | 957 | 0.50 |
| 30FL1 | 1.00 | 1629 | 0.70 |
| 30FL12 | 1.10 | 2051 | 1.00 |
| 30FL14 | 0.90 | 5933 | 3.00 |
| 30L15 | 0.95 | 6057 | 0.75 |
| 30L17 | 0.85 | 6060 | 0.70 |
| 30P12 | 1.00 | 6064 | 0.60 |
| 30P19 | 1.00 | 6065 | 1.00 |
| 30PL1 | 0.95 | 6080 | 2.30 |
| 30PL13 | 1.10 | 6146 | 2.25 |
| | | 6146B | 3.25 |
| | | 8020 | 5.00 |
| | | 9001 | 5.00 |
| | | 9002 | 0.50 |
| | | 9003 | 0.70 |
| | | 9004 | 0.35 |
| | | 9006 | 0.35 |

**VIDICON TUBES**
EMI types 9677A & 9677C £20.00 ea.

| Type | £ |
|---|---|
| 30PL14 | 1.10 |
| 35L6GT | 0.75 |
| 35W4 | 0.50 |
| 35Z4GT | 0.70 |
| 50C5 | 0.60 |
| 5DCD6G | 1.10 |
| 75 | 1.00 |
| 75C1 | 0.75 |
| 76 | 0.75 |
| 78 | 0.70 |
| 80 | 0.75 |
| 85A2 | 0.75 |
| 723a/b | 8.00 |
| 803 | 6.00 |
| 805 | 14.00 |
| 807 | 0.65 |
| 813 | 6.50 |
| 866A | 1.20 |
| 931A | 6.00 |
| 954 | 0.50 |
| 955 | 0.50 |
| 956 | 0.50 |

**C.R.TUBES**

| Type | £ |
|---|---|
| DG7-5 | 12.00 |
| DG13-2 | 18.00 |
| DG13-34 | 12.00 |
| MW13-35 | 35.00 |
| VCR139A | 8.00 |
| 3BP1 | 4.50 |
| 88D | 9.00 |
| 88J | 8.00 |
| 88L | 9.00 |

**SPECIAL VALVES**

| Type | £ |
|---|---|
| CV239 | 45.00 |
| M503-2 J42 | 42.00 |
| K301 | 7.00 |
| KRN2A | 6.00 |
| 725A | 23.00 |

A lot of these valves are imported and prices vary for each delivery, so we reserve the right to change prices for new stock when unavoidable.

## TRANSISTORS

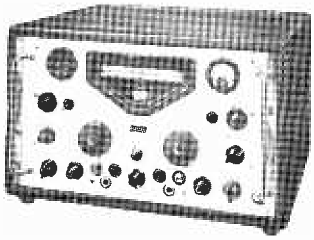
Please write or phone for current price of any of the transistors, diodes shown below.

| | | | | | | |
|---|---|---|---|---|---|---|
| AC113 | AF178 | BF167 | GET116 | OC36 | SX754 | 2N2062 |
| AC126 | AF186 | BF185 | GEX66 | OC42 | ZR11 | 2N2147 |
| AC127 | AFZ12 | BFY51 | NKT222 | OC44 | ZR21 | 2N2411 |
| AC128 | ASY26 | BFY52 | OA5 | OC45 | 1N23A | 2N2989 |
| AC176 | ASY27 | BFY90 | OA47 | OC70 | 1N25 | 2N3053 |
| ACY18 | ASY28 | BSY27 | OA70 | OC73 | 1N32A | 2N3054 |
| ACY19 | BC108 | BSY38 | OA71 | OC78 | 1N38A | 2N3055 |
| ACY20 | BC118 | BSY95A | OA73 | OC78D | 1N43 | 2N3390 |
| ACY28 | BC119 | BYZ16 | OA79 | OC81 | 1N70 | 2N3391 |
| ACY39 | BC136 | CRS1/10 | OA91 | OC82 | 1N277 | 2N3730 |
| ACY40 | BC137 | CRS1/20 | OA200 | OC82D | 1N415C | 2N3731 |
| AD149 | BC148A | CRS1/30 | OA202 | OC82DM | 1N4148 | 2N3819 |
| AD161 | BC172 | CRS1/40 | OAZ200 | OC83 | 2N456A | 2N4038 |
| AD162 | BC172A | CRS3/10 | OC22 | OC139 | 2N708 | 2N4058 |
| ADZ11 | BC212A | CRS3/20 | OC22 | OC140 | 2N918 | 2N4061 |
| ADZ12 | BCY31 | CRS3/30 | OC26 | OC170 | 2N1304 | 2N4785 |
| AF114 | BCY33 | CRS3/40 | OC28 | OC172 | 2N1305 | 2N5295 |
| AF115 | BCY72 | CRS25/025 | OC29 | OC200 | 2N1307 | 3N128 |
| AF116 | BF115 | GET115 | OC39 | OC206 | 2N1309 | 3N154 |
| AF117 | | | | | | 3N159 |
| AF118 | | | | | | 2S303 |
| AF124 | | | | | | 404 |
| AF125 | | | | | | 2082 |
| AF126 | | | | | | 40250 |
| AF127 | | | | | | 40251 |
| AF139 | | | | | | 40668 |

### VALVES AND TRANSISTORS

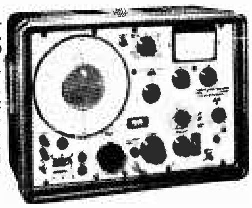
Telephone enquiries for valves, transistors, etc., retail 749 3934; trade and export 743 0899.

*OTHERS IN STOCK inc. Integrated circuits, CRT & special valves. Min. Mail Order £1. U.K. Postage £1-£2, 17p, £2-3, 22p, over £3 free. C.O.D. 25p extra.*



**RACAL RECEIVERS**
Models RA17, RA17 Mk. II, RA 17L, RA17W, RA117E, in condition from working "as seen" to brand new in cabinets. Prices on application.
**DIVERSITY SWITCH TYPE MA168B**, solid state, £45.00.

**TF144H SIGNAL GEN.** Freq. range 10 KHz-72 MHz, R.F. output 2µV to 2V at 50 ohms 400 and 1000 Hz internal mod. Limited qty. only available. Full spec. and price on request.



**TF 526B OSCILLATOR AND DETECTOR UNIT £50·00.**

**TF 1226B, TF1225A, TF 577A. WHITE NOISE TEST SET £185·00.** Full spec. on request.

**MARCONI TF 995A/5 FM/AM SIGNAL GENERATOR.** Four additional tuning controls facilitate narrow band measurements. 3 Int. A.M. mod Freq. of 400, 1000 & 1500Hz at up to 50% F.M. deviation ± 5kHz – ± 120kHz. Output 0.1µv–200mV depending on termination. Freq. Range 1.5–220MHz. P.O.A.

**TF 1258A VHF SPECTRUM ANALYSER** for analysis and measurement of Radar Equipment. Frequency range 190 to 230MHz with crystal check points. Sweep width 0·5 to 5MHz, output pulse delay (a) 85-175 µSec, (b) 0·7-1·4 mSec with ×1 and ×2 multiplier and ÷2, ×1, ×2 multiplier. Output 2µV to 20mV with ×10 multiplier. £200.

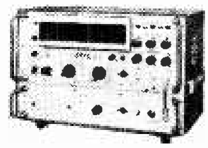
**BEST PRICES PAID FOR TEST AND COMMUNICATION EQUIPMENT.** Single items or quantities. Private or Industrial.

**TF 801D/1/S SIGNAL GENERATOR.** Range 10-485 MHz in five ranges. R.F. output 0·1 µV-IV source e.m.f. Dial calibrated in volts, decibels and power relative to thermal noise. Piston type attenuator. 50Ω output impedance. Internal modulation at 1 kHz at up to 90% depth, also external sine and pulse modulation. Built-in 5MHz crystal calibrator. Separate R.F. and mod. meters. P.O.A.

**TF 1400S DOUBLE PULSE GENERATOR WITH TM 6600/S SECONDARY PULSE UNIT.** For testing radar, nucleonics, 'scopes, counters, filters etc. **SPEC. TF 1400S.** Rep. freq. 10Hz to 100kHz, pulse width 0·1 to 100µ sec., delay −1·5 to +3000µ sec., rise time 30N sec. **SPEC. TM 6600/S.** As for TF1400S except pulse width 0·5 to 25µ sec., delay 0 to +300µ sec. £230.

**MARCONI OA 1094A/3 SPECTRUM ANALYSER** with L.F. extension unit. Freq. range 100MHz. Full Spec & P.O.A.

**RACAL UNIVERSAL COUNTER/TIMER SA550 (CT488)**



8 digit in-line read-out. Facilities include: direct frequency measurement up to 100MHz; pulse, period, ratio, time interval and totalising measurements. Input sensitivity variable from 300MV to 9V, three independent inputs, self-check etc. Full spec. on request. £145.

# PLEASE NOTE

Unless offered as "as seen"

# ALL EQUIPMENT

ordered from us is completely overhauled mechanically and electrically in our own laboratories

## TEKTRONIX
### OSCILLOSCOPES

DC to 100MHz. Separate time bases with delay and 5X magnifier. Time base A: 0·05 microsecs to 2 sec/cm in 24 stages also continuously variable between steps. Time base B: 2 microsecs to 10 sec in 18 stages. Delay 1 microsec to 10 sec. Complete with type 81 adaptor enabling use of all letter series plug ins. Type 80 plug-in (less probe) also available.

**571A-600MHz**, separate P.S.U. £150 complete.
**561A-10MHz**, solid state, complete with 3A1 dual trace vert. and 3B3 delay time base plug-ins P.O.A.
**541A-33MHz.** Choice of plug-ins. P.O.A.
**LA265A(545A)-33MHz**, separate time bases with delay. P.O.A.
**545-15MHz.** Separate time bases with delay. Price on application.

**PLUG-IN UNITS**
CA—24 MHz dual trace 50MV-20V.
G—20 MHz differential 50MV-20V.
L—30 MHz fast rise time 5MV-20V.
D—High gain differential 1MV-50V.
N 600MHz sampling 10MV-cm.
53/54C. Dual trace 33MHz, 60MHz, 0,05-20v.

**BOONTON FM/AM SIGNAL GENERATOR TYPE 202E.** 54–216MHz in 2 ranges, complete with separate power supply **£175.**
**EHV POWER SUPPLY** 115V input 100KV at 5mA output **£150.**

## SOLARTRON

**CD 1400 OSCILLOSCOPE** with 15MHz vert plug-ins and choice of standard or delay time base P.O.A.
**AS 870.3 CURRENT LIMITING POWER SUPPLY** 0–30v in steps of 10, 1, 0.1V at up to 3A **£50.**

★ **Open 9-12.30, 1.30-5.30 p.m. except Thursday 9-1 p.m.** ★

## HEWLETT – PACKARD

**175A OSCILLOSCOPE** with 1750A dual trace vert plug-in and 1781B delay time base plug-in. 50MHz minimum bandwidth at 50mV/CM. T/B modes: main, main single, mixed, main delayed, delaying. Full Spec & P.O.A.
**185A SAMPLING OSCILLOSCOPE.** 800MHz, complete with 188A 1mV/CM dual trace plug-in. 1GHz probe and manual. Full spec & P.O.A.
**524C ELECTRONIC COUNTER/ TIMER** direct reading to 10MHz, extended to 500MHz depending on converter plug-in, also period and time measurement. 8 digit in-line display on Nixie tubes. **£165** with one plug-in (as below) 5248 model, spec as for 524C but display on 6 neon lamp decades and 2 meters **£115** with one of the following plug-ins: 526A Video amp, 525A: 10-100MHz, 525B: 100-220 MHz. (525C: 100–500MHz **£45** extra).
**616B SHF SIGNAL GENERATOR** Freq 1.75GHz–4.2GHz. Mod: F.M., C.W., Pulse. Ext A.M., output 0.1µV–200mV. Full spec & P.O.A.
**200AB AUDIO OSCILLATOR** 19kHz. 600ohm balanced or unbalanced, small size. **£25.**
**300A HARMONIC WAVE ANALYSER** Freq. 0–16kHz. Full spec & P.O.A.

**TELEQUIPMENT 543C & D43H OSCILLOSCOPES £80.**
**KAHN SSB ADAPTOR MODEL RSSB=62=1B.** Designed for receivers with 455–500kHz I.F. (eg Collins 51J: AR88D etc) at 100mV (max) input. Features: Electronic A.F.C. carrier frequency diversity to combat fading: 20 sec R.C. memory to maintain tuning during severe fading: individual carrier meters: nuvistors: low distortion product demodulator Full spec & P.O.A.

**TEST EQUIPMENT**
for direct line for all enquiries regarding test equipment only, phone 01-748 5496.

## ROHDE & SCHWARZ

**Z-g DIAGRAPH TYPE** ZDU. 30–420 MHz, 50Ω. Directly measures multi-terminal networks, phase shift, phase angle etc. with complementary POWER SIGNAL GENERATOR TYPE SMLM High Freq. resolution, internal/external mod., up to 3V out. P.O.A.
**POLYSKOP SWOB** 1. 0.5–400MHz 75Ω. P.O.A.
**VHF WATTMETER & MATCHING INDICATOR** 30/80W, 230MHz, 75Ω. P.O.A.
**VHF VOLTMETER TYPE UDND** P.O.A.
**MICROWAVE POWER METER TYPE NRD.** 0–3200MHz at 50Ω. 0–200mW in 4 ranges, built-in calibration check with measuring head **£125.**
**FREQUENCY SYNTHESIZER TYPE XUA.** 30Hz–30MHz with **FREQUENCY INDICATOR TYPE FKM,** 15–30MHz: 30–100MHz. P.O.A.

## TECHNICAL MATERIAL CORP:

**EXCITER/TRANSMITTING MODE SELECTOR** Freq. 2–32MHz M.O. and 10 crystal positions. Vernier tuning. U.S.B./L.S.B. var carrier insertion etc. **£200.**
**F.S.K. EXCITER.** Freq. 1–6.5MHz. 0–100Hz continuous frequency shift. Up to ± 600Hz switched frequency correction. Modes F.A.X.: F.S.: M.S.C.: C.W. **£50.**

**500/250W MEDIUM WAVE BROADCAST TRANSMITTERS.** Price and details on application.

**3 PHASE AUTO TRANSFORMER,** wye input 400v, wye output 241.5/230/218.5v 50c 18kVA. Made by Westinghouse of USA. Brand new in original cases £60.00 including UK transport.

**FOR EXPORT ONLY**
**TRANSMITTERS:**
BC 610 Hallicrafters.
RCA ET 4336 also modified version of increased output to 700w.
COLLINS TYPE 231D 4/5kw., 10 channel, autotone and manual tuning. All above complete installation and spare parts.
**TRANSCEIVERS**
19, 19HP, 38, 62.
C-13 TRANSMITTERS
**RACAL COMMUNICATIONS EQUIPMENT**
We are able to offer a comprehensive selection from the range of this modern high class equipment including, receivers, L.F. Converters, SSB adaptors, panoramic adaptors, diversity switches, transmitter driver units, linear amplifiers can be built to customers' requirements. Please send us your enquiries.

**AR88 SPARES.** We hold the largest stock in U.K. Write for list.
**R.F. METER** 0-8 amp. 2½" (U.S.A.) £1·80 P. & P. 15p.
**TELEPHONE TYPE "J"** (Tropicalised) 10 line **MAGNETO TELEPHONE SWITCHBOARD**
50 line **AUTOMATIC PRIVATE TELEPHONE SWITCHBOARD**
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Matched tracks. Type PG58ST. Lin or log from 4K7 to 1 meg **60p**
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*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, 0·15, 0·22, 0·47, 0·68, 1·0 mF/35V, 1·5/20V ea. **14p**
2·2/16V, 2·2/35V, 4·7/16V, 10/6·3V ea. **6p**
4·7/35V, 10/16V, 22/6·3V ea. **9p**
10/25V, 22/16V, 47/6·3V, 100/3V, 6·8/25V, 15/25V ea. **13p**

**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**

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*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**

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1000pF/500, 2000/500, 5000/500, 0·01mF/50, 0·02mF/50, 0·1mF/3—each **2p**; 0·05mF/50V—**3p**

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20W 7·5V to 75V **94p**. Clip to increase 1·5W rating to 3 watts (type 266F), **5p**.
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Copper clad 0·1 matrix—2·5 × 3·75 ins. **32p**; 3·75 × 3·75 ins.—**35p**; 2·5 × 5 ins.—**35p**; 3·75 × 5 ins.—**33p**. Copper clad 0·15 in. matrix 2·5 × 3·75 ins.—**24p**; 3·75 × 3·75 ins.—**30p**; 2·5 × 5 ins.—**35p**; 3·75 × 5 ins.—**46p**.
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| 2N3704 | 11p | BC107A | 15p | BFX84 | 27p |
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| AC153K | 37p | BC182L | 26p | TIP32A | 80p |
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| AD161 | 42p | BD131 | 48p | | |
| AD162 | 40p | BD132 | 52p | | |

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### 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 | 11 | 10 | 8 nett |
| WW | 3 | 1–10K | 9 | 8 | 6 nett |
| WW | 7 | 1–10K | 11 | 10 | 8 nett |

**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.**

### 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 | — | — | — | — | — | — |

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**5 sided + lid (or base)**
2¾" × 5¼" × 1½" high, 4" × 4" × 1½" high, 4" × 2¾" × 1½" high, 4" × 2¼" × 2" high, each **43p**.
3" × 3" × 1" high **38p**; 4" × 5¼" × 1½" high **48p**;
6" × 4" × 2" high **60p**; 5" × 3½" × 2½" high **52p**

### JACKS AND PLUGS

**SOCKETS**
2 circuit unswitched S1/SS **12p**
2 circuit 2 break contacts S1/BB **15p**
3 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**

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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**

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| | | |
|---|---|---|
| **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** |

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CN240 **£2·15** Spare bits **32p**
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6ft strip **66p**

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1 pole 12 way; 2 pole 6 way
3 pole 4 way; 4 pole 3 way each **29p**
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Other sizes available

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|---|---|---|---|---|
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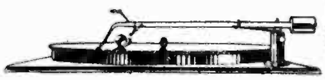

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| Pack No. | Qty. | Description | Price |
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| C4 | 75 | ⅛th W Resistors mixed preferred values | 0·55 |
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Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19, C20 & C21.

**PLUGS**

| | | |
|---|---|---|
| PS 1 | D.I.N. 2 Pin (Speaker) | 0·11 |
| PS 2 | D.I.N. 3 Pin | 0·12 |
| PS 3 | D.I.N. 4 Pin | 0·15 |
| PS 4 | D.I.N. 5 Pin 180° | 0·16 |
| PS 5 | D.I.N. 5 Pin 240° | 0·16 |
| PS 6 | D.I.N. 6 Pin | 0·17 |
| PS 7 | D.I.N. 7 Pin | 0·18 |
| PS 8 | Jack 2·5mm Screened | 0·18 |
| PS 9 | Jack 3·5mm Plastic | 0·12 |
| PS 10 | Jack 3·5mm Screened | 0·18 |
| PS 11 | Jack ¼" Plastic | 0·15 |
| PS 12 | Jack ¼" Screened | 0·22 |
| PS 13 | Jack Stereo Screened | 0·36 |
| PS 14 | Phono | 0·10 |
| PS 15 | Car Aerial | 0·22 |
| PS 16 | Co-Axial | 0·15 |

**INLINE SOCKETS**

| | | |
|---|---|---|
| PS 21 | D.I.N. 2 Pin (Speaker) | 0·14 |
| PS 22 | D.I.N. 3 Pin | 0·20 |
| PS 23 | D.I.N. 5 Pin 180° | 0·20 |
| PS 24 | D.I.N. 5 Pin 240° | 0.20 |
| PS 25 | Jack 2.5mm Plastic | 0.16 |
| PS 26 | Jack 3.5mm Plastic | 0.16 |
| PS 27 | Jack ¼" Plastic | 0.30 |
| PS 28 | Jack ¼" Screened | 0·35 |
| PS 29 | Jack Stereo Plastic | 0.30 |
| PS 30 | Jack Stereo Screened | 0.38 |
| PS 31 | Phono Screened | 0.18 |
| PS 32 | Car Aerial | 0.22 |
| PS 33 | Co-Axial | 0.22 |

**SOCKETS**

| | | |
|---|---|---|
| PS 35 | D.I.N. 2 Pin (Speaker) | 0·08 |
| PS 36 | D.I.N. 3 Pin | 0.11 |
| PS 37 | D.I.N. 5 Pin 180° | 0.11 |
| PS 38 | D.I.N. 5 Pin 240° | 0·11 |
| PS 39 | Jack 2·5mm Switched | 0·12 |
| PS 40 | Jack 3·5mm Switched | 0·12 |
| PS 41 | Jack ¼" Switched | 0·20 |
| PS 42 | Jack Stereo Switched | 0·30 |
| PS 43 | Phono Single | 0·18 |
| PS 44 | Phono Double | 0·10 |
| PS 46 | Co-Axial Surface | 0·10 |
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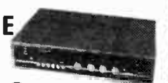

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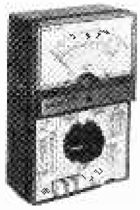

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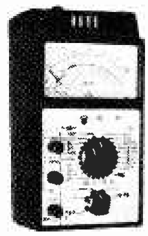

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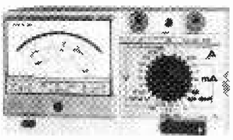

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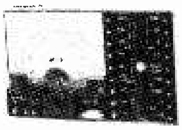

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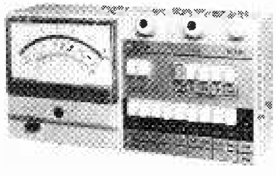

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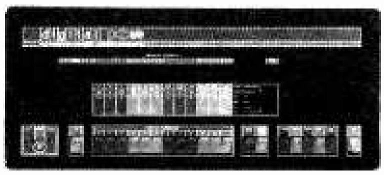

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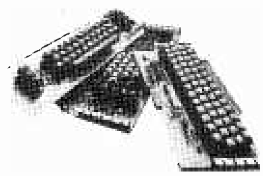

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| 2N2906 | 19p | 40408 | 50p | BC182L | 12p | 8FX30 | 27p | TAA263 | £1.00 |
| 2N2906A | 21p | 40409 | 52p | BC183 | 12p | BFX84 | 24p | TBA800 | £1.50 |
| 2N2907 | 22p | 40410 | 52p | BC183L | 12p | BFX85 | 30p | TBA810 | £1.50 |
| 2N2907A | 25p | 40411 | £2.25 | BC184 | 13p | BFX87 | 28p | TIP29A | 49p |
| 2N2926 | 11p | 40602 | 46p | BC1B4L | 13p | 8FX88 | 25p | TIP30A | 58p |
| 2N3053 | 25p | 40604 | 56p | BC212K | 16p | BFX89 | 45p | TIP31A | 62p |
| 2N3054 | 60p | 40669 | £1.00 | BC212L | 16p | BFY19 | 62p | TIP328 | 74p |
| 2N3055 | 75p | AC117 | 20p | BC214L | 21p | BFY51 | 23p | TIP33A | £1.01 |
| 2N3441 | 97p | AC126 | 20p | BC237 | 13p | BFY52 | 21p | TIP34A | £1.51 |
| 2N3442 | £1.69 | AC127 | 20p | BC238 | 13p | BFY90 | 75p | TIP35A | £2.90 |
| 2N3415 | 10p | AC128 | 20p | BC239 | 13p | 8RY39 | 48p | TIP36A | £3.70 |
| 2N3416 | 15p | AC151V | 25p | BC257 | 14p | C1060 | 65p | TIP41A | 79p |
| 2N3417 | 21p | AC152V | 17p | BC258 | 13p | CA3020A | £1.80 | TIP42A | 90p |
| 2N3702 | 11p | AC153K | 25p | BC259 | 14p | CA3046 | 70p | TIP2995 | 93p |
| 2N3703 | 12p | AC176 | 18p | 8C300 | 36p | CA3048 | £2.11 | TIP3055 | 60p |
| 2N3704 | 14p | AC176K | 25p | 8C301 | 34p | CA3089E | £1.96 | ZTX300 | 13p |
| 2N3705 | 12p | AC187K | 23p | BC307 | 11p | CA30900 | £4.23 | ZTX302 | 20p |
| 2N3706 | 9p | AC188K | 34p | BC308 | 12p | LM301A | 46p | ZTX500 | 15p |

Prices correct at October 1974, but all exclusive of VAT. **Post and Package** 20p

# 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 | 38 |
| 149 | 60 | 3 12 | 9·9× 7·7× 8·6 | 3·98 | 45 |
| 150 | 100 | 5 8 | 9·9× 8·9× 8·6 | 4·45 | 45 |
| 151 | 200 | 8 0 | 12·1× 9·3×10·2 | 7·39 | 53 |
| 152 | 250 | 13 12 | 12·1×11·8×10·2 | 8·93 | 73 |
| 153 | 350 | 15 0 | 14·0×10·8×11·8 | 10·80 | 73 |
| 154 | 500 | 19 8 | 14·0×13·4×11·8 | 12·41 | 91 |
| 155 | 750 | 29 0 | 17·2×14·0×14·0 | 18·85 | * |
| 156 | 1000 | 38 0 | 17·2×16·6×14·0 | 26·50 | * |
| 157 | 1500 | 46 0 | 21·6×13·4×18·1 | 30·25 | * |
| 158 | 2000 | 60 0 | 21·6×15·3×18·1 | 33·70 | * |
| 159 | 3000 | 85 0 | 23·5×17·8×19·7 | 53·25 | * |

### 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 | 1·52 | 30 |
| 64 | 75 | 2 4 | 7·0× 6·7 ×6·1 | 0-115-210-240 | 2·64 | 38 |
| 4 | 150 | 3 4 | 8·9× 7·7× 7·7 | 0-115-200-220-240 | 3·75 | 45 |
| 66 | 300 | 6 4 | 9·9× 9·6× 8·6 | ,, ,, | 5·29 | 53 |
| 67 | 500 | 12 8 | 12·1×11·2×10·2 | ,, ,, | 8·02 | 67 |
| 84 | 1000 | 19 8 | 14·0×13·4×14·3 | ,, ,, | 12·44 | 91 |
| 93 | 1500 | 30 4 | 14·0×15·9×14·3 | ,, ,, | 16·65 | * |
| 95 | 2000 | 32 0 | 17·2×16·6×14·0 | ,, ,, | 22·00 | * |
| 73 | 3000 | 40 0 | 21·6×13·4×18·1 | ,, ,, | 31·90 | * |

### CASED AUTO TRANSFORMERS

115V mains lead input and U.S.A. 2 pin outlets. 20VA £2·85. P. & P. 38p. 500VA £9·50. P. & P. 80p. 1000VA £15·92. Via B.R.S.

## 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 | 23 |
| 213 | 1·0 | 0·5 | 1 4 | 6·1× 5·8× 4·8 | 0-12V at 0·5A×2 | 1·58 | 30 |
| 71 | 2 | 1 | 1 12 | 7·0× 6·4× 6·1 | 0-12V at 1A×2 | 2·09 | 38 |
| 18 | 4 | 2 | 2 12 | 8·3× 7·7× 7·0 | 0-12V at 2A×2 | 2·60 | 38 |
| 70 | 6 | 3 | 3 8 | 8·9× 8·0× 7·7 | 0-12V at 3A×2 | 3·75 | 45 |
| 108 | 8 | 4 | 5 8 | 9·9× 8·9× 8·6 | 0-12V at 4A×2 | 4·15 | 45 |
| 72 | 10 | 5 | 6 4 | 9·9× 9·6× 8·6 | 0-12V at 5A×2 | 4·67 | 53 |
| 116 | 12 | 6 | 6 12 | 9·9×10·2×8·6 | 0-12V at 5A×2 | 5·02 | 53 |
| 17 | 16 | 8 | 8 12 | 12·1× 9·9×10·2 | 0-12V at 8A×2 | 6·62 | 60 |
| 115 | 20 | 10 | 15 8 | 14·0× 9·6×11·8 | 0-12V at 10A×2 | 9.45 | 73 |
| 187 | 30 | 15 | 18 8 | 14·0×12·1×11·8 | 0-12V at 15A×2 | 12·29 | 85 |
| 226 | 60 | 30 | 32 0 | 17·2×15·3×14·0 | 0-12V at 30A×2 | 15·30 | * |

### 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 | 1·65 | 30 |
| 79 | 1·0 | 2 4 | 7·0× 6·7× 6·1 | ,, ,, | 2·18 | 38 |
| 3 | 2·0 | 3 4 | 8·9× 7·7× 7·7 | ,, ,, | 3·18 | 38 |
| 20 | 3·0 | 4 8 | 9·9× 8·3× 8·6 | ,, ,, | 4·12 | 45 |
| 21 | 4·0 | 6 4 | 9·9× 9·6× 8·6 | ,, ,, | 4·67 | 53 |
| 51 | 5·0 | 6 12 | 12·1× 8·6×10·2 | ,, ,, | 5·83 | 53 |
| 117 | 6·0 | 8 0 | 12·1× 9·3×10·2 | ,, ,, | 6·51 | 60 |
| 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 | ,, ,, | 8·97 | 73 |

### 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 | 2·35 | 30 |
| 103 | 1·0 | 2 12 | 8·3× 7·4× 7·0 | ,, ,, | 3·08 | 38 |
| 104 | 2·0 | 5 8 | 9·9× 8·9× 8·6 | ,, ,, | 4·26 | 45 |
| 105 | 3·0 | 6 12 | 9·9×10·2× 8·6 | ,, ,, | 5·28 | 53 |
| 106 | 4·0 | 10 0 | 12·1×10·5×10·2 | ,, ,, | 6·91 | 67 |
| 107 | 6·0 | 12 0 | 14·0×10·2×11·8 | ,, ,, | 11·00 | 67 |
| 118 | 8·0 | 18 0 | 14·0×12·7×11·8 | ,, ,, | 11·80 | 85 |
| 119 | 10·0 | 25 0 | 17·2×12·7×14·0 | ,, ,, | 15·45 | * |

### 60 VOLT RANGE

| Ref. No. | Amps. | Weight lb oz | Size cm. | 60 VOLT RANGE | £ | P & P p |
|---|---|---|---|---|---|---|
| 124 | 0·5 | 2 4 | 7·0× 6·7× 6·1 | 0-24-30-40-48-60V | 2·12 | 38 |
| 126 | 1·0 | 3 4 | 8·9× 7·7× 7·7 | ,, ,, | 3·10 | 38 |
| 127 | 2·0 | 6 4 | 9·9× 9·6× 8·6 | ,, ,, | 4·62 | 45 |
| 125 | 3·0 | 8 12 | 12·1× 9·9×10·2 | ,, ,, | 6·84 | 60 |
| 123 | 4·0 | 13 12 | 12·1×11·8×10·2 | ,, ,, | 7·96 | 67 |
| 40 | 5·0 | 12 00 | 14·0×10·2×11·8 | ,, ,, | 8·87 | 73 |
| 120 | 6·0 | 15 8 | 14·0×12·1×11·8 | ,, ,, | 10·27 | 85 |
| 121 | 8·0 | 25 00 | 14·0×14·7×11·8 | ,, ,, | 13·64 | * |
| 122 | 10·0 | 25 0 | 17·2×12·7×14·0 | ,, ,, | 15·93 | * |
| 189 | 12·0 | 29 00 | 17·2×14·0×14·0 | ,, ,, | 18·16 | * |

### 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 | 1·40 | 10 |
| 212 | 1A 1A | 1 4 | 6·1×5·8×4·8 | 0-6 0-6 | 1·67 | 30 |
| 13 | 100 | 4 | 3·9×2·6×2·9 | 9-0-9 | 1·28 | 13 |
| 235 | 330, 330 | 4 | 4·8×2·9×3·5 | 0-9, 0-9 | 1·42 | 19 |
| 207 | 500, 500 | 1 00 | 6·1×5·4×4·8 | 0-8-9, 0-8-9 | 1·75 | 30 |
| 208 | 1A, 1A | 1 12 | 7·0×6·4×6·1 | 0-8-9, 0-8-9 | 3·00 | 38 |
| 236 | 200, 200 | 4 | 4·8×2·9×3·5 | 0-15, 0-15 | 1·30 | 19 |
| 214 | 300, 300 | 1 4 | 6·1×5·8×4·8 | 0-20, 0-20 | 1·76 | 30 |
| 221 | 700 (D.C.) | 1 8 | 7·0×6·1×6·1 | 20-12-0-12-20 | 1·98 | 38 |
| 206 | 1A, 1A | 2 12 | 8·3×7·7×7·0 | 0-15-20, 0-15-20 | 3·15 | 38 |
| 203 | 500, 500 | 2 4 | 8·3×7·0×7·0 | 0-15-27, 0-15-27 | 2·73 | 38 |
| 204 | 1A, 1A | 3 4 | 8·9×7·7×7·7 | 0-15-27, 0-15-27 | 3·50 | 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 | 1·82 | 38 |
| 5 | 4·0 | 3 4 | 8·9× 7·7× 7·7 | 3·30 | 38 |
| 86 | 6·0 | 6 4 | 9·9× 9·6× 8·6 | 4·84 | 53 |
| 146 | 8·0 | 6 12 | 9·9×10·2× 8·6 | 5·52 | 53 |
| 50 | 12·5 | 12 0 | 14·0×10·2×11·8 | 7·85 | 67 |

Please note, these units do not include rectifiers

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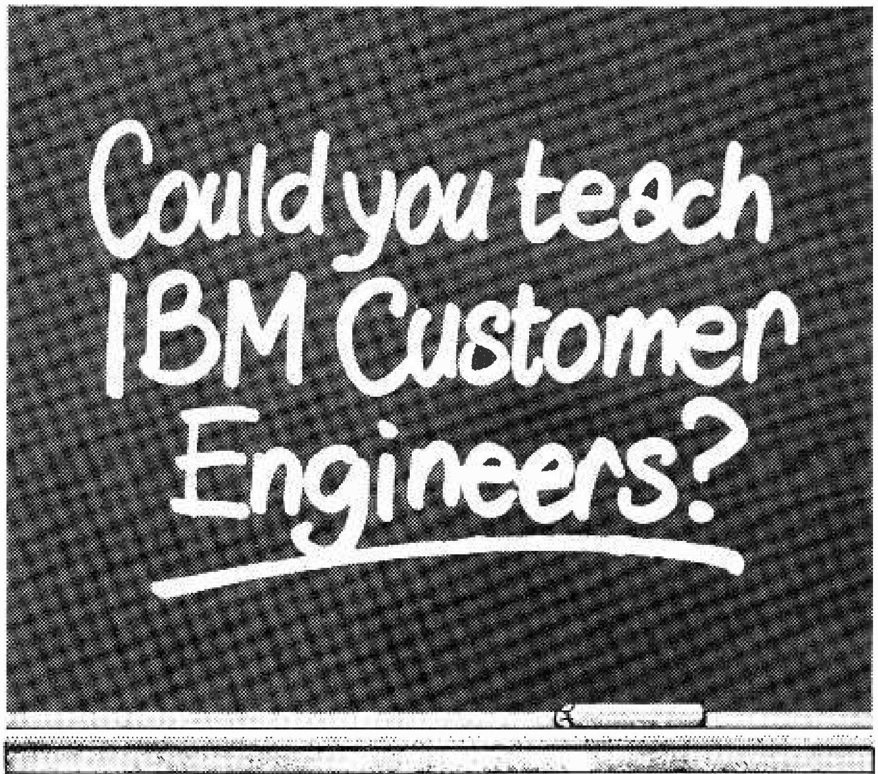


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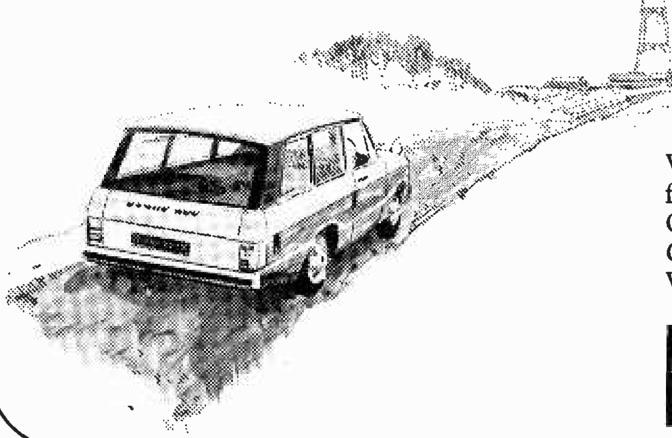

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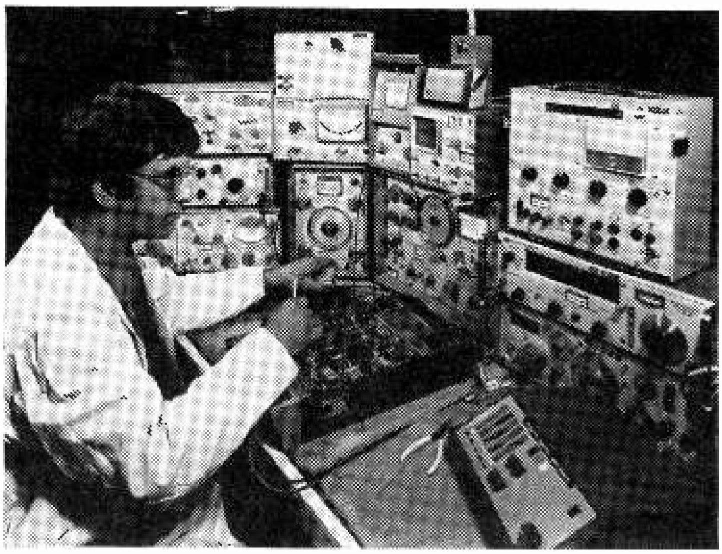

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## University of London

# TELEVISION TECHNICIAN

A Television Technician (Grade 5) is required to operate and maintain a wide range of audio and video equipment. The successful candidate will be expected to work closely with academic staff and students, and assist in the interpretation of their requirements in television terms. The television service at the College is expanding and the installation and commissioning of new equipment will present additional responsibilities. Salary Scale: £2,667—£3,123 per annum (including £228 London Allowance, which is under review).

Application forms from Personnel Officer WW, Chelsea College, Manresa Road, London, SW3 6LX.

[4341

OPPORTUNITY FOR

# GRADUATE IN ELECTRONICS

with some experience of industry to join fast expanding firm specializing in power supply and logic signalling equipment.

**ALPHA OMETRIC LTD., HOLMDALE, SIDMOUTH, DEVON. TEL: Sidmouth 5151.**

[4319

## AUDIO TEST ENGINEERS

Audix manufacture a wide range of public address, communications and broadcast studio equipment. To satisfy the increasing demand for our products we require engineers preferably with previous audio test/service experience and a good practical knowledge of transistor circuit techniques. Applicants will be expected to carry out systems and unit testing of custom built equipment, supervise junior staff and work, with the minimum of supervision.

Vacancies also exist for junior engineers having ONC or equivalent qualifications who have a keen interest in audio equipment. The posts offered will be centred at a new factory now nearing completion at Saffron Walden, Essex.

Applications should be made in writing to:

**AUDIX LIMITED STANSTED ESSEX**

[4336

# Senior Scientific Assistants - Physics

The duties of the posts relate to the development and application of special measurement techniques for use in generating stations and the initial work would be on high temperature strain measurement. Some work at Power Station sites will be required, although not over long periods.

Academic qualifications up to but not above HNC or HND level are desirable, but applicants with lesser formal qualifications having several years relevant experience and aged over 26 years will be considered. Some knowledge of modern electronics and workshop practice is desirable but experience in both is not essential

**Salary £2075 - £3300 p.a. plus Threshold Supplement.**

*Write to the Personnel Officer, C.E.R.L. Kelvin Avenue, Leatherhead, Surrey, KT22 7SE, for application forms or telephone Leatherhead 74488 Ext. 363 quoting reference WW/CERL/104.*

**CENTRAL ELECTRICITY RESEARCH LABORATORIES**

4323

# TELEVISION ENGINEERS

A million television rental contracts, hi-fi and audio sales plus overseas interests means we need a lively support team to handle the many engineering problems in our factories and in the field.

This team must be adaptable, thorough and yet speedy to cope effectively with these diverse tasks which cover the following areas.

* Television and audio equipment type approval
* BS415 safety requirements
* Design changes and component evaluation
* Quality assurance
* Factory and field technical support
* Preparation of technical information

Senior and junior positions are offered at our Chessington laboratories, situated on the edge of the Surrey countryside.

Applicants should ideally have some formal qualifications, but relevant experience is particularly important. Excellent salaries are offered and assistance with relocation expenses will be given where necessary.

If you are interested, or would like further information, contact:

J. Sinclair,
Rediffusion Consumer Electronics,
Fullers Way South,
Chessington,
Surrey,
KT9 1HJ. 01-397 5411

REDIFFUSION

4340

# Under 30? It's your electronics experience we're after

If you are wondering what your future holds you should consider a career with International Computers Limited. If your experience is in radar, communications or electronic navigation equipment, we will train you to become a member of our field engineers team who maintain and service our installations from bases all over the country. You'll make use of all your knowledge and experience, but your personality and initiative will play a big part as well.

Your thorough training on ICL equipment, will stand you in excellent stead, whatever your future career path. We are Europe's leading computer manufacturer, so you'll be dealing with our products over a wide range of customers, including government departments, universities, research organisations and industry.

This is not a 9-5 rut, hours are varied and prospects are excellent. Gross pay could be in excess of £2000 pa during initial training.

Don't gamble with your future, write now for an application form, quoting reference WW745C, to J Cunnell, International Computers Limited, 85/91 Upper Richmond Road, Putney, London S.W15.

**International Computers**

ICL

think computers-think ICL

4348

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**TV EYE**

The Company is looking for engineers of various grades to work from their new service and installation dept. in Langley, near Slough.

Applicants should be conversant with CCTV systems and equipment. Salary in accordance with age and experience.

*Write in the first instance to*

**CHIEF ENGINEER**
**TV EYE Ltd.,**
**23 Victoria Street,**
**Windsor,**
**Berks SL4 1HE.**

4321

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**SUNDERLAND POLYTECHNIC**
**FACULTY OF ENGINEERING**

## RESEARCH ASSOCIATE

Applications are invited from good honours graduates in Electrical Engineering, Computer Systems or an allied field, for the position of Research Associate in the above Faculty.

The research, which is in the area of image analysis by min-computer, is jointly sponsored by the Polytechnic and Joyce Loebl Ltd. The appointment is for three years, subject to satisfactory progress, and candidates will be expected to register for a higher degree. A range of computers will be available for the project.

This is an interesting opportunity to enable experience to be gained in a new and expanding field with important industrial applications.

Salary Scale £2,000 by 81 (2) to £2,162 plus threshold payments (based on the Burnham Scales for Assistant Lecturers, plus an industrial subvention).

Application forms may be obtained from the **Personnel Officer, Sunderland Polytechnic, Chester Road, Sunderland SR1 3SD,** and should be returned within 10 days of the appearance of this advertisement. [4333

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**Merton, Sutton & Wandsworth Area**
**Health Authority (Teaching)**
**Wandsworth & East Merton Teaching District**

**ST. GEORGE'S HOSPITAL, LONDON SW1**

## OPPORTUNITY IN ELECTRONICS—

A vacancy exists in the Electronics Section of the Department of Medical Physics. The work involves the design, development and manufacture of a wide variety of medical and research instruments; in particular, the solution of problems arising from the use of cardiac pacemakers. Experience with digital integrated circuits very desirable.

The salary is on the MPT II scale, which is £2,727–£3,516 pa plus Threshold. Minimum qualification HNC or the MPT III scale, which is £2,316–£2,943 pa plus Threshold. Minimum qualification ONC. The salary point on the above scale depends on experience and qualifications.

**Further information and application forms are available from the Secretary,**
**Cardiac Department,**
**St. George's Hospital,**
**Hyde Park Corner, London SW1X 7EZ.**

4291

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## SERVICE ENGINEERS

**ELECTRONIC and MEDICAL**

LKB require two additional engineers.

1. A workshop based engineer to service our range of scientific and laboratory equipment. Good working knowledge of electronics required. Training given.
2. A Medical engineer to work from our office covering a wide area of England and Wales. Equipment includes Respirators and Artificial Kidney apparatus. Previous experience not essential. Car provided, training given.

The Company offers excellent working conditions, including Pension Scheme, Profit sharing bonus scheme, BUPA Membership.

Write for application form to:

**The Service Manager,**
**LKB Instruments Limited,**
**232 Addington Road,**
**South Croydon,**
**Surrey CR2 8YD.**

[4334

# ELECTRONIC VACANCIES

Engineers
Draughtsmen ● Designers
Service and Test Engineers
Technicians ● Technical Authors
Sales Engineers

**£1,600-£5,000 pa**

**Permanent or Contract**

01-387 0742
**MALLA TECHNICAL STAFF LIMITED**
376 Euston Rd., London NW1 3BG
[95

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**UNIVERSITY COLLEGE OF NORTH WALES, BANGOR**

School of Physical and Molecular Sciences

## ELECTRONICS TECHNICIAN GRADE 5

Applications are invited for the post of Electronics Technician Grade 5 in the above mentioned School.

The successful applicant will be concerned with the development and construction of new specialised electronic equipment for research and teaching, and with the servicing and maintenance of existing equipment.

Applicants should have had several years practical experience in digital and linear solid state electronics, preferably in industry or the services, coupled with theoretical knowledge to about H.N.C. standard.

Salary at an appropriate point on the scale:- £2,439 — £2,895 per annum.

Applications (two copies), giving full details of age, qualifications and experience, together with the names and addresses of two referees should be submitted to the Secretary and Registrar, University College of North Wales, Bangor, not later than the 23rd December, 1974. [4317

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**ROYAL HOLLOWAY COLLEGE**
**(University of London)**
**Egham Hill, Egham, Surrey**

**EXPERIENCED**

## ELECTRONICS TECHNICIAN

**(GRADE 4)**

Required in the Physics Department for 1 year only. Salary on the scale £1,848—£2,163. Applications together with the names and addresses of two referees should be sent to the Personnel Officer (WW) as soon as possible.

[4312

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# Marine Radio Engineers

## for installation & maintenance work

We need some more engineers to work from our Tilbury and Glasgow Depots on the service and installation of marine radio and associated equipment. Half the time will involve work on board ships, often at sea, and applicants must be ex-merchant navy radio officers with two or more years sea experience in equipment maintenance.

*If interested, please write or phone:*
*Jonathan Smith,*
*International Marine Radio Co., Ltd.,*
*Peall Road, Croydon CR9 3AX.*
*Telephone 01-684 9771.*

4301

ITT Marine

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## *COLOUR TELEVISION ENGINEER*

We are a busy major international advertising agency working on household-name clients. To assist in the operation and maintenance of a growing colour-television installation we require a further television engineer. A sound basic knowledge of television is necessary together with operational experience of broadcast or closed-circuit television equipment. Experience in the operation and maintenance of a Rank Cintel Twin Lens Flying Spot Scanner would be particularly advantageous.

Excellent working conditions, five-day week, four weeks holiday, contributory pension scheme, free membership of BUPA.

Salary negotiable.

Applications to: **Jean Powell, Personnel Manager, Leo Burnett Ltd, 48 St Martin's Lane, London WC2. Tel. 01 836 2424.** 4355

FIJI

# TECHNICAL OFFICER

## HIGHER GRADE

## (TRANSMISSON CONSTRUCTION)

required by the Posts and Telecommunications department to lead a small team engaged in the installation and commissioning of VHF, UHF and SHF radio links, both single-channel and multi-channel and all associated equipment. May also be required to assist with detailed planning of systems and installations.

Candidates must hold a Final City and Guilds Certificate in Telecommunications (including Radio C) or equivalent plus five years' supervisory experience on maintenance or installation of VHF, UHF or SHF radio systems.

**Salary in the range £2,440 to £3,550 pa which includes an allowance, normally tax free, of £696 to £996 pa. Terminal gratuity 20% on basic salary, 25% on allowance.**

Other benefits include: low local income tax, generous paid leave, subsidised accommodation; free family passages, children's education allowances and holiday visit passages; (tour 2½–3 years), appointment or disturbance grant of up to £300, interest free car loan up to £600 may be payable.

The post described is partly financed by Britain's programme of aid to the developing countries administered by the Ministry of Overseas Development.

**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/740307/WF**

4314

# SERVICE MANAGER HI-FI

Do you have a good technical background in electronics with a flair for staff management and administration? Then you could be the man we need to take over and re-organise the service division of our organisation. The position entails close liaison with customers therefore a friendly personality and an awareness of public relations is important.

We are a fast-growing retail company specialising in audio, hi-fi and video products and this opportunity is at senior executive level responsible directly to the board. The person appointed will operate from our main service department at Watford.

An experienced man is envisaged with a proven record having spent at least five years in the audio/tape and television industry. He will command a salary commensurate with his abilities and the importance we attach to the position. The company has a non-contributory pension scheme with free life insurance and disability cover.

*Applications in writing and in the strictest confidence to:*

**Alan A. Grove, Director, KJ Leisuresound Ltd., Bridle Path, Watford, Herts WD2 4BZ.**

4296

**UNIVERSITY OF DURHAM**

**Department of Engineering Science**

**REQUIRES**

# ELECTRONICS TECHNICIAN

Applications are invited for the post of Technician in the Department of Engineering Science. The successful candidate will be responsible for the existing electronic equipment in the department's laboratories and will be called on to develop novel circuits for teaching and research.

Salary will be at an appropriate point on the scale £2,013 to £2,343, according to experience.

Applications in writing giving full details of age, education, qualifications and experience together with copies of two testimonials to the **PERSONNEL OFFICE, Old Shire Hall, Durham.**

[4287

# MEDICAL PHYSICS TECHNICIAN

required for servicing hospital and home-based kidney machines. Considerable travel in South East England, and there are opportunities for research. Previous experience of kidney machines is not essential but proven ability in this or similar fields of engineering is of greater importance. Academic achievement should at least be ONC or equivalent standard. Current driving licence essential. Salary according to qualifications and experience.

Apply:

**Personnel,**
**GUY'S HOSPITAL,**
**St. Thomas Street,**
**London, SE1 9RT**
**Tel: 01-407 3662 Ext. 68**

[4289

## Public Address Engineer

Experienced man with high standards required in the Public Address and Sound Recording field, capable of organising and operating temporary P.A. Systems covering conferences etc. Basic knowledge of electronics, tape editing and recording useful. Smart appearance (conventional dress) essential. Reliable driver—living central London—Age 24-40. Salary negotiable—Full details to:

**G. HANSEN,**
Griffiths Hansen (Recordings) Ltd,
12 Balderton Street,
London, W1F 1TF.
Telephone 01-499 1231/2.

[4225

# TELEVISION ENGINEER

A vacancy occurs for an additional TV. Engineer with an expanding Rental and Retail company. Applicant will preferably have some colour experience. Large s/c flat available after trial period. Salary according to experience.

**Hydes of Chertsey Ltd.,**

**56/60 Guildford Street, Chertsey 63243**

[39

## THE POLYTECHNIC OF NORTH LONDON
**Holloway, London, N7 8DB**

# TECHNICIAN VACANCIES

Applications are invited for the positions of Laboratory Technicians Grades 4 and 5 in the Department of Electronic and Communications Engineering.

Qualifications to C. & G. Full Technological Certificate and practical experience in the general field of modern electronics are desirable; also the ability to accept responsibility for the routine organization and development of students' laboratory work, with, at least eight years' experience, for the grade 5 appointment, and at least seven years' experience for the grade 4 appointment.

Salary Scale:
Grade 5—£2181–£2556 per annum.
Grade 4—£2022–£2337 per annum.
Inclusive of London Weighting Allowance (under review) plus the appropriate Threshold payment.

***Applications to: Establishment Officer, The Polytechnic of North London, Holloway Road, N7 8DB. Enquiries to S. A. Elliott (01-607 6767 ext. 289).***

4324

## audiointernational
RECORDING STUDIOS LIMITED

require an engineer to take charge of the service and development of their multi-track recording equipment.

**Contact:**
**The General Manager,**
**Audio International**
**Recording Studios Ltd.,**
**18 Rodmarton Street,**
**LONDON W1H 3FW.**
**Tel. 01-486 6466.**

4299

**LONDON BOROUGH OF BRENT**
**Willesden College of Technology**
**Denzil Road, London, NW10 2XD**

## DEPARTMENT OF ELECTRICAL ENGINEERING

**REQUIRE**

# LECTURER
## (Grade I)

to teach both theory and practice on City and Guilds Radio/TV and Electronics Technician and Mechanic courses.

Applicants should have at least an appropriate City and Guilds Final Certificate and good industrial experience.

**SALARY:** £2,317 to £3,391 (including LA and Threshold) with increments for relevant experience.

Further details and application forms may be obtained from the Registrar, to be returned within two weeks.

**UNITED KINGDOM ATOMIC ENERGY AUTHORITY**
**REACTOR DEVELOPMENT LABORATORIES**
**WINDSCALE AND CALDER WORKS**

require a number of

# Instrument Mechanics

The Laboratories have interesting work on the development, assembly, commissioning and maintenance of a wide range of instruments, including electronic and physical types of inspection, control and measurement instrumentation. The work is associated with the Nuclear development programme.

Vacancies exist for instrument mechanics to join an existing section supporting these services. Applicants should have served a recognised apprenticeship and have some years experience in their trade.

★ Rate of Pay: £45.95 for a 40-hour, 5-day week after training and inclusive of incentive bonus earnings;
★ Contributory Superannuation Scheme;
★ 18 Days Paid Holiday a year;
★ Housing on economic rents within easy reach of Eskdale, Wasdale and Ennerdale;
★ Hostel Accommodation for single men or married men awaiting housing.

Write for an application form quoting reference RG10 to:
**Works Labour Manager**
**Windscale and Calder Works**
**Sellafield**
**Nr Seascale**
**Cumbria CA20 1PG**

[4335

# Electronics Engineer Supervisor

Join an expanding team in Walthamstow. As part of an International Leisure Group we manufacture and distribute thousands of best-selling pre-recorded tapes and records each week on labels which are household names.

Attractive career opportunities are offered to someone educated to ONC standard with around five years' electronics experience, who can undertake testing work and trouble-shooting.

If necessary we will give full supervisory training which will enable you to ensure the smooth functioning of our team in the Tape-Product department. The actual duties include the electronic servicing and commissioning of Musicassette equipment and development work on manufacturing equipment.

You will be based at our manufacturing complex in Walthamstow.

A good salary is offered, together with benefits which include annual bonus, long holidays and products at discount.

For an early interview phone or write to:
**Ken Windsor,**
**Personnel Officer,**
**Phonodisc Ltd.,**
**Walthamstow Avenue,**
**London E.4.**
**Tel: 01-527 2256.**

phonodisc

[4313

# MARCONI INSTRUMENTS Ltd.
## AT ST. ALBANS AND LUTON
# ELECTRONIC TECHNICIANS

We are a company that manufactures precision electronic measuring instruments and have a range of technical career vacancies within our Production and Engineering departments at St. Albans and Service Division at Luton.
To fill these posts we are looking for people with a good electronic background, but not necessarily qualified.
Attractive salaries are offered for the right candidates along with the normal benefits of staff employment.

For further information and or application forms contact John Prodger, mi Ltd., Longacres, St. Albans, Herts. Tel:59292.
A G.E.C. Marconi Electronics Company.

4356

# Technical Advisers

To deal with problems of a technical nature and advise customers on queries relating to radio television, tape recorders, washing machines and all similar products.
This requires a good working knowledge of these products and the ability to convey technical information by telephone and correspondence. The work is interesting, varied and would provide a workshop engineer with the opportunity to use his technical abilities and further his career in the technical/commercial aspect of customer liaison. We provide, of course, product familiarisation training.

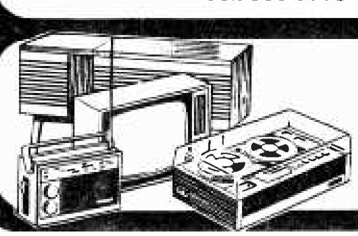
Excellent conditions of employment include monthly staff status, general annual bonus and annual salary reviews, pension/life assurance, sickness benefit scheme and one month's annual holiday.

Please write or phone for an application form.

**Personnel Officer,**
**Combined Electronic Services Ltd.,**
**604 Purley Way,**
**Waddon, Croydon CR9 4DR**
**Tel. 686 0505**

4350

**ces**



PHILIPS
Service
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Service

# ELECTRONIC CRAFTSMEN

***Is your present job routine and uninteresting?***

We are a research establishment and our craftsmen are engaged on a wide variety of work in the fields of prototype and small batch wiring and assembly, test and inspection, maintenance fault finding and repair. Why not join us and enjoy working in first class conditions in the country.

You can expect gross earnings including overtime of £45 per week, and we can offer good housing at low rental (for applicants who reside outside the radius of our Assisted Travel Area) together with 3 weeks paid holiday with holiday bonus, free pension and excellent sick benefit scheme.

Applicants who should have served a recognised apprenticeship or have had equivalent training together with experience in one of the fields detailed should 'phone Tadley 4111 (STD 073 56 4111) Ext. 5230, or write to:

**INDUSTRIAL RECRUITMENT OFFICER**
**(PA/57/WW) PROCUREMENT EXECUTIVE**
**MINISTRY OF DEFENCE**
**AWRE ALDERMASTON**
**READING, BERKS.**
**RG7 4PR.**

[4316

## APPOINTMENTS

REDIFON TELECOMMUNICATIONS LTD., London, S.W.18, have a vacancy for an enthusiastic, practical man with some experience of Volume Production Testing in the electronics industry. Phone: 01-874 7281 and ask for Len Porter. [4288

## SITUATIONS VACANT

ELECTRONICS TECHNICIAN required for further expansion of the electronics service. The person appointed will join a small team in a well-equipped laboratory. He will be responsible to a graduate electronics engineer for maintenance of a wide range of patient-orientated electronic equipment. Development of special-purpose systems is undertaken, and safety and purchase decisions are made on new equipment. Minimum qualifications: ONC or HNC. The appointment will be in either of the following grades depending on experience: Medical Physics Technician III (£2,190 to £2,817); Medical Physics Technician IV (£1,773 to £2,463) plus threshold agreements. Further details of the work may be obtained by telephoning Mr. L. R. Jenkin, Plymouth 68080 Ext. 369. Application forms are available from the Hospital Secretary, North Friary House, Greenbank Terrace, Plymouth PL4 8QQ. [4293

ELECTRONICS TECHNICIAN (Grade 5). Applications are invited for a position in an advanced electronics workshop. The post offers interesting and varied duties involving design, development, maintenance and repair of instruments comprising integrated circuits and discrete components. Experience in both analogue and digital systems is desirable. Minimum qualification is an HNC or equivalent and the salary (under review) is in the range £2,235 to £2,610. Threshold payments are applicable. 37½ hour, five-day week. Excellent social facilities are available. Applications in writing stating details of age and experience to Professor A. R. Ubbelohde, C.B.E., F.R.S., Department of Chemical Engineering and Chemical Technology, Imperial College, London, S.W.7. [4294

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

## SITUATIONS WANTED

ELECTRONICS ENGINEER required for Central London recording studio. Experience in audio electronic work essential, must be keen and prepared to work long hours. Box No. WW 4344.

ELECTRONICS TECHNICIAN, Grade 5, required for small research group in Zoology & Comparative Physiology Department, investigating ultrasonic communication and echolocation systems of animals. Responsibilities will include maintenance of various advanced instruments and the development of new equipment and techniques for investigating ultrasound in air. The appointment is temporary for one year in the first instance. Salary scale £2,439—£2,895 p.a. plus £228 p.a. London Weighting. Five weeks in total annual leave. Five day week. Letters only to Assistant Secretary (Establishment) ET/Z, Queen Mary College, Mile End Road, E1 4NS, stating age, qualifications and experience. [4342

UNIVERSITY OF LEEDS. Electronics Technician (Grade 5) required in the School of Chemistry Electronic Workshop to work in the construction and maintenance of electronic equipment used in the Department. The applicant must be conversant with multi-channel analysers, computor logic, printed circuit techniques and electrochemical transducers. Qualifications—H.N.C. or equivalent. Salary on the scale £2,007—£2,382 plus threshold (under review). Applications to Mr. S. Walker, Supervisor of the Electronics Workshop, School of Chemistry, The University of Leeds, Leeds LS2 9JT. [4346

## 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

CINTEL 3352 delayed pulse and sweep generator 1H3 to 1MHz variable width Pre pulse feature etc. G.W.O. £20. Wireless World 1968 to 1973, offers. Phone Wooley 248. [4307

Classifieds continued on p. 87

Classifieds continued from p. 86
**Articles for Sale continued.**

COIL WINDING COPPER WIRE, sleeving and equipment wire. Our company wishes to dispose of stocks surplus to its requirements. Contact—Ray Adam—Tel. 01-578 2300. [4290

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. Television construction cross hatch kit, £3.85, P/P 15p. Bush CTV 25. 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 £2.75, P/P 35p. CR1 Base panel, 75p. 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, P/P 35p. CRT Base 75p, P/P 20p. B9D valve bases 10p, P/P 6p. VARICAP TUNERS. UHF ELC 1043 NEW, £4.50, Philips VHF for Band 1 and 3, £2.85 incl. data. Salvaged VHF and UHF Varicap tuners, £1.50, P/P 25p. UHF TUNERS NEW, Transistorised. £2.85 or incl. slow motion drive, £3.85. 4 position and 6 pos. push-button 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. 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, 75p P/P 35p. PHILIPS 625 IF amplifier panel incl. cct., 75p. 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, £1.80 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. 200+200+100 Microfarad 350v Electrolytic, £1.00 P/P 20p. MANOR SUPPLIES, 172 WEST END LANE, LONDON, N.W.6. Shop premises, callers welcome. (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 9p for list. Ramar Constructor Services, 29 Shelbourne Road, Stratford on Avon, Warwks. Tel. Stratford on Avon (std 0789) 4879. [28

FOR SALE Handbook of space vehicles and satellites, £7.50; AVO 47A in case, £18.50; untesting INFRA-RED monocular, £4.50; Avominor, as new £8.00; Sinclair digital multimeter, as new, £46.50. Box WW 4337.

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LADDERS unvarnished 14ft. 1in. closed, 25ft. 4in. extd. £21.40 delivered. Tel: Telford 586644. [13

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Classifieds continued on p. 93

APPOINTMENTS

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| NE555 Timer + data 8 DIL | 76 | 73 | 69 |
| CA3046 Array 14 pin DIL | 76 | 73 | 69 |
| TDA1405 Reg. 5V 650mA | 100 | 92 | 85 |
| TDA1412 Reg. 12V 500mA | 100 | 92 | 85 |
| TDA1415 Reg. 15V 450mA | 100 | 92 | 85 |
| BC107, 108, 109 | 10 | 9.5 | 9 |
| BC182, 184 | 11 | 10.5 | 10 |
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| 7405 | 20 | 19 | 18 |
| 7410 | 19 | 18 | 17 |
| 7413 | 19 | 18 | 17 |
| 7420 | 19 | 18 | 17 |
| 7430 | 19 | 18 | 17 |
| 7442 | 80 | 76 | 73 |
| 7447 | 120 | 110 | 100 |
| 7473 | 42 | 40 | 38 |
| 7474 | 40 | 38 | 36 |
| 7476 | 46 | 43 | 41 |
| 7486 | 40 | 38 | 36 |
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| 7493 | 65 | 60 | 57 |
| 74121 | 50 | 46 | 43 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
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| ECC82 | 28.0 | PY500A | 85.0 | AF117 | 23p | BC149 | 12p | BF179 | 40p | BY127 | 12p |
| EF80 | 29.5 | PY800 | 29.0 | AF118 | 50p | BC153 | 20p | BF180 | 35p | E.1222 | 30p |
| EF183 | 34.5 | **SEMI-CONDUCTORS** | | AF139 | 42p | BC154 | 22p | BF181 | 35p | IN60 | 05p |
| EF184 | 34.5 | AC127 | 17p | AF178 | 45p | BC157 | 12p | BF184 | 21p | MJE340 | 45p |
| EH90 | 31.5 | AC128 | 15p | AF180 | 45p | BC158 | 10p | BF185 | 21p | OA202 | 7.5p |
| PC900 | 24.5 | AC141K | 30p | AF181 | 45p | BC159 | 14p | BF194 | 15p | OC71 | 15p |
| PCC89 | 40.0 | AC142K | 30p | AF239 | 45p | BC173 | 18p | BF195 | 15p | OC72 | 15p |
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| PCF80 | 31.5 | AC154 | 18p | BC107 | 11p | BC182L | 12p | BF197 | 17p | 2SC1172B | £2.40 |
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| PCL82 | 39.0 | AC187 | 19p | BC116 | 25p | BD124 | 70p | BF224 | 35p | **CIRCUITS** | |
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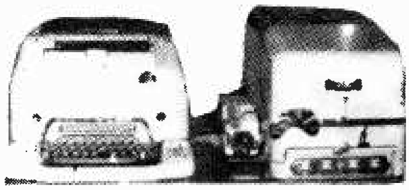

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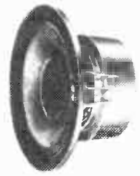

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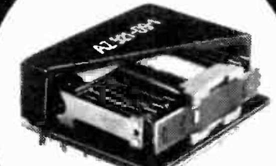


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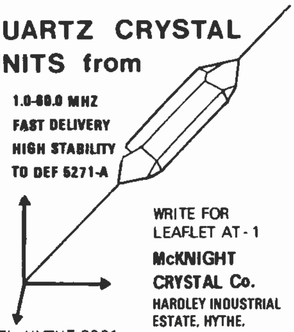

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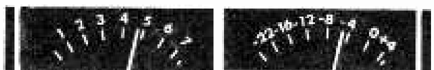

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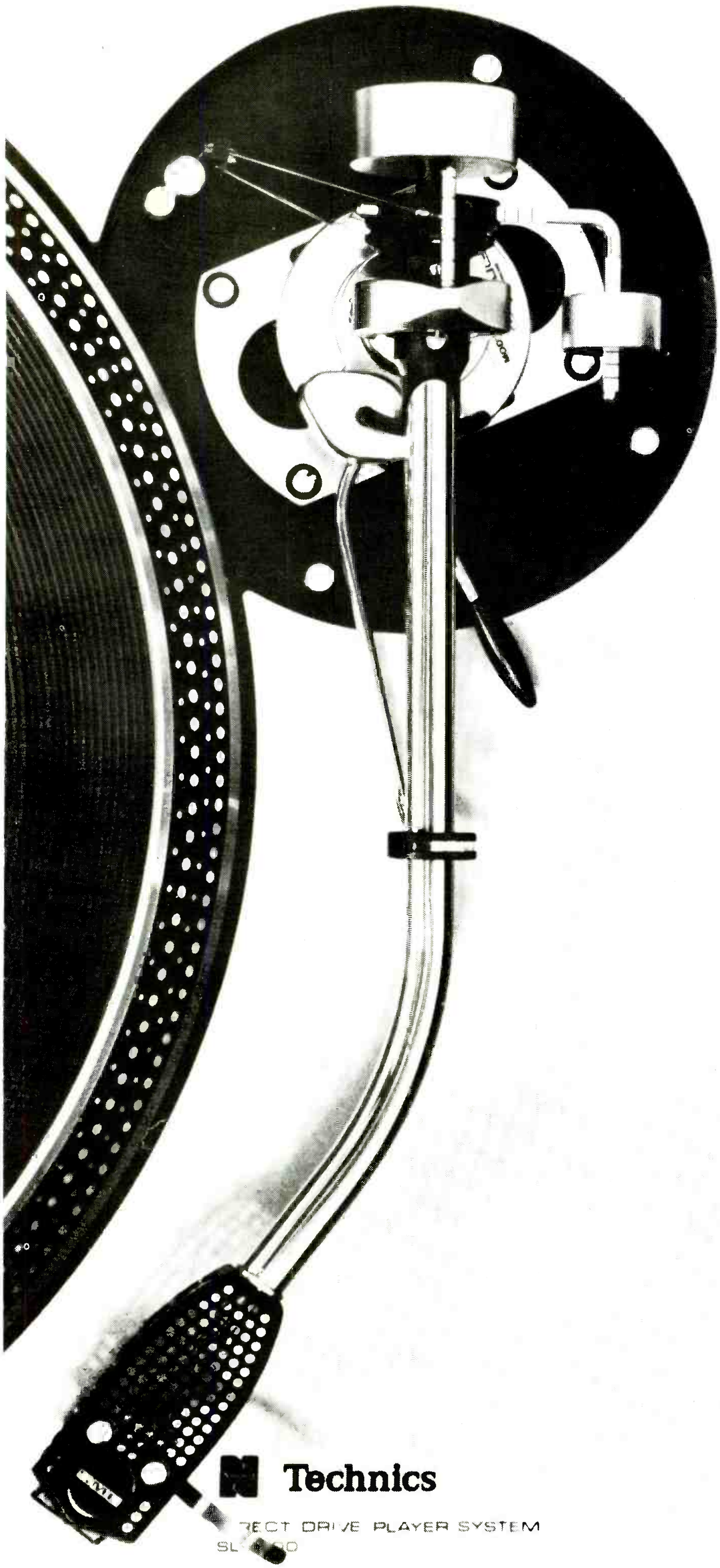


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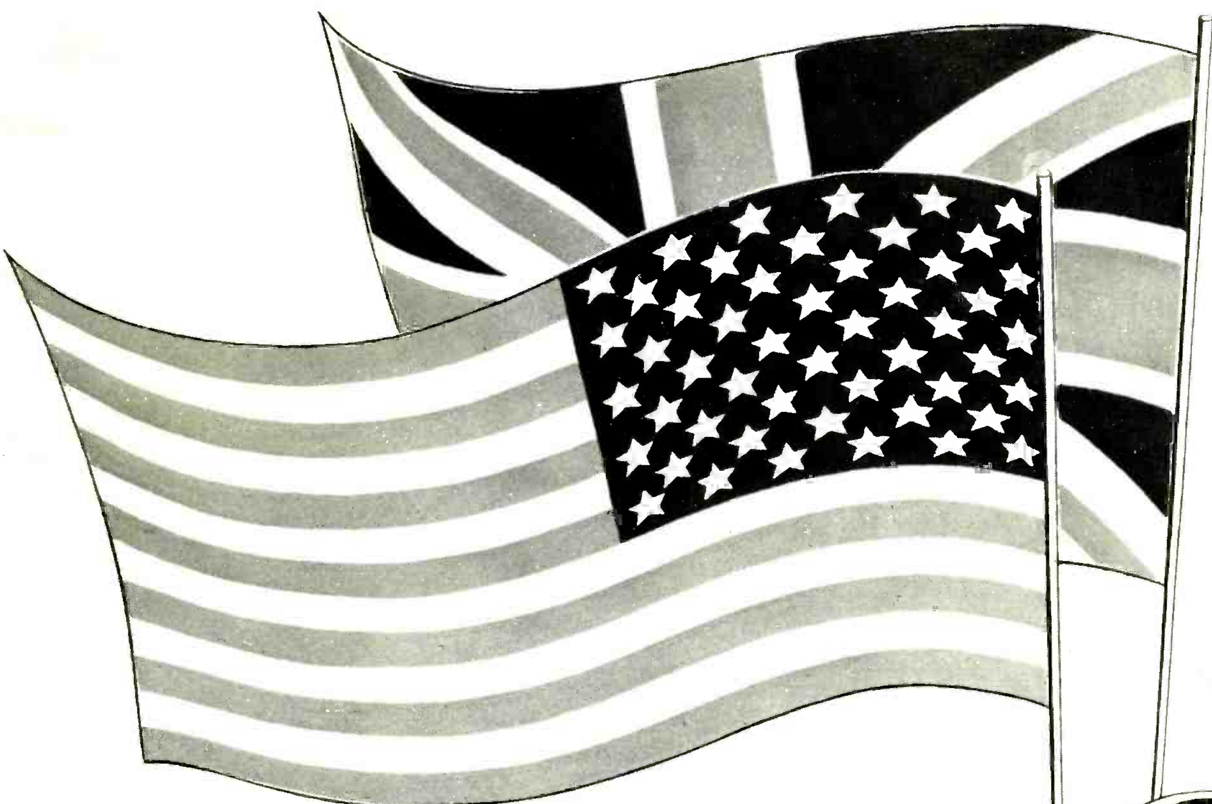

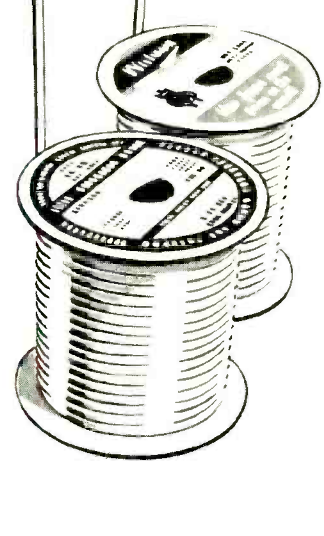

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