

# wireless world

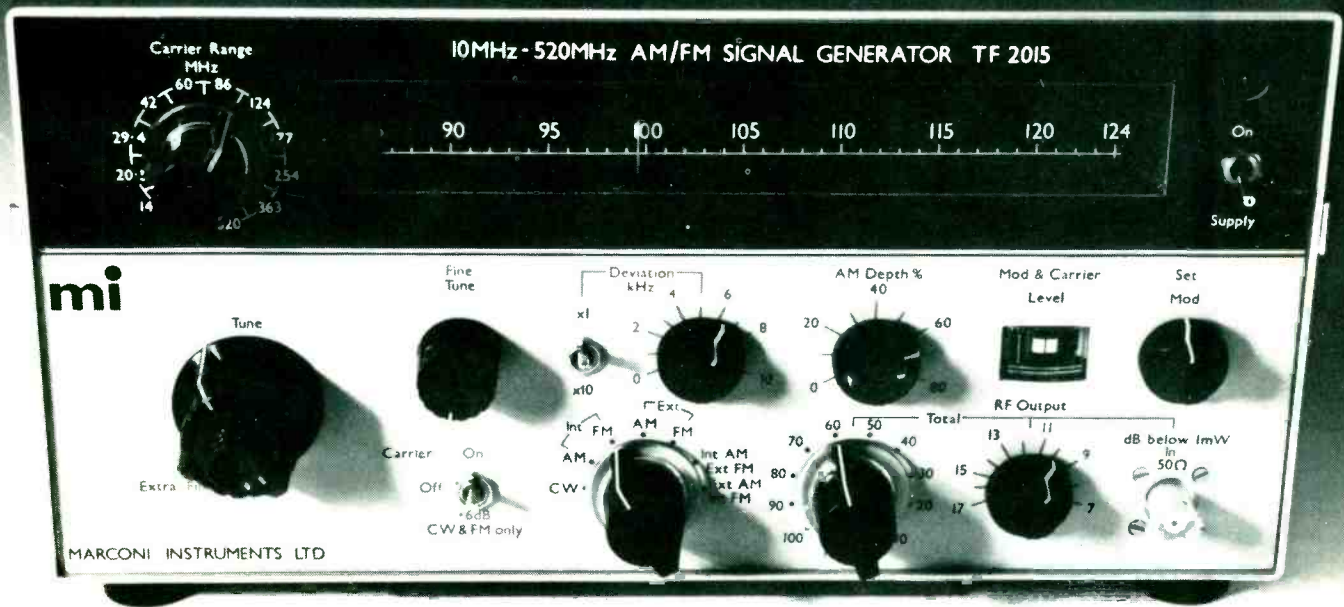
JUNE 1976 35p

**CD-4 demodulator**  
**Wireless across space**

Is  
anyone  
there?



Australia \$A1.20  
Belgium Fr. 61.80  
Canada \$1.80  
Denmark Kr. 11.00  
Finland Fmk. 6.20  
Germany Dm. 4.50  
Greece Dr. 45.00  
Holland Dfl. 4.50  
Italy L. 900  
Malaysia M\$3.25  
New Zealand \$NS1.20  
Norway Kr. 10.00 incl. moms  
Portugal Esc. 40.00  
South Africa R. 1.10  
Spain Ptas. 80.00  
Sweden Kr. 6.90 incl. moms  
U.S.A. \$1.80



# mi's TF 2015 a wider view of signal generation...

The TF 2015 is a versatile 10-520 MHz signal generator with calibrated a.m. and f.m. and an accuracy of output level setting normally found only in instruments costing three times as much. A special system gives very fast tuning across the bands yet provides smooth control within the narrowest of passbands. Leakage radiation is carefully screened out to enable accurate measurements to be made even at levels below  $1\mu\text{V}$ .

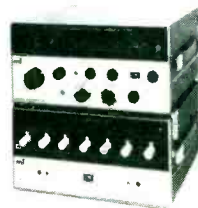
## Matched Synchronizer

The clip-on Synchronizer TF 2171 transforms the performance of TF 2015 into the equivalent of a synthesizer at less than half the comparable cost. The frequency is locked to crystal stability and can be dialled in 100 Hz. steps. Tuning is quick and easy – set the decade dials, switch to "lock" and tune the generator to the approximate

frequency and the synchronizer will finish the job for you. Now you can change the frequency by up to 2% using the decade dials **without touching the generator** – and all to an accuracy of 2 parts in  $10^7$ . It stays locked all day and doesn't degrade **any** aspect of the generator performance.

## I.F. Probes

These are an invaluable aid to the testing of receivers with squelch or battery economiser circuits. These circuits are inactivated when the crystal-controlled signal from the probes is brought into the proximity of the receiver's i.f. strip. This makes it easy to tune the generator to a receiver when its channel frequency is unknown. The probes can also be used to check exact tuning by adjusting for zero beat.



## mi: THE SIGNAL GENERATORS

MARCONI INSTRUMENTS LIMITED

Longacres, St. Albans, Hertfordshire, England, AL4 0JN · Telephone: St. Albans 59292. Telex: 23355.  
A GEC-Marconi Electronics company.

WW-001 FOR FURTHER DETAILS

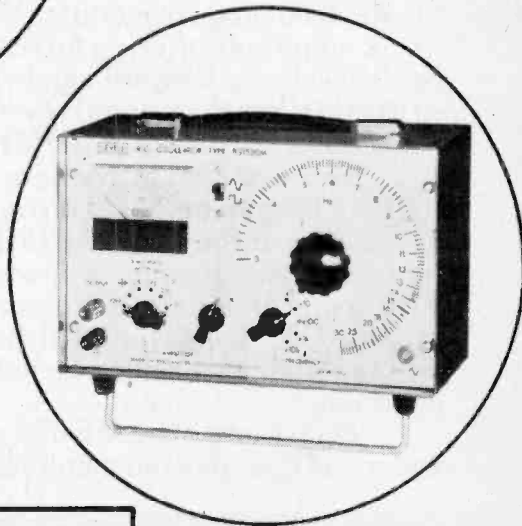
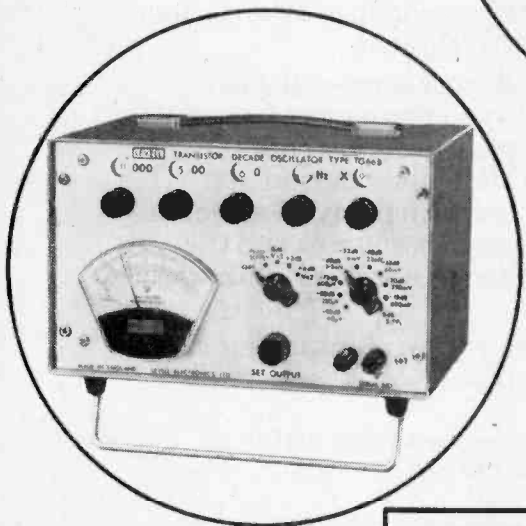
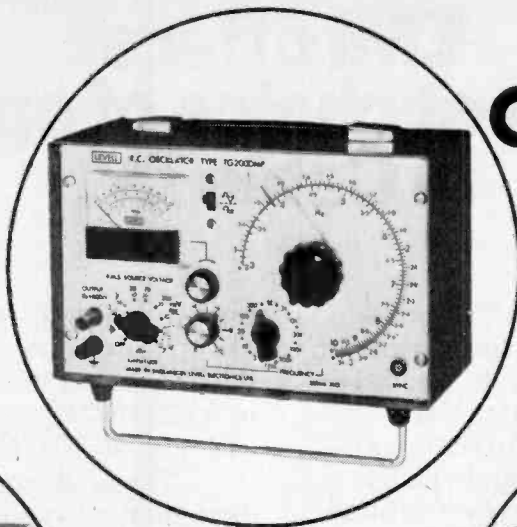
[www.americanradiohistory.com](http://www.americanradiohistory.com)

# LEVELL

## PORTABLE INSTRUMENTS

SEE US AT THE  
LEEDS ELECTRONICS  
EXHIBITION  
JUNE 29/30, JULY 1, 1976

# LOW COST OSCILLATORS



FREQUENCY	1Hz to 1MHz in 12 semi-decade ranges. 0 to 1% fine control included on TG200DMP.
ACCURACY	±2% ±0.03Hz.
SINE OUTPUT	7V r.m.s. down to <200 μV with $R_s = 600\Omega$ .
DISTORTION	<0.1% to 5V, <0.2% at 7V from 10Hz to 100kHz.
SQUARE OUTPUT	TG200D, DM & DMP only. 7V peak down to <200 μV. Rise time <150ns.
SYNC. OUTPUT	>1V r.m.s. sine in phase with output.
SYNC. INPUT	±1% freq. lock range per volt r.m.s.
METER SCALES	TG200M, DM & DMP only. 0/2V, 0/7V & -14/+6dBm.
SIZE & WEIGHT	260mm x 130mm x 180mm. 4.3kg.

TG200	TG200D	TG200M	TG200DM	TG200DMP
<b>£66</b>	<b>£70</b>	<b>£80</b>	<b>£84</b>	<b>£88</b>

FREQUENCY	0.2Hz to 1.22MHz on four decade controls.
ACCURACY	±0.02Hz below 6Hz. ±0.3% from 6Hz to 100kHz. ±1% from 100kHz to 300 kHz. ±3% above 300 kHz.
SINE OUTPUT	5V r.m.s. down to 30 μV with $R_s = 600\Omega$ .
DISTORTION	<0.15% from 15Hz to 15kHz. <0.5% at 1.5Hz and 150kHz.
METER SCALES	2 Expanded voltage & -2/+4dBm.
SIZE & WEIGHT	260mm x 190mm x 180mm. 5.6kg.

<b>TG66B</b>	<b>TG66A</b>
Battery model <b>£180</b>	Mains & battery model <b>£195</b>

FREQUENCY	3Hz to 300kHz in 5 decade ranges.
ACCURACY	±2% ±0.1 Hz up to 100kHz, increasing to ±3% at 300kHz.
SINE OUTPUT	2.5V r.m.s. down to <200 μV.
DISTORTION	<0.2% from 50 Hz to 50kHz.
SQUARE OUTPUT	2.5V peak down to <200 μV.
SYNC. OUTPUT	2.5V r.m.s. sine.
METER SCALES	0/2.5V & -10/+10dB on TG152DM.
SIZE & WEIGHT	260mm x 130mm x 180mm. 3.4kg.

<b>TG152D</b>	<b>TG152DM</b>
Without meter <b>£53</b>	With meter <b>£66</b>

**LEVELL ELECTRONICS LTD.**  
Moxon Street, High Barnet, Herts. EN5 5SD  
Tel. 01-449 5028/440 8686

Prices include batteries and U.K. delivery. VAT extra. Optional extras are leather cases and mains power units. Send for data covering our range of portable instruments.

WW-051 FOR FURTHER DETAILS

# EMI offers the widest choice of options in Cable T.V.

EMI Colorline Cable TV equipment provides long reach, low distortion and high channel capacity. It is based on the RE 1000 range of modular VHF trunk amplifiers offering full two-way facilities. Basic forward bandwidth is 40-300 MHz with optional reverse bandwidths of 5-30 MHz or 5-100 MHz.

And now EMI introduces hybrid VHF/UHF systems based on our new RE 1037, \* a unique VHF/UHF distribution converter. It enables up to seven VHF trunk channels to be converted into the UHF bands for local distribution together with unconverted VHF channels.

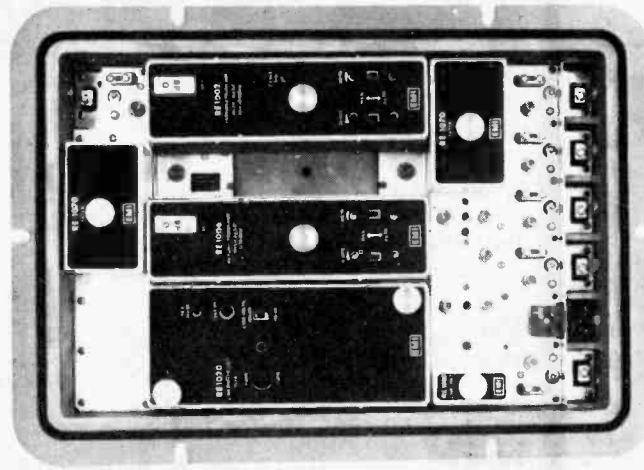
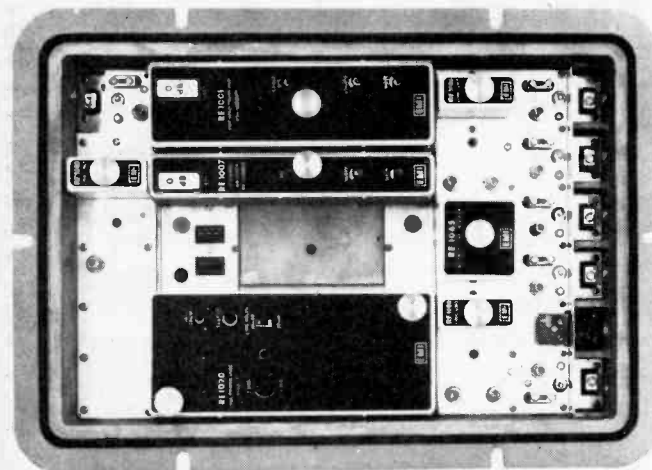
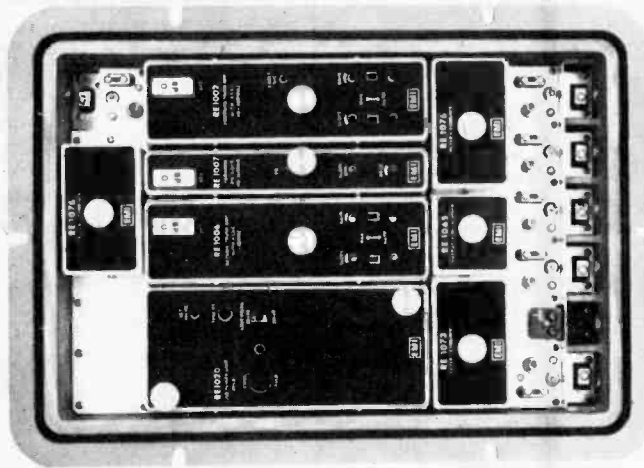
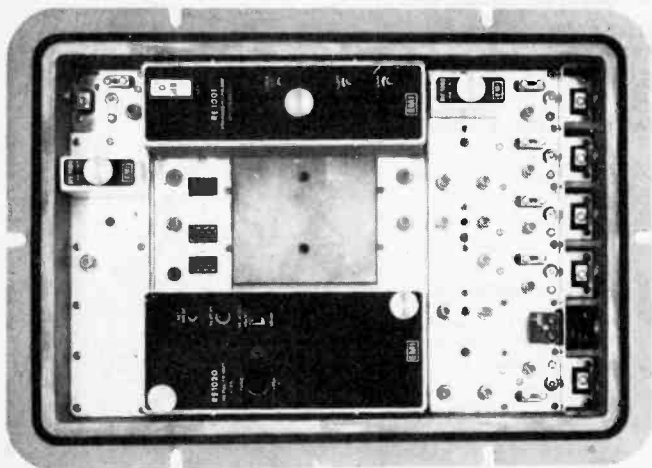
Then there's the ME 670, an ultra wideband distribution amplifier cover-

ing the range 40-860 MHz and incorporating its own line or mains power supply. Also covering the same range are the new RE 1022 ultra wideband Subscriber Tap and RE 1032 Splitter.

These are just some of the new developments you can expect from EMI, who cover virtually every requirement for VHF and UHF distribution networks, together with unrivalled technological and design resources and the most comprehensive service facilities in the business.

So when you're planning for cable television contact EMI, the specialists.

\*The RE 1037 is manufactured by EMI under licence from the British Post Office.



EMI Sound & Vision Equipment Ltd.,  
252 Blyth Road, Hayes, Middlesex, England.  
Tel: 01-573 3888. Telex: 25145. Cables: EMISOUND.  
A member of the EMI Group of Companies.  
International leaders in music, electronics and leisure.

WW-081 FOR FURTHER DETAILS

# We've joined Christopher Wren in the dome business...

... as users of our **Dome Tweeters** will already know

ISOPHON—are a company who have been manufacturing loudspeakers for over fifty years and are internationally known and respected for quality and reliability. They offer a wide range of tweeters, mid-range and bass units.

Owing to shortage of space we are only able to draw your attention to just two of the models currently being manufactured by Isophon ...

### The KK8

A dome tweeter, well known for its performance and reliability, and chosen by many loudspeaker manufacturers. Two models are available, one up to 50 watts and the other up to 80 watts RMS Power Rating. Frequency range from 800 to over 20,000 Hz.

### The PSL 245/60

A new 10" circular loudspeaker, offering up to 60 watts RMS Power Rating.

Our 28 page colour catalogue will give you details of the extremely wide choice of loudspeakers that are available from Isophon.



*For your free copy of the catalogue, please post the coupon to ...*

Hayden Laboratories Limited  
Hayden House, Churchfield Road  
Chalfont St. Peter, Bucks. SL9 9EW  
Tel: Gerrards Cross (028 13) 88447

Please forward your 28 page ISOPHON LOUD-SPEAKER catalogue

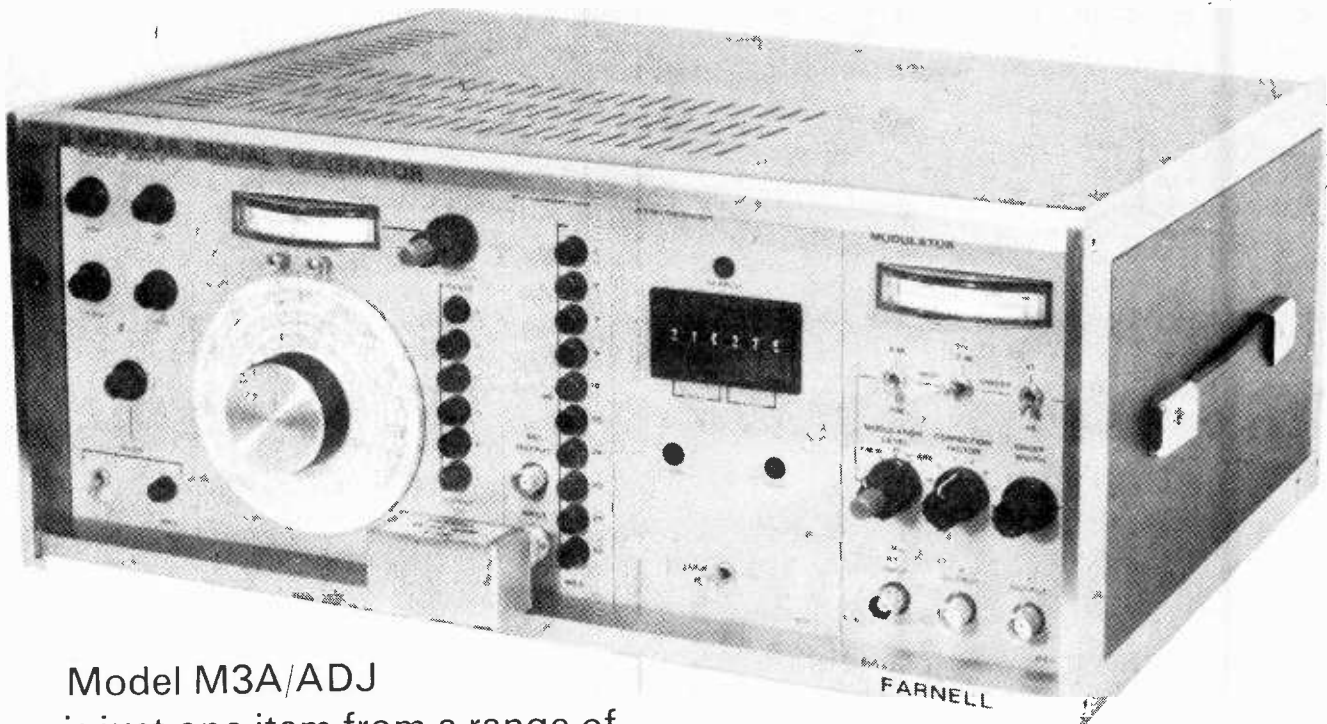
Name .....

Company .....

Address .....

Code .....

# 10 to 512 MHz GENERATOR



## Model M3A/ADJ

is just one item from a range of communication test equipment from Farnell which may be seen at the Communications '76 Exhibition.

### *Facilities include:*

- amplitude and frequency modulation
- narrowband sweep
- crystal stability and accuracy
- low r.f. leakage
- thumbwheel switch or dial frequency selection
- built in r.f. detector and xy outputs
- remote control facilities

### *Other products on display include:*

- Data cartridge recorders
- Computer peripherals
- Video display terminals
- Frequency counters
- R. F. millivoltmeters
- Sweepers
- Power supplies ● Alarms etc.

*Telephone us for a ticket to the show or use the publishers reply service for full data on all products.*



FARNELL INSTRUMENTS LIMITED  
 SANDBECK WAY, WETHERBY,  
 WEST YORKSHIRE LS22 4DH  
 TELEPHONE: 0937 3541 TELEX 557294  
 LONDON OFFICE: 01-864 7433



# For faster delivery try these sources

Our Appointed Distributors have been ordering instruments on your behalf for over a year now. This means they can deliver your order quicker than any other source. They can help you choose the right instrument, too. Here's where to contact them:

## LONDON AREA

### London

Edmundson Electric Ltd.  
Tel: 01-891 1331

ERD(South East) Ltd.  
Tel: 01-928 5620

Lugton & Co. Ltd. Tel: 01-348 8247

R.T. & I. Electronics Ltd  
Tel: 01-539 4986

ITT Distributors Ltd.  
Tel: 01-803 6522

### Harlow

ITT Instrument Services  
Tel: 0279 29522

Welwyn Garden City  
Ellistons (Welwyn) Ltd.  
Tel: 07073 26344

## MIDLANDS

### Coventry

Mercia Electronics Ltd.  
Tel: 0203 24091

## Birmingham

ITT Distributors Ltd.  
Tel: 021-236 5030

ERD(Midlands) Ltd. Tel: 021-236 5060

### Northampton

E.M.F.(Electrical) Ltd. Tel: 0604 21711

### Norwich

Newey & Eyre Ltd. Tel: 0603 49341

### Nottingham

Newey & Eyre Ltd. Tel: 0602 866531

## NORTHERN IRELAND

### Belfast

Eirco Ltd. Tel: 0232 42911

## NORTH EAST

### Hull

Edmundson Electric Ltd.  
Tel: 0482 20691

### Leeds

Farnell Electronic Components Ltd.  
Tel: 0532 636311

### Wetherby

Farnell Instruments Ltd.  
Tel: 0937 3541

### Newcastle upon Tyne

J. Gledson & Co. Ltd. Tel: 0632 860955

## NORTH WEST AND N. WALES

### Salford

Hirst Ibbetson & Taylor Ltd.  
Tel: 061-832 9711

## J. Walton (Electrical) Ltd.

Tel: 061-872 4224

## SCOTLAND

### Glasgow

ERD(Scotland) Ltd. Tel: 041-647 7141

Elesco-Fraser Ltd. Tel: 041-221 9301

## SOUTH WEST AND S. WALES

### Bristol

Black Arrow (Electronics) Ltd.  
Tel: 0454 315824

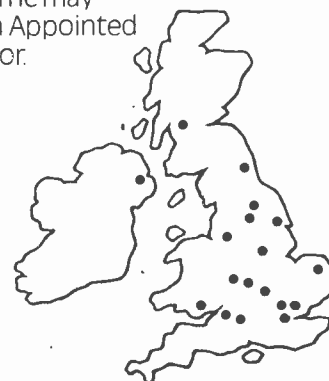
### Cardiff

Newey & Eyre Ltd. Tel: 0222 45831

### Bath

ERD(South West) Ltd. Tel: 0225 63281

You will still be able to buy our instruments through your usual wholesaler, although he may not be an Appointed Distributor.

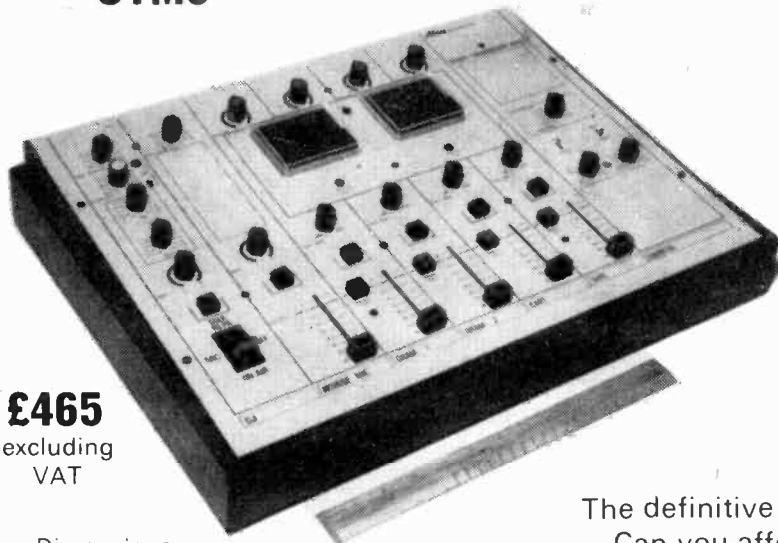


Thorn Measurement Control and Automation Division, Archcliffe Road, Dover, Kent. Telephone: Dover (0304) 202620

Avo Limited  
Evershed & Vignoles Limited MEGGER Instruments Division  
H. W. Sullivan Limited

WW-089 FOR FURTHER DETAILS  
www.americanradiohistory.com

## Alice Broadcasting STM6



**£465**  
excluding  
VAT

Dimensions  
20" x 15" x 4½"

## Six Channel Stereo Transmission Mixer (ALICE'S BABY)

### INPUTS

Microphones  
Lines/Tape/Carts  
Pick-ups  
Off Air

### OUTPUTS

Lines  
P.A.  
Headphones  
Recording

The definitive DJ/OB/Production Mixer  
Can you afford to use anything else?

Contact Chris Walden on Windsor 51056/7

**ALICE (STANCOIL LTD.), 38 ALEXANDRA ROAD, WINDSOR, BERKS, ENGLAND**

Also available from Roger Squires, London and Manchester

WW — 018 FOR FURTHER DETAILS

## AEL 3030

The AEL 3030 is a compact, fully solid-state 150 watt PEP output Transmitter-Receiver covering 2.16 MHz on 4 or 6 channels.

Rugged construction for today's tough environments.  
Easily accessible for simple maintenance.

Ten plug-in modules give maximum insurance against loss of service.

The advanced technology used in the AEL 3030 provides unmatched efficiency in point to point or mobile communication, minimises size and cost and maximises reliability!

### DESIGNED FOR RELIABILITY



**NEW  
COMMUNICATIONS  
EQUIPMENT  
FROM  
AEL**

For further information and  
colour brochure write to:

**AEL GATWICK HOUSE**  
**HORLEY, SURREY, ENGLAND**  
TELEPHONE: HORLEY (02934) 5353

Telex 87116 (Aerocon Horley)  
Cables: Aerocon. Telex: Horlev

WW—056 FOR FURTHER DETAILS





# PHILIPS

## Follow the 'Philips plus' way to prosperity

Make sure that your workshop is the most efficiently equipped and that your service engineer's home visits are the fastest and most effective. Get these Philips instruments now. You won't find better value for money.

### NEW



**PM5501 PAL TV Pattern Generator Price £149**

Extremely light, portable instrument for service in customers' home. 5 different test patterns for colour and black/white installation and service. RF output signal switchable: VHF Band III and UHF Band IV. 1 kHz tone for sound performance checks.

**PM5509 PAL TV Pattern Generator Price £350**

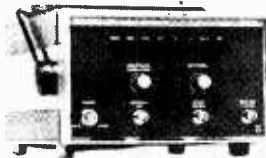
The ultimate in pattern generators. Full IF coverage; band I, III, IV and V. Electronic tuning with 5 preset channels. 10 test patterns (colour and black/white). Adjustable chroma/burst and HF-amplitude. Special sync, video and VCR outputs.



### NEW

**PM6456 FM Stereo Generator Price £192**

Complete stereo signal. L & R signal. Internal L.F. modulation: 1 & 5 kHz. External stereo modulation possibility. X-tal controlled pilot. Adjustable multiplex signal.



**PM5324 HF Generator**

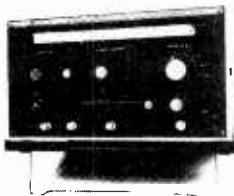
Frequency range 100 kHz - 110 MHz. X-tal calibration. Special band spread ranges. High frequency stability. Electronically stabilised output max. 50 mVrms in 75  $\Omega$ . Facilities for internal and external AM and FM modulation.



**Price £297**

**PM5334 TV Sweep Generator Price £399**

8 frequency ranges, 3 MHz - 860 MHz. Sweep width continuously adjustable over selected range. Sweep frequency adjustable, 8 - 50 Hz. One variable and 3 fixed markers. Signal frequency is accurate and thermally stable. Stabilised output into 75  $\Omega$  load.

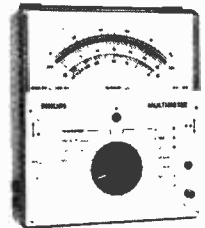


**PM2503 Electronic Multimeter Price £69**

AC/DC voltage ranges 100 mV - 1 kV. AC/DC current ranges 1  $\mu$ A - 1 A. Resistance ranges 100  $\Omega$  - 10 M  $\Omega$ . 2-3% accuracy on all ranges. Resistance measurements: unique linear scale. No zero adjustment necessary. Automatic polarity indicator.

**PM2412 General Purpose Multimeter Price £48**

DC voltage 300 mV - 1000 V. AC voltage 3 V - 600 V. DC current 10 mA - 6 A. AC current 100 mA - 6 A. (all values f.s.d.) Resistance 1  $\Omega$  - 10 M  $\Omega$ . Tautband 40,000  $\Omega$ /V. suspension-type meter.



**NEW PM2513 Low Cost Digital Multimeter Price £95**

DC voltage ranges 0.2 - 1000 V. AC voltage ranges 0.2 - 600 V. AC/DC current ranges 0.2 mA - 2 A. Resistance ranges 200  $\Omega$  - 2 M  $\Omega$ . Full circuit protection. Provision for temperature measurements, -60 to +200°C.

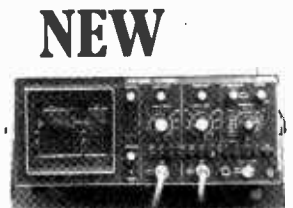


**PM3225 and PM3226 15 MHz oscilloscopes**

Comprehensive triggering facilities (Auto, AC, DC and TV) Large 8 x 10 div. screen Sensitivity 2mV/div Ergonomic styling and lightweight construction Single trace: PM3225. Price £210 Dual trace: PM3226. Price £290

The Philips Plus is the quality of design, specification and appearance - particularly in terms of human engineering - of every instrument. A total test and measuring range capability, which includes scopes, meters, counters, pulse generators, power supplies, recorders and generators. The ability to supply all the user's needs from a single source. All prices exclude VAT.

For prompt delivery of any of these instruments, send us your cheque. If you require further information, there is a new 16 page illustrated brochure packed with facts which we would be delighted to send you. Please use the reader reply service, write or telephone to



## Pye Unicam Ltd

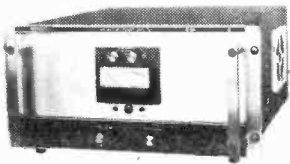
Philips Electronic Instruments Dept.  
York Street Cambridge England CB1 2PX.  
Tel: Cambridge (0223) 58866 Telex: 817331

A member of the Pye of Cambridge Group

WW - 067 FOR FURTHER DETAILS

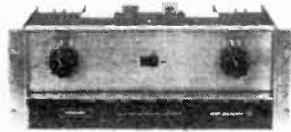
# AMCRON POWER AMPLIFIERS

The AMCRON range of DC-coupled power amplifiers are used by Government, and University Research Departments as well as by Industry for a variety of applications ranging from Shaker, and Vibrator driving, to driving both AC and DC Motors, providing variable frequency power supply, or high voltage material testing. All models are DC-coupled throughout, with Intermodulation, and Harmonic Distortion below 0.05%, damping factor of at least 400 from DC to 1 kHz, and the ability to operate into load impedances from 1 ohm to infinity even into highly reactive loads.



**M600**

RMS power out 750 watts into 8 ohms  
1 350 watts into 4 ohms  
Power bandwidth DC to 20 kHz + 1 db - 0 db  
+ 0' - 15' DC - 20 kHz  
Phase response 16 V/μsecond  
Slew rate 120 db below 600 Watts  
Hum & noise 19" std rack, 8¾" H, 16½" Deep  
Dimensions



**DC 300A**

500 watts rms into 2.5 ohms (1 chan)  
DC-20kHz + 1 db - 0 db  
+0, - 15' DC to 20kHz  
8 volts per microsecond  
At least 110db below 150 watts  
19" Rackmount, 7" High, 9¾" Deep



**D150A**

200 watts into 2.5 ohms (1 chan)  
DC-20 kHz + 1 db, - 0 db  
+ 0', - 15' DC to 20 kHz  
6 volts per microsecond  
At least 115 db below 90 watts  
19" Rackmount, 5¼" H, 8¾" D.



## MACINNES LABORATORIES LTD.

MacInnes House, Carlton Park Industrial Estate  
Saxmundham, Suffolk IP17 2NL. Tel: (0728) 2262 2615

## MACINNES FRANCE

45 Rue Fessart  
Paris 75019, France  
Tel: 203-30-01

WW-052 FOR FURTHER DETAILS

# Your copy?



**CT Series**  
3A 250V AC  
5A 29V DC  
Single and double pole, 2 and 3 position lever and rocker switches with solder lugs.



**T Series**  
5A 115V AC  
5A 29V DC  
Special Duty. Single and double pole, 2 and 3 position lever switches with solder lug or printed circuit terminals



**PM Series**  
1A 125V AC  
2A 29V DC  
Single, double and triple pole push button switches with momentary action. Solder lug or PC terminals

It's the new  
easy guide  
to the  
**ARROW**  
subminiature  
superstars

Send today for your copy of this new Arrow subminiature switch brochure

**ARROW  
Hart**

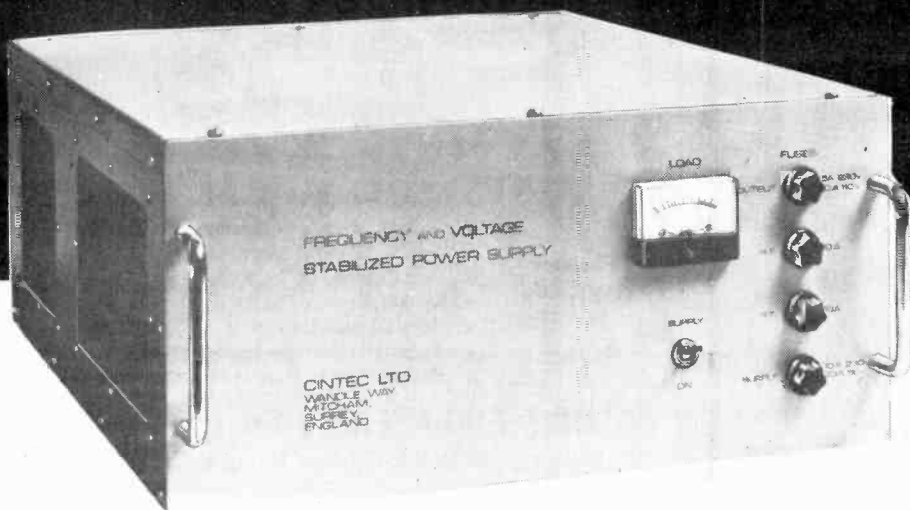
Arrow-Hart (Europe) Limited,  
Plymbridge Road, Estover,  
Plymouth, PL6 7PN  
Tel: Plymouth (0752) 701155

WW-065 FOR FURTHER DETAILS

# THE CINTEC SINUSOIDAL FREQUENCY AND VOLTAGE STABILIZER

## APPLICATIONS

- \* SOUND RECORDING
- \* VIDEO RECORDING
- \* MEDICAL
- \* MARINE
- \* COMPUTERS
- \* NAVIGATIONAL SYSTEMS



- ★ SOLID STATE
- ★ HIGH STABILITY
- ★ ROBUST
- ★ VERSATILITY
- ★ RELIABILITY
- ★ SINUSOIDAL

### Reliable Frequency & Voltage Stabilization

The efficient operation of sophisticated electrical and electronic equipment is, in many instances, dependent upon an electrical supply which is stable in both frequency and voltage.

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

**The CINTEC FREQUENCY & VOLTAGE STABILIZER provides the answer to both these problems.**

When the supply frequency is fluctuating wildly, between 40Hz and 60Hz and the voltage by more than 10% the output from the Stabilizer will not vary more than .01% from 50Hz or 1% in voltage, even when different loads are imposed.

It opens up new markets for the manufacturers of a wide range of equipment for use in Recording Studios, Offices, Hospitals, etc., and in particular, when it is required for mobile operation.

The CINTEC FREQUENCY & VOLTAGE STABILIZER is also available for supplies of 100-125 volts, 40-60Hz with an alternative output of 50Hz or 60Hz at 115 volts or 230 volts and as a dual frequency model with a switchable output for 50Hz or 60Hz.

The Stabilizer may also be used as a frequency converter. For example, the supply to it can be any frequency between 40-60Hz and the output can be switched to either 50Hz or 60Hz. In hotels, overseas visitors frequently arrive, bringing with them Audio-Visual equipment which they wish to use, only to find that the frequency of the supply in the hotel is unsuitable.

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

## SPECIFICATION

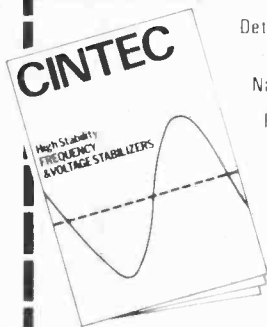
INPUT:	100-125 volts or 200-250 volts at 40-60Hz
OUTPUT:	115 volts or 230 volts (adjustable within $\pm 5\%$ )
STABILITY: Voltage:	$\pm 1\%$ No load to full load
Frequency:	$\pm 0.01\%$ No load to full load
FREQUENCY:	50Hz or 60Hz. Single or dual versions
WAVEFORM:	SINUSOIDAL
DISTORTION:	2% Max.
AMB. TEMP.	$-20^{\circ}$ to $+40^{\circ}$ C
DUTY:	Continuous
DIMENSIONS:	432 (W) x 196 (H) x 508mm (D) (17" x 7 3/4" x 20")
WEIGHT:	33Kg (72 lbs.)
CONSTRUCTION:	Cabinet or rack mounting
TERMINATION:	Barrier strip connections at rear of case.

### 24V DC Inverter

Inverter versions of the Stabilizer are available with output ratings of 500w, 250w and 150w, at 230 volts or 115 volts at 50Hz or 60Hz. The output stability has an accuracy to the same specification as for the A.C. versions and the Unit is housed in a case of similar design and size.

#### Certificate of Calibration

*The Stabilizer has been tested in accordance with National Standards by Bradley Services of London (Certification No. K5149/5832)*



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

Name \_\_\_\_\_  
 Position \_\_\_\_\_  
 Company \_\_\_\_\_  
 Address \_\_\_\_\_

# CINTEC LTD

Wandle Way, Mitcham, Surrey CR4 4NB, England. Telephone: 01-640 2241 Telex: 546177

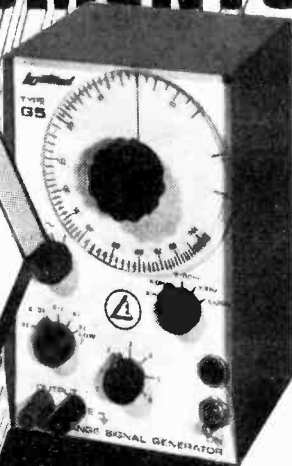
ww2

# LABORATORY INSTRUMENTS

**G5**

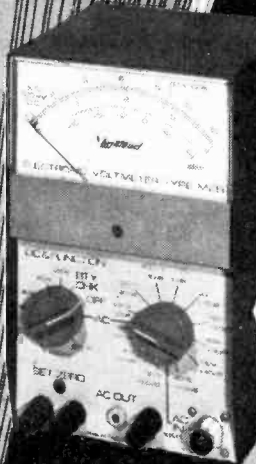
**WIDE BAND AUDIO SIGNAL GENERATOR**

a high accuracy solid state sine/square wave generator with 600 ohm attenuator output or low impedance output delivering 3 watts into a 5 ohm load.



UK price

**£53.70**  
plus VAT



**M2B**

**HIGH IMPEDANCE AC/DC MILLIVOLTMETER (The Modern equivalent of the Valve Voltmeter)**  
an AC/DC wide range meter with 20 scales covering 1.2 mV to 400 volts FSD incorporating a power scale in decibels.

UK price

**£53.70**  
Plus VAT

## LINSTEAD

MANUFACTURING CO. LTD.

ROSLYN ROAD LONDON N15 5JB

**01 - 802 5144**

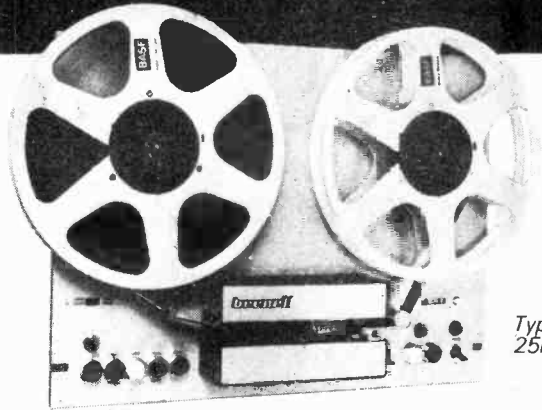
IRELAND: LENNOX LTD P.O. BOX 212A DUBLIN 2. DENMARK: SCANFYSIK AB 13/15 HJORRINGADE DK-2100 COPENHAGEN. SWEDEN: EMI SVENSKA AB TRITONVAGEN 17 FACK S-171 19 SOLNA 1. NORWAY: EMI NORSK AS POSTBOKS 42 KORSVOLL OSLO 8. MALAYSIA: LEC Sdn Bhd P.O. BOX 60 BATU-PAHAT. SOUTH AFRICA: PROTEA (PTY) 38 FARADAY STREET, JOHANNESBURG.

WW - 059 FOR FURTHER DETAILS

# brenell

## PROFESSIONAL TAPE TRANSPORTS

and multi-channel electronics for studio and industrial use



Type 19  
25mm model

**Finance available**

- \* Tapewidths up to 25mm
- \* Speeds: 3mm/s minimum up to 152cm/s max 2 and 4 speed models
- \* Reel Capacity up to 25cm
- \* Remote Control Facility
- \* Tape Tension Control
- \* Automatic Interlock against misuse
- \* Special models to customer requirements

### BRENELL ENGINEERING CO LTD

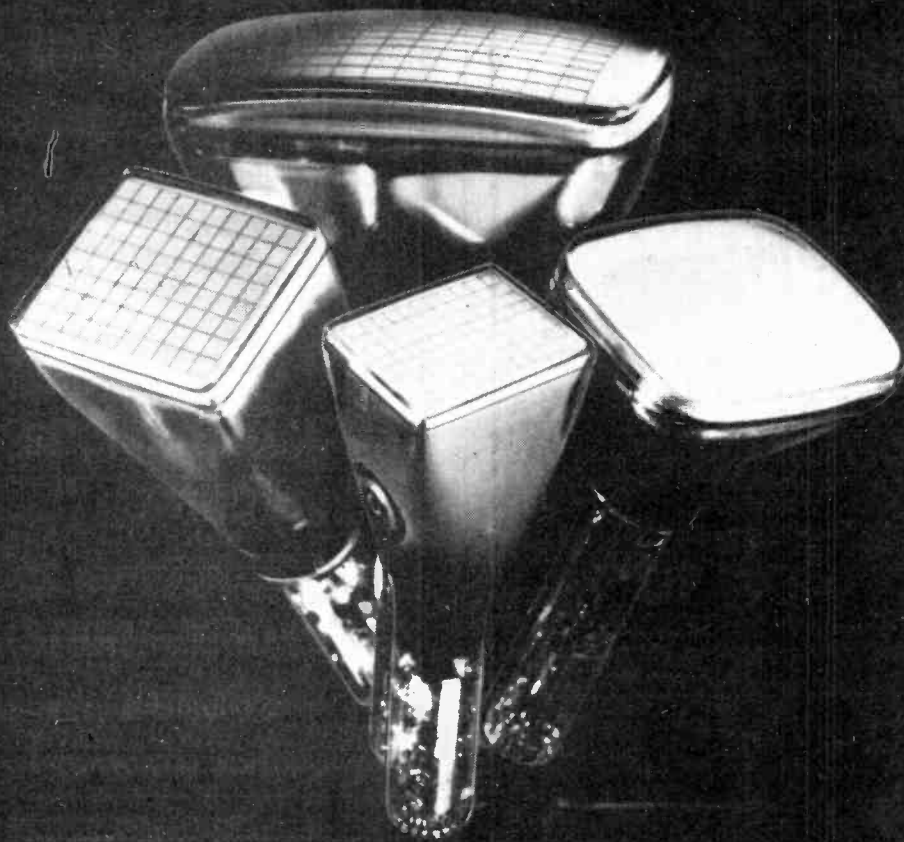
231-5 Liverpool Road, London N1 1LY. Tel: 01-607-8271

NEW FROM STRUMECH

Electric powered winch (110 volt / 5 amp).  
 Bolts directly onto existing towers without modification. Send for leaflet.  
 Price £115 ex works.

**VERSATOWER**  
 Strumech Engineer ne Limited  
 Coppice Side, Brownhills, Walsall, West Midlands  
 Telephone: Brownhill 4321

WW - 022 FOR FURTHER DETAILS



# Take your pick!...

**THOMSON-CSF electrostatic CRT's :**

■ for high-performance scopes :

Tube ref.	Useful screen area	Overall length cm	Typical frequency MHz	Capacitance pF	Writing speed mm. ns	Deflection factor	
	cm x cm					X <sub>1</sub> X <sub>2</sub> Y <sub>1</sub> Y <sub>2</sub> V. cm <sup>-1</sup>	
TH 8203	8 x 10	37	350	Z <sub>c</sub> = Z x 150 Ω	30	6.1	1.2
TH 8205	8 x 10	34	200	8	15	5.4	2.2
TH 8206	10 x 12.5	38	100	8	15	6.5	2.8
TH 8207	10 x 12.5	40.5	175	8	25	6.5	2.6

■ for large - screen wideband monitors :

Tube ref.	Useful screen area cm x cm	Overall length cm	Deflection angle Θ°	Sensitivity V. cm <sup>-1</sup>
TH 8000	25 x 19	44	70	9
TH 8201	18 x 13	35	85	7.5

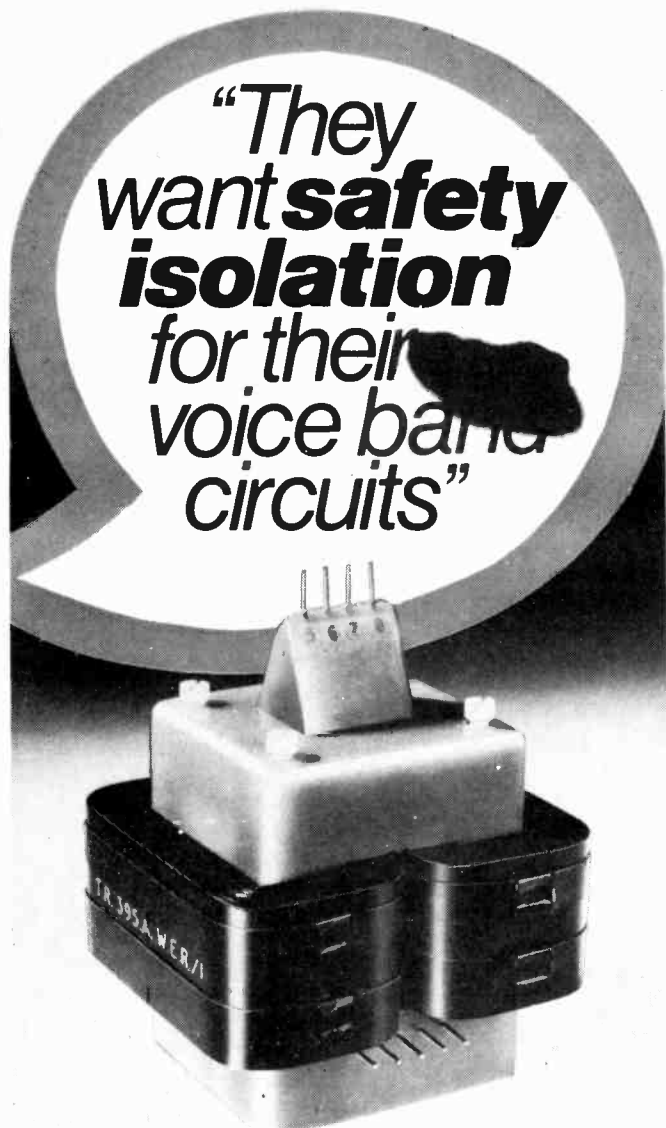
Rugged versions available.



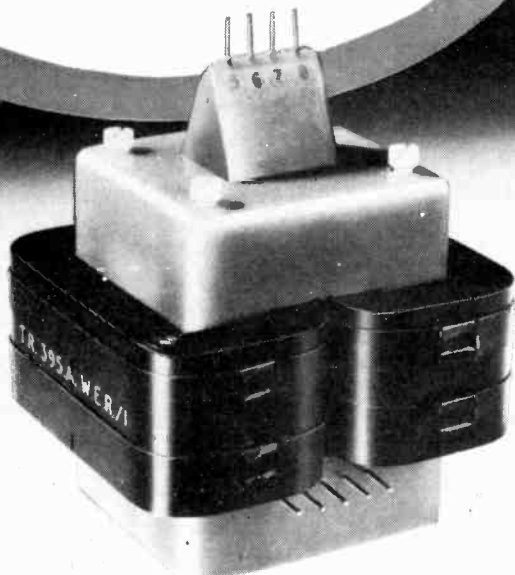
**THOMSON-CSF**

THOMSON-CSF ELECTRONIC TUBES LTD / RINGWAY HOUSE / BELL ROAD / DANESHILL \* BASINGSTOKE RG24 00G  
TEL. : (0256) 29155 / TELEX : 858865

WW-073 FOR FURTHER DETAILS.



**“They want safety isolation for their voice band circuits”**



One more request item. We met it with a neat little transformer. Now, in two versions, it joins the list of useful Whiteley products, and everyone involved in communications system design will be interested in the protection they provide. Inserted in voice band circuits, they effectively isolate equipment from the hazards of adjacent high voltage power circuits on the 'line' side. High isolation level between line and equipment windings gives protection against voltage surges, lightning strikes and fault conditions. One version is designed for 17Hz signalling circuits, the other with several voltage ratios also suits a 50Hz ringing circuit. All are Post Office and C.E.G.B. approved, and the second version is also approved with extra protection diodes added. Requests for data sheets welcome. Or if you want to request a product spec of your own — we're always interested!

*Surprising how often you'll find*

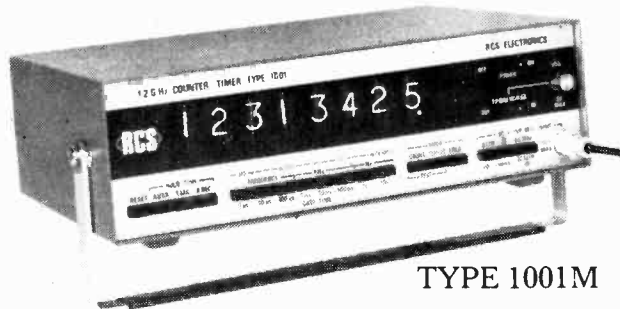
**Whiteley make it.**

Whiteley Electrical Radio Co. Ltd  
Mansfield, Notts NG18 5RW, England. Tel: 0623 24762.

WW—050 FOR FURTHER DETAILS

**FREQUENCY COUNTERS**

HIGHER PERFORMANCE INSTRUMENTS FROM 1/10 Hz to 1.2 GHz. MEASURING FREQUENCY, PERIOD, TIME, FREQ./RATIO AND CALIBRATED OUTPUT FACILITY. FAST DELIVERY.



TYPE 1001M

CRYSTAL OVEN OPERATING MANUAL TWO TONE BLUE CASE

£670 **1.2 GHz**

Sensitivity 10mV. Stability 5 parts 10.<sup>10</sup>

301M	32MHz 5 Digit £82	401	32MHz 6 Digit £121
501	32MHz 8 Digit £178	701A	80MHz 8 Digit £195
801A/M	300MHz 8 Digit £305	901M	520MHz 8 Digit £375
801B/M	250MHz 8 Digit £262	1001M	1.2GHz 8 Digit £670

Start/Stop versions plus £12

Memory versions available if not suffixed M £25 extra

Type 101 1MHz 100KHz 10 KHz Crystal Standard £85

Type 103 Off/Air Standard £85

SUPPLIERS TO: Ministry of Defence, G.P.O., B.B.C., Government Dept., Crystal Manufacturers and Electronic Laboratories world-wide

**RCS** **R. C. S. ELECTRONICS**  
NATIONAL WORKS, BATH ROAD  
HOUNSLOW, MIDD. TW4 7EE  
Telephone: 01-572 0933/4

WW — 025 FOR FURTHER DETAILS

**Vaco STRIPEX Wire Stripper**

Precision Stripping Tool for most types of PVC wire and cable from 38-10AWG. — Solid or stranded.

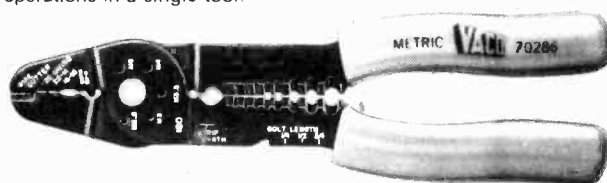


Model No. 70285

**Features include:**

- 33 self adjusting cutting knives penetrate and remove insulation without nicking the wire.
- Depth Control adjusts for different insulation thicknesses.
- Wire cutter with transparent finger guard snips cable clean.
- Lightweight moulded nylon body reinforced with fibreglass, reduces fatigue in continuous operations.
- Packed in contoured plastic case. Individually cartoned.

**No. 70286.** Metric wire plier. Crimps terminals, cuts and measures bolts, cuts and strips wire. Combines the most used cable operations in a single tool.



Distributed by **Special Products Distributors Limited**

81 Piccadilly, London W1V 0HL  
Tel. No. 01-629 9556

Cables: Speciproduct London W1

WW — 023 FOR FURTHER DETAILS

- P.A. SYSTEMS FOR AIRPORT, HOTEL, FACTORY.
- THEATRE AND LECTURE THEATRE AUDIO SYSTEMS
- AUDIO MIXING EQUIPMENT
- SIMULTANEOUS TRANSLATION SYSTEMS
- RADIO AND T.V. BROADCAST SOUND CONTROL EQUIPMENT
- MARINE INTERCOMMUNICATION AND ENTERTAINMENT EQUIPMENT
- *System design, manufacture and installation.*



**audix** **AUDIX LIMITED**  
 Wenden, Saffron Walden, Essex CB11 4L9  
 TEL. Saffron Walden (0799) 40888; TELEX: 817444

# Putting our test equipment to the test won't cost you a thing.



Send now for the new Heathkit catalogues. They're both free.

Then, when you get them, compare Heathkit equipment with the instruments you're using now.

We're sure you'll be pleasantly surprised.

In the assembled catalogue you'll find a wide range of laboratory grade assembled instruments. Including oscilloscopes, frequency counters, multi-meters, power supplies, function generators and chart recorders.

In the kit catalogue you'll find all you'd expect from the world's largest makers of electronic kits. Test equipment, audio equipment, kits for the home and many more.

We'll also be very happy to advise on all your service requirements.

For full details, just post the coupon now. Or call in and see us at the London Heathkit Centre, 233 Tottenham Court Road, or at our showroom in Bristol Road, Gloucester.

And test our test equipment for yourself.

Heath (Gloucester) Limited, Dept. WW-66 Bristol Road, Gloucester GL2 6EE. Tel: (0452) 29451.


To: Heath (Gloucester) Limited, Dept. WW-66, Gloucester GL2 6EE. Please send me both Heathkit catalogues.

Name \_\_\_\_\_

Address \_\_\_\_\_

Postcode \_\_\_\_\_

**HEATH**  
**Schlumberger**

DIGITAL	CLOCKS	MODULES	KITS	CALCULATORS																																								
<b>NEW PRICES</b>		<b>NEW MODELS</b>																																										
 <p><b>"DELTA"</b> 12 hour from <b>£9.00</b> 4 RED 0.5" LEDs</p> <table border="1"> <tr> <td>Module Kit</td> <td>(excl. case)</td> <td>9.00</td> <td>11.50</td> </tr> <tr> <td>Module: Assembled</td> <td>(excl. case)</td> <td>9.50</td> <td>12.00</td> </tr> <tr> <td>Complete Clock Kit</td> <td>Perspex Case</td> <td>12.00</td> <td>15.00</td> </tr> <tr> <td>Complete Clock Kit</td> <td>Teak Case</td> <td>12.70</td> <td>15.70</td> </tr> <tr> <td>Ready built Clock</td> <td>Perspex Case</td> <td>17.00</td> <td>21.00</td> </tr> <tr> <td>Ready built Clock</td> <td>Teak Case</td> <td>17.70</td> <td>21.70</td> </tr> </table>		Module Kit	(excl. case)	9.00	11.50	Module: Assembled	(excl. case)	9.50	12.00	Complete Clock Kit	Perspex Case	12.00	15.00	Complete Clock Kit	Teak Case	12.70	15.70	Ready built Clock	Perspex Case	17.00	21.00	Ready built Clock	Teak Case	17.70	21.70	<p><b>ALARMS:</b> Built-in alarm : Tilt operated snooze AM/PM indicator: Power failure indicator</p> <p><b>"ALPHA"</b> 4 GREEN 0.5" DIGITS 12/24 hour from <b>£10.00</b></p> <table border="1"> <tr> <td>Module Kit</td> <td>(excl. case)</td> <td>10.00</td> <td>13.00</td> </tr> <tr> <td>Module Assembled</td> <td>(excl. case)</td> <td>11.00</td> <td>14.00</td> </tr> <tr> <td>Complete Clock Kit</td> <td>Perspex Case</td> <td>12.50</td> <td>15.50</td> </tr> <tr> <td>Ready-built Clock</td> <td>Perspex case</td> <td>17.50</td> <td>21.50</td> </tr> </table>			Module Kit	(excl. case)	10.00	13.00	Module Assembled	(excl. case)	11.00	14.00	Complete Clock Kit	Perspex Case	12.50	15.50	Ready-built Clock	Perspex case	17.50	21.50
Module Kit	(excl. case)	9.00	11.50																																									
Module: Assembled	(excl. case)	9.50	12.00																																									
Complete Clock Kit	Perspex Case	12.00	15.00																																									
Complete Clock Kit	Teak Case	12.70	15.70																																									
Ready built Clock	Perspex Case	17.00	21.00																																									
Ready built Clock	Teak Case	17.70	21.70																																									
Module Kit	(excl. case)	10.00	13.00																																									
Module Assembled	(excl. case)	11.00	14.00																																									
Complete Clock Kit	Perspex Case	12.50	15.50																																									
Ready-built Clock	Perspex case	17.50	21.50																																									
<p>Perspex Case Colours: Black, White, Red, Blue, Green, Orange. Available separately</p> <p><b>NOVUS CALCULATORS</b> Send S.A.E. for complete range</p> <table border="1"> <tr> <td>650</td> <td>£5.40</td> </tr> <tr> <td>850</td> <td>£6.75</td> </tr> </table>					650	£5.40	850	£6.75																																				
650	£5.40																																											
850	£6.75																																											
<p><b>Built Alpha Units: State 12 or 24 hour</b>  <b>2-YEAR GUARANTEE ON READY BUILT CLOCKS</b></p>																																												
<p><b>CWD. PULSE ELECTRONICS LTD (E.1), 202 SHEFFORD ROAD, CLIFTON, SHEFFORD, BEDS. Tel. Hitchin (0462) 814477</b></p>																																												

# Join the Digital Revolution

Understand the latest developments in calculators, computers, watches, telephones, television, automotive instrumentation . . .

Each of the 6 volumes of this self-instruction course measures 11 3/4" x 8 1/4" and contains 60 pages packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra, to memories, counters and simple arithmetic circuits, and on to a complete understanding of the design and operation of calculators and computers.

Design of Digital Systems.



## £6.20

plus 80p packing and surface post anywhere in the world.

Payments may be made in foreign currencies.

Quantity discounts available on request.

VAT zero rated.

Also available — a more elementary course assuming no prior knowledge except simple arithmetic. Digital Computer Logic and Electronics.

In 4 volumes:

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

## £4.20

plus 80p P. & P.

Offer Order both courses for the bargain price £9.70, plus 80p P. & P.

**Designer  
Manager  
Enthusiast  
Scientist  
Engineer  
Student**

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

### Guarantee—no risk to you

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

To: Cambridge Learning Enterprises, Dept COM  
FREEPOST, St. Ives, Huntingdon, Cambs PE17 4BR  
\*Please send me . . . . . set(s) of Design of Digital Systems at £7.00 each, p & p included

\*or . . . . . set(s) of Digital Computer Logic and Electronics at £5.00 each, p & p included

\*or . . . . . combined set(s) at £10.50 each, p & p included

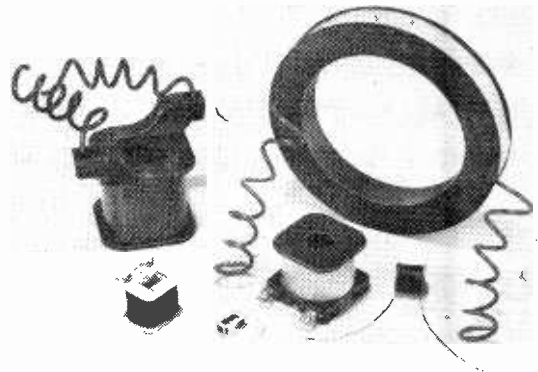
Name . . . . .

Address . . . . .

\*delete as applicable  
No need to use a stamp — just print FREEPOST on the envelope.

WW6

## COIL WINDING



Manufacturers of all wound components including transformers, chokes, stators and armatures. Prototype and design service available.

Electric Windings' factories are equipped to handle large or small volume production. Vacuum impregnation plants provide varnish impregnation for all temperature requirements.

**ELECTRIC WINDINGS (LONDON) LTD.**  
(Dept. WW) Avenue Works, Gallows Corner  
Romford, ESSEX RM3 0AJ

**Ingrebourne 46677**

WW—039 FOR FURTHER DETAILS

## servos synchronous steppers dc motors



## gearboxes and control systems



Stockists for **IMPEX** Motors

# McLennan

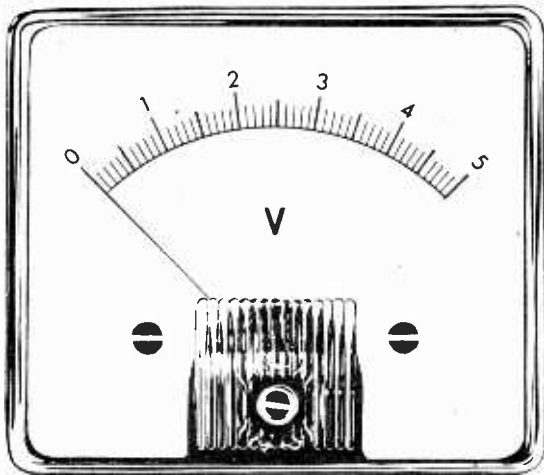
McLENNAN ENGINEERING LIMITED

Kings Road Crowthorne Berks Telephone: Crowthorne 5757/8

WW — 006 FOR FURTHER DETAILS



# METER PROBLEMS?



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

Full Information from:

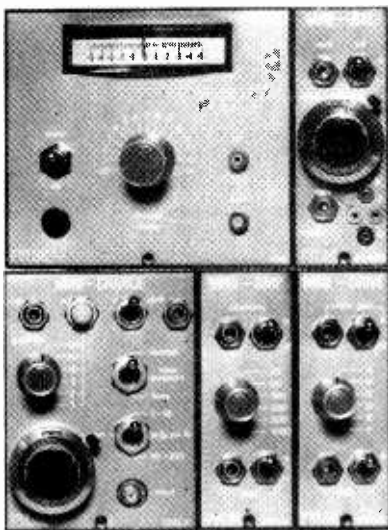
**HARRIS ELECTRONICS (London)**

138 GRAYS INN ROAD, W.C.1 Phone: 01/837/7937

WW — 032 FOR FURTHER DETAILS

# FYLDE

## TRANSDUCER and RECORDER AMPLIFIERS and SYSTEMS



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

# FYLDE

Fylde Electronic Laboratories Limited.

49/51 Fylde Road Preston PR1 2XQ Telephone 0772 57560

WW—037 FOR FURTHER DETAILS

# RADFORD

## AUDIO HIGH SENSITIVITY VOLTMETERS & NOISEMETERS

- HSV1 Audio Voltmeter. Average reading . . . . . £125.00
- HSV2 Audio Voltmeter. True r.m.s. reading . . . . . £175.00
- ANM1 Audio Noisemeter. Average reading . . . . . £150.00
- ANM2 Audio Noisemeter. True r.m.s. reading . . . . . £200.00

Four instruments are now available for the measurement of audio frequency signals including noise. They are derived from a basic battery operated voltmeter design having 16 measurement ranges from 10 $\mu$ V for full scale meter deflection to 300V f.s.d. The Voltmeter has a high input impedance and low inherent noise. It is fitted with a high grade meter having a 5" mirror scale of excellent linearity, calibrated in volts and dBv.

The Audio Voltmeter (HSV1) becomes an Audio Noisemeter (ANM1) by the inclusion of frequency contouring networks having characteristics recommended by international organisations concerned with specifications and measurement standards as being suitable for the quantitative measurement of the subjective effect of noise in audio systems. The HSV1 and ANM1 instruments respond to the average or mean value of the waveform being measured and are calibrated in r.m.s. values on a sine wave.

In the HSV2 and ANM2 instruments an r.m.s. to d.c. converter module is incorporated which provides a true r.m.s. reading on waveforms with a crest factor in excess of 10. These instruments are also provided with an additional output socket giving 1.00V d.c. output corresponding to 1.00V at nominal full scale meter deflection to operate a chart recorder or d.c. digital voltmeter.

All the instruments are fitted with a socket to enable an external network of any weighting characteristics to be introduced in the measuring circuit. This extends the use of the instruments to vibration and acoustical measurement as well as to the measurement of gramophone turntable rumble, f.m. receiver noise, etc.

**Brief Specification.**

Frequency response as Voltmeter	4Hz to 500kHz $\pm$ 0.5dB at frequency limits.
Input impedance	1Mohm shunted by 30pF.
Attenuator accuracy	0.25%.
Meter scale linearity	1%. Typically better than 0.5%.
Waveform error in true r.m.s. instruments	1% for crest factor 10.
Noisemeter included weighting characteristics	Wide band (flat response as voltmeter) DIN. 'Audio Band' IEC/DIN. Curve 'A' CCIR
Size	11 $\frac{1}{4}$ " x 7 $\frac{1}{4}$ " x 8 $\frac{1}{2}$ " deep overall

Please write or phone for descriptive leaflet giving details of the design and full performance characteristics of the above instruments, together with a reprint copy of Dolby Laboratories Inc. Engineering Field Bulletin No. 19/2 — 'Noise Measurement on Consumer Equipment'.

**RADFORD LABORATORY INSTRUMENTS LTD.**  
Ashton Vale Road, Bristol BS3 2HZ Avon  
Telephone 0272 662301

USA. Roth/Sindell. 540 Kelton Ave., Suite 102  
Los Angeles, California 90024. Tel. (213) 473-3687

WW—063 FOR FURTHER DETAILS

# BARR & STROUD MODULAR FILTERING

## EF3-04 Low Pass

Cut-off frequency variable from 0.1Hz to 100kHz

## EF3-03 High Pass

Cut-off frequency variable from 0.1Hz to 100kHz

## EF3-02 Low Pass

Cut-off frequency variable from 0.01Hz to 10kHz

## EF3-01 High Pass

Cut-off frequency variable from 0.01Hz to 10kHz



EF3 Basic Main Frame

Now FOUR Modules—and more to come!

The introduction of our EF3 Electronic Filter System was a breakthrough in electronic filtering, a System with options and interchangeability.

Now we introduce two additional modules to extend the scope and versatility of the EF3. To appreciate fully the technical and economic merits of the EF3 System you ought to have our detailed literature which we will be pleased to send. Continuing development of the EF3 System means that we will be announcing yet more modules in the near future.

Send now for full details to:

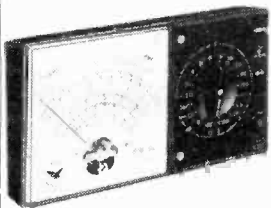


Glasgow and London

Barr & Stroud Limited,  
1 Pall Mall East, London SW1Y 5AU  
Tel: 01-930 1541 Telex: 261877

WW-041 FOR FURTHER DETAILS

## Test Equipment



### Multimeters

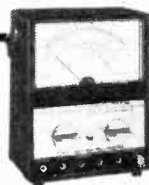
The Eagle range of multimeters covers every possible need of the electrical or electronic engineer. They cost from about £6 to £58 (inc V.A.T.). There's at least one which suits your job precisely.

We have a lot of other test equipment too. Send the coupon and we'll send you our complete catalogue.

Please send me details of all your test equipment

NAME .....

ADDRESS .....

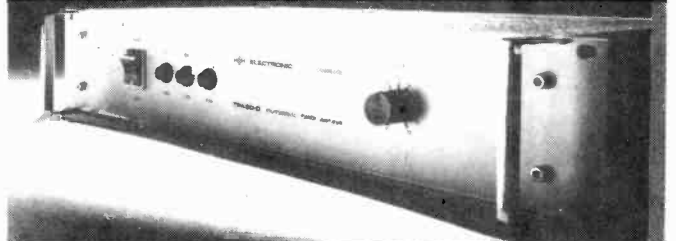


Eagle International Ltd., Precision Centre, Heather Park Drive, Wembley HA0 1SU  
Tel(01)-902 8832

# Eagle

WW-038 FOR FURTHER DETAILS

## TPA SERIES - D integrated circuit power amplifier



### TPA 50 - D Specification

Power Output	100 watts rms into 4 ohms 65 watts rms into 15 ohms
Freq Response	±0.1dB 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	0dBm
Noise	-100dB
Rise time	2 µ seconds
Price	£77 plus V.A.T.

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

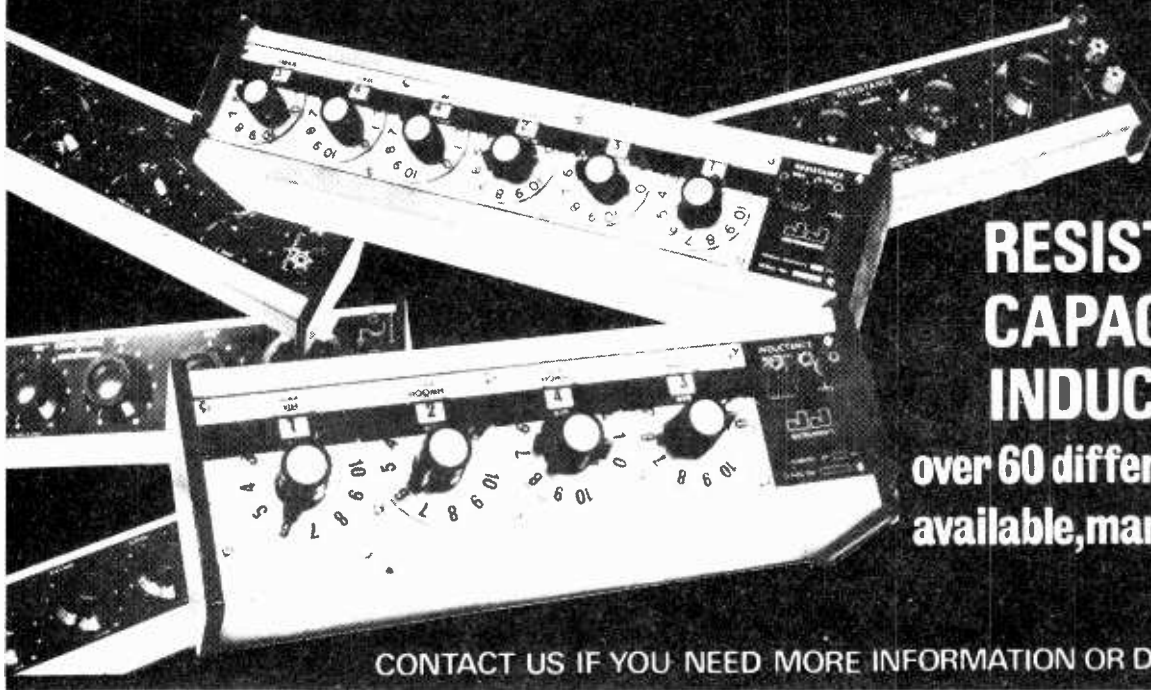
For full technical information contact:

## H/E ELECTRONIC

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

WW-031 FOR FURTHER DETAILS

# News of the Decade



**RESISTANCE  
CAPACITANCE  
INDUCTANCE**  
over 60 different models  
available, many from stock

CONTACT US IF YOU NEED MORE INFORMATION OR DEMONSTRATION

## DECADE BOXES

### "Junior" Series—Resistance—1%

Model	Decades	Ohms Range	Ohms Resolution	Price (£)
J1	5	0—1,111,100	10	30.90
J2	5	0—111,110	1	30.50
J3	4	0—111,100	10	25.10
J4	4	0—11,110	1	24.80
J5	3	0—11,100	10	20.60
J6	3	0—1,110	1	20.50
J60	6	0—1,111,110	1	37.20
J70	7	0—11,111,110	1	43.70

### "Junior" Series—Capacitance—1%

Model	Decades	pF Range	pF Resolution	Price (£)
JC1	3	100—111,000	100	22.20
JC2	2 + var	30—11,140	"Infinite"	23.20

### "Point One" Series—Resistance—0.1%

Model	Decades	Ohms Range	Ohms Resolution	Price (£)
R3	4	0—1,111	0.1	50.85
R4	4	0—11,110	1	50.53
R5	4	0—111,110	10	49.67
R7	5	0—1,111,100	10	61.71
R9	5	0—111,110	1	62.35
R10	5	0—11,111	0.1	62.89
R11	5	0—11,111,000	100	71.81
R20	6	0—1,111,110	1	74.71
R21	6	0—111,111	0.1	75.68
R22	6	0—11,111.1	0.01	82.24
R30	7	0—11,111,110	1	94.39
R31	7	0—1,111,111	0.1	87.72
R32	7	0—11,111,111	0.01	88.37
R41	8	0—11,111,111	0.1	107.07
R42	8	0—1,111,111.1	0.01	102.88

### "Hundred" Series—Resistance—0.03%

Model	Decades	Ohms Range	Ohms Resolution	Price (£)
R400	4	0—111,100	10	87.20
R401	4	0—11,110	1	91.40
R402	4	0—1,111	0.1	92.40
R403	4	0—111.1	0.1	98.70
R600	6	0—11,111,100	10	118.70
R601	6	0—1,111,110	1	120.80
R602	6	0—111,111	0.1	122.90
R603	6	0—11,111.1	0.01	128.70
R701	7	0—11,111,110	1	140.70
R702	7	0—1,111,111	0.1	142.80
R703	7	0—111,111.1	0.01	148.10
R802	8	0—11,111,111	0.1	160.20

## DECADE BOXES continued

R803 8 0—1,111,111.1 0.01 162.80

### High Dissipation—Resistance—1%

Model	Decades	Ohms Range	Ohms Resolution	Price (£)
HD1	5	0—1,111,100	10	104.70
HD1/L	5	0—111,110	0.2 Approx.	110.30

### "Point One" Series—Inductance—5%

Model	Decades	mH Range	mH Resolution	Price (£)
L1	3	0—1,110	1	95.60
L2	2	0—110	1	67.10
L3	2	0—1,100	10	74.50

### "Hundred" Series—Inductance—0.3%

Model	Decades	mH Range	mH Resolution	Price (£)
L300	3	0—1,110	1	277.00
L400	4	0—11,110	1	360.00

## CAPACITANCE BOXES

Decades	Decades	pF Range	pF Resolution	Accuracy	Price (£)
C3	3	100—111,000	100	1%	48.30
PC3	3	100—111,000	100	5%	66.70
C4	4	100—1,111,000	100	1%	73.60
PC4	4	100—1,111,000	100	5%	103.50

### Decade plus Variables

Model	Decades	pF Range	pF Resolution	Accuracy	Price (£)
VC4	3	50—111,150	INFINITE	1%	61.00
VC5	4	50—1,111,150	..	1%	86.30
PVC5	4	50—1,111,150	..	0.5%	128.80
SVC5	4	50—1,111,150	..	0.05%	574.20
C500	4	50—1,111,150	..	0.2%	238.50†

### Variables

Model	pF Range	Accuracy	Price (£)
PVC1 Mk. 2	5—200	0.5%	111.32
PVC2 Mk. 2	20—1,120	0.5%	101.20
VC2	20—1,130	1%	42.60
PVC4	0—10	1%	77.22
PVC1'S	20—120	0.5%	67.10

### Switched

Model	uF Range	uF Resolution	Accuracy	Price (£)
C140	0—140	1.0	5%	156.00†
C100	0—100	1.0	5%	132.00†
C60	0—61	0.1	5%	117.60†
C60P	0—61	0.1	1%	239.00†

† Packing and Handling extra. Prices do not include VAT



# J.J. Lloyd Instruments Ltd

Brook Avenue, Warsash, Southampton SO3 6HP  
Tel: Locks Heath 4221

WW—053 FOR FURTHER DETAILS

# HATFIELD BALUN

## The FIRST name for WIDEBAND MATCHING TRANSFORMERS

With over 30 year's experience in designing Wideband Matching Transformers Hatfield Instruments design team offer a solution to almost all problems of matching unbalanced to balanced impedances of different values.

The standard range of over 200 types includes:

**Low Power Wideband Transformers Series 3500**  
Matching 50 ohm and 75 ohm unbalanced impedances to 50, 75, 110, 150, 200, 300 and 600 ohm balanced impedances. Frequency coverage in three major bands. 5KHz to 3MHz, 100KHz to 100MHz, 3MHz-300MHz 3 Alternative styles.

**High Power H.F. Transformers Series 6700**  
Matching 50 ohm and 75 ohm unbalanced impedances to 75, 200, 300 and 600 ohm balanced impedances C.W. power ratings from 150W to 1.8KW. Frequency range 2 to 30MHz.



Many other impedance ratings and special types have been designed and manufactured for more specialised customer applications.

**Antenna Matching Units Series 7000**  
Matching 50 ohm and 75 ohm unbalanced impedances to 50, 75, 110, 150, 200, 300 and 600 ohm balanced impedances. Frequency Coverage in 3 major bands 5KHz to 3MHz, 100KHz to 50MHz, 2MHz to 30MHz. Power ratings from 5W to 15W. Options for load test facilities and lighting protection.

Ask for detailed data sheets and information on the Hatfield Range of Hybrid Units — Passive Couplers.

**HATFIELD**  
forward thinking in electronics

**HATFIELD INSTRUMENTS LIMITED,**  
Burrington Way, Plymouth PL5 3LZ, Devon.

Telephone: Plymouth (0752) 772773  
Telex: 45592. Grams: Sigjen, Plymouth.

WW—066 FOR FURTHER DETAILS

## INTRODUCTORY PRICES

In addition to National, Mostek and Caltex clock chips, we are now selling a range of General Instrument chips.

### AY-5-1202 + Futaba 5LT01

AY-5-1202 interfaces directly with 5LT01 to provide the basis for a very simple electronic clock. The hours and minutes can be in 12 or 24 hour format and 50 or 60 Hz can be used as the timing source. 5LT01 is a green phosphor diode display. Price £10.56.

### AY-5-1230 + Futaba 5LT01

This chip similar to 1202. It has an ON/OFF programmable alarm which can be used in 7 segment mode to drive the 5LT01 or in BCD format to drive logic or TV display chips. Price £11.05.

### MK50253 + Futaba 5LT01

12 or 24 hour, 6 digit alarm chip. Snooze facility. Price £11.40.

### MISTRAL CLOCK KIT

Uses AY-5-1202 + Futaba 5LT01. Complete kit including case. £11.58.

### CHEVIOT ALARM CLOCK

24-hour 4-digit alarm clock. 0.5" green display. tilt to snooze. Finished clock — not kit. £21.85.

Please send S.A.E. for new Catalogue

Terms: C.W.O. Access. Barclaycard (simply quote your number and sign)

Credit facilities to Accredited account holders  
ALL PRICES EXCLUDE VAT AT 8%

**BYWOOD**

**BYWOOD ELECTRONICS**  
68 Ebbens Road  
Hemel Hempstead, HP3 9RDF  
Tel. 0442 62757



## MOTOROLA IN-LINE WATTMETER

Measures power output from transmitter and reverse power from antenna.

Compact and light weight (approx. 1 lb)

Frequency range 2MHz to 19Hz.

Measures RF power from 1W to 1KW.

System includes a series of wide range RF elements which can be left permanently in-line in the transmission cable — measurements can then be taken without disconnecting the antenna.

**MOTOROLA ELECTRONICS LTD.,**

444 BATH ROAD, SLOUGH, BERKS.

TELEPHONE: BURNHAM 62427 TELEX: 847121.

WW — 010 FOR FURTHER DETAILS

# DOLBY NOISE REDUCTION

## *The First Successful Decade: 1966 - 1976*

**Dolby noise reduction has staying power. The A-system has been around for ten years. If you have read our technical papers and otherwise followed our progress, you're probably familiar with the reasons for this success. Here are ten quick reminders.**

**1**

The Dolby system works like a constant-gain amplifier in two critical dynamic regions — low levels and high levels. Error-free signal handling is thus ensured at the dynamic range extremes. Compression and expansion occur only at easy to handle mid-levels.

**2**

The system employs a simple adding and subtracting scheme which automatically results in mathematically exact complementary compression and expansion. There are no approximations, so the signal must come out the same as it went in (just get the Dolby Level right).

**3**

Compressor overshoots with high-level transient signals are suppressed without audible distortion, because of the basic system layout (dual signal paths). Since there are no overshoots to be clipped by the recorder, there is no impairment of even the most extreme transient signals.

**4**

The freedom from overshoot is a result of system philosophy, not an ultra-short attack time, so it is possible to utilize relatively gradual gain changes. This yields a compressor output which is remarkably free from modulation distortion. There is thus no need to depend upon cancellation of modulation products by the expander (which relaxes recorder performance requirements).

**5**

The reproduced dynamics of low-level signals are essentially immune to rumble in the input signal and head bumps and other frequency response errors in the recorder — the system has a solid low-level 'gain floor'.

**6**

The system gives a pre-determined amount of noise reduction which is realistically useful (set at 10 dB).

**7**

The noise that remains has a subjectively constant level. Noise modulation effects are almost non-existent.

**8**

The principles and parameters used in the Dolby system result in a high margin of safety. The system works well with all types of audio signals — speech, music, effects — and practically all types of noises. High noise levels (from multi-generation copies, for example) do not impair performance.

**9**

The system functions reliably on a day in, day out basis, with real workaday recorders and other equipment.

**10**

All of the above have been proved in ten years of dependable service to the industry — 25,000 professional channels in use by well over a thousand studios in more than 50 countries around the world.

The Dolby A-system now looks forward to

## *The Second Successful Decade: 1976 - 1986*



Dolby Laboratories Inc

'Dolby' and the double-D symbol are trade marks of Dolby Laboratories Inc.

731 Sansome Street  
San Francisco CA 94111  
Telephone (415) 392-0300  
Telex 34409  
Cable Dolbylabs

346 Clapham Road  
London SW9  
Telephone 01 - 720 1111  
Telex 919109  
Cable Dolbylabs London

WW — 083 FOR FURTHER DETAILS



## NOW IS THE TIME TO BUY!

Our prices were **reduced** in April. Now VAT has been halved. Will things ever be quite this good again? Make use of your credit card and buy now with confidence.

We give full after-sales service and guarantee with all parts and kits.

If you have already purchased, why not add a

## TOUCH-TUNE PRE-SELECT UNIT to your tuner

This is a separate unit, powered from the normal tuner supply, and designed as an alternative to the existing push button unit (K9a). It provides six pre-select channels while maintaining the manual control and frequency meter circuits. The pre-set pots (20 turn cermet types, of course) are accessible from the underside of the tuner without removing the cabinet, being mounted between the chassis and the front panel. The channel selected is indicated by L.E.D. lamps incorporated in the touch buttons, which replace the manual buttons without modification to chassis or front panel.



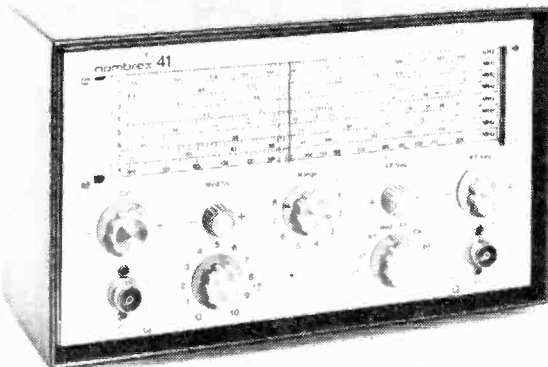
Send for full details and price list, etc. Or send 50p\* for our new booklet fully describing our updated tuner.

\*Refundable on order over £10

*Icon Design*

33 Restrop View  
Purton, WILTS.  
SN5 9DG

# nombrex



## MODEL 41 R.F. SIGNAL GENERATOR Price £54.85

PLUS V.A.T.

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

Trade and Export enquiries welcome

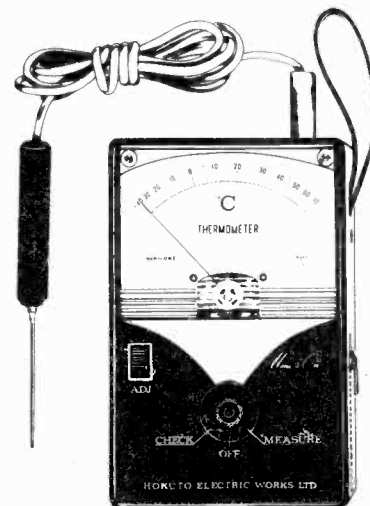
Send for full technical leaflets

Post and Packing £1.00 extra

**NOMBREX LTD., POUND PLACE, WOLBOROUGH STREET,  
NEWTON ABBOT, DEVON, TQ12 1NE  
Tel. Newton Abbot 68297**

WW-047 FOR FURTHER DETAILS

## ELECTRONIC INDUSTRIAL THERMOMETER



### THE MODERN WAY TO MEASURE TEMPERATURE

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

Model "Mini-Z 1" measures from -40° C to + 70° C

Model "Mini-Z 2" measures from -5° C to + 105° C

Model "Mini-on Hi" measures from + 100° C to + 500° C

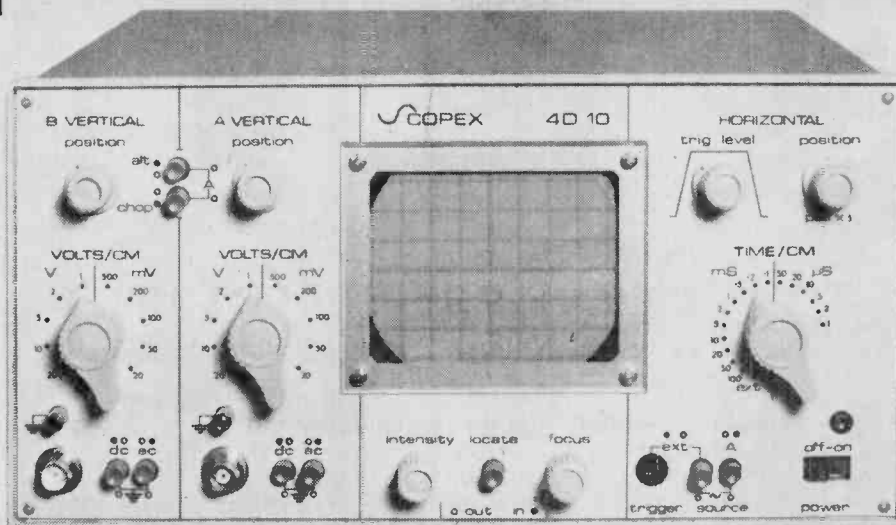
PRICE £20.00 each (VAT 8% EXTRA)

Write for further details to

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

WW — 033 FOR FURTHER DETAILS

# Scopex 4D 10—now in front



- Where else will you find for \*£125:-
- \* Dual trace, full portability
  - \* 10 MHz bandwidth, 10mV sensitivity
  - \* Time base 1  $\mu$ s to 100ms in 16 steps
  - \*  $\times 5$  magnification, Trace Locate button

\*UK List ex VAT

- \* Trig Level and Polarity by one control
- \* Bright, stable trace

For immediate attention write or telephone

**SCOPEX**

Scopex Instruments Ltd., Pixmore Industrial Estate,  
Letchworth, Herts. SG6 1JJ Tel: Letchworth (04626) 72771  
An independent British Company

WW—074 FOR FURTHER DETAILS

## Wayne Kerr's top-selling bridge



Meets modern requirements. Is accurate to 0.1%.

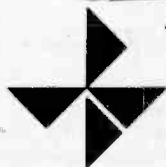
Is self-balancing. Has 2, 3 and 4-terminal connections. Continuous readout of real and quadrature terms. Overall range 10 micro-ohms to 100 gigohms, 0.001pF to 10 farads, 1 nanohenry to 10 megahenrys and 10 picomhos to 100 kilomhos. Built-in source/detector (1592Hz).

Connectors for 200Hz — 20kHz manual operation.

Comparator facilities. Analog outputs.

Adjustable sensitivity. Ask for B642

Data Sheet.



## Wilmot Breeden Electronics Limited\*

Durban Road, South Bersted, Bognor Regis, West Sussex, PO22 9RL  
Telephone: Bognor Regis (02433) 25811 Telex: 86120

Incorporating FERROGRAPH · RENDAR · WAYNE KERR

WW — 016 FOR FURTHER DETAILS



**sound equipment**  
by **Grampian**

**GRAMPIAN REPRODUCERS LTD.** HANWORTH TRADING ESTATE FELTHAM, MIDDLESEX TELEPHONE 01-894 9141

WW — 034 FOR FURTHER DETAILS

**Switching problems?  
Rely on Zettler.**

Producing 30 basic types of relay and 15,000 variants with regard to contact stacks, terminals, energizing current and contact material, Zettler is among the largest manufacturers of electro-mechanical components.

Our product range comprises:  
Low profile (flatform) · Timing · Miniature · Low contact capacity · Hermetically sealed · Stepping · Mains switching · Latching · Contact stacks · Solenoids

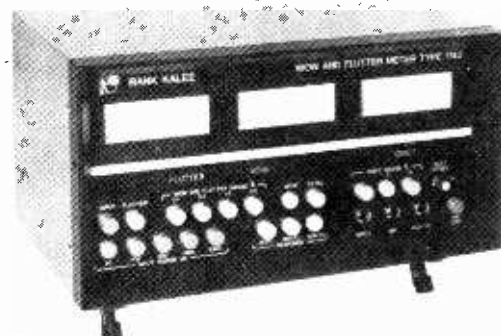


**Flatform Relay AZ 535**  
for reliable insulation between signal and heavy duty circuits. 1 changeover.  
Contact material: Silver cadmium oxide, or fine silver.  
Printed circuit mounting (32.5 x 20 x 11 mm).  
Coil voltages: 6 to 110 V DC.  
Contact rating: 240 V max., 3 A max., 500 VA.

We resolve your switching problems rapidly and expertly. Please contact us for further details.

 **ZETTLER** Zettler UK Division  
Brember Road, Harrow  
Middx. HA2 8AS. Tel. (01) 4220061  
A member of the worldwide ZETTLER electrical engineering group, est. 1877

WW—011 FOR FURTHER DETAILS



**\*  
The  
new  
Rank**

**WOW & FLUTTER Meter**  
Type 1742  
Fully transistorised for high reliability

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

**High accuracy**  
with crystal controlled oscillator

**Simple to use**  
accepts wide range of input signals with no manual tuning or adjustment

**Two models available:**  
Type 1742 'A' BS-4847: 1972 DIN 45507  
CCR 409-2 Specifications  
Type 1742 'B' BS 1988: 1953 Rank Kalee Specifications

For further information please address your enquiry to  
Mrs B. Nodwell  
Rank Film Equipment, PO Box 70  
Great West Road, Brentford  
Middlesex TW8 9HR  
Tel: 01-568 9222 · Telex 24408 · Cables Rankaudio Brentford

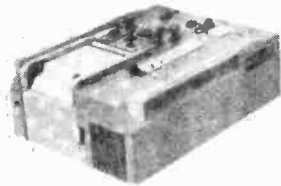
 **RANK FILM  
EQUIPMENT**

WW — 024 FOR FURTHER DETAILS



# FAST RESPONSE STRIP CHART RECORDERS

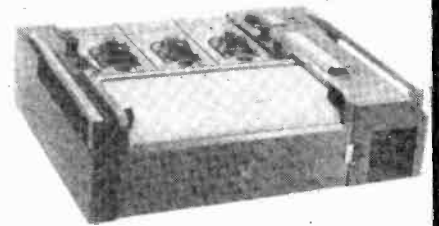
Made in USSR



Type H3020-1  
Single pen

### Specification

Basic error . . . . . 2.5%  
 Sensitivity . . . . . 8mA F.S.D.  
 Response . . . . . 0.2 sec.  
 Width of each channel . . . . . 80mm  
 Chart speeds, selected by  
 push buttons . . . . . 0.1-0.2-0.5-1-2.5-  
 -5-12.5-25mm/sec.  
 Chart drive . . . . . 200-250v 50Hz



Type H3020-3  
Three-pen

### Recording:

Syphon pen directly attached to moving coil frame, curvilinear co-ordinates

### Equipment:

Marker pen, Timerpen, Paper footage indicator, 10 rolls of paper, connectors, etc.

### Dimensions:

H320-1: 285x384x16.5mm  
H320-3: 475x384x16.5mm

PRICE: H320-1 £108.00  
H320-3 £160.00  
Exclusive of VAT

Available for immediate delivery

## Z & I AERO SERVICES LTD.

44A WESTBOURNE GROVE, LONDON W2 5SF

Tel. 01-727 5641

Telex: 261306

WW - 004 FOR FURTHER DETAILS

# The International Microphone



For over 40 years Beyer Dynamic microphones and headphones have served the needs of professional 'Sound Men' throughout the world.

The M500 (Illustrated) is only one of a range of microphones now serving thousands of users who still demand high quality performance and reliability.

Brochure showing the full range of microphones, headphones and accessories available on request.

### BEYER DYNAMIC

BEYER DYNAMIC (GB) LTD  
1 Clair Road, Haywards Heath, Sussex. Tel: 51003

WW - 013 FOR FURTHER DETAILS

## THE 'MISTRAL' 1 DIGITAL CLOCK

★ COMPLETE KIT ★



- Pleasant green display · 12/24 Hour readout
- Silent Synchronous Accuracy · Fully electronic
- Pulsating colon · Push-button setting
- Building time 1 Hr · Attractive acrylic case
- Easy to follow instructions · Size 10.5x5.7x8 cm
- Ready drilled PCB to accept components

**KIT PRICE £10.25**

+ 82p VAT P&P inc.

## THE 'MISTRAL' 2 DIGITAL ALARM CLOCK

★ Fully Built, Tested and Guaranteed ★  
WITH SLEEP-OVER FEATURE



- Soft Green Display
- 24 Hour Alarm
- 10 Minute Repetition
- Alarm Set Indicator
- Accurate Silent Timekeeping
- British Designed and Built

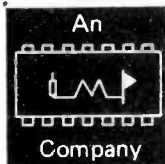
**COMPLETE CLOCK**

**£12.99**

+ £1.04 VAT P&P inc.



Cash, Cheque or Postal Order or if you wish to use Barclaycard or Access, simply quote name, address and card number when ordering.



## IMTECH PRODUCTS LTD

IMP HOUSE, ASHFORD ROAD  
ASHFORD, MIDDX. TW15 1XB W  
telephone ASHFORD 44211 (4 lines)  
telex 936291 WESSIMP ASHFORD

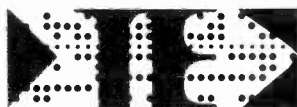
## DATA AND COMMUNICATIONS TERMINALS

Teletype 28, 32, 33, 35, 40  
TermiNet 30, 300 & 1200 (30 and 120 cps)  
Teleterm 1030 & 1132 (portable 30 cps with integral coupler and RS 232C)  
Other page printers (by Siemens, ITT Creed, etc.)  
TermiNet 120 line printer

- ★ Spares, repairs, overhauls and maintenance
- ★ Other types and models available
- ★ Refurbished units also available
- ★ Short and long period rentals
- ★ Minicomputer interfaces
- ★ Quantity discounts
- ★ Immediate delivery

**TELEPRINTER EQUIPMENT LTD.**  
70-80 AKEMAN STREET,  
TRING, HERTS., U.K.

Telephone 0442-82-4011  
Cables RAHNO Tring  
Telex 82362  
A/B Batelcom Tring



WW — 020 FOR FURTHER DETAILS

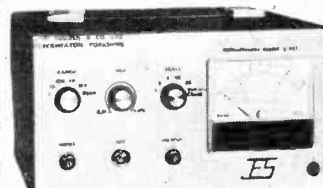
**QUARTZ CRYSTALS -FAST!**



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

WW—043 FOR FURTHER DETAILS

## J E S AUDIO INSTRUMENTATION



Illustrated the Si 451 Millivoltmeter — pk-pk or RMS calibration with variable control for relative measurements. 50 calibrated ranges **£50.00**

Si 452 ..... **£40.00**  
Distortion Measuring Unit.  
15 Hz — 20 KHz — .01%

Si 453 ..... **£50.00**  
Low distortion Oscillator.  
Sine — Square — RIAA

PRICES plus VAT

**J. E. SUGDEN & CO. LTD.** Tel. Cleckheaton (0274) 872501  
CARR STREET CLECKHEATON, W. YORKS BD19 5LA

WW — 021 FOR FURTHER DETAILS

Teonex are better known abroad... because we don't sell in the U.K.



Electronic valves (a really comprehensive range), semi-conductors (a wide variety), integrated circuits.

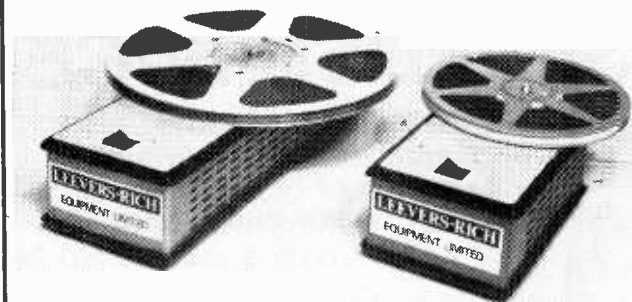
Teonex offers more than 4,000 devices. They are competitively priced and they are superlative in performance, because the company imposes strict quality control. Teonex concentrates entirely on export and now operates in more than 70 countries, on Government or private contract. All popular types in the Teonex range are nearly always available for immediate delivery. Write now for technical specifications and prices to Teonex Limited, 2a Westbourne Grove Mews, London W11 2RY, England. Cables: Tosupply London W11. Telex: 262256



ELECTRONIC VALVES + SEMI CONDUCTORS

for Teonexport only  
WW — 019 FOR FURTHER DETAILS

## BULK ERASURE PROBLEMS?



**LR71**

**MAX REEL SIZE 11 1/2"**

**LR70**

**MAX REEL SIZE 8 1/4"**

If it's personal we can only advise a diet or joining weightwatchers. If it's to do with tape, then why not consider the LR70/71 bulk tape erasers. They are simple to operate and will erase cassettes, cartridges and reels of tape up to a maximum reel size of 11 1/2" and tape width of 1", quickly and efficiently within the time it takes to read this advertisement.

The LR70/71 bulk erasers are currently used in Broadcast Companies, Recording Studios, Government Departments, Educational Establishments and the Computer Industry.

Moderately priced and available from

**LEEVERS-RICH EQUIPMENT LIMITED**  
INCORP. BIAS ELECTRONICS  
319 Trinity Road, Wandsworth, London SW18 3SL  
Telephone 01-874 9054  
Cables: Leemag London SW18. Telex 923455 Wembley

WW—069 FOR FURTHER INFORMATION

# With our New ORYX SUPER 30

soldering iron we have a slight problem at £2.95\* how do we convince you that it is a precision tool.

Our reputation for professional soldering equipment has been built on our precision products, so we have taken extreme care to see that our new ORYX Super 30 iron at, dare we repeat it, only £2.95, is going to be the best at its price.

\* plus VAT at 8%



Here are some of the features you get as standard:

- A neon Safety Light,
- A long life element,
- Iron coated screw-on tip,
- Stainless steel shaft,
- Styled handle,
- A two-minute element change, and a Stainless steel clip-on hook.

You can have further technical information, or by ordering one now you will see why we call it the Super 30.

Illustration actual size.

## Greenwood Electronics

Greenwood Electronics Portman Road, Reading RG3 1NE  
Telephone 0734-595844 Telex 848659

WW — 007 FOR FURTHER DETAILS

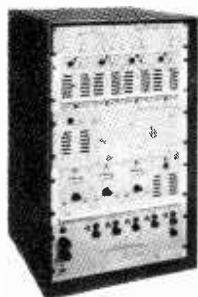
# D.M.W.

D.M.W. ASSOCIATES (ELECTRONICS) LIMITED

**Time code generators' translators, tape search systems with manual or computer control**

A comprehensive range of airborne and ground based Time Code Generators, Translators, and Tape Search Units. The equipment is used in conjunction with instrumentation and other types of magnetic Tape Recorders, for efficient data acquisition and analysis. Manually operated equipment and fully computer controlled systems are available. The computer controlled systems include installation, commissioning and checkout software. A design service for special time code applications is also available.

**High-power wideband linear amplifiers**



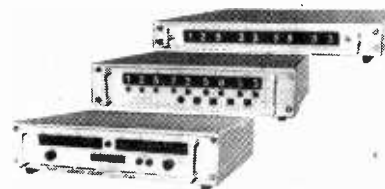
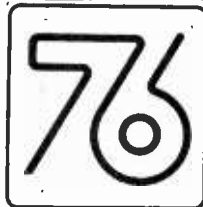
A comprehensive range of wideband linear amplifier systems covering the frequency range 500 kHz-60 MHz is available. A wide range of power output is available by combination of basic modules. Hybrid couplers for power splitting and combining, sub-octave high power switched filters, and automatic aerial matching units are also available. The company also offers a design and development service for special systems.

**HIGH SPEED VIDEO ANALOGUE TO DIGITAL AND DIGITAL TO ANALOGUE CONVERTERS AND SYSTEMS. VIDEO INSERTION UNITS**

**STAND 160 COMMUNICATIONS**

The third in a series of international expositions  
METROPOLE CONVENTION CENTRE  
BRIGHTON, ENGLAND  
8 9 10 11 JUNE 1976

Organised by Tony Davies Communications Limited

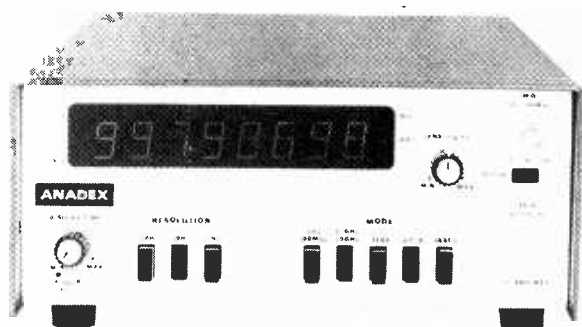


**RESEARCH AND DEVELOPMENT FACILITIES COVERING A WIDE RANGE OF TECHNOLOGY**

**DMW Associates (Electronics) Ltd**  
6-8 Morris Road  
Royal Oak Industrial Estate  
Daventry, Northamptonshire  
Great Britain, NN11 5PD  
Telephone: Daventry (032 72) 71472

ANADEX CF-700

## 1 GHz COUNTER FOR £564



Features include:—

- ★ 1 GHz count rate with 1 Hz resolution
- ★ 30mv sensitivity with high overload capability
- ★ 8 digit 'SPERRY' display

Also: Model CF-710 giving 0.001Hz resolution up to 10k Hz

**aspen electronics limited**

2 KILDARE CLOSE, EASTCOTE  
MIDDLESEX HA4 9UW  
TELEPHONE: 01-868 1188  
TELEX NO. 8812727

WW-046 FOR FURTHER DETAILS

## AEL SPEEDSERVICE

Hard-to-find tubes and semiconductors are normally included in our quotations. We try to give a complete answer.

AEL GATWICK HOUSE HORLEY SURREY RH6 9SU  
Telex 87116 Cables Aerocon Telex Horley Telephone Horley 5353

WW-044 FOR FURTHER DETAILS

<p><b>Random FLASHER UNIT</b> Full details on card price £18.95 Wired ready for use. Complete with three 100 watt coloured lamps that flash independently at random.</p>	<p><b>TWIN BANK 6 LIGHT UNIT</b> (less lamps) LENGTH 14 1/2 inches BC Fitting £9.55 ES Fitting £10.35</p>	<p><b>TWIN BANK 12 LIGHT UNIT</b> Length 31 1/2 (less lamps) BC Fitting £15.60   ES Fitting £17.00</p>
<p><b>Sound to Light MASTER UNIT</b> 600 WATTS PER CHANNEL £30.95 Connects to your loudspeaker or loud speaker socket. The unit can be connected to your existing spotlight fittings or to our Type A or B fittings.</p>	<p><b>TYPE A SPOT</b> (less lamp) BC Fitting £1.95   ES Fitting £2.12</p>	<p><b>TYPE B 3 BANK UNIT</b> (Less Lamps) BC Fitting £6.90   ES Fitting £7.26</p>
<p>100 WATT SPOT LAMPS RED, YELLOW, GREEN 3 lamps BLUE CLEAR £1.18 each   £3.54 B.C. or E.S. Fitting</p>		

ALBEN ENGINEERING CO. LTD. DEPT. WW, THE CRESCENT WORSTHORNE, BURNLEY LANCS. Tel. Burnley 20840

WW-042 FOR FURTHER DETAILS

# Now the Alpha costs less than the A\*\*\* will the 1567 engineers who are still without one please identify themselves?



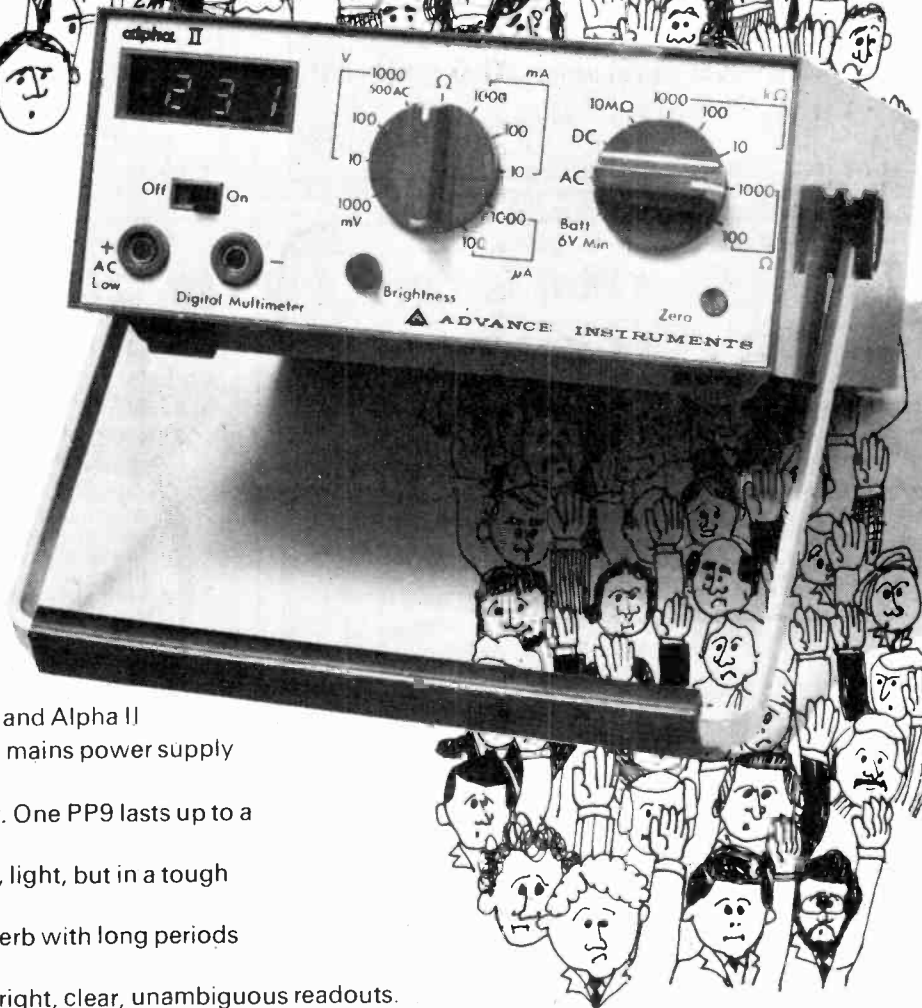
It was two years ago that Alpha one was launched by Advance.

As a brand new concept in low cost digital multimeters.

Now, many thousands of instruments later, Alpha I and II are everywhere.

You, too, should claim your Alpha. And to help you, we're listing the advantages engineers of competing firms enjoy:

- ★ Low, low prices. Alpha I now costs only **£49** and Alpha II is now only **£57** including a mains power supply but excluding VAT.
- ★ Extraordinary battery longevity. One PP9 lasts up to a year in an Alpha I.
- ★ No backache. Alphas are small, light, but in a tough as blazes carrying case.
- ★ No problems – reliability is superb with long periods between recalibration.
- ★ No squinting. Our LEDS give bright, clear, unambiguous readouts.



**Do get the Gould Advance data on Alpha. You see, it's so much better.**

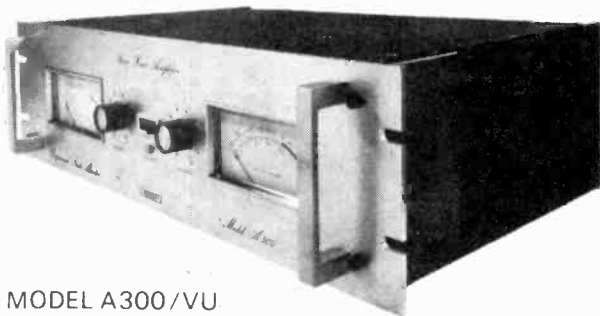
Gould Advance Limited  
Roebuck Road, Hainault, Essex, England.  
Telephone: 01-500 1000 Telex: 263785

**GOULD ADVANCE**

WW-049 FOR FURTHER DETAILS

**—TURNER—**

**STEREO POWER AMPLIFIERS**



MODEL A300/VU

A range of professional stereo power amplifiers designed and manufactured to a very high standard

The A Series (Professional Studio Monitor) amplifiers feature dual power supplies to maintain full RMS power on both channels.

The B Series (Professional) amplifiers feature single power supplies suitable for most music applications.

MODEL A500	250+250 watts RMS. 4 ohms
MODEL A300	150+150 watts RMS. 4 ohms
MODEL B300	150 watts RMS per channel
MODEL B200	100 watts RMS per channel

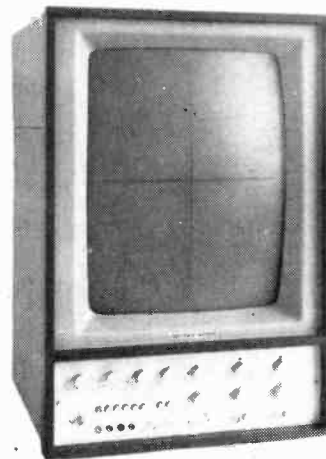
**TURNER ELECTRONIC INDUSTRIES LTD.**

175 Uxbridge Road, London W7 3TH

Tel. 01-567 8472

WW — 015 FOR FURTHER DETAILS

**NEW LAN-SCOPES...**



- 20 inch screen
- Fully stabilised
- New series of Plug-in Control Units
- 1, 2, 4 and 6 channel Models
- Vertical bandwidth DC-30kHz-3dB (small signal)
- 'Full House' Trigger and Sync to Y1 and Y2 or external.

The new 200 Series supersedes the well-known 19 inch 419A models and offers considerable improvements in bandwidth, dynamic input range and trace stability. The instrument is self-contained and made to the highest standards. Rack mounting versions are available.

Please ask for technical leaflets:

**LAN-ELECTRONICS LTD.**

95 Farnham Road, Slough

Berks., SL1 4UW. Tel. 26447/8 & 30431/5

WW — 088 FOR FURTHER DETAILS

a star is born..

# ROTEX

Emmen Holland

**ask for our catalogue!**

**FREQ. COUNTERS**  
RFC 30  
RFC 250

**LIGHTORGANS**  
3X500 AND  
3X1000 WATT

**2 MTR. RECEIVER**

**STEREO MIXERS 6 MODELS**

**POWER SUPPLIES**  
PS.2  
0.30V  
2A

**LIGHTIMMERS**

and a large variety of electronic modules.

**sales only via wholesale dealers**

**RADIO ROTOR EMMEN HOLLAND**  
P.O. BOX 260, TELEF. 01031-5910-16810, TELEX 53910

WW — 060 FOR FURTHER DETAILS



only  
£3.50  
+ 8% VAT

The CSP200 offers a good tough and versatile method of housing electronics at a very low cost. The case is constructed from moulded glass fibre with a detachable aluminium front panel & chassis. A choice of colour is also available i.e. Grey, Red or Blue. Size 10 3/4" x 5 1/2" x 5" Available ex-stock direct from our factory.

**SUPER PROFESSIONAL**

Designed for professional use but now also offered direct to the amateur enthusiast, and at a fantastically low price. The main feature of the cases, are the moulded glass fibre side/handle, this being a major safety factor. The cases are all standard sizes and are 3 1/4" high x 11 1/4" deep. Widths are CS101.94 (£5.25), CS102.12" (£6.25), CS103.17" (£7.25) which when fitted with brackets B103, fits in 19" G.P.O. rack size. All available ex-stock direct from our factory.

from  
£5.25  
+ 8% VAT

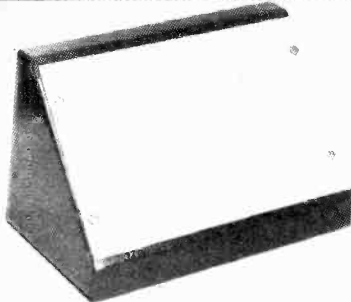


More details on request with S.A.F.

Send C.W.O. adding 60p carriage per case.  
All prices + 8% VAT

To: Case Systems, 20 Hunt Lane, Chadderton, Lancs. England.  
Trade Enquires welcome

WW—058 FOR FURTHER DETAILS



## NEW OLSON SLOPING CASES

Type	Panel Dim	Depth	Height	Price
1	150 m/m x 100 m/m	95 m/m	95 m/m	£1.55p
2	200 m/m x 100 m/m	95 m/m	95 m/m	£1.75p
3	250 m/m x 100 m/m	95 m/m	95 m/m	£1.95p

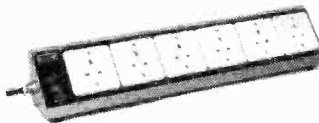
New range of cases at 45° sloping panels, attractively designed of robust construction and finished in two tone colour. Supplied complete with four rubber feet, available from stock in three different widths.

**Materials**  
Cases made from 20G. steel.  
Front panels made from 20G. aluminium.

**Colours**  
Cases sprayed in light brown hammer finish, front panels sprayed in light grey semi-gloss enamel.

---

### PORTABLE POWER DISTRIBUTION



**COMPLETE WITH 6FT CABLE AND 13-AMP PLUG**

4 Sockets 13A	8.80
6 Sockets 13A	10.45
4 Sockets 13A/SW	10.06
6 Sockets 13A/SW	11.11

**PLEASE ADD 60p for P&P & 8% for VAT**

Trade Counter is open for personal callers from 9 a.m. to 5.00 p.m. Monday-Friday

**OLSON ELECTRONICS LTD.** 5-7 LONG ST., LONDON, E.2  
TEL: 01-739 2343

WW-048 FOR FURTHER DETAILS

## PRECISION PETITE LTD.

119A HIGH STREET, TEDDINGTON, MIDDX.  
TEL. 01-977 0878

*Now with the:*

# • NEW MK. II DRILL •

10,000 r.p.m., 120 cmg.

## “MORE POWER — MORE TORQUE”

12v. - 14v DC

**DRILL ONLY £8.00**  
(P.P. 35p)

**STAND £3.76**  
(P.P. 35p)  
Incl. VAT

(Together 50p P.P.)

SAE for illustrated leaflet and order form

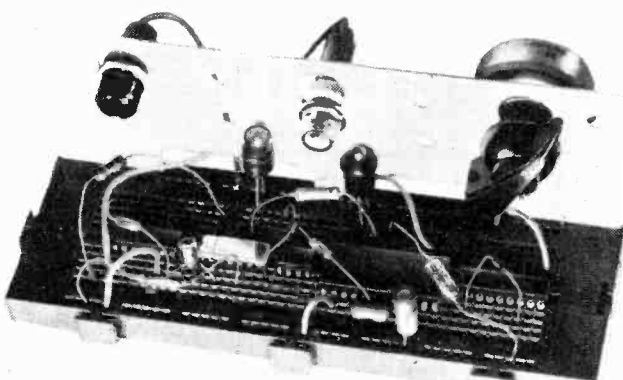


## BIMBOARD

Stop Ruining Your I.C.'s And Wasting Time Soldering  
Plug Into The Revolutionary New

# BIMBOARD

The Only Professional Quality Breadboard That  
Accepts All DIL Packages With 6 To 40 Pins  
Incorporates Bus Strips For Vcc And Ground  
Includes A Component Support Bracket  
Has Over 500 Individual Sockets  
And Allows You To Use And Re-Use  
IC's, Transistors, LED's, 7 Segment Displays,  
Diodes, Resistors, Capacitors



Only £9.72 (cheque with order) Including VAT and P.P.  
Special Quantity Discounts Available For  
Radio Clubs, Retail Outlets, Distributors

## BOSS INDUSTRIAL MOULDINGS LTD

Higgs Industrial Estate, 2 Herne Hill Road, London, SE24 0AU, England  
Telephone 01-737 2383 Telex 919693

# A NEW DIMENSION IN SOLDERING

## Iso-Tip Cordless Soldering Iron

Ideal for factory, field servicing, laboratory or home, the Iso-Tip Cordless offers a great advance in soldering. It is completely portable, heats in 5 seconds and recharges automatically in its own stand.

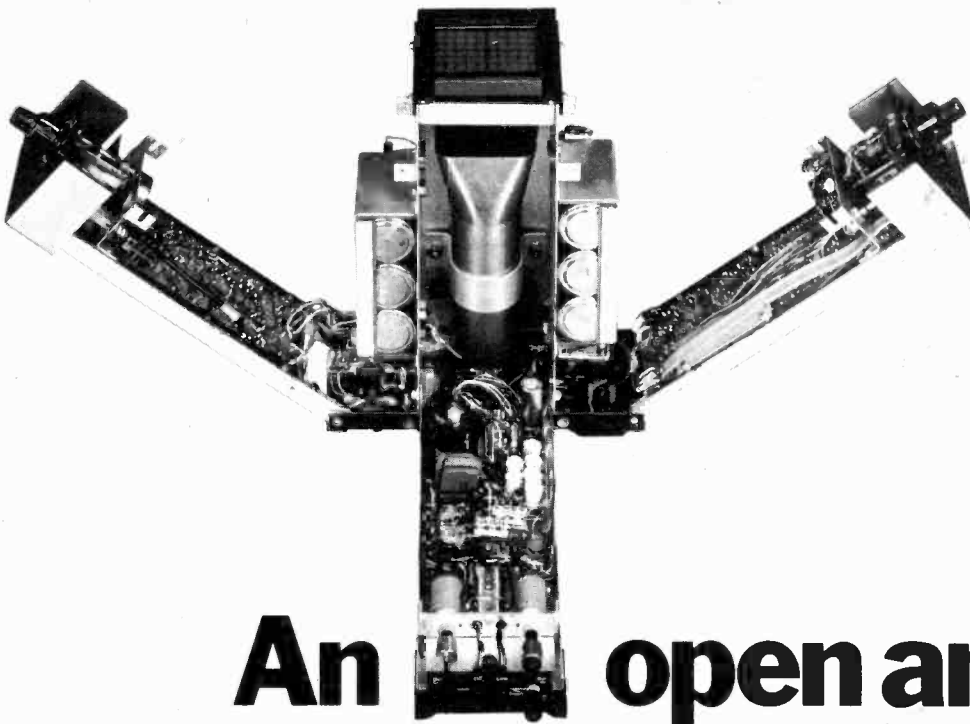
The Iso-Tip is powered by long-life nickel cadmium batteries giving tip performance up to 50 watts with a temperature of 370°C. Tips are available in five different sizes ranging from Micro to Heavy Duty to meet all soldering requirements.



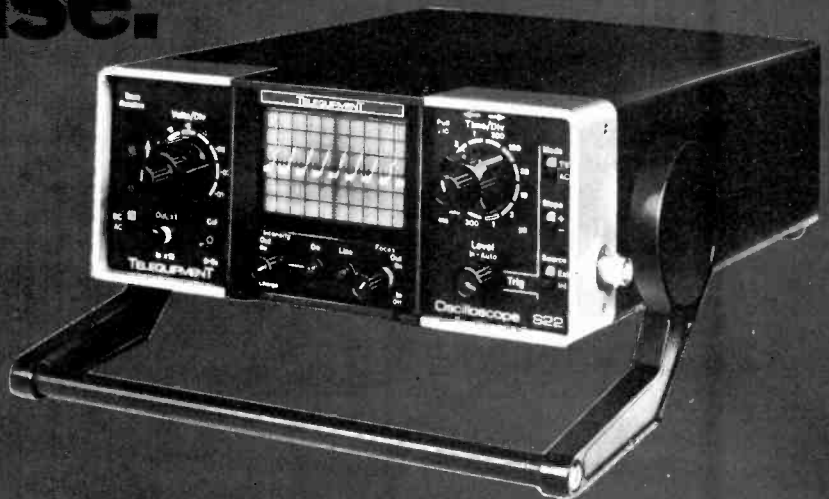
## Greenwood Electronics

Portman Rd, Reading RG3 1NE, England.  
Telephone: Reading (0734) 595844.  
Telex: 848659.

WW - 035 FOR FURTHER DETAILS



# An open and shut case.



No doubt about it our S22 portable 'scope is beautifully put together, from the compact and elegant case right down to the chassis where its three main circuits fan out giving easy access to the heart of the instrument.

Aesthetics apart, the S22 is a lightweight single-trace 5MHz oscilloscope designed for the travelling service engineer and offering high specification at a competitive price, including all the facilities of trigger selection plus a special TV mode giving auto lock on LINE and FRAME frequencies. Versatile too—the S22 can be mains or battery powered, only we don't give you the option—we give you both, complete with internal rechargeable cells and charger.

For 10MHz dual-trace requirements the Telequipment D32 is available, with a similar specification.

Prices S22 £185.00 (+vat)  
D32 £275.00

Interested? Then send today for the full colour leaflet describing both models.

**TELEQUIPMENT**



Tektronix U.K. Limited,  
P.O. Box 69, Beaverton House, Harpenden, Herts.  
Tel: Harpenden 63141 Telex: 25559

# Telequipment S22- the truly portable portable

WW — 061 FOR FURTHER DETAILS



# wireless world

Electronics, Television, Radio, Audio

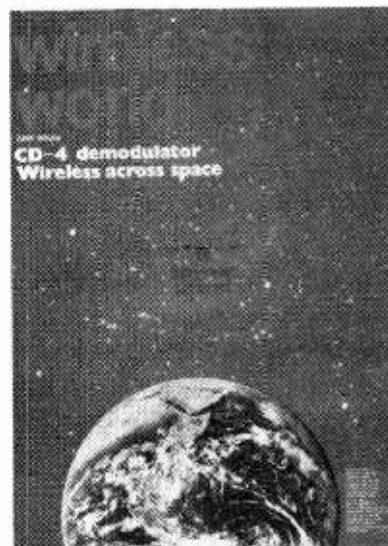
JUNE 1976 Vol 82 No 1486

## Contents

- 33 Myths and maths
- 34 Wireless across space by *Tong B. Tang*
- 39 News of the month
  - New video recording system
  - Eye direction recorder in Britain
  - New tape format
- 42 Surround-sound decoders — 1 by *David Heller*
- 47 Anti-phase or 180° phase-shift by *S. W. Amos*
- 48 Sixty years ago
- 49 Communication theory — 3 by *D. A. Bell*
- 52 H.F. predictions. Literature received
- 53 Wireless World Teletext decoder — 8 by *J. F. Daniels*
- 56 World of amateur radio
- 57 APRS preview
- 58 Letters to the editor
  - The consultants
  - Citizens' band in the UK?
  - Microprocessors oversold?
- 62 Low-noise, low-cost cassette deck — 2 by *J. L. Linsley Hood*
- 66 Books received
- 67 Balunamp design nomogram by *Andrew M. Stephenson*
- 68 Announcements
- 69 Generation of equal-tempered pitches by *Robert M. Youngson*
- 70 Circuit ideas
  - Class A power amplifier
  - Wide-band Y amplifier
- 75 Broadcast's biggest by *Pat Hawker*
- 77 Electronics à Paris
- 79 New products
- 82 Real and imaginary by "Vector"
- 123 APPOINTMENTS VACANT
- 136 INDEX TO ADVERTISERS

Price 35p (Back numbers 50p, from Room 11, Dorset House, Stamford Street, London SE1 9LU.)  
Editorial & Advertising offices: Dorset House, Stamford Street, London SE1 9LU.  
Telephones: Editorial 01-261 8620; Advertising 01-261 8339.  
Telegrams/Telex, Weworld Bisespres 25137 London. Cables, "Ethaworld, London SE1."  
Subscription rates: 1 year: £7.00 UK and overseas (\$18.20 USA and Canada). Student rate: 1 year, £3.50  
UK and overseas (\$9.10 USA and Canada)  
Distribution: 40 Bowling Green Lane, London EC1R 0NE. Telephone 01-837 3636.  
Subscriptions: Oakfield House, Perrymount Rd, Haywards Heath, Sussex RH16 3DH. Telephone  
0444 59188. Subscribers are requested to notify a change of address.

© IPC Business Press Ltd. 1976



Front cover is a reference to Dr Tang's article "Wireless across space," which examines the feasibility of communication with beings on planets of other stars (photographs by Richard Knox (stars) and AP (earth)).

## IN OUR NEXT ISSUE

**Video discs.** A review of the current state of this area of development, with a look at the latest contender.

**Wideband compander.** A noise-reducing circuit for tape-recording which uses power law compansion and does not exhibit the "breathing" effect.

**Simple modem for a.p.t. tape recording.** Design which overcomes amplitude variation on playback by using the frequency-modulated signal from a phase-locked-loop i.c.

SIXTY-SIXTH YEAR  
OF PUBLICATION



# S

## single source makes

## six way sense

- 1** CONSERVES YOUR CASH. No need to lock up capital in slow moving stocks.
- 2** SAVES TIME. Parts usually despatched by return. Orders phoned before midday are often on the way same day.
- 3** A PROTOTYPE SERVICE. Invaluable when assorted alternative experimental parts are required.
- 4** SOLVES BUFFER STOCK PROBLEMS. Eliminates need for heavy stock holding. *Our* stocks are at *your* immediate disposal.
- 5** SIMPLIFIES ORDERING. One transaction for a variety of parts saves bookkeeping and paper work.
- 6** NO ORDER TOO SMALL. Every enquiry is of equal importance and dealt with expeditiously.

Obviously Single Source Service can solve a lot of your day to day problems. As the first step get the relevant U-C S catalogue, which illustrates and describes hundreds of parts any of which you may want at any moment. Write, or better still phone 0602 328711.

### So make United-Carr Supplies your SINGLE SOURCE for:-





United-Carr Supplies Ltd., 112 Station Road, Ilkeston, Derbyshire DE7 5LF Tel: Ilkeston 328711 (STD 0602 328711). Telex 377117

WW — 068 FOR FURTHER DETAILS

It makes sense to use the United-Carr Supply Service when you require smaller or mixed quantities of any of the following:-

### CINCH

Barrier terminal strips.	Audio sockets.
Fanning strips.	Group boards.
Marker strips.	Valve holders.
Printed circuit board edge connectors.	Fuse holders.
D Subminiatures.	Battery connectors.
Multi way plugs and sockets.	

### DOT

<b>Electrical Components.</b>	<b>Industrial Fastenings.</b>
Single and double pole rocker switches.	Tee nuts.
Mains and low voltage indicator lights.	DOTLOC single thread lock nuts.
Plunger switches.	Lift the Dot fastenings.
Mains connector blocks.	Turnbuttons.
Automotive lamp holders.	Plugs and grommets.
Push on terminations.	Metal and plastic components.
Fuse holders.	Press studs.

### FT

Edge clips.	W buttons.
Cable clips.	Door catches.
Cover plates.	Cable straps.
Turnbuckles.	Metal and plastic components.
Knob clips.	

Separate catalogues are available for:-

**Electronic Components,  
Electrical Components  
& Industrial Fasteners.**

Write or phone for your free copy, stating possible requirements.

# wireless world

## Myths and maths

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

**Deputy Editor:**  
PHILIP DARRINGTON  
Phone 01-261 8435

**Technical Editor:**  
GEOFFREY SHORTER, B.Sc.  
Phone 01-261 8443

**Assistant Editors:**  
BILL ANDERTON, B.Sc.  
Phone 01-261 8620  
MIKE SAGIN  
Phone 01-261 8429

**Production:**  
D. R. BRAY

**Advertisements:**  
G. BENTON ROWELL (*Manager*)

KEVIN BURNAL  
Phone 01-261 8515

NIGEL LITTERICK  
Phone 01-261 8037

O. BAILEY (*Classified Advertisements*)  
Phone 01-261 8508 or 01-261 8423

JOHN GIBBON (*Make-up and copy*)  
Phone 01-261 8353

IPC Electrical-Electronic Press Ltd  
Publisher: Gordon Henderson

Why should scientists want to get in contact with possible intelligent beings in other solar systems? The author of "Wireless across space" in this issue does not set out to answer this question – he is writing a technical article. Yet the question is a legitimate one to ask. Much time, money and effort has been expended on this work. One answer could be in the "because it's there" category – the possibility exists, so we must take up the challenge. Another answer could be scientific curiosity. Science is part of university life – which is justified by education and passing on the culture – and science needs problems to work on. The psychologists might suggest that we have an inner wish to find life elsewhere: we are really seeking more evidence to demonstrate purpose and design in the universe, to reassure us that life on this planet is not just an isolated molecular accident.

Practical people will say these are specious answers. But when you try to find the basic motivation behind so much of our science and technology you find yourself among similar, apparently vague and mystical explanations. Technology, in particular, is supposed to serve the needs of man (such as for more communication channels). But the needs of man, beyond those of sheer survival, are largely generated by his visions of himself – in fact by myths. (Here "myths" is not intended to mean things that are not true, but expressions of ideas by which we act and live.)

Behind much of technology is the myth of human progress – that we are on some road that will eventually lead us to perfection if we work away hard enough at our gadgets. And there are also myths of perfection operating in the specialized areas of our progress. Take sound reproduction, for example. Frequency and phase response, harmonic and intermodulation distortion, signal-to-noise ratio and so on are ultimately all measurements – nothing more than meter deflections and points plotted on paper, symbols representing concepts. Yet those of us who feel we cannot rely on our own ears believe that if we make all the measurements absolutely right by sufficient expenditure of money and technical effort, the reproduced sound must necessarily be absolutely right also. This is an example of the myth of objectivity.

Technologists and scientists should always be aware that objectivity is a myth. It is so easy to fall into the trap of imagining that the laws of nature, of logic and mathematics somehow exist independently – that they existed before anyone was around to think them. As the eminent molecular biologist Jacques Monod points out in his book *Chance and Necessity*, the principle that objectivity is necessary for truth is in fact an ethical, and therefore wholly human, decision. Our myths and maths go hand in hand.

# Wireless across space

## Communication with possible intelligent beings on planets of other stars

by Tong B. Tang, M. Tech

St John's College, Cambridge

When the Viking lander-orbiter space-probe reaches the planet Mars in July 1976 we may receive the first confirmation that life exists not only on Earth but on extra-terrestrial bodies as well. It is extremely unlikely, however, that we shall find *intelligent* life either there or on other planets in the solar system. On the other hand, it is statistically likely that among the  $10^{11}$  stars constituting our galaxy (the Milky Way) many have planets which are inhabited by intelligent beings of one form or another and at various levels of social and technological development.

As yet we know of no physical principle which suggests that space travel at speeds faster than light can be implemented. The distances between stars are enormous. The star nearest to the sun is 4.29 light-years away, a distance of a quarter of  $10^{14}$  miles and nearly ten thousand times our distance from the outermost planet of the solar system. While interplanetary travel could be possible within fifty years, launching interstellar spacecraft, whether manned or unmanned, will at best be grossly inefficient, even after all the technological advances we can foresee have been achieved.

Communication by electromagnetic waves will remain the most convenient and fastest method of making contact between stars. It is also the cheapest, requiring only the expenditure of electrical power, granted that the antennae and associated electronics used for transmission and reception exist already. Using 1970s technology and prices, a ten-word telegram costs less than 10 pence if the antennae are 45 metres in diameter and 10 light-years apart<sup>1</sup>.

Extra-terrestrial civilisations could possess technology much more advanced than ours and make use of telecommunication means which we cannot implement (modulation and

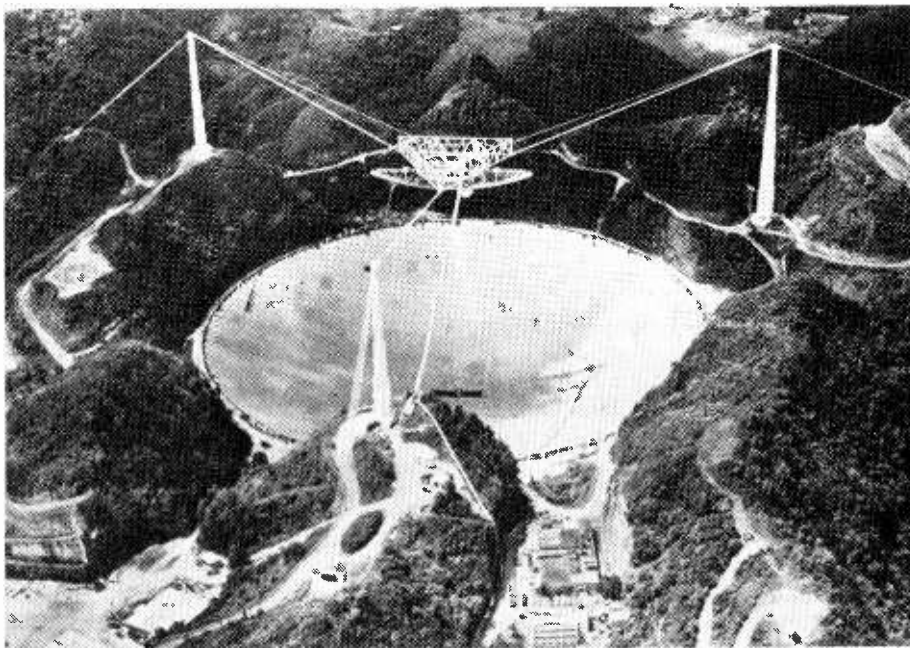
demodulation of gravitational waves or neutrino beams, etc.) or cannot imagine. But they would understand that, while some civilisations on other planets could be still more advanced than themselves, some could be behind them. Counting from the dating of the earliest known fossils of living things on Earth, we have been evolving for three thousand million years, and radio technology has been with us for less than a hundred years. Hence, to maximise the chance of achieving contacts, as primitive a communication technique as possible should be used by civilisations; this I shall call the "principle of presumed modesty". That is, every civilisation in attempting communication will try to make things as easy as possible for the other side, irrespective of whether the other side is in fact very advanced, because it does not know beforehand one way or another. Assuming that everywhere technology develops in the same overall sequence<sup>2</sup>, we need therefore consider only radio communication.

### Feasibility of interstellar radio communication

Our first television broadcasts took place at Alexandra Palace, London, nearly forty years ago. Within a distance of twenty light-years of our sun there are about a hundred stars and star components. It is not absolutely impossible that they all possess planets, on which there are civilisations who have built radio receivers sensitive enough to pick up those television transmissions. The people who sent out the television programmes, may therefore expect at any time now "replies" from up to a hundred different directions in the sky!

Returning from such speculation, we now show that indeed we already possess radio equipment capable of maintaining point-to-point communication with a planet of another star. Its technological advancement need be no higher than ours. (If it is more advanced the issue does not arise at all.) There is a definite low-noise "window" for the reception of interstellar radio signals, in the microwave region from 1 to 10 GHz (u.h.f. to radar s.h.f.). The window is

*Fig. 1. The radio telescope at Arecibo, Puerto Rico. The paraboloidal reflecting dish, 300m in diameter, is constructed within a natural valley in limestone mountains. The feed is supported 137m above ground by cables attached to three pillars. By moving the feed the telescope is made semi-steerable (at 1.42GHz, to any direction within 20° from the zenith).*



determined on the low-frequency side by the onset of intense radio frequency cosmic radiation and on the high-frequency side by that of atmospheric thermal noise. As far as we are concerned, if the interstellar radio station is built on the moon, then the upper frequency limit will be extended to the infra-red, where absorption by dust and debris in the interstellar space begins to be serious. By the "principle of presumed modesty" we should ignore this possibility. Further, the atmospheres of planets where life has evolved to advanced forms must have similar constituents (oxygen and water vapours) and therefore similar noise characteristics.

We now derive an equation for the maximum range of radio communication. If the transmitting antenna radiates a total power  $P_1$  over a bandwidth  $\Delta f$  in all directions with equal intensity, then from a distance  $l$  away the power received by an antenna of "effective" area  $A_2$  will be

$$P_2 = P_1 A_2 / (4\pi l^2)$$

When  $l$  is of the order of interstellar distances, it is obvious that with reasonable values of  $P_1$  and  $A_2$  (reasonable by earthly standards),  $P_2$  will be far too small to be detectable. However, the transmission can be beamed and made highly directional. If then a radio telescope with a parabolic reflector is used, there is a gain over the isotropic radiator of <sup>3</sup>

$$G_1 = \pi^2 (d_1 / \lambda)^2$$

where  $d_1$  is the diameter (aperture) of the reflector dish and  $\lambda$  the operating wavelength. (For simplicity it is assumed that it is radiating "uniformly", otherwise a numerical coefficient slightly less than 1 has to be included.)

Likewise, the receiving antenna will be a parabolic type and will have a gain  $G_2$ . If its aperture  $d_2$  is large, as should be the case, its effective area is close to the physical area:

$$A_2 = d_2^2 \pi / 4$$

If now  $P$  denotes the minimum detectable signal power at the receiver, and  $L$  the maximum range of communication, which we want to find, we can write

$$P = P_1 G_1 A_2 / (4L^2)$$

$$= (\pi^2 / 4^2) d_1^2 d_2^2 P_1 / (L^2 \lambda^2)$$

$$\text{so that } L = \frac{\pi d_1 d_2}{4 \lambda} \sqrt{\frac{P_1}{P}}$$

$P$  will depend on the background and receiver internal noises, characterised as noise temperatures<sup>4</sup>. Without going into the details we can reasonably take  $P$  as  $3.2 \times 10^{-24}$  watts per hertz. Within the window mentioned earlier the interstellar background noise<sup>4</sup> is nearly constant at  $3.2 \times 10^{-22}$  watts per hertz



Fig. 2. Earth's first message to the stars (from ref. 23). The first bit sent is at the upper right-hand corner. The sequence continues from right to left and down.

(except at a few specific frequencies like 1.42GHz). In addition, since the receiving radio telescope will be pointing towards a star, microwave-frequency radiation of the star will add to this noise. However, if the star is more than ten light-years away it will be quite negligible<sup>30</sup>. By using masers or parametric amplifiers, and signal processing techniques such as time integration, frequency cross-correlation<sup>5</sup> and phasor detection<sup>6</sup>, it is possible to dig out signals which are as much as 20dB weaker than this constant noise.

Now, let us assume the receiver passband has been adjusted to be the same as the signal bandwidth  $\Delta f$  so that  $P$  in watts is  $(3.2 \times 10^{-24} \Delta f)$ , with  $\Delta f$  in Hz. Take  $\lambda$  representatively as 10cm, corresponding to a frequency of 3GHz. Further, assume  $d_1$  and  $d_2$  both to be 300m, the same as the aperture of the Arecibo radio telescope (Fig. 1) which is the world's largest in operation at present, so that  $G_1 = G_2 \approx 80$ dB. Then if  $P_1$  is 0.25MW, the present limit in our technology, a little arithmetic will show that

$$L = 2 \times 10^4 / \sqrt{\Delta f} \text{ light-years}$$

The interested reader can draw graphs of  $L$  against  $P_1$  for various values of  $\Delta f$ .

at selected values of  $\lambda$  and  $ds$ . If one uses log-log scales they will be straight lines of slope  $-0.5$ .

It is seen at once that a larger  $L$  is obtained with a smaller  $\Delta f$ , though not quite proportionally. This is because reducing  $\Delta f$  diminishes the background noise power.  $\Delta f$  is limited by the frequency stability of the local oscillators of the transmitter and receiver, as it must be larger than the frequency drift. Using state-of-the-art quartz crystal oscillators and phase-locked loop systems for subsequent frequency up-conversion,  $\Delta f$  can now be made as small as 0.1Hz on s.h.f. waves. If this value of  $\Delta f$  is adopted,  $L$  is more than sixty thousand light years. In other words, two Arecibo-class radio telescopes, placed almost anywhere in the galaxy, could maintain communication with each other.

### Problems and solutions

Interstellar radio communication is not, however, without problems. The first few concern  $\Delta f$ . The maximum amount of information obtainable from a radio transmission lasting a period of time  $t$ , in bits,<sup>7</sup>

$$I = \Delta f \cdot \log_2 (1 + \alpha) \cdot t$$

$$\approx \Delta f \cdot \alpha \cdot t / \log_2 2$$

$$\approx (3/2) \Delta f \cdot \alpha \cdot t$$

where  $\alpha$  is the received message signal-to-noise-ratio and is assumed to be small. As an illustration, to send 3 megabits, which is the average amount of information contained in one book<sup>8</sup>, to be received up to points where  $\alpha$  is 1, then if  $\Delta f$  is 0.1Hz time  $t$  will be nearly 8 months. Unless we merely want to transmit call signals, which are of low  $I$  and serve only to advertise our existence and that we send call signals, then the chosen  $\Delta f$  cannot be too small so that the transmission time  $t$  will be reasonable. Moreover, signals of low  $I$  may be mistaken to be not artificial but of natural origin<sup>9</sup>. Here it is interesting to note that when the stellar objects called pulsars were first observed there were speculations that they were radio beacons for interstellar navigation — but their emissions pulse with extremely regular periodicity and nothing else. The speculations did not last long.

Also, on the receiver side, the time-constant of the passband determining filters is set to be  $1 / \pi \Delta f$ . If  $\Delta f$  is very narrow the time  $\tau_i$  required for a single signal recording (the "integration time") becomes inconveniently long, especially if the signal-to-noise-ratio is low.

More importantly, in the frequency domain, reducing  $\Delta f$  increases the total number of possible channels. Communication is achieved, of course, only if both the transmitter and the receiver are tuned to frequencies within the same channel. The trouble is that each side is ignorant of the other's choice of

frequency before the contact. Within the 1 to 10 GHz window there will be nine thousand channels if  $\Delta f$  is 1MHz, but ninety thousand millions if it is 0.1Hz.

Fortunately, this problem of frequency compatibility seems to be tractable. Within that window there are particular frequencies which have special significance. Although each civilisation does not know beforehand how the others think, to maximise the chance of contact each should in its planning converge on those points which can be identified by all the others; this has been referred to as the "principle of anti-cryptography".<sup>10</sup> For us, the first such "watch frequency" to be so identified is the 1.42040575GHz spin-flip emission line of neutral hydrogen. As a physical property of matter, its value is universal and known by all other civilisations. Its significance comes from the observation that hydrogen is the most abundant element in the universe, so that it may be regarded as one fundamental constant of nature. However, for the same reason, it is unusually noisy. There has been a suggestion that its second harmonics (2.84GHz) should be chosen instead.<sup>11</sup> Also suggested<sup>12</sup>, later, are the 1.667358 GHz radio frequency line of the hydroxyl radical and two "naturally" derived frequencies in the "water hole"<sup>13</sup> between it and the hydrogen line. (Water is composed of hydrogen and the hydroxyl radical, and it is most probably the basis of life anywhere in the universe.) All these frequencies lie near the low-frequency end of the window, an additional advantage since  $L \propto 1/\lambda$ .

There is an analogous problem in the time domain – the synchronisation of the transmitting and the receiving radio telescopes. As mentioned earlier, high gains on the telescopes, and therefore longer  $L$ , are obtained by making them highly directional. Hence, they are at one time transmitting or listening to only some small solid angles in the sky – in fact,  $(4\pi/G)$  steradians, where  $G$  is the gain of the telescope concerned. (The whole sky extends by definition  $4\pi$  steradians.) For communication to be achieved the two telescopes have to be in the same line of sight and pointing at each other. The probability of this happening by pure chance is  $(1/G_1G_2)$ . If  $G_1$  and  $G_2$  equal 80dB, it becomes  $10^{-16}$ , an exceedingly small probability. (A field of view of  $4\pi/10^8$  steradians is so narrow that generally at most one star lies in it.)

One solution is to reduce  $G_1$  and  $G_2$ , which however decreases  $L$  as well. Another solution is the simultaneous use of vast numbers of transmitting and receiving telescopes, pointing in different directions. Practical proposals are not lacking<sup>14</sup> Even if neither is feasible, the problem may still turn out to be solvable. In the same way that certain frequencies are special and, obviously to all, should be those used for

interstellar communication, some astronomical phenomena in the galaxy may be suitably exploited as "time markers" and used for synchronisation purposes. One example is, for binary stars (two suns circling each other), the times when the two stars are nearest and farthest away<sup>15</sup>. Another, I propose, is the occurrence of a supernova<sup>16</sup> (a star "blowing up"; and this is, incidentally, the event responsible for the generation of the heavy chemical elements and the cosmic rays which in turn are requirements for the appearance and evolution of life.)

After the interstellar signals have been located, yet another problem is presented by the demodulation process. Which modulation method has been used by the transmitting civilisation? For reasons of simplicity and obviousness, the information must have been in binary form. According to one analysis<sup>10</sup>, the optimum binary modulation process (and by "the principle of presumed modesty" the one to be used) is by sense-switching of the circular polarisation of the radio waves. This means that the waves will be circularly polarised, in the clockwise and anti-clockwise directions alternatively to represent 0 and 1. To use amplitude, frequency or phase modulation will be less efficient.

Assuming that we have got the message (as a sequence of 0s and 1s), we have to start decoding it into intelligent information. Much has been discussed about this subject of "interstellar cryptography". The information may be pictorial as was the first interstellar transmission by us (see later: Fig. 2). It may be more sophisticated and high-level, and it will not be so straightforward to interpret and translate into our own concepts. However, the transmitting and the receiving civilisations share quite a few things in common, irrespective of their differing systems of concepts (which in any case all reflect the same objective world). They are the message itself, the "same" understanding of physics (albeit with different "names," notations and unit systems), and the (universal) conception of arithmetic (counting one, two, three, etc.). A language of high expressional power can be defined, starting from

them and nothing else. A long message can consist of, in the first part, the construction of such a formalised syntactic language, followed then by "books". The reception and deciphering of such a message will have unimaginable effects.

Lastly, there are a few "tactical" problems. The transmitting and the receiving planets will be rotating as well as travelling in space, so that they are moving relative to each other. Hence, there will be a time-varying Doppler shift in the signal frequency, equal to the (varying) relative velocity divided by the speed of light. However, this can be eliminated easily if each side separately compensates for its contribution to the total shift, by using for example a phased frequency-scanned antenna system<sup>17</sup>. Another problem is due to the fact that interstellar space is not exactly a vacuum, so that dispersion of the radio signal occurs. The lower frequency components of the signal have slightly lower propagation velocities, resulting in distortion. However, with an unusually small  $\Delta f$ , it will not be serious unless the propagated distance is very large ( $>10^4$  light-years).<sup>1</sup>

### The receiving system

Let us now consider the radio telescope receiving system (sometimes referred to as a "radiometer") in some detail. Its basic function is to amplify, within a specified bandwidth at a selected frequency, the signal-carrying electromagnetic waves collected by the telescope. After appropriate demodulation the signal drives an output recorder.

Its front end will consist of a low-noise pre-amplifier – inevitably a parametric amplifier or the more expensive liquid-helium cooled maser<sup>18</sup> – which is usually placed right in the telescope to reduce feeder transmission loss. (A discussion of "noise temperature" and front-end amplifiers can be found in reference 4.) To eliminate misleading outputs due to internal drift in the system characteristics, the input to the pre-amplifier is switched between the telescope feeder and a standard noise source. The pre-amp is followed by several stages of superheterodyning intermediate-frequency amplifier, and

Investigator	Observatory	Frequencies	Targets
Troitsky	Eurasian network. USSR	0.6, 1 and 1.875 GHz	Entire sky
Zuckerman, Palmer	Green Bank, USA	1.420 GHz	Some 600 nearby sun-like stars
Kardashev	Eurasian network. USSR	Several	Entire sky
Bridle, Feldman	Algonquin Radio Observatory, Canada	22.2 GHz	Several nearby stars
Drake, Sagan	Arecibo, Puerto Rico	1.420, 1.653 and 2.380 GHz	Several nearby galaxies

Fig. 3. Project Ozma receiving system schematic (adapted from National Radio Astronomy Observatory diagram).

then by the detector, which is synchronised to the pre-amp switching frequency, so that signals from the feeder which are pulsed at the same frequency will be demodulated but receiver noises etc. which are not will be ignored. An integrator comes after the detector stage. It averages the signal over an interval  $\tau_i$  equal to its set time-constant, to give successive recordings. The root-mean-square deviation in a single recording is inversely proportional to  $\sqrt{\tau_i \Delta f}$ , so that a longer  $\tau_i$  leads to more significant digits in the reading. In the search period, before the signal has been detected, square-law (energy) detectors are used. After the signal has been found, however, a coherent or homodyne detection method is used to retain the phase information. The recordings usually go through analogue-to-digital converters and then are stored on tapes, to be dumped into a computer later. Sometimes, signal processing processes such as frequency-correlation are performed in real time immediately after the integrator, by a digital correlator<sup>19</sup>.

The first attempt by mankind to listen for extra-terrestrial radio messages (Project Ozma) was made fifteen years ago.<sup>20</sup> In the last five years there were three more publicised searches.<sup>21, 22</sup> Project Ozma used a telescope of  $d = 26$  metres, and searched at frequencies from 1.4202 to 1.4206GHz with  $\Delta f$  from 40 to 100Hz. The other three had  $d$  ranging from 26 to 50 metres, frequencies at 1.420 and 0.927GHz, and  $\Delta f$  at various values from 13Hz to 2MHz. Results were all negative, which is hardly surprising as these efforts were on very small scale. Using the Arecibo radio telescope ( $d = 300\text{m}$ ) the first radio signalling to other stars was carried out in 1974, just before the first man-made objects to leave the solar system would have left. (These were the Pioneer 10 and 11 space-probes, travelling more than a hundred thousand times slower than the radio signals.) The radio message<sup>23</sup> has 1,679 bits and therefore can be broken down into a two-dimensional picture in only two ways, either as  $73 \times 23$ , or as  $23 \times 73$  which is the intended one (Fig. 2). The frequency of transmission was 2.38GHz,  $\Delta f$  was 10Hz and the transmission time lasted 169 seconds. Binary frequency modulation was used, the effective average power was  $3 \times 10^{12}\text{W}$ , directed towards the Great Cluster in Hercules, a group of some 300,000 stars  $2.4 \times 10^4$  light-years distant. The Doppler shifts in the signal frequencies due to motions on the Earth side had been continuously compensated.

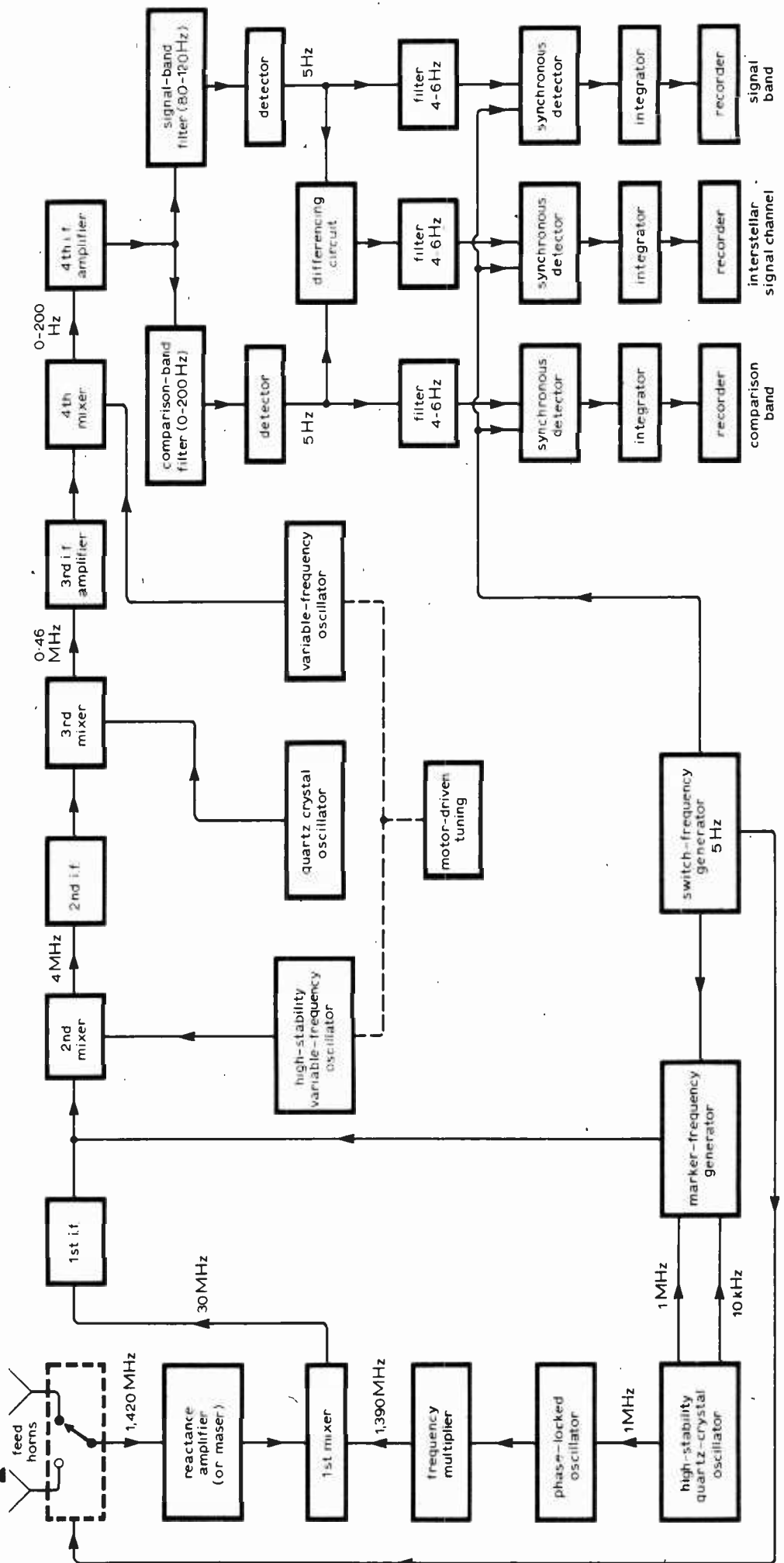
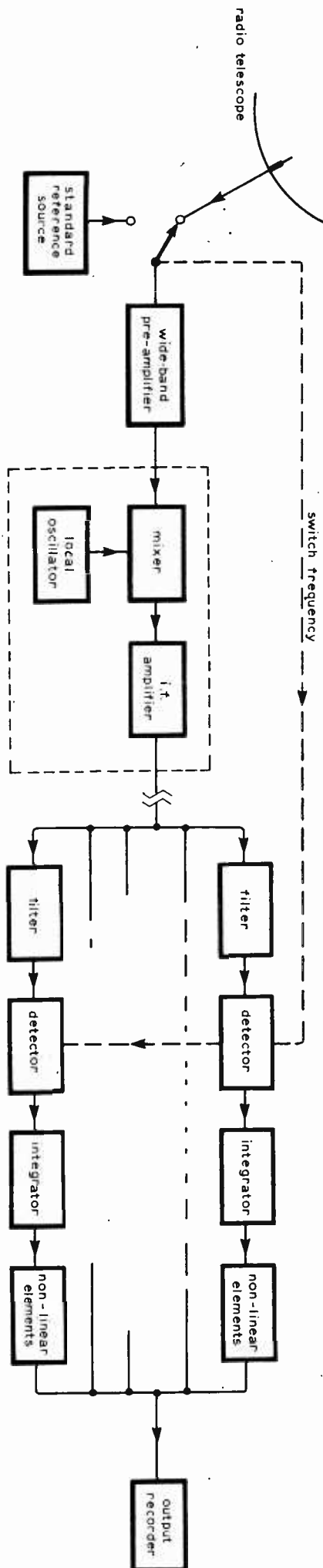


Fig. 4. Multi-channel receiving system



The functional block diagram for the receiving system used in Project Ozma, which will be representative, is shown in Fig. 3. Two horn antennae are connected by waveguides to an electronic switch, and the signals from them are fed alternately to the pre-amplifier. They are placed above the telescope reflector dish, so that one "looks" effectively at the star of interest and the other at a point in the celestial sphere just next to it. The second horn serves as a comparison noise source. The detectors on the right-hand side of Fig. 3 respond only to signal pulses synchronised with the switching frequency. In this way receiver internal drifts, and terrestrial interferences which are collected by both horns, are eliminated, since they are not synchronised.

The quartz crystal oscillator for the first mixing stage is kept at a very stable temperature in an oven-within-oven, and has a frequency drift of less than 1Hz in 1GHz. Its output is up-converted, in frequency to 1.39GHz by a phase-locked loop system.

After the fourth i.f. amplifier, two filters pick up one broad (0-200Hz) and one narrow (80-120Hz) band of signals. Their attenuations are in the ratio of 5 to 1, so that if the signals are broad-band their outputs are the same. In this case, the differencing circuit and thus the "interstellar signal channel" will have zero output. (The signal-band filter is shown as passing a  $\Delta f$  of 40Hz, but it can be easily and quickly re-adjusted and in the actual experiment  $\Delta f$  had varied from 40 to 100Hz.) Only when there are signals of bandwidth less than 200Hz will the filters' outputs be different. The other two outputs, shown as "comparison band" and "signal band," serve as checks on system performance.

The other receiving systems used in the search for extra-terrestrial radio messages are similar in construction, except that they are multi-channel so that a number of watch frequencies can be scanned simultaneously. Fig. 4 is a schematic of these systems. There is the radio telescope, and a standard reference source for noise comparison purpose. After going through the switch and the wide-band pre-amplifier, the signals pass several stages of mixers and i.f. amplifiers and are then selectively allowed through a number of pass-band defining filters. After detection and integration they are summed by non-linear circuit elements and go to an output recorder. Multi-channel one-bit digital correlators<sup>24</sup> are also sometimes incorporated. Each channel can be searched individually, and the data from several adjacent channels can be combined to represent a wider channel without any loss of information or sensitivity.

(It may be interesting to compare the

receiving systems just described with a home-made one operating at 0.2 and 0.45GHz and for less sophisticated purposes<sup>25</sup>, which, while being much simpler, contains all the essential ideas.)

To be continued

## References

1. Drake, F.D., in *Interstellar Communication: Scientific Perspective* (ed. C. Ponnamperuma and A.G.W. Cameron), Houghton Mifflin (Boston; 1974).
2. Sagan, C., "Life beyond the Solar System" in *Exobiology* (ed. C. Ponnamperuma), North Holland (1972) p.473.
3. I.T.T. Reference Data for Radio Engineers (5th ed.), H. W. Sams (New York, 1968) p.26-20.
4. Smith, K. L., "Noise - Confusion in more than one" Parts 3 and 4, *Wireless World*, vol. 81, pp.235-7 and 326-330 (1975).
5. Drake, F. D., in *Current Aspects of Exobiology* (ed. G. Mamikunian and M. H. Briggs), Pergamon (1965) p.323.
6. Golay, M. J. E., "Note on the probable character of intelligent radio signals from other planetary system", *Proc. IRE*, vol. 49, p.959 (1961).
7. *ibid* Ref. 3, p.38-15.
8. Shklovskii, I. S., and Sagan, C., *Intelligent Life in the Universe*, Holden-Day (1966) pp.427-8.
9. Slysh, V. L., "Radio astronomic artificiality criteria of radio sources" in *Extraterrestrial Civilisations* (ed. G. M. Tovmasyan), Israel Programme for Sci. Transl. (1967) pp.38-42.
10. Dixon, R.S., "A search strategy for finding extraterrestrial radio beacons", *Icarus*, vol. 20, pp.187-199 (1973).
11. von Hoerner, S., "The search for signals from other civilisations" in *Interstellar Communication* (ed. A. G. W. Cameron), Benjamin (1963) pp.272-286.
12. Drake, F. D., and Sagan, C., "Interstellar radio communication and the frequency selection problem", *Nature*, vol. 245, pp.257-8 (1973).
13. Oliver, B. M., in *Communication with extraterrestrial intelligence* (ed. Carl Sagan), M.I.T. Press (1973) pp.284-5.
14. for example, Gindilis, L. M. in *Extraterrestrial Civilisations* (ed. S. A. Kaplan), Israel Programme for Sci. Transl. (1971) p.68.
15. Pace, G. W., and Walker, J. C. G., "Time markers in interstellar communication", *Nature*, vol. 254, pp.400-1 (1973).
16. Tang, T. B., "Supernovae as time markers in interstellar communication", *J. Br. Interplanet. Soc.*, 1976 July-Aug.
17. Dixon, R. S., "An isotropic frequency-independent antenna system for simultaneous omnidirectional Doppler shift removal", *IEEE Trans. Antennas and Propagation*, vol. 22, pp.707-9 (1974); Teich, M.C., "Doppler-independent selective heterodyne radiometry for detection of remote species", *Rev. Sci. Instrum.* vol. 46, pp.1313-1317 (1975).
18. Kollberg, E. L., "A Travelling-wave maser system for radio astronomy", *Proc. IEEE*, vol. 61, pp.1323-9 (1973).
19. Bowers, F. K., Whyte, D. A., Landecker, T. L., and Klingler, R. J., "A digital correlation spectrometer employing multiple-level quantisation", *Proc. IEEE*, vol. 61, pp.1339-1343 (1973).
20. Drake, F. D., "How can we detect radio transmissions from distant planetary systems?" in *ibid* ref. 9, pp.165-175; "Project Ozma", pp.176-7.
21. Troitskii, V. S., Starodubtsev, A. M., Gershtein, L. I., and Rakhlin, V. L., "Search for monochromatic 927-MHz radio emission from nearby stars", *Soviet Astron. - AJ*, vol. 15, pp.508-510 (1971).
22. Verschuur, G. L., "A search for narrow band 21-cm wavelength signals from ten nearby stars," *Icarus*, vol. 19, pp.329-340 (1973); Zuckerman, B., "Ozma II", paper presented at US Commission V URSI Meeting, January 1973, Socorro, New Mexico.
23. The Staff at the National Astron. and Ionosphere Centre "The Arecibo message of November 1974", *Icarus*, vol. 26 pp.462-6 (1975).
24. Ables, J. G., Cooper, B. F. C. Hunt, A. J. Moorey, G. G., and Brooks, J. W., "A 1024-channel digital correlator", *Rev. Sci. Instrum.*, vol. 46, pp.284-295 (1975).
25. Duncan, J. H., "Radio telescope project at Frensham Heights School", *Wireless World*, vol. 81, pp.289-290 (1975).



# News of the Month

## New video recording system

When is a video disc not a video disc? The multiplicity of answers to this question seemed to have escaped the organizers of Video Disc 76, a recently held conference in London. For by choosing this title, they automatically excluded at least one system from being presented that has equal, if not more, potential than the best disc systems announced so far. A question and answer period however allowed Mr Sarason Liebler, president of Digital Recording Corporation, to give a brief description which were later expounded to *Wireless World* (more details next issue).

The system is an optical one that can store live colour television signals in digital form at a density of 300 million bits per square inch, a density that allows 30 minutes of TV programme to be stored on a 5 x 7in record. Mr Liebler told *Wireless World* that for consumer TV playback large-scale production could bring manufacturing cost down to \$120 per unit, as only relatively inexpensive components were required. But a large consumer market was seen to be a long way off, and application is more likely to be in other areas such as archival information storage and retrieval, military situations, and professional areas where high signal-to-noise ratio and a high bit rate or density is desirable.

Material to be stored is converted to a digital code and written as a series of micron-sized dots (or bars) and spaces on a photosensitive plate. For playback, which can use the same unit as for recording, digital tracks are scanned by a light beam. The modulated beam is converted by photodetector and a conventional digital-to-analogue converter to reproduce the original information. Scanning is achieved by a spinning scanning head that has several apertures in its periphery. An optical distributor switches the light beam in

such a way that the data at the end of one track are picked up at the start of the next track by the next aperture. It is the scanner that translates, the record remaining fixed.

## Eye-direction recorder in Britain

Accurate "eye direction" recording has posed difficult problems for researchers trying to find a system in which the measurement process itself does not interfere with the normal activity of the subject. The "remote oculometer", demonstrated recently in London, is claimed by its designers, Honeywell Radiation Centre, to overcome this problem.

The oculometer, which is the result of 10 years' research at the company's laboratories in Lexington, Massachusetts, uses a beam of infra-red light, aimed at the subject's eye, to operate a special TV camera. This camera locates the position of the eye's corneal reflection, which moves within the pupil area according to the direction of the line of sight. A small computer translates the position of the corneal reflection into a precise "measure" representing the point at which the subject is looking. This measure can be recorded and/or displayed on a TV screen showing the fixation point within the viewed area.

*Video tape recording showing a viewer's "eye fixation" on a TV commercial. The fixation point - shown as a white dot on the woman's mouth is superimposed on the screen by an oculometer computer.*

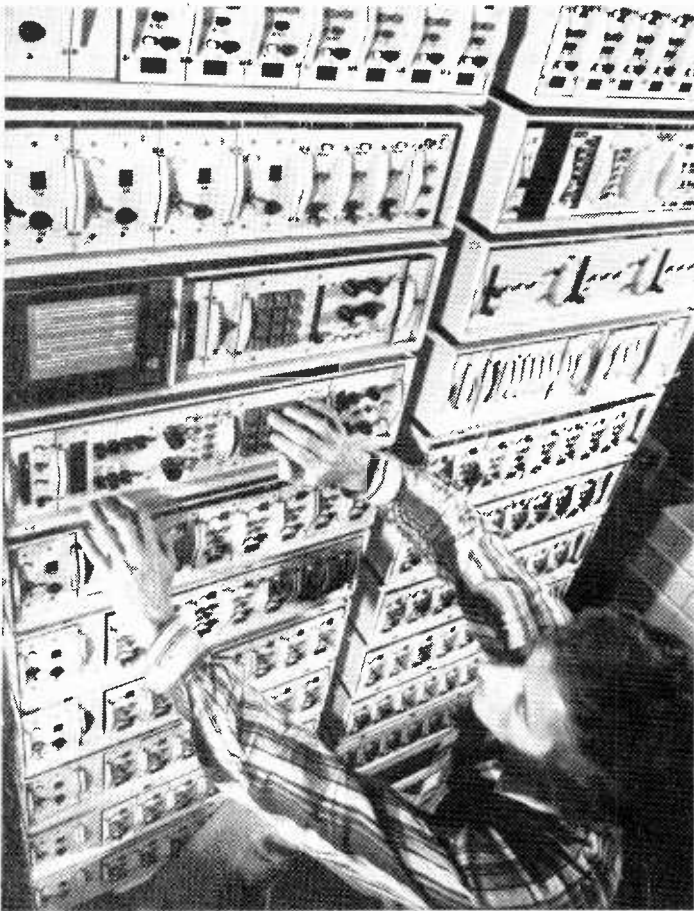


There are two basic types of oculometer; one which requires the subject's eyes to stay within one cubic inch of space, and another which, using a two-axis moving mirror and a servo-driven focusing lens automatically controlled by the computer processor, allows movement within one cubic foot of space.

The oculometer, Honeywell says, can provide objective data in many applications such as training and evaluation of aircraft pilot or air-traffic controllers' skills, instrument panel design, driving and road safety research, design of TV commercial and other advertising copy, and reading analysis. The U.S. Air Force are presently using a cubic-foot unit for study into the use of eye control as an alternative to conventional hand control, and oculometers have been purchased by a variety of other research centres, armed forces and universities in both the States and Europe. Honeywell's own Systems and Research Centre uses an oculometer for analysing the viewing pattern of shoppers asked to watch a series of TV commercials, and also for the National Highway Traffic Safety Administration for a night-driving study of headlight effectiveness.

## Post Office install electronic director

The first electronic 'director' equipment to be installed in a London telephone exchange is being tested under live traffic conditions. The original director equipment designed for London and other large cities in the 1920s, used Strowger two-motion selectors and



*Final checking of the Pye TMC electronic director equipment (see news item) before delivery to the Post Office for field trials.*

uniselectors to convert the three digits of the exchange code dialled by the subscriber into the necessary routing digits for directing the call across the particular city to the destination exchange. This equipment, which enabled a universal numbering scheme to be employed, has worked efficiently but does not provide some facilities now considered desirable by the Post office. Pye TMC was awarded a contract by the Post Office to design and develop a system which could not only replace the existing electromechanical equipment but would also incorporate additional facilities.

The new equipment, designed using m.o.s. l.s.i. techniques, is much more compact and has a translation store of 2,000 individual routing instructions. Any or all of these can be electrically rewritten, providing for the routing of traffic to several hundred local exchanges, to the trunk network or the various information centres as desired. The translators are triplicated for reliability. An added advantage for the maintenance staff will be the reduced noise level in the exchange to improve working conditions.

The first production TXE4 exchange is now carrying public traffic. Between now and March 1980, the Post Office expects to spend about £330M on electronic exchanges at current price levels.

(As pointed out in "Centenary of the Telephone", March issue, the TXE4 is not fully electronic, relying on reed relays. See also "Electronic telephone exchanges", June, July 1974.)

## Touch for iron and steel

A touch-sensitive display is taking a role in the investigation of data processing systems and information display techniques being carried out by the British Steel Corporation. Under a contract received by Marconi Radar Systems Ltd, a Digilux touch-sensitive display unit and a television alphanumeric display are being supplied to the Control and Human Factors Department of the BSC's Corporate Engineering Laboratory. The Digilux will be used in conjunction with the laboratory computer; a PDP11/45, to evaluate data processing systems and programmes developed for specific steelworks applications one of which is the operator guidance system for 'basic oxygen' steelmaking control.

The planned experimental programme being carried out by the Corporation also includes comparative evaluations of equipment and an investigation of the display parameters such as desirable contrast ratios, character size, alphanumeric data format design and techniques of graphical display. Digilux does not rely on physical contact between finger and a bare wire conductor but uses narrow infra-red beams to form an invisible grid over the display screen. At each of the intersection points a small stud is let into the screen and above each stud an item of data to serve as a label is written electronically on the tabular display screen. By touching the appropriate

stud, two beams at right angles are intercepted and the data designated by the label is signalled to the computer. This data is then written on the screen and at the same time a new set of labels designating the next stage of information to be fed in, is written above the studs.

## Cartridges to Tokyo

Goldring are feeling pleased with themselves as a result of a Japanese order for their new G900 pick-up cartridge. They first sold cartridges in Japan to Sony, with their 850 model, a derivative of the million-selling G800 series. But the 900 cartridge is a completely new design. Though the chemically-etched laminations of the pole shoe assembly, first introduced by Goldring in 1969, improved the mid-range droop of earlier cartridges, it still left a fairly heavy pick-up. The 900 uses the moving magnet technique enabling magnet size and weight to be reduced drastically, resulting in a cartridge weighing only 5gm. The cantilever stylus support has also been reduced in weight – the tube wall measures 0.9 "thou" – and a smaller diamond tip is used. Tip mass is said to be 0.32mg. The coil and pole shoe assembly is also improved with finer laminations and a coil construction technique that avoids the usual bobbin former; inductance of the pick-up is 640mH at 1kHz and 630mH at 10kHz. Droop at 5-10kHz is kept to within -1dB, giving an overall response of 20Hz to 20kHz  $\pm$  2dB.

## Local radio for the army

The Ministry of Defence is purchasing a mobile sound broadcasting facility which will enable the British Army deployed anywhere in the world to provide a local radio service of general interest and current news content. Two medium wave sound broadcasting transmitters together with studio equipment, h.f. receivers, antenna arrays, a demountable mast, an aerial tuning unit and a range of associated test equipment are being supplied by Marconi Communication Systems Ltd. All of this equipment is to be mounted in two Army containers so that the resultant station can be transported by air by Support Command to any destination and brought into operation, at short notice.

One of the containers will be fitted with two Marconi type B6023 1kW m.f. sound broadcast transmitters with a paralleling unit to provide 2kW of power. This container will also hold the drive units which will provide the choice of either crystal oscillator or synthesizer frequency control and a patching panel. The second container will function as the sound broadcasting studio and will be fitted with a

12-channel sound mixer, microphones, disc reproducers, tape recorders and sound monitoring equipment. A separate compartment within this container will mount h.f. receivers operating in space diversity to enable overseas broadcasts to be received and re-transmitted as required.

---

## I<sup>2</sup>L in volume

---

Claimed to be the first European based volume production facility for I<sup>2</sup>L devices, a facility of ITT Semiconductors at Footscray is approaching a production rate of one million devices per year. At this time, a significant proportion of these devices are for use in digital watch applications where the significant reduction in package size coupled with the capability to directly drive i.e.d. displays give I<sup>2</sup>L devices advantages over other comparable processes for certain applications. These advantages have potential for other applications and sample products are being evaluated by manufacturers in the telecommunications, TV, control systems and automotive markets. ITT inform us that development is now well advanced on a new range of consumer time pieces which use new circuit and packaging design techniques.

---

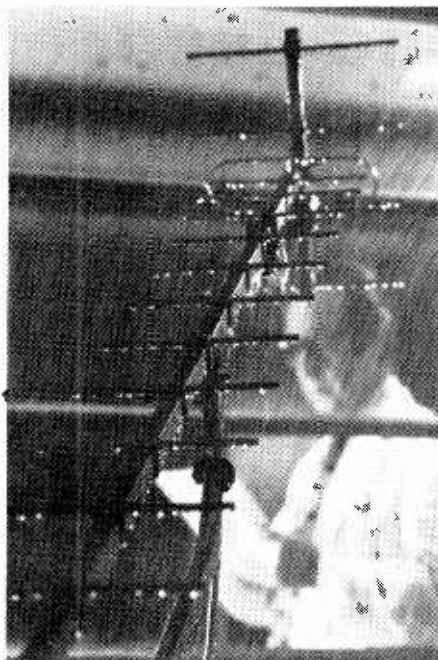
## New tape format

---

A consortium of Japanese manufacturers consisting of Sony, Matsushita and Teac have announced a new tape format. Called the Elcaset, it consists of a tape cassette containing 1/4in tape in a plastics housing of similar appearance to a compact cassette. Designed to run at a speed of 9.5cm/s, the Elcaset is a contender in the professional recording field alongside the BASF Uniset.

The principle difference between this new cassette and its competitor is that the tape is removed in a large loop by the recorder, thus isolating the cassette reel friction from the section of tape passing across the tape heads. Additionally, the track configuration allows for four conventional tracks and two control tracks down the centre of the tape. These control tracks can be used, one in each direction of tape travel, to carry synchronizing pulses for slide projectors, pilot-tone for film projectors, or a numeric code enabling selection of recorded items to be made using a programmable control unit. Automatic selection of bias and equalization is provided for three types of tape, by moulded lugs on the rear edge of the cassette.

Subsequent to the initial announcement, Aiwa and Victor (JVC) also announced agreement to adopt the format. The first machines using this format are expected to appear in the winter of 1976.



*Artificially produced showers are among the extreme stress conditions to which Siemens communications equipment is subjected for environmental testing.*

---

## Underwater inspection completed

---

An unmanned undersea inspection vehicle has completed a visual examination of the massive new Brent Spar oil storage and loading buoy for Shell UK Exploration and Production. The vehicle, equipped with colour and black and white television and stereo still cameras, inspected parts of the Spar Buoy in 25 hours of underwater operation. The buoy, whose underwater structures extend 109m below the surface of the sea, is 29m in diameter and can contain 320,000 barrels of oil. A British Aircraft Corporation team operated Consub 1 from a barge tethered alongside the structure. All areas were illuminated by lamps on Consub and real time television pictures were relayed and recorded on videotape at the operator's console on the barge for assessment by engineers.

---

## Broadcasting Convention 1976

---

The organizers of the biennial International Broadcasting Convention 76 to be held at Grosvenor House, London from September 20 to 24, have announced an excellent response to the call for papers. More than sixty papers by leading experts around the world will be presented during the fourteen sessions of the technical programme. They cover new techniques, systems, developments and trends which will be of interest to engineers concerned with all aspects of broadcasting.

In addition to conventional broadcasting techniques there will be two sessions concerned with new information systems utilising the domestic television receiver for information display. Papers will be presented on Teletext, Viewdata and Text Television, the experimental system of NHK in Japan. A special session will highlight 'Electronic Journalism' using lightweight camera, recording and transmission equipment specially designed for this purpose and now being produced by many manufacturers for increasing use around the world to cover new events for television. The exhibition at IBC 76 at which leading manufacturers will display and demonstrate an extensive range of professional broadcasting equipment will complement the technical sessions and enable delegates to get up-to-date information and firsthand experience of the latest equipment. Over 2000 delegates from 44 countries attended IBC 74.

---

## Marine electronics conference

---

The Society of Electronic and Radio Technicians, in association with the Institution of Electrical and Electronic Technician Engineers, has organised a three-day symposium on marine electronics at the University of Southampton. The symposium, which is to be held from 5th to 8th July, covers five sessions. The first session will deal with maritime communications and will include papers on ships' aerials, speech processing for high frequency communications and satellite communications. Other sessions will deal with navigation and radar, automation and computers, education, training and future developments of marine electronics, and safety at sea. Eighteen papers are to be presented, the authors being drawn from marine companies, manufacturing companies, government departments and corporations, shipping industries, shipbuilders and colleges. In addition to the papers, technical visits will be arranged and a full social programme is planned. Registration fee is £68 plus 8% v.a.t. (£50 plus v.a.t. for members inclusive of attendance, board and the volume of published papers. Amongst the chairmen are Sir Edward Fennessy, managing director of telecommunications at the Post Office, Air Commodore Alec Morris, Director of Signals (Air), Ministry of Defence, R. M. Billington, Maritime Radio Services at the Post Office, and Col. J. D. Parker, Secretary General, C.I.R.M.

## Briefly

**Approval for calibration centre.** The MSL Calibration Centre of Hunting Gate, Hitchin, Hertfordshire has been approved by the British Calibration Service.

# Surround-sound decoders — 1

## System details and circuit description of CD-4 demodulator

by David Heller, B.Sc.(Eng)

The Compatible Discrete 4 system (CD-4) was introduced in 1970 by the Victor Company of Japan. As its name implies, it was developed to allow four separate signals to be recorded on a disc record, at the same time having playback capability in stereo and mono when played through existing equipment.

A CD-4 record is cut in the familiar stereo format. Each of the two groove walls are cut at a  $45^\circ$  angle with the disc surface and at a  $90^\circ$  angle with respect to each other. Conventionally, the inner wall closest to the record centre is recorded with the left channel information. Modulation of the walls is perpendicular to their surfaces and, because of their  $90^\circ$  relationship, can be traced by a pickup to produce independent electrical outputs that correspond to the undulations of the wall.

Two signals are recorded on each wall side of the CD-4 disc: a sum signal,  $L_F + L_B$ , occupying the base band up to 15kHz, and a difference signal,  $L_F - L_B$ , modulated onto a 30kHz carrier. This last-mentioned signal occupies the 20 to 45 kHz band.

If a CD-4 disc is played on a normal two-channel stereo system, only the sum signal is detected. Information contained in either the left or the right channel is processed and appears in either the left or the right channel as a normal stereo disc. To obtain four audio channels from a CD-4 disc, a high frequency pickup and demodulator are required to recover the f.m. signals and thus obtain the difference signals. By combining these with the sum signals, four independent audio signals are obtained. Although the encode/decode principle used in the CD-4 system is basically simple, certain refinements have to be used in the difference signal processing to ensure that the signal-to-noise ratio is not substantially degraded over that obtainable in a normal stereo disc system.

### Recording system

Fig. 1 is a block diagram of a CD-4 recording system. Four independent signals are fed into the input matrix amplifiers. The sum signal, delayed by

about  $40\mu\text{s}$  to compensate for the delay of the difference signal during replay, is passed to the RIAA equalizer.

Before modulating the carrier, the difference signal is compressed and emphasized. To understand why this processing takes place it is necessary to explain two major sources of difficulty encountered in the difference signal path. Noise in the difference signal is caused because the wavelength of the modulated carrier is so short that the ratio of record particle size to wavelength is no longer negligible, and with angle modulation the noise spectrum corresponds with the particular modulation curve used. Angle modulation has a number of unique characteristics. In a frequency modulated signal, the noise density or noise power per unit bandwidth increases as the modulation frequency increases. Carrier deviation caused by the noise at a particular modulating frequency is directly proportional to that frequency. Theory and experimental evidence show that noise from an f.m. signal is greater at the upper frequency end of the sonic spectrum. However, noise from a phase modulated signal is flat throughout the sonic spectrum. Experiments using the best record material available were undertaken by JVC to derive the noise spectrum, and Fig. 2 shows both the theoretical and experimentally-obtained noise spectra; in the frequency range above 2kHz the signal-to-noise ratio and dynamic range are reduced.

Crosstalk occurs between the two modulated signals recorded on the two walls of a 45-45 record groove. It is impossible to entirely eliminate crosstalk between the two channels, but it is possible to minimize it. With modulated carrier systems, crosstalk causes beats between channels on playback and distortion of the sound because of leakage. To minimize this, the frequency and phase of the left and right-channel carriers must be the same and to prevent distortion due to leakage, the modulation index should be no greater than 1.9. The choice of the modulation index is, however, a compromise. Fig. 3 shows the frequency spectrum of several modulated signals

for various values of the modulation index ( $m$ ). For signals in the middle and low frequency ranges, the spectrum is mostly within the range  $30 \pm 1\text{kHz}$ . As the frequency increases above 1kHz, the spectrum becomes wider. To ensure that 95% of the energy falls within the frequency limits shown in Fig. 3, it is necessary that the value of  $m$  be greater than 1.9 at frequencies lower than 500Hz.

Distortion due to signal leakage depends on the amount of crosstalk and the modulation index. The larger the index and crosstalk, the greater the distortion and, if the signal leakage is the same in both directions, the crosstalk signal leaking from channel A to channel B will be identical in size and spectrum to the signal leaking from channel B to channel A. Distortion becomes significant at frequencies below 500Hz where the modulation index is greater than 1.9. Crosstalk distortion peaks at around 700Hz, as shown in Fig. 4.

A frequency-dependent compression-expansion system reduces interference caused by noise and crosstalk. As distortion caused by crosstalk peaks at about 700Hz, while noise from the f.m. signal starts rising at about 2kHz, the noise reduction system is designed to operate over two frequency bands. In addition, the difference signal is phase modulated over a proportion of its frequency band to minimize noise.

The noise reduction system consists of a compressor in the recording system and a complementary expander in the playback system. To function effectively, it must automatically emphasize low-level signals at about 700Hz and over 2kHz in the recording mode and de-emphasize them by exactly the same amount in the playback mode. Figs 5 and 6 show the compression-expansion level and the frequency versus input level characteristics. The curves are generated by a compressor based on a two-band scheme, with a band-pass filter having 3dB corner frequencies at 200Hz and 2kHz, and a high-pass filter with a 3dB corner frequency at 2kHz.

Response time of the compressor is chosen to make the noise improvement

Fig. 1. Signal processing for CD-4 half-speed disc cutting.

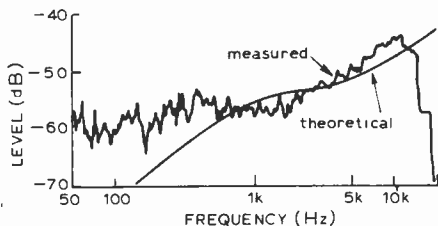
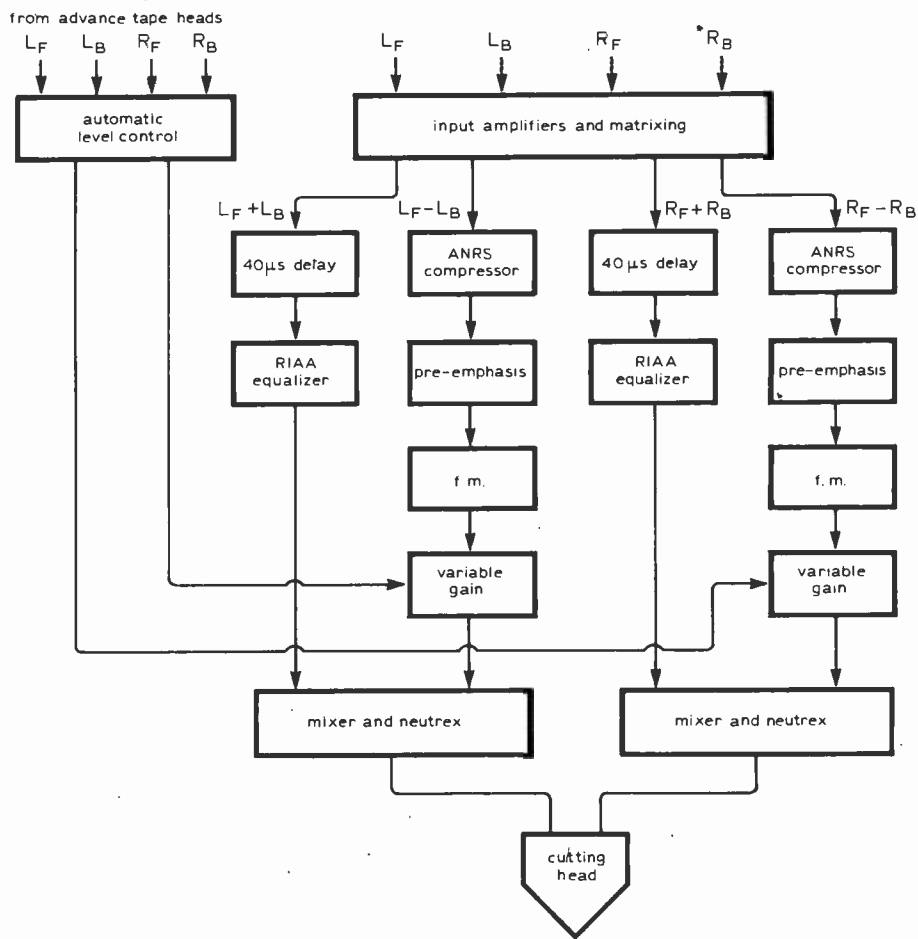


Fig. 2. Noise spectra of carrier channel for modulation scheme used.

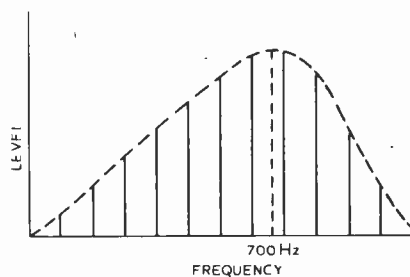


Fig. 4. Spectrum of crosstalk between carrier channels showing peak at around 700Hz.

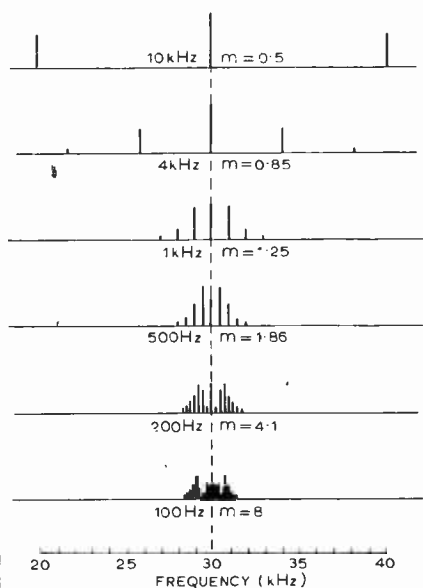


Fig. 3. Modulation spectra for different values of modulation index.

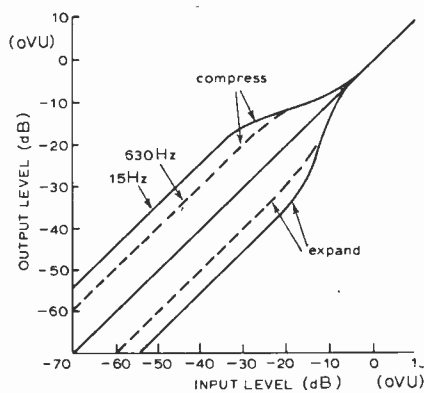


Fig. 5. Input-output characteristic of two-band compander.

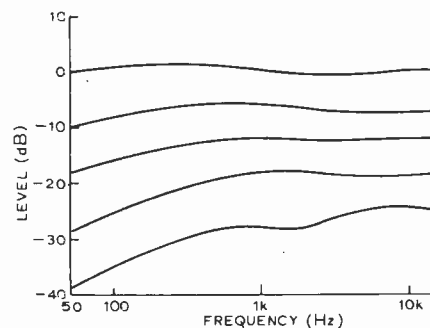
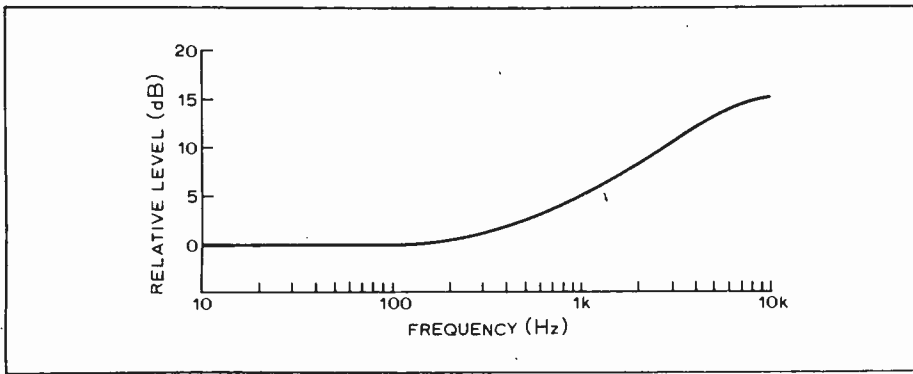


Fig. 6. Frequency-input level characteristic of two-band compressor.



arrangement as inaudible as possible during the automatic gain adjustments. At 630Hz, the rise time is specified at  $5\mu s$  when the level is increased in a jump from  $-30$  to  $-10$ dB and the restoration time is  $100\mu s$  for the reverse transition. Above 2kHz, the rise time is decreased to  $0.7\mu s$  for a step level change from  $-40$  to  $-10$ dB and restoration time is  $10\mu s$ .

Carrier deviation caused by the noise at a particular modulating frequency is directly proportional to that frequency. Consider a signal pre-emphasized with the characteristic of Fig. 7 and then used to angle modulate a carrier. The pre-emphasized signal is kept flat until 800Hz, boosted by 6dB per octave between 800Hz and 6kHz and flattened out thereafter. The total pre-emphasis operates over a range of a little less than three octaves, giving a total boost of 17.5dB.

When this pre-emphasized signal is used to angle modulate the carrier, the carrier is frequency modulated up to 800Hz. Frequency modulation is again resumed from 6kHz upwards. Between 800Hz and 6kHz, frequency modulation is carried out with a linear frequency boost - i.e. phase modulation. In a frequency modulated scheme, phase deviation decreases inversely with modulating frequencies. The same

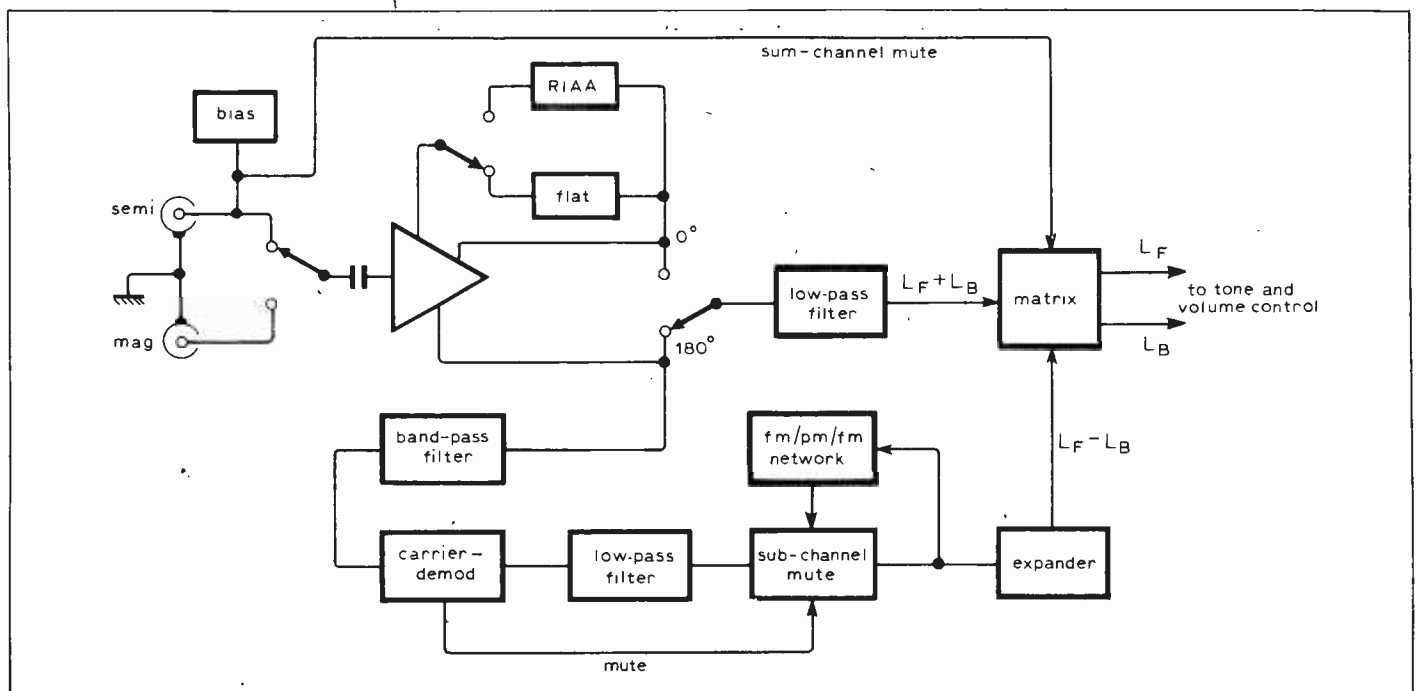
Fig. 7. Static pre-emphasis scheme giving a combination of frequency and phase modulation.

amplitude signal at 2kHz will phase deviate the carrier half as far as a 1kHz signal. If the pre-emphasis counteracts this decrease by a corresponding rise in its amplitude, the phase deviation will be independent of frequency and will only depend on the modulating amplitude. Phase modulation gives excellent signal-to-noise performance at the higher frequencies since any increase in phase deviation is not accompanied by increase in noise.

The difference signal now modulates the carrier, chosen to be 19dB lower than the sum signal reference level to minimize interference between the frequency bands and to ensure cartridge pick-up trackability on replay.

If the high frequency end of the sum signal is large, mistracking of the pickup results, reducing the detected carrier level and raising the susceptibility to interference and noise. To compensate for this, an automatic level

Fig. 8. Block diagram of one channel of CD-4 decoder.



control changes the carrier level accordingly, operating from advance heads on the master tape recorder.

The base-band signal and the carrier signal are then added together in the mixer. At this stage, the shapes of the resultant waveform are pre-distorted to compensate for the distortion resulting from the tracing of the base band interfering with the tracing of the carrier, which would otherwise degrade the sound quality and channel separation (Neutrex).

Incidentally, because of the restricted frequency range of disc cutting equipment, the composite signal is formed at half frequency to allow half-speed disc cutting.

**Circuit description**

The demodulator is designed around an integrated circuit, QSI5022. Designed by Quadracast Systems Inc and manufactured by Signetics, it was chosen as it houses all the required functions, including preamplifier. Fig. 8 gives a block diagram of the workings of a complete side of one demodulator. The signal entering via the cartridge is fed to a pre-amplifier and is either RIAA compensated (for a magnetic cartridge) or is amplified at a constant level over the whole frequency range (for a semi-conductor cartridge). In addition, provision is made to use the pre-amp as a buffer/amplifier to accept tuner, tape and auxiliary inputs. The base-band signal is filtered (low pass) and passed to the output matrix. The carrier signal is fed to a bandpass filter and demodulated. The 30kHz carrier is filtered out of the demodulated signal and the resultant signal de-emphasized and then expanded to compensate for the compression which took place during cutting. This difference signal is now added and subtracted from the sum signal in the matrix to produce the resultant back and front signals.

**Preamplifier.** The preamplifier, shown within the i.c. in Fig. 10, has antiphase outputs (pins 23 & 24). Its d.c. bias is determined by feedback from the non-inverting output, through  $R_4$  and  $R_5$ , back to the preamplifier input at pin 25. The ratio of  $R_4$  and  $R_5$  is chosen to ensure that both of the output voltages sit at about 6 volts for a 13-volt supply rail. Components  $R_7$ ,  $R_9$ ,  $C_3$  and  $C_4$  determine the RIAA playback characteristic. The demodulated carrier signal is constant for any cartridge as it is a function of carrier deviation and not carrier amplitude. The baseband signal level will, however, vary from cartridge to cartridge. To add and subtract the baseband and demodulated carrier signals correctly, a variable gain is therefore necessary to adjust the gain of the baseband signal, and potentiometer  $R_9$  allows the gain to be changed. Values chosen for  $R_9$  and  $R_{10}$  allow the preamplifier to accommodate inputs from 0.7mV r.m.s to about 15mV r.m.s.

A magnetic cartridge can be a.c.-coupled to the input of the pre-amplifier by a capacitor but a semiconductor cartridge requires bias current. The Technics 450C or 451C cartridge requires 4mA bias current, and  $R_{41}$  and  $R_{141}$  supply this current while  $C_{38}$  filters out any hum. Components  $C_{33}$  and  $R_{40}$  form a network to maintain the proper direct voltage across the input capacitor, and  $R_2$  matches the cartridge to the amplifier.

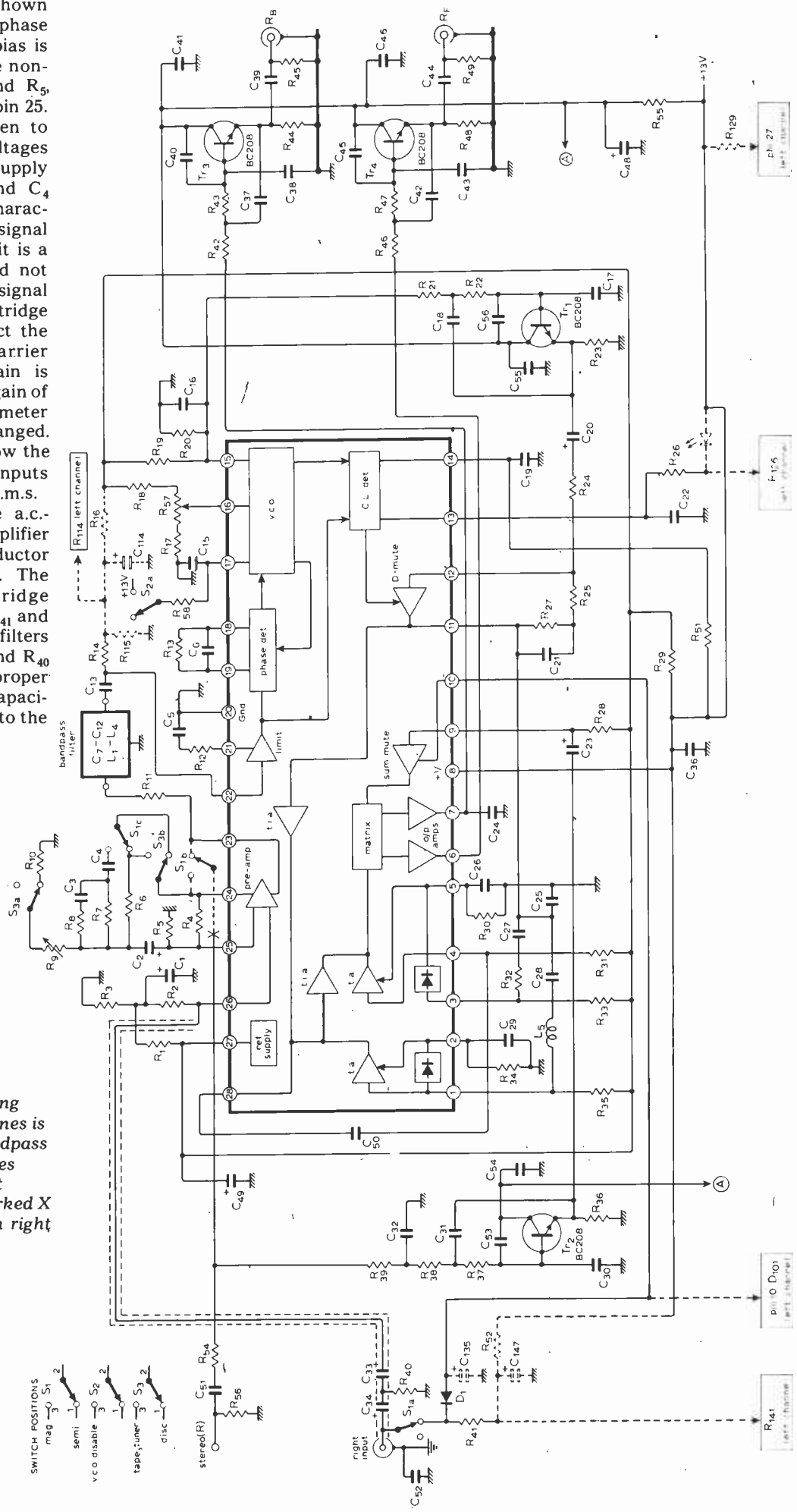


Fig. 9. Right-channel circuitry using QSI i.c. Circuit shown in broken lines is included in one channel only. Bandpass filter circuit, and component values will be given in part 2. Earth input socket at power supply. Point marked X is connected directly to pin 24 in right channel.

SWITCH POSITIONS  
mag S1 2  
semi S2 2  
vco disable S3 2  
tape tuner S3 2  
disc S3 2

The non-inverting output is from a class A stage designed to drive the 15kHz low-pass filter, while the inverting output is a class B output stage, designed to drive the 15kHz low-pass filter and the 30kHz band-pass filter. The band-pass filter is matched by  $R_{11}$ . On the left side only, the non-inverting output is used for magnetic cartridge playback. The inverting pin is used for semiconductor cartridge playback. This is required because the left channel of a semiconductor cartridge needs phase inversion to be in proper phase relative to the right channel.

In addition, the preamplifier is used as a buffer amplifier for tape, tuner and auxiliary inputs. In this mode a flat feedback characteristic is applied by switching  $S_{3a}$  and  $S_{3b}$  to its open-circuit position, making  $R_9$  and  $R_{109}$  gain controls ineffective, and by closing switches  $S_{3c}$  and  $S_{3d}$  thus applying a flat feedback characteristic to the preamplifier. A voltage gain of two occurs in this mode. Output is taken from the non-inverting output at pin 24 via  $R_{54}$  and  $C_{61}$ .

**Limiter.** The limiter's function is to provide a constant amplitude carrier to the demodulator and reduce the spike noise and amplitude modulation on the carrier. Components  $R_{15}$ ,  $R_{16}$  and  $C_{14}$  determine the d.c. bias of the limiter;  $R_{14}$  is a matching load for the band-pass filter, coupled via  $C_{13}$  and the bias feed. To reduce sum signal interference,  $C_{13}$  is chosen to allow maximum gain for the carrier signal but minimum gain for the sum signal. Components  $C_5$  and  $R_{12}$  determine the overall gain of the limiter. The value of 20 ohms chosen gives a gain of approximately 50dB for this stage.

**Phase-locked loop demodulator.** Pins 18 and 19 of the phase detector and pins 15, 16 and 17 of the voltage controlled oscillator form the phase-locked loop circuit used for demodulation of the difference signal. The carrier signal from the limiter is fed into the phase detector along with the v.c.o. signal, and the product of these two signals appears at the filter terminals, pins 18 and 19. The filter performs three functions:

- it maintains a large d.c. tracking range for turntable speed variations
- it controls the a.c. tracking range for optimum audio pass band
- it reduces carrier feed through to the v.c.o., thus increasing interference rejection.

Resistor  $R_{13}$  determines the a.c. tracking range and, together with  $C_6$ , forms a 15kHz low-pass filter for carrier rejection. Varying the carrier input level to the phase detector or altering the value of  $R_{13}$  and  $C_6$  varies audio passband response. Capacitor  $C_{15}$  is the v.c.o. timing capacitor, the value of which changes v.c.o. sensitivity or the audio

output level. The only alignment required for the system is the v.c.o. adjustment. This can be done by adjusting the v.c.o. free-running frequency to 30kHz with pin 22 a.c.-shorted to ground.

**Carrier level detector.** With proper carrier level output of the limiter and the phase-locked loop locked to the carrier, the carrier level detector will unmute the difference sub-channel. Attack and release time is controlled by  $C_{19}$  of the mute. It is advisable in practice to connect pin 14 to the supply rail by a resistor  $R_{51}$ . This is not always required and depends on the batch of i.c.s produced. Using a value of 560k $\Omega$ , the detector should unmute automatically if a 30kHz carrier is present. The four-channel indicator drive is designed to drive an i.e.d. at a maximum of 25mA. Series resistors  $R_{26}$  and  $R_{126}$  minimize power dissipation in the i.c. The limiter gain and the preamplifier gain chosen allow the carrier level detector to unmute when the carrier input level is approximately 50 $\mu$ V.

**Difference sub-channel mute.** This consists of a gated amplifier with the gate control for the difference sub-channel mute coming from the carrier level detector. The amplifier serves the additional purpose of level matching between the phase-locked loop demodulator, the expander and de-emphasis. Components  $C_{21}$ ,  $R_{25}$  and  $R_{27}$  determine the correction required for de-emphasis. Audio to the mute input arrives from the 15kHz low-pass active filter via filter matching resistor  $R_{24}$  and  $C_{20}$ .

**Expander.** The expander consists of two a.c.-d.c. converters, two transducer inversion amplifiers (t.i.a.) and two gain control transconductance amplifiers (t.a.). One of each is used in the mid-band expander and the high-band expander. The system operates over two bands and expands according to the characteristics given in Fig. 5. Values of the external components are chosen for complementing the compressor curves. Parts used here are  $C_{27}$  for the high band with  $L_5$  and  $C_{28}$  for the mid-range. The expander characteristics obtained are within  $\pm 3$ dB of the standard values stipulated by JVC.

**Sum signal mute.** Pin 24 of the preamplifier feeds the sum signal into a low-pass filter. This filter has exactly the same amplitude and phase characteristics as the low-pass filter placed in the difference signal channel. A sum channel mute (pins 9 and 10) is incorporated in the i.c. to facilitate the use of semiconductor cartridges. These cartridges when used with automatic turntables are likely to give a large spike into the preamplifier, when lifting off the record. The mute circuit detects this spike before it passes through the sum channel and turns the sum signal off.

When the cathode of  $D_1$  or  $D_{101}$  is earthed,  $C_{35}$  discharges to 0.75 volts, thus muting the sum signal. The difference signal will already be muted by the loss of the carrier. When the cathode potential of  $D_1$  or  $D_{101}$  is lifted,  $C_{35}$  is charged by approximately 100 $\mu$ A. When  $C_{35}$  is at about 1.4 volts, the sum channels unmute and the signals pass normally. The value of  $C_{35}$  is chosen for a delay long enough to allow the preamplifier to stabilize again.

**Matrix amplifier.** The matrix amplifiers recombine the difference signal and the sum signal to form the original front and back signals of a four-channel system. Output level is approximately 300mV r.m.s. for a 0dB (150mV) output from the preamplifier. Amplifier outputs at pins 6 and 7 are then fed into a second pole of a low-pass filter.

**Reference supply.** Pin 27 is a reference supply output from the i.c. This gives a voltage of around 5.8V which is used throughout the i.c. for reference and power purposes. The supply is filtered by  $C_{49}$ . Resistors  $R_1$ ,  $R_{29}$ ,  $R_{31}$ ,  $R_{33}$  and  $R_{35}$  supply the appropriate circuits.

**Filter requirements.** The demodulator requires three filters for each i.c. There are two low-pass filters and a band-pass filter. It is essential that the low-pass filters should have a linear-phase response, i.e. a constant delay, and a flat amplitude characteristic to 15kHz. The two low-pass filters should be identical in all respects. The five-pole Butterworth active filter shown in part 2 is used but is split up so that the latter poles appear at the output of the demodulator, thus saving duplication. When a CD-4 disc is cut, the sum signal is delayed with respect to the difference signal. On playback, the difference signal is delayed with respect to the sum signal as it passes through the cartridge system. There are additional delays through the difference channel of the demodulator. In particular, the band-pass filter is designed to have an almost constant delay over its pass band so that the delays during the encoding/decoding process in both the sum channel and the difference channel cancel. The delay of the band-pass filter system shown in the second article is 32 $\mu$ s for signals between 18 and 45kHz.

*Part 2 will give constructional details and performance using various pickup cartridges. A kit of parts for this and other decoder designs to be described subsequently is available from Compcor Electronics Ltd, 9 Dell Way, London W13 8JH. (See advertisement).*



# Antiphase or 180° phase shift?

## A clarification

by S. W. Amos, B.Sc., M.I.E.E.

The 180° phase difference between the signals at the base and the collector of a common-emitter amplifier is well known. Indeed many of us have been aware of it for as long as we can remember; originally, of course, we knew it as the 180° phase difference between the signal voltages at the grid and anode of a valve, but the principle is the same. It is not surprising therefore that an engineer once designed a piece of electronic equipment in which the fundamental mode of operation depended on this phase difference. The equipment did not work and at the ensuing post mortem it was discovered that a common-emitter amplifier does not introduce 180° phase shift: instead it inverts the input signal and this is a fundamentally-different process.

Fig. 1 illustrates the difference. The waveform chosen for this illustration is a sine wave together with some second harmonic. The effect of adding the harmonic is to exaggerate the peak of one half cycle of the sine wave and to flatten the peak of the other so that it is possible to distinguish one half cycle from the other. Fig. 1 shows the effect of phase shifting this signal by 180° and of inverting it. The two results are quite dissimilar waveforms showing that the two processes are fundamentally differ-

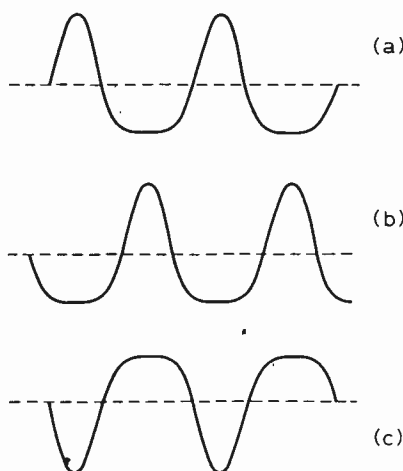


Fig. 1. The effect on an asymmetrical waveform (a), of phase-shifting it by 180° (b), and inverting it (c). Note that (b) and (c) are different.

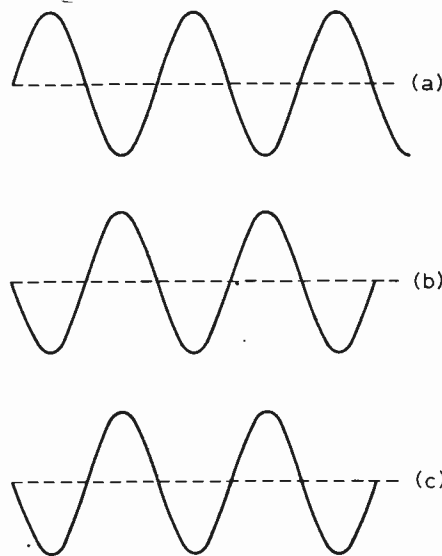


Fig. 2. The effect on a symmetrical waveform (a), of phase-shifting it by 180° (b), and inverting it (c). Note that (b) and (c) are the same.

ent. To facilitate comparison of the waveforms any increase in amplitude due to amplification has been ignored in this diagram and all the waveforms are shown with equal amplitudes. What has caused the confusion between 180° phase shifting and inversion is that, for a waveform which is symmetrical about the time axis, the effects give identical results; this is illustrated in Fig. 2 for a sine wave.

It is surprising that the myth of the 180° phase shift introduced by a transistor or valve should ever have gained credence. The only way of introducing phase shift is by the use of combinations of reactance and resistance e.g. capacitance and resistance or inductance and resistance. An ideal transistor or valve certainly contains resistance but it has no capacitance or inductance and cannot possibly therefore introduce any phase shift. All it can do is to invert the input signal and this has nothing to do with phase shift. In fact the term "antiphase" is a little unfortunate because it suggests that the process of inverting a signal has some

connection with phase. "Signal inversion" might be a better phrase than "antiphase".

To summarise then, for a wave symmetrical about the time axis the effects of 180° phase shift and of signal inversion are indistinguishable; for an asymmetric wave the two processes give quite different results.

These considerations are of importance in the design of an oscillator which can be regarded in general as a combination of a maintaining amplifier and a frequency-determining network as shown in Fig. 3. The requirements to be satisfied for oscillation to occur are:

- (a) that at the frequency of oscillation the frequency-determining network must introduce signal inversion which, with the inversion in the maintaining amplifier, gives the overall positive feedback which is essential for oscillation and
- (b) that the gain of the maintaining amplifier must exceed any attenuation in the frequency-determining network at the frequency of oscillation.

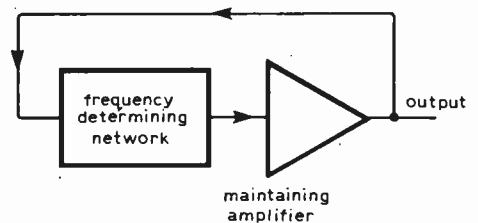


Fig. 3. A fundamental block diagram for an oscillator.

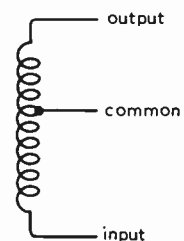


Fig. 4. A simple method of obtaining signal inversion using a tapped inductor.

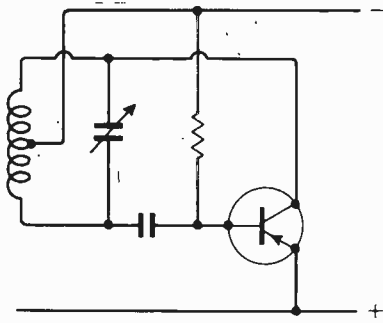


Fig. 5. A Hartley oscillator.

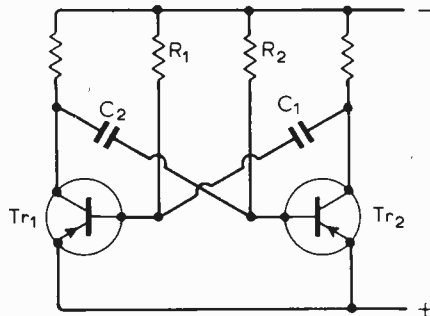


Fig. 6. An astable multivibrator circuit drawn in the conventional manner.

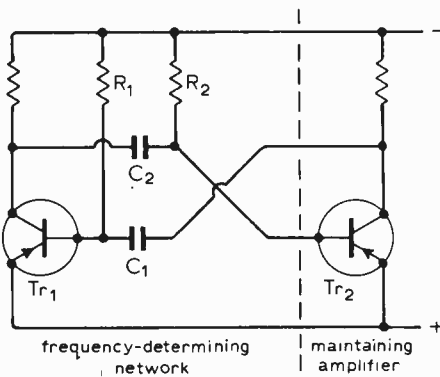


Fig. 7. The circuit of Fig. 6 re-arranged to show that it agrees with the basic form of the oscillator (Fig. 3).

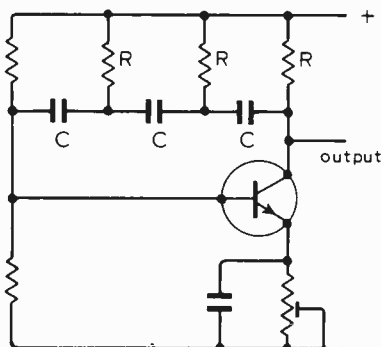


Fig. 8. An oscillator which relies on phase shift in the R-C filter for its operation.

The frequency-determining network must then give signal inversion at the oscillation frequency. One simple way of achieving signal inversion is by the use of a tapped inductor as shown in Fig. 4 and this can be tuned by a parallel-connected capacitor to give operation at a particular wanted frequency. By adding a common-emitter circuit as maintaining amplifier we obtain the familiar circuit of the Hartley oscillator shown in Fig. 5. In a similar way, by tapping the capacitive branch of a resonant circuit to obtain signal inversion, the Colpitts' oscillator circuit can be derived.

Any type of frequency-determining network can be used, and oscillation will result, provided the two conditions set out above are fulfilled. Thus a common-emitter amplifier can be used as a frequency-determining network. It introduces the necessary signal inversion but there is no attenuation. Instead there is usually considerable voltage and current gain at the frequency of operation and this, together with the gain of the maintaining amplifier, means that there is an excess of positive feedback — far more than is necessary just to sustain oscillation. As a result the oscillation amplitude grows rapidly until it is limited on one extreme by collector-current cut off and on the other extreme by the collector voltage falling to base potential and so applying a low-resistance shunt across the circuit. In other words this particular oscillator generates rectangular waves; it is, of course, a multivibrator and because of the symmetry of the circuit either transistor can be regarded as the maintaining amplifier or frequency determining network. The circuit diagram is shown in its familiar form in Fig. 6 but if it is recast as in Fig. 7 it is easier to visualise the circuit as a combination of maintaining amplifier and frequency-determining network. The components  $R_1C_1$  and  $R_2C_2$  are chiefly responsible for determining the free-running frequency which is given approximately by

$$f = \frac{1}{0.7(R_1C_1 + R_2C_2)}$$

So far in this discussion on oscillators it has not been necessary to mention the word "phase" but there is a type of oscillator in which the frequency-determining network operates by introducing phase shift. This is a workable solution if a symmetrical signal is being generated because, as shown in Fig. 2, for such signals the effect of 180° phase shift and signal inversion are indistinguishable. Thus in one form of phase-shift oscillator the frequency-determining network consists of a three-stage RC filter each section of which introduces 60° phase shift at the required frequency of oscillation. The circuit diagram is given in Fig. 8. If all three frequency-determining resistors have the same value R and all three fre-

quency-determining capacitors have the same value C, the oscillation frequency is given by

$$f = \frac{1}{2\pi\sqrt{6RC}}$$

and the current attenuation at this frequency is 29. The current gain of the transistor must hence exceed 29 for oscillation to occur but it should not greatly exceed this value, otherwise the oscillation amplitude will grow as in the multivibrator circuit and, if it is limited by circuit features such as collector-current cut off, the output will no longer be sinusoidal. As shown in Fig. 8 a preset resistor in the emitter circuit can be used to adjust the current gain to the critical value which gives a sine-wave output, but a system of a.g.c. which keeps the maintaining transistor operating in class A is perhaps the best method of securing a pure output waveform.

## Sixty Years Ago

The tremendous transmission distances nonchalantly achieved by Marconi operators and the commonplace use of wireless in military form might tend to obscure the fact that communication was still, in 1916, chiefly telegraphic, using spark-gap oscillation generators. A review article in June 1916 covered the field of such generators and was one of the earliest articles to fully explain the valve oscillator, to be used for the transmission of speech.

"In 1884 Edison showed that an incandescent filament of carbon (such as a lamp filament) possesses the property of ionising the surrounding air, so that it becomes a unilateral conductor.

"This property has been turned to practical utility by Dr Fleming and others, and forms the basis of the well-known Fleming oscillation valves which are now often used as wireless detectors. Some of these valves have characteristics (ie volt-ampere curves) which at some point are negative, like an arc characteristic, and hence it is possible to use such valves as generators of oscillations just as the arc can be so used.

"The mode of operation of this type of apparatus may be briefly summarised as follows: The hot filament has the property of emitting negative electrons, and hence the combination of hot filament and cold plate in an exhausted vessel forms an electrical conductor, which will allow current to flow in one direction only — that is to say, it is a unilateral conductor, and therefore will exert a rectifying action on an alternating P.D. applied to it. Since the current passing through this vacuous space is carried by a stream of moving electrons, and since an electron is merely a negative electric charge, it is evident that the motion of the electrons can be influenced either by an electro-static or by a magnetic field, ..."

 SHURE®

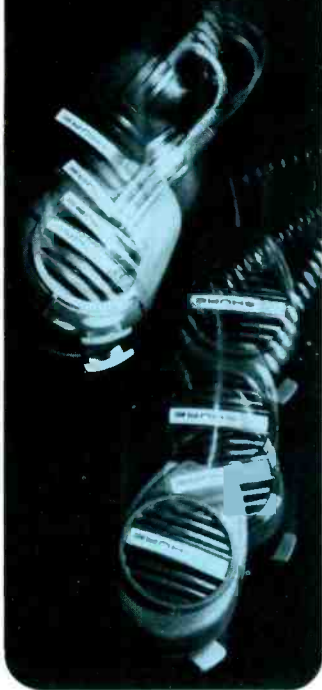
# COMMUNICATIONS MICROPHONES

the vital link  
when the message  
must go through.



SHURE

DROPS  
'EM



Shure Safety Communications Microphones are routinely subjected to 2-metre (6 ft.) test drops onto hard floors ... over and over and over again, and even though they've been manhandled and abused

...THEY  
WORK

SHURE

SHAKES  
'EM



Shure Safety Communications Microphones are tested with violent vibrations up-and-down, side-to-side, and back-and-forth *simultaneously* ... and even though we tumble 'em around for a while for good measure

...THEY  
WORK!

SHURE

FRIES  
'EM



Shure Safety Communications Microphones are tested for level and response at a searing 70° C ... often up to an incredible 85° C for day-long periods ... and even though the inside parts are too hot to touch

...THEY  
WORK

SHURE

FREEZES  
'EM



Shure Safety Communications Microphones are plunged to an appalling -45.6° C for half hour periods during severe temperature tests, and even though they're covered with frost

...THEY  
WORK

SHURE COMMUNICATIONS  
MICROPHONES:

THE  
STANDARD  
OF THE  
WORLD

A definite margin of extra reliability is the reason why, in the United States as well as in many other countries, Shure Mobile Communications Microphones are used with more public safety and professional business communications transceivers than all other brands combined. They are thoroughly field-proved. They perform when the chips are down, as they have been doing for over 20 years. Even after years of constant use and abuse in the most critical situations, often under the most adverse conditions imaginable, *they deliver* ... they get intelligible messages through when it counts.

**SHURE**

**STEAMS  
'EM**



Shure Safety Communications Microphones are tested in super steam baths with humidities of 100% at room temperature, 93% at 38° C and, though they're soaking wet at the end

**...THEY  
WORK**

**SHURE**

**DRAGS  
'EM**



Imagine! Shure Safety Communications Microphones are dragged behind swiftly moving vehicles for miles ... over all sorts of roads, and though scratched-up on the surface

**...THEY  
WORK**

**SHURE**

SUBJECTS THEM TO ...

**SAND  
RAIN  
INFRA-RED  
ULTRA-VIOLET  
ACIDS  
ALCOHOL  
SALT-SPRAY  
WIND  
ELECTROSTATIC  
FIELDS  
HIGH  
ALTITUDE**

Shure Safety Communications Microphones are carefully quality control checked at every step in manufacture—and random samples from every production run are subjected to the kind of torture testing and abuse that ruins most microphones ...

**AND...**

**THEY  
WORK**



**SHURE**

**COMMUNICATIONS  
MICROPHONES**

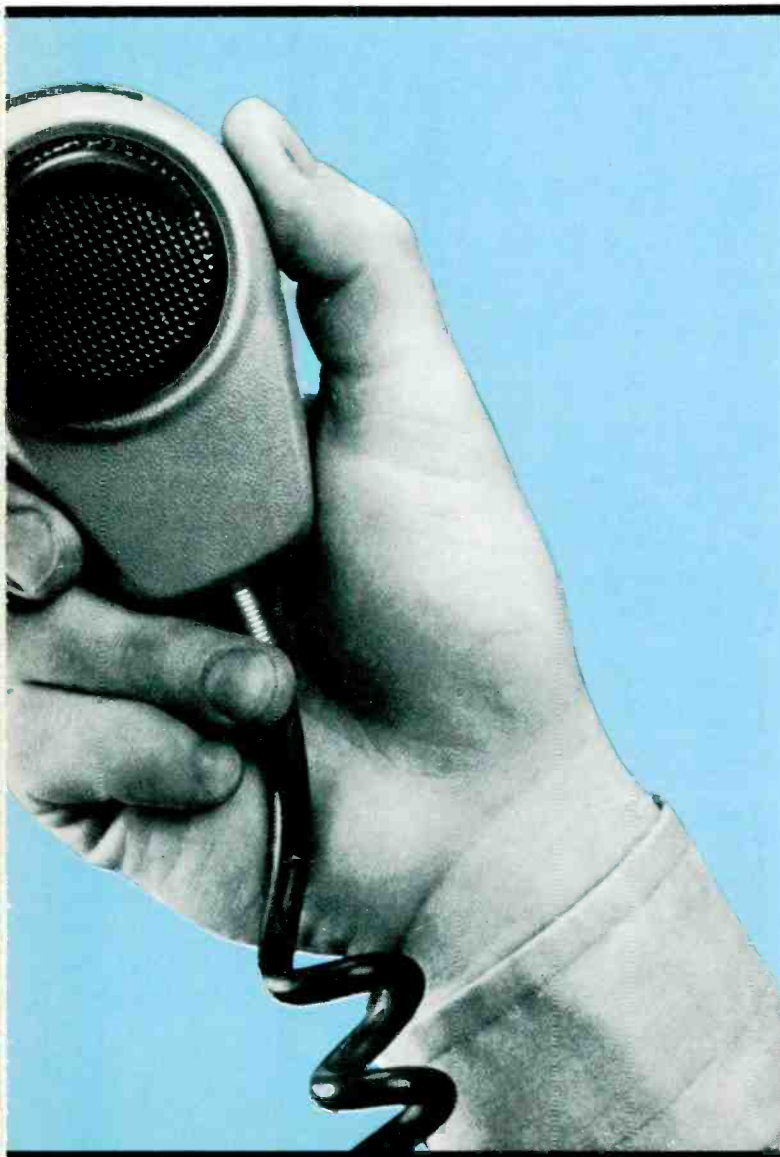
Look for the name *Shure* moulded into the back of the case of every microphone you buy. It identifies the microphones that have undergone the most rigid and demanding tests in the industry. And, it's your peace-of-mind assurance of reliability, know-how, quality, quality control, and conscientious fast service!

**QUALITY CONTROLLED EVERY STEP OF THE WAY**

Mechanically, environmentally, electrically, operationally, acoustically, and visually—Shure Mobile Communications Microphones go through the most comprehensive and extensive quality control procedures. And that's your assurance of getting microphones that have not been simply spot-checked, but thoroughly inspected at every stage in manufacture, from raw materials to finished product.

**OUR CASE HISTORY...**

Shure Mobile Communications Microphones feature an exclusive, virtually indestructible Armo-Dur® plastic case, which remains comfortable to the touch even if the microphone sits in the hot sun or in freezing temperatures, and is completely corrosion resistant and immune to oil, grease, salt spray, fumes, humidity, and perspiration. Shure's long-life cables and "million-cycle" switches are specially engineered and tested to outlast, by far, these most common failure points of ordinary mobile microphones. They also feature modular construction for easy in-the-field maintenance on those rare occasions when service is required.



## THE NEWEST BASE STATION MICROPHONE WITH POWER AND INTELLIGIBILITY!

### Strong, Clear Transmission

The new Shure 526T Super Punch Base Station Microphone features a high-articulation dynamic element and a transistorized preamplifier that operates for hundreds of hours on a standard 9-volt battery. The variable output level control allows you to maximize transmitter modulation for increased "talk power," regardless of your speaking distance from the microphone.

### Improved Intelligibility

The high quality dynamic transducer guarantees clear voice signals with a response that is optimized for maximum intelligibility with AM and sideband transceivers—even with a high background noise level. And the 526T is immune to hum pickup and radio-frequency interference.

### All These Extras, Too!

- Includes a two-way NORMAL/VOX switch
- Push-to-talk switch—locks-in for lengthy transmissions
- Electronic or Relay switching
- High-impact Armo-Dur™ case to withstand the roughest use

## SPECIFICATIONS

### Model 526T Transistorized Base Station Microphone

**Type:** Dynamic (with battery powered transistor preamplifier)

**Frequency Response:** 200 to 6,000 Hz, optimized for maximum vocal "punch" and intelligibility with AM and sideband units (See Figure C)

**Polar Pattern:** Omnidirectional

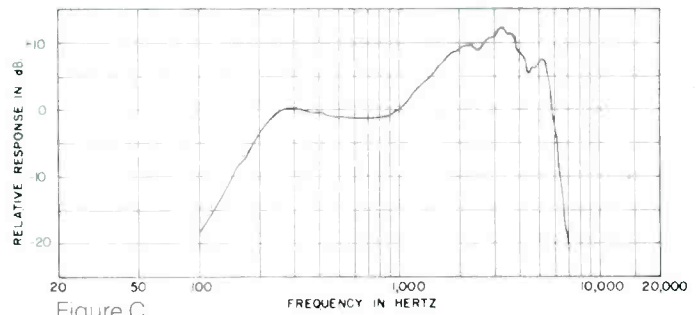
**Output Impedance:** 5,000 ohms

**Load Impedance:** 1,000 ohms minimum

**Output Level:** Adjustable from 0.63 to 14 mV for 1 microbar input

**Battery Type:** 9 Vdc

**Battery Drain:** 0.9 mA



**Switches:** Single-bar, locking or non-locking, push-to-talk switch. NORMAL/VOX, single-pole, double-throw slide switch

**Cable:** Non-detachable, 2.1 m (7 ft.), three-conductor (one conductor shielded), plastic-jacketed cable

**Case:** Black high-impact Armo-Dur™

**Dimensions:** 264 mm x 108 mm x 149 mm deep (10<sup>3</sup>/<sub>8</sub> in. x 4<sup>1</sup>/<sub>4</sub> in. x 5<sup>7</sup>/<sub>8</sub> in.)



## Model 524C

# Ranger 2

### THE MICROPHONE ON THE MOVE...

The new Shure Ranger 2 Microphone serves double-duty: It combines the quality transmission of a dynamic-element microphone with the Shure reputation for rugged dependability in mobile and fixed-station microphones.

**Internally**, a silicon transistor amplifier provides a direct replacement for a carbon microphone with reduced sensitivity to hum pickup and susceptibility to interference. The Ranger 2's wide 300 to 5,000 Hz frequency response range and low distortion are specially tailored for unusually smooth, natural voice signals.

**Externally**, there's the famous Armo-Dur® case that's lighter and stronger than die-cast metal (and comfortable to hold at any temperature). The coil cord is jacketed with long-life neoprene. Constant use and rough handling won't affect the "million-cycle" leaf-type switch—it's engineered to withstand the severest conditions. All this in a compact size for easy handling.

**Together**, the superior performance and heavy-duty construction offer you the clearest choice in communications microphones today!

## SPECIFICATIONS

### Model 524C Transistorized Dynamic Hand-Held Microphone

**Type:** Dynamic (with transistor preamplifier for carbon microphone circuits)

**Frequency Response:** 300 to 5,000 Hz (See Figure A)

**Output Level** (at 1,000 Hz, 5/16 in.): -44 dB (6.32 mV) with 10 Vdc, 500-ohm load (0 dB = 1 volt per microbar)

**Load Impedance Range:** 250 to 2,200 ohms

**Maximum Signal** (with 10 Vdc, 500-ohm load): 118 dB SPL at 1,000 Hz produces 0 dBV (1.0V) at 10% THD

**DC Supply Voltage Range:** 2.5 to 35 Vdc

**Switch:** Double-pole, single-throw, leaf-type, push-to-talk

**Cable:** Non-detachable, 1.5 m (5 ft.), four-conductor, neoprene-jacketed coil cord

**Case:** High-impact Armo-Dur®

**Dimensions:** 52.4 mm x 72.2 mm x 39.7 mm deep (2-1/16 in. x 2-27/32 in. x 1-9/16 in.)

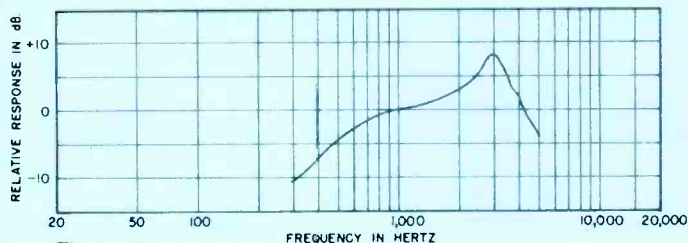


Figure A

## Series 577

# Sonobar

### Microphones: Break the Sound Barrier!

Be heard, even when ambient noise levels are so high you can hardly hear yourself. The 577 Sonobar Noise-Cancelling Dynamic Microphones dramatically block unwanted noise and boost close-up voice signals. The 577s' noise-cancelling pickup pattern and "tailored" voice-range frequency response can discriminate against environmental noise so that the transmission sounds loud and clear—even in noisy factories, disaster areas, or airport ramp areas.

The 577 Series features three models: the 577A for high-impedance inputs... the 577B for longer cable lengths (low impedance)... and the 577C transistorized carbon replacement model.

All have the tough Armo-Dur® cases to repel oil, grease, fumes, salt spray, humidity, and rust! A "lifetime" hang-up button and mounting bracket, Triple-Flex coiled cable, and shock-resistant construction features are all part of the 577s' built-in durability.

## SPECIFICATIONS

### 577 Series Noise-Cancelling Dynamic Microphones

**Type:** Dynamic, Noise-Cancelling

**Frequency Response:** 100 to 5,000 Hz (See Figure B)

**Impedance:** Model 577A: High impedance for connection to high-impedance inputs

Model 577B: Low impedance for connection to microphone inputs rated at 25 to 200 ohms

Model 577C: Transistorized for carbon microphone type circuits: Load Impedance Range: 250 to 2,200 ohms

### Output Level

(at 1,000 Hz, 5/16 in.):

### Open Circuit Voltage

**Model 577A**      **Model 577B**      **Model 577C\***  
-63.5 dB (.63 mV)   -84 dB (.062 mV)   -47 dB (4.5 mV)  
(0 dB = 1 volt per microbar)

\*With 10 Vdc, 500-ohm load

**Power Level:** -61.5 dB (Model 577B)

(0 dB = 1 milliwatt with 10 microbars)

**DC Supply Voltage Range** (Model 577C): 2.5 to 35 Vdc

**Hum Sensitivity:** (Equivalent to)

Model 577A: 44 dB SPL in 1 millioersted field

Model 577B: 32 dB SPL in 1 millioersted field

Model 577C: 27 dB SPL in 1 millioersted field

**Switch:** Double-pole, single-throw, leaf-type, push-to-talk

**Cable:** Non-detachable, 1.8 m (6 ft.), neoprene-jacketed Triple Flex coil cord

Model 577A: Three-conductor (one conductor shielded)

Model 577B: Four-conductor (two conductors shielded)

Model 577C: Four-conductor (non-shielded)

**Case:** Two-tone Grey, high-impact Armo-Dur®

**Dimensions:** 66.7 mm x 93.6 mm x 44.9 mm deep (2-5/8 in. x 3-11/16 in. x 1-25/32 in.)

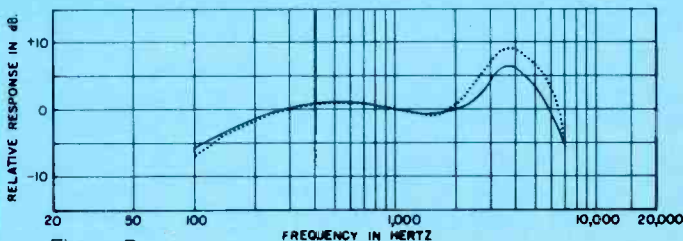
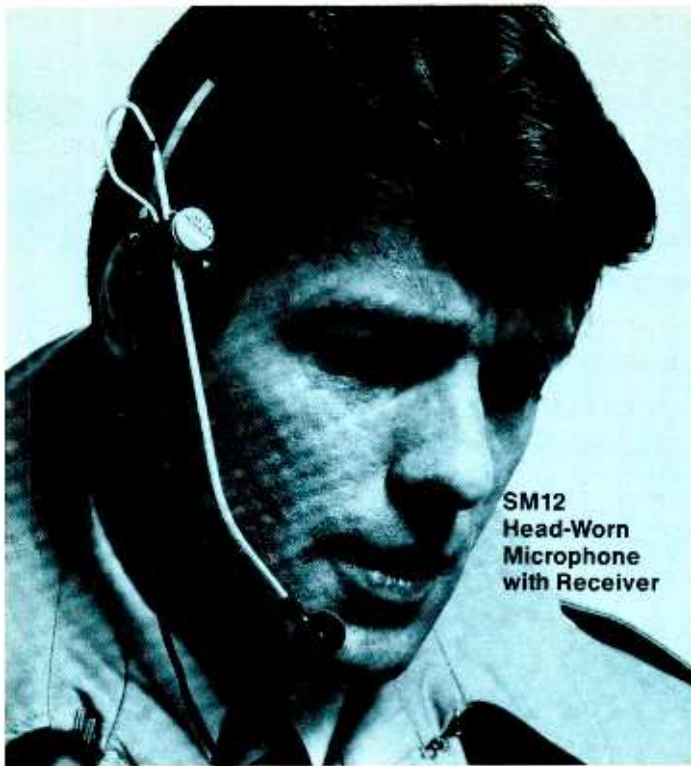


Figure B



**HANDS-FREE TRANSMITTING with built-in noise control!**

All new and field-proven! Shure's SM10 Head-Worn Microphone and SM12 Head-Worn Microphone/Monitor have every transmitting convenience you will need built into three ounces of comfort. Both microphones have high-power, clear-signal dynamic elements for maximum intelligibility. Yet, no batteries or cumbersome controls are needed—your hands will be free for note-taking or driving.\*

The SM10 and SM12 are specially designed to reduce pickup of annoying background sounds without masking close-up voice signals. Unidirectional pickup pattern means only the sounds of your voice are transmitted. The anti-noise feature is further enhanced by a strong, natural voice frequency response (50 to 15,000 Hz) that minimizes low background rumble. A built-in windscreen filter eliminates other noise distractions.

Headset mouthpiece is designed to pivot and extend to fit any face. Adjustable frame and padded headband assure a pleasant fit for anyone, too.

\*when used with a footswitch or other relay arrangement (not supplied with microphone)

**SPECIFICATIONS**

**MICROPHONE** (applies to both SM10 and SM12):

**Type:** Dynamic, Close-Talking

**Frequency Response:** 50 to 15,000 Hz (See Figure D)

**Polar Pattern:** Cardioid (unidirectional) response—uniform with frequency, symmetrical about axis (See Figure E)

**Impedance:** Microphone rating impedance is 150 ohms (200 ohms actual) for connection to microphone inputs rated at 25 to 200 ohms

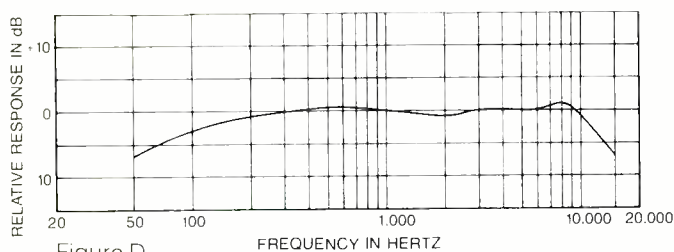


Figure D

**Output Level** (close-talked at 1,000 Hz):  
 Open Circuit Voltage ..... -87 dB (.045 mV)  
 (0 dB = 1 volt per microbar)  
 Power Level ..... -66 dB  
 (0 dB = 1 milliwatt with 10 microbars)

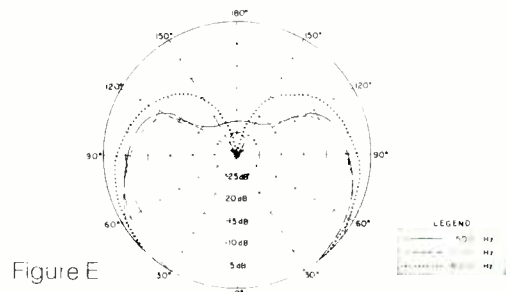


Figure E

**Hum Sensitivity:** Less than -62 dBm in 1 millioersted field

**Phasing:** Positive pressure on diaphragm produces positive voltage on pin 2 of microphone connector

**Connector:** Professional three-pin Male audio connector designed to mate with Cannon XL series, Switchcraft A3 (Q.G.) series or equivalent connector

**Cable:** Non-detachable 1.5 m (5 ft.), four-conductor, shielded, plastic-jacketed; additional 0.3 m (12 in.), two-conductor receiver cable attached to microphone connector on the SM12

**Case:** Black thermoplastic microphone and pivot housings, anodized aluminum end caps, stainless steel grille, ear tube and boom

**Dimensions:** 202 mm (7<sup>15</sup>/<sub>16</sub> in.) long; 44.5 mm (1<sup>3</sup>/<sub>4</sub> in.) maximum height (pivot housing).  
 Microphone: 15.9 mm (5/8 in.) diameter; 14 mm (9/16 in.) height

**Optional Accessory:** A10CH Cough Button

**RECEIVER (SM12 Only):**

**Type:** Dynamic

**Frequency Response:** 70 to 12,000 Hz

**Impedance:** 2,000 ohms at 1 kHz (200-ohm cartridge with matching transformer in phone plug)

**Output Level:** 106 dB SPL with 1.414V at 1 kHz (1.0mW into 2 cc cavity)

**Phasing:** Positive voltage on phone plug tip produces positive pressure in ear tube

**Connector:** Phone Plug (contains matching 2,000:200 ohm transformer)



# Communication theory

## 3 — The digital revolution

by D. A. Bell

University of Hull

In speaking of the "digital revolution" I am not thinking of the proliferation of digital computers (though this has its impact on telecommunication through the need for data transmission) nor of the fact that a simple pocket electronic "digital calculator" is now in almost the same price bracket as a good slide rule, its analogue predecessor; I am thinking rather of the impact of digital techniques on television (mostly behind the scenes) and on the use of the Post Office telephone network for the communication of both data and speech, with developments in Viewphone as well. All of these digital developments depend on the flexibility which digital techniques allow in exploiting three key features of Shannon's communication theory, namely *redundancy*, the possibility of an *exchange between signal-to-noise ratio and bandwidth*, and a certain *symmetry between time and frequency* in the calculation of information rate and channel capacity.

The problem of television standards conversion became important in this country as soon as BBC2 was introduced with 625 lines while BBC1 continued to use 405 lines (see *Wireless World* May 1971.) Then the development of international exchange of television programmes, especially since communication via satellite has been available, has drawn attention to the fact that there are also differences between scanning standards used in different parts of the world: in North America they have 525 lines per picture and 60 (interlaced) fields per second, but in Europe we usually have 625 lines with 50 fields per second. (There are also differences in colour transmission, such as between N.T.S.C., PAL and SECAM.) Conversion between these standards requires storage, and storage of information is simple and reliable only when it is in digital form.<sup>1</sup> Since the development of l.s.i. (large scale integration) both semiconductor memories and shift registers have become comparatively cheap, so that the digital solution is also an economic solution. In the simplest case each picture element is represented by several bits (as described below for

p.c.m.) and the number of bits is minimised by non-linear quantisation, using small steps for small signals but larger steps at each end of the scale.

There is also a great deal of redundancy in picture signals arising from the fact that neighbouring points are related to each other — they are said to be correlated. This correlation reduces the amount of information in the signal, but it is difficult to use because one must make provision for the occasional picture in which there is not much correlation — e.g. if the camera is panned across a scene. In most pictures, however, the difference between adjacent points in a line is much less than the full swing from black to peak white. It follows that for the same gradation of grey the signal conveying the difference between adjacent points will nearly always require fewer steps than would be needed to convey the absolute value of each point. So this *differential* p.c.m. (or d.p.c.m.) can use fewer bits per sample than direct p.c.m., which is particularly valuable if the picture has to be transmitted through a limited channel. The addition of vision to an ordinary telephone circuit ("Viewphone" in Britain or "Picturephone" in the Bell System, USA.) is a case where (a) economy of bandwidth is of great importance and (b) occasional momentary degradation of the picture may be tolerable. The addition of vision to an ordinary telephone channel may seem an extravagant luxury, but its supporters claim that it is justified by fuel economy if the addition of vision to the communication channel makes it an acceptable alternative to face-to-face meeting and so reduces travel. Bandwidth economy in television was the subject of a great deal of investigation some years ago<sup>2</sup> but in those days only analogue devices were considered for providing the storage from line to line or field to field which is needed to take advantage of the correlation in space between adjacent points or the correlation in time between the same points in successive scans ("picture difference" transmission)<sup>3</sup>. Now Post Office designers of Viewphone suggest digital

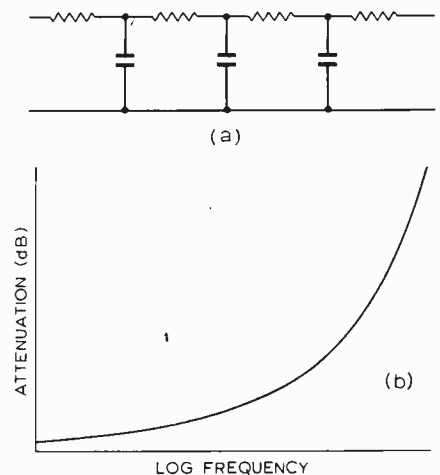


Fig. 1. (a) Lumped circuit approximation to an unloaded line. (b) Frequency response of such a network.

storage of a line in shift registers<sup>4</sup> so that use may be made of correlations between points which are adjacent vertically, in different lines, as well as that between adjacent points in the same line. A more elaborate system has been proposed for the American Picturephone, utilising correlation between successive scans. This has a buffer store of 67,000 bits (equivalent to about 4,000 words storage for a mini-computer using 16-bit words); and if movement in the picture destroys correlation to such an extent that a scan cannot be compressed into this size, the picture is deliberately degraded in two stages. First the scan is coarsened to use only half as many picture elements per line; and if that does not suffice the second stage is to omit a complete scan and instead re-transmit the previous scan.<sup>5</sup>

Another digital development in television is the transmission in the field blanking interval of alpha-numeric data. The system is called teletext (Oracle by the IBA and Ceefax by the BBC); and any viewer who has the appropriate adjunct for decoding, storage and character generation (as recently described in this journal) can

choose at any time to have the picture on his screen replaced by a page of information consisting of latest news or any one of a hundred or so pages which may be available.

But in more mundane telephone communication, digital methods first came in with the use of p.c.m. on junction lines which are usually in the range of 10 to 30 miles long and employ multi-pair paper-insulated cables — the last kind of cable one would think of for the transmission of a wide frequency band or narrow pulses. These cables have very little inductance of their own so that ideally they would behave as CR circuits (Fig. 1(a)) with a frequency response which falls continuously for all except the very lowest frequency (Fig. 1(b)).

The equivalent circuit of Fig. 1(a) with capacitors at intervals is only an approximation, since in fact the capacitance is uniformly distributed along the cable; but Pupin pointed out a long while ago that if one had inductance distributed along the line as well, or an approximation to this in the form of loading coils at intervals (Fig. 2(a)), the cable became a lossy low-pass filter which passed all frequencies up to a definite cut-off but very little beyond. So most telephone cables have these loading coils at intervals so as to maintain a uniform pass-band with a signal/noise ratio better than 50dB which is then divided into telephone channels by frequency-division multiplex. Now a binary signal can tolerate a much lower signal/noise ratio and the signal after regeneration is independent of the signal/noise ratio. Therefore a binary signal can use a much wider frequency range in Fig. 1(b), and does not require the attenuation to be uniform within that range.

In p.c.m. we need to sample the analogue signal twice per cycle, but Nyquist says we can transmit two pulses per second per hertz of bandwidth: so there appears to be no change so far. But if we are to reduce the pulses to a binary scale, i.e. p.c.m., we need several pulses per sample; and in fact eight are used, seven to quantize the signal into 128 levels and one for synchronising and signalling. The bandwidth is increased eightfold; but the characteristic of the cable is such that the useable bandwidth increases more than eight times when one drops the signal/noise ratio from that required for a good telephone channel to that required for binary signalling, so there is a net profit on the exchange. In terms of communication theory, this is an example of trading signal/noise ratio against bandwidth.

Pulse code modulation is now in widespread use on junction lines.\* It should be recognised that an important factor contributing to this is the availa-

bility of solid-state circuits for handling quantized signals which combine complexity of logic circuitry with small size, low power consumption and reliability. In the days of valve amplifiers the repeaters (line amplifiers) were usually housed in telephone exchanges, or occasionally in separate buildings. Such housing was necessary on account of their bulk, the need for a substantial power supply (with means of maintaining power in case of a mains failure) and the need for access for maintenance. Now, a solid-state regenerative repeater is put in whenever a loading coil is taken out. The loading coils were usually inserted at intervals of about a mile, and housed in cable-jointing chambers below manholes. A small solid-state regenerative repeater can be put there instead, and its small power requirement supplied along the telephone cable from the nearest exchange.

The spacing of repeaters is important. The signal must not be attenuated below the permissible signal/noise ratio

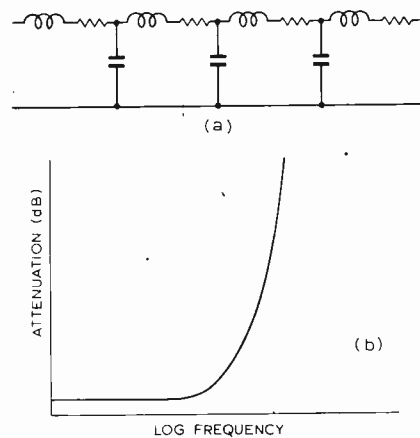


Fig. 2. (a) An inductively loaded line. (b) Bandpass frequency response of the loaded line.

before arriving at the next repeater; but the attenuation increases with frequency so that the maximum frequency which can be used depends on the closeness of spacing of repeaters.

For some thirty years engineers have been seeking an all-electronic telephone exchange. Note that I said "all-electronic" because the present generation of what are generally called "electronic exchanges" are really electronically controlled electromechanical exchanges. You must first understand that a telephone exchange has three functions: (a) to provide a switchable path for speech signals from an incoming to an outgoing line; (b) to receive, act upon and generate signals for controlling the speech path and (c) to interpret the signals and other data so as to provide speech paths efficiently. If we think of the old type of manual switchboard, (a) is provided by jack plugs and cords which can connect selected jack sockets, (b) depends on the senses and limbs of the operator (e.g. seeing a calling subscriber's light,

switching ringing tone on a called subscriber's line) and (c) depends on the operator's brain.

In the past generations of automatic exchanges, (b) and what could be done towards (c) were implemented by relay logic, and this has been replaced by computer-like electronic circuits in the current generation of electronically controlled exchanges.<sup>6</sup> But there has been comparatively little success in the search for a solid-state replacement for the metal-to-metal contact in the speech-path switches, though the mechanical form of the contacts has changed from Strowger two-motion switches through cross-bar switches to the sealed reed relays used in the current electronically controlled exchanges.<sup>7</sup> The metal-to-metal contact has virtually infinite ratio of open to closed resistance, perfect linearity and no noise in normal functioning. Engineers became increasingly convinced that these characteristics could not be approached by any solid-state device and therefore solid-state switches could not be employed in an analogue speech path. But the use of digital signals such as p.c.m. makes the characteristics of the switches far less critical, so that solid-state switches would be useable.†

Once an analogue signal has become contaminated with noise, it can never be "cleaned"; and the noise components introduced at successive links in the route are additive. A digital signal, on the other hand, can be regenerated by threshold devices so that it leaves each repeater stage as a perfectly clean on/off signal. The Post Office therefore took the view that a future "System X", which will one day supersede the present generation of electronic-control - plus - reed - relay - switching exchanges, will employ digital transmission on the main trunk circuits. Preliminary trials on trunk transmission between Portsmouth and Guildford using high-speed p.c.m. have recently been initiated by the Post Office.<sup>8</sup> Again there has been an exchange of bandwidth against signal-to-noise ratio, since p.c.m. at 120Mbit/s is sent over a coaxial cable which could only be used up to 12MHz for f.d.m. The first consequence of this change to digital transmission will be that our familiar frequency-division multiplexing will be replaced by time-division multiplexing. Then instead of picking out a frequency channel with filters we shall pick out a time-slot by strobing. Some of the exchange switching can then be replaced by the matching of time-slots between incoming and outgoing lines, but some switching of circuit connections (known as "space switching") will probably be needed as well. But in view of the greater tolerance of digital signals, "cross-points"\*\*\* could be solid-state.

† See section headed "Electronic exchanges" in "Centenary of the telephone", Wireless World, March 1976, p.92. — Ed.

\*\* See Appendix for explanation of "cross-point".

\* Lines 10 to 30 miles long which give direct connection between local exchanges, without using the trunk system.

A few years ago this was unquestioned and there seemed no hope for solid-state cross-points outside digital systems. Recently, however, there has been a revival of interest and a dozen manufacturers in the USA offer private automatic branch exchanges (PABX) using solid-state technology which offers the advantages of small size and little maintenance requirement. Most of them use four-layer devices, analogues to thyristors, as cross-points. But the point is that in this case the speech goes through only one solid-state switching system (or at most two if the subscriber at each end of the line has a solid-state PABX). This contrasts with the number of exchanges which may be involved in a long-distance call over a public network, and of course any noise or distortion arising in successive exchanges is additive.

An immediate advantage expected from digital transmission of speech is that data in binary form can immediately replace the p.c.m. signals. There has been much controversy over the question of whether we need a separate data network in addition to the telephone network. At present digital signals are usually fed into the frequency-division multiplexed analogue telephone system through modems (modulator-demodulators) which convert the on/off binary signal into a more or less complicated system of frequency-shift, phase-shift or multi-level amplitude modulation of an audio tone. It is much simpler to send binary digits straight to line, if the line is tailored to handle digital signals. Since the telephone network provides almost universal coverage, it seems uneconomic to set up another network alongside it just to handle data. So making telephoning digital confers a further advantage if it makes telephone traffic and data traffic fully compatible. (But it must be remembered that the telephone system is at times fully loaded, so that extra trunk lines and switching plant would be needed to enable it to carry a significant load of data traffic as well.)

A development in networks intended solely for data is called "packet switching." This arises because transmitting data has some of the characteristics of sending telegrams: there is no need for communication to be instantaneous and simultaneous with the origination of the information, though one would prefer that any delay in data transmission should be measured in seconds rather than hours. Given adequate buffering, data signals which arise at irregular intervals can be sent at a steady rate (most of the time) over the main transmission channel.

The idea is in fact very old since what we shall now call "a node in a packet-switching network" has as antecedent "a torn-tape relay station in a telegraph network." Telegrams are normally transmitted via punched paper tape and if they had to be sent through a relay station they could be received there on a

tape perforator. Originally an operator would read the address on an incoming message and at its end tear off the length of tape and transfer it to an appropriate transmitting machine for its particular destination; but later the address was read by machine and the length of tape directed automatically into the appropriate channel for retransmission, where it might join a queue of messages for that destination. The equivalent in modern technology is obviously to have at the relay centre a computer with appropriate buffer stores.

The torn-tape telegraph relay is not of great practical interest now because it is usually easier to switch electrical connections, so why has the principle been revived for data transmission? The first answer is that there is a considerable demand for transmitting small units of data, such as banking transactions of individual customers, which contain no more than a few hundred characters. At the present time it may take 15 seconds to set up a long-distance s.t.d. connection so if the data can then be transmitted in a similar or shorter time the whole process is rather inefficient. Secondly there is the problem of concentration of local traffic into trunk lines, which in telephony is achieved at present by frequency multiplexing. In the transmission of telephony by p.c.m. the sampling pulses are generated within the exchange, so that although there are problems of synchronism between exchanges in the proposed digital telephone network the timing is at least all controlled within the system. (Incidentally, one proposed method of matching time slots between different exchanges is called "pulse stuffing" and consists in inserting extra pulses into the signals from one of the channels. This clearly could not be used in data transmission).

So the idea is that data should be divided into units called "packets" of perhaps 1000 bits, each carrying a destination address. These would originate at sources of various types, ranging from a keyboard to a 48kHz line from a computer centre and would all be sent to a local switching centre or node on the special network. The computer here would take them into store, read the address, sort them into strings according to destination and transmit at high speed (of the order of 100 megabits/second) to other nodes in the network. Precautions have to be taken to see that no packet is lost and to see that the packets in a series constituting one message arrive in the right order. At the present time there is considerable activity in the development of data networks. The first was ARPA, set up by the United States Department of Defense to link a number of computer centres which each contain one or more powerful computers. It has also some access points in Europe. Part of the argument for such a network is that a computer centre may specialise in some

particular type of work for which its computer is particularly suitable on account of features such as the balance between fast-access store, backing store, input and output facilities, etc. It is then economic to send different kinds of work to different computers and a communication network serves this purpose. In Europe the emphasis is more on data collection, as implied in the explanation of packet-switching above. The British Post Office has opened an experimental packet-switched service on the route London-Manchester-Glasgow to assess the commercial value of such a system; the European banks are proposing a network called SWIFT for the rapid transfer of information about international banking transactions; there are plans for a European Information Network (EIN); and a EURONET is proposed to link all major scientific research establishments in Western Europe.

It seems a far cry from Shannon to digital television and packet-switched data networks. But the same principles apply throughout:

- (i) All information is finite and can therefore be digitised.
- (ii) The maximum capacity of any physical channel can be specified in terms of its bandwidth, signal-to-noise ratio and the time for which it is available.
- (iii) Within the bounds set by (ii) it is possible to exchange signal-to-noise ratio against the bandwidth-time product.

No doubt we shall see many further applications of these fundamental principles as time goes by.

#### Appendix: Cross-bar and cross-points

The Strowger system of automatic telephony is based on its two-notch switch. This first moves vertically to one of 10 levels and then horizontally to one of 10 positions in the level so as to select one out of 100 contact pairs. This is a direct mechanisation of the action of the manual exchange operator in

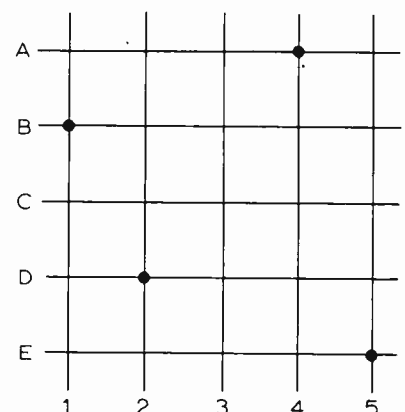


Fig. A. Principle of cross-point switch connecting any of inputs A, B, C, D, E to any of outputs 1, 2, 3, 4, 5.

selecting one out of a square array of jack sockets, but with one important difference. The whole of the Strowger switch remains engaged while the single call is passing through its contact field; but the operator after putting plugs in to make one connection can leave it and attend to other connections until she receives a signal to clear the first connection. The cross-bar switch, which is illustrated in principle in Fig. A comes nearer than Strowger does to simulating the methods of the human operator. The diagram shows input lines A, B, C, D, E crossed by output lines 1, 2, 3, 4, 5. At each point where the lines cross there is a switch, closing of which is indicated by a blob on the diagram. Thus the cross-bar switch can complete more than one circuit at a time: the connections shown are A → 4, B → 1, D → 2 and E → 5. While the numbers of lines in each direction may be varied, the principle is now universal and the only question is what kind of switch or cross point should be used at each crossing. In the original cross-bar switches the contacts were metal-to-metal and operated by a mechanical system of solenoids, bars and latches; in the current electronically controlled exchanges they are reed switches; and there is an increasing probability of the future use of solid-state devices as cross-points in some applications.

## References

1. J. L. E. Baldwin *et al.*, "DICE: the first intercontinental digital standards converter," *R. Telev. Soc. Journ.* 1974, vol. 15, pp 140-159.
2. D. A. Bell, "Economy of bandwidth in television," *Journ. Brit. Inst. Rad. Engrs.*, 1953, vol. 13, p.447.
3. R. Barthelemy, "Images Differentielles," *Comptes Rendus*, 1949, vol. 229, p.61.
4. J. E. Thompson and G. A. Gerrard, "A differential p.c.m. encoder for Viewphone signals." Conference on Digital Processing of Signals in Communications, 1972, IERE Conference Proceedings No. 23, pp.329-337.
5. D. J. Connor, B. G. Hashell and F. W. Mounts, "A frame-to-frame Picturephone coder for pictures containing differential quantizing noise," *Ibidem*, pp. 363-372.
6. M. T. Hills "Electronic telephone exchanges. Conclusion: Computer-controlled Systems," *Wireless World*, July 1974, p.241.
7. M. T. Hills, "Electronic telephone exchanges. A Review of Techniques," *Wireless World*, June 1974, p.164.
8. "High capacity p.c.m. system," *Wireless World*, February 1975, p.92.

## Literature Received

A guide to the range of thyristors, triacs and trigger devices made by Motorola is now available. Equivalents to other types are suggested and there is information on outlines and leads; application notes are listed. The guide is offered by GDS Data Centre, Michaelmas House, Salt Hill, Bath Road, Slough, Bucks ..... WW401

A price list of over 200 instruments, classified as signal sources, signal conditioners and analysers and measuring instruments, is produced by Lyons Instruments Ltd, Hoddesdon, Herts EN11 9DX ..... WW402

Measuring instruments for hire are described and classified in the 1976 Livingston Hire Catalogue. Most common electronics laboratory instruments are listed, as well as a range of industrial equipment. The catalogue can be obtained from Shirley House, 27 Camden Road, London NW1 9NR ..... WW403

High-voltage, stable and precise power supplies, intended for use with precision c.r.t. displays, photomultipliers and similar equipment, are described in a 4-page catalogue from CPS Inc., 722 E. Evelyn Avenue, Sunnyvale, California 94086, USA ..... WW404

Memories, microcomputer kits and development systems (including peripherals) are briefly described, with prices, in a price list produced by Rapid Recall, all the components being by Intel. Rapid Recall Ltd are at 9 Betterton St, London WC2H 9BS ..... WW405

"Foundation for a Career" is the title of a pamphlet, produced by the City and Guilds of London Institute, which outlines a scheme of courses to give school leavers vocational preparation. Five courses are described — construction, engineering, science industries, food industries and community care. Copies are available at 50p from the Sales Section of the Institute at 76 Portland Place, London W1N 4AA.

Digital, panel-mounted counters conforming to DIN43700 are produced by Orbit Controls and are described in their Industrial Electronic Instrumentation catalogue, available from Orbit at Langdown Industrial Estate, Cheltenham, Gloucestershire GL51 9PL ..... WW406

A supplement to the Doram mail-order catalogue has been sent to us. New products include amateur radio modules, a 432MHz-to-28MHz transverter, a 70cm varactor tripler, a 500MHz prescaler and a 50MHz counter. Price reductions on small components are announced. Doram Electronics Ltd, PO Box TR8, Wellington Road Industrial Estate, Wellington Bridge, Leeds LS12 2UF ..... WW407

Soldering irons, stands, de-soldering instruments and tools are fully described in a booklet from Adcola Products Ltd, Adcola House, Gauden Road, London SW4 6LH ..... WW408

Hygrometers, dewpoint meters and moisture analysers made by Shaw are the subject of a catalogue recently received. Brief details are given of instruments for the measurement of moisture in a range of materials. Shaw Moisture Meters, Rawson Road, Westgate, Bradford ..... WW409

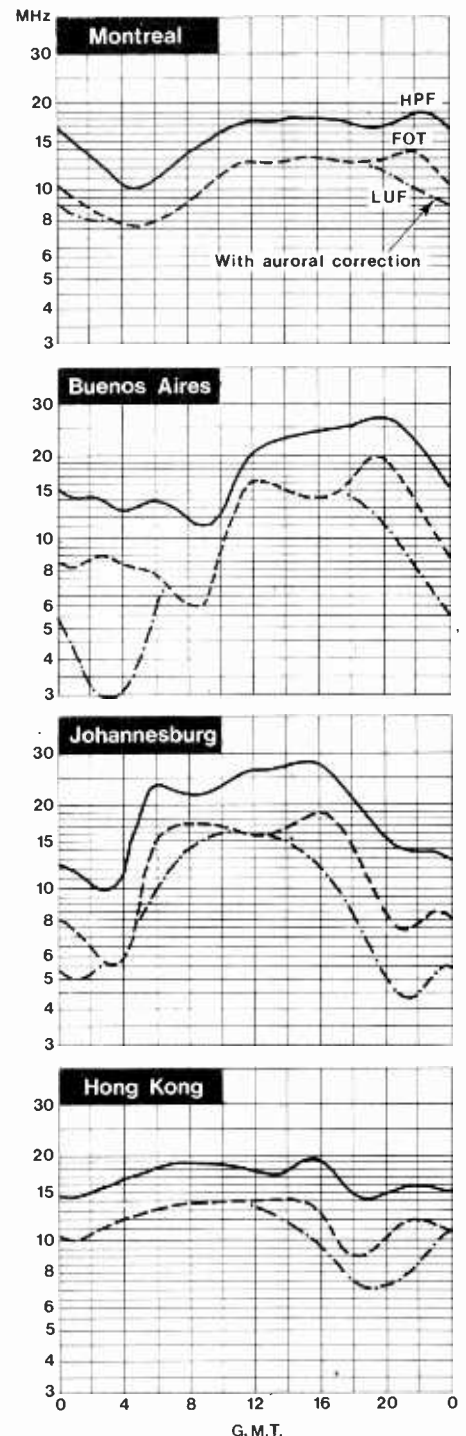
Coaxial connectors (Type N, BNC, 27, etc) and cables are illustrated and described in a new catalogue from Intel Connectors Ltd, R. F. Division, Henlow Trading Estate, Henlow, Beds. . . WW410

Thermistor materials, their resistance/temperature characteristics, tables, outline drawings and application information are presented in a new short catalogue by Fenwal Electronics. The catalogue can be obtained from Electrautom Ltd, Etom House, Queens Road, Maidstone, Kent ..... WW411

Jitter when displaying data streams can be avoided by recognizing a selected data bit and generating an oscilloscope trigger at that time. Hewlett-Packard describe the 1620A Pattern Analyser, designed for this purpose, in application note 167-8, obtainable from King Street Lane, Winnersh, Wokingham, Berks ..... WW412

## HF predictions

Predicted disturbed periods are May 21 — June 2 and June 15–21. Seasonal trend and minimum solar activity combine to produce FOTs and LUFs which give a restricted choice of time and frequency for reliable day to day communication. This feature is most evident when both ends of a radio path are in the northern hemisphere mid-latitudes.



# Wireless World Teletext decoder

## 8 — Modifications and lining up

by J. F. Daniels

Most constructors will probably want to use the decoder with a colour television receiver, but for those who use a black-and-white set, a few words on interfacing are needed.

### Monochrome receivers

If a black-and-white receiver is to be modified then there are two options open to the constructor. The decoder may be wired in, in a similar manner to that described for the colour receiver, or a separate tuner and i.f. strip may be used, the output of the decoder being fed via a u.h.f. modulator into the receiver's aerial socket. This second method has the advantage that the decoder may be electrically isolated from the TV set. Whichever system is used, the best display will be obtained by mixing the red, green and blue outputs of the decoder together by means of variable resistors, the resistances of which may be varied to give the desired grey levels for different transmitted colours. Mixed syncs must also be added at this point to lock the scan circuits in the TV set. The problem most likely to be encountered with black and white sets, especially the older ones, is lack of bandwidth in the i.f. strip — a good reason for using the extra i.f. and modulator approach.

### Character verticals

The following modification to the decoder circuitry has been found advantageous because it reduces the h.f. response requirements of the receiver video amplifier output stages. Fig. 1 shows the circuit, which uses existing "spare" i.c. gates. The extra gates are wired in series with the output of gate (57, 6). Gates (75, 8) and (75, 3) pass the signal through unchanged, but gate (75, 6) adds to the original signal a pulse derived from the trailing edge of the display character components.  $VR_3$  can be adjusted to give the best character appearance, and the setting of this control will depend on the frequency response of the receiver video amplifiers. At zero resistance setting, the signal passes through this stage unchanged, but as the resistance is increased the width of the character verticals gradually increases until the

appearance of the characters is obviously distorted. A suitable control setting should be found which gives the best character appearance.

### Upper and lower-case characters

Texas Instruments have recently announced a new character generator i.c., the X887, which has been developed as part of their Tifax decoder module, and as the i.c. was specifically designed for Teletext decoders, it has a number of advantages over the 2513.

Firstly, it contains a complete set of upper and lower-case characters, which includes all those characters defined in the latest Teletext code table. Secondly it has provision for a four-bit row-select input code which means that all ten rows of the characters may be addressed independently, and no shifting of address codes is required for characters with "tails". Thirdly, it only requires a +5V supply, which means that the decoder power supply may be simplified as the -12V rail is now unnecessary.

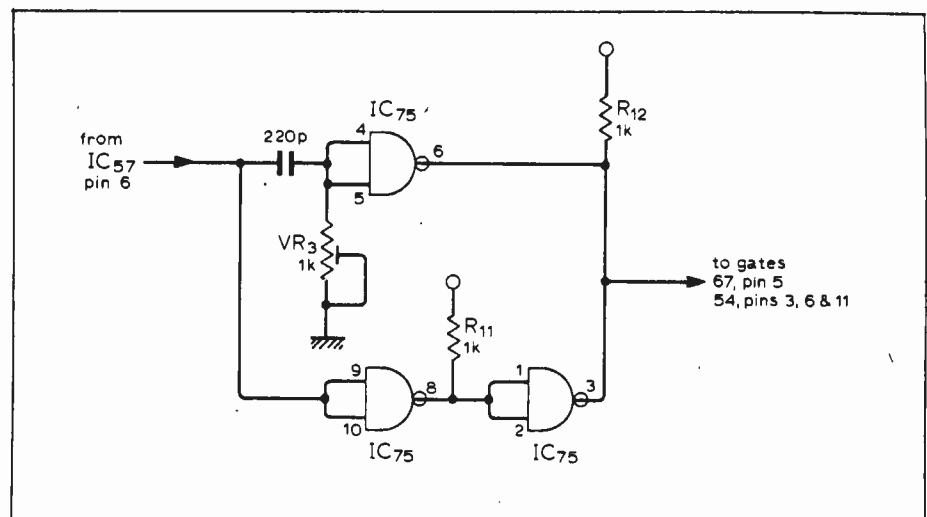
Fig. 1. This modification reduces the degrading effect of poor video frequency / amplitude response in the television receiver. The effect is to broaden vertical components of characters.

The circuit arrangement using the new i.c. is shown in Fig. 2 and is almost identical to the original circuit using the upper-case 2513. The differences are that all seven bits are now fed to the character-select inputs and the four-bit row-select inputs are fed from the  $Q_A$ ,  $Q_B$ ,  $Q_C$  and  $Q_D$  outputs of  $IC_5$  directly. The  $Y_1$ - $Y_5$  outputs feed, as before, into the five open-collector gates, although the timing of the strobe pulses from  $IC_{42}$  has been changed slightly to allow for the faster access time of the X887.

The cost of the X887 is around £20, which makes it rather expensive compared with the 2513, but if a decoder with the lower-case facility is required, then the X887 is the obvious choice.

### Line-up procedure

The following line-up procedure has been devised after lining up six decoders, but it does assume that the decoder has no faults and is being fed with a suitable video signal as described earlier. It would also be advisable to check that data is actually being transmitted on the selected TV channel, since the system is still in its experimental period and transmissions may be interrupted occasionally. To check the transmissions are present, reduce the height of the TV picture, or offset the vertical-hold control and look for lines of constantly-changing white dots and



dashes across the full width of the TV line in the field blanking interval.

The line-up procedure requires no test gear, but the power supply rails should be checked with a multimeter prior to following these instructions.

Set the six preset potentiometers (three on the analogue board, two on digital board 1 and one on digital board 2) to mid-position. A screen full of random characters will probably be obtained, because the flip-flops in the r.a.m.s take up random states at switch-on. Do not, however, push the clear-page button at this stage.

Adjust VR<sub>3</sub> on the analogue board (set sync separator) to give a display that is free from vertical jitter. Turning the potentiometer too far in one direction will cause the display to jitter vertically and move down the screen. Turning it too far the other way will make the display disappear altogether.

Adjust VR<sub>1</sub> on the upper digital board (horizontal shift), and VR<sub>1</sub> on the analogue board (display width) to give a correctly-centred and suitably proportioned display.

Connect a link between pins 13 and 14 of IC<sub>9</sub>. This disables the "framing-code allow" monostable, and this is essential during the first part of the setting up procedure.

Switch the decoder to the "roll" mode and adjust L<sub>1</sub> to give the maximum amount of "movement" of the display. The characters should start changing at random and this may appear to be happening on consecutive rows from top to bottom of the screen, giving a "rolling-through" appearance. If so, adjust the

coil for the most consistent rolling-through action. If the coil former being used is not the specified one, then the oscillation frequency can be checked as follows: - disconnect the uppermost wire link to the analogue board, (lines 11-21) and adjust L<sub>1</sub> to give a display of approximately the correct width. (Disconnecting this link inhibits the display oscillator and makes the data oscillator operate the whole time, so the characters will appear rather ragged). If this is outside the range of adjustment of L<sub>1</sub>, adjust the value of C<sub>2</sub> until the width of the display is approximately correct. Reconnect the link to the analogue board.

Adjust VR<sub>2</sub> on the analogue board (slice level) to improve the rolling through action and some correct pages may now be observed changing very rapidly. Continue adjusting L<sub>1</sub> and VR<sub>2</sub> alternately to give the best rolling action. (N.b., when the roll mode is selected the decoder reads out each data row as it is transmitted, and this enables the effect of each adjustment to be observed, instantaneously, rather than having to wait for up to 15 seconds, which would be the case if pages were selected in the normal way.

Remove the link from IC<sub>9</sub>, pins 13 and

14. The rolling-through action will probably cease. Adjust VR<sub>2</sub> on digital board 1 carefully, until the rolling-through action begins again. This control has an "on-off" action, unlike those previously adjusted, and is necessarily quite critical in its setting. The adjustment should be checked on different TV channels, since there may be slight differences in the position of the framing code between different channels.

Switch off the roll mode and select a clock-cracker page (at the time of writing page 899 on Oracle or page 140 on Ceefax). This page is used to accurately check the frequency of the data oscillator, and consists of 14 consecutive 1s followed by two 0s repeatedly across each row of the page. This means that the data oscillator gets the least possible amount of locking information on each line and so must free run at the correct frequency for almost two bytes of data. If L<sub>1</sub> is not quite correctly adjusted, a regular pattern will appear on the left-hand side of the screen which will gradually disappear or turn to "rubbish" on the right-hand side. L<sub>1</sub> should be adjusted a quarter of a turn at a time, until the page readout produces a pattern which is even over the whole screen. The two photographs in Fig. 3 show a correct and incorrect clock-cracker readout. These photographs were taken from the output of a decoder which had a lower-case character generator installed, and the characters displayed when an upper-case-only decoder is used are

Fig. 2. The revised character generator, which uses the Texas X887 to display both upper and lower-case characters, as well as the complete Teletext symbol set.

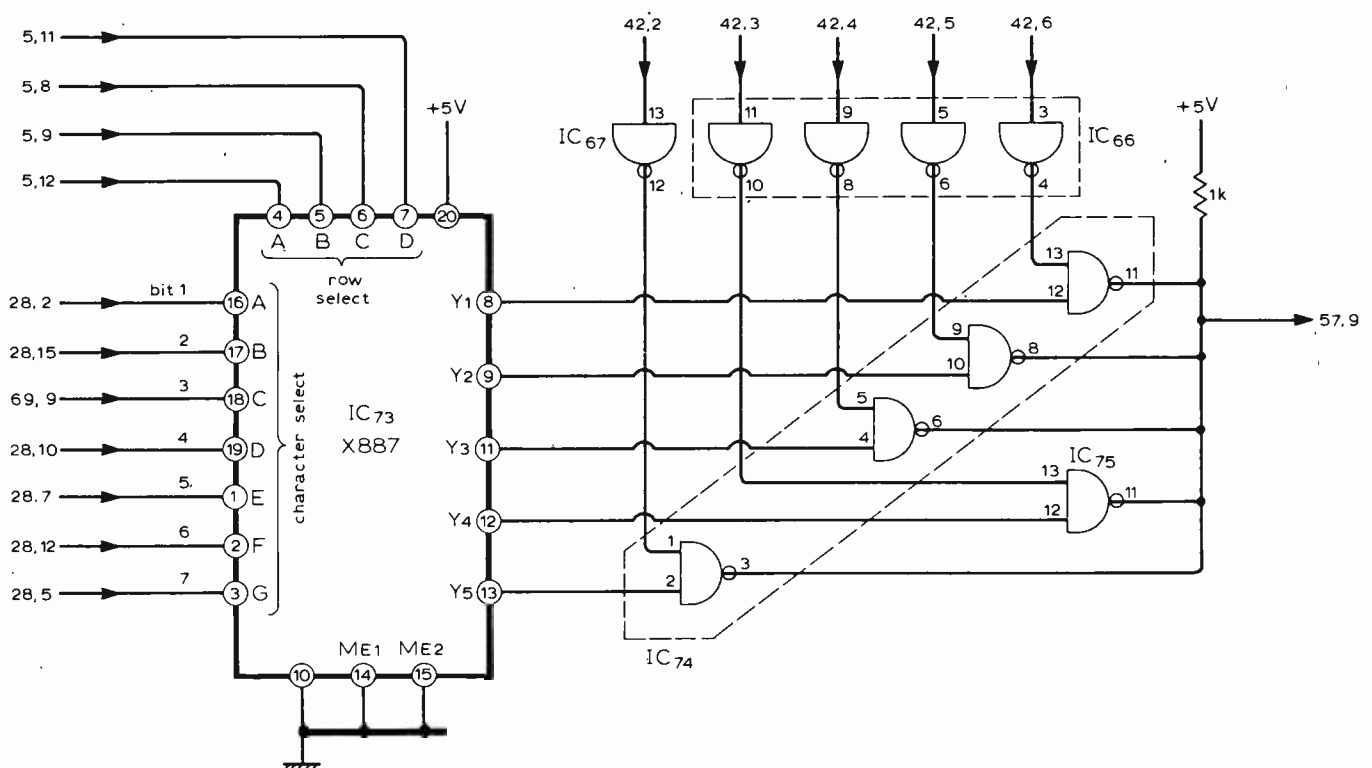


Fig. 3. The "clock-cracker" page, with  $L_1$  (April issue, p.66) correctly adjusted is shown at (a), while the result of incorrect tuning is seen in (b).

different to those shown. The principle of adjustment is, of course, the same.

Finally adjust the slice level control ( $VR_2$  on the analogue board) to give the most error-free page readouts, selecting pages in the normal manner. If the contrast control on the TV set alters the amplitude of the signal being fed to the decoder, check that both the sync separator and the data slicer work satisfactorily over the required range of the control.

Check that the decoder function switches operate correctly and adjust  $VR_3$  on the lower digital board to give the most pleasing character appearance.

### Fault finding

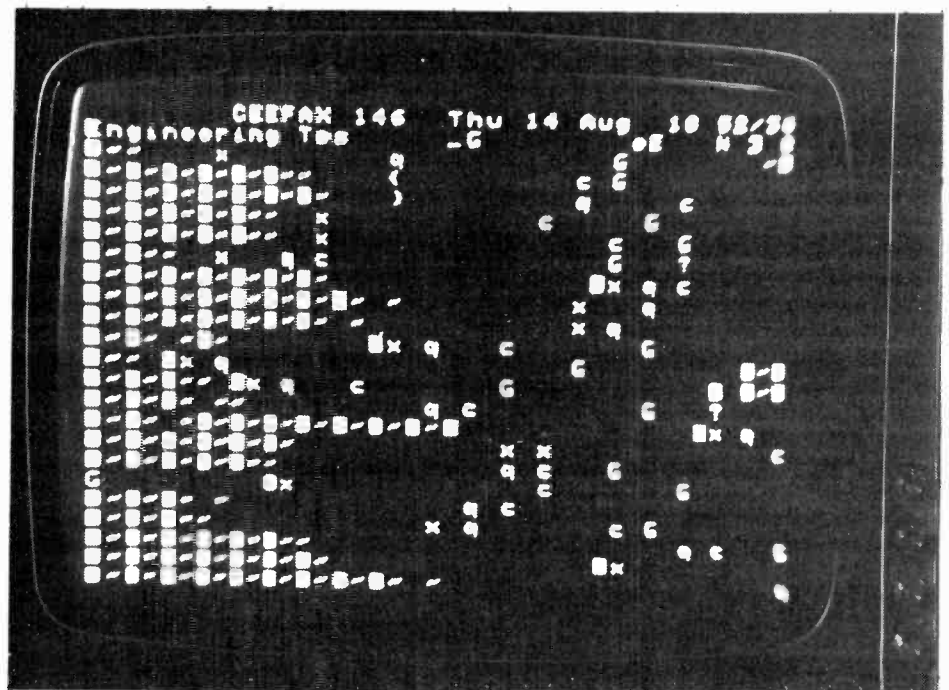
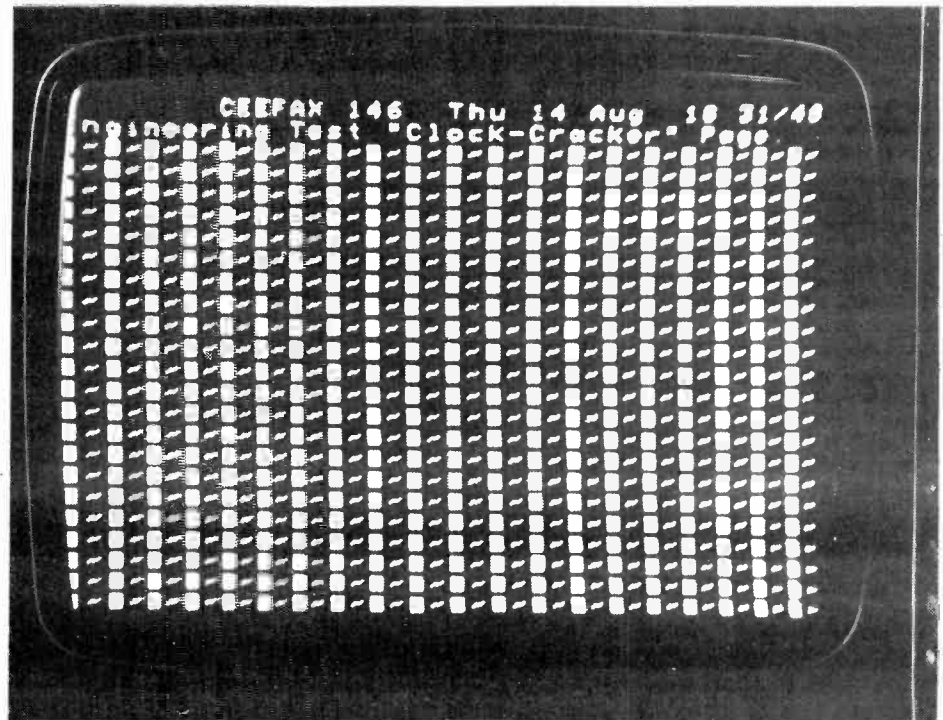
Experience with a number of decoders has shown that faults are almost invariably caused by i.c. pins being left unsoldered, especially on the top side of the p.c. boards, or missed connected-through holes, so it is best to check the boards very carefully before attempting the line-up procedure.

Faulty or suspect t.t.l. gates can be checked fairly easily by means of d.c. tests (remember that t.t.l. outputs can be shorted to the 0V rail for "in-circuit" testing of following gates, but must not be connected directly to the +5V rail.) If an oscilloscope is not available, suspect counters can only really be checked by substitution. Faulty r.a.ms can easily be detected by spotting an abnormally large number of spelling mistakes on each page and by consulting the code table, the bit which is common to all the incorrect letters can usually be located.

### Installation

A few final hints on wiring the decoder into a domestic receiver may be of some use. Coaxial cable must be used for the video input feed to the decoder, and this should be kept as short as is practical. The other feeds to the decoder will be +5V, -5V, -12V and 0V. From the decoder to the receiver there will be red, green and blue output signals, the video switch control wire, and the clamp pulse feed. These last nine feeds may be combined in a single multicore type of screened cable. Screening is necessary to prevent pick-up of the high frequency display components of the output waveforms in the receiver sound or video stages.

Finally it must be stressed again that great care must be taken when connecting the decoder into the TV



receiver, to ensure that every possible safety precaution is taken. The decoder box must be effectively earthed, not connected to the TV chassis, and there must be no exposed connections that are at anything other than earth potential. An isolating transformer (which allows the receiver chassis to be earthed) must be used while lining up the decoder, but if the above precautions are observed, this will not be necessary once the decoder is installed in its box.

### Acknowledgments

I would like to thank Mullard Ltd for their help with character generator i.c.s and also my colleagues, Dave Beavan,

Norman Riggs and Arnie Tidder for their helpful suggestions and help with building the prototype decoders.

# World of Amateur Radio

## Is h.f. propagation getting worse?

The many months during which amateurs have struggled with low m.u.f.s and early closing of the h.f. bands have underlined the recognised problems of the classic 11-year sunspot cycle. It is not so much that long-distance low-power signals disappear altogether but rather that activity becomes bunched on low frequencies, stations are heard more spasmodically and the resulting contacts go more and more to the elaborately equipped stations having effective aerials, leaving the less ambitious stations struggling after the occasional better "openings."

Such conditions this past winter came as no surprise to those radio amateurs whose memories stretch over several sunspot minima. But beyond this anticipated and transient deterioration there is another possibility that is attracting some attention: is there evidence to support a view that m.f.-h.f. radio propagation may be gradually changing – for the worse? That "average" propagation conditions today are less good than in the twenties or thirties?

Some people believe that a deterioration of conditions has been disguised by the gradual improvement in receivers and in the higher powers used by broadcasters and amateurs. Such a proposition would be extremely difficult to prove conclusively one way or the other; detailed information on signal path losses over many years is just not available, and it would be difficult to distinguish increased attenuation from the practical consequences of increasing mutual interference between stations.

Yet one does find a persistent belief among some old-timers that radio paths have gradually deteriorated or at least changed. One of the few tangible pointers in support of this view is the virtual disappearance of "long delay echoes" which, as recent correspondence has convinced me, were heard regularly and authentically in the period up to 1939.

If, in fact, ionospheric propagation has been subject to long-term changes this might be part of some as yet unidentified solar cycle or it might reflect the increasing effect of the vast increase in total radiated power, affecting electron temperatures in the ionosphere (as indicated for instance in the recent artificial radio aurora experiments in the United States).

## On the bands

National Field Day, to be held this year on June 12-13, is to be run under new rules, including the dropping of the "double station" entries and the removal of power restrictions other than those imposed by the amateur licence. Instead new "open" and "restricted" sections have been created with those clubs entering the "restricted" section having to limit their amount of equipment and type of aerials that may be used. The original purpose of NFD, established by the RSGB in 1933, was to show that low power portable stations set up at short notice outdoors were capable of maintaining reliable communications with similar stations throughout the UK – a proposition that today would be accepted without question with the result that there has been some flagging of enthusiasm in recent years. It will be interesting to see if the new rules lead to a revival of interest.

Recent Australian microwave activities have included a 244km contact on 2304MHz between Mount Genini, near Canberra and Mount Canobalis, near Orange, New South Wales. This was made between Des Clift, VK2AHC and Bill Cox, VK2ZAC. These amateurs have also been investigating 6cm and 3cm paths, including super refraction over coastal paths.

A new headquarters station of the Royal Naval Amateur Radio Society has been inaugurated at the HMS Mercury training school.

The Home Office has agreed that amateurs holding slow-scan television permits may now use 256-line transmissions as an alternative to 128-line systems without further notification of the authorities.

To avoid interference from radio-teleprinter transmissions the RSGB is proposing to change the frequency of its Sunday morning GB2RS news-bulletin transmissions from 3600kHz to 3650kHz.

J. Michale Gale, G3JMG, a civilian instructional officer at the Fleet Air Arm's Air Engineering School, HMS Daedalus, Lee-on-Solent, Hampshire, has been instrumental in the setting up of a local amateur radio society. The society, using the call G3JMG, will be regularly active on 1.8MHz.

Some tips from a lecture by Lewis McCoy, W1ICP, at a recent amateur

convention in the United States: "If you have confidence in your antenna it will work better than if you don't"; "If the antenna stays up it is too small"; and "If the confounded thing works, leave it alone." He is a strong advocate of the quad aerial as providing roughly 2dB more gain than comparable Yagi arrays.

For moonbounce operation, Peter Carey, ZE5JJ, is reported to be constructing a new 32ft dish aerial using some 500 metres of aluminium tubing. He also has a 128-element colinear array which gives 24-25dB gain on 432MHz. A 28ft diameter parabolic dish aerial with circularly polarized feed horn is used for moonbounce work on 1296MHz by Hans Lohmann Rasmussen, OZ9CR in Denmark.

## 25 years ago

25 years ago, following the imposition of unexpected operational conditions, the RSGB abandoned its original plans to equip and operate an amateur radio station in the Dome of Discovery at the 1951 Festival of Britain. However, special stations were established at Manchester, Leeds, Birmingham and Nottingham as part of the Land Travelling Exhibition, operating under the call GB3FB. A Festival amateur radio convention in London failed to attract anticipated support – and perhaps the most memorable feature from an amateur viewpoint of that Festival year turned out to be the publication of the first of the annual "RSGB Call Books", compiled by John Tyndall, G2QI.

## In brief

The New Zealand Association of Radio Transmitters (NZART) celebrates its golden jubilee with a special convention from June 4 to June 7 at the North Shore Teachers' Training College, Auckland . . . The 1976 Welsh Amateur Radio Convention will be held on Sunday, September 26 at its usual venue: Oakdale Community College, Blackwood, Gwent. It is being organised by the Blackwood & District amateur radio society . . . A weekly bulletin of ARRL news is transmitted on 14,095kHz r.t.t.y. at 1730 GMT on Sundays by W2QFR, beamed on Europe and with 170Hz frequency shift. DL8VX transmits an r.t.t.y. information bulletin every 2nd and 4th Sunday of the month, except during contests (0900 GMT, 3585kHz) . . . The British Amateur Radio Teleprinter Group has warned its members that a number of Model 54 teleprinters appearing on the surplus market have non-standard keyboards and codes and that it might be difficult to convert them for amateur r.t.t.y. applications.

**PAT HAWKER, G3VA**



# APRS 76

## Exhibitors and details for the Association of Professional Recording Studios exhibition

**The ninth international exhibition of professional recording equipment is to be held at The Connaught Rooms, Great Queen Street, London WC2 on Thursday, June 17 (09.00-19.00) and Friday, June 18 (09.00-18.00). Fire on February 5 this year at the Connaught Rooms had made the Grand Hall unusable for the time being so alternative arrangements have been made by the organizers within this venue. The exhibition is for professional users and is not open to the public. Tickets are available from E. L. Masek, 23 Chestnut Avenue, Chorleywood, Herts WD3 4HA.**

### APRS exhibitors

Acousmat  
Acoustic Research  
Agfa-Gevaert  
AKG Equipment  
Alice (Stancoil)  
Allen & Heath  
Allotrope  
Amek  
Amity Schroeder  
Ampex International  
Audio & Design Recording  
Audio Developments  
Audix

BASF United Kingdom  
B & K Laboratories  
Bauch, F. W. O.  
Beat Instrumental  
Beyer Dynamic (GB)  
Bose (UK)  
Brennell Engineering

Cadac (London)  
Calrec Audio  
Cetec Audio UK

Dolby Laboratories  
Drake Electronics, Philip

EMI Tape

Feldon Audio  
Ferroglyph Professional Recorder  
Fraser-Peacock Associates

H/H Electronic  
Hammond, C. E.  
Hampstead High Fidelity  
Hayden Laboratories  
Helios Electronics

Industrial Tape Applications  
International Musician & Recording World

Jackson Recording Studios

Clark-Teknik

Lee Engineering  
Leavers-Rich Equipment

Lennard Developments  
Levy, Jacques  
Lockwood & Co. (Woodworkers)

MCI (UK)  
3M United Kingdom  
Macinnes Laboratories  
Magnetic Tapes  
Midas Amplification  
Millbank Electronics Group  
Music Week

NTP Elektronik A/S  
Neve, Rupert  
North East Audio

Penny & Giles  
Pyral Magnetics

Quad

Racal-Zonal Group Services  
Radford Electronics  
Raindirk  
Richardson Electronics  
Rockwool  
Rola Celestion  
Rugby Automation Consultants

Scenic Sounds Equipment  
Shure Electronics  
Sonaplan  
Soundcraft Electronics  
Studio Republic  
Studio Sound  
Surrey Electronics

Tannoy  
Theatre Projects  
Trad Sales & Service  
Trident Audio Developments  
Turner Electrical Industries  
Tweed Audio

Uher (UK).

Veale & Associates, Edward  
Vitavox

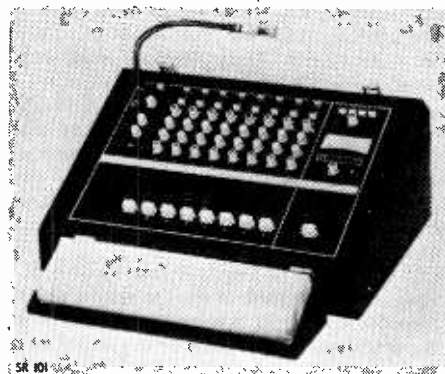
Webland Electronics

Zoot-Horn

Principle exhibit by Helios Electronics Ltd will be a music recording and re-mixing console designed and built for Release Records Ltd, Dublin. The console has 28 input channels, 16 main output groups and 24-track monitoring. The specification includes parametric equalization on all input channels and four echo sends with eight returns. Length of the console is less than 2m. New from Helios will be a rack mounting parametric equalizer. The unit has two independent channels, each with a four-section sweep equalizer, by-pass switch and overload indicator.

A range of acoustic screens will be exhibited by Sonaplan Ltd. Model A is designed for separating brass and woodwind from quieter sections of the orchestra. Model O has an observation window designed for vocalists, percussion and string sections where visual communication is desirable and Model S is a half size screen (1.05 × 1.00m) for rhythm sections.

Rupert Neve & Company Ltd who will be exhibiting at the show have released information about a new disc mastering system, the Neve/MSR 2000. This is the result of a joint venture between MSR Electronics Ltd and Rupert Neve to produce and market the mastering system on a worldwide basis. The lathe cuts monophonic and stereophonic production masters and direct replay acetates to the requirements of the recording industry and accommodates all standard record sizes. It has a range of four turntable speeds to facilitate half speed cutting of quadraphonic masters. The system offers such facilities as digital computer control of all functions, digital display readout of cutting suspension, a rumble-free servo-control turntable, turntable speed indication by electronic strobe and automatic groove compensation.



*Focal point of the Shure display will be the recently introduced SR line of sound reinforcement equipment. The SR101 mixing console when used with the SR106 electronic crossover, SR105 power amplifier and SR108 two-way horn loaded speaker units forms a complete sound system.*

# Letters to the Editor

---



---

## THE CONSULTANTS

---



---

As one of those interviewed last year by John Dwyer, I have read and followed with interest his article "The Consultants" published in the November 1975 issue, and the correspondence resulting from it. By and large, I found it a fairly well balanced commentary though, perhaps rightly, a little pointed. Not every conclusion he draws is accurate, and since others of your correspondents seem to have misinterpreted my views, perhaps I may be allowed to clarify them.

First of all, I know of no conscientious professional who is also a "26 hour a week" man. This time, as John Dwyer correctly quoted, is easily spent in the preparation and presentation of lecture and tutorial classes, but undergraduate students of engineering are not trained simply with a stick of chalk. Additional to this is the time necessarily spent on the development of a programme of laboratory experiments, projects and research, their supervision, examination and coursework assessment, the organisation and revision of these and other, new courses of conferences, my own registered research and participation in the Polytechnic's Faculty committees, in forming its long term academic plans. Those not qualified to teach might be forgiven for overlooking many of our responsibilities, but I hope they will at least take note of them.

I would have thought that James Moir and those of his calibre need have no fear of a little competition, whilst others have allowed this age-old reason for resentment to colour their judgment. Thus Gordon King (his letter, April 1976 issue) seems to think that an academically-based professional should not be paid for the work he does on commercial development or sponsored research projects. If that were the case, then some of the criticisms levelled at consultants in these columns recently, might eventually become more justified.

The same lack of judgment is evident in Mr King's interpretation of my comments about consultancy fees; it is because I do not wish the profit motive to dominate my work, as it must not, that I do not request high fees. There are other reasons why I want to see the excellent facilities in the PNL Acoustics Laboratory maintained and developed, which I thought were made clear in the article; not firstly to serve the hi-fi press, but to serve the best interests of my undergraduates. My consultancy work has assisted greatly in this; and it has created good will with certain sections of the engineering

industry, and it has benefitted our laboratory facility. Recently, as a result of some such work, an instrument worth ten times the fee we received, was donated, at my request, to the Acoustics Laboratory at PNL. Private consultants are not unique in having professional integrity and responsibility.

Finally, I would like to echo the major point made by C. A. Henn-Collins (also April 1976 issue) about the crucial importance of the consultant's impartiality, especially when he must earn a living from both company development and consumer review work. Obviously, the two undertakings have contrasting purposes, one for the manufacturer, the other for the user, and must always be viewed accordingly. My position as an academically based consultant affords me the privilege of being able freely to observe this distinction.

Roger C. Driscoll,  
The Polytechnic of North London.

---



---

## CITIZENS' BAND IN THE UK?

---



---

The consensus of the various references to Citizens' Band radio in your March issue seems to suggest that if CB ever comes to Britain, it will come at 27MHz. Surely this is not necessary.

If we are to have a Citizens' Band, and I hope we are, we would be far better advised to have one operating at v.h.f. with narrow band f.m. This would have many advantages over 27 MHz a.m., including reduced t.v.i. and b.c.i., less chance of interference during sunspot maxima, and smaller antennas. Such v.h.f. transceivers would be somewhat more expensive than 27MHz ones, but if such firms as Yaesu Musen, Inoue, Standard and Trio can make v.h.f. transceivers (for the 2-metre amateur market) for well under £100, I am sure that they can do even better for the much larger CB market.

I know that there is considerable pressure on the v.h.f. spectrum, but surely there must be six to ten channels somewhere between 60 and 300 MHz which could be allocated for this purpose — if e.r.p. is limited even this small number is unlikely to be too congested. A further refinement would be to incorporate a station identifying circuit which causes a tone sequence to be transmitted each time a transmitter is keyed. This could serve the dual purpose of uniquely identifying each transmitter and of acting as a selective call system — more sophisticated receivers could be set to unquench only on a call from a particular transmitter.

I feel that there will soon be a strong political demand for CB. I hope that when it comes, the Home Office will have plans ready — perhaps similar to those outlined above — and will not have an unsuitable 27 MHz system forced upon it from above for lack of a planned alternative.

James M. Bryant,  
Cheltenham,  
Glos.

Unlike Mr Webber I do feel that the introduction of Citizens' Band radio facilities in the UK would lead to abuse, caused by ignorance on the part of the user and commercial exploitation. If there is a need for a Citizens' Band in the UK then let it be

introduced in the u.h.f. bands and not in the 27 MHz band.

I and many thousands share a few hundred kilohertz of the 27-MHz band for model radio control. We already suffer from having several hundred pounds' worth of aeroplane and radio equipment "shot down" by the illegal use of walkie-talkies. If CB radio is introduced we may all be grounded. As a professional engineer and a keen modeller I protest!

L. K. Anderson,  
Braunton,  
Devon

---



---

## MICROPROCESSORS OVERSOLD?

---



---

Mr Hill has indeed made a number of valid points. Microprocessor technology is very new and by almost everyone's judgement, it has very great potential in the future. This therefore means that microprocessors have attracted considerable publicity in most of the media.

Mr Hill makes the point that the microprocessor chip cannot operate in isolation. This is, of course, true. The microprocessor only becomes a useful microcomputer when attached to memory devices and input/output interfaces, but already due to large-scale production these devices are very inexpensive for what they are. I think the semiconductor industry has proved that once a product goes into large scale production, costs fall dramatically. An example of this is the electronic calculator which, less than two years ago, would have cost £100 and is now available for less than £10. Significant microcomputer systems can be built now in only moderate volume for less than £40.

Mr Hill mentions the "shock situation" facing engineers wanting to use microprocessors in that they must learn some programming. I am sure that the majority of electronic engineers are well able to cope with learning a new technique and history proves that this is so, for every generation of engineers has had to learn to handle new technologies. In less than two decades, the industry has moved from the valve technology, through discrete semiconductors into the integrated circuit, with an aplomb that must have amazed some of the early experimenters and we are sure that the younger engineers will move into even higher levels of technology in the future without too much difficulty.

So, in answer to Mr Hill, I say yes, the engineers will have to learn programming but it is not that complex. The support hardware to help them to produce and debug programmes is available now and will be available in design centres all round the country in the future. Even if a company decides to buy some programme and system-proving hardware, it is no more expensive than a complex oscilloscope.

As Mr Hill says, the microprocessor is here to stay and indeed we are glad to see that he suggests an intelligent approach to dispel the image that it is the panacea for all ills, because, used intelligently, it can solve many problems of today and will obviously solve many problems in the future. We, as a company, are trying to educate the engineering fraternity and would be prepared to help Mr Hill in any way we can and I am sure this is true of all other semiconductor

manufacturers concerned in the development of microprocessors.

Yes, we agree, let us get together so that the learning is made less difficult.

Vic Yates,  
Motorola Ltd,  
Wembley,  
Middlesex.

When something important happens, like the introduction of the microcomputer, many claims are likely to be made as to the power and capability of the technology. Sometimes these claims are exaggerated and may, therefore, be misleading. You will sometimes find that such claims are made by individuals who have not yet acquired a full grasp of the subject or by companies who enter the new field late and are trying to establish themselves quickly.

However, I feel that Mr Hill's claim that much of the published material on microprocessors is misleading could also be construed to be an exaggeration in itself, since the bulk of this published information is in the form of technical data sheets and instruction manuals.

Now let us have a look at microcomputer systems to see if Mr Hill's other claims are justified. At the low end of the microcomputer spectrum it is possible to construct a powerful calculator-like system with just four chips: the 4040 c.p.u. the 4201 clock generator, a 4001 r.o.m. to hold the programme and a 4269 interface chip. This system will interface directly to encoded or non-encoded keyboards (up to 128 keys) and will drive a variety of multi-digit display devices. The display registers in the 4269 are used as read/write memory. If more r.a.m. is required, this can be provided by an additional chip. The system can be further expanded by adding a 4265 interface chip which will provide four four-bit ports, any of which can be inputs or outputs. These ports can be synchronous or asynchronous. The 4265 also incorporates all the logic necessary for 'handshaking' with a peripheral. These various options are selected by the software.

The important point here is that two chips provided a full keyboard and display interface, 16 programmable I/O lines and all the logic necessary to control a very wide variety of peripheral devices.

The same principles apply to 8-bit microcomputers. Interface chips are available that approach the c.p.u. in terms of internal complexity and which will provide serial, parallel, synchronous, asynchronous and bidirectional inputs and outputs. These chips also contain a great deal of sophisticated control logic, which relieves the c.p.u. from many of the repetitive and mundane tasks needed to service some peripherals.

A company which is about to use a microcomputer as the processing element in a piece of equipment that is being designed for production, will purchase a development system such as the MDS (see *Wireless World*, February 1976, page 40) which will provide the necessary teletype interface and interfaces for other peripheral equipment that might be needed for the project. In addition, the MDS will provide all the other aids required such as hardware and software development and diagnostic facilities. The cost of the MDS will be amortized over all

the systems that are to be produced in this, and future, microprocessor projects.

The alternative to a microcomputer design is to use t.t.l. logic which, if the system is not a simple one, will involve a considerable amount of design effort. Once designed and in prototype form it is difficult, and expensive, to make changes since, amongst other things, circuit board artwork will have to be changed.

The microcomputer is controlled by a programme of instructions stored in read-only memory (r.o.m.). The more complex the task to be performed, the more r.o.m. will be needed. It can be said, therefore, that the r.o.m. in a microcomputer system is being used to replace the gates in a t.t.l. system. It takes between 8 and 16 bits of r.o.m. to form the equivalent of a gate. Since an average small or large-scale t.t.l. circuit contains an average of 10 gates, between 80 and 160 bits of r.o.m. are needed to replace each package. Memories are available with capacities of up to 16kbits and a r.o.m. of this size will replace between 100 and 200 gates.

It can be shown that a microcomputer replacement for a t.t.l. system requiring between 130 and 140 gates will take two circuit boards less, will consume about 14W less power and will save more than 130 cubic inches of space. This means real savings in production costs.

If we take a microprocessor equivalent of a 75-gate logic system of which 100 a year are going to be produced and include all component and production costs, it can be shown that the t.t.l. system will cost in the region of £56 and the microprocessor about £41.

A company starting on their first microcomputer design project can expect to spend around £5,000 on equipment and will take about six months to get an average system into production. This will add about another £5,000 to the cost of the project. On a second design project, using the same microcomputer family, the company will have zero capital expenditure (since they already have the equipment) and could expect to have a similar sized system in production in three to four months (since they have acquired the necessary expertise).

While writing, I would also like to comment on the statement made by J. O. Owen in the February issue, that "PL/M reduces the number of lines of programme by a factor of ten." This is somewhat misleading and, if I may beg a little more space, I would like to explain why.

What must be kept in mind is that when a microcomputer system is designed, it is usually intended that a fairly large number of identical systems are going to be produced. We know that a microcomputer is controlled by binary coded instructions stored in a read-only memory. These binary instructions are normally produced by a computer from a source programme which can either be written in the high-level compiler language PL/M or in assembly language. It is a fact of life that a source programme written in PL/M will be much shorter than an equivalent assembly language programme. The assembly language programme will, however, result in less machine code than the equivalent PL/M programme. Usually, therefore, the assembly language programme will make more efficient use of the programme store since fewer bytes will be needed, and the saving in memory capacity per system will be multiplied by the number of systems to be produced. In cash terms, the actual saving in

memory cost will depend on the type of memory being used.

On the other side of the coin, it is much cheaper to write a programme in PL/M because it takes far less time. Therefore, the increased cost of writing an assembly language programme must be set against the likely savings on memory components.

As a general rule of thumb, it is more cost effective to use PL/M for systems which are not going to be produced in large quantities – say, below 1,000 systems if mask-programmed r.o.m. is used or below 100 systems if e.p.r.o.m. is used.

If the programme is very large or very complex, it is probably better to use PL/M regardless of the size of the envisaged production run since, in these circumstances, inefficiencies can be introduced by the programmer writing in assembly language.

Keith Chapple  
U.K. Manager  
Intel Corporation (UK) Ltd  
Oxford

---

## ELECTRODYNAMICALLY INDUCED E.M.F.

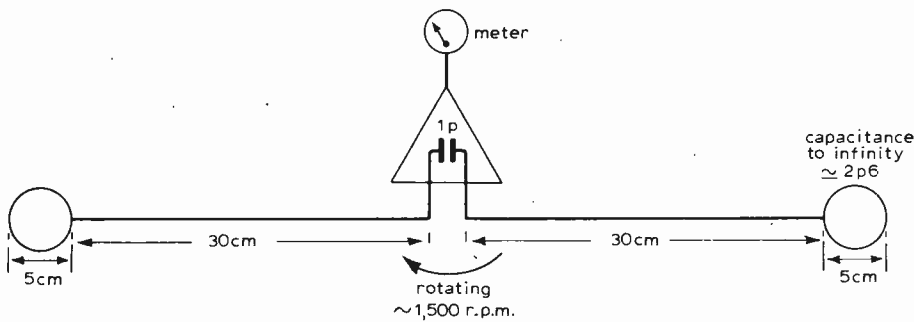
---

The opinions and proofs relating to this old problem as expressed by "Cathode Ray" and Messrs Smith and Masson all make good sense to me. It is clear that regardless of screening no e.m.f. will be measured. I personally do not need to look for proof as the following facts show.

An important measurement in oilwells is the spontaneous potential generated by telluric currents of various sources between a downhole electrode and a surface electrode. This is made by an insulated conductor screened with two layers of steel cable which is partially spooled on a winch drum. It is a fact that if the winch is mounted on a moving barge, the EMF induced in the coiled drum by the earth's field appears as a "noise" on the signal. It is effectively eliminated by mounting a small coil in series opposition in the same field. This coil need not be screened. Again, I would ask any doubting Thomases "Would electric motors, whose conductors are often totally surrounded by iron, work if the iron was effective in screening them?"

"Cathode Ray" (September 1975 Letters) suggests cutting the dipole and inserting a perfect field-effect device to measure the e.m.f. This raises a very interesting point. When he does this, will the capacitance across any real device destroy the effect? In school physics texts we read that a sphere has a capacitance to infinity, whatever that may mean, equal to its radius. If, then we put spheres on the ends of our dipole the theoretical measurement once again becomes practical, because the capacitance created will override, the effect of capacitance across the amplifier. As "Cathode Ray" points out, the signal must be made into a.c. by rotating it. This will not change its magnitude. The experiment is not only feasible, it can be made with existing semiconductors as the signals, assuming reasonable dimensions of the apparatus, are well above the noise level. Furthermore I have obtained the necessary field-effect amplifier and would like to invite anyone with the time to spare to make the experiment.

What will we measure? Originally I was



attempting to devise an absolute speedometer for a sailing boat. I fear, though, that what we will actually measure will be the differential component of the changing earth's magnetic field.

I include a sketch of the apparatus as I designed it some years ago. There is no need for slip rings because it is battery operated the whole thing can rotate. There exist a number of output displays which would be legible even if rotating at high speed.

R. Hunt-Grubbe,  
University of Reading.

I was interested to read in your December 1975 issue Mr Gray's comments on my letter in the September issue, but I continue to maintain that the electric field perceived from the aircraft is real. Far from contradicting the principle of relativity, it is in fact a direct corollary. If the electric field were in any way unreal then the observer on the aircraft would be able to detect this and determine his state of motion without any external reference.

A correct description of the situation would be something like the following: Knowing the values of electric and magnetic fields measured in the aircraft, the navigator may calculate his velocity relative to the inertial frame in which the electric field is zero. Then, from the information that the electric field measured by a ground-based observer is zero, he is able to identify this calculated velocity with the speed of the aircraft relative to the earth.

I would also like to take issue with the other point raised in Mr Gray's letter. Unfortunately I have not been able to find a copy of his reference so I can only comment on his statement that "relative motion between a conductor and the system within which the conductor e.m.f. is to be detected is a basic requirement for electrodynamic induction of e.m.f. in the conductor". This may be refuted by a simple experiment in which a coil of wire is connected to the terminals of a meter. The insertion of a bar magnet into the coil causes an e.m.f. to be induced and the resulting current is indicated by the meter. Relative motion is, indeed, involved but not between the conductor and detector. Other examples may readily be adduced.

"Cathode Ray's" arrangement should work since, as the conductor is rotated, the electrons within it must be periodically redistributed to maintain an equipotential surface (as seen from the aircraft). The meter in the centre of the conductor will register an alternating current constituted by the flow of these electrons.

Colin Masson,  
Cambridge.

Assuming that magnetic field uniformity is still conditional, in the continuing correspondence relating to Electro-dynamically

Induced E.M.F. (Cathode Ray's letter in your February issue), I retain my belief that Einstein's axiom is fundamental to the matter under consideration.

I cannot see that Cathode Ray's reference to "the measurement of relative velocity with reference to a field in another system" has any meaning; though I would agree to a condition of velocity of the field's source, relative to the conductor with which the observer is travelling, which returns one to my original argument. Detection of the field's velocity is another matter, for which I suggest that non-uniformity is a necessity.

Acceptance of the argument for "electrodynamic" detection of absolute conductor motion would require acceptance of induced e.m.f.s in a multitude of superficial conductors, moving with the earth and within its magnetic field; and I am not aware that these have become manifest.

John Gray,  
College of Technology,  
Belfast.

## WAS BAIRD FOOLING THE PUBLIC?

THE letter "Was Baird Fooling The Public?" from Mr H. F. Haynes in the April 76 issue, is, I think, likely to cause confusion among readers trying to follow the various articles about the Baird half-centenary. The original article by Messrs. Waddell, Smith and Sanderson, to which Mr Haynes refers, was purely concerned with the period 1925 to 1928 about which information is sparse and frequently contradictory, thanks partly to Baird's own passion for secrecy, a trait shared by many of his contemporary rivals.

But the 30-line story extends to September 1935 (at least) and about these later years there is no shortage of information, since that august body, the BBC, was itself responsible for the regular programme of news and entertainment until December 1935. The "Televisor" referred to by Mr Haynes, in spite of many subsequent mechanical (and even electronic) rivals, continued to be the most popular type of receiver until the termination of the 30-line service, probably because of its basic simplicity, reliability and relative cheapness.

As for "synchronization over a distance" during these later years, the toothed wheel device, covered by a Baird patent, gave adequate results within the transmitter's reception limits, which were very extensive.

Whether the 30-line service gave acceptable standards for entertainment purposes, is perhaps a matter for debate. The recent practical demonstrations of the mechanical low-definition techniques by Mr E. W. Elliott

at the University of Strathclyde and on the BBC programme "Blue Peter", and public shows by the Low Definition Television Association, have given a modern generation the chance to judge this issue in a direct and subjective way instead of by the largely sterile method of literary research.

Certainly, if one judges the techniques by the calibre of the artistes offering their services to the BBC for 30-line entertainments, one cannot fail to be impressed. A glance through the TV programmes of 1934 and 1935 resulted in a list of names that included some of the "top liners" of the period, all by courtesy of various kinds of "trundling mechanical image analyser" which remained supreme at both ends of the television process until the demise of the BBC service in September 35.

D. B. Pitt,  
Chairman, Low Definition  
Television Association,  
Nottingham

Mr Haynes in a recent letter to the editor, *Wireless World*, April 1976, p.52, "Was Baird fooling the public?" mentions an article written by myself and others, "John Logie Baird and the Falkirk Transmitter", *Wireless World*, January 1976, pp.43-46.

I feel it is Mr Haynes who is fooling the public, not John Baird. The statement in his letter that Radio Societies were amused is inaccurate. Over 600 people attended Baird's lecture, in November 1943, to the Institute of Radio Engineers in London, the lecture being on all-electronic, 3D colour television, a subject in which Baird could reliably be said to be leading the world. The Hankey Committee produced in 1945 a white paper on the future of British television. Up to 1,000 lines with 3D and colour were amongst the recommendations but, to that date, only Baird had demonstrated all three.

Mention is made of *Wireless World* remaining silent: this is grossly inaccurate. Following the E.M.I.-Marconi and Baird TV demonstrations at Alexandra Palace (November 1936 - Feb. 1937) Baird resumed cinema colour television, a world first. *Wireless World* reported this pioneering work and gave it much praise on February 17th, 1938, p.148, and August 17th, 1939.

Mr Haynes comments that Baird tried, in the late 1920's, to sell by pretence. This is inaccurate; newspaper articles by Baird in late 1928 stated that he was not yet prepared to sell television to the public on a production basis - keen amateurs could procure kits and check for reception.

I do not recollect in my article asking for "a serious study of the business and technical aspects of Baird's 30-line TV work." I asked simply for any photographic or written proof of what Baird used for TV equipment from late 1924 until early 1928. Mention is made by Mr Haynes of no synchronization: this is a strange comment, considering Baird's London-to-Glasgow demonstration in May 1927 and his transatlantic demonstration of February 1928!

Mr Haynes says that fibre optics were "well known" and not requiring synchronization. This is again inaccurate: Baird's patent (1927) on multi-fibre tube bundles was a world first, so how it could be well known to him beats me, he had to invent it first! Fibre optics still required synchronization; the fibres only eliminated a rotating lensed disc to dissect the transmitter image, but the receiver still had to be synchronized to the transmitter.

I have in my possession information on

John Baird which will, on publication, do much to redress the comments still being made against Baird. I am not ashamed to admit that I admire John Baird's many talents and to state that in my opinion the treatment he received in this country in the lack of scientific awards and credits is little short of a national disgrace.

Dr P. Wassell,  
University of Strathclyde,  
Glasgow

I feel I cannot let Mr Haynes' letter in your April issue pass without comment because in one respect at least, in his last sentence, it is factually incorrect.

The *Wireless World* did not remain silent. This may be checked by reference to your issue for 12 March, 1930. On page 277 you said in the first paragraph of an article . . . "At last a Baird television receiver built for sale to the public has arrived. As no commercial product can live that does not fulfil the purpose for which it is created, there is the obvious inference that this new apparatus functions in the way it should and that moving pictures can be received by the broadcast transmission. Without further preamble it can be stated that this receiver does give reception of images with sufficient definition to be readily intelligible." In the final paragraph of the article you said . . . "Such results will interest the enthusiast, and these have become possible since the adoption of the signal controlled toothed wheel method of synchronization first introduced towards the end of last year." The article also refers to an earlier article on p.282 of the issue for 18 September 1929 which reports the start of the 11-11.30 a.m. radio transmission from 2LO and illustrates the toothed wheel synchronizer. About this you said . . . "The aim is to provide for the rotation of a disc with a degree of constancy that after long periods of running must possess no cumulative error. In the Baird apparatus we find that this is accomplished by the phonic wheel method." You ended by saying . . . "a few facts as to the results may help others to appreciate clearly the degree of success at present obtainable. The image is viewed through a magnifier and possesses a slight, yet not tiring, flicker. Good brilliance is obtained, but with an excessive contrast between light and shade. A sitter at the transmitter is at once recognised, and his expressions considerably enhance his words which come from an adjoining loud speaker. With a little concentration one can note the time from a normal watch. Letters running past the transmitter in the manner of an advertising sign are clear and easily followed. These results, it is stated, will be obtainable on home equipment working on the broadcast service."

So, your impressions are clearly set down. But a quite different opinion was expressed in a third article in the issue for 18 December, 1929, on page 669. The author says . . . "Knowing that the real difficulty in television is that of synchronizing the revolving mechanism at transmitter and receiver, no inventor can claim success who does not first put forward a solution to this problem." He continues . . . "We know now that Baird had no important contribution to make in solving the synchronizing problem." The author of this article had applied considerable ingenuity in construction to improving the magnetic circuit of the synchronizer. It was unfortunate that he then coupled the light source and synchronizer to his output valve by a circuit different from that used by the Baird

television receiver. He added four expensive and unnecessary components (a choke, two 4 $\mu$ F capacitors and a variable resistor, roughly the cost of 2 to 3 weeks' lunches for a student at that time) which altered completely the shape of the synchronizing pulses. That the pulses were distorted seriously is shown by his own statement in the article that, from the appearance of the pictures, it seemed that the synchronizing pulses lasted for about half the length of a line. This finding, that a method which was different in a number of significant respects from Baird's did not work, clearly does nothing but show that the author had made a mistake. The mistake was entirely justifiable in the technical milieu of that time, but it remains a mistake. The author's name? I nearly forgot; it was F. H. Haynes!

Some of us who later made the simplest possible equipment (this was dictated by cost, not insight) found that synchronization could be held over sufficiently long periods for the pictures to be interesting. Fading of the radio signal, which was then being received in Manchester from the late night transmissions, was the biggest problem. In the comparison with the cinema at that time I would agree that the results were not commercially viable. Entertainment, in anything like the modern sense, had to wait until high frequency transmission made possible a 300 times increase in the picture information. Even then, some years passed before TV became a serious threat to the cinema.

However, the results that could be obtained were just as fascinating as listening on a one or two valve short wave receiver, to snatches of intelligible messages from all over the world. That was not commercially viable as a method of communication either. If the pictures had not been worthwhile there would have been none of the drive that led to a mirror drum receiver projecting a 7 $\times$  3 in picture and using a polarizer, analyser and Kerr cell to modulate the light source.

Should we not give Baird full credit for what he did do? True, others might have done it equally well. Professional engineers might have done it better. But none of them, if they tried at all, tried long enough or hard enough. What Baird did do, on a shoestring budget, by prolonged and concentrated effort is made clear in your reports. This surely seems worth full recognition.

Prof. G. D. Dawson, MSc.,  
Dept. of Physiology,  
University College,  
London.

I was very interested to read the letter in your April issue from F. H. Haynes on the claims made for Baird's contribution to the development of television. Those of your readers whose memories of W. W. go back to the 1920s may recall that Mr Haynes was its assistant editor. In that position he undoubtedly looked very closely into Baird's claims on behalf of W. W. and his conclusions should not therefore be dismissed out of hand.

Leslie Bailey in his "BBC Scrapbooks" (Vol 2: 1918-1939) reproduced the following advertisement which Baird inserted in the personal column of *The Times*. "SEEING by WIRELESS. - Inventor of apparatus wishes to hear from someone who will assist (not financially) in making working model. - Write Box . . . ." Mr Bailey's comments are: "Baird was not a trained scientist. Indeed, it is astonishing to know that his knowledge of radio techniques at this period was so limited that he went to the staff of *The Wireless World* for help over the design of

amplifiers. Mr Hugh S. Pocock, the then editor of that magazine, has written to Scrapbook: "I well remember Baird coming into the office and having a talk about his difficulties and particularly the problem of distortion which arose when he tried to amplify the shadow effects he was obtaining. We designed and built for him a suitable amplifier because at that time he had little knowledge of the correct design of distortionless amplifiers."

P. P. Eckersley, whose ability to cut down to size anyone who made unjustifiable claims is well known to members of the I.E.E. where he so frequently entered into discussions, after reading of papers, wrote in his 1941 book "The Power Behind The Microphone" that Baird possessed "that flair for picking about on the scrap-heap of unrelated discoveries and assembling the bits and pieces to make something work and so revealing possibilities if not finality."

I think it was Baird's obituary in 1948 that W. W. said he was the catalyst in the development of television.

H. W. Barnard,  
Leigh-on-Sea,  
Essex.

---

## PHASE AND SOUND QUALITY

---

Reading all those contributions on "phase effects in loudspeakers," I cannot escape from the impression that many experts do not dare to be too certain and prefer referring to the opinions of others instead. What is everybody so worried about? Undo the tweeter from your loudspeaker cabinet so that it stands off, an inch or so nearer to the listener's ear. The result is a change in phase relationship between the high- and the low-frequencies, right? An inch difference in path length corresponds with something in the order of a full wavelength for a tone of, say, 10 kHz. If this is not enough phase shift, move the tweeter further, a foot or so, so that the phase tumbles several times over and over before it reaches your ear. Better still, ask somebody to move the tweeter forward and backwards for you, so that there is a continuously varying phase shift between the high- and low-frequency components.

Why not try that on a rainy Sunday afternoon?

I did. With sounds of harpsichords, pianos, plucked strings, whole orchestras, voices, rushing water, white noise, square waves. And I eat my hat if I hear phase effects.

Hans Evers,  
Lammersdorf,  
Germany.

# Low-noise, low-cost cassette deck — 2

by J. L. Linsley Hood

Any convenient power supply circuit may be used for a.c. mains operation, provided that it can be set to give a stable, ripple-free output of 13.5-14V at output currents up to 250mA. A suitable design is shown in Fig. 8. The low-value resistor in the record amplifier supply line is to limit the supply line current surge through the changeover micro-switch when the large capacitor on this line is connected in parallel with the capacitor on the output of the power supply. To avoid noise originating from the pulsating current demand from the d.c. cassette-drive motor-control circuitry, the recorder supply is taken directly from the power supply reservoir capacitor through a 20Ω, 10W resistor, with the negative return line being also directly connected to the reservoir capacitor, rather than to a chassis return.

The chassis itself is only connected to the zero-volt line at the input to the replay amplifier.

## Recording and bias levels

One of the most obscure areas in the field of tape recording, in the eyes of the layman, is the interaction between tape types and biasing levels. While much

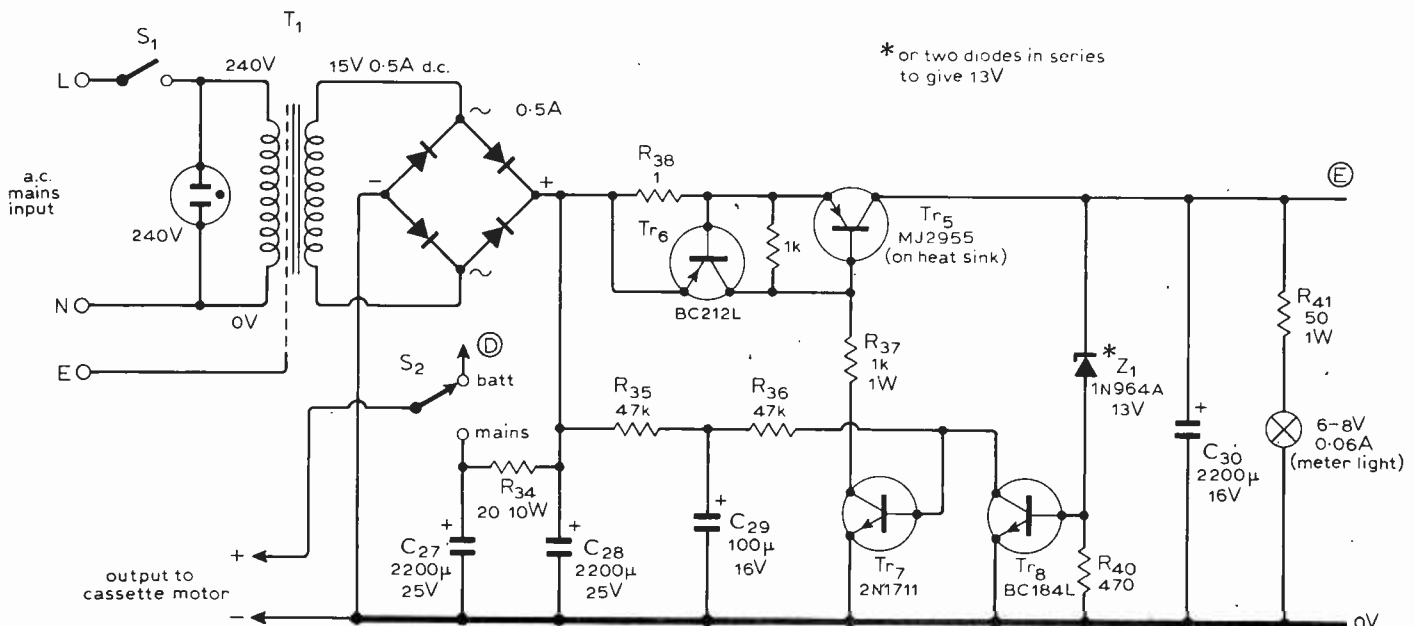
information has been published on this subject, it is often discussed in obscure terms which make the argument difficult to comprehend. Since it is possible that the construction of a cassette recorder of this type may be of interest to those with no previous experience in this medium, an attempt has been made to provide a simple introduction to this topic.

In general, it is not practicable to obtain an adequate remanent magnetic flux in a magnetic tape, for the reproduction of signal waveforms of low harmonic distortion and good output level, unless a high frequency "bias" of suitable magnitude is superimposed on the signal at the time of recording. The effect upon the various signal parameters of variations in the bias level is shown in schematic form in Fig. 9. From this it will be seen that there is not a single biasing level which is optimum for all recorded frequencies, and that the optimum level for 1kHz is in excess

of that which gives the highest output for, say, 10kHz. Also, the level which gives the lowest recorded noise level is less than that which gives the lowest t.h.d.

It is apparent from this that the setting of this parameter is one which demands some compromise, and the one which is chosen will depend upon the preferences of the user. In general, for cassette recorders, the chosen bias is that which gives the maximum output at 330Hz, or a slight excess of that optimum for 1kHz, and the reduction in output at higher frequencies is compensated by modifications to the record pre-emphasis curve. However, the required bias and compensation characteristics will be different from one make of tape to another, and from one design of record/replay head to another. In this design, the decision had been taken, partly in the interests of running costs, and partly in the interests of minimizing wear in the Permalloy heads, to optimize the design for "ferric" tapes rather than chrome types, and the Philips standard low noise C90 was taken as the reference. It was found, however, that the settings derived for this was also optimum for

Fig. 8. Power supply. The motor is fed with 3.5V by the stabilizer, but the solenoid is provided with the full 12-14V.



"super" tapes of the types exemplified by Memorex MRX<sub>2</sub>, and BASF Super LH, although these gave an improved performance.

In general, there is very little difference in the background "bulk-erased" noise levels of most good-quality commercial cassette tapes, although there will be larger differences between the noise outputs of tapes passed through a recorder set to record at zero signal level. The greater the degree of homogeneity of the tape oxide layer, the lower the zero-recorded-level noise will be, down to a minimum which depends on the fundamental granularity of the oxide medium. The recently introduced "super" series tapes have a more uniform oxide coating, which can give a 1-2dB zero-signal background level improvement.

However, there are also improvements which have been made in the output level and harmonic distortion for a given output level, due to a more careful balance of grain shapes and sizes. The extra 2-3dB in output can lead, in total, to a small though audible improvement in overall signal-to-noise ratio (some typical results are shown in Fig. 11, and Table 1.) Useful though this is, a far greater capacity for improvement in overall performance lies in the hands of the user in a careful choice of the recording level setting. Ideally, one should record at as high a level as possible, so long as few signal peaks significantly exceed the DVU level. A 1-2dB excess is unlikely to be noticed in replay, especially with good tape, provided that the duration of overrun is brief, and the difference in s/n ratio from "correct" to over-cautious choice of record levels can readily exceed the difference between a cheap tape and an expensive one.

Probably the best way of choosing recording levels is to set the mechanism to Record but with the pause button pushed in, and in this condition to experiment with the gain settings until the optimum setting is found, when the recording can be started. In the case of a live performance, assuming one has the co-operation of the performers, it is usually possible to persuade them to execute a known fortissimo and set the record levels appropriately for this.

**Noise characteristics of the system**

During the development of this circuit, the sources of noise in the system were investigated at some length, since, although it was envisaged that some form of external noise-reduction system would be incorporated for use during replay, it seemed advisable to try to minimize noise in the design before taking additional palliative action. The reduction of noise in the replay circuit has already been described; if the unweighted noise level at this stage, without tape, is taken as the unit, the bulk-erased-tape noise level corresponds to about one and a half or two units, and the zero-record-level noise

(with the circuit parameters arranged in accordance with normal practice) was then equivalent to some five or six units.

Obviously there was little that could be done about the noise level of the tape, as received, but it seemed that quite a lot could or should be done about the 14dB worsening of this during no-signal recording. Indeed, if it were possible to get down to the level of the original tape, the overall performance would have been beyond reproach, in

spite of the low tape speed and narrow tape width. An additional piece of evidence which seemed of interest was that the replayed noise was "whiter" than would have been expected from an original white-noise source (i.e., the tape) when replayed through the type of equalizing characteristic employed in the replay amplifier. This seemed to be a common characteristic of commercial cassette recorders, which all sounded "whiter" on the replay noise tone than

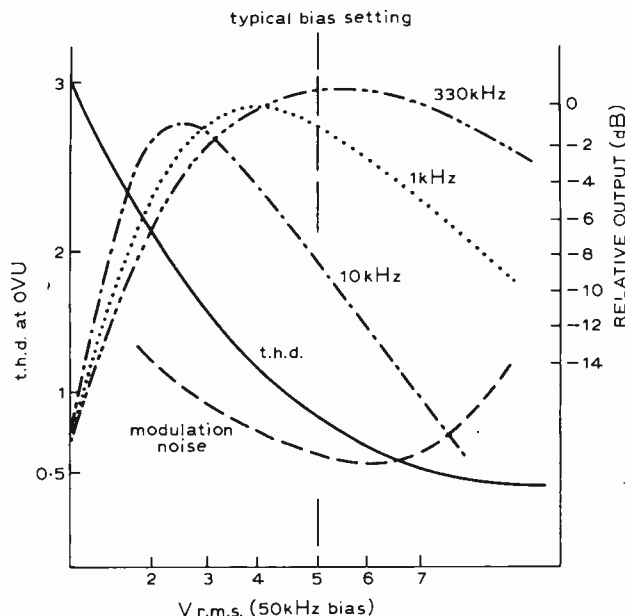


Fig. 9. The effects of changes in the h.f. bias level on output, t.h.d. and modulation noise.

Fig. 10. Record/replay frequency/amplitude curves for a variety of tapes, optimized for maximum flatness and for best square-wave reproduction

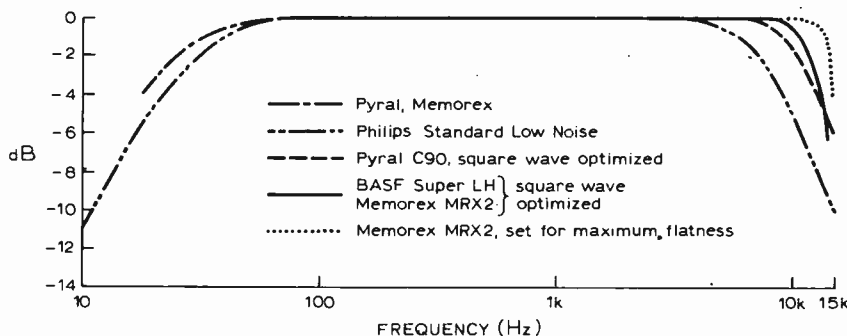


Table 1.

Relative output at 660Hz (0VU recording level)	
Philips Standard C90	0VU (+0dB)
Pyral C90	+2dB
Memorex MRX <sub>2</sub> C90	+2dB
BASF Super LH C90	+3.5dB

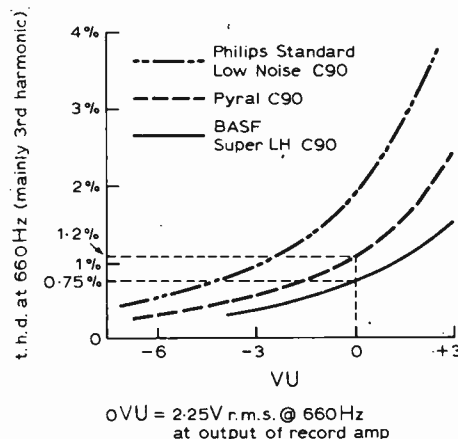


Fig. 11. Harmonic distortion (including noise) as a function of recording level for three types of tape.

seemed reasonable to expect. It was also observed that changes in the level, frequency or shape of the bias waveform made no difference to the result. The conclusion began to grow that the problem was due to generally-distributed noise, in the source and record amplifier, being selectively amplified in the 10-15 kHz band and applied to the tape at high levels through excessive signal pre-emphasis.

Having become convinced on this point, the attempt was made to determine the optimum compromise between flatness of frequency response and signal-to-noise ratio for a given record level. At this stage it was found that optimization of a recorded 1kHz square wave to reduce the initial overshoot and ringing found when more conventional magnitudes of pre-

emphasis were applied gave also the best performance compromise on bandwidth against s/n ratio. The bias levels found during this exercise were compared to those obtained by more conventional setting-up procedures, and found to be substantially identical. However, the zero-signal-level recorded noise was found to have been reduced by about 10dB by the process of square-wave optimizing, as compared to that given by frequency response optimizing. The two curves are shown in Fig. 10, and it will be seen that the h.f. loss amounts to only 1dB at 10kHz and some 4dB at 14kHz, which can be remedied by the use of amplifier tone controls on replay with very little detriment to performance.

The final conclusion is that in general far more h.f. pre-emphasis is employed

on recording, in the interests of maximum flatness of the published response curves, than is sensible in the light of the overall performance, and that with more prudence exercised in this respect, noticeable improvements could well be made. Interestingly, programme recordings made before and after optimizing of the square-wave performance of the recorder did not show the expected small loss of higher frequencies, with the upper register seeming both cleaner and more extended than before, possibly due to the lessening of the incidence of h.f. tape or head saturation.

One final recommendation in this respect is that for one's own use, even on ferric tapes, the 70µs characteristic should be used both on record and replay. However, this is a choice which can be assessed readily by individual experiment. Certainly, in the case of the author's prototype, the use of this equalizing time-constant, in association with an optimized square-wave characteristic, has given a system in which the tape noise, on a good quality tape, is sufficiently unobtrusive to render further noise reducing circuitry unnecessary.

**Bias and equalization settings**

It will be apparent from Fig. 9 that adjustment of the h.f. bias level of the recorder will have the effect of altering the whole response curve, by altering the effective recorded levels of the h.f. and l.f. components relative to one another, and it may therefore appear difficult to optimize either the bias or the equalization. The suggested method is therefore as follows:

- Set VR<sub>2</sub> so that the response curve on record is as curve A on Fig. 5., (approx. 85Ω) when measured at the output of IC<sub>3</sub>.
- Set the bias level so that there is approximately a 1-2dB drop in output at 1kHz.
- Record a square wave at 660Hz, and make small adjustments to VR<sub>2</sub> until the cleanest leading edge is obtained on the replayed square wave, with only a small single overshoot.
- Finally, leaving VR<sub>2</sub> set at the chosen value, record a 660Hz square-wave at various bias levels and adopt the one which gives the best overall square-wave shape for the tape which it is desired to employ.

The technique of square-wave optimization is well known in the audio field as a means for setting tone-controls and filters to optimum flatness, because of the facility which it offers for a simultaneous examination of a wide range of frequencies. On exactly the same score it would appear to be an excellent method of optimizing bias levels.

While it is hoped that the performance given by the prototype will prove to be fairly typical of the results given by other models built to this design, it is appreciated that in a system in which

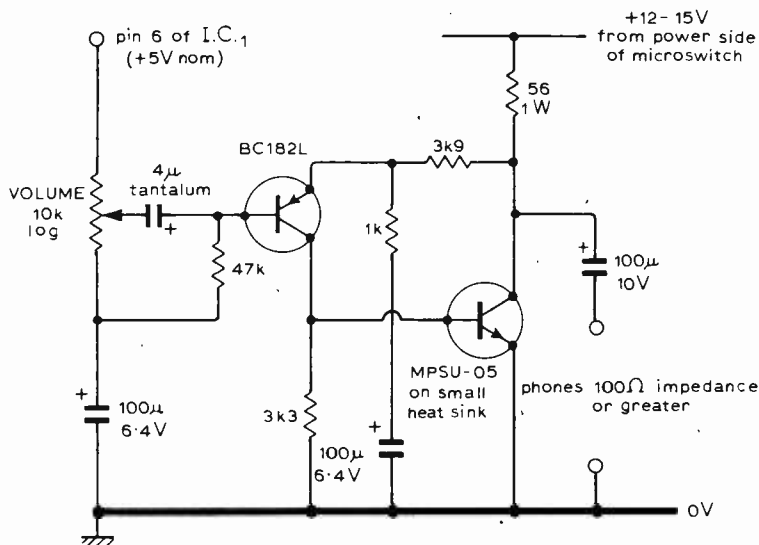
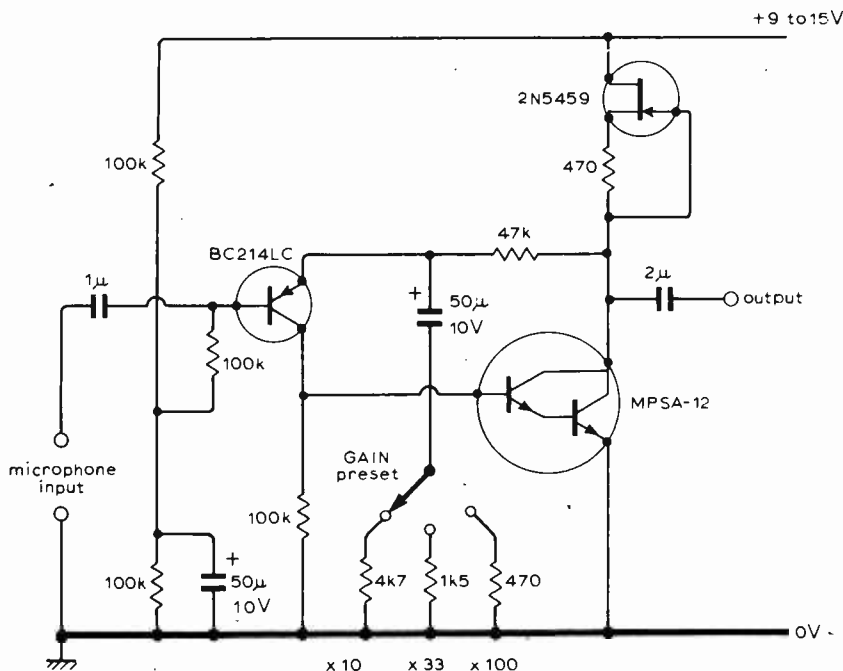


Fig. 12. Class A headphone amplifier, with a gain of 5.

Fig. 13. Low-noise microphone pre-amplifier.





not only will components vary in types and tolerances, but also the tape transport mechanism and heads (which may be changed during the manufacturer's production run for reasons of commercial availability) may differ from those used by the author, the scope for variability is considerable. Also, from personal experience, and measurements, there is a considerable variation in performance from one tape type to another, although the consistency of performance of the better-grade tapes from the better manufacturers appears to be fairly good. On the credit side may be set the fact that one does not have quality control problems in a unit that is one-off, and that one can optimize one's channel balance and h.f. performance for the tapes one prefers and the heads one happens to possess.

**Headphone operation**

Both the output level and the drive capability of the final 741s of the replay amplifier are adequate to give a satisfactory signal strength and quality into the 2kΩ load impedance of the author's headphones (Sennheiser HD414), so, for simplicity, this was the course adopted. However, for those with lower-impedance or less-sensitive headphones, a suitable circuit is shown in Fig. 12. This operates in class A, and is suitable for load impedances down to 100 ohms.

**Direct microphone recording**

The sensitivity of the record input is only intended to be sufficient for recording from an existing audio amplifier or radio tuner capable of delivering some 50-100mV output at a fairly low impedance, and it would not be suitable for microphone inputs. For this purpose a pre-amplifier can be used, of which a suitable circuit is shown in Fig. 13. Three preset gain positions are given, of 10, 33 and 100×, which should cope with the bulk of microphones likely to be found in practice. A typical gain suitable for a low-output cardioid capacitor electret microphone is of the order of 33, for a normal recording level at half-gain setting on the recorder.

Final details of the design will be in the final part, including information on the motor controller – lack of space prevents publication in this issue.

We are informed that components and metalwork for this design will be available from Hart Electronics, Penylan Mill, Oswestry.

**Appendix**

**Derivation of record equalisation characteristics.**

The generation of a recording pre-emphasis characteristic of the general form shown in Fig. 5 is normally done by incorporating a damped LC parallel resonant circuit in the feedback loop of an inverting amplifier stage. However,

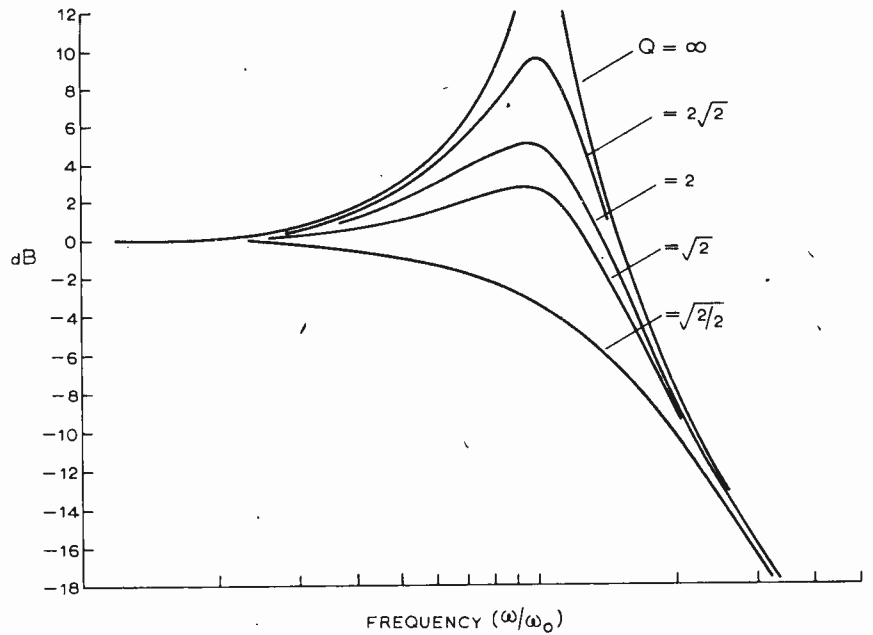


Fig. 15. Frequency/gain response of filter in Fig. 14.

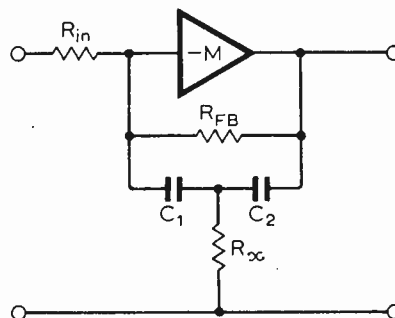


Fig. 14. Basic second-order active low-pass filter (as Reference 1).

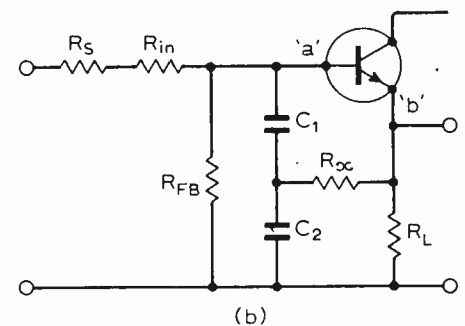
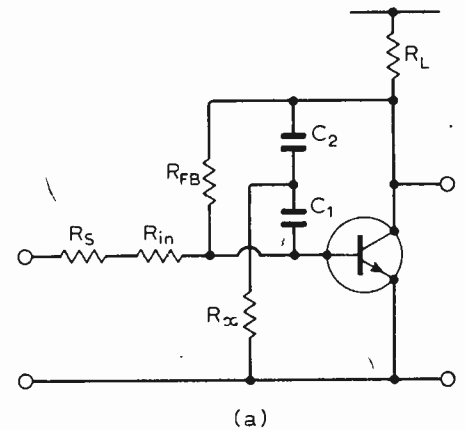


Fig. 16. Common-emitter (a) and common-collector (b) arrangements of basic circuit shown in Fig. 14.

since it was desired, in the interests of simplicity, to avoid the use of inductors, and it was also required to avoid possible trouble due to the intrusion of 38kHz signals from multiplex stereo decoders, the decision was made to use the gain/frequency characteristics of an under-damped second-order active low-pass filter, such as that shown in Fig. 14.

This is one of the classic forms of active element, and was analysed by Girling and Good<sup>1</sup> in the first part of their survey of active filters in *Wireless World*. It has a gain/frequency response of the type shown in equation (1) and

illustrated in Fig. 15 for various values of Q (1/α)

$$\frac{V_{out}}{V_{in}} = \frac{1 + j\alpha \frac{\omega}{\omega_c}}{1 + j\alpha \frac{\omega}{\omega_c} - \left(\frac{\omega}{\omega_c}\right)^2} \quad (1)$$

If this is redrawn, ignoring biasing, in the form in which the amplifying element is a single, common-emitter-connected transistor, as shown in Fig. 16(a), it will clearly be seen that this can be rearranged into the common-collector form of Fig. 16(b) without significant alteration of the expression for the

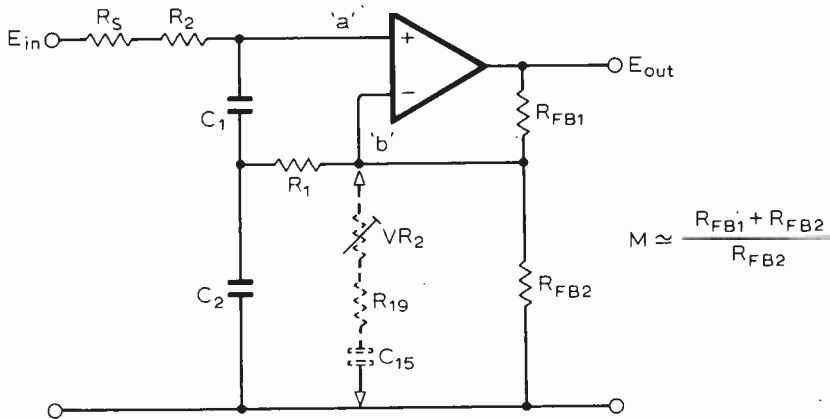


Fig. 17. Use of the active filter in a stage possessing gain, as in Fig. 4.

frequency response. (It was pointed out by Girling and Good that a similar rearrangement leads to the evolution of the filter circuit due to Sallen and Key<sup>2</sup> from the type based on a feedback loop containing an integrator and a lag, described earlier by Baxandall<sup>3</sup>.)

Filters of the type shown in Fig. 14, and 16(b) were used in the authors "Modular preamplifier" design (*Wireless World* July 1969) and the subsequent postscript to this and the earlier class A amplifier, published in December 1970. The performance of the circuit shown in Fig. 16(b) referred to as a bootstrap or "H" filter, was analysed by the author in another place<sup>4</sup> and, in a

different context, by Hemingway<sup>5</sup>.

The operation of the filter circuit of Fig. 16(b), like that of the Sallen and Key configuration, can be realised by any active element in which there is approximately unity gain between points "a" and "b". This allows the use, for example, of a voltage-follower operational amplifier as the active circuit element, or even a non-inverting operational amplifier having more than unity gain, as shown in Fig. 17, provided that an adequate feedback gain margin is available at the frequency of interest. The gain and frequency of maximum response of such a circuit is given by equations (3) and (4) where M is the

normal gain of the stage with feedback.

$$f_c \approx \frac{1}{2\pi \sqrt{[C_3 C_4 R_1 (R_2 + R_5)]}} \quad (3)$$

$$\left| \frac{E_{out}}{E_{in}} \right| = M \left( 1 + \frac{(R_2 + R_5)}{R_1} \frac{C_1 C_2}{(C_1 + C_2)^2} \right) \quad (4)$$

While, basically, the Q of the system is determined by the ratios of  $R_1 : R_2 + R_5$  in a stage with a shunt network, such as that of VR<sub>2</sub>, R<sub>19</sub> and C<sub>15</sub> in Fig. 4, the gain will change in the frequency region of the filter attenuation band. The associated phase shift due to this network also modifies the Q and allows adjustment of this by VR<sub>2</sub>, which is a feature of some practical convenience.

## References

1. Girling, F. E. J., and Good, E. F., *Wireless World*, vol. 75, No. 1406, pp 348-352.
2. Sallen, R. P., and Key, E. L., *Trans. IRE.*, vol. 2, No. 1, pp. 74-85.
3. Baxandall, P. J., *Wireless World*, vol. 61., No. 1, pp. 8-14.
4. Linsley Hood, J. L., *Hi-Fi News and Record Review*, vol. 18, No. 2., pp. 293-294.
5. Hemingway, T. K., *Electronic Designers Handbook*, pp. 283-288.

## Component supplies

Goldring-Lenco CRV cassette mechanisms can be obtained from Goldring Ltd, 10 Bayford St, Hackney, London E8 3SE, or Hart Electronics, Penylan Mill, Oswestry, Salop. VU meters are available from J. E. T. Electronics, 90a Mawney Road, Romford, Essex.

## Books Received

According to its sleeve note **Problems and Solutions in Logic Design** by Prof. D. Zissos, makes easy and reliable logic design techniques available to those with no specialist knowledge of mathematics or engineering. Even those who are not familiar with Boolean algebra will find an appendix giving sufficient foundation for the rest of the book. The emphasis throughout is on optimal rather than strictly minimal designs which have become less important with the availability of integrated circuits. In the case of sequential circuits, these allow hazard-free designs for the realistic engineering constraint of a maximum variation of 33½% in gate speed. A feature of the book is the comprehensive set of problems and solutions at the end of each chapter. These have been chosen to appeal to the student and include the design of logic circuits for traffic lights, a panel game, digital clocks and electronic dice. For the practising engineer solutions are given for commonly used circuits such as flat sorters, shaft encoders and counters. After an introduction to the basic concepts of logic design, the chapters deal with unlocked sequential circuits, clocked sequential circuits, counters and combinational circuits. The design pattern used

throughout the book was developed by Prof. Zissos several years ago and is now gaining rapid acceptance. The technique involves the conversion of a design problem into a flow diagram which can be converted directly into the basic logic equations before the circuit is then drawn. The three stages are analogous to flow charting, writing the software statements and executing a computer programme. An important feature is that the documentation is inherent in the design. The use of state diagrams and sequential equations eliminates confusion in verbal statements. Price £1.75. Pp.146. Oxford University Press, 37 Dover Street, London W1X 4AH.

**High Speed Pulse Techniques** by J. A. Coebin describes the nature of pulse signals and the deliberate or inadvertent processing of them. The emphasis is on an appreciation of circuit and system behaviour at very high and ultra high speed. It is assumed that the reader is familiar with a.c. theory, use of the Laplace transform, small-signal transistor response, and the fundamentals of logic. Price £5.00 (£3.50 paperback). Pp. 219. Pergamon Press Ltd, Headington Hill Hall, Oxford, OX3 0BW.

**Noise and Fluctuation in Electronic Devices and Circuits** by F. Robinson. Noise to the physicist represents a phenomena described by statistical mechanics. To the engineer, noise is an obstacle in the realization of useful devices. This book attempts to interest

the physicist and be sufficiently practical for the engineer. The emphasis is entirely on the physical origins of noise in electronic devices, and the way noise behaves in electronic circuits which are used as building blocks. Price £8.50. Pp. 246. Oxford Books, 37 Dover Street, London W1X 4AH.

**Japanese Consumer Electronics — Schematic/Service Manual.** This publication contains details and schematic diagrams for about 90 products manufactured by J.V.C., Lloyds, Midland, Panasonic, Sanyo, Sharp, Sony and Toshiba. Items covered are digital clock radios, a.m.-f.m. radios, monochrome television receivers, cassette recorders, eight-track tape players and receivers. Four chapters deal with radio principles, radio, recorder, and stereo servicing, transistor and i.c. cross references, and typical circuit diagrams. Foulsham-Tab Ltd, Yeovil Road, Slough, Bucks SL1 4JH.

Recent additions to the **Tab Books** range are **Radio Astronomy for the Amateur** by Dave Heiserman (No. 714, \$5.95 paperback). **Transistor Theory for Technicians and Engineers** by A. Veronis (No. 717, \$5.95 paperback). **Computer Programming Handbook** by P. A. Stark (No. 752, \$8.95 paperback). **Handbook of Multichannel Recording** by A. Everst (No. 781, \$7.95 paperback). **Toshiba Colour TV Service Manual Vol. one** (from 1970 to 1974, \$5.95). Tab Books, Blue Ridge Summit, Pa.17214, U.S.A.

# Balunamp design nomogram

## Converting an unbalanced signal into a balanced one at low frequencies

by Andrew M. Stephenson

*Plessey Telecommunications Research Ltd.*

"Balunamp" is my portmanteau neologism for a device which converts a balanced electrical signal into an unbalanced one while providing a predetermined amount of amplification. That the gain may be less than one is irrelevant; the most important feature is that the input impedance is balanced about earth. In practice a balunamp is a special case of a differential amplifier incorporating an operational amplifier. What has been attempted is the design of a simple nomogram with which even a novice may construct a working balunamp with the minimum of fuss and false starts.

Fine. So what use is a balunamp?

Assuming that the reader is not interested in frequencies much above the audio spectrum, nor in the ultimate of performance, the device may be applied to almost any situation where it is desired to produce an unbalanced signal from a balanced one. Instances are microphone amplifiers and preamplifiers, floating a.c. to grounded d.c. converters, and line receivers.

The basic circuit is shown on page 68. This is a much simplified theoretical one; it has been left to the reader to decide what op-amp he will use and hence what other components are needed. The four resistors,  $R_1$  to  $R_4$  suffice to define the basic performance of the device.

- The characteristics desired are
- an input impedance ( $R_{in}$ ) balanced about earth or zero volts.
  - an output impedance which is not balanced about earth.
  - a certain voltage gain ( $G$ ).

Few such amplifiers will be required to have a gain above 100. Thus if a good balance is to be preserved it is necessary to choose the values of  $R_1$  to  $R_4$  with care so as to take advantage of those commonly available, assuming that specials are to be avoided. This problem becomes particularly acute at lower values of  $G$ , such as 20 or below, and it is the peculiar virtue of this nomogram that it allows this choice to be made quickly and easily - more easily than by heuristic methods. Sceptics may prove this point to themselves if they wish.

As this is a practical article no attempt is made to derive the equations on which it is based; essentially they are straightforward derivations of standard amplifier design expressions. They are given next.

Knowing  $R_{in}$  and  $G$  (defined as the output voltage divided by the differential input voltage), then

$$R_1 = R_{in}/2, R_2 = R_{in}G/2, R_3 = R_{in}/2(1 + G), R_4 = R_{in}G/2(1 + G).$$

Two important assumptions must be pointed out: the op-amp is assumed to have an open-loop gain much greater than  $G$ , say, more than 20 times, and to have a negligible phase shift (other than 180° inversion) at the operating frequency.

From these equations one could derive values for  $R_1$  to  $R_4$  directly. In practice, however, some difficulty may be experienced in fitting them to real resistors; therefore their values have been calculated for  $G$  varying from 0.1 to 100, normalized to give  $R_1 = 1.0$ , and plotted on log-log graph paper, as in the nomogram.

Next, a substitute for a sliding scale has been drawn to the right of these curves, where three decades of the standard E24 series of resistors, commonly available in 2% tolerance, are marked.

### Example 1

A balunamp having a  $G$  of 10 is required, the differential input impedance to be 300 ohms.

First draw a vertical line through  $G = 10$ . This intersects the four resistor

curves at  $R_1 = 1.0$  (naturally),  $R_2 = 10.0$ ,  $R_3 = 0.0909$ , and  $R_4 = 0.9091$ .

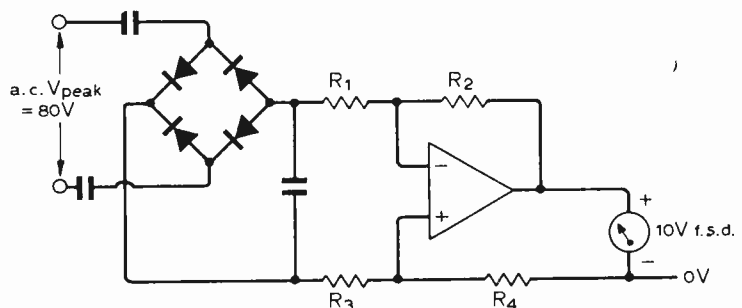
Now these values must be scaled to give  $R_1 = 150$  ohms, this being half the desired input impedance. Sometimes it is not possible to perform this scaling and arrive at realistic values for the other resistors, as is the case here. Scaling gives  $R_1 = 150$ ,  $R_2 = 1500$ ,  $R_3 = 13.635$ ,  $R_4 = 136.35$ . Therefore a compromise is necessary.

Often the impedance is not crucially important and may be altered slightly. Here, by extending the unscaled values of  $R_1$  to  $R_4$  across the E24 grid, we find that another suitable set of values is  $R_1 = 180$ ,  $R_2 = 1800$ ,  $R_3 = 16$ ,  $R_4 = 160$ . This results in  $R_{in}$  being 356 ohms, there being an imbalance of only two ohms, or about 2.2%.

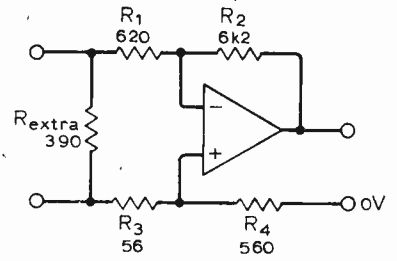
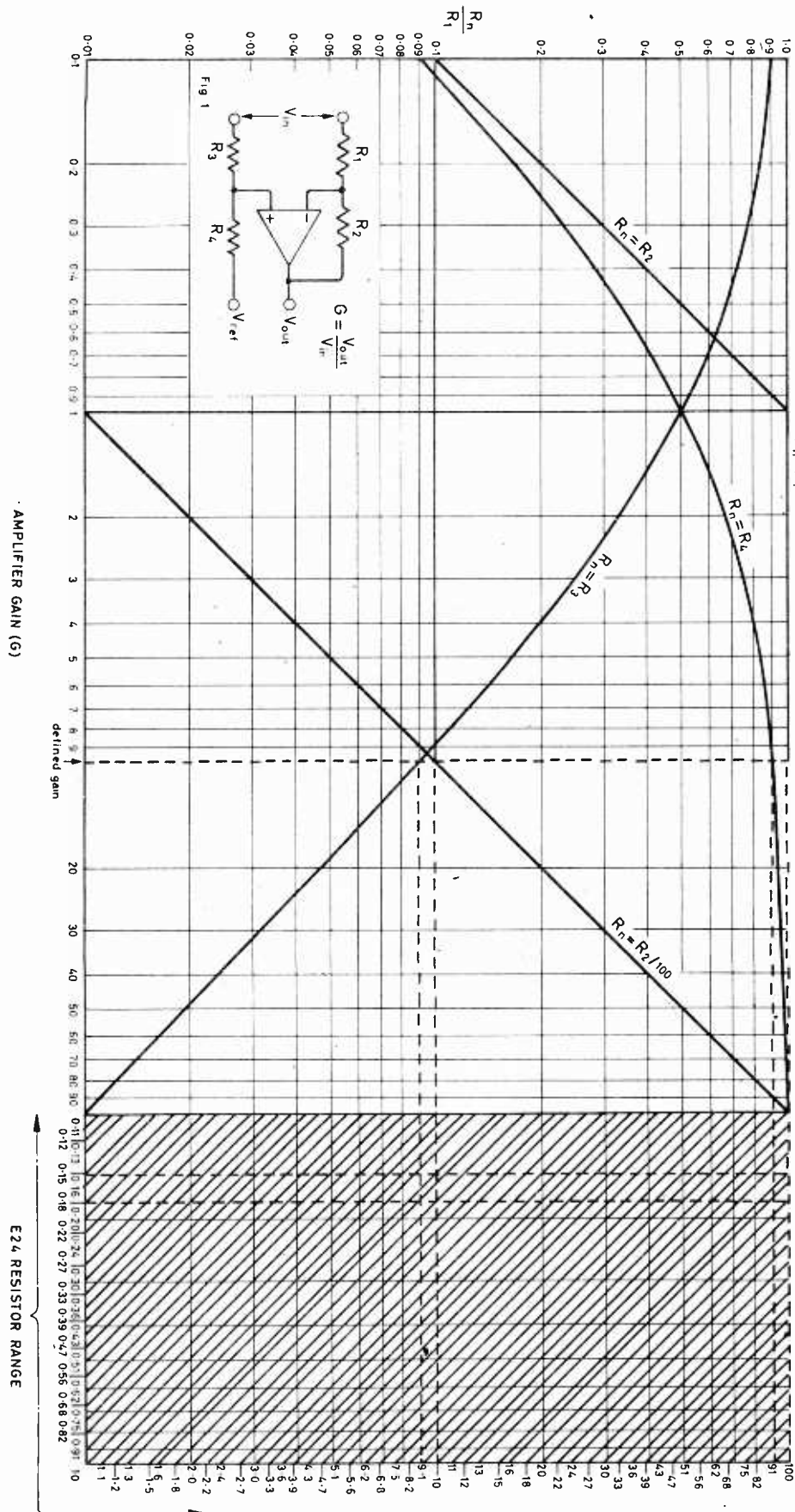
If the balance and the value of  $R_{in}$  are important, a modification must be made: an additional resistor across the input will adjust  $R_{in}$  to the right value while allowing greater flexibility in the choice of the other resistor values; thus  $R_1 = 620$ ,  $R_2 = 6200$ ,  $R_3 = 56$ ,  $R_4 = 560$  with an extra resistor of 390 ohms, as on p.68, gives  $R_{in} = 296$  and an imbalance of about 0.65%. Naturally one may argue over the definition of imbalance, but for the applications in which the balunamp is likely to be used it is low by any measure.

### Example 2

This simple case serves as an introduction. Consider another: a balanced a.c. to unbalanced d.c. converter such as



Application of nomogram to design of a.c. voltmeter - see Example 2.



Circuit to illustrate use of nomogram - see Example 1.

might be used in an a.c. voltmeter, as shown on page 67. The desired features are: a  $G$  of 0.125 and a very high input impedance, partly to make it a useful voltmeter but also to reduce the size of the various capacitors; assume for the moment that the capacitors are large enough to be ignored in these calculations.

Returning to the nomogram, the standardized values of  $R_1$  to  $R_4$  are  $R_1=1.0$ ,  $R_2=0.125$ ,  $R_3=0.889$ ,  $R_4=0.111$ .

Now, there will be practical limitations such as the stability of high value resistors subjected to large voltages (up to 80V here); therefore set an upper bound on the largest resistor,  $R_1$  in this case. Say  $R_1$  to be equal to or less than 220 kohm.

Scaling with the aid of the E24 grid yields:  $R_1=150k\Omega$ ,  $R_2=18k\Omega$ ,  $R_3=130k\Omega$ ,  $R_4=16k\Omega$ ,  $G$  is about 0.1215, and the gain imbalance is only about 0.22dB with these values, while the input impedance is 296k $\Omega$ . At 50Hz, 1 $\mu$ F capacitors would be more than adequate.

These two examples should suffice to demonstrate the theory of the nomogram. It is left to the reader to recognize the applications which will help him personally.

One final point: at no time has any allowance been made for offset currents or voltages. It was felt that should this be important the designer should be able to devise some means of providing the necessary balance of resistance to ground while keeping the a.c. impedances at their correct values.

**Acknowledgment:** Thanks to Plessey Telecommunications Research Limited, for whom the early work leading to the construction of this nomogram was done, for permission to publish this article and the diagrams associated with it.

# Generation of equal-tempered pitches

Robert M. Youngson

An adequate approximation to the equal-tempered musical scale can be derived from a fixed-frequency waveform by integer division. The realization of this process, by t.t.l. m.s.i. integrated circuits, is easy and reasonably economical.

Table 1 gives the frequencies of the 12 equal-tempered semitones in the octave from middle C upwards, based on the standard pitch A = 440Hz. A set of divisor integers is given with the resultant frequencies, for comparison with the standard pitches. In practice, the master oscillator frequency is selected as a convenient binary multiple of that given, so that the chromatic octave obtained by division by these integers lies above the frequency of the highest pitch required. All the necessary musical tones may then be obtained by successive binary division.

As the largest divisor in the set given is less than 256, the divisions may be implemented using 8-bit counters. Fig. 1 shows how pairs of SN 74193 counters may be connected to achieve division by the decimal number corresponding to an 8-bit binary number.

A suitable crystal oscillator circuit is given in Fig. 2 and the connections for

the binary division stages for the descending octaves of the chromatic intervals are shown in Fig. 3.

Variations in the frequency of the master oscillator do not, of course, have any effect on the accuracy of the relative tuning of the pitches, and if absolute accuracy is unimportant, almost any crystal can be used, extra division stages being inserted as

required. In this event, a single SN 74193 would offer great flexibility in obtaining a suitable clock frequency for the set of 12 programmable dividers. Alternatively, a variable frequency oscillator, allowing immediate "one knob" tuning of the whole instrument may be preferred.

The set of divisors given offers a good compromise between relative tuning accuracy and economy and provides, about the minimum of musically acceptable accuracy. The standard of precision may of course, be indefinitely improved by using even higher master oscillator frequencies with larger divisors. A sample set using 12-bit counters, and achieving a maximum inaccuracy of 0.013%, is given in Table 2.

This method of deriving musical tones is well suited to large scale integration, and implementation by l.s.i. has already been achieved.

**TABLE 1**  
Master oscillator frequency = (4, 8 or 16 x) 57,290.5628Hz.

Pitch	Frequency	Divisor	Resultant Frequency	Percentage Error
B	493.8833	116	493.8833	—
A#	466.1637	123	465.7758	-0.08
A	440.0000	130	440.6956	+0.15
G#	415.3046	138	415.1480	-0.03
G	391.9954	146	392.4001	+0.10
F#	369.9944	155	369.6156	-0.10
F	349.2282	164	349.3318	+0.02
E	329.6275	174	329.2553	-0.11
D#	311.1270	184	311.3610	+0.07
D	293.6648	195	293.7970	+0.04
C#	277.1826	207	276.7655	-0.15
C	261.6256	219	261.6001	-0.01

**TABLE 2**  
Master oscillator frequency = (4, 8 or 16 x) 963,600.00Hz.

Pitch	Divisor	Resultant Frequency	Percentage Error
B	1951	493.9004	+0.0034
A#	2067	466.1828	+0.0040
A	2191	440.0000	—
G#	2320	415.3448	+0.0096
G	2458	392.0260	+0.0078
F#	2604	370.0460	+0.0139
F	2759	349.2569	+0.0082
E	2923	329.6613	+0.0102
D#	3097	311.1398	+0.0041
D	3281	293.6909	+0.0088
C#	3476	277.2151	+0.0117
C	3683	261.6345	+0.0034

Accuracy, with these divisors, can be improved further, by lowering the oscillator frequency so as to distribute errors about zero.

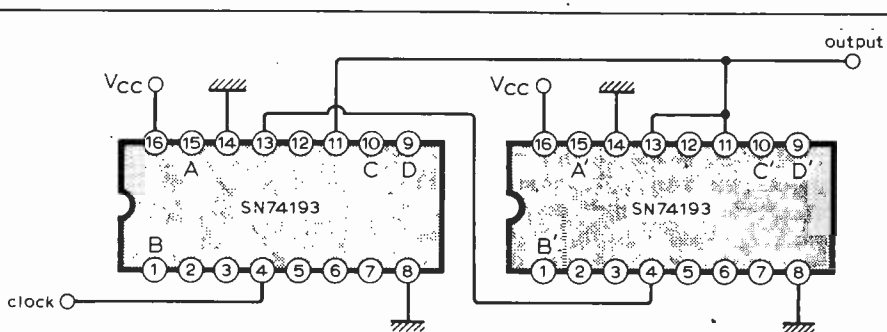


Fig. 1. Binary counters connected to divide by the decimal number corresponding to an 8-bit binary number.

Fig. 2. Crystal oscillator circuit.

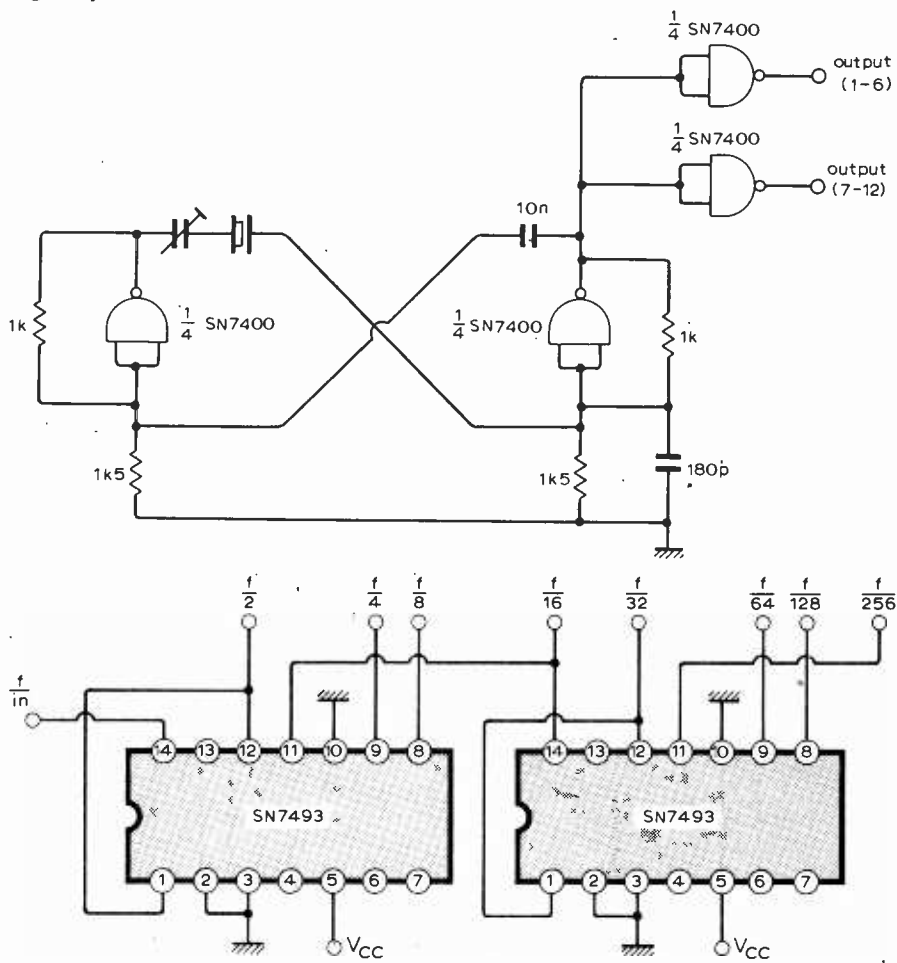


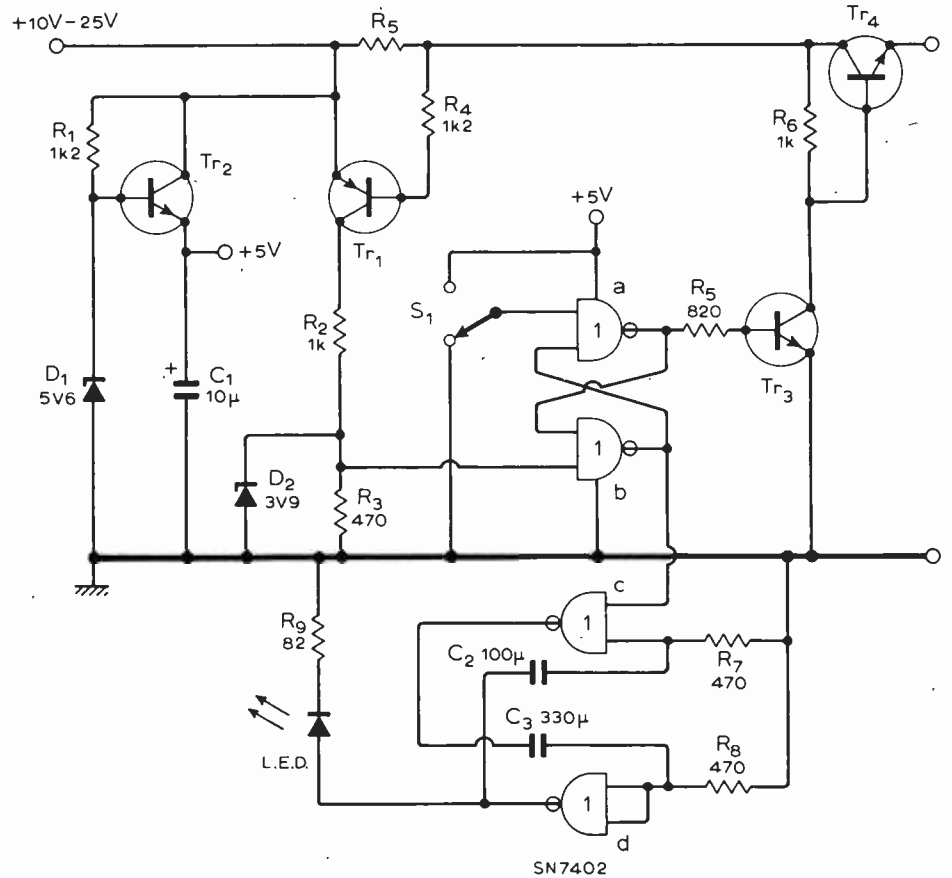
Fig. 3. Binary division stages for descending octaves of the chromatic intervals.

# Circuit Ideas

## Electronic cut-out

The circuit shows a practical design used to protect experimental equipment against transients. Resistor  $R_1$ ,  $D_1$ ,  $Tr_2$  and  $C_1$  form a rudimentary 5V supply for the t.t.l. gates. Diode  $D_2$  prevents overvoltage at gate b input. Transistors  $Tr_3$  and  $Tr_4$  provide the turn-off control. Note that  $Tr_4$  needs no heat-sink because it is used as a switch. The two spare gates, c and d can be used as an indicator. They form an astable oscillator enabled by a 0 on gate c input. Thus the l.e.d. turns on when the power is applied, and flashes when the cut-out trips.

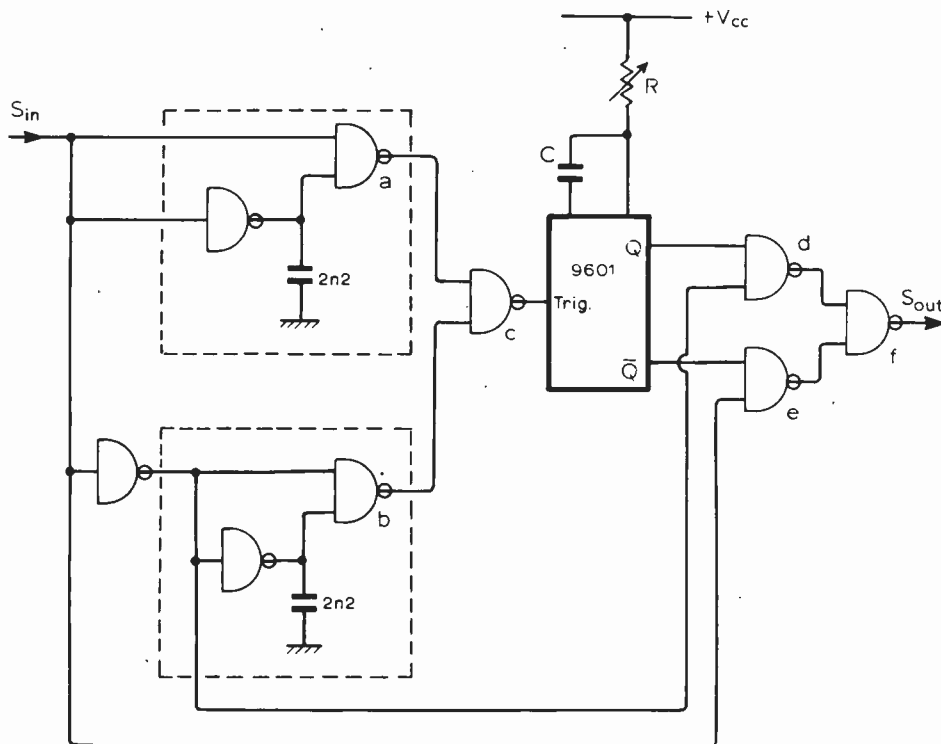
A variation of this circuit is a complementary version using 7400 gates and an n-p-n sensing transistor for negative rails. Bypassing  $R_5$  with a capacitor reduces sensitivity to tran-



sients, or all a.c. signals, whereas adding a diode in  $Tr_1$ 's collector as a reverse voltage protection allows one half-cycle of an a.c. circuit to be monitored. This arrangement is possible because the latch need not have the sensed line as its power supply.

The circuit is instantly reset by  $S_1$  but, inexplicably, the circuit invariably resets when switched on. Any explanations would be welcome.

C. Woolf,  
Swanland,  
Yorks.



## Variable phase delay for digital signals

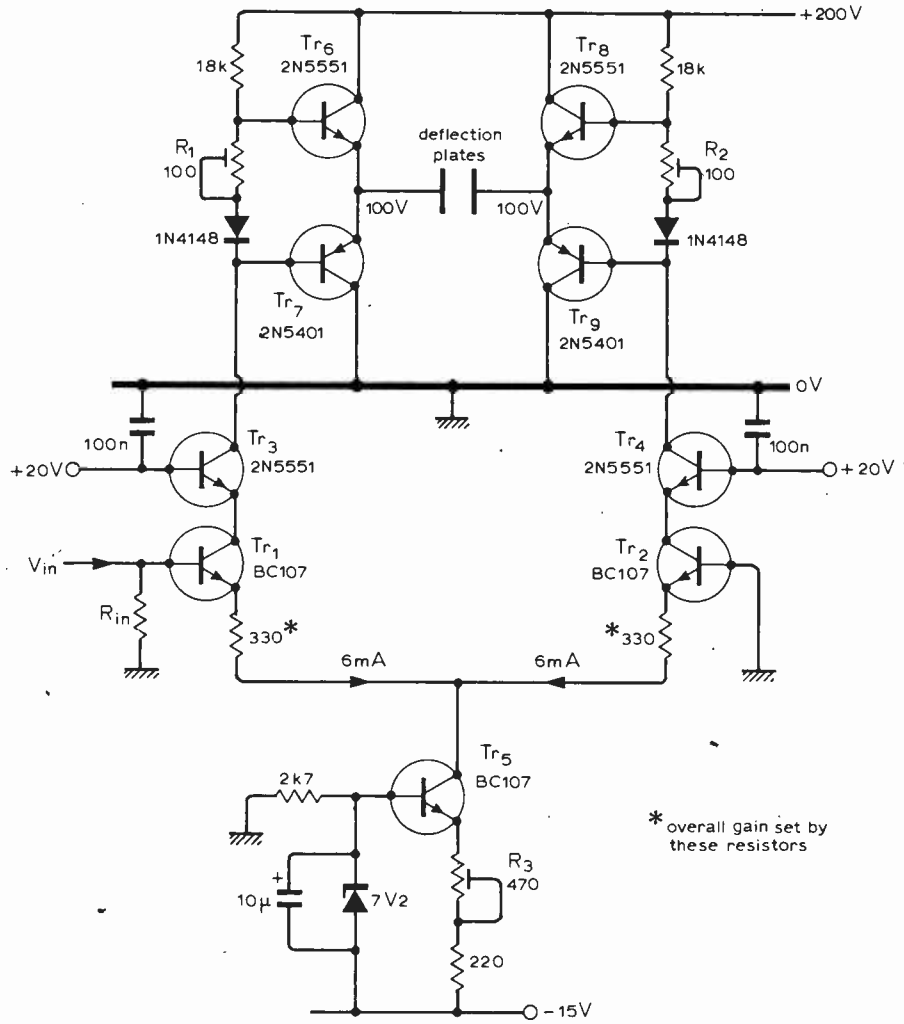
In the diagram shown the monostable circuits generate a very narrow pulse on the leading and trailing edges of the input signal. These spikes are OR-ed together and used to trigger a 9601 monostable with a period dependent on C and R. Gate e NANDS the 9601 Q output with the input signal and causes a section of the input signal to be gated out. Gate d NANDS the 9601 Q output with the input signal thus generating a pulse at the trailing edge of  $S_{in}$ . These two outputs are effectively OR-ed by gate f to produce  $S_{out}$ , a delayed version of  $S_{in}$ .

If the signal needs to be advanced and retarded with respect to a second signal, an identical delay unit can be incorporated in the other signal line. Delays between the two signals may then assume any desired phase relationship.  
W. D. Gunn,  
Glenrothes,  
Fife.

### Wideband Y amplifier for oscilloscope

Transistors  $Tr_1$  to  $Tr_4$  operate as a constant-current tail with  $Tr_5$  added to improve linearity. This draws 6mA down each side of the amplifier and results in a voltage drop of nearly half the 200 volts across each 18kΩ collector resistor. Driven by this voltage, and with a slight forward bias provided by the 100-ohm preset potentiometers and diodes,  $Tr_6$  and  $Tr_7$  act as complementary emitter followers. They have their counterparts in  $Tr_8$  and  $Tr_9$  and both sets have a quiescent current of about 3mA. Bandwidth of this circuit seems independent of output capacitance loads up to 200pF and appears to be only limited by the 18kΩ resistors and the collector-base capacitance of the complementary pairs. Rise time of the circuit is 40ns, which improves to around 30ns with compensation. A bandwidth of 10MHz was easily obtained by driving the amplifier from a 50Ω source. An increase in the speed can probably be achieved by increasing the tail current and lowering the value of the 18kΩ resistors at the expense of increased dissipation. Any complementary small-signal transistors capable of withstanding above 200V can be used, but a supply current-limited at about 20mA is advisable.

B. J. Frost,  
Paignton,  
Devon.



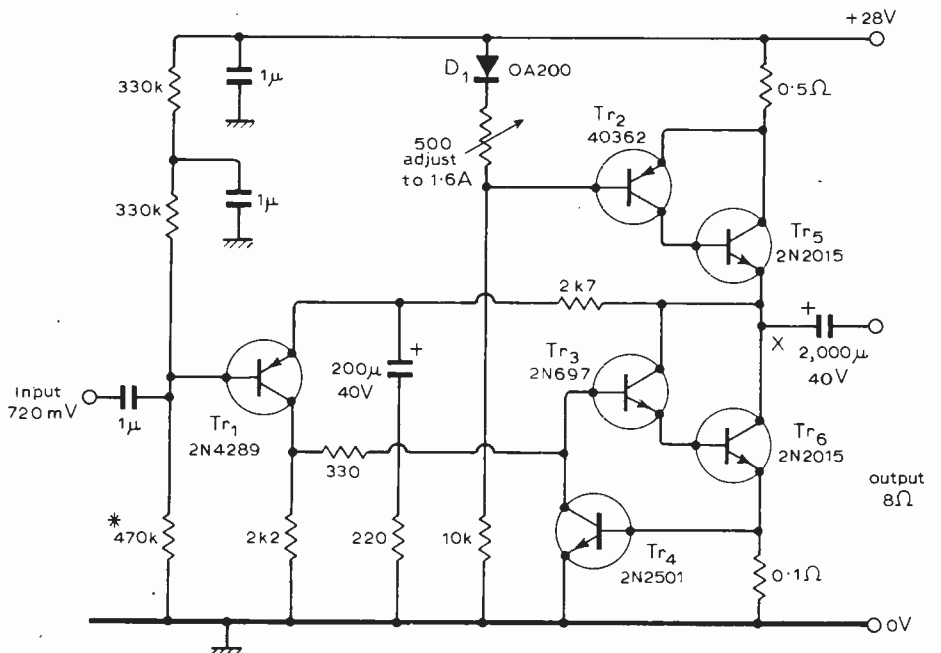
\* overall gain set by these resistors

### Class A power amplifier

This circuit was designed using easily available components. Its operating conditions are unconditionally stable, unaffected by individual transistor parameters and the transistor types are not critical. Short-circuit protection is provided by the constant-current source  $D_1$ ,  $Tr_2$ ,  $Tr_5$  and  $Tr_4$ . Transistor  $Tr_4$  may be omitted if short-circuit protection is not required. The amplifier may be altered for a different load impedance (R) or power output (W) by putting the output-stage current  $I = 2W/R$ , and supply voltage equal to  $2 + 0.61 + 2\sqrt{2WR}$ .

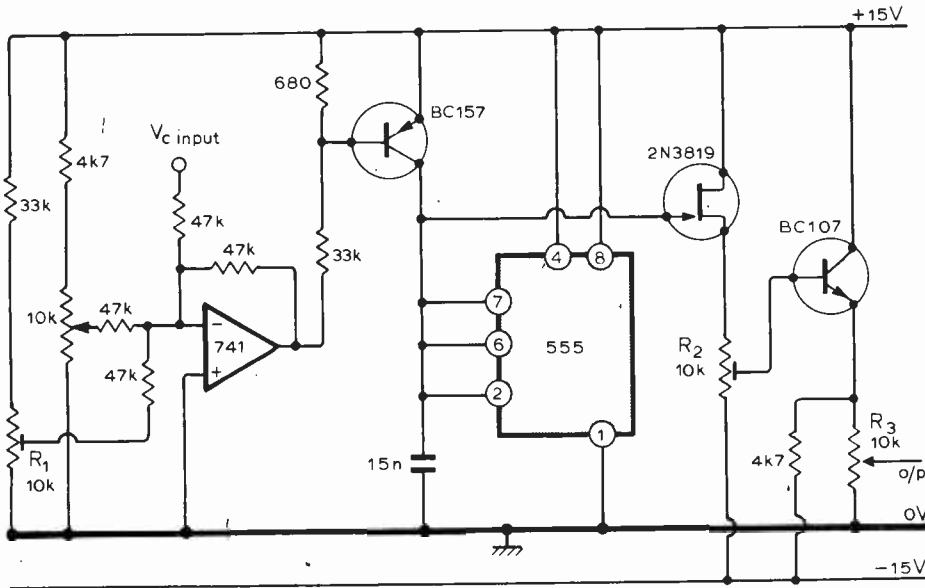
Dissipation in the output transistors is roughly  $W \times 4$  watts, so the heat sinks need to be adequate. The amplifier shown will deliver 10W into an eight-ohm load. Diode  $D_1$  and  $Tr_2$  should be in thermal contact.

A. H. Calvert,  
London NW1.



\* adjust to make point X half the supply voltage (if necessary)

## Voltage-controlled ramp generator



By using the 555 timer as an astable multivibrator with the charge current supplied by a transistor, a wide frequency range can be covered. With the values shown, the range is greater than 0.2Hz to 20kHz. Potentiometer  $R_1$  sets the lowest frequency,  $R_2$  sets the

average output to zero volts, and  $R_3$  sets the output level. The voltage/frequency relationship is logarithmic which makes the oscillator suitable for use in sound synthesizers.

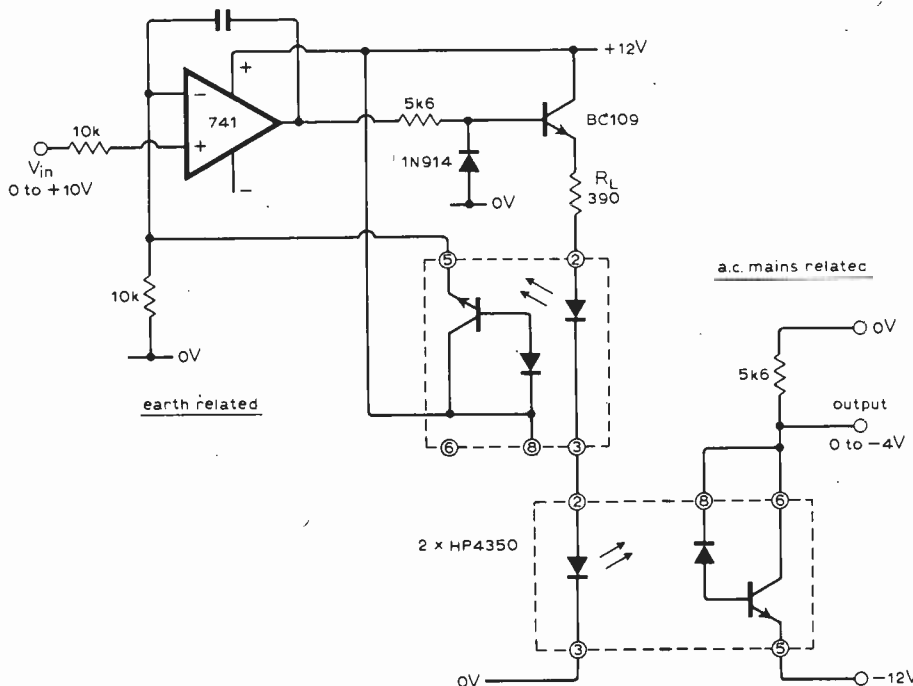
J. L. Brice,  
Fulwood,  
Preston.

## Linear d.c./d.c. opto isolator

The circuit shown was initially designed to provide input isolation for mains related thyristor converters. Diode turn-on voltage is rendered insignificant by the amplifier loop gain, and temperature effects are minimised by close tracking of the isolator characteristics. Linearity is within 2%. The circuit may be re-arranged to achieve alterna-

tive input/output polarities and operate with other power rails. Resistor  $R_L$  must, however, be chosen to limit diode current to 20mA, and the supply rail which provides the feedback current (positive in the circuit shown) must be at least  $V_{in} + 2$  volts.

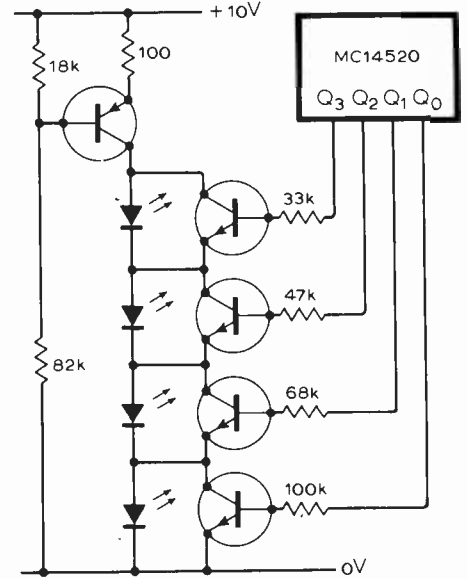
R. J. Haney,  
Fletching, Sussex.



## L.e.d. display

The low voltage and relatively high current requirement of l.e.d.s means that when used in the normal way as digital indicators considerable power is wasted. In battery equipment with reasonably high voltages and where a number of indicators are required, it is advantageous to connect the l.e.d.s in groups using a constant-current source for each group. The diagram shows a circuit to display a four-bit binary number from a c.m.o.s. counter.

T. R. E. Owen,  
University of Cambridge.



## Low-frequency triangle wave generator

In this generator circuit (Wireless World, May 1976),  $R_2$  in parallel with  $R_3$  is greater than  $10k\Omega$  and not  $R_2/R_3$  as shown. Time  $t$  is  $C_1 R_1 R_3 / R_2$  and  $F$  is  $1/T = R_2 / 4 C_1 R_1 R_3$ .

Contributors to *Circuit Ideas* are urged to say what is new or improved about their circuit early in the item, preferably in the first sentence.



# A good image gets around.



## EEV's Leddicon<sup>®</sup> is the consistent colour tube.

The EEV Leddicon<sup>®</sup> is the advanced lead oxide colour tube made with high purity materials to the most precise standards.

Ease and speed of line-up are exceptional. Perfect colour registration can be achieved in seconds. Geometry is precise. Manufacture is consistent. Tube dependability is excellent.

EEV Leddicons are in use with most major colour networks. A good image gets around – and so does EEV service. All EEV camera tubes are available across the world from local representatives.

For your nearest contact, please write to EEV at Chelmsford, Essex, England.

Leddicon Type	Application	Features	Leddicon Type	Application	Features
P8000	Monochrome Luminance + Chrominance channels	30mm diameter. Integral mesh construction.	P8130	Monochrome Luminance + Chrominance channels	30mm diameter, coaxial construction. Separate or integral mesh. Fixed integral light bias.
P8001	Monochrome Luminance + Chrominance channels	30mm diameter. Separate mesh construction.	P8131 *	Monochrome Luminance + Chrominance channels	Similar to P8130 series but with variable integral light bias.
P8003	Red channel Luminance/green channels Monochrome channel	30mm diameter. Separate mesh with extended red response, with or without IR faceplate filter.	P8132	Red Channel Luminance/green channels Monochrome channel	Similar to P8130 series but with extended red response, with or without IR faceplate filter.
P8005 *	Monochrome Luminance + Chrominance channels	30mm diameter. Separate mesh. Improved lag under low-light conditions.	P8133 *	Red Channel Luminance/green channels Monochrome channel	Similar to P8131 series but with extended red response, with or without IR faceplate filter.

\* Uses integral light bias but requires socket modification and bias supply

<sup>®</sup> Leddicon is a Registered Trade Mark of English Electric Valve Co Ltd

## EEV and M-OV know how.

ENGLISH ELECTRIC VALVE CO LTD, Chelmsford, Essex, England CM1 2QU. Tel: 0245 61777. Telex: 99103. Grams: Enelectico Chelmsford. **S&C**

WW — 009 FOR FURTHER DETAILS

# We've driven germanium out of its last stronghold

Until a short time ago germanium's last stronghold seemed to be the TV tuner.

In fact this was the only application left in which the germanium transistor had not yet been replaced by the silicon type.

It wasn't easy for silicon to conquer this field; after all the germanium transistor worked very well, and there did seem to be insurmountable difficulties in the production of equivalent silicon types.

We at SGS-ATES met the challenge when we created the family of PNP silicon transistors which combined the characteristics of germanium and the reliability and stability intrinsic to silicon.

In addition we gained improvement on some important parameters such as noise.

Today these products have become standard for industry, and over 20 million pieces have already been sold.

## And now 5 GHz!

An achievement unthinkable during the era of germanium. Today SGS-ATES presents the BFT 95, a 5 GHz PNP silicon transistor with  $NF = 2 \text{ dB}$  at 1 GHz.

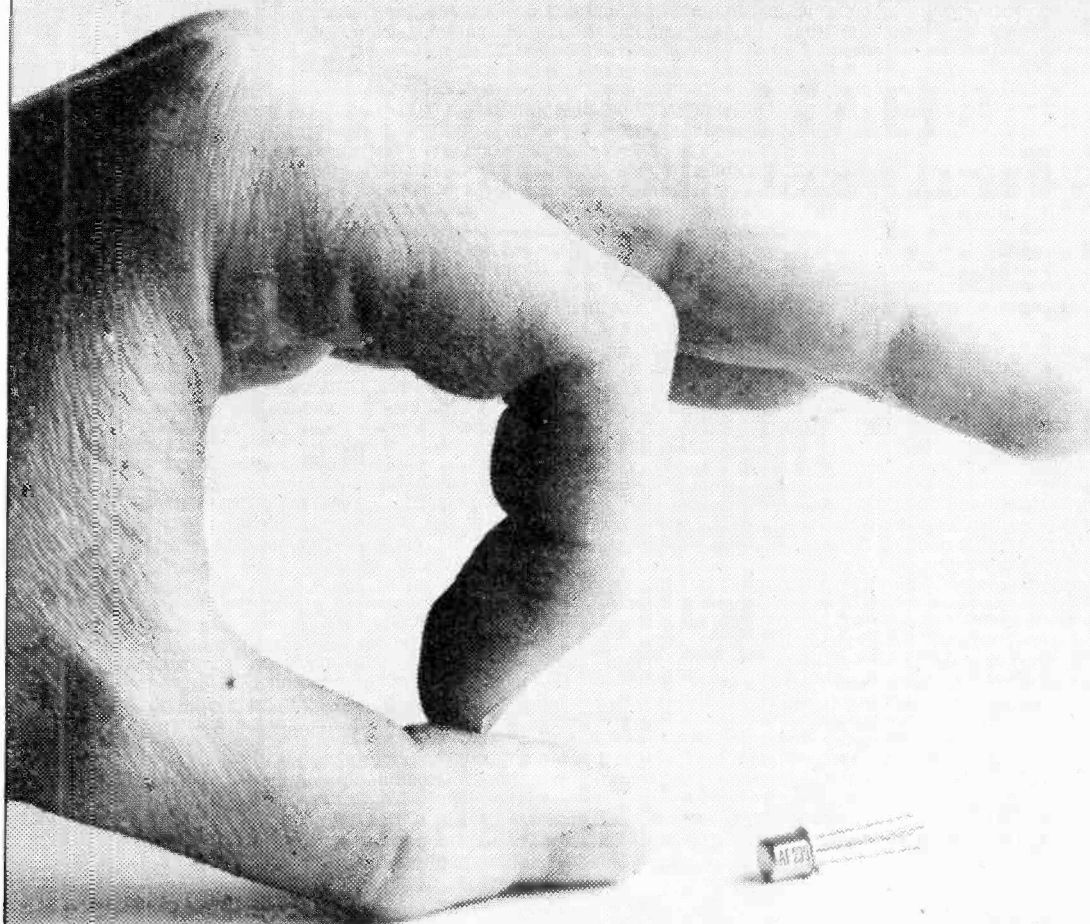
Low noise, high gain, minimum intermodulation distortion, low cost T-plastic package, make it ideal for wide band amplifiers and converters in the 1 GHz frequency range.



## And that's why



SGS-ATES (UNITED KINGDOM) LTD.



WW-064 FOR FURTHER DETAILS

# Broadcasting's biggest

## Highlights of the National Association of Broadcasters 1976 Convention reported by Pat Hawker

The NAB convention and exhibition returned this year to Chicago: by moving into the massive new McCormick Place exhibition centre on the shores of Lake Michigan, the 54th annual convention was able to reach new heights in size and scope. With well over 200 firms participating — including many from Europe — some 6,000 visitors and 4,000 industry representatives it reflected for those more used to Montreux and IBC in London the significant differences in broadcasting outlook and practice in North America and Europe.

At NAB broadcasting is an industry or trade; the attraction of any new equipment tends to be evaluated directly on whether it will increase the appeal of a station to its audience by jumping ahead of the competition or whether it will reduce operating costs or provide better coverage. Higher technical standards, if these are beyond those required to meet FCC regulations, or whose advantages will not accrue for some time to come — such matters are not for NAB unless as a means of securing commercial prestige. Montreux and IBC may give you a better idea of what broadcast engineering will be like in ten years' time — but NAB provides a wonderfully exciting and dynamic panorama of what the stations will be doing in the months ahead, provided that the new products stand up to the hard assessments that constitute the American form of Operational Research.

It is easy to say that the Americans do not have the same engineering dedication as Europeans to high standards of technical quality; that many of their television programmes would never make British screens. But when one considers what is available (for no licence fee) in metropolitan areas such as Chicago — where over many, many hours each day there are three network-affiliated stations (CBS, NBC and ABC); the local independent WGN; a public broadcasting/educational station on a v.h.f. channel (carrying much British and European programme material); a clutch of u.h.f. stations; and separate streams of m.f. and v.h.f. radio

stations — it is difficult not to have at least a sneaking feeling that there is more to American broadcasting, as it is today, than is sometimes conceded over here.

### Electronic journalism

News has become a major element in American programming and is still evolving rapidly. This is particularly true in the area known as "electronic news gathering" (e.n.g.). The use of electronic cameras as a replacement for film in news operations has made rapid progress in the past few years (ITN with a compact Range Rover unit have been active in this field). But the emphasis in the States is towards even smaller and lighter equipment, requiring less technical support, and even the complete elimination of news film by some stations.

E.n.g. fulfils the criteria for appeal to American broadcasters: it can provide more national and local news inserts, including 'live' and late news, making newscast more attractive to audiences; potentially it offers (at least debatably) economic advantages if film processing can be eliminated and tape is re-used and not stored for possible archival purposes. But against these must be set the proven reliability, low capital cost and ease of transportation of film, and film cameras.

The past 12 months have seen a number of North American stations convert to all-electronic news, many more to hybrid e.n.g./film working; and many sitting on the fence waiting to see what the competition will do.

All-electronic news became possible with the appearance of light-weight "portable" (though often heavy) backpack cameras and more especially with the improvement in low-cost helical video recorders such as Sony U-matic or JVC units that became possible with digital time-base correctors. Now firms are rushing out new products specially designed for e.n.g. and to eliminate some of the reliability problems that do arise. Cables, cable connectors, head cleaning on recorders, batteries, "instant" interference-free microwave links and general maintenance all give more headaches

than the early e.n.g.-advocates anticipated, but these problems are being tackled vigorously in the new designs.

E.n.g. cameras featured at NAB included the Thomson-CSF (CBS Laboratories) "Microcam" which sets a new record for an all-up weight of 13 lbs for a camera based on three 2/3-in. Plumbicons with built-in image enhancement. Camera head including lens weighs 8lb, a shoulder-slung hip pack weighs 3lb, and a typical battery belt weighs 1lb. Power consumption is 22 watts, including viewfinder. It is claimed the camera can be fully operational in 4 seconds from switch on. First production units are due to be delivered to CBS this summer. Size and weight reduction has been achieved largely by the use of l.s.i. circuits.

Other lightweight e.n.g. cameras include the RCA TK76 (shown at Montreux 1975) of about 28lb all-up weight; several Ikegami units including the HL77 with no back pack and weighing 6 kg (plus lens and viewfinder); the NEC MNC-61, again with no back pack, and weighing some 6.7 kg including viewfinder and hand grip; the Hitachi SK80 with a basic weight of 7.5kg. Many other portable cameras including those using 1-in lead oxide vidicons are being offered either for e.n.g. or as portable production or sports cameras, although some call for a strong cameraman rather than camera person. Many use 1-in lead oxide vidicons to give quality comparable with studio cameras.

Another area where considerable development can be seen is in microwave link equipment where it is not only required to set up links quickly and easily but where problems are being encountered in mutual interference between competing teams and those presented in such areas as New York due to high buildings. Trends include "quad polarization" for pick-up, allowing remote selection of right-hand or left-hand circular polarization or vertical or horizontal polarization, often also with remote selection of direction. The mobile units often use circularly polarized aerials.

Nurad have a new 2 GHz "Golden-

rod" aerial for mobile use in the form of a 2-in diameter rod just under 4ft long which is claimed to provide circularly-polarized signals comparable with those from a 2 ft parabolic dish but with far less wind loading and easier to store and handle.

### Video tape recording

For the past five years or so the "format controversy" of video tape recording has been waging, but most television broadcasts continue to be based on 2-in quadruplex machines — even ENG material is often transferred to 2-in cassettes for transmission. With the issue to RCA, Philips and IVC of licences for the manufacture and marketing of the Fernseh 1-in BCN series of helical scan recorders, and the introduction of a new Sony 1-in unit (BVH-1000), the stage is set for more general acceptance of 1-in tape.

The IVC-Cintel 9000, a 2-in super-band helical-scan studio machine, appeared at NAB in a new guise as the IVC 9000-4 half-track machine for archival purposes, where a 3 dB lower signal-to-noise performance (47 dB instead of 50 dB) can be tolerated.

Ampex introduced their new AVR 3. machine aimed at operators seeking modern replacements for the widely used VR2000-series. This uses the super high band plus pilot tone technique which Ampex first demonstrated on 625-line PAL. The pilot tone at 1.5 times colour subcarrier is claimed to provide superior autochroma and time base corrector performance, resulting in reduced head banding and reduced moirè patterning. The AVR3 is the first use of this system as an integral part of the design including automatic switching between normal high band and super high band pilot on playback. Ampex however has for this model abandoned the vacuum-buffered transport system that they introduced with the AVR1 to provide virtually instantaneous lock-up: in the AVR3 lock-up is achieved in 1-2 seconds.

Although the machine was not shown, J. Dierman of Ampex presented a detailed paper on the company's "electronic still store" the first delivery of which is due this summer to CBS. This is designed to replace the large collections of slides and graphics held by most broadcasters (it is suggested that the average broadcaster has a slide library of 3000 to 5000 items) by using computer disc drive techniques to store the material digitally. The system provides instant random access to 1472 stills and can store additional graphics off-line: still sequences can be assembled in advance. The basic storage medium is gamma ferrous oxide coated on to a thin aluminium disc.

A rather similar application was demonstrated by RCA with its optical disc recording system which can store up to 10,000 still pictures on a 12-inch disc. This is based on the original RCA video disc system and is distinct from

the firm's later Selectavision technique with capacitance pick-up seen as having consumer applications. Although the optical system was shown working effectively on stills (it could be used for motion) no attempt was being made to indicate the appearance of an early production model, with final development put at 2 to 5 years away. RCA, however, are now offering a half-speed (7.5in/sec) version of their TR600 video tape recorder and also a modification kit including 6mm headwheel tip and use of super high-band f.m. for existing machines.

Other video memory systems include a 3M D8000 system and an Arvin/Echo "video frame-store" handling 400 stills.

As a lower cost arrangement to the massive video cartridge machines, Recortec have introduced a "video spot assembler" which is intended for use with two vacuum-buffered tape machines. The assembler itself is priced under \$9000.

Apart from the IVC 9000-4 and the Fernseh BCN series, a number of new broadcast helical scan recorders have been introduced including a new 1-in Sony BVH-1000 with a tape speed (525-line) of 9.63 in/sec and claimed to be the only machine that eliminates head band flicker by recording in the vertical gap. It is being marketed with built-in time coding, and a 625-line version is expected in 1977.

### Transmission

One of the problems which have faced u.h.f. stations using relatively low-efficiency multicavity klystrons has been the rising cost of electricity. This has often meant that with power amplifier efficiency less than 25 per cent the cost of maintaining a high power transmitter on the air has been significant. In recent years a number of klystron manufacturers have shown that efficiency can be increased to just over 40%; at NAB John Bullock of RCA and Robert Schmidt of Varian Associates presented a joint paper on a new approach to klystron operation that could further reduce power consumption by up to about 13%. This pulser or electronic switching system makes use of the fact that maximum output from the klystron is required only during the sync periods, representing on 525-lines just 8% of the total time. At other times the beam current can be significantly reduced, using radar techniques, by reducing the mod. anode voltage from —2000 to —4000 volts provided that greater linearity correction is applied. The bi-mode system has been developed for use with Varian "H" type klystrons and it has been estimated that for 16-hour per day operation annual savings of between about \$3500 to \$7000 are possible with high power u.h.f. transmitters.

Power saving is also seen as one of the attractions of all-solid-state m.f.-a.m. transmitters; Harris, Sparta and RCA

were among the firms showing or announcing designs from 1 to 5 kW. RCA were also demonstrating their a.m.-f.m. m.f. stereo system — one of five m.f. stereo systems already proposed to the National AM Stereo Committee of the Electronic Industries Association. This committee is due to report in the Spring of 1977 but it will be some time before FCC is ready to accept a national system. The recent industry report on discrete quadraphonic systems has apparently left the matter up in the air since no direct inter-system comparisons are provided: meanwhile about 100 f.m. stations in the United States are using matrix quad encoders and several hundred are playing matrix encoded records. If a.m. stereo becomes established this could be a serious blow to the f.m. stations who still find it difficult to attract majority audiences — but undoubtedly would provide a boost for m.f..

Automation of radio stations continues to attract interest although the aim is now often to provide hybrid systems that have the appearance of being "live" stations. A new emergency broadcast system has just been introduced in the United States.

For many years the planning and operation of the m.f. band in the United States has been the envy of European broadcasters, with the effective use of directional aerials and day/night switching. However some U.S. operators are alarmed at the increasing number of extremely high power stations in the Caribbean not under FCC control.

Several firms have developed circularly-polarized v.h.f. and u.h.f. for television transmissions following field trials by RCA (v.h.f.) and Jampro (u.h.f.). To achieve true circular polarization — in terms of good axial and polarization ratios in all azimuth directions for broadband television transmissions — is by no means easy, and if, as seems likely, there is progressive utilization of this technique in North America it is likely to be an expensive undertaking (European use will probably be limited because of the use made of polarization discrimination). Certainly the field trials indicate that considerable reduction of ghosting is experienced by many viewers (especially those using bow-tie aerials). Harris have developed circular polarized v.h.f. aerials using a cavity-backed radiator. So far FCC have authorized only experimental use of circular polarization for television broadcasting.

### Digital techniques

A year or two back, NEC introduced a series of large digital framestore synchronizers designed to allow any non-synchronous colour signal to be locked to the local station sync, and thus to be handled as a local source without special gen-lock techniques. This year Quantel (DFS 3000), and RCA (TFS 121) both show how it is now possible to

provide these facilities in a compact unit. The DFS 3000 for instance is packaged complete with power supply and associated analogue circuitry into only 8.75-in of panel space. Prices of framestores are in the region of \$50,000.

Apart from the time-based correctors and frame-store synchronizers, there were few signs that the Americans are thinking as seriously as Europeans of digital video throughout a studio or for transmission networks — although digital control and computer techniques are prominent. The convention papers and discussions on digital video were generally disappointing and undoubtedly the single most-sophisticated digital equipment on display was the first of the Marconi-built DICE (standards converters, to the IBA design).

The recent decision by FCC to permit much wider use of unattended operation of all classes of broadcast transmitters will undoubtedly be reflected in more use in North America of interval

test signals and automatic measuring equipment of the type already in use in Europe, and several firms were showing sophisticated systems developed in Europe.

British and European firms were prominent. With the acquisition of CBS Laboratories, CSF-Thomson appear to have moved firmly into North America in a similar manner to Philips. Marconi had their largest display ever at NAB. Rank Cintel featured their new Mark 3 capstan-driven flying-spot colour telecine unit suitable for NTSC operation. Evershed Power-Optics, EEV, Marconi Instruments, Matthey Printed Products, Quantel, Racal, Amplivox, Rupert Neve, W. Vinten and several of the Rank companies were among those present at NAB.

Communications-systems of all types are proliferating, partly as a result of the emphasis on news gathering both television and radio. ABC in New York have been experimenting with extra

sub-carriers on their television sound channel — similar to SCA f.m. radio techniques — to provide communications cueing and one-way communication with outside-broadcast units. A related development are more complex multi-channel radio microphone systems (Thomson-CSF are marketing a u.h.f. unit made by RF Technology suitable for up to 15 radio-microphone channels). A recently introduced "Optimod-FM" system by Urban is claimed to raise modulation levels by 2-3 dB with less than 0.25% distortion.

In brief, NAB 1976 was an exciting, rewarding reflection of broadcasting trends in North America; both for broadcast engineering and broadcast management.

Grateful acknowledgement is made to Mr Howard Steele, Director of Engineering, IBA, for permission to publish this report — the views expressed, however, are solely those of the author.

## Electronics à Paris

### New products at the Paris component show

The air of economic dependency of the previous Paris components show seemed to have disappeared this year although it was difficult to tell if this was a result of enthusiasm on the part of the organizers or of an increase in trade. The number of exhibitors this year (1013) was less than the previous year (more than 1100) mainly due to there being no section for test and measuring equipment. This aspect is to have its own venue in Paris at a later date.

Turnover in the French electronic component industry declined 6% in 1975. The semiconductor and capacitor branches were the hardest hit, their figures being down 24 and 15% respectively. Signs of a recovery appeared in the final quarter of 1975 in the consumer goods field which had been the worst affected early in the crisis along with data processing equipment. The French electronic components industry faces a less gloomy climate in 1976, a marked feature being the upturn in orders for consumer goods. Underlying trends in the international components market are a cause for reasonable optimism between now and 1980 even though competition is likely to be increasingly

tough with new component manufacturers appearing particularly in the developing countries.

A single-chip, 8-bit, 40-pin c.m.o.s. microprocessor, the CDP1802, was launched by RCA. Also introduced by this company were several new memory and timekeeping devices using silicon-

on-sapphire plus numerous additions to the range of c.m.o.s. and linear integrated circuits, power transistors and resistors. The CDP1802 microprocessor family is a development of the existing CDP1801 series, but with the two c.m.o.s. chips in the earlier microprocessor replaced by a single chip using self-aligned silicon-gate fabrication. Although compatible with the CDP1801 series, it is faster and is supplied with a wider range of instruction sets. Typical of the new range of RCA silicon-on-sapphire memories is the MWS 5001, a 1024 × 1-bit r.a.m. with an access time of 150ns for only 4mW of operating power. Operating

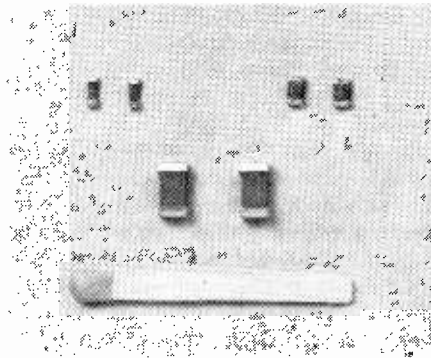


temperature range is  $-20$  to  $+85^{\circ}\text{C}$  and voltage range is  $+4.5$  to  $6\text{V}$ . A colour TV receiver featured by RCA contained several novel circuits. The horizontal deflection system for the  $110^{\circ}$  precision in-line tube combined a switched-mode power supply with a thyristor deflection circuit. The main point here was that no input inductor is required and the chassis is completely isolated. A similar system was also demonstrated by Videocolor S.A., a joint venture of Thomson and RCA.

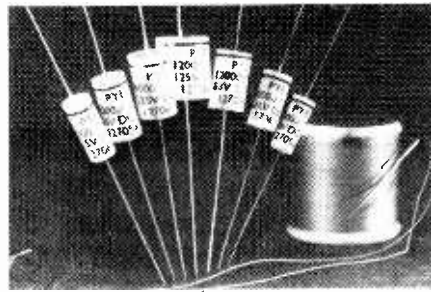
An array of new products was exhibited by Plessey. These included two new ranges of circular connectors now in production, together with an inter-rack wiring connector for telecommunications use. New capacitors exhibited included examples from the recently announced improvements to the  $400\text{V}$  a.c. general purpose range which now has a reduction in physical size of up to 25% together with an extension of capacitor values so that values from  $0.5$  to  $20\mu\text{F}$  are available. The Minicap range of aluminium electrolytic capacitors has been extended to much larger capacitance values, up to  $360,000\mu\text{F}$ . Being shown for the first time were smaller additions to the 1.60 Minibox series of low-cost miniature metallized polyester capacitors. The new values have radial leads at  $5\text{mm}$  separation.

A new miniature chip tantalum capacitor to complement the use of ceramic capacitors on thick-film hybrid circuits was announced by Sprague. The type 194D Midget is available in eight chip sizes. Capacitance ratings at the lowest working voltage range up to  $100\mu\text{F}$  while at the highest working voltage the maximum capacitance is  $4.7\mu\text{F}$ . The new capacitor can be reflow solder-attached to substrates at temperatures up to  $300^{\circ}\text{C}$  for three minutes without damaging the electrical or mechanical characteristics of the capacitor.

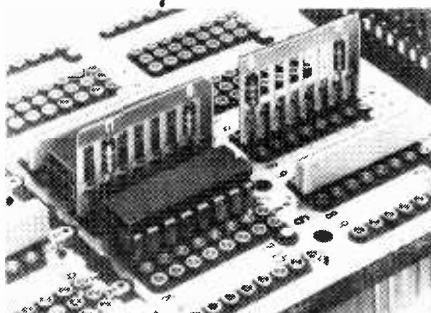
The SGS-Ates BFT95 is a new  $5\text{GHz}$  silicon p-n-p transistor with low noise ( $2\text{dB}$  at  $1\text{GHz}$ ) intended for high-volume radio-frequency applications such as antenna amplifiers and cable TV. The device is constructed with the Planax silicon nitride technique and is mounted in the SGS-Ates T-plastic package using a copper alloy frame to withstand high currents and thus achieve an improved cross-modulation level. The device has a forward transmission gain of  $10\text{dB}$  at  $1\text{GHz}$ . The BFT95 will shortly be followed by another device able to handle even higher signal levels and designed for ultra-linear output stage applications. SGS-Ates has also developed three high-voltage, high-current Darlington transistor arrays each consisting of seven silicon n-p-n Darlington transistors. The L201 array is suitable for d.t.l., t.t.l., p.m.o.s. and c.m.o.s. The L202 is designed for use with  $14$  to  $25\text{V}$  p.m.o.s. elements and the L203 allows operation directly with t.t.l. or c.m.o.s. operating at a supply voltage of  $5\text{V}$ . The three devices have an output sink capability



*New tantalum miniature capacitor chip, the 194D Midget introduced by Sprague is available in eight sizes.*



*Pye has introduced a range of foil polystyrene capacitors encased in a newly developed plastic. They are claimed to have high reliability, low self inductance and low series resistance.*



*Augat's single-in-line terminating-resistor adaptor plug.*

maximum of  $500\text{mA}$  with a specified level of input current at  $50\mu\text{A}$ .

One of the most interesting stands was that of Thomson-CSF on which several novel demonstrations took place. The TH7601 flat screen display was operated as part of an alphanumeric storage display terminal. The characters of the display could be generated either from an associated keyboard or read from a punched tape where they had been previously stored. Also demonstrated on the Thomson stand was an experimental system of video transmission by optical fibres and video image delay using a THX1105 charge transfer device. The monitor display consisted of two juxtaposed images one arriving directly, the other having been delayed by the charge-couple device. Each TV line was treated separately, the time lag being constant for each line but being adjustable by modifying the clock frequency of the THX1105 (number of elements: 256,

distortion: 1%, dynamic range:  $60\text{dB}$ , delay-bandwidth product: 128 and clock frequency:  $10\text{kHz}$  to  $10\text{MHz}$ ).

Siemens are investigating the use of optoelectronics in transistor car ignition units. Ignition units are already in existence in which the mechanical contact breaker points have been replaced by Hall effect generators or inductive type transducers – a light barrier provides an even simpler and longer lasting solution. The high operating temperature of the internal combustion engine to which the optoelectronic elements would be exposed presents difficulties but development work by Siemens has shown there are good prospects of being able to supply suitable light-emitting diodes and phototransistors with an adequate resistance to high temperatures. Siemens has a new m.o.s. device available for manufacturers of multimeters. The device incorporates a four-decade counter and automatically selects one of four possible current or voltage ranges in decade steps. This circuit, S190, has automatic polarity selection and a power dissipation of  $50\text{mW}$ .

Several new additions to the Thorn Brimar range of cathode ray tubes were on view including a working demonstration of the smallest monitor tube yet produced by Brimar, the M8.100GX. Designed for avionic applications, the tube is also suitable for other alphanumeric applications where compact, low profile presentation is required. The Brimar TBK3 is a deflection component kit for use on  $70^{\circ}$ ,  $90^{\circ}$  and  $110^{\circ}$  cathode ray tubes with  $20\text{mm}$  diameter necks. This kit provides a typical final anode voltage of  $11\text{kV}$  from an  $11.5\text{V}$  d.c. supply and the various auxiliary voltages required by the circuit.

International Electronics S.A., a Greek TV tube manufacturing company were demonstrating a new TV tube whose screen was designed for operation in high incident light conditions. No detailed information is available yet but the tube has a dark raster and is used for both colour and black and white tubes.

News of a new processing technique was released by Isotronics who have begun production of a type of hermetic window which uses a new method of glass-to-metal hermetic sealing permitting high transmission of ultraviolet light for quick erasure of the programme material stored on erasable memory devices. The window can be sealed onto the package with a low leakage level. Windows presently used are made of quartz which also has high transmission of u.v. However, quartz requires time consuming and expensive finishing processes such as mechanical machining and lapping. The new window from Isotronics is claimed to be not only inexpensive to manufacture but easy to seal to the semiconductor packages. The first windows being manufactured are in a form suitable for solder sealing.

# New Products

## Deflection yoke

A colour deflection yoke, the type GI 1080-1, has been introduced by General Instrument (UK) Ltd. Intended for use with the Philips 26-inch 110° picture tubes type A66-500X (in for example the Philips 20AX system), it can be used in conjunction with an associated beam centering device type 1081 or similar assembly. The yoke housing is moulded from self-extinguishing plastic. Saddle coils of the pegged type are used for horizontal and vertical deflection whilst a toroidally-wound quadrapole winding on the ferrite core is used for convergence tolerance corrections. The yoke can be adjusted within the housing after fitting to the TV tube. General Instruments (UK) Ltd, Cock Lane, High Wycombe, Bucks.

WW 301 for further details

## Capacitance meter

The ESP 200A linear capacitance meter from Electronic Services and Products Ltd is designed for fast, accurate mea-

surements on a wide range of capacitors. Capacitances ranging from 1pF to 50μF may be measured simply by selecting the appropriate range and reading the value direct from the meter; no balancing is necessary. The instrument, which is housed in a robust metal case, has a stabilized supply and can be connected directly to a chart recorder for plotting capacitance changes. Short term stability is better than 1% of the meter reading. Electronic Services and Products Ltd, Cross Lane, Braunston, Nr. Daventry, Northants.

WW 302 for further details

## Universal breadboard

Up to 36 14-pin d.i.p.s can be fitted to a breadboard from GDS. The board, called the "All Circuit Evaluator," is intended for fast, solderless circuit building and testing, and consists of a matrix of 3,648 plug-in tie points, consisting of 512 separate 5-point terminals, 32 vertical distribution buses and 4 horizontal buses. The vertical buses each have five connected 5-point terminals, and the horizontal buses each have eighteen 4-point types. Any combination of links may be made between buses to provide both unique and common circuit functions. Components are simply plugged into the breadboard terminals and interconnections are made easily using ordinary 22-gauge solid wire. No special patch cords are required. The tie-point material is a non-corrosive nickel-silver with acetal-copolymer dielectric, and the base, which serves as a ground plane, is made from anodized aluminium. Rubber feet are fitted to prevent sliding. The overall size of the breadboard is 10¼ × 9¼ in. GDS Sales Ltd, Michaelmas House, Salt Hill, Bath Road, Slough, Bucks.

WW 303 for further details

## Logic troubleshooter

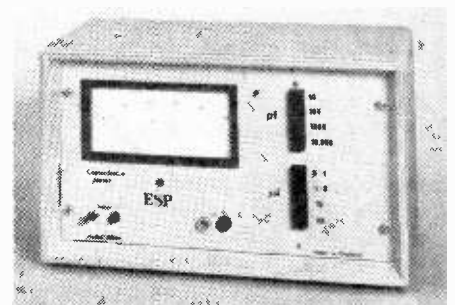
Hewlett-Packard have introduced a probe which can indicate digital states and the presence of pulses in both high-level c.m.o.s. and low-level t.t.l. The logic probe, designated as model 545A, has been designed for simplicity and speedy logic circuit testing. A single lamp displays high, low, unacceptable or open circuit conditions, and it is claimed that this probe enables almost all positive logic up to +18V d.c. to be sensed, including d.t.l., r.t.l., h.t.l., n.m.o.s., m.o.s. and high noise-immunity logic. The probe also features a pulse memory which controls the indicator lamp switching when logic changes occur. A pulse stretching facility allows the operator to see fast pulses — as short as 10ns — pulse trains up to 80MHz being detected in t.t.l. and up to 40MHz in c.m.o.s. logic. The hand-held probe, which requires a supply of up to 15V d.c. on t.t.l., and up to 18V d.c. on c.m.o.s., is protected against voltage overloads. Hewlett-Packard Ltd, King Street Lane, Winnersh, Wokingham, Berkshire RG11 5AR.

WW 304 for further details

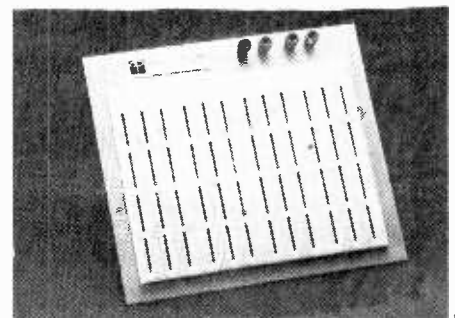
## Low cost solenoids

N.S.F. have introduced the Ledex "D frame" range of solenoids, designed for simplicity, high performance and low cost. The solenoids, which have a dielectric strength of 1000V r.m.s., may be supplied for operating voltages ranging from 6 to 240V d.c. or 60Hz a.c. Design features include a plunger cavity as an integral part of the nylon/glass bobbin, a dichromate-treated cadmium-plated frame and multiple tapped mounting holes for easy installation and interchangeability. N.S.F. Ltd, Switches and Controls, Keighley, Yorkshire BD21 5EF.

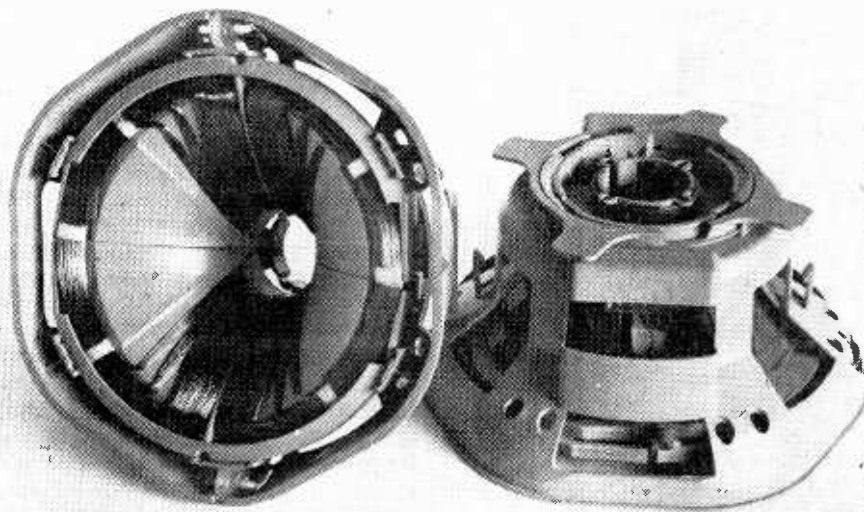
WW 305 for further details



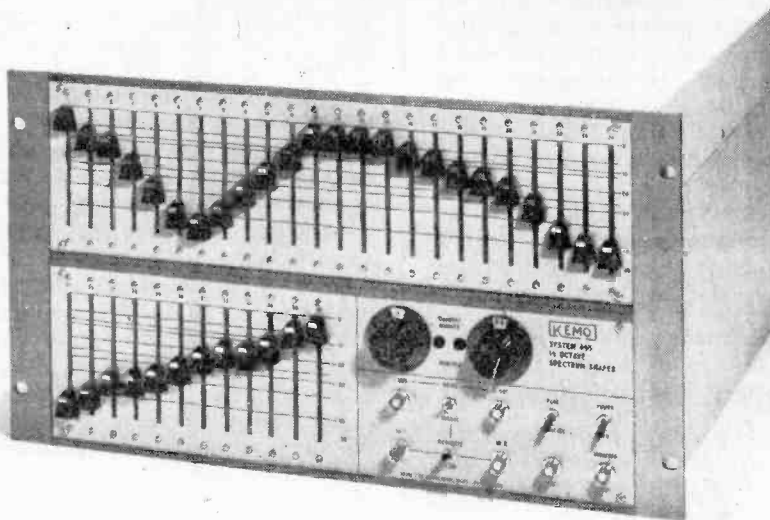
WW 302 for further details



WW 303 for further details



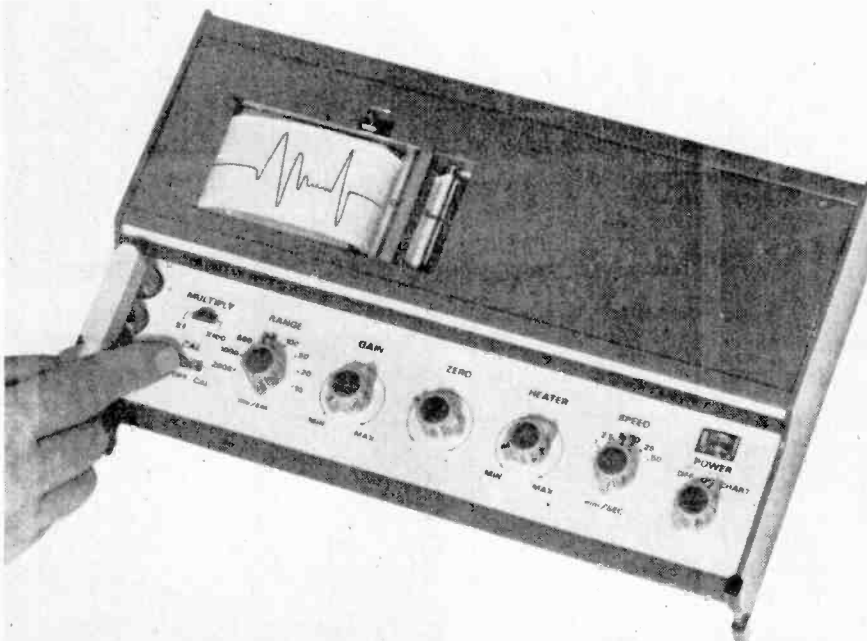
WW 301 for further details



WW 306 for further details



WW 307 for further details



WW 308 for further details

## Spectrum shaper

The Kemo type 495 spectrum shaper has 36 channels, the input to each being adjusted by slide attenuators (patch panel optional). The outputs from each channel are summed and applied to an equalized output terminal. Each channel may also be selected by means of a rotary switch and applied to an output terminal. Provision is made within the system to fit two Kemo KA1193,  $n = 19$ , pseudo-random Gaussian noise sources which may be switched in at will. Main specifications are: frequency range 1Hz to 100kHz, filter accuracy  $\pm 2\%$  of centre frequency, filter level accuracy  $\pm 0.5\text{dB}$ , maximum equalized output signal  $\pm 10\text{V}$  peak into  $2\text{k}\Omega$ , output impedance  $51\Omega$ . Kemo Ltd, 9-12 Goodwood Parade, Elmers End, Beckenham, Kent BR3 3QZ.

WW 306 for further details

## Portable oscilloscope

Small size, light weight and simplicity of controls are the features of the S22 single-beam portable oscilloscope. The Telequipment instrument can be operated from its internal rechargeable batteries, or direct from the mains supply. Although the instrument is small enough to pack into an attache case or tool box, it contains a relatively large screen size of about  $6 \times 3.6\text{cm}$ . Normal bandwidth of the oscilloscope is 5MHz at 10mV sensitivity, but a gain switch enables the sensitivity to be increased to 1mV for a bandwidth of 1MHz. Tektronix UK Ltd, Beaverton House, P.O. Box 69, Harpenden, Herts.

WW 307 for further details

## Fast response recorder

The WTR771 portable Miniwriter, made by Environmental Equipments Ltd, is a single-channel fast-response recorder having a 40mm chart width and a frequency response from 0 to 60Hz. This model, which supersedes the WTR711 Miniwriter, features a thermal writing system incorporating an automatic heat control which, it is claimed, improves the record obtained. The WTR771, which has a higher sensitivity and improved chart speed accuracy, has 14 switched input ranges, having a maximum sensitivity of 10mV/cm on the standard version, and 0.5mV/cm on the high-sensitivity version. Chart speeds range from 1 to 50mm/s in 6 switchable steps. The recorder weighs only 5.5kg and can be operated from the mains supply or from a 12V battery. Optional extras include a solenoid-operated event marker, a 1/10 speed gearbox, and a rechargeable battery pack. Environmental Equipments Ltd, Eastheath Avenue, Wokingham, Berkshire, RG11 2PP.

WW 308 for further details



## Data selecting system

Fenscan 3 is a versatile data scanning and logging system designed for demanding process system applications such as multipoint digital temperature indication, alarm scanning and logging, and intrinsically-safe multiplexing in computer systems. The system, which was launched at the "All Electronics Show" by Fenlow Electronics Ltd, features up to 200 low-level analogue inputs, two 16-segment linearization programmes, manual point selection by a calculator-style keyboard, and a high-accuracy dual-ramp digital voltmeter which uses a strobe-locking technique to reduce series mode mains interference by ensuring that integration is performed over one complete cycle. Optional extras include alarms to aid the automatic point scanning and a trend recording facility. The units are designed to give freedom of location for the scanner, keyboard and display. Fenlow Electronics Ltd, Whittots Eyot, Weybridge, Surrey.

WW 309 for further details

## Coaxial attenuators

Fixed 50Ω axial-attenuators, for use from d.c. to 4GHz, are available in six values between 3 and 40dB from Aspen Electronics Ltd. The LDV 5033 series offers an attenuator accuracy of between ±0.5dB and ±1.0dB, depending on the model, a maximum v.s.w.r. of 1.2, and has a power handling capability of 15W continuous and 13kW peak. Each attenuator unit consists of an internal resistor and black anodized-metal fins on a rugged substrate. The unit has a distributed structure designed for uniform power distribution and low skin temperature. Aspen Electronics Ltd, 18a High Street, Northwood, Middlesex HA6 1BN.

WW 310 for further details

## Instrumentation amplifier

A compact differential d.c. amplifier has been produced by Fylde Electronic Laboratories Ltd, for instrumentation applications in transducer and recording systems. This modular amplifier, designated as FE-351-UA, has a bandwidth greater than 50kHz and exhibits less than 8μV pk-pk noise. The gain is variable between 0.2 and 10000 from two outputs, one being matched for galvanometers up to 20mA, with less than 0.02% non-linearity and a typical stability of 1μV/°C. The amplifier, which can be powered by either an isolated d.c. supply or the integral mains circuit, has both input and output protection, and greater than 100dB common-mode rejection. A wide range of compatible analogue conditioning modules are available and fourteen of the amplifiers can be packed into a 19in two unit high crate. Fylde Electronic Laboratories Ltd, 49 Fylde Road, Preston PR1 2XQ.

WW 311 for further details

# Solid State Devices

Names of suppliers of devices in this section are given in abbreviation after each entry and in full at the end of the section.

## High frequency transistors

Motorola have added two more n.p.n. silicon transistors to their range of radio frequency products. The transistors, BFR90 and BFR91, are designed primarily for use in high gain, low noise, small signal amplifiers, but are also claimed to be suitable for applications requiring fast switching times. The devices are in Macro-T plastic packages and have radially arranged leads.

Motorola

## Amplifier transistors

BCX38 is a family of 60V, 800mA 1W n.p.n. Darlington amplifier transistors introduced by Ferranti's Electronic Components Division. The transistors, produced in E-line plastic encapsulations and available in gain bands, offer high gains and input impedances and are claimed to be suitable for use in driver and output stages of audio amplifiers and also for interfacing with integrated circuits.

Ferranti

## High current transistors

Two high current transistors, designated as 2N4276 and 2N4283, have been introduced by the Germanium Power Devices Corporation. The devices, available in copper TO-3 and TO-41 hermetically sealed packages, have high gain and low voltage saturation and are suitable for inverter and computer power supply applications.

GPD

## Transistor package

Thirty-four different transistors in the Durawatt 92-Plus package are offered by National Semiconductors. This is a modified TO-92 package containing a small heat sink. The 34 transistor types are n-p-n and p-n-p general purpose devices, n-p-n Darlington pairs and high-voltage transistors (300V  $V_{CE0}$ ). A square inch of copper p.c. board is required to reach at least 1.2W power dissipation at an ambient temperature of 25°C.

National

## Op-amps

The CA301AG, CA307G, and CA748G general-purpose operational amplifiers, CA1458G dual operational amplifiers, CA3401G quad operational amplifier and CA3119 voltage comparator are

additions to the Gold Chip linear i.c. ranges produced by RCA Solid State. All of the circuits are hermetically packaged and are available in industrial and military temperature range options.

RCA

## High performance r.a.m.

The MK4027 is a 4kbit r.a.m. which has a claimed 200ns access time and a 10% tolerance on all supplies. The 16-pin d.i.p. memory system offers a performance matching the 160ns obtainable from a 22-pin 4-kbit r.a.m. by eliminating the 40ns delay of the 12V clock driver. Features include direct interfacing capability with Schottky-t.t.l., two methods of chip selection, and a cycling operation, called page-mode, which allows an increased access speed of 135ns at decreased power for successive memory operations within the same row address.

Mostek

## Multipurpose p.m.o.s. dividers

A range of G.I.M. frequency dividers can be driven by both square and sine wave inputs up to 1MHz, and require -13-volt and -27-volt supplies. All outputs are changed on the negative-going clock edges. In particular, the AY-1-5050 divider, supplied in a 14-lead dual in-line plastic package, can divide by 1, 2, 3, 4, 5, 6 and 7 by appropriate selection of divider elements.

SCS

## Silicon power rectifiers

A series of high current silicon rectifiers, SCSFO5-SCSM6, has been introduced by Semtech specifically for high frequency, high power industrial, military and space applications. The rectifiers, known as "Cupac 150", have fast recovery characteristics and allow heat sinking from both the anode and the cathode. Peak inverse ratings extend from 50 to 600 volts.

Bourns

**Bourns (Trimpot) Ltd**, Hodford House, 17/27 High Street, Hounslow, Middlesex TW3 1TE.

**Ferranti Ltd**, Electronic Components Division, Gem Mill, Chadderton, Oldham, Lancs.

**Germanium Power Devices Corp**, P.O. Box 65, Shawsheen Village Station, Andover, Ma 01810, U.S.A.

**Motorola Ltd**, Semiconductor Products Division, York House, Empire Way, Wembley, Middlesex HA9 0PR.

**Mostek UK Ltd**, 240 Upper Street, London N.1.

**National Semiconductor U.K. Ltd**, 19 Goldington Road, Bedford MK40 3LF.

**RCA Ltd**, Solid State— Europe, Sunbury-on-Thames, Middlesex.

**SCS Components**, Northfield Industrial Estate, Beresford Avenue, Wembley, Middlesex HA0 1SD.

# Real and Imaginary

by "Vector"

## "COME IN, REYNARD 51, YOUR TIME IS UP"

I see that the Min of Ag., Fish and Food has been advertising for an electronics engineer. Not any old run-of-the-mill electronics engineer, you understand, but one (and I quote)

"To work in a biological laboratory concerned with control of vertebrate pests. Development of radio-telemetry systems for tracking movements of foxes, badgers, rats, coypu, polecats and other species in a variety of habitats. Considerable scope for research and development."

That first sentence — control of vertebrate pests — is perfectly straightforward and will, I'm sure, meet with the full approval of every thinking electronics engineer. I mean, we could all, at the drop of a microcircuit, provide a long list of vertebrate pests we would like to control; vacillating marketing managers; all group leaders; H.M. Collector of Taxes; that anonymous Scrooge in Accounts Dept who is constantly ringing to reduce our latest expense account presentation by an order of magnitude, *et al.* By the time this piece gets into print the onerous post at the Ministry will doubtless have been filled and I'm sure the best wishes of all go to the successful candidate. It's a comforting thought to know that one of our fraternity has infiltrated into a Government laboratory and (one earnestly hopes) is actively working on our behalf.

So far, so good, and if only the Ministry man who compiled the advertisement had downed his ball-point at this juncture and gone home to his fish and chips, he would have left me a happy man. But no. I can only suppose that he felt that his story so far didn't constitute a fair week's work and so, after a painful gestation period and a w.p.b. full of rejected copy, he at length gave birth to the foxes, badgers and rats

bit and caught the 4.15 back to Pinner, thoroughly exhausted.

I think it's a tribute to the restraint with which affairs in the animal kingdom are conducted that the author of that piece of copy hasn't been torn to pieces by the savage carnivores with which our country is infested. Foxes, in particular, must be feeling grossly ill-used. As is well-known, foxes relish being chased over the terrain by well-bred huntspersons and aristocratic hounds. It is their express reason for being, and, no doubt, as they are being torn to pieces, their last thoughts are of intense satisfaction at having fulfilled their destiny, particularly if the MFH is an Old Etonian. But to be tracked across country by a miscellany of microcircuits is quite another matter. It is devoid of dignity; the babel of binary code will never be an adequate substitute for the resounding "Tally-Ho!" from the throats of the elite and the impetuous "There goes the little brown \*\*!\*?!!" from the less erudite followers.

In a Gallup poll taken on the 8.27 a.m. from Woking, commuters were asked whether they considered polecats to be a pest. Of those questioned, 247 thought they were extinct, 123 said "don't know" and one said he preferred the Military Two-Step. It subsequently transpired that his hearing-aid was defective.

But what particularly intrigues me is this; exactly how does one go about selecting a radio-telemetry coypu-tracker? It's worried me to the point where I have a recurring nightmare about it . . . The scene is the Ministry office where the Comptroller of Pest Infestation is interviewing a candidate, a gangling six-footer with red hair and a wild look in his eyes. The Comptroller glances down at the application form

"Good morning, Mr Shakespeare —"

"Not Shakespeare, sir — Napoleon."

"But it says Shakespeare on your application," says the Comptroller, peering through his gold-rimmed spectacles.

"Ah, yes, sir. That was last week when I sent it in. This week it's Napoleon."

"Good gracious me! Do you change your name every week?"

"No sir, of course not. That would be silly, wouldn't it? No — just every other week."

"H'm. Now, Mr — er — Napoleon; I presume you have had previous experience in a biological laboratory. Which one?"

"Broadmoor, sir. It's the invisible ink."

"The what?"

"The invisible ink, sir, why the form is apparently incomplete. I had to do it that way. You see, THEY are after me."

"They?"

"No sir. — THEY, in capitals; or, to put it another way, in upper case. THEY. The ones with snow on their boots. They want to know how I do it."

"Do what?"

"Why, how I track the movements of foxes, badgers, rats, coypu, polecats and other species in a variety of habitats of course. What else?"

At this the Comptroller leans forward excitedly.

"You mean that you're already doing this? By radio-telemetry?"

"Well, not exactly, sir. It's more what you might call audio than radio."

"Audio? I don't follow."

"Well, sir, I'm not supposed to tell you this — Official Secrets Act, and all that rubbish. But this is how I do it. First, I concrete over their variety of habitats, and then I fit the animal pests with little hobnailed boots. They make such a noise coming and going that I can keep track of them over quite long distances. Bang, bang, bang they go, all night long; sometimes it makes me go quite funny in the head. But that's the price of science, I always say. What do you always say, sir?"

"But —"

"Funny you should say that sir, because it reminds me of my latest development. I don't need concrete or hobnails any more. It works a treat with my experimental goat. I call him 'Nearly'."

"'Nearly'? That's an odd name for a goat. Why do you call him 'Nearly'?"

"I was hoping you'd ask that, sir. I call him 'Nearly' because he's all but. D'you get it, sir? All butt — see? Why aren't you laughing, sir? I wish you would. I get funny pains in the head and things swim around in a red mist when people don't laugh at my little jokes."

"I do not wish to know that! Now, Mr Napoleon — let us stick to the matter in hand. You say you have dispensed with your earlier — er — apparatus and you can still track this goat of yours?"

"Yes, sir, and foxes, and polecats in a variety of habitats."

"Ah. Now we are getting somewhere. Radio-telemetry this time, I presume?"

"No sir. I sniff them out. Did you ever smell a polecat, sir?"

"Most certainly not. Now, Mr — er — Napoleon; you seem to be under a certain misapprehension as to our *modus operandi*. Our approach is to catch the pests, implant a miniscule telemetry transmitter in each and then turn the animals loose again."

"Why, sir?"

"Perfectly obvious, I would have thought. By applying modified mine-detector techniques we can then track down these pests and destroy them. Ingenious — what?"

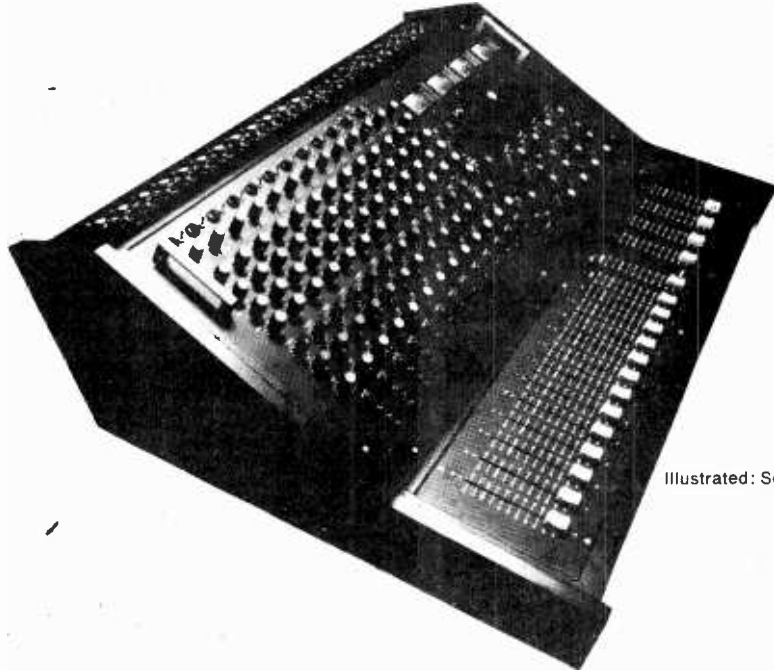
"But — sir! If that's what you wanted, why didn't you kill them in the first place? Why bother with implants?"

At this the Comptroller sits bolt upright, his face a mixture of incredulity and joy.

"By jove! A lateral thinker at last! Mr Napoleon — my congratulations, my boy. You've provided us with the breakthrough we've been looking for! When can you start?"

# Soundcraft-Series II

## revised specification.



Illustrated: Series II original format

The Series II range of recording consoles are now available with many more facilities as standard, enabling the engineer to record four and eight-track with the four-group output mixers, eight & sixteen-track with the eight group mixers. Input modules are available in groups of four channels. All connections between the channels are by multipin connectors and a mother board system. Two types of equalisation:— the standard module features the Soundcraft four-band E/Q with the addition of a high pass filter (bass cut), 12dB/octave below cut-off frequency, continuously

variable between 20Hz and 350Hz. The special module features sweepable frequency of the two mid-frequency peaking and dipping equalisers, addition of a low pass filter to the HF shelving equaliser, and the same 50Hz shelving equaliser and high pass filter as supplied on the standard module. There are four cue sends from each input and monitor channel.

Write for complete details direct to Soundcraft Electronics Ltd., or to the local agent or distributor if listed below.

## SOUNDCRAFT – Mixing Consoles to the World of Music

- U.S.A.** Systems & Technology in Music, Inc., 2025 Factory Street, Kalamazoo, Michigan 49001. Tel: (616) 382 6300. (Mr. Verne Wandell)
- CANADA.** Franchised dealer network – write for your local dealer.
- NETHERLANDS.** Selectronic B.V., Sluisplein 3-4, Ouderkerk aan de Amstel. Tel: (02963) 3838/3966.
- SWEDEN.** Ing. Jan Setterberg, Forstavsgatan 1, S-431 36 Molndal. Tel: (031) 13 02 16 87 58 93.
- GERMANY.** Franchised dealer network – write for your local dealer.
- BELGIUM.** Delta Equipment, Rue de Calevoet 112, 1180 Bruxelles. (02) 376 60 34.  
Calevoet Straat 112, 1180 Brussel. (02) 376 60 34.
- SWITZERLAND.** Professional Audio Systems, 4132 Muttenz, Kappeliweg 41. Tel: 061/41 51 56.
- AUSTRALIA.** Klarion Enterprises (Pty) Ltd., P.O. Box 379, South Melbourne, Victoria 3205. Tel: 61 3801. Cables: Klarionmelb.
- SOUTH AFRICA.** Tru-Fi Electronics S.A. (Pty) Ltd., P.O. Box 31801, Braamfontein, TVL 2017. Tel: Johannesburg 838 4930.
- JAPAN.** C.M.C. Inc., Kasumi Building No. 503, 21-20 Nishi-Azabu, 3-Chome, Minato-ku, Tokyo 104.



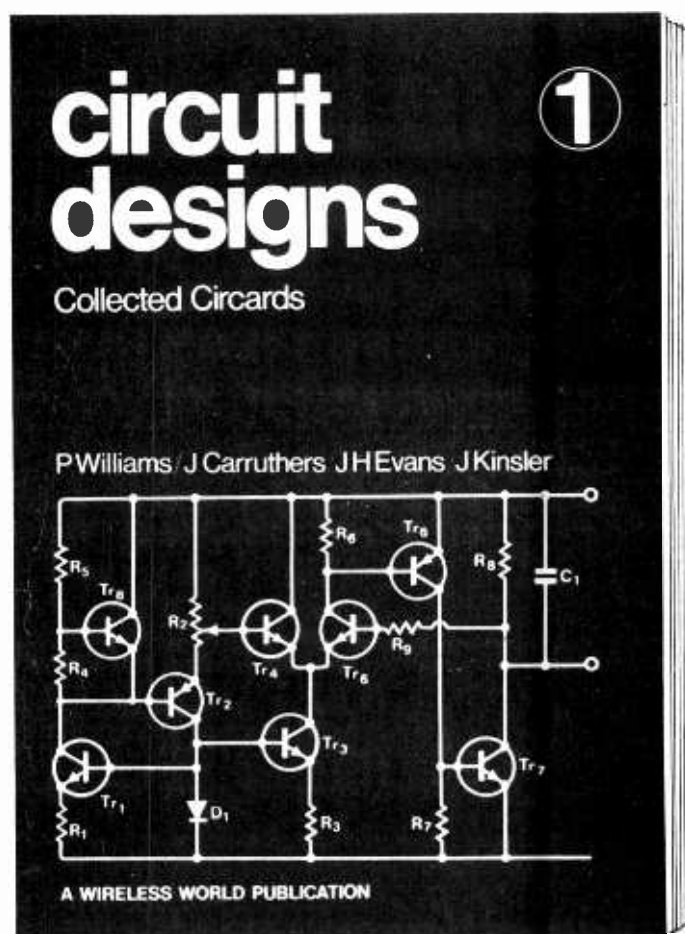
5-8 Gt Sutton Street London EC1V 0BX Tel: 01-251 3631/2/3 Telegrams: Soundcraft LDN EC1

# For all who want to know about electronic circuits

Here's a book of very special appeal to all concerned with designing, using or understanding electronic circuits. It comprises information previously included in the first ten sets of Wireless World's highly successful Circards – regularly published cards giving *selected* and *tested* circuits, descriptions of circuit operation, component values and ranges, circuit limitations, modifications, performance data and graphs. Each of the ten sets – including additional circuits – in this magazine size hard cover book has been updated where necessary, and is preceded by an explanatory introduction. Circuit designs (1) is the first collection of its kind.

Circuits covered are:

- Basic active filters**
- Switching circuits**
- Waveform generators**
- AC measurements**
- Audio circuits**
- Constant-current circuits**
- Power amplifiers**
- Astable circuits**
- Optoelectronics**
- Micropower circuits**



## A new book from Wireless World

### ORDER FORM

To: General Sales Department,  
IPC Business Press Limited,  
Room 11, Dorset House,  
Stamford Street, London SE1 9LU.

Please send me . . . . . copy/copies of  
Circuit Designs – Number 1 at £10.40  
each inclusive. I enclose remittance  
value £: . . . . . (cheques payable to  
IPC Business Press Ltd.)

NAME (please print) . . . . .

ADDRESS . . . . .

Company registered in England and a subsidiary of Reed  
International Limited Registered No 677128 Regd. office  
Dorset House, Stamford Street, London SE1 9LU.



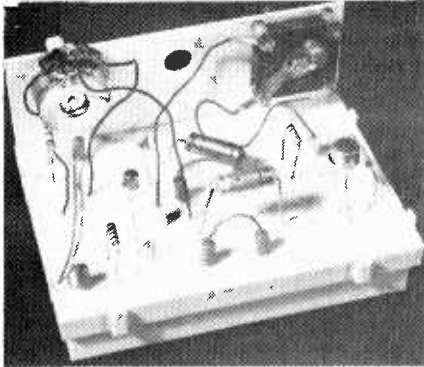
# P.B. ELECTRONICS LTD.

SCOTLAND

ELECTRONIC — SCIENTIFIC — INSTRUMENTS

Sales Office: 57 High Street, Saffron Walden, Essex. Tel: Saffron Walden (0799) 22876  
 Factory: 62 Largo Road, St. Andrews, Fife, Scotland. Tel: St. Andrews 2641.

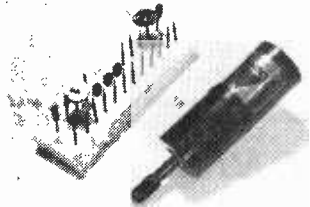
## S—DEC Solderless Breadboard for only £1.00



The world proved S—DEC can now be yours at half price.  
 S—DEC just plug components directly in, no soldering, use components over and over again.  
 With your S—DEC you receive FREE a booklet which gives a range of circuits which can be quickly assembled on the S—DEC including Radio-Receiver, VHF Radio-Microphone, 3 Stage Amplifier and many others, also FREE control panel for mounting switches, lamps, etc.  
 S—DEC normally £1.98 with this advertisement only **£1.00**  
 (When ordering direct send £1.20 to cover Post & VAT)  
 T—DEC normally £3.63, with this advertisement **£3.38**  
 (When ordering direct send £3.87 to cover Post & VAT)  
 U—DEC—A for discrete and use with I.C. send **£4.31**.  
 N.B. These half-price S—DECS are seconds and may be chipped or wrong colour

ALL FULLY  
 GUARANTEED

## Expo Reliant Drills and Kits



Powerful, miniature, low-voltage drills capable of sawing, grinding, burring, brushing and polishing — as well as drilling holes up to 3mm diameter through virtually any material.  
 The Expo drill operates from a power supply of 12V d.c. or, using the Titan transformer / rectifier unit (0220), from a.c. mains supplies at 200-250V a.c., 50Hz.  
 The Expo Reliant Mini Kit, consists of the Reliant Standard Drill (0510) and a set of 20 assorted tools (0305), providing a powerful, versatile kit for use both by the professional and the hobbyist.  
 Prices: **£9.40** including postage and packing, and VAT.

## Special offer Fibre Glass Circuit Board

Offcuts of perfect Fibre Glass material (includes 3 pieces 1.2 x 12) .....	10 sq. ft. <b>ONLY £3.00</b>
1/32in. thick Fibre Glass Circuit Board, size 12 x 12 .....	10 sq. ft. <b>ONLY £4.00</b>
Resist coated Circuit Board, size 12 x 12 .....	5 sq. ft. <b>ONLY £5.00</b>
All Double sided Circuit Board .....	10 sq. ft. <b>ONLY £4.00</b>

Please add £0.60 to all above for Post & VAT. N.B. No smaller amounts supplied

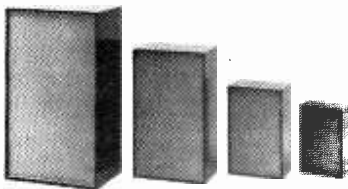
## Make Your Own Circuit Boards

Draw circuit on circuit board with etch resist pen (not supplied) place circuit board in ferric chloride, etch off copper, wash, produce perfect circuit board. 5 sq. ft. of fibre glass circuit board + 5 litre mix of ferric chloride ..... **£4.00**

## Teach Yourself Electronics Book with Free S—DEC

A set of 38 experiments based on the S—DEC covering such subjects as: Applications of Diodes, Biasing, Amplifiers, The Multivibrator Family, Oscillators, etc., etc. EXPERIMENT AND PROJECT GUIDE AND FREE S—DEC ..... **ONLY £5.00**

## Zippy Cabinets. Ideal for All Assembly Cabinets



Robust ABS plastic assembly boxes, front panel designed to be cut and drilled, slots inside for mounting circuit boards, attractive colouring and styling.  
 TP1 80 x 50 x 30mm **£0.72** 1 OFF  
 TP2 115 x 65 x 40mm **£1.27** 1 OFF  
 TP3 155 x 90 x 50mm **£1.62** 1 OFF  
 TP4 210 x 125 x 70mm **£2.27** 1 OFF

● Special low price offer  
 TP4 only **£1.75**  
 inc. Post & VAT

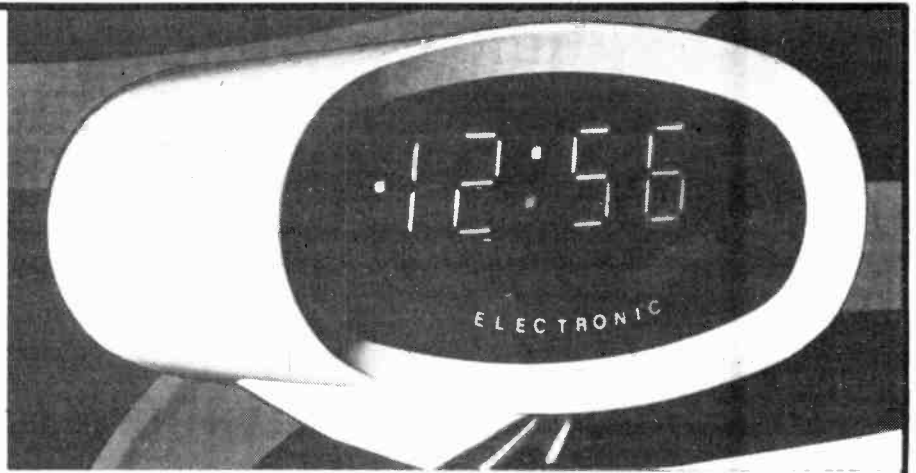
Discount for quantity prices include Post & VAT.

PB Electronics (Scotland) Ltd.  
 57 High Street, Saffron Walden, Essex CB10 1AA  
 Tel: 0799 22876

All stockists of DEC Breadboards  
 Please note PB are the manufacturers and suppliers,  
 please send all orders, communications direct.

# ELECTRONIC DIGITAL CLOCK

with alarm and  
snooze features



**FEATURES:** ● 0.7-inch high digits ● Variable intensity ● 24-hour alarm ● 5-minute repeating, snooze alarm ● Alarm set indicator ● Snooze indicator ● Pulsing second indicator ● Power interrupt indicator ● Alarm cancel features -- tilt operation ● Alarm tone output ● AM, PM, Indicator.

Size 130mm x 90mm x 95mm

Weight 10oz

Power Supply 230 VAC± 10% 50Hz

Manufactured to high standards by a major American electronics corporation this superbly styled solid-state timepiece is made available to all readers fully guaranteed.

Mail Order only. Please enclose 55 pence for postage and packing

## SPECIAL OFFER

# £12.48

+ 99 pence VAT

**FREE TRIAL IN YOUR HOME.** Try out the clock in your home. If digital time is not for you return it in original condition within ten days and we'll refund your money without question. Allow 21 days for delivery.



**TIME MICROELECTRONICS**

**BRIGHTON HILL PARADE, BASINGSTOKE  
HANTS RG22 4EH**

Please send  electronic clocks as illustrated.

I enclose cheque  postal order  money order

Name .....

Address .....

Signature .....

## NEW FROM COMPUTER APPRECIATION!

- ★ **VDU KIT.** The CT 1024 is the first TV compatible terminal everyone can afford. Featuring: 1024 character memory (2 pages of 16 x 32), serial interface 110 to 1200 baud, video output (RF modulator available). Kit includes all components and fibreglass plated-through cards, TTY compatible ASCII keyboard, and PSU. Price £215 (excl. VAT).
- ★ **MOTOROLA M6800 4K MICROPROCESSOR KIT.** Includes 4K static RAM, serial interface, PSU, cabinet, and manuals. Manufactured to the same high standards as the CT 1024. Price £375 (excl. VAT).
- ★ Available very soon! A range of interfaces for the M6800, including a cassette recorder interface. We shall also be offering both kits assembled and tested at around £100 extra per kit.

*Trade enquiries welcomed.*

**Computer Appreciation, Castle St., Bletchingley, Surrey RH1 4NX, Godstone (088 384) 3106.**

WW—076 FOR FURTHER DETAILS

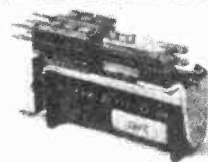
## Your choice of Live Sockets— Instantly!

A Lexor DIS-BOARD gives you up to 6 sockets from one power outlet. Portable or permanent fixing, compact units, with safety neon. Over 1,000 socket combinations available from stock. All types of fittings and finishes.

Brochure from  
LEXOR DIS-BOARDS LIMITED  
Allesley Old Road, Coventry  
Telephone 726 14 or 72207



WW — 028 FOR FURTHER DETAILS



## Wilkinsons RELAYS

POST OFFICE TYPE 3000 AND 600 BUILT TO YOUR OWN SPECIFICATIONS AND REQUIREMENTS. THE BEST KNOWN OF ALL RELAYS WITH A LARGE VARIETY OF CONTACT ARRANGEMENTS. KNOWN THROUGHOUT THE WORLD. COMPLETE BANKS OF CONTACTS MADE TO ORDER AND COMPONENT PARTS SUPPLIED. HIGHEST QUALITY AT COMPETITIVE PRICES WITH A QUICK DELIVERY SERVICE. QUOTATIONS BY RETURN HOME AND OVERSEAS. WE ARE SPECIALISTS IN EXPORT ORDERS.

**JACK — IN AND STRIP MOUNTINGS** to house BPO type 3000 Relays and associated components used in BPO 2000 and 4000 type telephone exchange equipments and industrial control systems. The mountings are drilled to accept BPO type 3000 Relays or any other type of equipment using similar drawings, supplied complete with test jacks. Prices on request.

Single and Double pole High Speed Relays available, various resistances, Uniselectors, Line Transformers, Multi-point plugs, P.O. type Boggin resistors and complete Relay Selector Units also available at competitive prices.

**HIGH SPEED COUNTERS** £1.75 each  
3 1/2" x 1" 10 counts per second with 4 figures. The following D.C. voltages are available: 6 v., 12 v., 24 v., 50 v., or 110 v. Auxiliary contacts normally open 40p extra.

Five Digit Counters BPO type 150A 500 ohms 35mA operating current £3 each

**TUNING FORKS** 125 Hz for 45/50 band teleprinter speeds. £2.50 each

**MINIATURE DIGITAL INDICATOR** 1/4 inch digits, illuminated by 28 volt midget flanged lamps, weight 3 ozs reading 0 to 9 with decimal points £2 each

**L. WILKINSON (CROYDON) LTD., LONGLEY HOUSE  
LONGLEY ROAD, CROYDON, CR0 3LH. Phone 01-684 0236 - Grams: WILCO CROYDON**

All prices shown are carriage paid U.K. only but subject to VAT at the standard rate



WW—090 FOR FURTHER DETAILS

# Professional Tape Recorders for Mini-Studio use



### REVOX 2-TRACK

REW carry the largest stocks of Revox in the country. All models available for immediate delivery at very low prices to professional and educational users. High speed models of the A77 and A700 ranges off the shelf.



### DOKORDER 1140 4-TRACK

Now available for immediate delivery. The 1140 offers the ultimate quality and facilities for a 1/4" 4-channel recorder. Motion sensing logic transport, automatic sync switching, front panel bias adjustment, auto. rewind-replay facility, console format, built-in pink noise generator.

**REW offer the largest range at the best prices!**



### TEAC TASCAM 8-TRACK

New Teac Tascam 80-8 8-track 1/2" recorder available in May. 15 ips, modular electronics, perfect sync response. Studio quality, under £2,000 + VAT. Also in stock the Teac A3340S 4-track 1/4" recorder, 15 ips, 10 1/2" reels, and also A2340 4-track recorder, 7 1/2 ips, 7" reels.

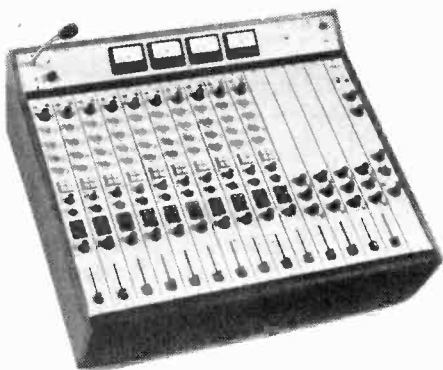


For details of our complete range of Professional Audio and Studio Sound Equipment please send for our new catalogue and price list.

**REW Professional Audio, 146 Charing Cross Rd. London, WC2. Tel. 01-240 3064/5**

WW-078 FOR FURTHER DETAILS

## A Mini Mixer with a true PROFESSIONAL STUDIO SPECIFICATION



10 input Channels, 4 Output Groups. Auxiliary Sends and Echo Returns. XLR Connectors to balanced Mic Inputs and Line Returns. Normalised Insert Jacks. Low Noise and High Output levels. Portable. Extension units, PPM's, Limiters, etc., also available.

### SOUTH AFRICA

Prosound  
Musicians Sound Centre  
J'burg  
Tel. 642-87-21

### SPAIN

TELCO Sociedad Limitada  
Madrid  
Tel. 221-5606

### HOLLAND

Pieter Bollen  
Eindhoven  
Tel. 040-512777

### BELGIUM

ARC, S.P.R.L.  
Brussels  
Tel. 771-30-63

### DENMARK

Audiophil  
Copenhagen F  
Tel. (01)fa. 5209

### WEST GERMANY

Elmus GmbH  
Berlin 12  
Tel. 030-312-2012

**Raindirk Ltd.** Downham Market, Norfolk  
Tel. (036 63) 2165-3617

WW - 091 FOR FURTHER DETAILS

### SINCLAIR CALCULATORS\*

Cambridge £7.95. Cambridge % £8.95.  
Cambridge Scientific £14.95. Scientific  
£11.95. Oxford 100 £6.95. Oxford 300  
£16.95. Programmable Scientific £25.95.  
Mains adaptors for Programmable and  
Oxfords £3.19. For Cambridge and  
Scientific £3.15.

### S-DECS AND T-DECS\*

S-DeC £2.24  
T-DeC £4.05  
u-DeC A £4.45  
u-DeC B £7.85  
IC carriers:  
16 dit. plain £1.07  
With socket £2.21  
10 T05 plain 99p. With socket £1.95.  
SSTI 60p. SSUI 60p. SSNI 80p.

### BATTERY ELIMINATORS

6-WAY SPECIAL  
3.4 1/2 6. 7 1/2 9. 12V  
at 500mA with  
unique 4-way  
multi-jack  
connector and  
free matching  
socket £5.20.

### 6-WAY DOUBLE RADIO MODEL

Similar to above, but with press stud battery  
connectors 3+3. 4 1/2 + 4 1/2. 6 + 6.  
7 1/2 + 7 1/2. 9 + 9. 12 + 12V at 250mA. Can  
also be used to give 15. 18 and 24V single.  
£6.20.

### 3-WAY MODEL\*

Switched output of 6. 7 1/2 and 9V. at  
250mA with 4-way multi-jack connector  
and free matching socket £2.95.

### RADIO MODELS

50mA with press-stud battery connectors  
for radios, etc. 6V £3.45. 9V £3.25.  
4 1/2 + 4 1/2 V £4.45. 6 + 3/4 V £4.45. 9 + 9V  
£4.45.

### CASSETTE MAINS UNITS

7 1/2V output to run cassette tape recorders  
from the mains. Complete with 5 pin DIN  
plug. 50mA model £3.45. 300mA model  
£3.95.

### CAR CONVERTERS

Input 12V DC. Output 6/7 1/2/9V DC 1A  
regulated £3.95\*.

### SINCLAIR BLACK

#### WATCH\*

Fully assembled  
with black  
strap £20.95.  
With Bracelet £22.95.

#### DIGITAL CLOCK KIT\*

24 Hr display. Includes pcb, mains power  
supply, attractive case, 0.5in. jumbo green  
display, clock chip and all other parts.  
Displays hours and minutes separated by  
pulsating colon. Kit £12.50. Built £13.50.

#### SINCLAIR IC20

IC20 10W+10W stereo amp kit with  
printed circuit £4.95.  
PZ20 Power supply for above £3.95.  
VP20 Volume, tone control and preamp kit  
£7.95.  
SP20 10W 4 Ohm speaker £2.95.  
CS20 Case for IC20 £2.95.  
Send sae for free leaflet.

#### SINCLAIR PROJECT 80

FM tuner £13.25. Q16 £10.15. PZ5  
£3.95. PZ6 £8.70. PZ8 £9.10. Trans for  
PZ8 £5.60. Z40 £5.75. Z60 discontinued,  
but we stock a similar 30W equivalent amp  
£10.30. Stereo 80 £11.95. Project 80SQ  
£18.95. Quadraphonic decoder £14.95.

#### JC12 AMPLIFIER

6W IC audio amp  
with free data  
and printed  
circuit £1.95\*

#### DELUXE KIT FOR JC12

Includes extra parts for the pcb and volume  
and tone controls. Mono £2.06. Stereo  
£4.46.

#### JC12 POWER KIT

Supplies 25V 1 Amp. £3.25.

#### JC12 PREAMP KITS

Type 1 for magnetic pickups, mics and  
tuners. Mono £1.40. Stereo £2.80. Type 2  
for ceramic or crystal pickups. Mono 78p.  
Stereo £1.56.

#### LOUDSPEAKERS

FOR JC12 8in x 5in 8 Ohms. W £2.28.  
Send SAE for free leaflet.

Post 30p on orders under £2, otherwise free. Prices include VAT (Overseas customers deduct 7% on items marked \*, otherwise 10%). Official orders from schools, etc welcome

**SWANLEY ELECTRONICS**  
DEPT. WW, PO BOX 68, SWANLEY, KENT BR8 8TQ

# LOW PRICED Top Quality Components



## VALVES

Qty	Type	Price (p)	Qty	Type	Price (p)
	DY87	37.0		PCF802	48.0
	DY802	37.0		PCL82	54.0
	ECC82	37.0		PCL84	46.0
	EF80	34.0		PCL85	52.0
	EF183	39.0		PCL86	50.0
	EF184	39.0		PFL200	65.0
	EH90	40.0		PL36	63.0
	PC86	58.0		PL84	30.0
	PC88	58.0		PL504	75.0
	PCC89	46.0		PL508	78.0
	PCC189	47.0		PL509	£1.35
	PCF80	38.0		PY88	43.0
	PCF86	44.0		PY500A	£1.00
	PCF801	46.0		PY800	42.0

## SEMI CONDUCTORS

Qty	Type	Price (p)	Qty	Type	Price (p)
	AC127	20		BC135	15
	AC128	15		BC137	20
	AC141K	25		BC138	30
	AC142K	25		BC142	20
	AC151	20		BC143	25
	AC154	18		BC147	8
	AC155	18		BC147A	11
	AC156	20		BC148	9
	AC176	22		BC149	10
	AC187	20		BC153	20
	AC187K	30		BC154	20
	AC188	18		BC157	11
	AC188K	30		BC158	10
	AD142	62		BC159	11
	AD149	45		BC173	15
	AD161	38		BC178B	20
	AD162	38		BC182L	12
	AF114	25		BC183L	12
	AF115	22		BC187	25
	AF116	22		BC214L	15
	AF117	20		BC328	28
	AF118	45		BC337	19
	AF139	35		BD124	75
	AF178	45		BD131	35
	AF180	40		BD132	39
	AF181	40		BD160	£1.65
	AF239	45		BD235	50
	AF240	20		BD237	60
	BC107	10		BDX32	£2.40
	BC108	10		BF115	24
	BC109	12		BF160	35
	BC109C	14		BF167	24
	BC113	15		BF173	25
	BC116A	25		BF178	33
	BC117	14		BF179	38
	BC125B	18		BF180	31
	BC132	15		BF181	37

BF184	29
BF185	30
BF194	8
BF195	8
BF196	10
BF197	11
BF198	23
BF200	25
BF218	40
BF224	20
BF258	26
BF336	27
BF337	35
BF355	50
BFX86	28
BFY50	19
BFY52	20
BSY52	30

BT106	£1.20
BU105/02	
	£1.60
BU108	£1.80
BU208	£2.20
E1222	38
MJE340	45
OC71	18
OC72	18
R2008B	£1.90
R2010B	£1.90
RCA16334	80
RCA16335	80
TIP31A	52
TIP32A	62
TIP41A	60
TIP42A	75
2N3055	55

## DIODES

Qty	Type	Each Price (p)
	BA115	7
	BA145	16
	BA148	16
	BA154/201	12
	BY126	11
	BY127	10
	BY199	25

Qty	Type	Each Price (p)
	BY206	17
	BY238	25
	OA90	6
	OA202	8
	IN60/OA91	7
	IN914	6
	IN4002	5

## INTEGRATED CIRCUITS

Qty	Type	Each Price (p)
	ETTR6016	£2.00
	MC1351P	70
	SN76003N	£2.35
	SN76013N	£1.43
	SN76013ND	£1.25
	SN76023N	£1.43
	SN76023ND	£1.20
	SN76033N	£2.15
	SN76227N	£1.45
	SN76532N	£1.45
	SN76660N	60
	SN76666N	90
	TAA550	32
	TAA700	£3.80

Qty	Type	Each Price (p)
	TBA120AS	60
	TBA120SQ	£1.00
	TBA480Q	£1.40
	TBA520Q	£2.40
	TBA530Q	£1.75
	TBA540Q	£1.25
	TBA550Q	£2.30
	TBA560CQ	£2.40
	TBA800	£1.10
	TBA920Q	£2.90
	TBA990Q	£2.50
	TCA270Q	£2.90

## EHT MULTIPLIERS MONOCHROME B.R.C.

Qty	Type	Price (p)
	2TQ 950MK2 1400	£2.05
	2DAK 1500 (17" x 19")	£1.85
	2TAK 1500 (23" x 24")	£2.05

## EHT MULTIPLIERS COLOUR

Qty	Type	Price each
	11 TAQ ITT CVC 1, 2 & 3	£5.10
	ITN GEC Sobell	£4.50
	IITAZ GEC 2110	£4.50
	IITAM Philips G8	£4.50
	IITBD Philips 550	£4.65
	3TCW Pye 691/693	£3.49
	ITH Decca 30 Series	£4.60
	3TCU Thorn 3000/3500	£5.00
	11HAA Thorn 8000	£1.99
	11HAB Thorn 8500	£4.31
	IITPC Bush 823	£5.50

## New BLACK & WHITE TUBES with Full Year's Guarantee

Qty	Type	Price each
	20" CME 2013	£13.90
	24" CME 2413	£15.95

## New TOSHIBA TUBES with 12 months in service guarantee

Qty	Type	Price each
	19" A49-191X equivalents	
	A49-192 and A49-120X	£52.00
	20" 510DJB22 equivalent	
	A51-110X	£54.30
	22" A56/120X	£55.40

\* All goods subject to settlement discount of 5% 7 days and 2% monthly.

\* Prices subject to 12 1/2% VAT w.e.f. April 12th 76

\* No Postal Charges

\* C.P.C. - Price · Quality · Service

\* No Minimum Orders

# C.P.C.

Extend Life Tubes Limited

Around the World Export Service



C.P.C. supply many large Multiple Organisations in the U.K. Contact our Export Division for special prices NOW. Or send your order with this page. I enclose cheque/PO to the value £.....p for the goods as specified above.

Name \_\_\_\_\_ Position \_\_\_\_\_  
 Company \_\_\_\_\_  
 Address \_\_\_\_\_  
 \_\_\_\_\_ Tel. No. \_\_\_\_\_

Send this coupon NOW to:  
 C.P.C., Dept.W, 194-200 NORTH ROAD, PRESTON, LANCASHIRE, ENGLAND.  
 Phone: Preston (STD 0772) 55034. Telex 677122  
 New price list 1.4.76



# MORE THAN JUST A CATALOGUE!

**READY MADE ALARM CLOCK MODULE!**  
\* CAN CONTROL A RADIO, TOO!

- BRIGHT 4 DIGIT 0.5 INCH DISPLAY
- FLASHING COLON (H/H)
- SWITCH FOR DISPLAY SECONDS
- ALARM SET INDICATOR
- P.M. INDICATOR
- POWER FAILURE INDICATION
- SLEEP TIMER
- SNOOZE TIMER
- AUTOMATIC DISPLAY BRIGHTNESS (NEEDS C&S CELL)
- TIME CAN BE SET ACCURATELY TO WITHIN ONE SECOND
- LEADING ZERO BLANKING

Just add transformer and switches!



This is a fully constructed and tested electronic clock module as illustrated. Data sheet supplied with module shows how simple it is to connect an audible alarm, and your battery or mains radio. A smart case will be available shortly. Data sheet available separately. Please send s.a.e.

**ONLY £8-60**  
INC. V.A.T. & P/P

Please note: Details not in catalogue

Simple Clock Kit	£9.38
Alarm Clock Kit	£10.99
Alarm Clock / Radio Switching Kit	£11.51
Case	£1.99
All prices include VAT & P&P	

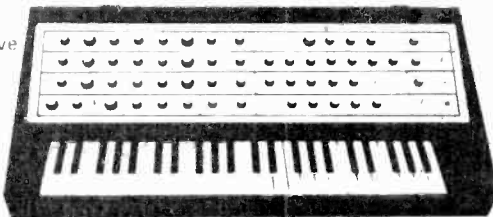
Really good value for money at just 40p.



132 pages!

## The 3600 SYNTHESISER

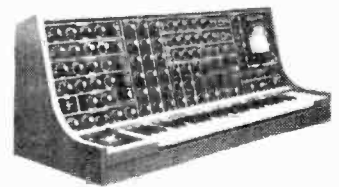
The 3600 synthesiser includes the most popular features of the 4600 model, but is simpler. Faster to operate, it has a switch patching system rather than the matrix patchboard of the larger unit and is particularly suitable for live performance and portable use.



S.A.E. please for price list

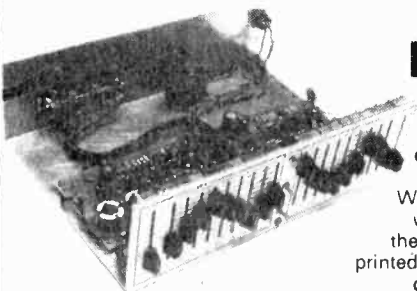
## The 4600 SYNTHESISER

We stock all the parts for this brilliantly designed synthesiser including all the PCBs, metalwork and a drilled and printed front panel, giving a superb professional finish.



Opinions of authority agree the ETI International Synthesiser is technically superior to most of today's models. Complete construction details available now in our booklet price £1.50, or S.A.E. please for specification

## GRAPHIC EQUALIZER



A really superior high quality stereo graphic equaliser as described in Jan. 1975 issue of ETI. We stock all parts (except woodwork) including all the metal work drilled and printed as required to suit our components and PCBs. Complete reprint of article — price 15p.

## ELECTRONIC ORGAN

Build yourself an exciting Electronic Organ. Our leaflet MES51, price 15p, deals with the basic theory of electronic organs and describes the construction of a simple 49-note instrument with a single keyboard and a limited number of stops. Leaflet MES52, price 15p, describes the extension of the organ to two keyboards each with five voices and the extension by an octave of the organ's range. Solid-state switching and new footages along with a pedal board and a further extension of the organ's range are shown in leaflet MES53, price 35p.



## NO MORE DOUBTS ABOUT PRICES

Now our prices are GUARANTEED (changes in VAT excluded) for two month periods. We'll tell you about price changes in advance for just 30p a year (refunded on purchases). If you already have our catalogue send us an s.a.e. and we'll send you our latest list of GUARANTEED prices. Send us 30p and we'll put you on our mailing list — you'll receive immediately our latest price list then every two months from the starting date shown on that list you'll receive details of our prices for the next GUARANTEED period before the prices are implemented! — plus details of any new lines, special offers, interesting projects — and coupons to spend on components to repay your 30p

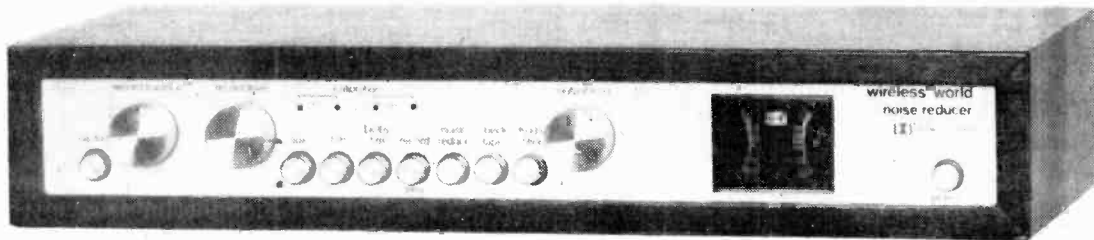
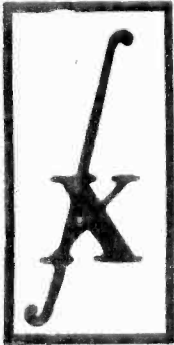
NOTE: The price list is based on the Order Codes shown in our catalogue so an investment in our super catalogue is an essential first step.

Call in at our shop, 284 London Road, Westcliff on Sea, Essex. Please address all mail to

**MAPLIN ELECTRONIC SUPPLIES**  
P.O. Box 3 Rayleigh Essex SS6 8LR

I enclose Cheque/P.O. value \_\_\_\_\_ ww  
 For \_\_\_\_\_ copy/copies of your Catalogue  
 Name \_\_\_\_\_  
 Address \_\_\_\_\_

MAPLIN ELECTRONIC SUPPLIES P.O. Box 3 Rayleigh Essex SS6 8LR



# Wireless World Dolby<sup>TM</sup> noise reducer

Trademark of Dolby Laboratories Inc.

We are proud to announce the latest addition to our range of matching high fidelity units.

### Featuring:

- switching for both encoding (low-level h.f. compression) and decoding
- a switchable f.m. stereo multiplex and bias filter
- provision for decoding Dolby f.m. radio transmissions (as in USA)
- no equipment needed for alignment
- suitability for both open-reel and cassette tape machines
- check tape switch for encoded monitoring in three-head machines

### The kit includes:

- complete set of components for stereo processor
- regulated power supply components
- board-mounted DIN sockets and push-button switches
- fibreglass board designed for minimum wiring
- solid mahogany cabinet, chassis, twin meters, front panel, knobs, mounting screws and nuts

### Typical performance

Noise reduction: better than 9dB weighted

Clipping level: 16.5dB above Dolby level (measured at 1% third harmonic content)

Harmonic distortion 0.1% at Dolby level typically 0.05% over most of band, rising to a maximum of 0.12%

Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal at Dolby level) at Monitor output.

Dynamic Range > 90dB

30mV sensitivity.

**PRICE: £34.40 + VAT**

Calibration tapes are available for open-reel use and for cassette (specify which) . . . . . **Price £1.80 + VAT\***

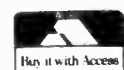
Single channel plug-in Dolby<sup>TM</sup> PROCESSOR BOARDS (92 x 87mm) with gold plated contacts are available with all components . . . . . **Price £6.50 + VAT**

Single channel board with selected fet. . . . . **Price £2.00 + VAT**

Gold plated edge connector . . . . . **Price £1.27 + VAT\***

Selected FET's **54p** each + VAT, **96p** + VAT for two, **£1.76** + VAT for four

Please add VAT at 12½% unless marked thus\*, when 8% applies  
We guarantee full after-sales technical and servicing facilities on all our kits



Please send SAE for complete lists and specifications  
**Portwood Industrial Estate, Church Gresley,  
Burton-on-Trent, Staffs DE11 9PT  
Burton-on-Trent (0283) 215432 Telex 377106**

# INTEGREX LTD.

# INTEGREX

## S-2020TA STEREO TUNER / AMPLIFIER KIT

**SOLID MAHOGANY CABINET**

*A high-quality push-button FM Varicap Stereo Tuner combined with a 20W r.m.s. per channel Stereo Amplifier.*

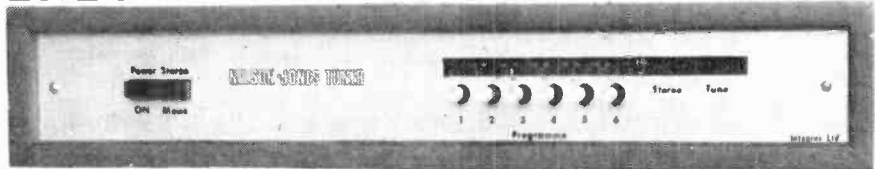
**Brief Spec.** Amplifier: Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc), THD less than 0.1% at 20W into 8 ohms. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section: uses Mullard LP1186 module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88—104MHz. 30dB mono S/N @ 1.8 $\mu$ V. THD typ. 0.4%



**PRICE: £48.95 + VAT**

## NELSON-JONES STEREO FM TUNER KIT

*A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter / dual IC IF amp.*



**Brief Spec.** Tuning range 88—104MHz. 20dB mono quieting @ 0.75 $\mu$ V. Image rejection — 70dB. IF rejection—85dB. THD typically 0.4% IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

*Compare this spec. with tuners costing twice the price*

**Mono £26.31 + VAT**

**With ICPL Decoder £30.58 + VAT**

**With Portus-Haywood Decoder  
£32.81 + VAT**



Sens. 30dB S/N mono @ 1.8 $\mu$ V  
THD typically 0.4%  
Tuning range 88—104MHz  
LED sig. strength and stereo indicator

## STEREO MODULE TUNER KIT

*A low-cost Stereo Tuner based on the Mullard LP1186 RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC*

**PRICE: Mono £25.55 + VAT**

**Stereo £28.65 + VAT**

## S-2020A AMPLIFIER KIT

*Developed in our laboratories from the highly successful "TEXAN" design. PC mounting potentiometers, switches, sockets and fuses are used for ease of assembly and to minimize wiring*



**Typ. Spec.** 20+20W r.m.s. into 8-ohm load at less than 0.1% THD. Mag. PU input S/N 60dB. Radio input S/N 72dB. Headphone output. Tape In/Out facility (for noise reduction unit, etc.). Toroidal mains transformer.

**PRICE: £30.94 + VAT**

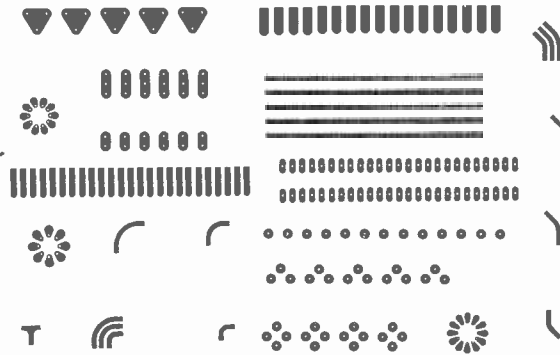
**ALL THE ABOVE KITS ARE SUPPLIED COMPLETE WITH ALL METALWORK, SOCKETS, FUSES, NUTS AND BOLTS, KNOBS, FRONT PANELS, SOLID MAHOGANY CABINETS AND COMPREHENSIVE INSTRUCTIONS**

**BASIC NELSON-JONES TUNER KIT** £13.13 + VAT  
**BASIC MODULE TUNER KIT (Mono)** £13.25 + VAT  
**BASIC MODULE TUNER KIT (stereo)** £15.25 + VAT

**PHASE-LOCKED IC DECODER KIT** £4.47 + VAT  
**PUSH-BUTTON UNIT** £3.50 + VAT

**PORTUS-HAYWOOD PHASE-LOCKED STEREO DECODER KIT** £7.93 + VAT

# PRINTED CIRCUIT BOARD TRANSFER SYSTEMS



Acid resistant transfers for direct application to P.C. Board. This is a new approach to printed circuit board manufacture, giving a professional finish with all details that an electronics engineer would require, including all drilling positions automatically marked.

Ideal for single unit boards or small quantities. All at a very low cost—for example an average 6" x 4" layout would cost less than 30p, and the time taken under one hour, including etching to complete.

The system is simple, briefly it consists of 10 sheets of self adhesive acid resistant transfers made in required shapes — i.e. edge connectors, lines, pads, dual in line I.C.s, 8-10-12, T.O.5 Cans, 3-4 lead transistors, etc., which only require pressing into the required positions on the printed circuit board before etching.

The printed circuit transfer system is a genuine offer to the public and industry. A full money back guarantee is sent with each order, trade prices on application.

### List of Prices

Complete system including post and VAT	£2.95
Individual sheets	30p
Sample sheet	30p
Ex. U.K. Post Extra	£1.00

Printed circuit board PCB transfer systems patent applied for

**E. R. NICHOLLS, 46 LOWFIELD ROAD, STOCKPORT, CHESHIRE**  
**TELEPHONE NUMBER 061-480 2179**

## WEST HYDE Instrument cases

**MOD 3**

Offer instrument manufacturers low cost cases ex stock. Blue PVC coated steel strength and rigidity. PVC aluminium grey front and rear panels are removable. PCB and PSU mounting system available. Also available in black. 301 price of 302. BK 302. 303. BK 304. 305.

**CONTIL**

A range of eyebrow cases in blue textured acrylic. Front panels normally white (zinc) or PVC aluminium, also available unpainted up to 1277 size. Aluminium panels 20p extra up to 16127 only.

All dimensions are Wxd HxHghtxDepth

PRICES	1 off inc.	P & P but not VAT	
MOD 3 (including chassis)			
301	7x3 x5 x4	5.23	C 4.5x10x 6.5
302	7x4 x5 x4	5.61	D 9 x 3x 6.5
303	7x6 x5 x4	7.15	E 9 x 7x 6.5
304	11x3 x5 x4	6.44	F 9 x10x 6.5
305	11x4 x5 x4	7.59	G 13 x 3x 6.5
306	11x6 x5 x4	9.08	H 13 x 7x 6.5
			I 13 x10x 6.5
			J 18 x 3x 6.5
			K 18 x 7x 6.5
			L 18 x10x 6.5
			M 4.5x 3x12
			N 4.5x 7x12
			O 4.5x10x13
			P 9 x 3x13
			Q 9 x 7x13
			R 9 x10x13
			S 13 x 3x13
			T 13 x 7x13
			U 13 x10x13
			V 18 x 3x13
			W 18 x 7x13
			X 18 x10x13
			20.35
			Mod 2 + Woodgrain in Black finish in sizes A-L & N
			Prices as for one price up on
			5.50 Mod 2, e.g. Mod 2A Woodgrain
			6.38 for Black as Mod 2B
CONTIL TEXTURED			
755	7x5x5	7.25	
867	8x7x6	8.60	
975	9x5x7	8.60	
1277	12x7x7	9.90	
1277	unpainted	7.36	
16127	16x7x12	13.66	
191010	19x10x10	18.74	
ELF CASES (grey line chassis)			
Elf	8x4x5	2.40	
Mini Elf	8x5x5	1.95	
Mini Elf	8x5x5	3.60	
Long Elf	9x4x5	2.90	
Jumbo Elf	10 x5 x5	4.80	

## WEST HYDE Instrument cases

**MOD 2**

Mod 2 cases over 24 sizes. Front and back panels grey PVC. Aluminium chassis included. Packed flat. Outer casing blue PVC steel (up to size L) also available in wood grain and black. (Price as for next price higher or A Black is B price)

**CONTIL ELF**

These tough little cases add very little to the cost of a job. Front panel aluminium with protective coat. Elf cases are available in 4 sizes, all dough moulded in grey glass polyester, all panels, feet and chassis included.

All West Hyde cases are available with substantial discounts for quantities. Most cases have discounts of 5 off and 25 off with discounts up to 25% at 100 off. Prices include P & P and are less 10% if collected on first three price breaks on cases only.

### BUY A CASE FROM A SMALL RANGE, YOU GET A CASE—BUY A CASE FROM A BIG RANGE, YOU GET A SOLUTION

**Brightcase**

A prestige finished case, black PVC steel top and bottom which can be supplied finished at no extra cost. Free standing or rack mounting, available in rack or half width assembled in special polystyrene pack for safe postage.

**MINOS**

Smart miniature ABS cases in tough rigid high gloss black. Front panels either aluminium or PVC steel. Built in slots for PC cards, dividers, etc. Chassis or PC boards can be supported on 'P' clips from internal pillars.

## THE INSTRUMENT

**Instrument cases**

BRIGHTCASE MARK II	SAMOS	
BC212 (3 1/2" Full Rack)	S1 100x100x50mm	1.13
BC222 (3 1/2" Full Rack)	S2 100x100x50mm	1.29
BC232 (3 1/2" Full Rack)	S3 100x150x50mm	1.44
BC222 (3 1/2" Full Rack)	S4 125x100x75mm	1.62
Rack Back (see also 161)	S5 125x100x75mm	1.85
Nil extra for Covers add L	S6 125x150x75mm	2.17
	S7 125x200x75mm	2.41
MINOS		
M2 165x100x50mm	0.61	HEAVY DUTY CASE
M3 100x100x50mm	0.77	8x Hx5
M2	0.40	10x10x7
M4	0.45	12x10x7

**OVER 250 DIFFERENT CASES IN STOCK—SIZE RANGE OVER 5000:1 IN VOLUME**

Send for catalogue

**WEST HYDE DEVELOPMENTS LIMITED**  
 Ryefield Cwm, Northwood Hill, Northwood, Middx., HA8 1NN  
 Telephone: Northwood 24941/28732/27864  
 Telex: 923231 West Hyde Wtdow.

## WEST HYDE CASE SPECIALISTS

**SAMOS**

Miniature instrument cases in blue and white PVC steel. Assemble in the lower half clip in feet, 2 screws allow the cover to hinge off cases, 2 more to fix, PC feet are available to hold up to 4 PC boards horizontally in case.

**HEAVY DUTY**

Available in 3 sizes. Heavily constructed in zinc steel, welded corners with heavy hinges, 2 screw fixings and flange around the door. In the base a gland plate with gasket and a chassis with screws provided.

## WEST HYDE CASE SPECIALISTS

WW—055 FOR FURTHER DETAILS



# DEMA ELECTRONICS INTERNATIONAL

## ELECTRONIC COMPONENTS DISTRIBUTOR FOR INDUSTRY AND HOBBYIST

### MONTHLY SPECIALS "ANNIVERSARY SALE" - WHILE THEY LAST

TTL				LINEARS			
7400	.09	7483	.59	LM380	.69	LM709	.19
7451	.09	74154	.89	LM555	.69	LM741	.19
7453	.11	74165	.89	LM556	.69	LM3900	.29

MEMORIES							
1101	256	Bit Ram Mos.	.99	5262	2048	Bit Ram	3.95
1103	1024	Bit Ram Mos.	1.45	1702A	2048	Bit Prom.	9.95
5260	1024	Bit Ram	1.45	5203	2048	Bit U/Violet Proms.	8.95
5261	1024	Bit Ram L/Power	1.45	2102	1024	Bit Status Ram	2.75

CALCULATOR CHIPS				CLOCK CHIPS			
CT5001	12 Digit 4 Func.	49 or 3/1.00		5311	28 Pin BCD 6 Dig Mux	2.75	
CT5002	Batt Dper 5001	59 or 3/1.25		5314	24 Pin 6 Dig Mux		
CT5005	12 Dig 4 Func w/Mem.	69 or 3/1.50		7001	4 or 6 Digit Alarm	3.50	

TTL 7400 SERIES			
7400	£ 0.11		
7401	0.11	7441	0.60
7402	0.11	7442	0.55
7403	0.11	7443	0.55
7404	0.13	7444	0.60
7405	0.13	7445	0.75
7406	0.22	7446	0.85
7407	0.22	7447	0.75
7408	0.14	7448	0.65
7409	0.14	7450	0.12
7410	0.11	7451	0.13
7411	0.16	7453	0.13
7413	0.26	7454	0.14
7416	0.22	7460	0.11
7417	0.22	7470	0.24
7420	0.11	7472	0.21
7426	0.23	7473	0.25
7430	0.12	7474	0.25
7432	0.22	7475	0.37
7437	0.25	7476	0.26
7438	0.25	7483	0.69

SCHOTTKY			
74500	24	74504	29
74502	29	74508	35
74503	29	74510	29

LOW POWER SCHOTTKY			
74LS00	23	74LS20	.23
74LS02	23	74LS32	.27
74LS04	25	74LS40	.33
74LS08	27	74LS42	1.35
74LS10	23	74LS74	.39

CMOS 4000 SERIES			
4000A	£ 0.19	4014	£ 1.10
4001	0.19	4015	1.10
4002	0.19	4016	0.55
4006	0.90	4019	0.67
4007	0.19	4020	1.15
4008	1.30	4021	1.10
4009	0.49	4023	0.19
4010	0.49	4024	0.85
4011	0.19	4025	0.19
4013	0.39	4027	0.75

LINEARS			
LM300	TO99	£ 0.45	340U
301	V DIP	0.29	380
302	TO99	0.45	381
304	TO100	0.50	546
305	TO99	0.60	550
307	V DIP	0.38	555
308	A DIP	0.45	566
309K	TO3	1.45	562
310	T pkg	0.65	565
311	V DIP	0.90	566
320K	TO 3 NEG	567	V DIP
324	A DIP	1.67	709
339	A DIP	1.49	710
340K	TO3	2.10	711

MEMORIES w/DATA			
1101	256	Bit Ram Mos.	£ 1.79
1103	1024	Bit Ram Mos.	2.25
7489	(8225)	64 Bit Ram TTL	1.50
8223		Programmable ROM	7.50
5260	1024	Bit Ram Low Power	1.95

CALCULATORS & CLOCKS w/DATA			
5001	Cat Chip	£ 0.99	
5002	Cat Chip	1.19	
5005	Cat Chip	1.49	
5311	Clock Chip	2.95	
5312	Clock Chip	2.95	
5313	Clock Chip	2.95	
5314	Clock Chip	3.45	
5316	Clock Chip	3.95	
Data only for any of above Refundable Against Purchase			

TRANSISTORS			
2N 2219A	TO5	£ 0.37	2N 4124
2N 2222	TO18	0.15	2N 4126
2N 2369	TO18	0.10	2N 4401
2N 2905A	TO5	0.38	2N 5225
2N 3227	TO18	0.32	2N 5226

DISCOUNTS:		MIN ORDER	
10%	on orders over £ 10	£ 2.5	
15%	on orders over £ 25		

**TERMS:** PRICES LISTED ARE BRITISH POUNDS & PENCE. SEND CHEQUE WITH ORDER. ACCESS CARD, BANKAMERICARD, BARCLAY CARD ACCEPTED. (Card # and expiration date requested). TERMS OFFERED TO SCHOOLS & INSTITUTIONS.

POSTAL AND HANDLING CHARGES SHIPMENT VIA AIR MAIL under 4.99 add .45 £ 10 and over 5.00-9.99 add .35 No Charge

**DEMA ELECTRONICS INTERNATIONAL**  
P.O. Box 407 San Ramon, Ca. 94583 USA  
Cable DEMAELINTL

# CATRONICS

## WW TELETEXT DECODER

The design of this decoder is being described in a series of articles being published by 'Wireless World' (from last November). All the components are available from Catronics Ltd.

Our kit contains all the printed circuit boards and components necessary to build the complete decoder. The power supply and video switching circuitry are normally installed within the television cabinet and the main decoding control and memory circuitry in a separate cabinet positioned on top of the television.

### PRICES ARE AS FOLLOWS:

Set of 5 PCBs (incl. PSU & Video Switching)	£16.00 + VAT = £18.00
Component Kit (incl. PCBs)	£96.02 + VAT = £104.10
Add-on Unit for Lower Case: PCB only	£2.00 + VAT = £2.25
Component Kit (incl. PCB)	£12.65 + VAT = £13.75
Cabinet	£12.00 + VAT = £13.50
READY BUILT AND TESTED for Lower Case add --	£148.00 + VAT = £162.55
	£15.00 + VAT = £16.40

Post & Packing. PCBs are post free but add £1 for component kit and 50p for cabinet. ALL COMPONENTS ALSO AVAILABLE SEPARATELY - SAE for price list

A wide range of other components is also available, including SL600 series i.c.s.:

SL610C	£1.90	SL611C	£1.90	SL612C	£1.90	SL613C	£3.30
SL620C	£2.90	SL621C	£2.90	SL622C	£7.10	SL623C	£5.25
SL624C	£2.80	SL630C	£1.80	SL640C	£3.20	SL641C	£3.20

KVG filters, AERIALS for Commercial, Mobile and Radio Amateur bands. IGNITION interference Suppression Components plus, of course, the famous Catronics Frequency Counters and Prescalers, including 200 MHz DFM, 7 digit display, mains or 12v supply Only £121 + £1 carriage + VAT (8%)

Send SAE for current price list (stating requirements) or 30p + large SAE (11p stamp) for full catalogue.



**Catronics** Ltd. (Dept. 626)  
39 Pound Street, Carshalton, Surrey  
Tel: 01-669 6700

WW-626 FOR FURTHER DETAILS

# THE RADIO SHOP

16 CHERRY LANE BRISTOL BS1 3NG TELEPHONE 0272-421196

OFFICIAL ORDERS WELCOMED GOVT / EDUCATIONAL DEPTS. ETC.

### TRIACS

1.5 AMP PLASTIC		6 AMP ISOLATED TAB		10 AMP ISOLATED TAB	
NAS0161W	100V 29	NAS0651W	100V 62	NAS1001W	100V 73
NAS0161X	100V 28	NAS0651X	100V 61	NAS1001X	100V 72
NAS0162W	200V 30	NAS0652W	200V 66	NAS1002W	200V 78
NAS0162X	200V 29	NAS0652X	200V 65	NAS1002X	200V 76
NAS0164W	400V 40	NAS0654W	400V 72	NAS1004W	400V 1.09
NAS0164X	400V 38	NAS0654X	400V 70	NAS1004X	400V 1.04
NAS0166W	600V 50	NAS0656W	600V 88	NAS1006W	600V 1.36
NAS0166X	600V 48	NAS0656X	600V 78	NAS1006X	600V 1.34
3.5 AMP CLIPPED TAB		8.5 AMP ISOLATED TAB		15 AMP ISOLATED TAB	
NAS0351W	100V 53	NAS0851W	100V 69	NAS1501W	100V 1.05
NAS0351X	100V 52	NAS0851X	100V 68	NAS1501X	100V 95
NAS0352W	200V 58	NAS0852W	200V 78	NAS1502W	200V 1.04
NAS0352X	200V 56	NAS0852X	200V 76	NAS1502X	200V 1.02
NAS0354W	400V 68	NAS0854W	400V 88	NAS1504W	400V 1.51
NAS0354X	400V 67	NAS0854X	400V 85	NAS1504X	400V 1.48
NAS0356W	600V 86	NAS0856W	600V 1.10	NAS1506W	600V 1.89
NAS0356X	600V 84	NAS0856X	600V 1.06	NAS1506X	600V 1.84

Devices with internal trigger have "W" suffix. "X" denotes standard Triac.

### THYRISTORS

1.5 AMP TO 5		4 AMP ISOLATED TAB		6 AMP ISOLATED TAB	
NAS006P	50V 25	NAS106P	50V 26	NAS206P	50V 37
NAS006Q	100V 28	NAS106Q	100V 30	NAS206Q	100V 42
NAS006R	200V 31	NAS106R	200V 36	NAS206R	200V 50
NAS006S	400V 40	NAS106S	400V 57	NAS206S	400V 77
NAS006T	600V 52	NAS106T	600V 90		
8 AMP ISOLATED TAB		16 AMP TO 48			
NAS306P	50V 41	16A	50V 55		
NAS306Q	100V 47	16A	100V 59		
NAS306R	200V 59	16A	200V 65		
NAS306S	400V 85	16A	400V 78		
		16A	600V 1.08		

### INTEGRATED CIRCUITS

TAA550	TO18	.54	●TBA800	.90	●709	14 Di	.27
TAA263	TO18	.62	●TBA10AS	1.08	●741	8 Di	.35
555	8 Di	.40	●ZN414	TO18	●748	14 Di	.50
556	8 Di	1.05			723	14 Di	.67

### CLOCK CHIPS

CT7001	28 Pin Skt	4.95	AY 51224	16 Pin	3.75
	Data	50	16 Pin Skt		.15
		15	Data		.15

707 LED	3" Common Anode Display	90
704 LED	3" Common Cathode Display	1.00
747 LED	6" Common Anode Display	1.65

● Please add 25% VAT Remainder 8% P&P 20p Phone in your Access or Barclaycard order. Catalogue 20p Callers w.u.some

THE *new* WORLD OF AUDIO

# AUDIO FAIR 76

**1976 INTERNATIONAL AUDIO FESTIVAL & FAIR OLYMPIA LONDON**

13th – 19th September (inclusive)

There is a whole new deal for exhibitors at the 1976 Audio Festival & Fair. A new deal designed to ensure that participation spells success in every way. The formula has been created by a new management team comprising people with a real understanding of Hi-Fi and people possessing deep experience and expertise in staging major exhibitions.



Plans  
for the  
1976  
Audio  
Fair  
include:—

**new** – earlier dates  
**new** – extended trade  
only period  
**new** – floor plans  
**new** – cost structure  
**new** – Biggest ever  
all-media  
promotion

**plus** –

The backing of  
all the key  
IPC Business  
Press  
publications

**IT'S SOUND SENSE FOR YOUR COMPANY TO BE THERE**

*Complete and post the coupon below for more details*

Please send me a brochure with details for intending exhibitors at the 1976 Audio Festival & Fair.

Name

Company

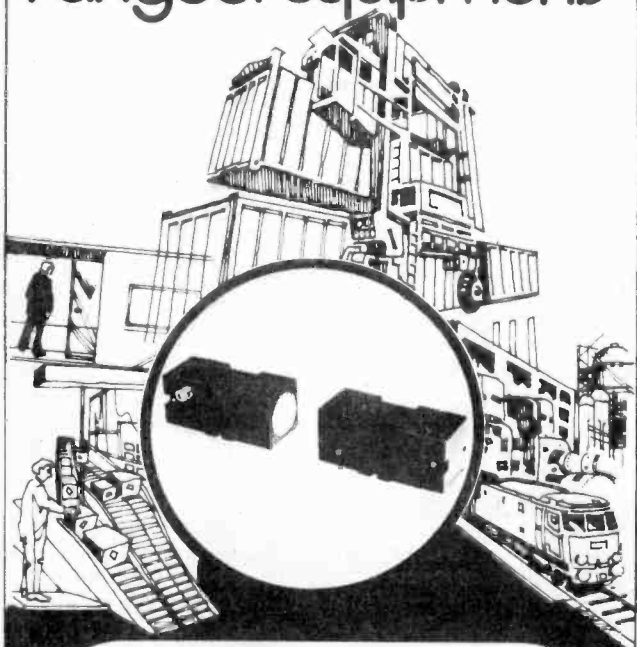
Address

Telephone number

Complete and post to: **Audio Festival & Fair, Iliffe Promotions Ltd.,  
Dorset House, Stamford Street, London SE1 9LU.  
Tel: 01-261 8000**

# Industrial Action with the JAMES SCOTT INDUSTRIAL

## MICROWAVE range of equipments



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

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

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

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



**JAMES SCOTT**  
 (Electronic Engineering) Ltd

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

# Get to the Point Quickly with ANTEX Model X25

## Point 1

Near-perfect insulation. Breakdown voltage 1500 A.C. Leakage current 3.5 uA.

## Point 2

Top-efficiency in heat transfer. Element slides inside the soldering bit. 25 watts but equivalent in heat capacity to 60 watts.

## Point 3

High grade phenolic handle (own moulding!) Stainless steel shaft. — 3 core 0.4mm. Flexible lead.

## Point 4

Iron-coated bits that do not stick to the shaft but slide on and off easily. 3 tip sizes 2.4, 3.2 and 4.7mm.

## Point 5

Price with standard (3.2mm.) bit £3.20 (P+P 0.22) each  
 Spare elements £1.52 each  
 Spare bits £0.50 each

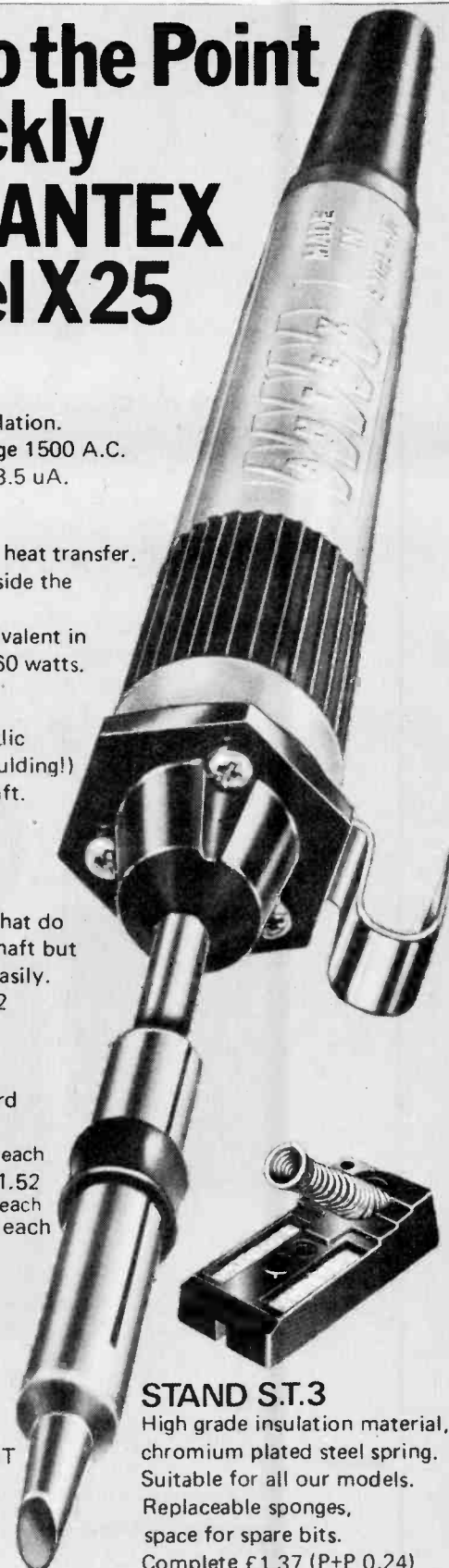
## Point 6

A well balanced tool — length 22cm. weight 50gr.

Prices include VAT Postage + Packing extra as shown in brackets.

### STAND S.T.3

High grade insulation material, chromium plated steel spring. Suitable for all our models. Replaceable sponges, space for spare bits. Complete £1.37 (P+P 0.24)



from electrical, radio or car accessory shops or from Antex Ltd., Freepost (no stamp required) Plymouth. PL1 1BR Telephone 0752 67377/8.

Please send the following:

Name .....

ANTEX colour catalogue.

Address .....

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

WW6.



# 15 — 240 Watts!

## HY5 Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge tuner etc) are catered for internally. The desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

**FEATURES:** Complete pre-amplifier in single pack — Multi-function equalization — Low noise — Low distortion — High overload — Two simply combined for stereo

**APPLICATIONS:** Hi-Fi — Mixers — Disco — Guitar and Organ — Public address

**SPECIFICATIONS:**

**INPUTS:** Magnetic Pick-up 3mV Ceramic Pick-up 30mV Tuner 100mV Microphone 10mV

Auxiliary 3-100mV input impedance 47k $\Omega$  at 1kHz

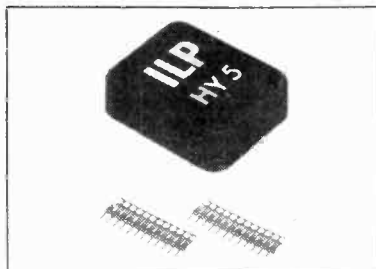
**OUTPUTS:** Tape 100mV Main output 500mV R.M.S

**ACTIVE TONE CONTROLS:** Treble — 12dB at 10kHz Bass — at 100Hz

**DISTORTION:** 0.1% at 1kHz Signal Noise Ratio 68dB

**OVERLOAD:** 38dB on Magnetic Pick-up **SUPPLY VOLTAGE:** 16-50V

**Price £4.75 + 59p VAT P&P free.**



## HY30 15 Watts into 8 $\Omega$

The HY30 is an exciting New kit from I.L.P. it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C. heatsink P.C. board 4 resistors 6 capacitors mounting kit together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

**FEATURES:** Complete Kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build

**APPLICATIONS:** Updating audio equipment — Guitar practice amplifier — Test amplifier — audio oscillator

**SPECIFICATIONS:**

**OUTPUT POWER:** 15W R.M.S. into 8 $\Omega$ ! **DISTORTION:** 0.1% at 15W

**INPUT SENSITIVITY:** 500mV **FREQUENCY RESPONSE:** 10Hz-16kHz — 3dB

**SUPPLY VOLTAGE:** 18V

**Price £4.75 + 59p VAT P&P free.**

Available  
June '76

## HY50 25 Watts into 8 $\Omega$

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

**FEATURES:** Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components

**APPLICATIONS:** Medium Power Hi-Fi systems — Low power disco — Guitar amplifier

**SPECIFICATIONS:** **INPUT SENSITIVITY:** 500mV

**OUTPUT POWER:** 25W RMS into 8 $\Omega$ ! **LOAD IMPEDANCE:** 4-16 $\Omega$ ! **DISTORTION:** 0.04% at 25W at 1kHz

**SIGNAL NOISE RATIO:** 75dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB

**SUPPLY VOLTAGE:** 25V **SIZE:** 105 50 25mm

**Price £6.20 + 77p VAT P&P free.**



## HY120 60 Watts into 8 $\Omega$

The HY120 is the baby of I.L.P.'s new high power range designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

**FEATURES:** Very low distortion — Integral heatsink — Load line protection — Thermal protection — Five connections — No external components

**APPLICATIONS:** Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ

**SPECIFICATIONS:**

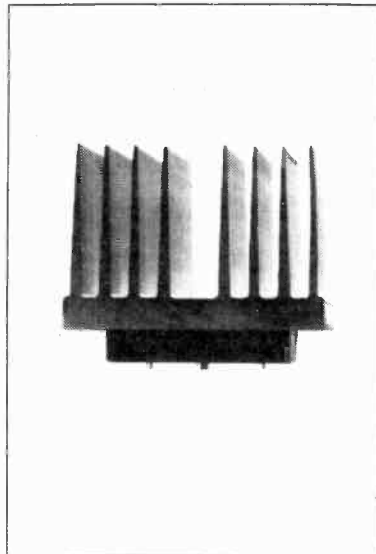
**INPUT SENSITIVITY:** 500mV

**OUTPUT POWER:** 60W RMS into 8 $\Omega$ ! **LOAD IMPEDANCE:** 4-16 $\Omega$ ! **DISTORTION:** 0.04% at 60W at 1kHz

**SIGNAL NOISE RATIO:** 90dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB **SUPPLY VOLTAGE:** 35V

**SIZE:** 114 50 85mm

**Price £14.40 + £1.16 VAT P&P free.**



## HY200 120 Watts into 8 $\Omega$

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

**FEATURES:** Thermal shutdown — Very low distortion — Load line protection — Integral heatsink — No external components

**APPLICATIONS:** Hi-Fi — Disco — Monitor — Power slave — Industrial — Public Address

**SPECIFICATIONS:**

**INPUT SENSITIVITY:** 500mV

**OUTPUT POWER:** 120W RMS into 8 $\Omega$ ! **LOAD IMPEDANCE:** 4-16 $\Omega$ ! **DISTORTION:** 0.05% at 100W at 1kHz

**SIGNAL NOISE RATIO:** 96 dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB **SUPPLY VOLTAGE:** 45V

**SIZE:** 114 100 85mm

**Price £21.20 + £1.70 VAT P&P free.**

## HY400 240 Watts into 4 $\Omega$

The HY400 is I.L.P.'s 'Big Daddy' of the range producing 240W into 4 $\Omega$ ! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

**FEATURES:** Thermal shutdown — Very low distortion — Load line protection — No external components

**APPLICATIONS:** Public address — Disco — Power slave — Industrial

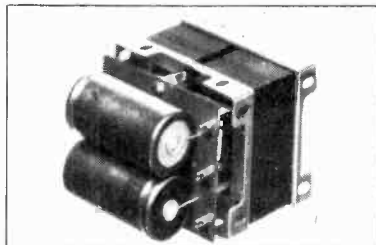
**SPECIFICATIONS:**

**OUTPUT POWER:** 240W RMS into 4 $\Omega$ ! **LOAD IMPEDANCE:** 4-16 $\Omega$ ! **DISTORTION:** 0.1% at 240W at 1kHz

**SIGNAL NOISE RATIO:** 94dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB **SUPPLY VOLTAGE:** 45V

**INPUT SENSITIVITY:** 500mV **SIZE:** 114x100x85mm

**Price £29.25 + £2.34 VAT P&P free.**



### POWER SUPPLIES

PSU36 suitable for two HY30s — £4.75 plus 59p VAT P.P. free  
PSU50 suitable for two HY50s — £6.20 plus 77p VAT P.P. free  
PSU70 suitable for two HY120s — £12.50 plus 1.00 VAT P.P. free  
PSU90 suitable for one HY200 — £11.50 plus 1.00 VAT P.P. free  
PSU180 suitable for two HY200s or one HY400 — £21.00 plus 1.68 VAT P.P. free

TWO YEARS' GUARANTEE ON ALL OF OUR PRODUCTS

I.L.P. Electronics Ltd  
Crossland House  
Nackington, Canterbury  
Kent CT4 7AD  
Tel (0227) 63218

Please Supply \_\_\_\_\_  
Total Purchase Price \_\_\_\_\_  
I Enclose Cheque  Postal Orders  Money Order   
Please debit my Access account  Barclaycard account   
Account number \_\_\_\_\_  
Name & Address \_\_\_\_\_  
Signature \_\_\_\_\_

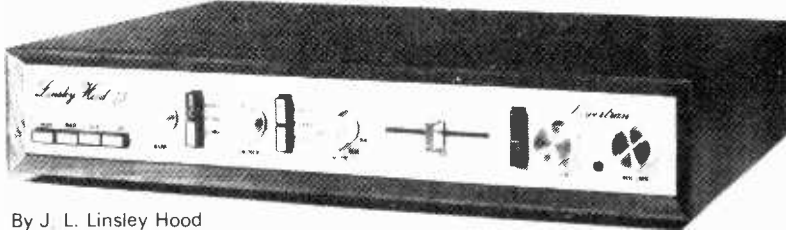
Bahrain Singapore Thailand Iceland Brazil Sweden Germany Iran Jamaica St. Kitts Tunisia

# POWERTRAN ELECTRONICS

INCORPORATING

# AMBIENTACOUSTICS

## HI-FI NEWS 75W/CHANNEL AMPLIFIER



By J. L. Linsley Hood

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.

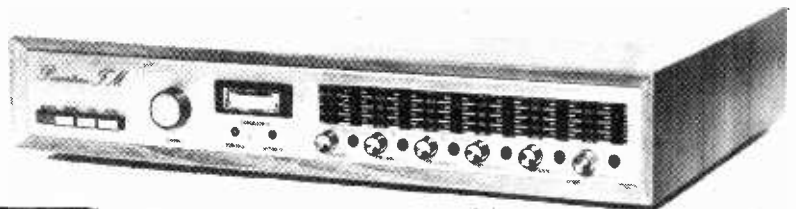
Pack	Price	Pack	Price
1. Fibreglass printed-circuit board for power amp	£0.85	11. Fibreglass printed-circuit board for power supply	£0.65
2. Set of resistors, capacitors, pre-sets for power amp	£1.70	12. Set of resistors, capacitors, secondary fuses, semi-conductors for power supply	£3.50
3. Set of semiconductors for power amp	£6.50	13. Set of miscellaneous parts including DIN skts, mains input skt, fuse holder, inter-connecting cable, control knobs	£4.25
4. Pair of 2 drilled, lined heat sinks	£0.80	14. Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.	£6.30
5. Fibreglass printed-circuit board for pre-amp	£1.30	15. Handbook	£0.30
6. Set of low noise resistors, capacitors, pre-sets for pre-amp	£2.70	16. Teak cabinet 18.3" x 12.7" x 3.1"	£9.85
7. Set of low noise, high gain semiconductors for pre-amp	£2.40		
8. Set of potentiometers (including mains switch)	£2.05		
9. Set of 4 push-button switches, rotary mode switch	£3.70		
10. Toroidal transformer complete with magnetic screen/housing primary: 0 117-234 V; secondaries: 33-0-33 V, 25-0-25 V	£9.15		

2 each of packs 1-7 inclusive are required for complete stereo system. Total cost of individually purchased packs ..... £72.25

Designed in response to demand for a tuner to complement the world-wide acclaimed Linsley Hood 75W Amplifier, this kit provides the perfect match. The Wireless World published original circuit has been developed further for inclusion into this outstanding slimline unit and features a pre-aligned front end module, excellent a.m. rejection and temperature compensated varicap tuning, which may be controlled either continuously or by push button pre-selection. Frequencies are indicated by a frequency meter and sliding LED indicators attached to each channel selector pre-set. The PLL stereo decoder incorporates active filters for birdy suppression and power is supplied via a toroidal transformer and integrated regulator. For long term stability metal oxide resistors are used throughout.

**FREE** TEAK CASE WITH FULL KITS  
KIT PRICE ONLY **£62.40**

## WIRELESS WORLD FM TUNER



Pack	Price	Pack	Price
1. Fibreglass printed board for front end IF strip, demodulator, AFC and mute circuits	£2.15	9. Function switch, 10 turn tuning potentiometer, knobs	£5.30
2. Set of metal oxide resistors, thermistor, capacitors, cermet preset for mounting on pack 1	£4.80	10. Frequency meter, meter drive components, fibreglass printed circuit board	£8.60
3. Set of transistors, diodes, LED, integrated circuits for mounting on pack 1	£6.25	11. Toroidal transformer with electrostatic screen, Primary: 0-117V-234V	£4.45
4. Pre-aligned front end module, coil assembly, three section ceramic filter	£8.80	12. Set of capacitors, rectifiers, voltage regulator for power supply	£2.95
5. Fibreglass printed circuit board for stereo decoder	£1.10	13. Set of miscellaneous parts, including sockets, fuse holder, fuses, inter-connecting wire, etc.	£1.50
6. Set of metal oxide resistors, capacitors, cermet preset for decoder	£2.60	14. Set of metal work parts including silk screen printed fascia panel, acrylic silk screen printed tuning indicator panel insert, internal screen, fixing parts, etc.	£6.50
7. Set of transistors LED, integrated circuit for decoder	£3.45	15. Construction notes (free with complete kit)	£0.25
8. Set of components for channel selector switch, module including fibreglass printed circuit board, push-button switches, knobs, LEDs, preset adjusters, etc.	£8.30	16. Teak cabinet 18.3" x 12.7" x 3.1"	£9.85

One each of packs 1-16 inclusive are required for complete stereo FM tuner. Total cost of individually purchased packs ..... £76.85

**FREE** TEAK CASE WITH FULL KITS  
KIT PRICE only **£66.75**

### PRICE STABILITY!

Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement for two months from issue date provided that this advertisement is quoted with your order. E&OE VAT rate changes excluded. All components are brand new first grade full specification devices. All resistors (except where stated) are low noise carbon film types. All printed circuit boards are fibre-glass, drilled, roller tinned and supplied with circuit diagrams and construction layouts. U.K. Orders, Subject to 12½% Surcharge for VAT. Carriage free MAIL. ORDER ONLY (\*or at current rate if changed). Secunor Delivery. For this optional service (Mainland only) add £2.50 VAT inc per kit. Overseas Orders. No VAT. Postage charged at actual cost plus 50p packing and handling.

## STOP PRESS!

### LINSLEY-HOOD CASSETTE DECK

Goldring-Lenco mechanism, as specified ..... **£19.10**

PCB, Components — Please send for details

### Wireless World Amplifier Designs

Full kits are not available for these projects but component packs and PCBs are stocked for the highly regarded Bailey and 20W class AB Linsley Hood designs, together with an efficient regulated power supply of our own design. Suitable for driving these amplifiers is the Bailey Burrows pre-amplifier and our circuit board for the stereo version of it features 6 inputs, scratch and rumble filters and wide range tone controls which may be either rotary or slider operating.

For those intending to get the best out of their speakers we also offer an active filter system described by D. C. Read which splits the output of each channel from the pre-amplifier into three channels each of which is fed to the appropriate speaker by its own power amplifier. The Read/Texas 20W or any of our other kits are suitable for these. For tape systems a set of three PCBs have been prepared for the integrated circuit based, high performance stereo Stuart design. Details of component packs are in our free list.

30W Bailey Amplifier	£1.00
BAIL Pk 1 F/Glass PCB	£2.35
BAIL Pk 2 Resistors, Capacitors, Potentiometer set	£4.70
BAIL Pk 3 Semiconductor set	
20W Linsley Hood Class AB	£1.05
LHAB Pk 1 F/Glass PCB	£3.20
LHAB Pk 2 Resistor, Capacitor, Potentiometer set	£3.35
LHAB Pk 3 Semiconductor set	
Regulated Power Supply	£0.85
60VS Pk 1 F/Glass PCB	£1.95
60VS Pk 2 Resistor, Capacitor set	£3.10
60VS Pk 3 Semiconductor set	£7.95
60VS Pk 6A Toroidal transformer (for use with Bailey)	£7.25
60VS Pk 6B Toroidal transformer (for use with 20W LH)	
Bailey Burrows Stereo Pre-Amp	£2.35
BBPA Pk 1 F/Glass PCB	£6.10
BBPA Pk 2 Resistor, capacitor semiconductor set	£2.40
BBPA Pk 3R Rotary Potentiometer set	£2.70
BBPA Pk 3S Slider Potentiometer set with knobs	

Further details of above and additional packs given in our FREE LIST

DEPT. WW06

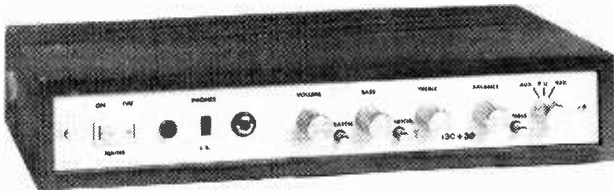
## POWERTRAN ELECTRONICS

PORTWAY INDUSTRIAL ESTATE  
ANDOVER, HANTS SP10 3NN

Portugal Mozambique Belgium Sumatra

Hong Kong Jersey Australia St. Lucia India Barbados Antigua Jordan Spain Israel Mauritius St.

# AUDIO KIT SUPPLIERS TO THE WORLD



## T20+20 and our new T30+30 20W, 30W AMPLIFIERS

Designed by Texas engineers and described in Practical Wireless the Texan was an immediate success. Now developed further in our laboratories to include a Toroidal transformer and additional improvements, the slimline T20 + 20 delivers 20W per channel of true Hi-Fi at exceptionally low cost. The design is based on a single F/Glass PCB and features all the normal facilities found on quality amplifiers, including scratch and rumble filters, adaptable input selector and head phones socket. In a follow up article in Practical Wireless further modifications were suggested and these have been incorporated into the T30 + 30. These include RF interference filters and a tape monitor facility. Power output of this new model is 30W per channel.

Pack	T20	T30	Pack	T20	T30
1. Set of low noise resistors	0.95	1.05	8. Toroidal transformer — 240V prim.		
2. Set of small capacitors	1.50	2.10	e.s. screen	4.95	6.80
3. Set of power supply capacitors	1.40	2.05	9. Fibreglass PCB	2.50	2.90
4. Set of miscellaneous parts	1.90	1.90	10. Set of metalwork, fixing parts	4.20	4.80
5. Set of slide, mains, P.B. switches	1.20	1.20	11. Set of cables, mains lead	0.40	0.40
6. Set of pots, selector switch	2.00	2.00	12. Handbook (free with complete kit)	0.25	0.25
7. Set of semiconductors, ICs, SKTs.	7.25	7.75	13. Teak cabinet 15.4" x 6.7" x 2.8"	4.50	4.50

### FREE TEAK CASE WITH FULL KITS

T20+20  
KIT PRICE only **£28.25**

T30+30  
KIT PRICE only **£32.95**

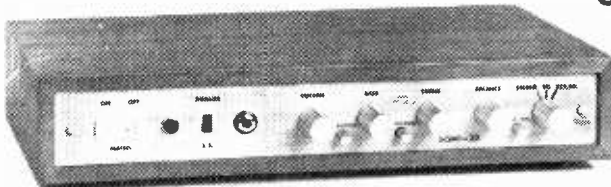
## 2 NEW TUNERS!

### WW SFMT II

Following the success of our Wireless World FM Tuner kit we are now pleased to introduce our new cost reduced model designed to complement the T20 and T30 amplifiers. The frequency meter of the more advanced model has been omitted and the mechanics simplified however the circuitry is identical and this new kit offers most exceptional value for money. Facilities included are switchable afc, adjustable, switchable muting channel selection by slider or readily adjustable pre-set push-button controls and LED tuning indication. Individual pack prices in our free list.

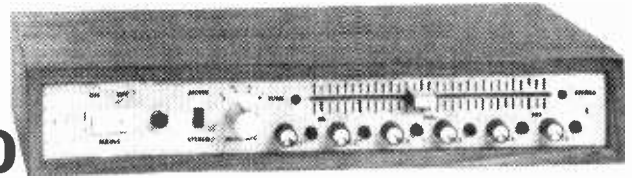
### POWERTRAN SFMT

This easy to construct tuner using our own circuit design includes a pre-aligned front end module PLL stereo decoder, adjustable, switchable muting, switchable afc and push-button channel selection. As with all our full kits, all components down to the last nut and bolt are supplied together with full constructional details.

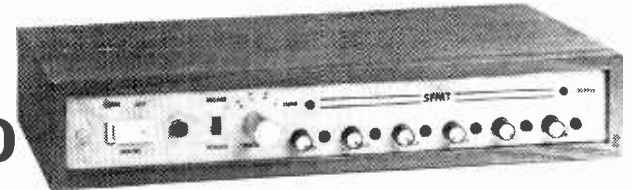


**SQM1 — 30**  
KIT PRICE **£37.15**

KIT PRICE  
**£47.40**



KIT PRICE  
**£32.60**



## CONVERT NOW TO QUADRAPHONICS!

With 100s of titles now available no longer is there any problem over suitable software. No problems with hardware either. Our new unit the SQM1-30 simply plugs into the tape monitor socket of your existing amplifier and drives two additional speakers at 30W per channel. A full complement of controls including volume, bass, treble and balance are provided as are comprehensive switching facilities enabling the unit to be used for either front or rear channels, by-passing the decoder for stereo-only use and exchanging left and right channels. The SQ matrix decoder is based upon a single integrated circuit and was designed by CBS whilst the power and tone control sections are identical to those used in our T30 + 30 amplifier which the SQM1-30 matches perfectly. Kit price includes CBS licence fee.

**Special offer to T20 + 20 and Texan owners!**  
Owners of T20 + 20 and Texan amplifiers, which have no tape monitor outlet, purchasing an SQM1-30 will be supplied, on request, a free conversion kit to fit a tape monitoring facility to the existing amplifier. This makes simple the connection to the highly adaptable SQM1-30 quadrasonic decoder/rear channel amplifier.

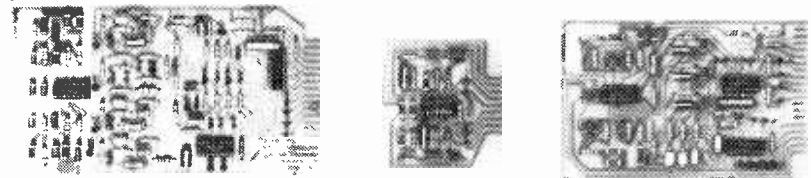


### SEMICONDUCTORS

as used in our range of quality audio equipment.

2N699	£0.20	BC212K	£0.12	MPSA65	£0.35
2N1613	£0.20	BC182L	£0.10	MPSA66	£0.40
2N1711	£0.25	BC184L	£0.11	MPSU05	£0.60
2N2926G	£0.10	BC217L	£0.12	MPSU55	£0.70
2N3055	£0.45	BC214L	£0.14	SBA750A	£2.50
2N3442	£1.20	BCY72	£0.13	SL301	£1.30
2N3711	£0.09	BD579	£0.85	SL3045	£1.60
2N3904	£0.17	BD530	£0.85	SN72741P	£0.40
2N3906	£0.20	BDY56	£1.60	SN72748P	£0.40
2N4062	£0.11	BF257	£0.40	TIL209	£0.30
2N4302	£0.60	BF259	£0.47	TIP29A	£0.50
2N5087	£0.42	BFR39	£0.25	TIP30A	£0.60
2N5210	£0.54	BFR79	£0.25	TIP29C	£0.71
2N5457	£0.45	BFV51	£0.20	TIP30C	£0.78
2N5459	£0.45	BFV52	£0.20	TIP41A	£0.74
2N5461	£0.50	CA3046	£0.70	TIP42A	£0.90
2N5830	£0.35	LC1351	£5.50	TIP41B	£0.82
40361	£0.40	MC1310	£2.90	TIP42B	£0.98
40362	£0.45	MC1351	£1.05	1N914	£0.07
BC107	£0.10	MFC4010	£0.95	1N916	£0.07
BC108	£0.10	MJ4B1	£1.20	1S920	£0.10
BC109	£0.10	MJ491	£1.30	5B05	£1.20
BC109C	£0.12	MJE521	£0.60		
BC125	£0.15	MPSA05	£0.25		
BC126	£0.15	MPSA12	£0.55		
BC182	£0.10	MPSA14	£0.35		
BC217	£0.12	MPSA55	£0.25		
BC182K	£0.10				

## SQ QUADRAPHONIC DECODERS



Feed 2 channels (200-1000mV as obtainable from most pre-amplifiers or amplifier tape monitor outlets) into any one of our 3 decoders and take 4 channels out with no overall signal level reduction. On the logic enhanced decoders Volume, Front-Back, LF-RF, balance, LB-RB balance and Dimension controls can all be implemented by simple single gang potentiometers. These state-of-the-art circuits used under licence from CBS are offered in kits of superior quality with close tolerance capacitors, metal oxide resistors and fibre-glass PCBs designed for edge connector insertion. All kit prices include CBS licence fee.

M1 Basic matrix decoder with fixed 10:40 blend. All components, PCB **£5.90**  
 L1 Full logic controlled decoder with 'wave matching' and 'front back logic' for enhanced channel separation. All components, PCB **£17.20**  
 L2A More advanced full logic decoder with variable blend, extended frequency response, increased front back separation. All components, PCB **£24.60**

## EXPORT NO PROBLEM.

Our Export Department will be pleased to advise on postal costs to any country in the world. Some of the countries to which we sent kits in 1975 are shown surrounding this advertisement.

Kenya France St. Martin, Java New Zealand Borneo South Africa Denmark Nigeria Anguilla

Vincent Uganda Ascension Island Malta Sierra Leone Somalia New Guinea Italy Kuwait Netherlands Canada Trinidad Malaysia Austria Finland

# BI-PRE-PAK

## Bargains in Semi-Conductors, components, modules & equipment.

### B-P-P Packs

Originated in 1959 by the Company's managing director, his were the first semi-conductor and component packs to be marketed in this country, and indeed, the company's name grew out of "British Industrial Pre-Packed Components". Today, Bi-Pre-Pak continues to occupy a position of pre-eminence in the supply of packs as well as a vastly extended range of products detailed in our latest 24-page A4 size free catalogue. Send 10p stamped large addressed envelope for your copy by return.

IT'S ALL IN OUR FREE CATALOGUE

### Component Packs

- CP1 150 Capacitors mixed bag of paper, silver mica, electrolytics, etc. Approx. quantity, counted by weight **60p**
- CP2 200 Resistors mixed bag of different types, values, wattages etc. Approx. quantity, counted by weight **60p**
- CP3 40 Wirewound resistors, mixed types, values and wattages **60p**
- CP4 12 Potentiometers, pre-sets, w/wound, carbon etc. Mixed types and values **60p**
- CP5 5 Earphones, single low impedance for transistor radios, cassettes, etc. Less plugs, for suitable plugs see PAKs CP9 and CP10 **60p**
- CP6 50 TO-5 mounting pads, fits between transistor and board, for that pro finish **60p**
- CP8 500 Cable clips for G.P.O. 1/4" dia. cable. Nylon with hardened steel pin (probably tungsten) per sealed box of 500 **60p**
- CP9 5 3.5mm plugs, miniature jack, to fit earphones in PAK CP5 **60p**
- CP10 2 5.25mm sub miniature jack plugs, to fit earphones in PAK CP5 **60p**
- CP11 6 Screwdrivers, 1 x mains neon tester, 5 x grub screwdrivers **60p**
- CP12 10 Reed relay inserts, 1" long 1/4" dia. These will operate from an external magnet or coil. For magnets see PAK CP13 **60p**
- CP13 10 Magnets of various sizes for operating reed switches on PAK CP12. Ideal for burglar alarms on doors and windows etc. **60p**
- CP14 40 Potentiometers, pre-sets, wirewounds, carbons, dual gangs, with and without switches, etc. Mixed values and wattages **£1.20**
- CP15 12 Standard crocodile clips, screw fixing, good quality **60p**
- CP16 5 P.C. boards each containing a BF180 UHF amplifier transistor. A good basis for building a T.V. aerial pre-amp as various parts inc. **60p**
- CP17 25 Electrolytic Capacitors, various values and voltages, many useful types, from T.V. to transistor radio and Hi-Fi **60p**
- CP18 1 Light activated SCR 50 volts 1.6 amps type L9F. Ready mounted on P.C. board with gate resistor and leads fitted. Full data and circuit diagrams for 14 projects, includes slave photo flash unit, burglar alarm, etc. **60p**
- CP19 3 Micro switches 1 pole change over, standard model 1 1/4" x 1/2" **60p**
- CP20 10 Relays assorted types, Ex-G.P.O. and others mixed voltages **£1.20**
- CP21 200 Square inches of copper laminate P.C. board, in approx. 8 pieces **60p**
- CP22 3 Fibreglass plain printed circuit boards, approx. 2 1/2" x 14" **60p**
- CP23 4 Switches, miniature push to make, single pole **60p**

### Semi-Conductors

#### TESTED AND GUARANTEED PACKS

TP4 3 SN7490 integrated circuits, 14 pin dual in line TTL type. Decade counter. Get one FREE, these are 60p each in singles **£1.20p**

#### ALL THE FOLLOWING ARE AT 60p EACH PACK

- TP9 5 SN7400 integrated circuits, 14 pin dual in line TTL type. Quad 2-input NAND gate. Get one FREE, these are 15p each **60p**
- TP10 2 Light dependant resistors, 400 ohms light, 1 megohm dark, 1/4" dia **60p**
- TP11 10 Transistors XB102 and XB112 equivalent to AC126, AC156, OC81/2, OC72 etc **60p**
- TP12 4 BY127 Silicon rectifiers 1000 piv 1 amp. Plastic T.V. rectifier **60p**
- TP13 5 OCP71 Light sensitive transistors **60p**
- TP14 20 OC71 germanium PNP audio pre amp transistor, black glass type **60p**
- TP15 20 OC81 Germanium PNP audio output transistor, white glass type **60p**
- TP16 20 OC200/1/2/3 transistors, PNP silicon TO-5, unmarked **60p**
- TP17 20 1 watt zener diodes mixed voltages 6.8 to 43 volts **60p**
- TP18 20 2N3707/8/9/10 transistors, NPN silicon plastic, unmarked **60p**
- TP19 100 Diodes, mixture of germanium, gold bonded, silicon, etc. a useful selection of many types, marked and unmarked **60p**
- TP20 10 Mullard OC45 transistors, I.F. amp. PNP germanium **60p**
- TP23 20 BFY50/1/2, 2N696/7, 2N1613, etc. NPN silicon TO-5 unmarked, COMPLEMENTARY TO PAK TP24 **60p**
- TP24 20 BFY64 2N2904/5, etc. PNP silicon TO-5 unmarked, COMPLEMENTARY TO PAK TP23 **60p**
- TP30 20 NPN silicon planar transistors, TO-18 similar to BC108, etc. unmarked **60p**
- TP31 20 PNP silicon planar transistors, TO-18 similar to BC178, etc. unmarked **60p**
- TP32 20 2N2926 silicon plastic transistors, unmarked and ungraded for colours **60p**

#### UNTESTED PACKS — 60p each Specially for keen bargain hunters

- UT1 50 PNP germanium transistors, AF and RF. Very good yield **60p**
- UT2 150 Germanium diodes, miniature glass type **60p**
- UT5 40 Zener diodes, 250 mW OA2240 range, average 50% good **60p**
- UT6 25 Zener diodes, 1-1 1/2 watt top hat type, mixed voltages **60p**
- UT9 40 NPN silicon planar transistors, of the 2N3707-11 range, low noise amp **60p**
- UT10 15 Power transistors, PNP germanium and NPN silicon, mostly TO-3 but some plastic and some marked **60p**
- UT13 15 Integrated circuits, experimenters pak, dual in line, TO-5 TTL, DTL, marked and unmarked, some definitely good but old types **60p**

#### FOR FULL RANGE — SEE CATALOGUE

#### Singles BRIDGE RECTIFIERS Plastic encapsulated

P.I.V.	50v	100v	400v
1 amp	25p	35p	45p
2 amp	35p	45p	55p
4 amp	45p	50p	80p
6 amp	50p	60p	90p

BY164 equiv. SKB2.02 400v 1.5 amp 45p

FETs	UNI-JUNCTION TRANSISTORS	
2N3919	2N2160	65p
2N4416	2N2646	48p
MOS F.E.T.s	T1S43	31p
3N141/MEM616		

Also Power Diodes, Thyristors, Triacs, Diacs-Zener Diodes, Opto-Electronics, etc.	PUTs 2N28027	50p
	LEDs TIL209—Red TIL211—Green	18p 33p

**X-44 POCKET SIZE R.F. CROSS HATCH GENERATOR**  
 Improved version of our famous Mk 2 model, of which thousands are in regular use. Size 150 x 75 x 50mm, strong plastic case with handle/stand, 4 push button operation, 4 patterns. Self-contained line and frame generator and synchro pulse. Pre-set adjust for R.F. output and line/frame synch. Uses 4 alkaline type 1600, batts. Blank raster facility. **FOR COLOUR AND MONO.** (P/P add 35p)  
**£27.50** Built & tested

### POWER TRANSISTORS

	Vce	Watts	Ic Amps	Price
40P1	15	20	3	30p
40N2	40	40	4	30p
40P2	40	40	4	30p
90N1	15	45	4	25p
90P1	15	45	4	25p
90N2	40	90	8	35p
90P2	40	90	8	35p

Many other types available from 3 to 115 watts

#### INTEGRATED CIRCUITS

MM5314 Dual in line clock chip **£3**  
 LMS380/SLS60745 Dual in line 2w audio amp with data, etc **75p**  
 Dual in line I.C. sockets 8 pin **14p**; 14 pin **15p**; 16 pin **16p**.

### Sundry

#### SIGNAL GENERATOR

For MW and LF. Covers 550 KHz to 1.6 MHz for MW and 400 to 550KHz for LF. Fully portable. Invaluable in AM repair and alignment jobs (p/p 90p) **£4.25**

#### FOUNTAIN-PEN TYPE SIGNAL INJECTOR

Not new but in perfect order. per pair **50p**

#### EX-G.P.O. 5in SIDECUTTERS

Not new but in perfect order. per pair **60p**

#### EX-G.P.O. 6" LONG NOSE PLIERS

Not new but in perfect order. per pair **60p**

#### MAINS TRANSFORMERS

MT6	6v 0 6v 100mA	£1.22
MT12	12v 0 12v 50mA	£1.22
SST9/1	9v 1amp	£1.67
SST12/1	12v 1amp	£2.05
SST18/1	18v 1amp	£2.50
SST25/2	25v 2amp	£3.00
SST30/2	30v 2amp	£4.25
SST35/4	35v 4amp	£5.50

(P/P 50p any one)

#### PC EDGE CONNECTORS

Type	Sizes	Pitch	Price
SSEC 6-way	1 1/2"	156"	32p
SSEC 10	1 1/2"	156"	50p
SSEC 12	2"	156"	60p
SSEC 16	2 1/2"	156"	75p
SSEC 18	3"	156"	85p
SSEC 22	3 1/2"	156"	1.00

#### UHF TUNER UNITS

Brand new, by famous manufacturer. 625 lines. Channels 21-65. Ideal for use as TV sound receiver. With data **£2.50**

#### BOOKS

All free of VAT. We carry very large stocks of technical books by Babani & Bernard Publishers, by Newnes & Butterworth as well as reference books from the Common Market in English/German/Italian. All detailed in our catalogue.

#### MONEY SAVER FOR CAR OWNERS

The Super Spark Capacitor Discharge Ignition Unit developed out of our original model (of which we have sold well over 9 000) enables you to enjoy this system at a truly economic price. Facilities include simple adaption to pos or neg earth, immediate switch back to conventional ignition, anti-burglar immobilisation with all parts in totally enclosed strong metal case. Very easy to fit and install. With full instructions (P/P add 50p)

**KIT £7.95 ● READY-BUILT £10.50 ●**



**YOUR SUPPLIERS FOR:**  
 Semi-conductors — all popular types. Opto-electronic devices inc. Nixie Tubes, Solder Tools, Terminals, Switches, Knobs, Ex-G.P.O. items, Aluminium Boxes, Triacs, Thyristors, Zener Diodes and much more in our catalogue and shop.

### VAT ADD 12 1/2%

EXCEPT ITEMS MARKED WHICH CARRY ONLY 8%

# BI-PRE-PAK LTD

Co Reg No 820919  
 222 224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX SSO 9DF.  
 TELEPHONE: SOUTHEND (0702) 46344.

### B-P-P SECURITY CHECK POINT

- Write your own name and address clearly in block capital letters.
- Check that your order is correct for description, quantity and price.
- Don't forget VAT at 25% of total value of order unless otherwise marked or (8%).
- MAKE SURE YOU GET OUR NAME AND ADDRESS RIGHT WHEN ORDERING.
- Cash (cheque, money or postal order) with your order please. Made out to Bi-Pre-Pak Ltd.
- Mention this journal when ordering if you don't want to cut out the coupon.

TERMS OF BUSINESS: VAT rates subject to alteration if decreed by Government

VAT at 12 1/2% must be added to total value of order, except for items marked \* or (8%), when VAT is to be added at 8%. No VAT on overseas orders. **POST & PACKING** Add 30p for UK orders except where shown otherwise. Minimum mail order acceptable — £1. Overseas orders add £1 for postage. And difference will be credited or charged. **PRICES** Subject to alteration without notice. **AVAILABILITY** All items available at time of going to press when every effort is made to ensure correctness of information.

To: BI-PRE-PAK, 220/222 WEST RD. WESTCLIFF-ON-SEA, ESSEX SSO 9DF

Please send ..... inc. VAT  
 for which I enclose .....  
 NAME .....  
 ADDRESS .....

WW6A

# Electrotime

**THE TIME HAS ARRIVED  
FOR YOU TO JOIN THE  
DIGITAL REVOLUTION**

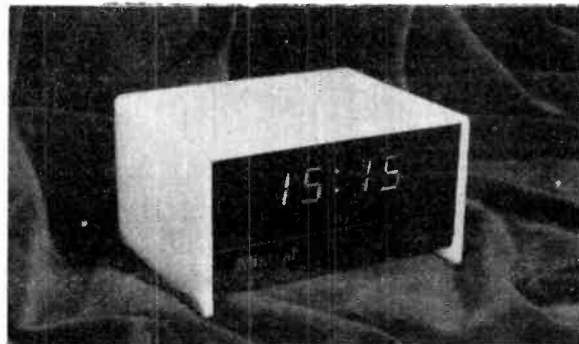
## ELECTRONIC DIGIT ALARM CLOCK MODEL EC3



- ★ Large 4 digit display
- ★ Variable display intensity
- ★ AM/PM indicator
- ★ 24-hour alarm
- ★ 5 minute repeating snooze alarm
- ★ Power interrupt indicator
- ★ Tilt operation alarm cancel
- ★ Pulsing seconds indicator
- ★ Attractive white case

COMPLETE BUILT CLOCK PRICE **£14.00** inc. VAT

## THE MISTRAL Mk 1 DIGITAL CLOCK



- ★ Pleasant green display
- ★ Pulsating colon
- ★ Building time 1 hour
- ★ 12/24 hour readout
- ★ Fully electronic
- ★ Push-button setting

KIT PRICE **£11.07** inc. VAT  
COMPLETE BUILT CLOCK PRICE **£14.95** inc. VAT

## CONTINUOUS LIQUID CRYSTAL DISPLAY MODEL TLC4

RHODIUM **£39.95**  
inc. VAT  
GOLD **£41.50**  
inc. VAT

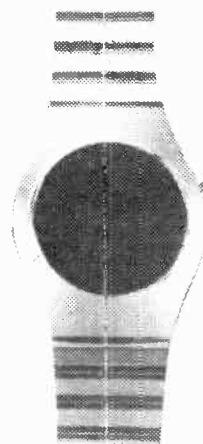


### FEATURES

- ★ Hours
- ★ Minutes
- ★ Seconds
- ★ Date

**WITH UNIQUE  
BACKLIGHT FEATURE  
FOR NIGHT READING**

## LED MODEL TLE5



**£29.50**  
inc. VAT

### FEATURES

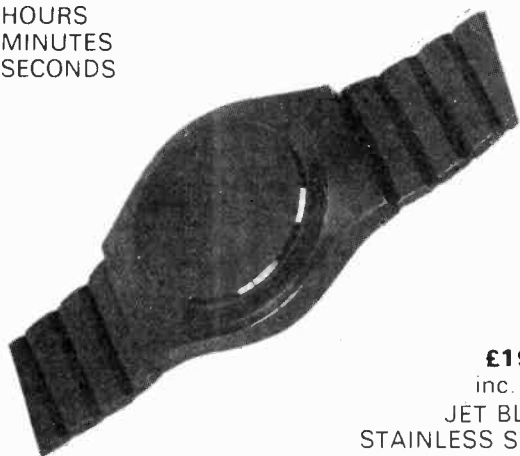
- ★ Hours
- ★ Minutes
- ★ Seconds
- ★ Date
- ★ Day of week

GOLD OR RHODIUM PLATED

## LED MODEL TLE3

### FEATURES

- ★ HOURS
- ★ MINUTES
- ★ SECONDS



**£19.95**  
inc. VAT  
JET BLACK  
STAINLESS STEEL  
CASE AND BRACELET

**ALL MODELS FEATURE ELECTRONIC ACCURACY  
TO WITHIN SECONDS PER MONTH**

**Money back if not completely satisfied  
One-year guarantee with all models**

Electrotime, Dept. 1/6  
111 Storforth Lane Trading Estate  
Chesterfield, Derbyshire. Tel: 35804

Please supply .....

I enclose cheque/postal order

Name .....

Address .....

(5332)



# Get a great deal from Marshall's

A Marshall (London) Ltd Dept WW  
42 Cricklewood Broadway London NW2 3ET Tel 01-452 0161/2 Telex 21492  
& 85 West Regent St Glasgow G2 2QD Tel 041-332 4133  
& 1 Straits Parade Fishponds Bristol BS16 2LX Tel 0272-654201/2  
& 27 Rue Danton Issy Les Moulineaux Paris 92  
Call in and see us 9-5.30 Mon-Fri 9-5.00 Sat  
Trade and export enquiries welcome

Catalogue price 25p

## OUR RANGE COVERS OVER 7,000 ITEMS THE LARGEST SELECTION IN BRITAIN TOP 200 IC'S, TTL, CMOS & LINEARS

CA3020A 1.80	CD4030 0.52	LM7815 1.99	SN7413 0.28	SN7486 0.29	SN74190 1.86
CA3028A 0.79	CD4031 1.98	LM7824 1.99	SN7416 0.28	SN7490 0.42	SN74191 1.86
CA3035 1.37	CD4037 0.88	MC1303L 1.50	SN7417 0.28	SN7491 0.75	SN74192 1.15
CA3046 0.70	CD4041 0.70	MC1303P 2.50	SN7420 0.16	SN7492 0.45	SN74193 1.15
CA3048 2.11	CD4042 0.83	MC1330P 0.90	SN7423 0.23	SN7493 0.45	SN74196 1.60
CA3052 1.62	CD4049 0.45	MC1351P 0.80	SN7425 0.23	SN7494 0.75	SN74197 1.58
CA3089E 1.96	CD4050 0.45	MC1466 3.50	SN7427 0.23	SN7495 0.68	SN74198 1.80
CA3090A 4.23	CD4510 1.25	MC1469 2.75	SN7430 0.15	SN7496 0.68	SN74199 1.80
CA3130 0.88	CD4511 1.94	MC14553 4.07	SN7432 0.22	SN74100 1.10	SN76003N2.92
CD4000 0.18	CD4516 1.25	NE555V 0.70	SN7437 0.28	SN74107 0.30	SN76013N1.95
CD4001 0.18	CD4518 1.87	NE556 1.30	SN7438 0.28	SN74118 0.85	SN76023N1.60
CD4002 0.18	CD4520 1.87	NE560 4.48	SN7440 0.16	SN74119 1.75	SN76033N2.92
CD4006 0.99	LM301A 0.48	NE581 4.48	SN7441 0.68	SN74121 0.32	SN74122 0.42
CD4007 0.18	LM308 1.17	NE585 4.48	SN7442 0.65	SN74122 0.42	IAX300 1.84
CD4008 0.82	LM309K 1.88	SL414 2.35	SN7445 0.78	SN74123 0.65	TAA350A 2.10
CD4009 0.52	LM380 0.98	SL610C 2.35	SN7446 0.84	SN74141 0.75	TAA550 0.32
CD4010 0.52	LM380 0.98	SL611C 2.35	SN7447 0.80	SN74145 0.72	TAA611C 2.18
CD4011 0.18	LM702C 0.75	SL612C 2.35	SN7448 0.90	SN74150 1.20	TAA621 2.03
CD4012 0.18	LM709 0.50	SL620C 3.50	SN7450 0.16	SN74151 0.68	TAA661B 1.03
CD4013 0.45	T099 0.38	SL621C 3.50	SN7451 0.16	SN74153 0.68	TBA641B 2.25
CD4014 0.89	BD1L 0.45	SL623C 5.75	SN7453 0.16	SN74154 1.20	TBA651 1.69
CD4015 0.89	14DIL 0.38	SL640C 4.00	SN7454 0.16	SN74155 0.78	TBA800 0.98
CD4016 0.45	LM710 0.47	SN7400 0.16	SN7460 0.16	SN74157 0.76	TBA810 0.89
CD4017 0.88	LM723C 0.66	SN7401 0.16	SN7470 0.29	SN74160 0.88	TBA820 0.80
CD4018 0.88	LM741C 0.50	SN7402 0.16	SN7472 0.21	SN74161 0.88	TBA920 1.79
CD4019 0.52	T099 0.40	SN7403 0.16	SN7473 0.31	SN74162 0.88	14DILSKT 0.14
CD4020 0.98	BD1L 0.40	SN7404 0.19	SN7474 0.41	SN74163 0.88	16DILSKT 0.16
CD4021 0.88	14DIL 0.38	SN7405 0.19	SN7475 0.35	SN74164 1.60	
CD4022 0.85	LM747 1.05	SN7406 0.36	SN7476 0.30	SN74165 1.60	
CD4023 0.18	LM758 0.44	SN7407 0.36	SN7480 0.42	SN74167 3.30	
CD4024 0.72	BD1L 0.44	SN7408 0.19	SN7481 1.00	SN74174 0.99	
CD4025 0.19	14DIL 0.41	SN7409 0.18	SN7482 0.65	SN74175 0.70	
CD4027 0.43	LM3900 0.61	SN7410 0.16	SN7483 0.82	SN74176 1.14	
CD4028 0.83	LM7805 1.88	SN7411 0.20	SN7484 0.95	SN74180 1.10	
CD4029 1.06	LM7812 1.99	SN7412 0.22	SN7485 1.00	SN74181 1.95	

LONDON, GLASGOW, PARIS — AND NOW BRISTOL  
IT'S OUR SERVICE THAT MAKES US GROW

## POPULAR SEMICONDUCTORS

2N696 0.22	2N3716 1.80	AC153 -0.35	BC239C 0.15	8FX30 0.34	TIP35A 2.90
2N697 0.16	2N3771 2.20	AC176 0.41	BC257A 0.16	8FX84 0.30	TIP36A 3.70
2N699 0.59	2N3773 2.65	AC187K 0.35	BC259B 0.17	8FX85 0.30	TIP42A 0.90
2N706 0.14	2N3789 2.06	AC188K 0.40	BC301 0.34	8FX88 0.30	TIP295S 0.98
2N708 0.17	2N3819 0.37	AD143 0.68	BC307B 0.17	BFY50 0.30	TIP305S 0.50
2N916 0.28	2N3820 0.29	AD161 0.69	BC308A 0.15	BFY51 0.28	TIS43 0.28
2N918 0.32	2N3904 0.19	AD162 0.69	BC309C 0.20	BFY52 0.30	ZTX300 0.13
2N1302 0.185	2N3906 0.19	AF106 0.40	BC327 0.23	BRV39 0.48	ZTX301 0.13
2N1306 0.31	2N4058 0.18	AF109 0.40	BC328 0.22	ME0402 0.20	ZTX500 0.15
2N1308 0.47	2N4062 0.15	AF115 0.35	BCY70 0.17	ME0412 0.18	ZTX501 0.13
2N1711 0.27	2N4921 0.83	AF116 0.35	BCY71 0.22	ME4102 0.11	ZTX502 0.18
2N2102 0.60	2N4923 1.00	AF117 0.35	BCY72 0.18	MJ480 0.95	IN914 1.35
2N2148 0.94	2N5245 0.29	AF118 0.35	BD121 1.00	MJ481 1.20	IN3754 0.36
2N2218A 0.47	2N5294 0.48	AF124 0.30	BD123 0.82	MJ490 1.05	IN4007 0.10
2N2219A 0.52	2N5296 0.48	AF139 0.65	BD124 0.67	MJ491 1.45	IN4148 0.07
2N2220 0.25	2N5458 0.26	AF239 0.65	BD131 0.40	MJ2955 1.00	IN4504 0.22
2N2221 0.18	2N5459 0.29	AF279 0.70	BD132 0.50	MJE340 0.48	IN5408 0.30
2N2222 0.20	2N6027 0.45	AF280 0.79	BD135 0.21	MJE370 0.65	AA119 0.08
2N2369 0.20	3N128 0.73	AL102 1.00	BC136 0.22	MJE371 0.75	BA102 0.25
2N2646 0.55	3N140 1.00	BC107 0.14	BD137 0.24	MJE520 0.60	BA145 0.18
2N2905 0.47	3N141 0.81	BC109 0.15	BD139 0.26	MJE521 0.70	BA154 0.12
2N2906 0.33	3N200 2.49	BC147B 0.10	BD139 0.21	MJE2955 1.20	BA155 0.12
2N2907 0.22	40361 0.40	BC149B 0.11	BF115 0.79	MJE3055 0.75	BB1C3B 0.23
2N2926G 0.12	40362 0.45	BC157A 0.16	BF117 0.55	MPB113 0.47	BB1C4B 0.45
2N3053 0.25	40406 0.44	BC158A 0.16	BF154 0.20	MPF102 0.39	BY126 0.27
2N3054 0.60	40407 0.35	BC167B 0.15	BF180 0.35	MPSA05 0.25	BY127 0.29
2N3055 0.65	40408 0.50	BC168B 0.15	BF181 0.36	MPSA06 0.31	BV211 0.51
2N3391 0.28	40409 0.52	BC169B 0.15	BF184 0.30	MPSA06 0.31	BV212 0.51
2N3392 0.15	40410 0.52	BC182 0.12	BF194 0.12	MPSA55 0.21	OA47 0.06
2N3393 0.15	40411 2.00	BC182L 0.12	BF196 0.13	MPSA56 0.31	OA81 0.18
2N3440 0.59	40594 0.74	BC183 0.12	BF197 0.15	OC2B 1.48	OA90 0.06
2N3442 1.40	40595 0.84	BC183L 0.13	BF198 0.18	OC2C 0.50	OA91 0.06
2N3638 0.15	40636 1.10	BC184 0.13	BF244 0.21	OC45 0.32	OAC20 0.08
2N3702 0.12	40673 0.73	BC184L 0.13	BF258 0.53	TIP29A 0.49	BT164 0.57
2N3703 0.13	AC126 0.20	BC212 0.16	BF259 0.55	TIP29C 0.80	ST2 diac 0.20
2N3704 0.15	AC127 0.40	BC212L 0.16	BF598 0.25	TIP31A 0.62	40669 1.00
2N3706 0.15	AC128 0.35	BC213L 0.15	BF839 0.24	TIP32A 0.74	TIC64 0.29
2N3708 0.14	AC151 0.27	BC214L 0.18	BF879 0.24	TIP32A 1.01	TIC6D 0.65
2N3714 1.38	AC152 0.49	BC237B 0.16	BFX29 0.32	TIP33A 1.51	OPR12 0.60

Prices correct at May 1976, but all exclusive of V A T

Post & Packing 30p

# TEAC

TEAC A3340(S)  
4-CHANNEL  
RECORDER



Industrial version upgraded to studio requirements, with increased signal to noise performance and improved reliability. Four totally independent channels each with sel sync input mixing, switchable VU's and all the facilities for easy multitracking. This industrial model is in more studios than any other version.

Available only from ITA  
(Semi-pro version also available)  
IMMEDIATE DELIVERY

# REVOX

REVOX A-700 SERIES



The new big Revox — ideal for all studio requirements. Highly sophisticated design features include servo tape tension, full deck logic, crystal controlled servo electronics, 3 speeds, tape footage counter

£635 IMMEDIATE DELIVERY

The famous A77 has been consistently improved over the past 8 years and is now available in the latest Mk 4 version.

The wide choice of specifications includes versions for duplicating and logging applications. Backed by UK's latest fastest service



Hire service Check our prices from £298 IMMEDIATE DELIVERY

# ITA

ITA 10-4  
MODULAR MIXER



Ten balanced inputs, four output groups, 4 limiters, bass mid and treble EQ, modular construction, headphone monitoring. Extremely high quality construction only matched by mixers costing around £1,000.

10-4 £690  
20-4 £1190  
EIGHT OUTPUT £1260

IMMEDIATE DELIVERY  
Also available for hire

PRICES EXCLUSIVE OF V.A.T.

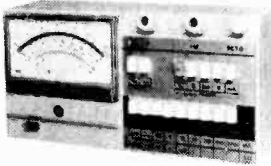
Industrial Tape Applications



5 Pratt Street, London NW1 OAE  
Telephone: 01-485 6162. Telex: 21879

WW-075 FOR FURTHER DETAILS

### MULTIMETER F4313 *(Made in USSR)*



**SENSITIVITY:**  
 1200V DC range: 10,000 Ω/V  
 Other DC ranges: 20,000 Ω/V  
 1200 AC range: 6,000 Ω/V  
 600V AC range: 15,000 Ω/V  
 300V AC range: 15,000 Ω/V  
 Other AC ranges: 20,000 Ω/V

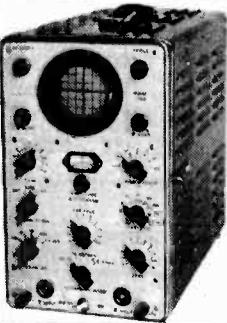
AC/DC current ranges: 60-120-600 μA-3-12-300mA-1.2-6A  
 AC/DC voltage ranges: 60-300mV-1.2-6-30-120-300-600-1200V  
 Resistance ranges: 300Ω-10-100-1000Ω  
 Accuracy: 1.5% DC, 2.5% AC (of full scale deflection)

Mirror scale and knife edge pointer. Taut suspension of movement. Transistor amplifier is used for all AC ranges thus achieving a common linear scale for both AC and DC ranges.

Meter is fully protected for a transistorised cut-out relay circuit. Range selection is achieved by clearly marked piano keys. Power source: 5 1.5V dry cells. Dimensions: 95 x 225 x 120mm.

**Price £37.50 plus VAT**  
 Packaging and postage £1.10

### OSCILLOSCOPE CI-5 *Made in USSR*



Extremely simple and easy to use single beam oscilloscope. Well proved design based on standard octal valves makes servicing and maintenance straightforward and inexpensive. Because of its bandwidth of 10 MHz the instrument is suitable for general electronic applications and educational purposes where a sophisticated instrument would be both too expensive and delicate. 3-in. tube giving a 50 x 50mm clear display. Amplitude and time base calibrations. Sensitivity 30mm/v max. Triggered and free-running time base, suitable for displaying pulses from 0.1 μ sec. to 3 m sec. A.C. mains operation.

**Price £55.00 ex. works**  
 Packing and carriage (U.K. only £2.50)

### FULLY GUARANTEED



0A2	0.45	6SN7GT	0.55	ECC83	0.38	EF86	0.40	KT86	3.40	PL508	0.90
0A3	0.55	12AT7	0.45	ECC84	0.35	EF183	0.35	KT88	3.85	PL509	1.30
0B2	0.45	12AU7	0.38	ECC85	0.45	EF184	0.40	PC86	0.85	PL802	1.40
0C3	0.45	12AX7	0.38	ECC86	1.25	EFL200	0.75	PC88	0.85	PY31	0.50
0D3	0.45	12BA4	0.80	ECC88	0.60	EL34	0.70	PC900	0.95	PY33	0.63
5R4G1	1.00	128A6	0.60	ECC89	0.60	EL36	0.60	PCC84	0.45	PY81	0.45
5U4G	0.55	128E6	0.60	ECC89	0.60	EL36	0.60	PCC85	0.45	PY82	0.45
5Z4G	0.55	128H7	0.60	ECC89	0.60	EL36	0.60	PCC88	0.85	PY88	0.50
5Y3GT	0.65	12X4	0.50	ECC189	0.80	EL41	0.80	PCC89	0.55	PY500A	1.10
6A84	0.50	19A05	0.75	ECC83	0.38	EF86	0.40	PCC189	0.85	PY800	0.50
6A15	0.65	30A5	0.70	ECC84	0.35	EF183	0.35	PCF80	0.40	TT21	5.90
6A15	0.45	35A3	0.70	ECC84	0.35	EF183	0.35	PCF82	0.40	TT22	5.90
6A15	0.30	35A5	0.80	ECC85	0.45	EF184	0.40	PCF86	0.85	WABC80	0.50
6A05	0.50	35B5	0.70	ECC86	1.25	EFL200	0.75	PCF200	0.80	UAF42	0.70
6AT6	0.60	35C5	0.70	ECC88	0.60	EL34	0.70	PCF201	0.85	UBC41	0.50
6AV6	0.50	35A5	0.80	ECC89	0.60	EL36	0.60	PCF801	0.55	UBC81	0.50
6AWBA	0.75	35WA	0.60	ECC189	0.80	EL41	0.80	PCF802	0.55	UBF80	0.50
6AU6	0.40	50A5	1.00	ECF80	0.45	EL81	0.60	PCL200	0.75	UBF89	0.50
6BA6	0.38	50B5	0.85	ECF82	0.45	EL82	0.60	PCL81	0.55	UCC84	0.75
6BE6	0.45	50C5	0.70	ECF86	0.75	E183	0.60	PCL82	0.70	UCF85	0.50
6BN6	0.75	57B3	1.50	ECF801	0.75	EL84	0.35	PCL83	0.70	UCF80	0.75
6BL6	0.75	5ABC80	0.40	ECF802	0.75	EL90	0.50	PCL84	0.50	UCH42	0.80
6BN6	0.80	5AC91	0.55	ECH42	0.85	EL95	0.70	PCL85	0.60	UCH81	0.50
6BN8	0.65	5AF42	0.70	ECH81	0.50	EL500	0.80	PCL86	0.60	UCL82	0.40
6B76	0.55	5AF801	0.65	ECH83	0.50	EM80	0.55	PCL200	0.75	UCL83	0.70
6BZ7	0.70	5BC41	0.75	ECH84	0.50	EM81	0.60	POS00	1.70	UF41	0.75
6CA	0.40	5BC81	0.50	ECL80	0.40	EM84	0.40	PFL200	0.70	UF42	0.75
6CB6	0.50	5BF80	0.50	ECL81	0.75	EY51	0.45	PL35	0.40	UF80	0.40
6EA6	0.75	5BF83	0.50	ECL82	0.42	EY51	0.45	PL36	0.60	UF85	0.50
6EK5	0.70	5BF89	0.40	ECL83	0.75	EY87	0.50	PL38	0.85	UF89	0.50
6K5	0.65	5C86	0.75	ECL84	0.60	EY88	0.50	PL81	0.55	UL41	0.70
6J4	0.75	5C86	0.75	ECL85	0.65	EY40	0.60	PL82	0.50	UL84	0.50
6J5GT	0.55	5C91	2.60	ECL86	0.55	EZ41	0.75	PL83	0.50	UY41	0.55
6J6	0.35	5CC40	0.80	ECL800	4.50	EZ80	0.30	PL84	0.50	UY42	0.55
6L6GT	0.60	5CC81	0.45	EF80	0.35	EZ81	0.35	PL95	0.70	UY82	0.60
6SL7GT	0.55	5CC82	0.38	EF85	0.45	EZ34	0.75	PL504	0.80	UY85	0.50

### HIGH GAIN DARLINGTON PAIRS

Plastic 3-Lead Case Darlington Pairs. Typical current gain 30,000. Max. collector voltage VC80 40V. Max. collector current 400mA. IC80-10mA.  
 BC516 PNP **£0.80**  
 BC517 NPN **£0.80**

### TRANSISTORS FOR T.V.

R20008B **0.95**  
 R2010B **1.85**  
 BU126 **1.55**  
 BU133 **1.55**  
 BU208 **2.00**

## Z & I AERO SERVICES LTD.

Head Office: 44A WESTBOURNE GROVE, LONDON W2 5SF  
 Tel.: 727 5641 Telex: 261306

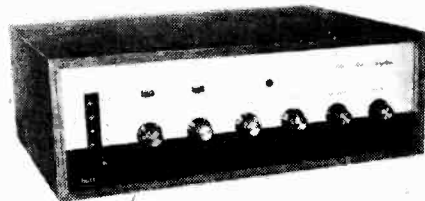
Retail Branch:  
 85 Tottenham Court Road  
 London W1. Tel: 580 8403

WW-005 FOR FURTHER DETAILS

# HART ELECTRONICS

Audio Kit Specialists since 1961

## J. L. Linsley-Hood High Quality Cassette Recorder



### STEREO BAILEY 30 WATT TUNER AMP.

This complete tuner/amp unit is of the very highest quality and is the amalgam of our Compact FM Tuner, Bailey 30watt power amps and the Bailey/Burrows/Quilter pre amp. The wooden sleeve is available in either teak or sapele finish to blend with existing equipment or furnishings.

The combination of our excellently designed printed circuits and the high quality components used makes this unit unequalled on the kit market and approached in quality of performance and durability by few made up tuner amps. Full details are in our free lists.

**STUART TAPE CIRCUITS.** Our printed circuits and components offer the easy way to convert any suitable quality deck into a very high quality Stereo Tape unit. Input and output levels suit Bailey pre amp. Total cost varies but around **£35** is all you need. We can offer tape heads as well if you want new ones. All above kits have fibreglass PCB's. Prices exclude VAT but P&P is included.

**FURTHER INFORMATION ON ALL KITS FREE** if you send us a 9 in. x 4 in. S.A.E.

**REPRINTS** Post free, no VAT

Bailey 30W 18p.

**STUART TAPE RECORDER.** All 3 articles under one cover 30p.

**BAILEY/BURROWS/QUILTER** Preamp circuits, layouts and assembly notes 15p.

All prices exclude VAT @ 12½ per cent except for reprints which are exempt.

Full kits of parts for this outstanding design, including metalwork, cabinet, low humfield mains transformer and all other parts. Please send SAE for full data.

**Cassette Mechanism** only complete with Erase and Record/Playback head, £19.10 + 12½% VAT. Post 40p.

**FM Tuner.** Several useful modifications have been made to our compact tuner. The mechanical layout with all its advantages is retained and four important electrical extras are now offered. 1. Multi-turn preset pots for easier tuning. 2. MPX filter for trouble free taping. 3. Extra thermal stabilisation for tuning line to eliminate drift. 4. Provision for remote control tuning of as many stations as you require.

## Penylan Mill, Oswestry, Salop

Personal callers are always welcome, but please note we are closed all day Saturday



# SERVICE TRADING CO

## RELAYS

SIEMENS PLESSEY, etc. MINIATURE RELAYS			
1	2	3	4
52	4-8	2 c/o	75p
58	5-9	6 c/o	85p
185	8-12	6 M	75p
230	9-18	2 c/o HD	75p
430	9-24	2 c/o	75p
430	15-24	4 c/o	75p
600	10-20	6M	85p
		15k	85-110 6 M 75p
		5800	33-72 2 c/o 75p

(1) Coil ohms; (2) Working d.c. volts; (3) Contacts; (4) Price HD=Heavy Duty. All Post Paid. (\*including Base)

### OPEN TYPE RELAYS

**6 VOLT D.C.** 1 make con. 45p. Post 15p

**9 VOLT D.C. RELAY** 3 c/o 5 amp contacts 70 ohm coil 85p. Post 15p

**9/12 VOLT D.C. RELAY** 3 c/o 5 amp contacts 120 ohm available as single hole fixing or P.C. fixing. Size type required 85p. Post 15p

**24 VOLT D.C.** 2 HD c/o 700 ohm coil 85p. Post 15p

4 c/o 300 ohm coil 95p. Post 15p

100 VOLT ac 2 c/o 75p. 3 c/o 85p. Post 15p

### ENCLOSED TYPE RELAYS

**6 VOLT DC** 3 c/o 85p. Post 15p

**24V DC** 3 c/o 85p. Post 20p Base 15p

**24 VOLT A.C.** Mfg. HT 3 hd c/o contacts 85p. Post 20p Base 15p extra

**55 VOLT A.C.** 3 heavy duty c/o contacts Price 65p. Post 20p Base 15p

**230 VOLT A.C. RELAY** 240V A.C. heavy duty 3 c/o contacts

Price 85p. Post 20p Octal base 15p extra

**220/240 VOLT AC RELAY** 3 c/o 5 amp cont Sealed Mfg ISKRA £1.35. Post 20p Base 15p extra

**ARROW 230/240V AC** 2 c/o 15 amp contacts Arc connectors £1.10. Post 20p

**CLARE-ELLIOT Type RP 7641 G8** Miniature relay 675 ohm coil 24 volt D.C. 2 c/o 80p P.P.

MANY OTHERS FROM STOCK. PHONE FOR DETAILS

### LATCHING RELAY

Twin latching relay. Flip flip. 2c/o each relay. Mains contacts. 115 volts A.C. or 50 volt D.C. operation or 240 volts A.C. with 2.5K resistor 85p. Post 20p

### PRECISION CENTRIGUGAL BLOWERS

Mfg by Smiths Industries. Miniature Model Series SF/200 Size 95mm x 82mm x 82mm Aperture 38mm x 31mm 12 C.F.M. £2.75. Post 50p

Mfg by Airflow Developments Ltd Precision made continuously rated smooth running 230/240V A.C. motor 80C.F.M. As illustrated but with round aperture £6.50. Post 75p

Mfg by Woods. Extremely powerful 220/250V A.C. 0.3 amp. 2 700 r.p.m. continuously rated. Capacitor start. Cast construction Aperture 56mm x 50mm O.A. 200mm. £12.00. Post 11.00

Mfg by Parvalux Type SD38B 220V A.C. 50 Hz. 0.55wmp. Continuously rated 2800rpm 120cm. Brand new. Fraction of makers price £10.00. Post 11.00

### 230 VOLT FAN ASSEMBLY

Continuously rated. removable aluminium blades Price £1.25. Post 50p

VAT 25%

### C/O MICRO SWITCH

VERY SPECIAL OFFER Mfg by C.E.M. 3 amp 250 volt 10 amp 125 volt 50 for £3. Post 36 100 for £5. Post 50p 1.000 for £45. Post paid

DOUBLE POLE C/O or 2 make/2 break micro switch 10 amp 250 v A.C. With detachable roller assembly 10 for £2.50. Post 50p (Min. order 10)

### MINIATURE ROLLER

M. switch OMRON type V15 FL 22 1C 10 for £2.00 post 50p (Min. order 10)

### 230-250 VOLT A.C. SOLENOID

Similar in appearance to illustration. Approximately 1 1/2 lb. pull. Size of feet 1 1/2 x 1 1/2. Price £1.00. Post 25p

### SOLENOID HEAVY DUTY MODEL

230/250V A.C. Approx 10lb. pull. 4" long x 2 1/4" wide x 3" high £2.50. Post 50p

### 24 VOLT DC SOLENOIDS

UNIT containing 1 heavy duty solenoid approx 25 lb. pull at 1 in. travel. 2 solenoids of approx. 1 lb. pull at 1/4 in. travel. 6 solenoids of approx. 4 oz. pull at 1/4 in. travel. Plus 1 24V D.C. 1 heavy duty 1 make relay. Price £2.50. Post 11.00

### ABSOLUTE BARGAIN

**240 V.A.C. SOLENOID OPERATED FLUID VALVE**

Rated 1 p.s.i. will handle up to 7 p.s.i. Forged brass body stainless steel core and spring. 1/8" h.s.p. inlet outlet. Precision made British mfg. PRICE £2.25. Post 50p. N.W. original packing

### 600 WATT DIMMER SWITCH

Easily fitted. Fully guaranteed by makers. Will control up to 600 watts of all lighting except fluorescent at mains voltage. Complete with simple instructions £2.75. Post 25p

1000 watt model £4.00. Post 25p

2000 watt model £8.00. Post 40p

ALL MAIL ORDERS, ALSO CALLERS AT:

57 BRIDGMAN ROAD, CHISWICK, LONDON, W4 5BB. Phone: 01-995 1560  
Closed Saturdays.

## VARIABLE VOLTAGE TRANSFORMERS

Carriage extra INPUT 230 v. A.C. 50/60 OUTPUT VARIABLE 0/260V. A.C.

BRAND NEW. All types.

200W (1 Amp) £10.00

0.5 KVA (Max. 2 1/2 Amp) £11.50

1 KVA (Max. 5 Amp) £16.50

2 KVA (Max. 10 Amp) £30.00

3 KVA (Max. 15 Amp) £33.00

4 KVA (Max. 20 Amp) £60.00

(max. 37.5 Amp) £102.50

## LT TRANSFORMERS

0 6 12 volt 10 amp £6.15 Post 70p

0 10 17 18 volt 10 amp £8.70 Post 1.00

0 6 12 volt 20 amp £10.90 Post 1.00

0 12 24 volt 10 amp £9.90 Post 1.00

0 6 12 24 32 volt 10 amp £10.30 Post 1.00

0 6 12 17 18 20 volt 20 amp £11.80 Post 1.00

Other types to order at short notice. Phone your enquiries.

## AUTO TRANSFORMERS

Step up step down 0 115 200 220 240 volts

At 75 watt £3.00 Post 40p 150 watt £4.30 Post 50p 300 watt £6.20. Post 60p 500 watt £9.20 Post 75p 1000 watt £13.50 Post 90p

## RING TRANSFORMERS

Functional Versatile Educational

These multi-purpose Auto Transformers, with large centre aperture, can be used as a Double wound current Transformer. Auto Transformer H.T. or L.T. Transformer by simply hand winding the required number of turns through the centre opening. E.g. Using the RT 100 V A. Model the output could be wound to give 8V at 12 1/2 Amp. 2V at 25 Amp or 2V at 50 Amp etc. Price RT 100V 3 1/8 turns per volt £5.00. Post 75p RT 2kVA 1 1/2 turns per volt £21.00. Post £1.50 RT 3kVA 1 1/5 turns per volt £28.00. Post £1.50

## STROBE! STROBE! STROBE!

\* **HY-LIGHT STROBE Mk. IV** Latest type Xenon white light tube. Solid state timing and triggering circuit. 230/240 volt A.C. operation. Speed adjustable 1-20 f.p.s. Designed for large rooms, halls, etc. Light output greater than many so called 4 Joule) strobes. Price £15.40. Post 75p

\* Specially designed case and reflector for Hy-Light £8.25. Post £1.00

\* **XENON FLASH GUN TUBES** Range of Xenon tubes available from stock. S.A.E. for full details

\* **ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES**

\* 4ft. 40 watt £6.00 (callers only) 2ft. 20 watt £4.60. Post 60p (For use in special fittings) MINI 12in. 8 watt £1.75. Post 35p 9in. 6 watt £1.40. Post 25p Complete ballast unit and holders for either 9" or 12" tube £1.70. Post 30p (9" x 12" measures approx.)

## SQUAD LIGHT

A new conception in light control. Four channels each capable of handling 750 watts of spotlights, floodlights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free. Price only £58.00

Post 75p S.A.E. (Footscap) for further details

## WHY PAY MORE?!

MULTI-RANGE METER A.C. volts 2.5-500 D.C. volts 2.5-500 (Sensitivity 20000) V.D.C. & A.C. DC current 0.1-10 100 mA Ohms range Sturdy compact moving coil instrument with 21 ranges, dimensions 120x80x44mm Weight 0.32 kg SERVICE TRADING CO Price £50.00. Incl leads and battery. Post 50p (Total price inc VAT & Post £5.94)

## TRIAC

Raytheon Tag symmetrical Triac. Type 1AG 250-500V 10 amp 500 p.p.v. Glass encapsulated plastic tube. Swiss precision product for long term reliability £1.00. Post 10p (inclusive of Date and application sheet) Suitable Diac 18p.

## INSULATION TESTERS (NEW)

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work. constant speed clutch. Size L 8 in., W. 4 in., H. 6 in., weight 6 lb.

500 VOLTS 500 megohms £40.00 Post 80p

1000 VOLTS 1000 megohms £46.00 Post 80p.

**VAT AT 8% MUST BE ADDED TO ALL ORDERS FOR THE TOTAL VALUE OF GOODS INCLUDING POSTAGE UNLESS OTHERWISE STATED**

**SERVICE TRADING CO.** SHOWROOMS NOW OPEN AMPLER PARKING

## NICKLE CADMIUM BATTERY

Type V022 1.2V 22AH Height 210mm width 55mm depth 25mm weight 1050 gms. £2.50. Post 50p + 25p extra for each additional cell

## GEARED MOTORS

115 lbs. ins. 110 volt 50Hz 2.8 amp. single phase split capacitor motor Immense power. Continuously rated. Totally enclosed. Fan cooled. In-line gearbox. Length 250mm dia 135mm Spindle dia 15.5mm Length 145mm. ex-equipment tested £12.00. Post £1.50 Suitable transformer 230/240 volt £8.00. Post 75p

### 15 R.P.M.

Type SD48 15 r.p.m. 80 lb. ins. Input 100/120 volt A.C. Length incl gearbox 270mm. Height 135mm. Width 150mm. Shaft drive 16mm. Weight 8.5 kilos. BRAND NEW Price £10.00. carr. £1.00 Suitable transformer for use on 220/240 volt A.C. £3.85. Post 50p

### 60 R.P.M. REVERSIBLE

220/240 volt A.C. Small, powerful, continuously rated motor. Mfg. BERGER (Germany). Size 80mm x 65mm x 65mm. Spindle dia. 6mm. Length 15mm. Weight 725 grams. £6.50. Post 50p

## BODINE TYPE N.C.I. GEARED MOTOR

(Type 1) 71 r.p.m. torque 10 lb. ins. Reversible 1/70th h.p. cycle 38 amp

(Type 2) 28 r.p.m. torque 20 lb. ins. Reversible 1/80th h.p. 50 cycle 28 amp

The above two precision made U.S.A. motors are offered in as new condition. Input voltage of motor 115V A.C. Supplied complete with transformer for 230/240V A.C. input.

Price, either type £6.25. Post 75p or less transformer £3.75. Post 65p

These motors are ideal for rotating aerials, drawing curtains, display stands, vending machines, etc. etc.

### 20 r.p.m. GEARED MOTOR

230/240 volt 20 r.p.m. motor £1.00. Post 20p

### REVERSIBLE MOTOR 230V A.C.

General Electric. 230V A.C. 1600 r.p.m. 0.25 amp. Complete with anti-vibration mounting bracket and capacitor. O. A. size 110mm x 95mm Spindle 5/16" dia 20mm long. Ex-equipment tested £3.00. Post 50p

## METERS NEW

90mm Diameter.

Type 65C5 2A DC M/C 5A DC M/C 10A DC M/C 20A DC M/C

Type 6212 1A A.C. M/I 20A A.C. M/I 300V A.C. M/I, ALL ABOVE £2.50. Post 30p

Type 65L5 300V A.C. R/M/C £2.75. Post 30p

## ROTARY VACUUM AIR COMPRESSOR AND PUMP

Carbon vane oil-less 100/115V A.C. 1 1/2 h.p. motor 50/60 cycle 2875/3450 r.p.m. 20" vacuum 1.25 c.f.m. 10 p.s.i. (approx figures) New unused surplus stock, with electric connection data. Fraction of maker's price. £12.00. Post 11.00 Suitable transformer £3.50. Post 50p

## TIME SWITCH

Horsmann Type Wk II Time Switch. 200/250 volt A.C. Two on two off every 24 hours, at any manually pre-set time. 30 amp contacts. 36-hour spring reserve in case of power failure. Day omitting device. Fitted in heavy high impact case, with glass observation window. Built to highest Electricity Board spec. individually tested. Price £7.75. Post 50p (Total inc VAT £8.91)

## A.C. MAINS TIMER UNIT

Based on an electric clock, with 25 amp. single pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135 mm x 130 mm x 60 mm Price £2.25. Post 40p (Total inc. VAT & Post £2.87)

## POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.

25 WATT 10 25 100 150 250 500 1k 1.5k ohm

£1.70. Post 20p 50 WATT 1.5 5 10 25 50 100 500 1k ohm

£2.10. Post 25p 100 WATT 1 10/25/50/100/250/500/1k/1.5k/2.5k/5k ohm. £3.30. Post 35p

Black Silver Skirted knob calibrated in Nos. 1-9. 1 1/2 in. dia. brass bush. Ideal for above Rheostats, 22p ea.

## PROGRAMME TIMERS

50 volt A.C. operation. Each cam operates a c/o micro switch. Ideal for lighting effects, displays, etc. Ex-equipment, tested similar to illustration. 6 cam model 20 r.p.m. £3.50. Post 60p 12 cam model 15 r.p.m. £5.00. Post 60p Suit. transformer 230v operation £1.50.

# DESIGNED BY TEXAS

**30,000 ALREADY SOLD**

**Texan Amplifier as featured by PRACTICAL WIRELESS**

**SOLE U.K. DISTRIBUTORS - HENRY'S**

*Build it yourself for only*

**£32 KIT PRICE** INC. VAT + £1.00 p&p  
 Built and tested £42.00 inc. VAT + £1.00 p&p

Build the Texan stereo amplifier, then you can be doubly proud! For a start, you'll own a superb home entertainment unit. And have had all the pleasure of doing it yourself, with the Henry's kit. Look at the Texan specification. Incorporating fully integrated stereo preamp and power amp, with 6 IC's, 10 transistors, 6 rectifiers and zener diodes. Plus stabilised, protected circuitry, glass fib pcb, Gardeners low-field low-line mains transformer, all facilities and controls. Slim design, chassis 14 1/2" x 6" x 2" overall. 20 watts per channel RMS, less than 0.1% distortion at 1 kHz.

★ Can be built Stage by stage  
 Ask for leaflets 5.  
 ★ Everything necessary supplied.  
 Full after sales service and guarantees.

**TEXAN FM TUNER KIT** **£23.50**  
 inc. VAT + 50p p&p

Built and tested £28.50 inc. VAT + 50p p&p

Build the matching Texan stereo tuner! Features advanced varicap tuning. Phase lock loop decoder. Professionally designed circuit. Everything you need is in the kit. From the glass fibre pcb to the cabinet itself. Excellent spec. 2.5uV aural sensitivity. 500mV output (adjustable). Tuning range 87-102 MHz. Mains powered.

**THE NATURAL FOLLOW-ON**

**Henry's latest ELECTRONICS CATALOGUE**

## VIDEO SPORT

An up-to-the minute game. Plug into your own TV aerial socket. Switch on. And you're away! Choose your game - football, tennis or hole in the wall. Absolutely safe for you. Your children. And your TV. Mains powered. List Price £42.50

**HENRY'S PRICE £25.00**  
 inc. VAT + 50p p&p

★ OVER 10,000 ALREADY SOLD  
 ★ IDEAL GIFT

For this latest edition, we have made hundreds of changes and additions. Features now include

- \* over 5000 items - many new
- \* free 50p voucher inside every copy
- \* virtually everything needed by amateurs and professionals
- \* over 200 pages
- \* easy-to-use, complete alphabetical index
- \* section index
- \* everything at competitive prices

**ONLY 50p**

**TRANSISTOR & VALVE DISCOUNT PRICE LIST**  
 over 2000 types SEND FOR YOUR FREE COPY

FREE to Educational Establishments when ordered on official headed notepaper + 20p cart/pack

**HENRY'S RADIO**

All mail to: Henry's Radio  
 303 Edgware Rd. London W2

- LONDON W2: 404/6 Edgware Road. Tel: 01-402 8381  
 LONDON W1: 231 Tottenham Ct Rd. (lower sales floor) Tel: 01-636 6681  
 \*NOTTINGHAM: 94/96 Upper Parliament St. Tel: (0602) 40403  
 \*READING, BERKS: 130/131 Friar Street. Tel: (0734) 583230  
 \*HARROW: 190/4 Station Road. Tel: 01-863 7788  
 \*CROYDON: 110 North End. Tel: 01-681 3310

NEW STORES  
 Please Note: Mail Order Customers HENRY'S WILL CREDIT ANY VAT OVERPAYMENTS  
**VAT DOWN**

**P. F. RALFE** 10 CHAPEL ST. LONDON NW1.  
 Phone 01-723 8753

**SIGNAL GENERATORS**

- MARCONI TF801D/IS. 10-480 mHz P.O.A.
- MARCONI TF801B/2S. 10-480 mHz £225.
- HGN MS3/U. 9.7-11.9 and 77-109 mHz. AM/FM.
- ADVANCE SG63D. AM/FM 7.5-230mHz £125.
- RACAL/AIRMEC 201A. 30kHz-30mHz. As new. P.O.A.
- ADVANCE SG21 VHF Square-wave generator 9kHz-100mHz. £25.



**OSCILLOSCOPES**

- SOLARTRON CD1400 DC-15mHz.
- COSSOR CDU110. DC-80mHz
- TEKTRONIX 545A with CA unit. DC-30mHz Price only £295.00
- TEKTRONIX 531 DC-15mHz with L type plug-in
- TEKTRONIX 535 DC-15mHz with L type plug-in
- TEKTRONIX 545B DC-30mHz with 'CA' plug-in.
- TEKTRONIX 585A. DC-80mHz with type 82 plug-in
- TEKTRONIX 654B. Storage oscilloscope.
- TEKTRONIX 502. 200uV. Sens. X-Y.
- TEKTRONIX C27 Polaroid Camera. Series 125 with 560 series adapter.



**CO-AXIAL CHANGE OVER RELAYS.** Terminated in N-type sockets (3 off) Suitable for frequencies up to 1GHz 48 V D.C. coil Plugs available at 50p each Relay only £5.50 each

**PRINTED CIRCUIT MOTORS.** Manufactured in U.S. by Photocircuits Corp. 24 V D.C. 2,000 rpm. 14 cms diameter. These are quality made, high precision motors offered at a fraction of list price. Only £8.50 each

**"WEE MEGGERS"**. 250V Insulation Testers. Good working condition £8.50.

**'MUFFIN' INSTRUMENT FANS.** Manufactured in Holland by 'Rotron Dims' 4.5x4.5x1.5 ins. This is a precision cooling fan, very quiet running specially designed for the cooling of electronic equipment, amplifiers, etc. 115V.50Hz operation. drawing only 11 Watts. The list price from Rotrons is over £10 each. Our price, brand new, only £4.50 each

**MINIATURE DEAC NI-CADMIUM** batteries, type 70DK. 3 cells in package making 3.7 Volts. 25x17x15mm only 75p post paid

- DAWE Stroboroch type 1202C. Excellent condition £85.00
- MARCONI TF2700 Universal Bridge. LC&R ±100
- PYE Electrostatic Voltmeter. reads up to 40KV RMS £120.00
- TEKTRONIX type 575 Transistor curve tracer. excellent condition.

**ADVANCE** type 63A AM/FM R.F. Signal generators. type 5-230mHz Deviation 0-22.5 and 0-75 kHz. X-sweep output. Crystal calibrator. 'scope output £75.00.

**MARCONI TF995A2/M AM/FM R.F. SIGNAL GENERATORS.** 1.5-220mHz. 0-100kHz Deviation. 1µV-100mV output. Sold in excellent condition. P.O.A.

**METRIX 210 WOBBLATORS.** 0-25mHz Sweep width 0.5-20mHz. Output 100mV attenuable in steps of 10 to 10uV. Last few of these left at only £15.00 each to callers only

EMI oscilloscopes model WM16 with type 7/1 WBA plug-in unit. Supplied in perfect condition complete with trolley £125.00.

**20-way BPO Jack strips** to accept 316 type Jack plugs. Also quantity of 316 plugs available. All good condition.

Centrifugal blowers by WOODS 8 inch small type. Outlet 2 1/4 x 2 in. 24V DC 2.8A 2400 rpm. Grey stove finish. All brand new. Price is £10.50 + carriage

**GENTS/FRIEDLAND** fire alarm bells. Operating voltages 12v dc/24v dc. All in as new condition and tested before despatch. Sizes 6.8/12 inch. Prices £4.80, £5.20 and £6.50 resp.

**COMPUTER PERIPHERALS.** Tape punches. 8 hole by Westrex and other well known manufacturers. Tape readers by Elliot. All virtually brand new. Prices are better than one half the maker's. Write or phone for quotation

An exceptional buy enables us to offer stabilised and regulated power supplies by APT at a very cheap price. 16-24v dc @ 10 Amps and 8-10v dc @ 1A. Both supplies are extremely stable with low ripple voltage. Price each £18.50 + carriage

**MISCELLANEOUS TEST EQUIPMENT**

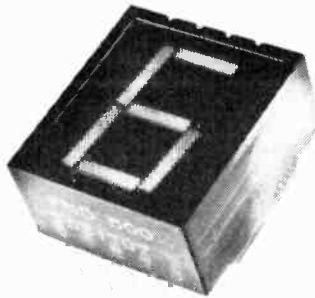
- MARCONI TF1400S double pulse generator with TM6600/S secondary pulse unit. £105.
- MARCONI TF791D deviation meter. 4-1024mHz. 0-100kHz deviation
- MARCONI 455E Wave Analyser £120.
- MARCONI TF2600 Valve Voltmeter 1mV-300V. Excellent. £75.
- ROHDE & SCHWARZ USVD calibrated receiver 280-940mHz (4600mHz)
- LEVELL TG200 DM. RC Oscillator, c/w case. £65.
- 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.
- AIRMEC TYPE 210 modulation meter. Excellent condition.
- ROHDE & SCHWARZ "SCR" V.H.F. Signal Generator 1000-1900 mHz
- MARCONI type TF936 Impedance Bridge £85.00.
- GERTCH Phase Angle V. Meters. Range 1mV-300V. in 12 ranges
- SOLARTRON oscillator type CO 546 25Hz-500kHz. £30.00.
- GAMBRELL Precision 4 Decade Resistance Box 1:11, 110 ohms £24.50.
- MARCONI TF329G Q-Meter £95.

**PLEASE ADD 8% V.A.T. TO THE TOTAL AMOUNT WHEN ORDERING. INCORRECT AMOUNTS WILL CAUSE DELAY IN DESPATCH. THANK YOU.**

Displays from major manufacturers backed by our no-quibble guarantee

CMOS from the leading manufacturers only

# DISPLAYS



## FND500

Outstanding Value:  
Only £1.02 each for  
this high quality  
display.

Part No	Manufacturer	Colour	Type	Size	Price
FND500	Fairchild	Red	Common Cathode LED	0.5"	£1.02
TIL322	Texas Instr.	Red	Common Cathode LED	13mm	£1.20
TIL321	Texas Instr.	Red	Common Anode LED	13mm	£1.30
XAN654	Xcicon	Green	Common Cathode LED	0.6"	£1.75
XAN652	Xcicon	Green	Common Anode LED	0.6"	£1.75
MAN3M	Monsanto	Red	Common Cathode LED	0.13"	48p
5LT01	Futaba	Green	4 dig Phos Diode	0.5"	£5.80

Note: TIL322's Texas Instrument pin-for-pin equivalent of the FND500 may be supplied instead of FND500's, please state if you would not want this substitution, e.g. if you want FND500's to match a previous purchase.

**DISPLAY PCB's** (wired for multiplexed output — each PCB fits neatly into Verocase J)  
For FND500 or TIL322 or TIL321 D500-6 (6 digit clock) £1.35; D500-4 (4 digit clock) 90p;  
D500-8 (up to 8 digits counter, etc.) £1.35.  
For DL704 D704-6K (6 digit clock) £1.35; D704-8C (up to 8 digit, counter) £1.35.

**ADD VAT** at standard rate (now 8%) — 25p p&p on all orders. Price List sent with orders, or on request. Data available on request. Export: no VAT 50p (Europe), £1 (Overseas) for Air Mail p&p (no Export outside Europe for databooks and transformers).

**SINTEL** 53c ASTON STREET, OXFORD  
TEL. 0865 49791

CD4000	0.18	CD4028	0.78	CD4053	0.81	CD4086	0.62
CD4001	0.18	CD4029	0.99	CD4054	1.01	CD4089	1.34
CD4002	0.18	CD4030	0.48	CD4055	1.14	CD4093	0.69
CD4006	1.02	CD4031	1.92	CD4056	1.14	CD4094	1.62
CD4007	0.18	CD4032	0.92	CD4057	21.56	CD4095	0.91
CD4008	0.83	CD4033	1.21	CD4059	4.77	CD4096	0.91
CD4009	0.48	CD4034	1.55	CD4060	0.97	CD4097	3.12
CD4010	0.48	CD4035	1.02	CD4061	18.92	CD4099	1.59
CD4011	0.18	CD4036	2.23	CD4062	7.77	CD4502	1.07
CD4012	0.18	CD4037	0.83	CD4063	0.95	CD4510	1.18
CD4013	0.48	CD4038	0.93	CD4066	0.61	CD4511	1.36
CD4014	0.87	CD4039	2.23	CD4067	3.12	CD4514	2.72
CD4015	0.87	CD4040	0.92	CD4068	0.20	CD4515	2.72
CD4016	0.48	CD4041	0.73	CD4069	0.20	CD4518	1.18
CD4017	0.87	CD4042	0.73	CD4070	0.48	CD4518	1.08
CD4018	0.87	CD4043	0.87	CD4071	0.20	CD4520	1.08
CD4019	0.48	CD4044	0.81	CD4072	0.20	CD4527	1.37
CD4020	0.97	CD4045	1.22	CD4073	0.20	CD4532	1.25
CD4021	0.87	CD4046	1.16	CD4075	0.20	CD4555	0.78
CD4022	0.83	CD4047	0.78	CD4076	1.34	CD4556	0.78
CD4023	0.18	CD4048	0.48	CD4077	0.48	MCI4528	1.38
CD4024	0.67	CD4049	0.48	CD4078	0.20	MCI4534	6.04
CD4025	0.18	CD4050	0.48	CD4081	0.20	MCI4553	5.29
CD4026	1.50	CD4051	0.81	CD4082	0.20	MCI4566	1.21
CD4027	0.48	CD4052	0.81	CD4085	0.62	MCM 4552	8.05

Motorola MCMOS Databook (Vol. 5 Series A) £2.77 (No VAT)  
IC SOCKET PINS. Lowest Cost Sockets for CMOS TTL IC's Displays Strip of 100 pins for 50p;  
400 for £2.1000 for £4.3000 for £10.50.

Verocases: White ABS Cases with PCB guides, etc. front and rear aluminium panels. 75-1410J  
205 x 140 x 40 mm £2.64. 75-14110 205 x 140 x 75 mm £2.94.

8-way BOSS Switch (for programming, BCD, etc.) 8 ultra-min toggle switches in 16 pin DIL £2.60

DL704E 0.3" Common Cathode Red LED Now Only 75p

**ADVANCED CLOCK KIT.** Complete kit including attractive slim case for 6 digit alarm clock with  
bleep alarm, snooze and automatic intensity control, high brightness display driving — with  
optional touch switch controls and crystal control/battery back-up (both extra) using MK50253 and  
Jumbo 0.5" LED displays. Kit also includes PCBs, active and passive components, IC socket,  
miniature cool transformer, switches, flat cable, loudspeaker, perspex panel, and full instructions  
£26.80

**CRYSTAL TIMEBASE KIT.** All components including PCB (47 x 59mm) to provide 50 cps for  
clock IC's, giving time accurate to a few seconds a month. Kit includes PCB, 32.768 kHz miniature  
watch crystal, trimmer, 3 CMOS IC's and sockets, C.S. R's  
Advanced Clock Kit + Crystal Timebase Kit + Battery Back-up Kit  
£6.28  
The clock will keep correct time if mains power is disconnected.  
£33.58

**32.768 kHz.** Min. Watch Quartz Crystal £3.60. 5.12 MHz Quartz Crystal £3.60.

**PE CAR CLOCK with Journey Timer.** 6 digit clock for use in any car with 12V battery with an  
independent 6 digit, 24-hour, journey timer incorporated. Jumbo LED display comes on with  
ignition — automatic intensity control. Complete kit of all parts needed including case, PCB and all  
components.  
£39.50

**Easy to Build EED DIGITAL CLOCK (Jan 76)** Kit of all components including case, PCB, mini-  
transformer, etc. to build this attractive 4 digit clock with 0.5" green display.  
£15.70

plus  
DISPLAYS

**SINTEL**

Official Orders Welcomed. Terms: 30 days, for written or  
phoned orders from Companies, Govt. Dep'ts, Nat.  
Industries, Univs, Polys, etc. Fast delivery for R&D.

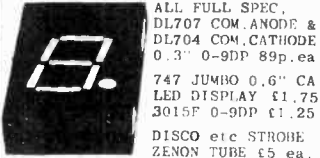


# TRAMPUS ELECTRONICS LTD. WINDSOR

**58-60 GROVE RD.  
WINDSOR, BERKS. SL4 1HS.**  
ADD 8% VAT TO PRICES MARKED \*  
ADD 12% VAT TO ALL OTHER PRICES.  
SEND CWO (EXCEPT GOVT. DEPTS.)  
POST & PACKING 20p FOR THE UK.

**NEW FAST SERVICE, LOW PRICES.  
MONEY BACK IF NOT SATISFIED.  
ALL BRAND NEW TOP GRADE FULL  
SPEC DEVICES, CALLERS WELCOME  
NEW CATALOGUE LIST FREE SAE,  
HARCLAYCARD & ACCESS BY POST,  
OR TELEPHONE ON £5 MINIMUM**

## FAST SERVICE



## LEDS red 12p.

- 209 STYLE OR 0.2" NO CLIP 11p\*
- TIL209 or 0.2" RED & CLIP 13p\*
- GREEN LARGE/SMALL & CLIP 22p\*
- ORANGE LARGE/SMALL & CLIP 22p\*
- ORP12 57p\* 2N5777 33p\* TEC12 50p\*
- DIGITAL CLOCKS MM5316 £5\*
- MM5314 £3.39\* MM5311 £5\*
- AY51224 £3.49\* PCB £1\*
- CAPACITORS
- CERAMIC 22pf-0.1uf 50v 5p.
- ELECTROLYTIC: 10/50/100 uf 10 or  
25V 7p. 50V 9p. 2uf/10V 6p.
- 1000uf 25V 18p. 200/500uf 9p.
- POTENTIOMETERS 1kN/LOG 16p ea
- PRESSETS 6p. RESISTORS 1 p ea

## IC's LOW PRICES

703 RF/IF	26p	MC1303	£1.47
709 T099	22p*	MC1310	£2.09
DL707 COM. ANODE & DL704 COM. CATHODE	28p*	MC1312 SQ	£1.50
0.3" 0-9DP	89p. ea *	MC1318	£2.50
723 Regul'r	45p*	MC1330	75p
741 DIL 8	20p*	MC1339	£1.49.
741 DIL 14	31p*	MC1350/1/2	75p
741 T099	31p*	MC1466 /9	£3
747 2x741	67p*	MFC4000 1W	59p
748 DIL 8	27p*	NE536 FETOPA	£2*
7805 5V	£1.39*	NE540	£1.10*
7812 12V	£1.39*	NE550 2vr	£1*
7815 15V	£1.39*	NE555 TIMER	41p*
7900 Series	£3*	NE556 2x"	84p*
76013 6W AF	75p	NE560 PLL	£4.00
CA3046	59p	NE561 PLL	£4.00
CA3048	£2.20	NE562 PLL	£4.00
CA3054	£2	NE563	£2.25
ICL8038	£2.69*	NE565	£2.50
LM300	£1.50*	NE566	£1.55
LM301 OPA	41p*	NE567	£2.20
LM304 0-40V	£3*	SN72741	741 20p*
LM308 HI Bo	95p*	SN76660	IF 75p
LM309K 5V	£1.75*	SN76611	IF £1
LM372 1F	£2.00*	TAD100 & IF	£2
LM377 2x2W	£3	TBA800	89p
LM380 80246	89p	TBA810 7WAF	80p
LM381	£2	TBA820	£1.49
LM3900 40PA	63p*	2N114	RX 99p

## 749 TTL FULL SPEC. 5% off 100MIX

7400	9p*	7474	27p*
7401	10p*	7476	27p*
7402/3	11p*	7490	37p*
7404	13p*	7491	60p*
7405/6/7	23p*	7492/93	43p*
7408/9/10	9p*	7494	43p*
7413	26p*	7496	68p*
7420/30	12p*	74100	£1
7410	12p*	74121	26p*
7411	12p*	74123	58p*
7412	64p*	74141	64p*
7413	67p*	74174	£1*
7414	25p*	74175	95p*
7415	22p*	74196	£1*
7416	26p*		

## TRANSISTORS

PRICE EACH:-	MATCHING 20p*
AC127 & 12R 10p*	INS. BUSH SET 6p*
AC176 15p*	TIP29 & 30 43p*
AC187 & 18R 18p*	TIP31 & 32 54p*
AD119 45p*	TIP41 63p*
AD161 & 162 33p*	TIP42 67p*
BC107 8p*	TIP2955 99p*
BC107B 12p*	TIP3055 67p*
BC108 7p*	TIS43 UJCT 26p*
BC108B 12p*	ZTX107/8/9 11p
BC109 8p*	ZTX300 & 304 20p
BC109C 12p*	ZTX500 & 504 12p
BC147/8/9 9p	2N706 & 798 11p
BC157/8/9 12p	2N2616 UJT 38p*
BC167/8/9 12p	2N2904 & 5 20p*
BC177/8/9 18p	2N2926 broyg 9p
BC182/3/4A&L10p	2N3053 16p*
BC212/3/4A&L12p	2N3054 42p*
BCY70/1/2 16p*	2N3055 115W 37p*
BD131 & 132 39p*	2N3055 RCA 60p*
BFR88 250V 35p	2N3702/3/4/5 8p
BFY50 14p*	2N3706/7/8/9 8p
BFY51 14p*	2N3710 & 11 8p
BFY52 & 53 14p*	2N3819F PET 12p
BSX19/20/21 16p*	2N3820 PET 40p
MJE2955 T03 75p*	2N3823F PET 16p
MJE2955 89p*	2N3904/5/6 15p
MJE3055 64p*	2N4289 mini 31p
MPU131 PIT 49p	2N5457 PET 45p

## TELEPHONE 54525

- DIODES
- 0A81 & 0A91 GERMANIUM 5p.
- 1N4001 1A50V & 1N4002 5p\*
- 1N4004 6p\* 1N4007 9p\*
- 1N4148 & 1N914 SILICON 4p.
- ZENERS BZY88 400mW 9p.
- ZENERS 14W 17P. Z1Jnotae£1
- BRIDGE RECTIFIER 1A50 18p
- 1A400V 25p. 4A100V 45p

- SCR's TRIACS
- SCR's TAG1/400 1A400V 50p\*
- 1A50V 38p\* 1A 600V 70p\*
- C106D 4A400V SCR ONLY 47p\*
- TRIAC SC146D 10A400V £1\*
- TRIAC DISCO 16A400V £1.75\*
- DIACS: ST2 20p. BR100 25p

**vero**  
36PINS 28p\*FACE CUTTER49p\*  
COPPERCLAD 0.1 PITCH VERO  
21"x5" 32p\* 21"x31" 29p\*  
31"x5" 37p\* 31"x31" 32p\*  
31"x17" £1.70\*  
31"x17" PLAIN 0.1" £1.06\*  
DIL BREADBOARD 6x4" £2\*

## DALO 69P pen

DALO ETCH RESIST PEN 69p\*  
FEC ETCH PAK 500gm 89p\*  
6x4" COPPER BOARD 50p\*  
PCB KIT 3 ITEMS £2\*  
TANGS MECHANISM £9 & ASC12  
TGS GAS DETECTORS 308etct£2\*

**oil sockets**  
TOP QUALITY NYLON  
SOCKETS 8PIN 12p\*  
14PIN 12p\* 16PIN 12p  
SOLDERCON PINS:  
100 65p\* 1000 £3.50\*

# RS VALVE MAIL ORDER CO.

159 Fallsbrook Rd, Streatham, London, SW16 6ED  
Tel: 01-677 2424 Telex: 946 708.


VALVES		E280		E281		E282		E283		E284		E285		E286		E287		E288		E289		E290											
AZ21	1.00	ECH35	1.50	E280	0.30	E281	0.30	E282	0.30	E283	0.30	E284	0.30	E285	0.30	E286	0.30	E287	0.30	E288	0.30	E289	0.30	E290	0.30								
AZ41	1.00	ECH81	0.35	E290	0.45	E291	0.45	E292	0.45	E293	0.45	E294	0.45	E295	0.45	E296	0.45	E297	0.45	E298	0.45	E299	0.45	E300	0.45	E301	0.45						
CR131	1.40	ECH84	0.50	E300	0.60	E301	0.60	E302	0.60	E303	0.60	E304	0.60	E305	0.60	E306	0.60	E307	0.60	E308	0.60	E309	0.60	E310	0.60	E311	0.60	E312	0.60				
CL33	1.50	ECL80	0.40	GZ32	0.65	PL81	0.55	PL82	0.55	PL83	0.55	PL84	0.55	PL85	0.55	PL86	0.55	PL87	0.55	PL88	0.55	PL89	0.55	PL90	0.55	PL91	0.55	PL92	0.55				
CV31	1.00	ECL82	0.40	GZ34	0.75	PL82	0.55	PL83	0.55	PL84	0.55	PL85	0.55	PL86	0.55	PL87	0.55	PL88	0.55	PL89	0.55	PL90	0.55	PL91	0.55	PL92	0.55	PL93	0.55				
DAF96	0.40	ECL86	0.55	H63	0.90	PL83	0.55	PL84	0.55	PL85	0.55	PL86	0.55	PL87	0.55	PL88	0.55	PL89	0.55	PL90	0.55	PL91	0.55	PL92	0.55	PL93	0.55	PL94	0.55				
DD390	1.25	ECL800	0.50	H64	1.00	PL84	0.55	PL85	0.55	PL86	0.55	PL87	0.55	PL88	0.55	PL89	0.55	PL90	0.55	PL91	0.55	PL92	0.55	PL93	0.55	PL94	0.55	PL95	0.55				
DF91	0.40	EF37A	1.50	HN309	1.50	PL500	0.85	PL501	0.85	PL502	0.85	PL503	0.85	PL504	0.85	PL505	0.85	PL506	0.85	PL507	0.85	PL508	0.85	PL509	0.85	PL510	0.85	PL511	0.85				
DF96	0.60	EF39	1.25	KT61	3.40	PL508	0.85	PL509	0.85	PL510	0.85	PL511	0.85	PL512	0.85	PL513	0.85	PL514	0.85	PL515	0.85	PL516	0.85	PL517	0.85	PL518	0.85	PL519	0.85				
DK91	1.00	EF41	0.75	KT66	3.40	PL509	1.55	PL510	1.55	PL511	1.55	PL512	1.55	PL513	1.55	PL514	1.55	PL515	1.55	PL516	1.55	PL517	1.55	PL518	1.55	PL519	1.55	PL520	1.55				
DK92	1.00	EF55	1.50	KT81 (7C5)	1.50	PL801	1.00	PL802	1.00	PL803	1.00	PL804	1.00	PL805	1.00	PL806	1.00	PL807	1.00	PL808	1.00	PL809	1.00	PL810	1.00	PL811	1.00	PL812	1.00				
DN96	0.75	EF80	0.35	KT88	1.85	PL802	2.00	PL803	2.00	PL804	2.00	PL805	2.00	PL806	2.00	PL807	2.00	PL808	2.00	PL809	2.00	PL810	2.00	PL811	2.00	PL812	2.00	PL813	2.00				
DL92	0.50	EF86	0.50	KTW61	1.50	PY332	0.63	PY333	0.63	PY334	0.63	PY335	0.63	PY336	0.63	PY337	0.63	PY338	0.63	PY339	0.63	PY340	0.63	PY341	0.63	PY342	0.63	PY343	0.63	PY344	0.63		
DL96	0.55	EF89	0.35	KTW62	1.50	PY381	800	PY382	800	PY383	800	PY384	800	PY385	800	PY386	800	PY387	800	PY388	800	PY389	800	PY390	800	PY391	800	PY392	800				
DM70	0.70	EF91	0.40	N78	5.00	35A	0.50	35B	0.50	35C	0.50	35D	0.50	35E	0.50	35F	0.50	35G	0.50	35H	0.50	35I	0.50	35J	0.50	35K	0.50	35L	0.50				
DY78/7	0.45	EF92	0.50	OA2	0.45	PY82	0.45	PY83	0.45	PY84	0.45	PY85	0.45	PY86	0.45	PY87	0.45	PY88	0.45	PY89	0.45	PY90	0.45	PY91	0.45	PY92	0.45	PY93	0.45	PY94	0.45		
DY802	0.47	EF98	0.80	OB2	0.45	PY82	0.45	PY83	0.45	PY84	0.45	PY85	0.45	PY86	0.45	PY87	0.45	PY88	0.45	PY89	0.45	PY90	0.45	PY91	0.45	PY92	0.45	PY93	0.45	PY94	0.45		
EABC80	0.38	EF183	0.40	OZ4	0.55	PY90	1.10	PY91	1.10	PY92	1.10	PY93	1.10	PY94	1.10	PY95	1.10	PY96	1.10	PY97	1.10	PY98	1.10	PY99	1.10	PY100	1.10	PY101	1.10	PY102	1.10		
FAF42	0.70	EH90	0.60	PC88	0.85	SP11	3.00	SP12	3.00	SP13	3.00	SP14	3.00	SP15	3.00	SP16	3.00	SP17	3.00	SP18	3.00	SP19	3.00	SP20	3.00	SP21	3.00	SP22	3.00	SP23	3.00		
FAF901	0.75	EL34	3.00	PC90	0.55	SP81	1.85	SP82	1.85	SP83	1.85	SP84	1.85	SP85	1.85	SP86	1.85	SP87	1.85	SP88	1.85	SP89	1.85	SP90	1.85	SP91	1.85	SP92	1.85	SP93	1.85		
EBC33	1.00	EL37	3.40	PC98	0.55	U25	1.00	U26	1.00	U27	1.00	U28	1.00	U29	1.00	U30	1.00	U31	1.00	U32	1.00	U33	1.00	U34	1.00	U35	1.00	U36	1.00	U37	1.00		
EBC41	0.75	EL41	0.90	PCC189	0.65	U26	0.85	U27	0.85	U28	0.85	U29	0.85	U30	0.85	U31	0.85	U32	0.85	U33	0.85	U34	0.85	U35	0.85	U36	0.85	U37	0.85	U38	0.85		
EBC81	0.40	EL42	1.65	PCF90	0.40	U180	0.75	U181	0.75	U182	0.75	U183	0.75	U184	0.75	U185	0.75	U186	0.75	U187	0.75	U188	0.75	U189	0.75	U190	0.75	U191	0.75	U192	0.75		
EBF80	0.40	EL44	0.35	PCF96	0.65	U34	0.75	U35	0.75	U36	0.75	U37	0.75	U38	0.75	U39	0.75	U40	0.75	U41	0.75	U42	0.75	U43	0.75	U44	0.75	U45	0.75	U46	0.75		
EBF83	0.40	FL91	2.00	PCF80	0.60	U80	1.10	U81	1.10	U82	1.10	U83	1.10	U84	1.10	U85	1.10	U86	1.10	U87	1.10	U88	1.10	U89	1.10	U90	1.10	U91	1.10	U92	1.10		
EBF89	0.32	EL95	0.60	PCF802	0.55	UABC80	0.40	UABC81	0.40	UABC82	0.40	UABC83	0.40	UABC84	0.40	UABC85	0.40	UABC86	0.40	UABC87	0.40	UABC88	0.40	UABC89	0.40	UABC90	0.40	UABC91	0.40	UABC92	0.40	UABC93	0.40
EFL12	2.00	EL96	1.75	PCF905	0.90	UABC80	0.40	UABC81	0.40	UABC82	0.40	UABC83	0.40	UABC84	0.40	UABC85	0.40	UABC86	0.40	UABC87	0.40	UABC88	0.40	UABC89	0.40	UABC90	0.40	UABC91	0.40	UABC92	0.40	UABC93	0.40
ECC40	1.00	EM80	0.55	PCF906	0.80	UABC82	0.75	UABC83	0.75	UABC84	0.75	UABC85	0.75	UABC86	0.75	UABC87	0.75	UABC88	0.75	UABC89	0.75	UABC90	0.75	UABC91	0.75	UABC92	0.75	UABC93	0.75	UABC94	0.75		
ECC81	0.45	EM81	0.60	PCF908	1.00	UABC84	0.85	UABC85	0.85	UABC86	0.85	UABC87	0.85	UABC88	0.85	UABC89	0.85	UABC90	0.85	UABC91	0.85	UABC92	0.85	UABC93	0.85	UABC94	0.85	UABC95	0.85	UABC96	0.85		
ECC82	0.38	EM81	0.60	PCF912	0.45	UABC88	0.50	UABC89	0.50	UABC90	0.50	UABC91	0.50	UABC92	0.50	UABC93	0.50	UABC94	0.50	UABC95	0.50	UABC96	0.50	UABC97	0.50	UABC98	0.50	UABC99	0.50	UABC100	0.50		
ECC83	0.38	EY61	1.45	PCF915	0.70	UABC88	0.50	UABC89	0.50	UABC90	0.50	UABC91	0.50	UABC92	0.50	UABC93	0.50	UABC94	0.50	UABC95	0.50	UABC96	0.50	UABC97	0.50	UABC98	0.50	UABC99	0.50	UABC100	0.50		
ECC85	0.45	EY85	1.50	PCF918	0.50	UABC90	0.50	UABC91	0.50	UABC92	0.50	UABC93	0.50	UABC94	0.50	UABC95	0.50	UABC96	0.50	UABC97	0.50	UABC98	0.50	UABC99	0.50	UABC100	0.50	UABC101	0.50	UABC102	0.50		
ECC88	0.50	EY86	1.50	PCF920	0.60	UABC92	0.50	UABC93	0.50	UABC94	0.50	UABC95	0.50	UABC96	0.50	UABC97	0.50	UABC98	0.50	UABC99	0.50	UABC100	0.50	UABC101	0.50	UABC102	0.50	UABC103	0.50	UABC104	0.50		
ECC90	0.45	EZ40	0.60	PCF925	0.50	UABC94	0.50	UABC95	0.50	UABC96	0.50	UABC97	0.50	UABC98	0.50	UABC99	0.50	UABC100	0.50	UABC101	0.50	UABC102	0.50	UABC103	0.50	UABC104	0.50	UABC105	0.50	UABC106	0.50		
ECC92	0.45	EZ41	0.75	PCF930	1.50	UABC96	0.50	UABC97	0.50	UABC98	0.50	UABC99	0.50	UABC100	0.50	UABC101	0.50	UABC102	0.50	UABC103	0.50	UABC104	0.50	UABC105	0.50	UABC106	0.50	UABC107	0.50	UABC108	0.50		

INDUSTRIAL VALVES		60C66		60C67		60C68		60C69		60C70		60C71		60C72		60C73		60C74		60C75		60C76		60C77		60C78		60C79		60C80		60C81		60C82		60C83		60C84		60C85		60C86		60C87		60C88		60C89		60C90																					
6061	1.00	60C66	1.20	60C67	1.20	60C68	1.20	60C69	1.20	60C70	1.20	60C71	1.20	60C72	1.20	60C73	1.20	60C74	1.20	60C75	1.20	60C76	1.20	60C77	1.20	60C78	1.20	60C79	1.20	60C80	1.20	60C81	1.20	60C82	1.20	60C83	1.20	60C84	1.20	60C85	1.20	60C86	1.20	60C87	1.20	60C88	1.20	60C89	1.20	60C90	1.20	60C91	1.20	60C92	1.20	60C93	1.20	60C94	1.20	60C95	1.20	60C96	1.20	60C97	1.20	60C98	1.20	60C99	1.20	60C100	1.20
6062	1.00	60C91	1.20	60C92	1.20	60C93	1.20	60C94	1.20	60C95	1.20	60C96	1.20	60C97	1.20	60C98	1.20	60C99	1.20	60C100	1.20	60C101	1.20	60C102	1.20	60C103	1.20	60C104	1.20	60C105	1.20	60C106	1.20	60C107	1.20	60C108	1.20	60C109	1.20	60C110	1.20	60C111	1.20	60C112	1.20	60C113	1.20	60C114																							

## RETURN OF POST MAIL ORDER SERVICE

### BSR HI-FI AUTOCHANGER STEREO AND MONO

Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months guarantee. A.C. 200/250V. Size 13 1/2" x 14 1/2" x 3 1/2". Above motor board 3 1/2". Below motor board 2 1/2". with STEREO and MONO CARTRIDGE



**£10.95** Post 75p

---

### PORTABLE PLAYER CABINET

Modern design. Rexine covered. Vynair front grille. Chrome fittings

Size 17 x 15 x 8in. approx **£4.50** Post 50p

Motor board cut for BSR or Garrard deck

### HEAVY METAL PLINTHS

With P.V.C. Cover. Cut out for most BSR or Garrard decks. Silver grey finish. Model "A" Size 12 1/2" x 14 1/2" x 7 1/2" **£5.95**

Model "B" Size 16 x 13 1/2" x 7in **£6.50** Post 75p

### COMPLETE STEREO SYSTEM

Two full size loudspeakers 13 1/2" x 10 x 3 1/2" Player unit clips to loudspeakers making it extremely compact. overall size only 13 1/2" x 10 x 8 1/2". 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls

Attractive Teak finish **£25**


240V a.c. mains **£1 carriage**



### SPECIAL OFFER! SMITH'S CLOCKWORK 15 AMP TIME SWITCH

0-60 MINUTES **£2.50** Post 35p

Single pole two-way. Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or intermediate settings. Brand new and fully guaranteed




---

TEAKWOOD LOUDSPEAKER GRILLES will easily fit to baffle board. Size 10 1/2" x 7 1/2" - **45p.**

### WEYRAD P50 - TRANSISTOR COILS

RA2W Ferrite Aerial <b>85p</b>	Driver Trans LFDT4 <b>65p</b>
1F P50/2CC 470 kc/s <b>40p</b>	Printed Circuit, PCA1 <b>65p</b>
3rd I.F. P50/3CC <b>40p</b>	J B Tuning Gang <b>£2.00</b>
P50/1AC <b>60p</b>	OPT1 <b>65p</b>

Ferrite Rod 8 x 3/8in. **20p.** 6 x 5/16in. **20p.** 3 x 3/8in **10p**

### VOLUME CONTROLS

5kΩ to 2MΩ LOG or LIN L/S **25p.** D.P. **40p.** STEREO L/S **55p.** D.P. **75p.** Edge 5K, S.P. Transistor **30p.**

### 80 Ohm Coax 8p yd.

BRITISH AERIALITE AERIAL-AIR SPACED 40 yd **£3.** 60 yd **£4.50**

FRINGE LOW LOSS **15p**

Ideal 625 and colour yd.

### ELAC HI-FI SPEAKER

8in. or 10 x 6in.

Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 c/s Bass resonance 55 c/s 8 ohm impedance. 10 watts. music power. **£4.35** Post 35p



### E.M.I. 13 1/2 x 8in. SPEAKER SALE!

With tweeter and crossover 10 watt State 3 or 8 ohm As illustrated **£6.60**

Post 35p Post 45p

With flared tweeter cone and ceramic magnet 10 watt Bass res 45-60 c/s Flux 10 000 gauss 8ohm 40 to 11,000 c/s. **£3.45** Post 35p

### Bookshelf Cabinet

Teak finish 16 x 10 x 9in For EMI 13 x 8 speakers **£6.95** Post 75p

### THE "INSTANT" BULK TAPE ERASER AND HEAD DEMAGNETISER.

Suitable for cassettes and all sizes of tape reels. A.C. mains 200/250V Leaflet S A E Will also demagnetise small tools **£4.35** Post 30p



### BLANK ALUMINIUM CHASSIS.

6 x 4 - **70p.** 8 x 6 - **90p.** 10 x 7 - **£1.15.** 12 x 8 - **£1.35.** 14 x 9 - **£1.50.** 16 x 6 - **£1.45.** 16 x 10 - **£1.70.**

### ALUMINIUM PANELS.

6 x 4 - **17p.** 8 x 6 - **24p.** 14 x 3 - **25p.** 10 x 7 - **35p.** 12 x 8 - **43p.** 12 x 5 - **30p.** 16 x 6 - **43p.** 14 x 9 - **52p.** 12 x 12 - **68p.** 16 x 10 - **75p.**

### ELAC 9 x 5in HI-FI SPEAKER TYPE 59RM

This famous unit now available. 10 watts. 8 ohm **£3.45** Post 35p

### RCS LOW VOLTAGE STABILISED POWER PACK KITS

All parts and instructions with Zener diode, printed circuit rectifiers and double wound mains transformer. Input 200/240V a.c. Output voltages available. 6 or 7.5 or 9 or 12V d.c. up to 100mA or less. Size 3 x 2 1/2 x 1 1/2 in. Please state voltage required. **£2.95** Post 45p

### RCS POWER PACK KIT

12 VOLT 750mA. Complete with printed circuit board and assembly instructions. 12 VOLT 300mA KIT. **£3.15.** 9 VOLT 1 AMP KIT. **£3.35.**

### R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER - BRITISH MADE

Ideal for Mike, Tape, P.U., Guitar, etc. Can be used with Battery 9-12V or H.T. line 200-300V d.c. operation. Size. 1 1/4 x 1 1/4 in. Response 25 c/s to 25 kc/s. 26 dB gain For use with valve or transistor equipment Full instructions supplied. Details S.A.E. **£1.45** Post 30p

### ELECTRO MAGNETIC PENDULUM MECHANISM

1.5V d.c. operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays. teaching electro magnetism or for metronome, strobe, etc **95p** Post 30p

### R.C.S. "MINOR" 10 watt AMPLIFIER KIT

This kit is suitable for record players, guitars, tape playback, electronic instruments or small P.A. systems. Two versions available Mono, **£12.50.** Stereo, **£20.** Post 45p Specification 10W per channel, input 100mV, size 9 1/2 x 3 x 2in. approx S.A.E. details. Full instructions supplied. AC mains powered

### MAINS TRANSFORMERS

ALL POST 50p

250-0-250V 70mA. 6.5V. 2A	<b>£3.45</b>
250-0-250 80mA. 6.3V 3 5A. 6.3V 1A or 5V 2A	<b>£4.60</b>
350-0-350 80mA. 6.3V 3 5A. 6.3V 1A or 5V 2A	<b>£5.80</b>
300-0-300V 120mA. 6.3V 4A CT. 6.3V 2A	<b>£7.00</b>
MIDGET 220V 45mA. 6.3V 2A	<b>£1.40</b>
HEATED TRANS. 6.3V 1/2 amp £1; 3 amp <b>£1.40</b>	

GENERAL PURPOSE LOW VOLTAGE Tapped outputs at 2 amp 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V **£4.60.** 1 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£4.60.** 2 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£7.00.** 3 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£8.70.** 5 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£11.25.** 6.06V 500mA **£1.9V** 1 amp **£1.** 12V 300mA. **£1.** 12V 500mA. **£1.** 12V 750mA. **£1.** 10V. 30V. 40V. 2 amp **£2.75.** 20V. 3 amp **£2.45.** 40V 2 amp. **£2.95.** 22-0-22V. 4 amp d.c. **£3.45.** 16V. 1/2 amp. **£1.** 16V. 2 amp. **£2.20.** 0. 5, 8, 10, 16V. 1/2 amp. **£1.95.** 20V 1/2 amp. **£1.75.** 20V. 1 amp. **£2.20.**

AUTO TRANSFORMERS. 115V to 230V or 230V to 115V 150W **£5.** 250W **£6.** 400W **£7.** 500W **£8.**

FULL WAVE BRIDGE CHARGER RECTIFIERS 6 or 12V outputs. 1 1/2 amp **40p.** 2 amp **55p.** 4 amp **85p.** CHARGER TRANSFORMERS 1 1/2 amp **£2.75.** 4 amp **£4.60.** 12V. 1 1/2A HALF WAVE Selenium Rectifier. **25p.**

### GOODMANS 8-inch HI-FI BASS WOOFER

8 ohm 10W Large ceramic magnet Special Rubber cone surround. Frequency response. 30-8000 c/s **£6.75**

Ideal Hi-Fi Enclosure Systems.



### NEW ELECTROLYTIC CONDENSERS

2/350V 20p	250/25V 20p	50 + 50/300V 50p
4/350V 20p	500/25V 25p	900/350V 95p
8/350V 28p	100 + 100/275V 65p	32 + 32/250V 20p
16/350V 35p	150 + 200/275V 70p	32 + 32/450V 80p
32/500V 60p	8 + 8/350V 50p	350 + 50/325V 85p
25/25V 15p	8 + 16/350V 50p	100 + 50 + 50/350V 85p
50/50V 15p	16 + 16/350V 60p	32 + 32 + 32/350V 65p
100/25V 15p	32 + 32/350V 60p	4700/63V 95p

### LOW VOLTAGE ELECTROLYTICS

1. 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V **10p.** 500mF 12V **15p.** 25V **20p.** 50V **30p.** 1000mF 12V **17p.** 25V **35p.** 50V **47p.** 100V **70p.** 2000mF 6V **25p.** 25V **42p.** 50V **57p.** 2500mF 50V **82p.** 3000mF 25V **47p.** 50V **85p.** 5000mF 6V **25p.** 12V **42p.** 25V **75p.** 35V **85p.** 50V **95p.**

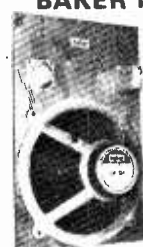
### DRT WAVE 100pF air spaced gangable tuner. 95p.

TRIMMERS 10pF 30pF 50pF 100pF 150pF 5p. CERAMIC. 1pF to 0.01mF. 5p. Silver Mica 2 to 5000pF 5p. PAPER 350V-0 1 7p; 0 5 13p; 1mF 150V 15p; 2mF 150V 15p; 500V-0 001 to 0 05 5p; 0 1 10p; 0 25 13p; 0 47 25p. MICRO SWITCH SINGLE POLE CHANGEOVER 20p. SUB-MIN MICRO SWITCH, 25p. Single pole change over TWIN GANG, "O-0" 208pF + 176pF £2.00; 500pF standard 75p; 365 + 365 + 25 + 25pF. Slow motion drive 50p. 120pF TWIN GANG, 50p; 365pF TWIN GANG, 50p. NEON PANEL INDICATORS 250V AC/DC. Amber or red. 30p. RESISTORS. 1/4W 1/2W 1W 20% 2p; 2W 10p; 10Ω to 10M HIGH STABILITY. 1/2W 2% 10 ohms to 6 meg 12p. Dttio 5%. Preferred values 10 ohms to 10 meg 5p. WIRE-WOUND RESISTORS 5 watt. 10 watt 15 watt 10 ohms to 100K 12p each TAPE OSCILLATOR COIL Valve type 35p. BRIDGE RECTIFIER 200V PIV 1/2 amp 50p.

### BAKER MAJOR 12" £11.50

30-14,500 c/s. 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 25W NOTE: 3 or 8 or 15 ohms must be stated.

Module kit, 30-17,000 c/s with tweeter, crossover, baffle and instructions **£14.50** Post 60p each Please state 3 or 8 or 15 ohms.



### BAKER "BIG-SOUND" SPEAKERS.

Post 50p each.

'Group 25' 12in 30W 3 or 8 or 15 ohm	'Group 35' 12in 40W 3 or 8 or 15 ohm	'Group 50' 15in 75W 8 or 15 ohm
<b>£8.95</b>	<b>£10.50</b>	<b>£19.50</b>

### NEW MODEL BAKER LOUDSPEAKER, 12-inch 60 WATT GROUP 50/12, 8 OR 15 OHM HIGH POWER.

FULL RANGE PROFESSIONAL QUALITY 30-16,000 CPS MASSIVE CERAMIC MAGNET ALUMINIUM PRESENCE CENTRE DOME. **£14.50** Post 80p

### TEAK VENEERED HI-FI SPEAKERS AND CABINETS

For 12in or 10in speaker 20x13x12in **£12.50** Post 95p  
For 13x8in or 8in, speaker 16x10x7in **£6.95** Post 75p  
For 8x5in, speaker 12x8x6in **£4.95** Post 50p  
LOUDSPEAKER CABINET WADDING 18in wide 20p ft.

### R.C.S. 100 watt VALVE AMPLIFIER CHASSIS

Four inputs Four way mixing, master volume, treble and bass controls Suits all speakers This professional quality amplifier chassis is suitable for all groups, disco, P.A., where high quality power is required 5 speaker outputs A/C mains operated Slave output. Produced by demand for a quality valve amplifier Send for leaflet Price **£85** carr £2 50



### SPEAKER COVERING MATERIALS.

Samples Large 'S A E' Horn Tweeters 2-16kc/s, 10W 8 ohm or 15 ohm **£3.60**  
De Luxe Horn Tweeters 2-18kc/s 15W, 15 ohm **£4.50**  
CROSSOVERS. TWO-WAY 3000 c/s 3 or 8 or 15 ohm **£1.90.** 3-way 950 cps/3000 cps. **£2.20.**  
LOUDSPEAKERS P.M. 3 OHMS. 7x4in **£1.50;** 6 1/2in. **£1.80;** 8x5in. **£1.90;** 8in. **£1.95.**  
SPECIAL OFFER: 80 ohm 2 1/2in 2 1/2in. 35 ohm, 2in. 3in. 25 ohm, 2 1/2in dia. 3in dia. 5in dia. 8 ohm; 2 1/2in. 3in. 3 1/2in. 15 ohm. 3 1/2in dia. 6x4in. 7x4in. 8x5in. 2 ohm. 2 1/2in. 2 1/2in. 3in. 5in dia. **£1.25 each.**  
PHILIPS LOUSPEAKER, 8in. 4 ohms. 4 watts. ceramic magnet **£1.95**  
RICHARD ALLAN TWIN CONE LOUSPEAKERS Bin diameter 4W **£2.50.** 10in. diameter 5W **£2.95;** 12in diameter 6W **£3.50.** 3/8/15 ohms. please state VALVE OUTPUT TRANS. 40p; MIKE TRANS. 50 1. 40p. \*Mike trans. mu metal 100 1 **£1.25.**

Loudspeaker Volume Control 15 ohms 10W with one inch long threaded bush for wood panel mounting. 1/4in. spindle. **65p**

### BAKER 100 WATT ALL PURPOSE AMPLIFIER

All purpose transistorised Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm. a.c. Mains Separate treble and bass controls Guaranteed Details S.A.E. NEW MODEL MAJOR - 50 watt. 4 input. 2 vol Treble and bass Ideal disco amplifier **£49.95**



### 100 WATT DISCO AMPLIFIER CHASSIS

volume, treble, bass controls 500 mV input Four loudspeaker outputs 4 to 10 M ohm **£52**

### BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER

Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output 9V **£5.20**

### TWO STEREO CHANNEL VERSION

**£6.85**

### BARGAIN 3 WATT AMPLIFIER.

4 Transistor Push-Pull Ready Built, with volume, Treble and bass controls. 18 volt d.c. Mains Power Pack **£3.45**


### COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p. OUTLET BOXES, SURFACE 40p. FLUSH 60p. TWIN 85p. BALANCED TWIN RIBBON FEEDER 300 ohms. 7p yd. JACK SOCKET Std. open-circuit 20p. closed circuit 25p; Chrome Lead-Socket 45p. Mono or Stereo. Phono Plugs 8p. Phono Socket 8p. JACK PLUGS Std. Chrome 30p; 3.5mm Chrome 15p. DIN SOCKETS Chassis 3-pin 10p. 5-pin 10p. DIN SOCKETS FREE 3-pin 25p; 5-pin 25p. DIN PLUGS 3-pin 25p; 5-pin 25p. VALVE HOLDERS, 10p; CANS, 10p.

### R.C.S. SOUND TO LIGHT KIT

Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel **£12.50.** Post 35p \*Easy to build Full instructions supplied, cabinet **£3.** As featured in December Practical Wireless

### E.M.I. TAPE MOTORS.

240V ac 1 200 r.p.m. 4 pole 185mA Spindle 0 18x0 75in Size 3 1/4 x 2 1/2 x 2 1/4in **£2.** Post 40p 120V Model. **£1**



# LYNX ELECTRONICS (LONDON) LTD.

AC126 0.15	BC301 0.32	BY206 0.15	1N4003 0.06*
AC127 0.16	BC323 0.60	BY207 0.20*	1N4004 0.07*
AC128 0.13	BC327 0.18*	BYX36-300 0.12*	1N4005 0.08*
AC128K 0.25	BC328 0.16*	BYX36-600 0.15*	1N4006 0.09*
AC141 0.18	BC337 0.17*	BYX36-900 0.18*	1N4007 0.10*
AC141K 0.28	BC338 0.17*	BYX36-12000.21*	2N696 0.12
AC142 0.18	BCY70 0.12	BYX38-300 0.50	2N697 0.14
AC142K 0.28	BCY71 0.18	BYX38-600 0.55	2N698 0.10
AC176 0.16	BCY72 0.12	BYX38-900 0.60	2N929 0.14
AC176K 0.25	BD115 0.55	BYX38-12000.65	2N930 0.14
AC187 0.18	BD131 0.36	BZX61 Series	2N1131 0.15
AC187K 0.25	BD132 0.40	Zeners	2N1132 0.16
AC188 0.18	BD135 0.36	BZX83 or BZX88	2N1304 0.20
AC188K 0.25	BD136 0.39	Series	2N1305 0.20
AD140 0.50	BD137 0.40	Zeners	2N1711 0.18
AD142 0.50	BD138 0.48	C106A 0.40	2N2102 0.44
AD143 0.46	BD139 0.48	C106B 0.45	2N2369 0.14
AD149 0.45	BD181 0.86	C106D 0.50	2N2369A 0.14
AD161 0.35	BD182 0.92	C106F 0.35	2N2484 0.16
AD162 0.35	BD183 0.97	CRS1 05	2N2646 0.50
AL102 0.95	BD232 0.60*	CRS1 10	2N2905 0.18
AL103 0.93	BD233 0.48*	CRS1 20	2N2905A 0.22
AF114 0.20	BD237 0.55*	CRS1 40	2N2926R 0.10*
AF115 0.20	BD238 0.60*	CRS1/60	2N2960 0.09*
AF116 0.20	BD184 1.20	CRS3-05	2N29267 0.09*
AF117 0.20	BDY20 0.80	CRS3-10	2N2926G 0.10*
AF118 0.50	BDY38 0.60	CRS3-20	2N3053 0.15
AF139 0.33	BDY60 0.60	CRS3 40	2N3054 0.40
AF239 0.37	BDY61 0.65	CRS3-60	2N3055 0.50
BC107 0.14	BDY62 0.55	MJ480 0.80	2N3440 0.56
BC107B 0.16	BF178 0.28	MJ481 1.05	2N3442 1.20
BC108 0.13	BF179 0.30	MJ490 0.90	2N3525 0.75
BC109 0.14	BF194 0.10*	MJ491 1.15	2N3702 0.10*
BC109C 0.16	BF195 0.10*	MJE340 0.40*	2N3703 0.10*
BC111 0.19*	BF196 0.12*	MJE371 0.60	2N3703 0.10*
BC125 0.18*	BF197 0.12*	MJE520 0.45	2N3704 0.10*
BC126 0.20*	BF224J 0.18*	MJE521 0.55	2N3705 0.10*
BC141 0.28	BF244 0.17*	OA5 0.50*	2N3706 0.10*
BC142 0.23	BF257 0.30*	OA90 0.08	2N3707 0.10*
BC143 0.23	BF258 0.35	OA91 0.08	2N3714 1.05
BC144 0.30	BF337 0.32	OC41 0.15	2N3715 1.15
BC147 0.09*	BFW60 0.17*	OC42 0.15	2N3716 1.25
BC148 0.09*	BFX29 0.26	OC44 0.12	2N3771 1.60
BC149 0.09*	BFX30 0.30	OC45 0.10	2N3772 1.60
BC152 0.25*	BFX84 0.23	OC70 0.10	2N3773 2.10
BC153 0.18	BFX85 0.25	OC71 0.10	2N3819 0.28*
BC157 0.09*	BFX88 0.20	OC72 0.22	2N3904 0.16*
BC158 0.09*	BFY50 0.20	OC84 0.14	2N3906 0.16*
BC159 0.09*	BFY51 0.18	SC40A 0.73	2N4174 0.14*
BC160 0.32	BFY52 0.19	SC40B 0.81	2N4290 0.12*
BC161 0.38	BFY64 0.35	SC40D 0.98	2N4348 0.20
BC168B 0.09*	BFY90 0.65	SC40F 0.65	2N4870 1.35
BC182 0.11*	BR100 0.20	SC41A 0.65	2N4871 0.35
BC182L 0.11*	BRV39 0.40	SC41B 0.70	2N4919 0.70*
BC183 0.10*	BSX19 0.16	SC41D 0.85	2N4920 0.50*
BC183L 0.10*	BSX20 0.18	SC41F 0.60	2N4922 0.58*
BC184 0.11*	BSX21 0.20	ST2 0.20	2N4923 0.64*
BC184L 0.11*	BSY95A 0.12	TIP29A 0.44	2N5060 0.20*
BC207B 0.12*	BT106 1.00	TIP30A 0.52	2N5061 0.25*
BC212 0.11*	BT107 1.60	TIP31A 0.54	2N5062 0.27*
BC212L 0.11*	BT108 1.60	TIP32A 0.64	2N5064 0.30*
BC213 0.12*	BT109 1.00	TIP34 1.05	2N5496 0.65
BC213L 0.12*	BT116 1.00	TIP41A 0.68	
BC214 0.14*	BU105 1.80	TIP42A 0.72	
BC214L 0.14*	BU105 1.80	TN299 0.14	
BC237 0.16*	O2 1.90*	1N2070 0.16	
BC238 0.16*	BU126 1.60*	1N4001 0.04*	
BC300 0.34		1N4002 0.05*	

## DIGITAL DISPLAYS & LED'S

DL704	99p	DL747	£1.75	2 RED LED ONLY	13p
DL707	99p	DL750	£1.75	GREEN LED	15p

## THYRISTORS

	8A (TO92)	1A (TO5)	3A (TO6 type)	6A (TO220)	8A (TO220)	10A
50	20	25	35	41	42	47
100	25	40	40	47	48	54
200	27	35	45	58	60	68
400	30	40	50	87	88	98
600	35	65	70	1.09	1.19	1.26

## TRIACS (PLASTIC TO-220 PKGE. ISOLATED TAB)

	4A		6.5A		8.5A		10A		15A	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
100V	0.60	0.60	0.70	0.70	0.78	0.78	0.83	0.83	1.01	1.01
200V	0.64	0.64	0.75	0.75	0.87	0.87	0.87	0.87	1.17	1.17
400V	0.77	0.78	0.80	0.83	0.97	1.01	1.13	1.19	1.70	1.74
600V	0.87	0.99	0.87	1.01	1.21	1.26	1.42	1.50	2.11	2.17

N.B. Triacs without internal trigger diac are priced under column (a). Triacs with internal trigger diac are priced under column (b). When ordering please indicate clearly the type required.

## 74 TTL mixed prices

	1 24	25 99	100+		1 24	25 99	100+		1 24	25 99	100+
7400	14p	12p	10p	7445	85p	71p	57p	7493	45p	40p	32p
7401	14p	12p	10p	7447	81p	75p	65p	7495	67p	55p	45p
7402	14p	12p	10p	7448	75p	62p	50p	74100	£1.08	89p	72p
7403	15p	12 1/2p	10p	7447A	95p	83p	67p	74107	35p	28p	22p
7404	16p	13p	11p	7470	30p	25p	20p	74121	34p	28p	23p
7408	16p	13p	11p	7472	25p	21p	17p	74122	47p	39p	31p
7409	16p	13p	11p	7473	30p	25p	20p	74141	78p	65p	53p
7410	16p	13p	11p	7474	32p	26p	21p	74145	68p	58p	48p
7413	29p	24p	20p	7475	47p	39p	31p	74154	£1.62	£1.48	86p
7417	27p	22 1/2p	20p	7476	32p	26p	21p	74174	£1.00	83p	67p
7420	16p	13p	11p	7482	75p	62p	50p	74180	£1.06	88p	71p
7427	27p	22 1/2p	18p		£1.30	£1.09	87p	74181	£3.20	£2.50	£1.90
7430	16p	13p	11p	7486	32p	26p	21p	74192	£1.35	£1.14	90p
7432	27p	22 1/2p	18p	7489	£2.92	£2.80	£2.10	74193	£1.31	£1.11	90p
7437	27p	22 1/2p	18p	7490	49p	40p	32p	74196	£1.64	£1.34	99p
7441	75p	62p	50p	7491	65p	55p	45p				
7442	65p	55p	43p	7492	57p	46p	36p				

## LINEAR IC'S

301A 8 pin DIL	35p*	3900 14 pin DIL	70p*	565 14 pin DIL	£2.00*
307	55p*	709 B 14 pin DIL	35p*	566 8 pin DIL	£1.50*
309K	£1.60	741 8 pin DIL	28p*	567 8 pin DIL	£2.00*
380 14 pin DIL	90p	741 14 pin DIL	35p*	CA3046 14 pin DIL	50p*
381 14 pin DIL	£1.60*	748 8 pin DIL	36p*	CA3045	85p*
		555 8 pin DIL	45p*		

## HIGHAM MEED, CHESHAM, BUCKS. Tel. (02405) 75151

VAT - Please add 8% except items marked \* which are 12 1/2 %

# The SECOND-USER Computer Specialists

COMPUTER SALES AND SERVICES

## Peripherals and Systems for Data Processing Systems, Equipment and Components

### Mini-Computer Exchange

**JUST RECEIVED - PDP8E 8K Processor**  
 PDP11/20 24K Processor with RF11/RS11 Disk Drive and Control and Remex High Speed Reader/Punch & Control  
 Tektronix Graphics Display & Control (for PDP11 series)  
 PDP81 16K Processor, rack-mounted, with Teletype Control  
 PC81 High Speed Reader Punch  
 RK05 Disk Drive (no controller)  
 DF32 Disk Drive and Control (for PDP8E series)  
 TU60 DUAL Cassette Drive and Control (for PDP8E series)  
 RT02 Single-line Alphanumeric Display and Control (for PDP8E series)  
 DEC 6ft Cabinets  
**IMMEDIATE EX STOCK DELIVERY OF ASR33 TELETYPES, ALSO ASR35 and KSR33**  
 NOVA 2/10 32K Processor with Hardware Multiply / Divide, Floating Point, Real Time Clock and Paper Tape Reader  
 NOVA 1200 16K Processor with Real Time Clock, Twin Cassette Unit and Matrix Printer  
 Also available: Nova 4K Memory Module 8103, a few only 8K 8115 from £250.  
 NOVA 2/10 16K Processor with Teletype Control - BRAND NEW IN ORIGINAL PACKING!

### IBM PUNCHED CARD EQUIPMENT

EX STOCK DELIVERY OF IBM 024, 056, 026, 077

Add 8% VAT to all prices shown. Carriage extra - details on request.

### Paper Tape Punches and Readers



**TELETYPE BRPE 110 cps Synchronous Punch** 5-7-8 channel Self contained mains operated unit consisting of punch unit, base motor and tape supply spool. Price **£145.00** Sound buffering cabinet available at **£25.00**

**FACIT 4060** rack mounting heavy duty punch. 5-8 channel maximum operating speed 150 cps. Complete with supply and take up spools, tape low out sensor and large built in chad box. **£595.00**. Control unit also available.

**TALLY P.120** panel mounted perforator. Asynchronous operation up to 120 cps. Integral tape supply and take up spools. Price **£150.00**

**TALLY 420** Rack-mounted perforator. Asynchronous operation up to 60 cps. Integral supply and take-up spools. Complete with Model 5088 transistorised drive package. **£495.00**

**WELMEC LOW-SPEED PUNCH** Magnetically driven up to 17 cps. Ideal for data logging. Large chad box. **£45.00**

**FACIT 4001** Rack mounting high speed reader. A very high quality unit with electric reading and capstan drive. Reading speed up to 500 cps (or 1000 cps using separate spooler). Can be stopped between two consecutive characters. **£650.00**

**TALLY R150A READER** 150 cps. Fast rewind. Suitable for rack mounting. Complete with supply and take up spools. **£200.00**

**TALLY 424** rack mounting starwheel reader. Bidirectional operation up to 600 cps. Complete with supply and take up spools. Price **£125.00**

**WELMEC R82** Synchronous opto-mechanical reader. Low cost low speed reader for speeds up to 17 cps. Compact free standing unit. **£45.00**

**DATA DYNAMICS** Punched Card-to-Paper Tape Converter. Paper tape hand editing units. **£12.50** (P&P 50p). Paper tape hand splitters **£18.50** (P&P 50p)

**IBM 1130 SYSTEM** 8K Processor. Paper tape reader and punch. Card read punch. Automatic typewriter console.

**IBM I/O WRITERS** Model 73 Golfball Input. Output typewriters. BCD Coded. **£295.00**

**IBM 7330 TAPE DECKS**. Stripped down units (i.e. no electronics) consisting of complete deck with 7-track read/write head, drive and vacuum motors and control panel. Read/write speed 36 2/3 sec. 556 p.p.m. low and high speed rewind.

**MDS KEY-TO-TAPE ENCODERS**. 9-track encoders. IBM coded. Price **£450.00**.

### New Economy 80 Column Hand Punch

Completely redesigned with many important new features - send for brochure from **£69.50**



### Keyboards

**16-Key Japanese Keyboard**. BRAND NEW SURPLUS! Magnetically operated reed relay switches mounted on PCB. 9 white keys, 4 black, 2 yellow, 1 red. Dimensions 3" x 3" x 1". Price **£30** (P&P 30p)

**4 BANK HONEYWELL BRAND-NEW ALPHANUMERIC KEYBOARD - BRAND NEW**. Mounted on printed circuit board (non-coded) 53 character keys + 10 instruction keys and 2 space bars. Layout can be re-arranged as required. Ideal for prototypes and special applications. Hall-effect switches. Power requirement + 5V 420 mA. Price **£20.00** (P&P £1)

**RED-SWITCH 4-BANK ALPHANUMERIC KEYBOARD** mounted on printed circuit board with ASCII coded output. 43 character keys + 2 shift keys and 12 instructional keys. Ideal for data displays, computer programming etc. (a) Ex equipment housed in metal case **£30.00** + £3.00 P&P (b) Brand new mounted on PCB board only **£30.00** + £1.00 P&P

**MINIATURE MATRIX PROGRAMME BOARDS**. X-Y matrix board with 3mm grating. BRAND NEW by Ghelmetti of Switzerland. 20x30 positions (4 1/2" x 3 1/2"). **£15.00**; 12x10 (2 1/4" x 2 1/4") **£8.00**; 3x10 (1 1/4" x 1") **£4.00**. P&P 40p. Diode pins available to special order from **40p** each.

**SANDERS 720 DATA DISPLAY SYSTEM**. 6 ASCII-coded visual display units linked via control unit to communications buffer. Suitable for use with IBM 360/370 and many other processors.

## COMPUTER SALES & SERVICES (EQUIPMENT) LIMITED

49/53 Pancras Road, London NW1 2QB. Tel. 01-278 5571

Orders welcome Monday to Friday 9am to 5pm

# BENTLEY ACOUSTIC CORPORATION LTD.

7A GLOUCESTER ROAD, LITTLEHAMPTON, SUSSEX. Tel. 6743  
ALL PRICES SHOWN INCLUDE V.A.T. AT 12 1/2 %

0B2 0.40	68B8 0.35	6L6GC 0.70	12AV6 0.60	30P16 0.45	AZ41 0.50	EC53 1.00	EL96 0.90	PC805 0.60	Q575/20 1.00	U50 0.55	2N3988 0.58	BCY12 0.58	GET887 0.26	OC81 0.13
0A3 0.55	68A6 0.40	6L7M 0.60	12AX7 0.40	30P18 0.50	BL63 2.00	EC54 1.00	EL95 0.70	PC806 0.75	Q585/10 1.00	U76 0.70	2S323 0.58	BCY33 0.23	GET889 0.26	OC81D 0.13
1A2 0.80	68C8 0.90	6L12 0.45	12Y7 1.00	30P19 0.95	CL37 1.75	EC86 0.90	EL96 1.20	PCF80 0.40	Q510/15 1.00	U81 0.45	AA119 0.18	BCY34 0.26	GET890 0.26	OC82 0.13
1A5GT 0.55	68E6 0.40	6L8J 0.60	12BA6 0.50	30P12 0.45	CV6 0.60	EC88 0.90	EL97 0.50	PCF82 0.50	QV03/12 1.65	U81 0.80	AA120 0.18	BCY38 0.26	GET896 0.26	OC82D 0.13
1A7GT 0.60	68G6 1.00	6L19 2.00	12BE6 0.55	30P13 1.20	CV63 1.00	EC92 0.55	EM80 0.55	PCF84 0.70	QV06/20 3.50	U153 0.40	AA129 0.18	BC107 0.14	GET897 0.27	OC83 0.23
1B3GT 0.55	68H6 0.70	6L22 0.40	12BH7 0.55	30P14 1.30	CV988 0.25	EC32 1.00	EM81 0.60	PCF86 0.60	R16 2.00	U192 0.40	AC107 0.18	BC109 0.14	GET898 0.26	OC84 0.26
1C2 1.00	68J6 0.65	6L20 0.80	12BY7 0.85	30P15 0.50	CY1C 1.00	EC33 2.00	EM83 0.60	PCF200 1.00	R17 1.00	U193 0.45	AC113 0.30	BC113 0.30	GEX113 0.21	OC123 0.26
1G6 1.00	68K7A 0.85	6N7GT 0.70	12E1 3.50	35A3 0.90	CY31 0.70	EC35 2.00	EM84 0.45	PC201 1.00	R18 1.20	U251 1.00	AC114 0.47	BC115 0.18	GEX36 0.58	OC169 0.26
1H5GT 0.60	68Q5 0.35	6PL12 0.40	12J5GT 0.40	35C5 0.85	D1 0.50	EC40 1.00	EM85 1.20	PCF800 1.00	R19 0.75	U281 0.75	AC126 0.14	BC116 0.50	GEX45 0.58	OC172 0.41
1J4 0.25	68Q7A 0.60	6PL15 0.35	12J7GT 0.70	35D5 0.90	D63 0.50	EC81 0.40	EM86 0.50	PCF810 0.55	R20 0.65	U282 0.70	AC127 0.30	BC118 0.18	GEX52 0.57	OC200 0.55
1LD5 0.70	68R7 1.00	6Q7G 0.50	12K5 1.50	35L6GT 0.90	DAC32 0.90	EC82 0.40	EM87 1.20	PCF802 0.55	R52 0.55	U283 0.55	AC128 0.23	BF130 0.30	GEX59 0.26	OC201 0.53
1LN5 0.75	68R8 1.25	6Q7GT 0.50	12K7GT 0.50	35W4 0.55	DAF91 0.35	EC83 0.40	EM88 0.50	PCF804 0.60	R44 1.00	U301 0.55	AC132 0.23	BF158 0.30	GEX61 0.58	OC202 0.50
1NSGT 0.75	68S2 1.70	6Q7M 0.65	12K8 0.75	35Z3 0.90	DAF96 0.60	EC84 0.45	EM89 0.55	PCF806 0.60	SP13C 0.75	U329 1.00	AC154 0.30	BF159 0.30	GEX62 0.58	OC203 0.35
1RS 0.50	68W6 1.00	6R7G 0.70	12Q7GT 0.50	35Z4GT 0.70	DC90 0.70	EC85 0.45	EM90 0.55	PCF808 1.00	TH4B 1.00	U339 0.50	AC156 0.23	BF163 0.23	GEX63 0.58	OC204 0.35
1S4 0.40	68W7 0.85	6R7(M) 1.00	12SA7GT 0.75	35Z5GT 0.80	DD4 0.80	EC86 1.25	EM91 0.50	PCF810 1.00	TH43 1.00	U381 0.50	AC157 0.30	BF173 0.44	GEX64 0.58	OC205 0.50
1S5 0.35	68X6 0.30	6SA7 0.55	12SC7 0.50	42 1.50	DF33 0.75	EC88 0.55	EM92 0.55	PCF812 0.50	TP220 1.00	U403 0.90	AC165 0.30	BF180 0.30	GEX65 0.58	OC206 0.55
1T4 0.70	68Y7 0.40	6SC7GT 0.75	12SG7 0.55	50B5 1.00	DF91 0.50	EC89 0.80	EM93 0.55	PCF814 0.50	TP22 1.00	U404 0.75	AC166 0.30	BF181 0.47	GEX66 0.58	OC207 0.55
1U1 0.85	68Z4 0.40	6SH7 0.55	12SH7 0.50	50C06G 1.20	DH63 0.50	EC807 1.40	EM94 0.55	PCF816 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX67 0.58	OC208 0.55
2D25 0.55	68CG 0.60	6S7 0.60	12SK7 0.60	50EH5 0.85	DH76 0.50	ECF80 0.50	EM95 0.55	PCF818 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX68 0.58	OC209 0.55
2GK5 0.75	68C6 0.45	6SK7GT 0.55	12SN7GT 0.75	50L6GT 1.00	DH77 0.50	ECF82 0.50	EM96 0.55	PCF820 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX69 0.58	OC210 0.55
2X2 0.70	68C9 2.00	6S07 0.60	12SQ7 0.80	72 0.70	DH81 0.80	ECF86 0.60	EM97 0.55	PCF822 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX70 0.58	OC211 0.76
3A4 0.55	68C10 0.90	6U4GT 0.80	12SQ7GT 0.80	77 0.45	DK32 0.60	ECF84 2.60	EM98 0.55	PCF824 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX71 0.58	OC212 0.44
3B7 0.55	68C15A 0.50	6U7G 0.35	12SR7 0.75	85A2 0.75	DK40 0.70	ECI12 2.00	EM99 0.55	PCF826 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX72 0.58	OC213 0.44
3D6 0.40	68C15 0.65	6V6GT 0.50	12ST7 0.50	85W4 0.55	DK91 0.50	ECI35 1.60	EM100 0.55	PCF828 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX73 0.58	OC214 0.44
3Q4 0.80	68C16A 0.60	6V8GT 0.55	1457 1.10	90AGC 1.00	DK92 1.00	ECI42 0.80	EM101 0.55	PCF830 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX74 0.58	OC215 0.44
3Q5GT 0.70	68C18 0.80	6X4 0.45	18 1.25	90CG 2.00	DK96 0.70	ECI48 0.35	EM102 0.55	PCF832 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX75 0.58	OC216 0.44
3S4 0.45	68C16 0.75	6X5GT 0.50	19A05 0.65	90CV 2.00	DL92 0.45	ECI48 0.35	EM103 0.55	PCF834 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX76 0.58	OC217 0.44
3V4 0.80	68C18A 0.95	6V6G 0.95	19B9G6 1.00	90C1 0.85	DL94 0.80	ECI48 0.35	EM104 0.55	PCF836 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX77 0.58	OC218 0.44
4CB6 0.75	68C17 1.00	6V7G 1.25	19B6 0.50	150B2 1.00	DL96 0.65	ECI48 0.35	EM105 0.55	PCF838 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX78 0.58	OC219 0.44
4CG8 0.75	68C15 0.75	7A7 1.00	19H1 4.00	2155G 0.60	DM70 0.90	ECI48 0.35	EM106 0.55	PCF840 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX79 0.58	OC220 0.44
5R4GY 1.00	68C14 1.17	7B6 0.80	20D1 0.70	*301 1.20	DM71 1.75	ECI48 0.35	EM107 0.55	PCF842 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX80 0.58	OC221 0.44
5T4 1.00	6D3 0.75	7B7 0.80	20D4 2.50	302 1.20	DM4/350 1.15	ECI48 0.35	EM108 0.55	PCF844 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX81 0.58	OC222 0.44
5U4G 0.60	6DE7 0.80	706 2.00	20F2 0.85	303 1.20	DY87/6 0.40	ECI48 0.35	EM109 0.55	PCF846 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX82 0.58	OC223 0.44
5V4G 0.60	6DT6A 0.85	7F8 2.00	20L1 1.20	305 1.10	DY802 0.45	ECI48 0.35	EM110 0.55	PCF848 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX83 0.58	OC224 0.44
5Y3GT 0.55	6EW6 0.85	7H7 0.80	20P1 1.00	807 1.20	E80CC 2.50	EF22 1.00	EM111 0.55	PCF850 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX84 0.58	OC225 0.44
5Z3 1.00	6C15 1.90	7A7 1.00	19H1 4.00	2155G 0.60	E80CF 5.00	EF40 0.85	EM112 0.55	PCF852 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX85 0.58	OC226 0.44
5Z4G 0.55	6F1 0.90	7V7 2.00	20P4 1.00	1625 2.50	E80F 2.20	EF41 0.75	EM113 0.55	PCF854 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX86 0.58	OC227 0.44
5Z4GT 0.55	6F6G 0.60	7Y4 0.80	20P5 1.50	1821 1.00	E80F 2.20	EF42 0.90	EM114 0.55	PCF856 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX87 0.58	OC228 0.44
6/30L2 0.80	6F12 0.50	7Z4 0.80	25A6G 0.70	5702 1.20	E88CC 1.20	EF73 1.75	EM115 0.55	PCF858 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX88 0.58	OC229 0.44
6A8G 1.40	6F13 0.90	8D8 0.50	25L6G 0.70	5763 1.65	E92CC 0.70	EF80 0.30	EM116 0.55	PCF860 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX89 0.58	OC230 0.44
6A7 0.55	6F14 0.90	9B9W6 0.90	25Y5 0.90	6087 1.00	E190CC 0.90	EF83 1.25	EM117 0.55	PCF862 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX90 0.58	OC231 0.44
6AG5 0.35	6F15 0.75	9C7 0.70	25Z4G 0.50	6096 0.50	E180F 1.15	EF85 0.40	EM118 0.55	PCF864 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX91 0.58	OC232 0.44
6AG7 0.80	6F18 0.80	10C2 0.70	25Z5 0.75	6087 1.00	E182CC 0.90	EF86 0.50	EM119 0.55	PCF866 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX92 0.58	OC233 0.44
6AH6 0.70	6F23 0.80	10D1 0.85	25Z6G 0.60	7193 0.60	E188CC 2.50	EF89 0.35	EM120 0.55	PCF868 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX93 0.58	OC234 0.44
6AJ5 0.75	6F24 0.80	10E7 0.80	2807 2.00	7475 1.20	E280F 0.50	EF91 0.50	EM121 0.55	PCF870 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX94 0.58	OC235 0.44
6AJ8 0.35	6F25 1.00	10F1 0.75	30A5 0.75	9002 0.55	E1148 0.80	EF92 0.50	EM122 0.55	PCF872 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX95 0.58	OC236 0.44
6AK5 0.45	6F26 0.40	10F3 1.17	30C1 1.00	9006 0.45	E450 0.40	EF93 0.40	EM123 0.55	PCF874 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX96 0.58	OC237 0.44
6AK6 0.70	6F28 0.75	10F8 0.65	30C15 1.00	A1834 1.00	E476 1.50	EF94 0.40	EM124 0.55	PCF876 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX97 0.58	OC238 0.44
6AK8 0.40	6F32 1.00	10F18 0.65	30C17 0.50	A2134 3.00	E48C30 0.40	EF97 0.90	EM125 0.55	PCF878 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX98 0.58	OC239 0.44
6AL5 0.20	6G6G 0.60	10L14 0.50	30C18 1.00	A3042 6.00	EAC91 0.55	EF98 0.90	EM126 0.55	PCF880 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX99 0.58	OC240 0.44
6AM6 0.50	6GH8A 0.80	10LD1 0.75	30F5 0.75	AC2PEN 1.00	EAF42 0.70	EF183 0.40	EM127 0.55	PCF882 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX100 0.58	OC241 0.44
6AM8A 0.70	6GK5 0.75	10L13 0.45	30FL1 1.10	AC2PENDD 1.00	EAF801 0.75	EF184 0.40	EM128 0.55	PCF884 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX101 0.58	OC242 0.44
6AN8 0.70	6GU7 0.90	10P13 0.80	30FL2 1.10	AC3PEN 1.00	EB34 0.30	EF90A 1.75	EM129 0.55	PCF886 0.50	U403 0.90	U404 0.75	AC166 0.30	BF181 0.47	GEX1	

# Samson's

(ELECTRONICS) LTD.

9 & 10 CHAPEL ST., LONDON, N.W.1  
01-723 7851 01-262 5125

ADJACENT TO EDGWARE ROAD MET. LINE STATION  
PLEASE ADD 8% TO ALL ORDERS INC. CARR.

### CURRENT RANGE OF NEW L.T. TRANSFORMERS OPEN TYPE TAG CONNECTIONS ALL PRIMARIES 220-240V

Type	Sec. Taps	Amps	Price	Carr.
1	24-30-40-48-60V	12	£20.25	£2.00
2	24-30-40-48-60V	10	£19.40	£2.00
3	24-30-40-48-60V	8	£18.75	£1.50
4	24-30-40-48-60V	5	£10.24	£1.00
5	24-30-40-48-60V	3	£7.90	75p
6	24-30-40-48-60V	2	£5.53	75p

8-8-10-12-16-18-20-24-36-40-48-60V  
CAN BE OBTAINED FROM THE ABOVE RANGE

7	19-25-33-40-50V	10	£17.75	£2.00
8	19-25-33-40-50V	6	£12.00	£1.25
9	19-25-33-40-50V	3	£6.00	75p
10	19-25-33-40-50V	2	£4.95	75p

6-7-8-10-13-15-17-20-25-30-40-50V  
OR 25-0-25v or 20-0-20v CAN BE  
OBTAINED FROM THE ABOVE RANGE

11	12-15-20-25-30V	10	£10.35	£1.25
12	12-15-20-25-30V	5	£6.70	£1.00
13	12-15-20-25-30V	2	£3.75	75p

3-4-5-6-8-9-10-12-15-18-20-24V  
OR 12-0-12v or 15-0-15V CAN BE  
OBTAINED FROM THE ABOVE RANGE

14	12-24V	12V 60A 24V 30A	£17.50	£2.00
15	12-24V	12V 30A 24V 15A	£14.25	£1.50
16	12-24V	12V 20A 24V 10A	£10.75	£1.25
17	12-24V	12V 10A 24V 5A	£5.50	75p
18	12-24V	12V 4A 24V 2A	£2.95	60p

### FULLY SHROUDED TYPE TERMINAL CONNECTIONS

19	4.16-24-32V	2	£6.95	75p
20	4.16-24-32V	4	£8.65	65p
21	12-20-24V	10	£9.80	£1.00
22	12-20-24V	5	£6.50	75p
23	24-30-36V	10	£12.00	£1.25
24	24-30-36V	5	£9.50	£1.00
25	24-30-36V	2	£4.50	65p

### CENTRE TAPPED L.T. TRANSFORMERS

Fully shrouded terminal block connections. Pn 220-240V. Sec. tapped 30-25-0-25-30V 2 amps £5.95, p.p. £1. Open frame type tag connections Pn 117-220-240V. Sec 28-0-28V 3 amps. 30-0-30V 100 mA 6V 1A £3.75, p.p. 85p

### WOODEN AUTO TRANSFORMERS

3000 watts tapped 105-115-125-135-200-215-230-245-260V. Open type terminal block connections £19.60, carr. £2. In metal case with twin American 2/3 pin flush mounted sockets. 3 core 240V mains lead, carrying handle. £32.50, carr. £3

### AUTO TRANSFORMERS FOR AMERICAN EQUIPMENT

240/110V 80-3000 watts, fitted with 2.3 pin sockets, and 3 core mains lead. Send sae for price list. We have England's largest selection of American electrical accessories 2.3 pin plugs, recessed and surface type 2.3 sockets, multi-way adaptors 2.3 pin grounding adaptors Cable type sockets. Extension cords 240V Edison screw type light bulbs Industrial plugs and sockets. Let us know your requirements

### HT TRANSFORMERS

BY FAMOUS MAKER. ALL PRIMARIES 240V OPEN TYPE TAG CONNECTIONS  
Sec 350-0-350V 120 m/a, 6.3v CT 4A 5v 2A £3.78, p.p. 85p 300-0-300V 150 m/a 6.3CT 4A 5v-6.3v 2A £3.75, p.p. 85p 300-0-300V 100 m/a 6.3v 3.5A 5v 2A £3.00, p.p. 85p 250-0-250V 120 m/a 6.3v 3.5A 5v 2A £3.00, p.p. 85p C core type 250-0-250V 50 m/a 6.3v 1A 6.3v 0.7A 6.3v 0.8A £2.00, p.p. 75p  
Shrouded type: 500-0-500V 200 m/a £4.50, carr. £1 250V, 20 m/a 6.3v 1A £1, p.p. 40p

### ISOLATION TRANSFORMERS

BY FAMOUS MAKERS  
Pn 200-220-240V. Sec 240V 13 amps conservatively rated. Open type terminal block connections £38.00, carr. £2. Pn 200-220-240V. Sec 240V 700 watts Open type Cable lead connections £8.80, carr. £2. Pn 115-200-220-240V. Sec 115V 13.5 amps. Shrouded type table type connections, conservatively rated £32.50, carr. £3. Pn 200-220-240V. Sec 240V 500-110-120V 7.5 amps. Conservatively rated. Shrouded type Table top connections £19.80, carr. £3

### GARDNERS HEAVY DUTY LT TRANSFORMER

Pn 240V. Sec 50V 20A 20V conservatively rated (AERE Standard) type 9x3x7 inch. Terminal block connections £28, carr. £3

### LT TRANSFORMERS

BY FAMOUS MAKERS. ALL PRIMARIES 240V  
Sec. 6-12v 20 amps. Open type table top connections £8.50, carr. £2. 20v 20 amps. 12v 30 amps twice £17.50, carr. £3

### GARDNERS LT TRANSFORMERS 'C' CORE

Pn 110-220-230V. Sec. 5.6v CT. 28 amps. 24v 3A 6.3v 3A 5v 2A 250-0-250V 60 m/a. Table top connections £8.50, carr. £1.50 Pn 110-220-230V. Sec. 2.5v 10A. 2.5v 5A 2.5v 5A. £3.00, carr. £1

### HOWELLS 'C' CORE TRANSFORMERS

Pn 200-220V. screen Sec. 70.0-70v. 10 amp table top connections. size 7x7x7 inches. £15.00, carr. £2.00 Pn 220-240V. Sec 18-0-18v. 12.5 amps, conservatively rated Table top connections. £10.00, carr. £2.00

### A.E.I. 240V AC CONTACTORS 20AMP CONTACTS

Type	Contact	Price
0656	6M 2B	£1.50
0659	3M 1B	£1.25
0658	2M 2B	£1.25

AC 110V Types  
0651 3M 1B £1.25  
0654 2M 2B £1.25  
0653 4M £1.25  
Brand new and boxed offered at a fraction of maker's price P.P. all types 25p

### MINIATURE RELAYS PLESSEY VARLEY

52) 4 CO 75p. 52) 2 CO 60p. 280) 4 CO 60p. 430) 4 CO 60p. 430) 2 CO 50p. 1250) 4 CO 60p. Postage 10p ea. Open type size 1 1/4 x 1 1/4 ins. 6v OC 1 CO 35p. P.P. 10p

HEAT SINKS 7 1/2 x 4 1/2 ins.  
With two OC 28 or 2N 3055 either type £1, P.P. 25p

HIGH CAPACITY ELECTROLYTICS  
1600 MFD 350V DC 2500 350V DC £1.25, P.P. 25p 7100 MFD 40V DC 4500 MFD 64V DC 75p, P.P. 15p

### ITT LEVER SWITCHES

Type 801 AAO 72 42 420 contacts overall size 1 1/4 x 2 1/2 ins. White layer gold flash contacts 60p. Three for £1.50, P.P. 20p

### BENSON SOLENOIDS

AC 240V 25% duty. Approx 2 ins. 1/2 in. pull Size 2 1/2 x 1 1/2 ins. Res. 350) 75p, P.P. 25p

### COIN OPERATION TV METERS

An ideal component unit, comprising 1 1/2 v battery motor, coin mechanism, 240V 5A micro switch, gear wheels, etc. housed in bakelite case. 75p, P.P. 25p

### COMPUTER VANS AC 230V

Size 4 1/2 x 4 1/2 x 2 ins. 100 CFM. Ex-exceptional Perfect condition £3.50, P.P. 50p

### AC WKG BLOCK CAPACITORS

Dublier 1.5mld 330V AC Wkg £1.25, P.P. 25p 10mld 350V AC Wkg £1.00, P.P. 25p 5mld 300V AC Wkg 75p, P.P. 25p 4mld 650V AC Wkg £1.00, P.P. 25p 4mld 500V AC Wkg 75p, P.P. 25p T.C. 4mld 250V AC Wkg 50p, P.P. 20p 1.5mld 400V AC Wkg 75p, P.P. 20p 0.4mld 440V AC Wkg 50p, P.P. 20p Bosch 1mld 800V AC £1.00, P.P. 20p

### H.T. SMOOTHING CHOKES

Parmeko potted types 10H 180 M/A. £2.00, P.P. 50p 10H 75 M/A £1.00, P.P. 35p 50H 25 M/A £1.00, P.P. 35p. Swinging type 5H 0.02A 4H 0.25A £1.75, P.P. 50p Gardners 100H 20 M/H £1.25, P.P. 35p 20H 120 M/A £1.25, P.P. 35p 20H 80 M/A £1.00, P.P. 35p C core type 10H 350 M/A. £3.50, P.P. £1.00

### L.T. TRANSFORMERS BY FAMOUS MAKERS

Open types No 1 Pn 240. Sec. 26v 10A and 12v 0.1A £5.50. No 2 Pn 220-240V. Sec Tapped 51-61-65-67-69V 10A. £10.00, carr. £1.50. No 3 Pn 220-240V. Sec Tapped 58-53-58-74V 3A £4.75, carr. £1. No 4 Pn 117-220-240V. Sec. 28-0-28V. 3A and 30-0-30V 100M/A and 6v 1A £3.50, P.P. 75p No 5 Pn 115-230V. Sec 33v 6A and 18-0-18V 1A. £3.00, P.P. 75p. No 6 Pn 110-200-220-240V. Sec 14v 5A, 14v 2.5A, 12v 10A, 6v 10A, 24v 750M/A, 200V 500M/A. Separate windings £10.00, carr. £1.50. No 7 Pn 200-220-240V. Sec 4v 6A, 4v 3A. £3.50, P.P. 75p. No 8 Pn 110-220-235V. Sec 12v 2.2A and 12v 1A and 200V 35M/A. £2.50, P.P. 75p. No 9 Pn 200-220-240V. Sec 37v 5.5A and 37v 2A and 21v 11A. £8.50, carr. £1.50. No 10 Pn 200-220-240V. Sec 31v 7A, 26v 5A, 16v 4A, 25v 2A. Separate windings. £8.50, carr. £2.00. No 11 C core types. Pn 220-240V. Sec. 18-0-18V 21A £10.00, No 12 Pn 230V. Sec 1.25-0-1.25V 10A, £2.00, P.P. 50p. No 13 Potted types. Pn 110-220-240V. Sec 70v 1A and 30v 1A. £3.50, carr. £1. No 14 Pn 115-220-240V. Sec 43v 0.75A and 43v 0.5A and 6.3v 1A. £3.50, P.P. £1. No 15 Pn 110-220-240V. Sec 29v 7v 5A, 23v 5v, 7v 80M/A 181v 100M/A. Separate windings. £8.00, carr. £1.50. No 16 Pn 220-240V. Sec 12v 6A and 15v 6A 1.5A £4.00, carr. £1.50. No 17 Pn 220-240V. Sec. 50v 2A £3.00, P.P. 75p. No 18 Pn 110-220-240V. Sec. Tapped 4.3-5.3-6.3v. 10-11-12-22-23-24-25-26 1A and 55v 1A. £4.00, P.P. £1. No 19 Pn 200-220-240V. Sec. 6v 1A twice £2.00, P.P. 75p. No 20 Pn 200-220-240V. Sec 105v 2A, £2.00, P.P. 75p. No 21 Pn 200-220-240V. Sec Tapped 4.5v 8A £2.00, P.P. 75p. No 22 Pn 220-240V. Sec 22.25v 3.5A and 46v 45M/A. £4.50, P.P. £1

### GRESHAM L.T. TRANSFORMERS

All primaries tapped 10-0-200-220-240v open type tropicalised. Terminal block connections fraction of maker's price  
No 2 4-7-11-31-32-33-34V 20A £8.50, No 3 4-7-11-32-33-34-35V 10A £8.50, No 4 6-13-20-54-55-58-59V 5A £8.50, Carr. on all types £1. C core types, all primaries 200-220-240V. No 1 separate secs. 1v, 3v, 9v, 27v All at 15A, £12.00, No 2, 3 separate secs. 29-30-33v 15A, 23-24-26v 5A, 14-15-17v 5A £12.00, carr. £2

### HIGH VOLTAGE TRANSFORMERS

Gresham Pn 240V. Sec 200V 10 M/A 6.3v 1.5A Open type Table top connections £35.00, P.P. 50p Woden Pn 230V. Sec 890-710-0-710-890V. 120 M/A Open type T.T. connections. £37.50, P.P. 75p. Parmeko potted type. Pn 110v 220-240V. Sec 1875v 60 M/A. 6.4v 6A 5v 3A. £5.50, carr. £1

### MOTOROLA

Diodes Transistors, etc., over 3500 Pages £10.50  
CMOS over 400 Pages £1.50  
Linear i.c. over 800 Pages £2.00  
Motorola M6800 Programming Manual £3.50  
Motorola M6800 Applications Manual £7.00  
From Minicomputers to Microprocessors £1.00

### SIGNETICS

Data/Applications book, over 1800 Pages £4.00  
DMOS: 74LS: Consumer; shift registers; RAM's; PROM's 20p each

### FERRANTI

E-Line Applications 50p  
Complete range of data and applications notes available

### NO VAT THIS SECTION

### LINEAR ICs

LM301 AV Ext. comp. operational amplifier 36p  
LM307V Int. comp. operational amplifier 45p  
MC1458V Dual comp. operational amplifier 80p  
NE510A Video amplifier £1.58  
NE540L Audio power driver £1.17  
NE555V Timer 44p  
NE558A Dual 555 14 pin 95p  
NE516B Phase locked loop with A.M. demode £2.70  
NE582B Phase locked loop with V.C.O £2.70  
NE566V Phase locked loop function gen. £1.50  
PA239A Dual low noise stereo pre-amp. 95p  
PA741CV Op. amp. 42p  
PA747CA Dual op. amp. 90p  
MC1303L Dual Stereo pre-amp. £1.47  
MC1306P 1/2W audio amp. 64p  
MC1304P F.M. multiplex stereo demodulator £1.12  
MC1301P Stereo demodulator £1.92  
MC1312P £1.94  
MC1314P Quadrophonic decoder kit £3.31  
MC1315P £3.59  
MC1330P Low level video detector 67p  
MC1496G Double Balanced mixer

### MOS I.C.s

AY-5-1224 12/24 24 hour digital clock circuit £4.25  
AY-5-3510 3 1/2 digit DVM circuit £6.10  
AY-1-0212 Master tone generator £5.95  
AY-1-5051 4 stage divider £1.20  
AY-1-6721 5/5 stage divider £1.30  
AY-1-6721 6/6 stage divider £1.45  
AY-1-5050 7 stage divider £1.75  
C550 8 digit calculator chip £6.50  
C508 8 digit calculator chip £3.25  
21028 MOS 1024 bit static RAM £3.00

### FERRANTI I.C.s

ZN1040E Universal counter/display CCT £12.00  
ZN1034E Precision timer CCT £2.99  
ZN41A A.M. radio circuit £1.00  
Data and Circuits on ZN414 5p

### SPECIAL OFFERS

IN4148 Diodes 12 for 50p  
30 for £1.00  
1000 for £25.00  
O'127" Display (MANJIM) 35p  
5% Discount orders over £5.00  
10% Discount orders over £10.00  
Discount not applicable to kit or special offers

### I.C. SOCKETS

14 pin 12p 28 pin 27p  
16 pin 18p 40 pin 30p  
24 pin 26p

### CAPACITORS

Electrolytic; paper; Non polar Tant.  
Pack of 25 Mixed our choice 50p  
Metal Tant 6v - 1: 3.3; 4.7; 56; 68; 180;  
10v - 150;  
15v - 47  
20v - 0.1; 1; 39; 68  
35v - 0.47; 0.56; 0.68; 0.82; 1  
18; 27; 33; 4.7; 10; 15; 33  
50v - 3.3; 3.9; 10; 15; 22; 27; 50  
Plastic Tant 6v - 47  
Tubular 20v - 15  
35v - 2; 3; 3.3; 4.7; 6.8  
All values microfarads  
Your choice 10p each  
Pack of 20 mixed our choice £1.00  
Polyethylene - Pack of 25 mixed 50p

### RESISTORS

1/2 Watt Carbon. Mullard CR37 10 for 20p  
1/2 Watt Metal Film Weiswyn MR5 10 for 50p  
8 Watt Wirewound Weiswyn W22 37p  
12 Watt Wirewound Weiswyn W23 39p  
20 Watt Wirewound Weiswyn W24 41p  
CR37 and MR5 min. quantity any one value 10 pcs.  
E12 Series available to 1 MO except W23 and W24 up to 27k only.

### POTENTIOMETERS

Moulded Track - Panel Mounting  
Lin - 1w - 250k; 2M  
Log - 1/2w - 10k; 500k  
Min. Moulded Track Linear - Panel Mtg.  
1/4w - 22k; 100k; 220; 2M2  
Open Min. Preset 1/4w Linear  
100R; 220R; 250R; 330R; 470R; 500R; 1k; 10k; 25k; 100k; 500k; 500k; 1M.  
Sealed Min. Preset 1/4w Linear  
33k; 100R; 220R; 330R; 500R; 4k7; 5k; 8k; 22k; 25k; 50k.  
Your Choice 10p each - panel mtg; 5p each - preset  
Pack of 10 (inc. 2 panel mtg) 30p  
Wirewound helical pots (10 turn) 100R, 5k, 50p each

Mullard Transistors	BD232	£3.10	8RY39	50p	8Y128	95p
	BD233	68p	8RY50	52p	8Y164	59p
	BD234	70p	8SW67	96p	8Y182	£1.30
	BD235	80p	8SX19	32p	8Y184	41p
	BD237	80p	8SX20	42p	8Y208	18p
	BD238	80p	8SY95A	37p	8Y207	27p
	BD239	21p	8T102	£2.40	8YX10	23p
	BD240	27p	8U126	£2.00	8YX38-180	12p
	BD241	29p	8U205	£2.50	8YX38-600	17p
	BD242	63p	8U208	£3.00	8YX38-600	41p
	BD243	47p	8U208	£4.00	8YX38-800R	59p
	BD244	47p	8U210	6p	8YX48-800R	43p
	BD245	43p	8U210	44p	8YX87	7p
	BD246	23p	8F181	42p	OC28	£1.00
	BD247	10p	8F182	40p	OC70	8p
	BD248	50p	8F183	48p	OC75	8p
	BD249	69p	8F184	26p	OC171	8p
	BD250	35p	8F188	26p		
	BD251	30p	8F194	9p		
	BD252	26p	8F194B	14p	MULLARD	
	BD253	25p	8F196	13p		
	BD254	13p	8F196	12p	DIODES	
	BD255	32p	8F197	30p	- 12 1/2% VAT	- 12 1/2% VAT
	BD256	30p	8F200	13p		
	BD257	42p	8F241	20p	AA119	11p
	BD258	9p	8F241	27p	AA215	13p
	BD259	9p	8F262	56p	AA213	10p
	BD260					




<h3>TTLs by TEXAS</h3> <table border="1"> <tr><td>7400</td><td>13p</td><td>7482</td><td>70p</td></tr> <tr><td>7400</td><td>20p</td><td>7483</td><td>80p</td></tr> <tr><td>7401</td><td>14p</td><td>7484</td><td>95p</td></tr> <tr><td>7402</td><td>14p</td><td>7485</td><td>120p</td></tr> <tr><td>7403</td><td>16p</td><td>7486</td><td>30p</td></tr> <tr><td>7404</td><td>16p</td><td>7489</td><td>270p</td></tr> <tr><td>74H04</td><td>22p</td><td>7490</td><td>40p</td></tr> <tr><td>7405</td><td>16p</td><td>7491</td><td>75p</td></tr> <tr><td>7406</td><td>38p</td><td>7492</td><td>45p</td></tr> <tr><td>7407</td><td>36p</td><td>7493</td><td>40p</td></tr> <tr><td>7408</td><td>16p</td><td>7494</td><td>75p</td></tr> <tr><td>7409</td><td>20p</td><td>7495</td><td>65p</td></tr> <tr><td>7410</td><td>13p</td><td>7496</td><td>78p</td></tr> <tr><td>74H10</td><td>20p</td><td>7497</td><td>270p</td></tr> <tr><td>7411</td><td>22p</td><td>74100</td><td>108p</td></tr> <tr><td>7412</td><td>23p</td><td>74107</td><td>30p</td></tr> <tr><td>7413</td><td>32p</td><td>74110</td><td>40p</td></tr> <tr><td>7414</td><td>60p</td><td>74118</td><td>84p</td></tr> <tr><td>7416</td><td>33p</td><td>74121</td><td>30p</td></tr> <tr><td>7417</td><td>30p</td><td>74122</td><td>46p</td></tr> <tr><td>7420</td><td>14p</td><td>74123</td><td>68p</td></tr> <tr><td>7421</td><td>40p</td><td>74126</td><td>70p</td></tr> <tr><td>7422</td><td>18p</td><td>74132</td><td>70p</td></tr> <tr><td>7423</td><td>34p</td><td>74136</td><td>75p</td></tr> <tr><td>7425</td><td>30p</td><td>74141</td><td>65p</td></tr> <tr><td>7427</td><td>37p</td><td>74145</td><td>70p</td></tr> <tr><td>7428</td><td>36p</td><td>74148</td><td>160p</td></tr> <tr><td>7430</td><td>14p</td><td>74150</td><td>125p</td></tr> <tr><td>7432</td><td>25p</td><td>74151</td><td>72p</td></tr> <tr><td>7437</td><td>25p</td><td>74153</td><td>85p</td></tr> <tr><td>7440</td><td>14p</td><td>74154</td><td>150p</td></tr> <tr><td>7441</td><td>65p</td><td>74155</td><td>76p</td></tr> <tr><td>7442</td><td>60p</td><td>74156</td><td>76p</td></tr> <tr><td>7443</td><td>140p</td><td>74160</td><td>99p</td></tr> <tr><td>7444</td><td>140p</td><td>74161</td><td>99p</td></tr> <tr><td>7445</td><td>90p</td><td>74162</td><td>99p</td></tr> <tr><td>7446</td><td>90p</td><td>74163</td><td>99p</td></tr> <tr><td>7447</td><td>75p</td><td>74164</td><td>120p</td></tr> <tr><td>7448</td><td>70p</td><td>74166</td><td>126p</td></tr> <tr><td>7450</td><td>15p</td><td>74174</td><td>120p</td></tr> <tr><td>7451</td><td>16p</td><td>74175</td><td>85p</td></tr> <tr><td>7453</td><td>16p</td><td>74176</td><td>120p</td></tr> <tr><td>7454</td><td>16p</td><td>74177</td><td>100p</td></tr> <tr><td>7460</td><td>15p</td><td>74180</td><td>100p</td></tr> <tr><td>7470</td><td>27p</td><td>74181</td><td>298p</td></tr> <tr><td>7472</td><td>25p</td><td>74182</td><td>82p</td></tr> <tr><td>7473</td><td>30p</td><td>74185</td><td>135p</td></tr> <tr><td>7474</td><td>30p</td><td>74190</td><td>144p</td></tr> <tr><td>7475</td><td>45p</td><td>74191</td><td>144p</td></tr> <tr><td>7476</td><td>30p</td><td>74192</td><td>120p</td></tr> <tr><td>7480</td><td>50p</td><td>74193</td><td>120p</td></tr> <tr><td>7481</td><td>95p</td><td>74194</td><td>108p</td></tr> </table>		7400	13p	7482	70p	7400	20p	7483	80p	7401	14p	7484	95p	7402	14p	7485	120p	7403	16p	7486	30p	7404	16p	7489	270p	74H04	22p	7490	40p	7405	16p	7491	75p	7406	38p	7492	45p	7407	36p	7493	40p	7408	16p	7494	75p	7409	20p	7495	65p	7410	13p	7496	78p	74H10	20p	7497	270p	7411	22p	74100	108p	7412	23p	74107	30p	7413	32p	74110	40p	7414	60p	74118	84p	7416	33p	74121	30p	7417	30p	74122	46p	7420	14p	74123	68p	7421	40p	74126	70p	7422	18p	74132	70p	7423	34p	74136	75p	7425	30p	74141	65p	7427	37p	74145	70p	7428	36p	74148	160p	7430	14p	74150	125p	7432	25p	74151	72p	7437	25p	74153	85p	7440	14p	74154	150p	7441	65p	74155	76p	7442	60p	74156	76p	7443	140p	74160	99p	7444	140p	74161	99p	7445	90p	74162	99p	7446	90p	74163	99p	7447	75p	74164	120p	7448	70p	74166	126p	7450	15p	74174	120p	7451	16p	74175	85p	7453	16p	74176	120p	7454	16p	74177	100p	7460	15p	74180	100p	7470	27p	74181	298p	7472	25p	74182	82p	7473	30p	74185	135p	7474	30p	74190	144p	7475	45p	74191	144p	7476	30p	74192	120p	7480	50p	74193	120p	7481	95p	74194	108p	<h3>74195 75p</h3> <p>74196 100p 74197 100p 74198 198p 74199 180p</p> <h3>C-MOS I.C.s</h3> <table border="1"> <tr><td>CD4000AE</td><td>16p</td></tr> <tr><td>CD4001AE</td><td>16p</td></tr> <tr><td>CD4002AE</td><td>16p</td></tr> <tr><td>CD4007AE</td><td>16p</td></tr> <tr><td>CD4009AE</td><td>67p</td></tr> <tr><td>CD4011AE</td><td>16p</td></tr> <tr><td>CD4012AE</td><td>16p</td></tr> <tr><td>CD4013AE</td><td>55p</td></tr> <tr><td>CD4016AE</td><td>50p</td></tr> <tr><td>CD4017AE</td><td>120p</td></tr> <tr><td>CD4018AE</td><td>175p</td></tr> <tr><td>CD4020AE</td><td>250p</td></tr> <tr><td>CD4022AE</td><td>170p</td></tr> <tr><td>CD4023AE</td><td>19p</td></tr> <tr><td>CD4024AE</td><td>120p</td></tr> <tr><td>CD4025AE</td><td>19p</td></tr> <tr><td>CD4026AE</td><td>196p</td></tr> <tr><td>CD4027AE</td><td>75p</td></tr> <tr><td>CD4028AE</td><td>140p</td></tr> <tr><td>CD4029AE</td><td>175p</td></tr> <tr><td>CD4030AE</td><td>55p</td></tr> <tr><td>CD4042AE</td><td>137p</td></tr> <tr><td>CD4043AE</td><td>202p</td></tr> <tr><td>CD4046AE</td><td>140p</td></tr> <tr><td>CD4047AE</td><td>154p</td></tr> <tr><td>CD4049AE</td><td>63p</td></tr> <tr><td>CD4054AE</td><td>196p</td></tr> <tr><td>CD4055AE</td><td>196p</td></tr> <tr><td>CD4056AE</td><td>135p</td></tr> <tr><td>CD4060AE</td><td>229p</td></tr> <tr><td>CD4069AE</td><td>37p</td></tr> <tr><td>CD4071AE</td><td>27p</td></tr> <tr><td>CD4072AE</td><td>27p</td></tr> <tr><td>CD4081AE</td><td>19p</td></tr> <tr><td>CD4082AE</td><td>27p</td></tr> <tr><td>CD4510AE</td><td>130p</td></tr> <tr><td>CD4511AE</td><td>200p</td></tr> <tr><td>CD4518AE</td><td>100p</td></tr> <tr><td>CD4528AE</td><td>120p</td></tr> </table>		CD4000AE	16p	CD4001AE	16p	CD4002AE	16p	CD4007AE	16p	CD4009AE	67p	CD4011AE	16p	CD4012AE	16p	CD4013AE	55p	CD4016AE	50p	CD4017AE	120p	CD4018AE	175p	CD4020AE	250p	CD4022AE	170p	CD4023AE	19p	CD4024AE	120p	CD4025AE	19p	CD4026AE	196p	CD4027AE	75p	CD4028AE	140p	CD4029AE	175p	CD4030AE	55p	CD4042AE	137p	CD4043AE	202p	CD4046AE	140p	CD4047AE	154p	CD4049AE	63p	CD4054AE	196p	CD4055AE	196p	CD4056AE	135p	CD4060AE	229p	CD4069AE	37p	CD4071AE	27p	CD4072AE	27p	CD4081AE	19p	CD4082AE	27p	CD4510AE	130p	CD4511AE	200p	CD4518AE	100p	CD4528AE	120p	<h3>OP. AMPS</h3> <table border="1"> <tr><td>1458</td><td>Dual Op. Amp Int. Comp</td><td>8 pin DIL</td><td>70p</td></tr> <tr><td>301A</td><td>Ext. Comp</td><td>8 pin DIL</td><td>35p</td></tr> <tr><td>3130</td><td>COSMOS/BI-Polar MosFet</td><td>8 pin DIL</td><td>100p</td></tr> <tr><td>3900</td><td>Quad. Op. Amp</td><td>14 pin DIL</td><td>70p</td></tr> <tr><td>536T</td><td>FET Op. Amp.</td><td>TO-99</td><td>275p</td></tr> <tr><td>709</td><td>Ext. Comp</td><td>8/14 pin DIL</td><td>30p</td></tr> <tr><td>741</td><td>Int. Comp</td><td>8/14 pin DIL</td><td>22p</td></tr> <tr><td>747</td><td>Dual 741</td><td>14 pin DIL</td><td>70p</td></tr> <tr><td>748</td><td>Ext. Comp</td><td>8/14 pin DIL</td><td>35p</td></tr> <tr><td>776</td><td>Programmable Op. Amp.</td><td>TO-5</td><td>140p</td></tr> </table>		1458	Dual Op. Amp Int. Comp	8 pin DIL	70p	301A	Ext. Comp	8 pin DIL	35p	3130	COSMOS/BI-Polar MosFet	8 pin DIL	100p	3900	Quad. Op. Amp	14 pin DIL	70p	536T	FET Op. Amp.	TO-99	275p	709	Ext. Comp	8/14 pin DIL	30p	741	Int. Comp	8/14 pin DIL	22p	747	Dual 741	14 pin DIL	70p	748	Ext. Comp	8/14 pin DIL	35p	776	Programmable Op. Amp.	TO-5	140p	<h3>TRANSISTORS</h3> <table border="1"> <tr><td>AC125</td><td>16p</td><td>BFY52</td><td>16p</td><td>2N3442</td><td>140p</td></tr> <tr><td>AC126</td><td>12p</td><td>BRV39</td><td>34p</td><td>*2N3702</td><td>11p</td></tr> <tr><td>AC127</td><td>12p</td><td>BSX19</td><td>18p</td><td>*2N3703</td><td>11p</td></tr> <tr><td>AC128</td><td>11p</td><td>BSX20</td><td>20p</td><td>*2N3704</td><td>11p</td></tr> <tr><td>AC141</td><td>18p</td><td>*BU105</td><td>140p</td><td>*2N3705</td><td>11p</td></tr> <tr><td>AC142</td><td>18p</td><td>BU108</td><td>250p</td><td>*2N3706</td><td>10p</td></tr> <tr><td>AC176</td><td>11p</td><td>*MJE304</td><td>45p</td><td>*2N3707</td><td>11p</td></tr> <tr><td>AC187</td><td>13p</td><td>MJ2955</td><td>75p</td><td>*2N3708</td><td>9p</td></tr> <tr><td>AC188</td><td>12p</td><td>MJE2955</td><td>99p</td><td>*2N3709</td><td>9p</td></tr> <tr><td>AD149</td><td>43p</td><td>MJE3055</td><td>65p</td><td>*2N3773</td><td>22p</td></tr> <tr><td>AD151</td><td>36p</td><td>*MPS6534</td><td>181p</td><td>*2N3886</td><td>90p</td></tr> <tr><td>AL162</td><td>36p</td><td>*MPSA06</td><td>30p</td><td>*2N3903</td><td>18p</td></tr> <tr><td>AF114</td><td>18p</td><td>*MPSA12</td><td>50p</td><td>*2N3904</td><td>16p</td></tr> <tr><td>AF115</td><td>18p</td><td>*MPSA56</td><td>32p</td><td>*2N3905</td><td>18p</td></tr> <tr><td>AF116</td><td>18p</td><td>*MPSU06</td><td>62p</td><td>*2N3906</td><td>16p</td></tr> <tr><td>AF117</td><td>18p</td><td>*MPSU56</td><td>78p</td><td>*2N4058</td><td>13p</td></tr> <tr><td>AF139</td><td>33p</td><td>OC28</td><td>65p</td><td>*2N4059</td><td>10p</td></tr> <tr><td>BF129</td><td>45p</td><td>OC35</td><td>55p</td><td>*2N4060</td><td>13p</td></tr> <tr><td>BC107</td><td>9p</td><td>OC36</td><td>60p</td><td>*2N4123</td><td>18p</td></tr> <tr><td>BC108</td><td>9p</td><td>*OC71</td><td>20p</td><td>*2N4124</td><td>18p</td></tr> <tr><td>BC109</td><td>10p</td><td>*TIP29A</td><td>40p</td><td>*2N4125</td><td>18p</td></tr> <tr><td>BC109C</td><td>12p</td><td>*TIP29C</td><td>55p</td><td>*2N4126</td><td>18p</td></tr> <tr><td>*BC117</td><td>22p</td><td>*TIP30A</td><td>48p</td><td>*2N4789</td><td>20p</td></tr> <tr><td>*BC147</td><td>7p</td><td>*TIP30C</td><td>60p</td><td>*2N3437</td><td>130p</td></tr> <tr><td>*BC148</td><td>7p</td><td>TIP31A</td><td>52p</td><td>2N4348</td><td>160p</td></tr> <tr><td>*BC149C</td><td>8p</td><td>TIP31C</td><td>70p</td><td>*2N4401</td><td>27p</td></tr> <tr><td>*BC157</td><td>11p</td><td>TIP32A</td><td>58p</td><td>*2N4403</td><td>27p</td></tr> <tr><td>*BC158</td><td>10p</td><td>TIP32C</td><td>82p</td><td>*2N5089</td><td>27p</td></tr> <tr><td>*BC159</td><td>11p</td><td>TIP33A</td><td>90p</td><td>*2N5401</td><td>50p</td></tr> <tr><td>*BC169C</td><td>15p</td><td>TIP33C</td><td>115p</td><td>40380</td><td>40p</td></tr> <tr><td>BC177</td><td>18p</td><td>TIP34A</td><td>115p</td><td>40361</td><td>38p</td></tr> <tr><td>BC178</td><td>17p</td><td>TIP34C</td><td>160p</td><td>40362</td><td>40p</td></tr> <tr><td>BC179</td><td>18p</td><td>TIP35A</td><td>225p</td><td>40364</td><td>120p</td></tr> <tr><td>*BC182</td><td>10p</td><td>TIP35C</td><td>290p</td><td>40409</td><td>55p</td></tr> <tr><td>*BC183</td><td>10p</td><td>TIP36A</td><td>270p</td><td>40410</td><td>55p</td></tr> <tr><td>*BC184</td><td>10p</td><td>TIP36C</td><td>340p</td><td>40411</td><td>225p</td></tr> <tr><td>BC187</td><td>30p</td><td>TIP41A</td><td>65p</td><td>40594</td><td>75p</td></tr> <tr><td>*BC212</td><td>11p</td><td>TIP41C</td><td>75p</td><td>40595</td><td>85p</td></tr> <tr><td>*BC213</td><td>10p</td><td>TIP42A</td><td>70p</td><td></td><td></td></tr> <tr><td>*BC214</td><td>14p</td><td>TIP42C</td><td>82p</td><td></td><td></td></tr> <tr><td>BC478</td><td>30p</td><td>TIP2955</td><td>70p</td><td></td><td></td></tr> <tr><td>BCY70</td><td>18p</td><td>*ZX108</td><td>10p</td><td></td><td></td></tr> <tr><td>BCY71</td><td>22p</td><td>*ZX300</td><td>13p</td><td></td><td></td></tr> <tr><td>BD124</td><td>65p</td><td>*ZX500</td><td>15p</td><td></td><td></td></tr> <tr><td>BD131</td><td>36p</td><td>*ZX502</td><td>18p</td><td></td><td></td></tr> <tr><td>BD132</td><td>40p</td><td>*2N697</td><td>13p</td><td></td><td></td></tr> <tr><td>*BD135</td><td>43p</td><td>*2N698</td><td>30p</td><td></td><td></td></tr> <tr><td>*BD139</td><td>63p</td><td>*2N706</td><td>16p</td><td></td><td></td></tr> <tr><td>*BD140</td><td>70p</td><td>*2N708</td><td>18p</td><td></td><td></td></tr> <tr><td>BF115</td><td>22p</td><td>*2N918</td><td>40p</td><td></td><td></td></tr> <tr><td>BF167</td><td>23p</td><td>*2N930</td><td>18p</td><td></td><td></td></tr> <tr><td>BF170</td><td>23p</td><td>*2N1131</td><td>18p</td><td></td><td></td></tr> <tr><td>BF173</td><td>25p</td><td>*2N1132</td><td>18p</td><td></td><td></td></tr> <tr><td>BF177</td><td>26p</td><td>*2N1304</td><td>32p</td><td></td><td></td></tr> <tr><td>BF178</td><td>28p</td><td>*2N305</td><td>32p</td><td></td><td></td></tr> <tr><td>BF179</td><td>33p</td><td>*2N306</td><td>36p</td><td></td><td></td></tr> <tr><td>BF180</td><td>33p</td><td>*2N307</td><td>36p</td><td></td><td></td></tr> <tr><td>BF184</td><td>22p</td><td>*2N308</td><td>36p</td><td></td><td></td></tr> <tr><td>*BF194</td><td>10p</td><td>*2N309</td><td>36p</td><td></td><td></td></tr> <tr><td>*BF195</td><td>9p</td><td>*2N313</td><td>20p</td><td></td><td></td></tr> <tr><td>*BF196</td><td>14p</td><td>*2N721</td><td>20p</td><td></td><td></td></tr> <tr><td>*BF197</td><td>15p</td><td>*2N893</td><td>30p</td><td></td><td></td></tr> <tr><td>BF200</td><td>32p</td><td>*2N219</td><td>20p</td><td></td><td></td></tr> <tr><td>BF257</td><td>32p</td><td>*2N222</td><td>20p</td><td></td><td></td></tr> <tr><td>BF258</td><td>36p</td><td>*2N2369</td><td>14p</td><td></td><td></td></tr> <tr><td>*BF39</td><td>30p</td><td>*2N2484</td><td>30p</td><td></td><td></td></tr> <tr><td>*BF40</td><td>30p</td><td>*2N2361</td><td>20p</td><td></td><td></td></tr> <tr><td>*BF49</td><td>30p</td><td>*2N2905</td><td>20p</td><td></td><td></td></tr> <tr><td>*BF80</td><td>30p</td><td>*2N2906</td><td>20p</td><td></td><td></td></tr> <tr><td>*BF88</td><td>30p</td><td>*2N2926R</td><td>7p</td><td></td><td></td></tr> <tr><td>BFX30</td><td>30p</td><td>*2N2926E</td><td>7p</td><td></td><td></td></tr> <tr><td>BFX84</td><td>26p</td><td>*2N2926Q</td><td>8p</td><td></td><td></td></tr> <tr><td>BFX85</td><td>25p</td><td>*2N2926Y</td><td>9p</td><td></td><td></td></tr> <tr><td>BFX86</td><td>25p</td><td>*2N2926G</td><td>9p</td><td></td><td></td></tr> <tr><td>BFX87</td><td>20p</td><td>*2N3053</td><td>18p</td><td></td><td></td></tr> <tr><td>BFX88</td><td>24p</td><td>*2N3054</td><td>45p</td><td></td><td></td></tr> <tr><td>BFY50</td><td>16p</td><td>*2N3055</td><td>50p</td><td></td><td></td></tr> <tr><td>BFY51</td><td>15p</td><td>*2N3439</td><td>67p</td><td></td><td></td></tr> </table>		AC125	16p	BFY52	16p	2N3442	140p	AC126	12p	BRV39	34p	*2N3702	11p	AC127	12p	BSX19	18p	*2N3703	11p	AC128	11p	BSX20	20p	*2N3704	11p	AC141	18p	*BU105	140p	*2N3705	11p	AC142	18p	BU108	250p	*2N3706	10p	AC176	11p	*MJE304	45p	*2N3707	11p	AC187	13p	MJ2955	75p	*2N3708	9p	AC188	12p	MJE2955	99p	*2N3709	9p	AD149	43p	MJE3055	65p	*2N3773	22p	AD151	36p	*MPS6534	181p	*2N3886	90p	AL162	36p	*MPSA06	30p	*2N3903	18p	AF114	18p	*MPSA12	50p	*2N3904	16p	AF115	18p	*MPSA56	32p	*2N3905	18p	AF116	18p	*MPSU06	62p	*2N3906	16p	AF117	18p	*MPSU56	78p	*2N4058	13p	AF139	33p	OC28	65p	*2N4059	10p	BF129	45p	OC35	55p	*2N4060	13p	BC107	9p	OC36	60p	*2N4123	18p	BC108	9p	*OC71	20p	*2N4124	18p	BC109	10p	*TIP29A	40p	*2N4125	18p	BC109C	12p	*TIP29C	55p	*2N4126	18p	*BC117	22p	*TIP30A	48p	*2N4789	20p	*BC147	7p	*TIP30C	60p	*2N3437	130p	*BC148	7p	TIP31A	52p	2N4348	160p	*BC149C	8p	TIP31C	70p	*2N4401	27p	*BC157	11p	TIP32A	58p	*2N4403	27p	*BC158	10p	TIP32C	82p	*2N5089	27p	*BC159	11p	TIP33A	90p	*2N5401	50p	*BC169C	15p	TIP33C	115p	40380	40p	BC177	18p	TIP34A	115p	40361	38p	BC178	17p	TIP34C	160p	40362	40p	BC179	18p	TIP35A	225p	40364	120p	*BC182	10p	TIP35C	290p	40409	55p	*BC183	10p	TIP36A	270p	40410	55p	*BC184	10p	TIP36C	340p	40411	225p	BC187	30p	TIP41A	65p	40594	75p	*BC212	11p	TIP41C	75p	40595	85p	*BC213	10p	TIP42A	70p			*BC214	14p	TIP42C	82p			BC478	30p	TIP2955	70p			BCY70	18p	*ZX108	10p			BCY71	22p	*ZX300	13p			BD124	65p	*ZX500	15p			BD131	36p	*ZX502	18p			BD132	40p	*2N697	13p			*BD135	43p	*2N698	30p			*BD139	63p	*2N706	16p			*BD140	70p	*2N708	18p			BF115	22p	*2N918	40p			BF167	23p	*2N930	18p			BF170	23p	*2N1131	18p			BF173	25p	*2N1132	18p			BF177	26p	*2N1304	32p			BF178	28p	*2N305	32p			BF179	33p	*2N306	36p			BF180	33p	*2N307	36p			BF184	22p	*2N308	36p			*BF194	10p	*2N309	36p			*BF195	9p	*2N313	20p			*BF196	14p	*2N721	20p			*BF197	15p	*2N893	30p			BF200	32p	*2N219	20p			BF257	32p	*2N222	20p			BF258	36p	*2N2369	14p			*BF39	30p	*2N2484	30p			*BF40	30p	*2N2361	20p			*BF49	30p	*2N2905	20p			*BF80	30p	*2N2906	20p			*BF88	30p	*2N2926R	7p			BFX30	30p	*2N2926E	7p			BFX84	26p	*2N2926Q	8p			BFX85	25p	*2N2926Y	9p			BFX86	25p	*2N2926G	9p			BFX87	20p	*2N3053	18p			BFX88	24p	*2N3054	45p			BFY50	16p	*2N3055	50p			BFY51	15p	*2N3439	67p			<h3>DIODES</h3> <p><b>SIGNAL</b></p> <table border="1"> <tr><td>0A07</td><td>7p</td></tr> <tr><td>0A70</td><td>9p</td></tr> <tr><td>0A81</td><td>8p</td></tr> <tr><td>0A85</td><td>10p</td></tr> <tr><td>0A90</td><td>7p</td></tr> <tr><td>0A91</td><td>8p</td></tr> <tr><td>0A95</td><td>7p</td></tr> <tr><td>0A200</td><td>8p</td></tr> <tr><td>0A202</td><td>10p</td></tr> <tr><td>IN914</td><td>4p</td></tr> <tr><td>IN916</td><td>4p</td></tr> <tr><td>IN4148</td><td>4p</td></tr> </table> <p><b>RECTIFIER</b></p> <table border="1"> <tr><td>*BY126</td><td>25p</td></tr> <tr><td>*BY127</td><td>12p</td></tr> <tr><td>IN4001</td><td>5p</td></tr> <tr><td>IN4002</td><td>5p</td></tr> <tr><td>IN4004</td><td>6p</td></tr> <tr><td>IN4005</td><td>6p</td></tr> <tr><td>IN4007</td><td>7p</td></tr> </table> <p><b>ZENER</b></p> <table border="1"> <tr><td>2.7v to 33v*</td><td>9p</td></tr> <tr><td>*400mW</td><td>9p</td></tr> <tr><td>*1W</td><td>18p</td></tr> </table> <p><b>TUNNEL</b></p> <table border="1"> <tr><td>AEEY11</td><td>70p</td></tr> </table> <p><b>VARICAP</b></p> <table border="1"> <tr><td>*BB105</td><td>25p</td></tr> </table> <p><b>NOISE</b></p> <table border="1"> <tr><td>*25J</td><td>110p</td></tr> </table> <p><b>BRIDGE RECTIFIERS</b></p> <table border="1"> <tr><td>*25A100V</td><td>20p</td></tr> <tr><td>*1A 50V</td><td>20p</td></tr> <tr><td>*1A 100V</td><td>22p</td></tr> <tr><td>*1A 200V</td><td>24p</td></tr> <tr><td>*1A 400V</td><td>25p</td></tr> <tr><td>*2A 50V</td><td>30p</td></tr> <tr><td>*2A 100V</td><td>35p</td></tr> <tr><td>*2A 200V</td><td>40p</td></tr> <tr><td>*2A 300V</td><td>45p</td></tr> <tr><td>*4A 100V</td><td>60p</td></tr> <tr><td>6A 50V</td><td>65p</td></tr> <tr><td>6A 100V</td><td>72p</td></tr> <tr><td>6A 200V</td><td>78p</td></tr> <tr><td>6A 400V</td><td>84p</td></tr> </table> <p><b>TRIACS</b></p> <table border="1"> <tr><td>Amp Volts</td><td></td></tr> <tr><td>3 400</td><td>120p</td></tr> <tr><td>6 400</td><td>150p</td></tr> <tr><td>6 500</td><td>180p</td></tr> <tr><td>10 400</td><td>185p</td></tr> <tr><td>10 500</td><td>195p</td></tr> <tr><td>15 400</td><td>210p</td></tr> <tr><td>15 500</td><td>250p</td></tr> <tr><td>40A30</td><td>95p</td></tr> <tr><td>40B66</td><td>95p</td></tr> <tr><td>40B69</td><td>95p</td></tr> <tr><td>DIAC</td><td></td></tr> <tr><td>BR100</td><td>25p</td></tr> </table>		0A07	7p	0A70	9p	0A81	8p	0A85	10p	0A90	7p	0A91	8p	0A95	7p	0A200	8p	0A202	10p	IN914	4p	IN916	4p	IN4148	4p	*BY126	25p	*BY127	12p	IN4001	5p	IN4002	5p	IN4004	6p	IN4005	6p	IN4007	7p	2.7v to 33v*	9p	*400mW	9p	*1W	18p	AEEY11	70p	*BB105	25p	*25J	110p	*25A100V	20p	*1A 50V	20p	*1A 100V	22p	*1A 200V	24p	*1A 400V	25p	*2A 50V	30p	*2A 100V	35p	*2A 200V	40p	*2A 300V	45p	*4A 100V	60p	6A 50V	65p	6A 100V	72p	6A 200V	78p	6A 400V	84p	Amp Volts		3 400	120p	6 400	150p	6 500	180p	10 400	185p	10 500	195p	15 400	210p	15 500	250p	40A30	95p	40B66	95p	40B69	95p	DIAC		BR100	25p
7400	13p	7482	70p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7400	20p	7483	80p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7401	14p	7484	95p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7402	14p	7485	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7403	16p	7486	30p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7404	16p	7489	270p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
74H04	22p	7490	40p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7405	16p	7491	75p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7406	38p	7492	45p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7407	36p	7493	40p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7408	16p	7494	75p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7409	20p	7495	65p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7410	13p	7496	78p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
74H10	20p	7497	270p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7411	22p	74100	108p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7412	23p	74107	30p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7413	32p	74110	40p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7414	60p	74118	84p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7416	33p	74121	30p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7417	30p	74122	46p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7420	14p	74123	68p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7421	40p	74126	70p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7422	18p	74132	70p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7423	34p	74136	75p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7425	30p	74141	65p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7427	37p	74145	70p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7428	36p	74148	160p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7430	14p	74150	125p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7432	25p	74151	72p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7437	25p	74153	85p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7440	14p	74154	150p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7441	65p	74155	76p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7442	60p	74156	76p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7443	140p	74160	99p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7444	140p	74161	99p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7445	90p	74162	99p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7446	90p	74163	99p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7447	75p	74164	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7448	70p	74166	126p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7450	15p	74174	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7451	16p	74175	85p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7453	16p	74176	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7454	16p	74177	100p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7460	15p	74180	100p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7470	27p	74181	298p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7472	25p	74182	82p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7473	30p	74185	135p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7474	30p	74190	144p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7475	45p	74191	144p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7476	30p	74192	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7480	50p	74193	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7481	95p	74194	108p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
CD4000AE	16p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4001AE	16p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4002AE	16p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4007AE	16p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4009AE	67p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4011AE	16p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4012AE	16p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4013AE	55p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4016AE	50p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4017AE	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4018AE	175p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4020AE	250p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4022AE	170p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4023AE	19p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4024AE	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4025AE	19p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4026AE	196p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4027AE	75p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4028AE	140p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4029AE	175p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4030AE	55p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4042AE	137p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4043AE	202p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4046AE	140p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4047AE	154p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4049AE	63p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4054AE	196p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4055AE	196p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4056AE	135p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4060AE	229p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4069AE	37p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4071AE	27p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4072AE	27p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4081AE	19p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4082AE	27p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4510AE	130p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4511AE	200p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4518AE	100p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CD4528AE	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1458	Dual Op. Amp Int. Comp	8 pin DIL	70p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
301A	Ext. Comp	8 pin DIL	35p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
3130	COSMOS/BI-Polar MosFet	8 pin DIL	100p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
3900	Quad. Op. Amp	14 pin DIL	70p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
536T	FET Op. Amp.	TO-99	275p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
709	Ext. Comp	8/14 pin DIL	30p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
741	Int. Comp	8/14 pin DIL	22p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
747	Dual 741	14 pin DIL	70p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
748	Ext. Comp	8/14 pin DIL	35p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
776	Programmable Op. Amp.	TO-5	140p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
AC125	16p	BFY52	16p	2N3442	140p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AC126	12p	BRV39	34p	*2N3702	11p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AC127	12p	BSX19	18p	*2N3703	11p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AC128	11p	BSX20	20p	*2N3704	11p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AC141	18p	*BU105	140p	*2N3705	11p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AC142	18p	BU108	250p	*2N3706	10p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AC176	11p	*MJE304	45p	*2N3707	11p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AC187	13p	MJ2955	75p	*2N3708	9p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AC188	12p	MJE2955	99p	*2N3709	9p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AD149	43p	MJE3055	65p	*2N3773	22p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AD151	36p	*MPS6534	181p	*2N3886	90p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AL162	36p	*MPSA06	30p	*2N3903	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AF114	18p	*MPSA12	50p	*2N3904	16p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AF115	18p	*MPSA56	32p	*2N3905	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AF116	18p	*MPSU06	62p	*2N3906	16p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AF117	18p	*MPSU56	78p	*2N4058	13p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
AF139	33p	OC28	65p	*2N4059	10p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
BF129	45p	OC35	55p	*2N4060	13p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
BC107	9p	OC36	60p	*2N4123	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
BC108	9p	*OC71	20p	*2N4124	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
BC109	10p	*TIP29A	40p	*2N4125	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
BC109C	12p	*TIP29C	55p	*2N4126	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC117	22p	*TIP30A	48p	*2N4789	20p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC147	7p	*TIP30C	60p	*2N3437	130p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC148	7p	TIP31A	52p	2N4348	160p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC149C	8p	TIP31C	70p	*2N4401	27p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC157	11p	TIP32A	58p	*2N4403	27p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC158	10p	TIP32C	82p	*2N5089	27p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC159	11p	TIP33A	90p	*2N5401	50p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC169C	15p	TIP33C	115p	40380	40p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
BC177	18p	TIP34A	115p	40361	38p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
BC178	17p	TIP34C	160p	40362	40p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
BC179	18p	TIP35A	225p	40364	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC182	10p	TIP35C	290p	40409	55p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC183	10p	TIP36A	270p	40410	55p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC184	10p	TIP36C	340p	40411	225p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
BC187	30p	TIP41A	65p	40594	75p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC212	11p	TIP41C	75p	40595	85p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
*BC213	10p	TIP42A	70p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BC214	14p	TIP42C	82p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BC478	30p	TIP2955	70p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BCY70	18p	*ZX108	10p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BCY71	22p	*ZX300	13p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BD124	65p	*ZX500	15p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BD131	36p	*ZX502	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BD132	40p	*2N697	13p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BD135	43p	*2N698	30p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BD139	63p	*2N706	16p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BD140	70p	*2N708	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF115	22p	*2N918	40p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF167	23p	*2N930	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF170	23p	*2N1131	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF173	25p	*2N1132	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF177	26p	*2N1304	32p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF178	28p	*2N305	32p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF179	33p	*2N306	36p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF180	33p	*2N307	36p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF184	22p	*2N308	36p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BF194	10p	*2N309	36p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BF195	9p	*2N313	20p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BF196	14p	*2N721	20p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BF197	15p	*2N893	30p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF200	32p	*2N219	20p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF257	32p	*2N222	20p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BF258	36p	*2N2369	14p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BF39	30p	*2N2484	30p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BF40	30p	*2N2361	20p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BF49	30p	*2N2905	20p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BF80	30p	*2N2906	20p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
*BF88	30p	*2N2926R	7p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BFX30	30p	*2N2926E	7p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BFX84	26p	*2N2926Q	8p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BFX85	25p	*2N2926Y	9p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BFX86	25p	*2N2926G	9p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BFX87	20p	*2N3053	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BFX88	24p	*2N3054	45p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BFY50	16p	*2N3055	50p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
BFY51	15p	*2N3439	67p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
0A07	7p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0A70	9p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0A81	8p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0A85	10p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0A90	7p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0A91	8p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0A95	7p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0A200	8p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0A202	10p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
IN914	4p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
IN916	4p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
IN4148	4p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*BY126	25p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*BY127	12p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
IN4001	5p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
IN4002	5p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
IN4004	6p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
IN4005	6p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
IN4007	7p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
2.7v to 33v*	9p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*400mW	9p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*1W	18p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
AEEY11	70p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*BB105	25p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*25J	110p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*25A100V	20p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*1A 50V	20p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*1A 100V	22p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*1A 200V	24p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*1A 400V	25p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*2A 50V	30p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*2A 100V	35p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*2A 200V	40p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*2A 300V	45p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
*4A 100V	60p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
6A 50V	65p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
6A 100V	72p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
6A 200V	78p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
6A 400V	84p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
Amp Volts																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
3 400	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
6 400	150p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
6 500	180p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
10 400	185p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
10 500	195p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
15 400	210p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
15 500	250p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
40A30	95p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
40B66	95p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
40B69	95p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
DIAC																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
BR100	25p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
<h3>MEMORIES</h3> <table border="1"> <tr><td>2602B</td><td>1024 bit RAM</td><td>£2.50</td></tr> <tr><td>2513(UC)</td><td>Character Generator</td><td>£8.50</td></tr> <tr><td>2513(LC)</td><td>Character Generator</td><td>£8.50</td></tr> </table>		2602B	1024 bit RAM	£2.50	2513(UC)	Character Generator	£8.50	2513(LC)	Character Generator	£8.50	<h3>MULLARD MODULE</h3> <p>*LP1186 Varicap FM Tuner £6.75</p>		<h3>LOW PROFILE DIL SOCKETS BY TEXAS</h3> <p>8 pin 13p, 14 pin 14p, 16 pin 15p, 24 pin 50p, 40 pin 75p.</p> <p>INSULATORS Mica + 2 Bushes for TO3 &amp; TO66 5p</p>		<h3>VOLTAGE REGULATORS</h3> <p>FIXED — Plastic 3 Terminals</p> <table border="1"> <tr><td>1 Amp Positive</td><td>1 Amp Negative</td></tr> <tr><td>5V 7805 140p</td><td>5V 7905 200p</td></tr> <tr><td>12V 7812 140p</td><td>12V 7912 200p</td></tr> <tr><td>15V 7815 140p</td><td>15V 7915 200p</td></tr> <tr><td>18V 7818 140p</td><td>18V 7918 200p</td></tr> <tr><td>24V 7824 140p</td><td>24V 7924 200p</td></tr> </table> <p>LM309K 1 Amp 5V TO3 140p</p> <p><b>DUAL VOLTAGE REGULATOR</b></p> <p>1468 -15V 100mA 16 pin DIL 300p. (Adjustable by resistors from - 8V min. to + 20V max.)</p> <p><b>VARIABLE VOLTAGE REGULATOR</b></p> <p>723 2V to 37V 150mA 14 pin DIL 45p LM305H 4.5V to 30V 20mA TO5 120p Basic Data Sheets on Vol. Regs. at 10p each + SAE</p>		1 Amp Positive	1 Amp Negative	5V 7805 140p	5V 7905 200p	12V 7812 140p	12V 7912 200p	15V 7815 140p	15V 7915 200p	18V 7818 140p	18V 7918 200p	24V 7824 140p	24V 7924 200p	<h3>SEVEN SEGMENT DISPLAYS</h3> <table border="1"> <tr><td>3015F</td><td>Minitor 0.3 in</td><td>120p</td></tr> <tr><td>DL704</td><td>Com. Cathode 0.3 in</td><td>140p</td></tr> <tr><td>DL707</td><td>Com. Anode 0.3 in</td><td>140p</td></tr> <tr><td>DL747</td><td>Com. Anode 0.6 in</td><td>225p</td></tr> </table>		3015F	Minitor 0.3 in	120p	DL704	Com. Cathode 0.3 in	140p	DL707	Com. Anode 0.3 in	140p	DL747	Com. Anode 0.6 in	225p	<h3>OPTO-ISOLATORS</h3> <table border="1"> <tr><td>Phototransistor</td><td>TIL 112 (IL 12)</td><td>6 pin DIL 140p</td></tr> <tr><td>Photodarlington</td><td>ILCA-55</td><td>6 pin DIL 250p</td></tr> </table>		Phototransistor	TIL 112 (IL 12)	6 pin DIL 140p	Photodarlington	ILCA-55	6 pin DIL 250p	<h3>DRIVERS</h3> <table border="1"> <tr><td>75491</td><td>Quad Segment Driver</td><td>14 pin DIL 72p</td></tr> <tr><td>75492</td><td>Hex Digit Driver</td><td>14 pin DL 90p</td></tr> </table>		75491	Quad Segment Driver	14 pin DIL 72p	75492	Hex Digit Driver	14 pin DL 90p	<h3>SCR-THYRISTORS</h3> <table border="1"> <tr><td>1A 50V TO5</td><td>40p</td><td>4A/400V Plastic</td><td>55p</td></tr> <tr><td>1A100V TO5</td><td>42p</td><td>*MCR101</td><td></td></tr> <tr><td>1A400V TO5</td><td>45p</td><td>0.5A/15V TO-92</td><td>25p</td></tr> <tr><td>1A600V TO5</td><td>70p</td><td>2N3525</td><td></td></tr> <tr><td>3A100V Stud</td><td>49p</td><td>5A/400V TO-66</td><td>90p</td></tr> <tr><td>3A400V Stud</td><td>75p</td><td>2N4444</td><td></td></tr> <tr><td>7A100V TO5+HS</td><td>84p</td><td>8A/600V Plastic</td><td>185p</td></tr> <tr><td>7A400V TO5+HS</td><td>90p</td><td>*2N5060</td><td></td></tr> <tr><td>8A 50V Plastic</td><td>130p</td><td>0.8A/30V TO-92</td><td>34p</td></tr> <tr><td>12A400V Plastic</td><td>160p</td><td>*2N5062</td><td></td></tr> <tr><td>16A100V Plastic</td><td>160p</td><td>0.8A/100V TO-92</td><td>37p</td></tr> <tr><td>16A400V Plastic</td><td>180p</td><td>*2N5064</td><td></td></tr> <tr><td>16A600V Plastic</td><td>220p</td><td>0.8A/200V TO-92</td><td>40p</td></tr> </table>		1A 50V TO5	40p	4A/400V Plastic	55p	1A100V TO5	42p	*MCR101		1A400V TO5	45p	0.5A/15V TO-92	25p	1A600V TO5	70p	2N3525		3A100V Stud	49p	5A/400V TO-66	90p	3A400V Stud	75p	2N4444		7A100V TO5+HS	84p	8A/600V Plastic	185p	7A400V TO5+HS	90p	*2N5060		8A 50V Plastic	130p	0.8A/30V TO-92	34p	12A400V Plastic	160p	*2N5062		16A100V Plastic	160p	0.8A/100V TO-92	37p	16A400V Plastic	180p	*2N5064		16A600V Plastic	220p	0.8A/200V TO-92	40p	<h3>SEMICONDUCTOR KITS</h3> <p>1) Teletext Decoder U.C. £47.00 inc. VAT and P &amp; P L.C. £11.00 inc. VAT and P &amp; P</p> <p>2) Time-Code Receiver Clock £26 inc. VAT and P &amp; P (extra £6 includes 45 DIL sockets)</p> <p>Please send S.A.E. for details.</p>		<p>VAT RATES: All items at 8% EXCEPT where marked * which are at 25%.</p>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
2602B	1024 bit RAM	£2.50																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
2513(UC)	Character Generator	£8.50																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
2513(LC)	Character Generator	£8.50																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
1 Amp Positive	1 Amp Negative																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
5V 7805 140p	5V 7905 200p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
12V 7812 140p	12V 7912 200p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
15V 7815 140p	15V 7915 200p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
18V 7818 140p	18V 7918 200p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
24V 7824 140p	24V 7924 200p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
3015F	Minitor 0.3 in	120p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
DL704	Com. Cathode 0.3 in	140p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
DL707	Com. Anode 0.3 in	140p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
DL747	Com. Anode 0.6 in	225p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Phototransistor	TIL 112 (IL 12)	6 pin DIL 140p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Photodarlington	ILCA-55	6 pin DIL 250p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
75491	Quad Segment Driver	14 pin DIL 72p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
75492	Hex Digit Driver	14 pin DL 90p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
1A 50V TO5	40p	4A/400V Plastic	55p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
1A100V TO5	42p	*MCR101																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
1A400V TO5	45p	0.5A/15V TO-92	25p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
1A600V TO5	70p	2N3525																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
3A100V Stud	49p	5A/400V TO-66	90p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
3A400V Stud	75p	2N4444																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
7A100V TO5+HS	84p	8A/600V Plastic	185p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
7A400V TO5+HS	90p	*2N5060																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
8A 50V Plastic	130p	0.8A/30V TO-92	34p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
12A400V Plastic	160p	*2N5062																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
16A100V Plastic	160p	0.8A/100V TO-92	37p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
16A400V Plastic	180p	*2N5064																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
16A600V Plastic	220p	0.8A/200V TO-92	40p																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
<p>Fully branded devices by Texas, RCA Motorola, National, Mullard, etc.</p>						<p>Minimum Order £2 P&amp;P 20p Please add VAT to total</p>		<p>Mail Order Only Govt., Colleges, etc., orders accepted</p>		<p><b>TECHNOMATIC LTD.</b> 54 SANDHURST ROAD, LONDON, NW9 Tel: 01-204 4333</p>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

## EQUIPMENT designed by J. L. LINSLEY-HOOD

### AUDIO OSCILLATOR

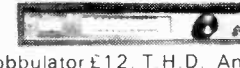
Simple design. Very Low Distortion. In kit form  
**£14.00** or READY MADE **£18.00**



Phase Locked Loop F.M. Stereo Tuner Full kit  
**£40** or in pack form  
(Add Tax 12½% (except instruments — 8%))

### FAMOUS 75 watt HI FI AMPLIFIER

Distortion below normal measurement  
Price (Kit) **£64**  
Also in component and module form



ALSO AVAILABLE F.M. Sig / Gen-Wobbulator £12. T.H.D. Analyser £18.50 0-60v 1A P.S.U. £17.30

Detailed leaflets gladly sent. Send foolscap S.A.E.

## TELERADIO ELECTRONICS

325 FORE STREET, EDMONTON, LONDON, N.9. 01-807 3719

## ELECTRONORTECHNICA

# carbon film RESISTORS

1/8 and 1/4w 70°C 5% tol. E.12

EX-STOCK

## £4.50 PER 1,000 OF ONE VALUE PLUS V.A.T.

Contact John Gingell

## Z & I AERO SERVICES LTD.

44A Westbourne Grove  
London W2 5SF  
TEL 01-727 5641 TELEX 261306

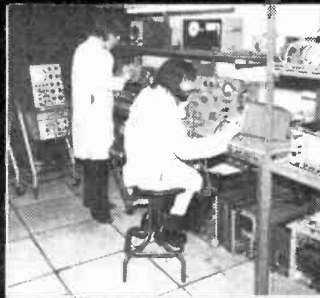
WWW-072 FOR FURTHER DETAILS

# ELECTRONIC BROKERS

Electronic Brokers Ltd. are one of the leading electronic instrumentation companies in the UK, providing a full range of services to Universities, Industry, Colleges and Governments both at home and overseas.

We have the largest stocks of secondhand test equipment in Europe as well

as a selected range of new products. These are on display at our London showrooms where customers can examine the equipment of their choice and see it working.



Electronic Brokers Ltd. have fully equipped workshops on the premises to test and report on the majority of equipment we sell.



## TELEPHONE TEST EQUIPMENT

- SIEMENS**  
 Level Meter 3D 332 0 3-1200KHz £250  
 Level Meter 3D 335 10KHz-17MHz £300  
 Level Oscillator 3W/29 0 3-1200KHz £250  
 Level Oscillator 3W/518 £300  
 Carrier Frequency Sweep measuring set up Type Rel 32 M710 (to 15MHz) Comprising Level Oscillator Rel 3W 518 Level Meter Rel 3D 335 Sweep Attachment Rel 3W 933 Tracing Receiver Rel 3D 346 Used for measurement on carrier telephone equipment for coaxial systems (e.g. V960 V1200 & V2700) and wideband radio relay systems (e.g. FM600 FM900 FM1800) P.O.A.
- WANDEL & GOLTERMAN**  
 Level Transmitter TFPS 42 10KHz-14MHz £375  
 Level Meter TFFM 43 10KHz-14MHz £375  
 Wandel & Golterman V2M 2 Distortion measuring set for phase and amplitude mod. For multichannel FM Radio Systems up to 12MHz base bands. £350

## SWEEP GENERATORS

- HEWLETT PACKARD**  
 Sweep Oscillator 692D 2-4GHz Sweeps from start to stop freq. SPECIAL OFFER £320  
 Sweep Oscillator 693B 4-8GHz £325  
 Sweep Oscillator 693D 4-8GHz £325
- JERROLD**  
 Sweep Signal Generator 900B Central Freqs 500KHz-1200MHz Sweep widths narrow as 10KHz to 400MHz wide 50ohms o.p impedance £400
- M.E.S.L.**  
 Sweep Signal Source MH883 7.12 5GHz £480.00

## FUTURE ADDITIONS

The following equipment is becoming available to us in the near future, should you require prices etc., please contact us and then we will reserve your specific requirements.

- HEWLETT PACKARD**  
 334A Distortion Analyser  
 5245L Electronic Counter  
 626A Signal Generator  
 8552B Spectrum Analyser - IF Section  
 8616A Signal Generator  
 141T Spect. Anal. Display  
 211A Crystal Monitored Sig. Gen.  
 355D Attenuator  
 6920B Mixer Calibrator  
 5328B Univ. Timer/Counter/D.V.M.  
 435A Power Meter  
 1707B
- MARCONI INSTRS.**  
 TF 1068/6 FM Signal Generator
- FLUKE**  
 8100A Digital Multimeter  
 8100B Digital Multimeter  
 8300A Digital Voltmeter  
 332B Voltage Calibrator  
 341A D.V.M. Calibrator
- TEKTRONIX**  
 434  
 488 100MHz D.T. Scope  
 485/05/07 TV Scope  
 475 200MHz D.T. Scope  
 422 15MHz D.T. Scope  
 549 Storage Scope  
 1L40 Spectrum Analyser Plug in.

## SIGNAL SOURCES

- ADVANCE**  
 V.H.F. Square Wave Generator SG21 10 KHz-100MHz Max o.p 2V £35.00

- GENERAL RADIO**  
 Unit Oscillator 1209C Freq 250-920MHz Accuracy 1% Drift 0.2% 0 pin to 50ohms=150mV supplied with Power Supply Type 1201-CQ18 as illustrated £215.00  
 Unit Oscillator 1218A 900 2000MHz Power output of 200mW across band £140.00
- HEWLETT PACKARD**  
 F.M. A.M. Signal Generator 202H F.M. A.M. C.W. & pulse coverage 54 to 216 MHz R.F. o.p 0.1µV-0.2V 50ohms Impedance £450  
 V.H.F. Signal Generator 608E 10-480MHz (5 bands) Accuracy ±0.5% o.p 0.1µV-1V (variable) 50ohms Int. AM 400 & 1000Hz Ext. AM 20Hz 20KHz Superh condition £895  
 S.H.F. Signal Generator 618C 2.8-7.6GHz ±1-50ohms £550.00  
 U.H.F. Signal Generator 616A 1.8-4.2GHz £475.00

- MARCONI INSTRS.**  
 F.M. A.M. Signal Generator TF 995A 3S. Ministry type No. CT402 1.5MHz-220MHz R.F. o.p 2µV-200mV Internal & External Mod Facilities V good condition £385  
 F.M. A.M. Signal Generator TF 995A 5 1.5-220MHz in 5 bands 0.1µV-200mV F.M. up to ±120KHz from 50Hz-15KHz A.M. up to 50% from 100Hz-10KHz o.p 1µV-200mV (2) with terminating unit 1µV-100mV Int. mod freqs 400Hz 1KHz & 1.5KHz Distortion (1) on internal F.M. =25Hz (2) on internal A.M. 6% at 30% mod. £300 to £450.00  
 A.M. Signal Generator TF801D 1 Freq range 10-70MHz R.F. output 0.1µV-1V Piston attenuator 50ohms Impedance Modulation Int. AM 1KHz Ext. AM 30 Hz-20KHz Low spurious F.M. & drift V.S.W.R 1.2 or less £400-£800  
 A.M. Signal Generator TF801D 1S Military Version 10-85MHz £450-£800  
 R.C. Oscillator TF1370A 10Hz-10MHz Square Wave up to 100KHz High Output up to 31 6V £285  
 Phase A.M. Signal Generator TF 2003 0.4-12MHz £150  
 A.M. Signal Generator TF 801B 3S 12-485MHz 0.1µV-1V £195.00  
 R.C. Oscillator TF1101 Frequency range 20Hz-200KHz Output Direct into 600Ω-20V variable Attenuator 0-6dB in 10dB steps impedance 600Ω Distortion Via 1KHz Filter less than 0.1% Direct or via Attenuator Less than 0.5% 50Hz-20KHz Less than 1% 20Hz-200KHz Superh condition £175  
 U.H.F. & S.H.F. Signal Generator TF105B 1600-4000MHz 0.1µV-445mV 50ohms Impedance £295.00  
 FM AM signal Generator TF937 1 CT320 35KHz-18.3MHz As seen condition £80.00  
 Portable Receiver Tester TF888 3 Freq 70KHz-70MHz Xtal check 500KHz & 5MHz Output Phase A.M. Signal Generator TF2003 0.4-12MHz £150.00  
 V.H.F. Mobile Radio Test Set TF1064B 5M £300  
 Signal Generator TF144H 4 Late models in superb condition £500 to £650  
 AM FM Generator TF995B 5 (Brand new - unused) £750

- MURHEAD**  
 L.F. Decade Oscillator D880A 2 phase 0.01Hz-11.2KHz £295.00  
 Decade Oscillator D890A 1Hz-11.2KHz £335.00
- RADIOMETER**  
 Stereo signal generator SMG1C Full spec on request Superh condition £400

- AM FM Generator Type MS27G £315  
**WAYNE KERR**  
 Video Oscillator 0 222 7KHz-8MHz in 6 ranges £75.00  
 Video Oscillator 0 22D 10 KHz-10MHz £150.00

## OSCILLOSCOPES

- HEWLETT PACKARD**  
 Oscilloscope 140A c.w. 1415A time domain reflectometer For testing of cables connectors striplines & transmission lines £750  
 Sampling Scope 185B DC-3.5 GHz £395.00  
 Oscilloscope 175A DC-50MHz Main Frame £150.00  
 Plug-ins available from £25-£55.00  
 50MHz single channel 1751A Time Mark Gen 1783 Aux Plug in 1780A Display Scanner 1722A Sweep Delay Gen 1781B Dual Trace Vert. Amp 1750A Delay Gen 1781A

## HAMEG

- Transistorised compact single beam portable scope bandwidth of 8MHz Compensated Y - attenuator 12 ranges 50mV/cm to 30V/cm Timebase sweep range of 10Hz to 500KHz and can be triggered from +Ve or -Ve externally or internally Y input can be AC or DC coupled Display area 6cm X 4cm Rise time 44ns Dimensions 203mm X 160mm X 240mm Wt. 5kg BRAND New Type No. HM207 £85.00

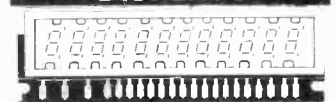
- MARCONI**  
 T.V. Scope TF 2200A 1 c.w. TV Diff. plug in TM 6457A DC-30MHz £190  
 Portable Scope TF2203 15MHz Bandwidth DC coupled 50mV/cm sensitivity £125.00

- SOLARTRON**  
 Portable Scope DC-6MHz Double Beam GT436 £95  
 CD 1014 DC 5MHz £90  
 Portable Scope CD 1400 DC 15MHz Plug ins available CX 1441 1413 £180  
 Wide Band General Purpose Scope CD-1212 (Min. spec. CT484) Plug ins CX1251 & CX1252 (collection only) £149.50  
 Portable transistorised CD 1642 Dual trace DC - 15MHz 10mV/cm Sensitivity triggering to 25MHz Screen 10 x 6cm £195

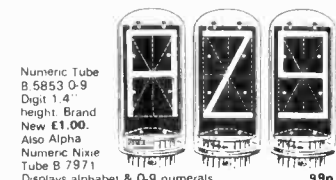
- HEATHKIT**  
 10 12 µs Scope Single Beam 50MV/cm AC coupled B/W 4.5MHz 5" Tube Assembled Refurbished 90 Day Warranty Our price £49.50

- ROBAND**  
 25MHz Scope R 050 c/w 5C Plug in £200  
 25MHz Scope R 05DA c/w 5C Plug in £225  
**TEKTRONIX**  
 Sampling Scope 661 c/w plug ins £450  
 453 DC-50MHz Solid state & portable £650
- EQUIPMENT**  
 D31R Dual Beam DC - 6MHz £75

## DISPLAYS



Segmented Multiple Cold Cathode Gas-filled Indicator Tube Type ZM1500/12 made by Mullard - unused 12 Decades Character height 7.6mm Striking voltage 160 Ideal for Display Applications requiring a large No. of digits to be displayed, e.g. Desk Top Calculators Overall width 86.2mm Overall height 26mm £3.75 + P&P 30p + VAT 8%



**SELF SCAN**  
 Panel Display Model SSD 1000-0030 Direct Visual Presentation of Alpha-Numeric Data Each panel is a self-contained package, providing 16 to 18 display positions, each of which may be instructed by a 6-bit coded signal to display one of 64 pre-programmed characters as a 5 x 7 dot matrix, formed by special gas-discharge units. Each character is 0.4 inches high providing a bright image visible over a wide viewing angle Full applications data is available giving all necessary information Price £60

## POWER SUPPLIES

- I.B.M.**  
 Ex Computers highly stabilised transistorised incl. overload protection (220V input) ON INPUT & OUTPUT Load regulation of 1% or better. Low ripple Fast response time  
 6V-6A £14  
 3V-8A £17  
 3V-4A £9.50  
 3V-16A £25  
 Regulated only  
 48V-2.7A --7.25V 4.8A £9.50
- N.C.R.**  
 Ex Computer (108-132V Input) Type 007-6004501 Mod 0 240V-20A £30  
 Type 315-0516424 B 32-36V-4.8A £20

# ELECTRONIC

A member of the EB group

ADD 8% VAT TO ALL PRICES

WW-85 FOR FURTHER DETAILS

# the test equipment people



Type 315—0502654D 12V—15A £32  
Type 315—0505928G 12V—25A £40

**ELECTRONIC BROKERS TEST EQUIPMENT CATALOGUE**

The most comprehensive catalogue of its kind ever compiled in the UK. Send 50p towards printing, postage, etc. (Overseas customers £1) and a catalogue will be sent by return. Electronic Brokers Ltd. will then keep the catalogue updated by forwarding revision sheets free of charge.

- ### MULTIMETERS
- AVO Avometer Test Set No. 1 (Panclimatic Version of Model 9) £44
  - Avometer Model 85X (same spec. as Model 8) £40
  - Avometer Model 7 £29
  - All above refurbished, calibrated and guaranteed test leads. NEW for above Models £4
  - RUSSIA AC Clamp Voltmeter U 91 Brand New £13.75
  - Spec. Current 10-25-100-250-500 Amps. Voltage 300-600V Accuracy 4%. Used for measurements of AC Voltages and currents without breaking the circuits. Ranges are selected by means of a Rotary Selector Switch £37
  - Megohmmeter Type M4100/3 Brand New £37
  - Nominal o/p Voltage (open ckt.) 500V High measurements Range (at 500V) 500M $\Omega$  (Mid Scale

- 5M $\Omega$  Low measurements Range 1000K $\Omega$  Portable (7lbs.) and Hand operated c/w carrying case. SEE ALSO INSIDE BACK PAGE. £65.00

### VOLTMETERS

**HEWLETT PACKARD**  
DC Vacuum Tube Voltmeter 412A 1Mv-1000V 1% Accuracy Can also be used as Ohmmeter & Ammeter £75

V7VM 400D 1mV to 300V FSD 12 ranges 10Hz to 4MHz 2% accuracy Input impedance 10Mohms £85

V7VM 400L Logarithmic version of 400D Reads RMS value of sine wave Log. voltage scale 0.3 to 1 & 0.8 to 3 Linear dB scale Input impedance 10Mohms £90

Vacuum Tube Voltmeter 410B Freq. Range 20Hz-700MHz AC 1-600V (6 ranges) DC 1V-1KV ohmmeter 0.2 ohms to 500Mohms (7 ranges) Accuracy  $\pm 3\%$  £65.00

Vacuum Tube Voltmeter 400H Freq. Range 10Hz-4MHz Volts 10mV-300V F.S. (12 ranges) Accuracy  $\pm 1\%$  (50Hz-500KHz)  $\pm 2\%$  (20Hz-1MHz) P.O.A.

AV Voltmeter 400E Solid state AC volts 1mV-300V F.S. (12 ranges) Freq. 10Hz-10MHz Accuracy 1% P.O.A.

- MARCONI**  
Sensitive Valve Voltmeter TF 1100 100V-300V AC Freq. coverage 10Hz-10MHz Meter has dB scale facility £85
- Valve Voltmeter TF 1041B General Spec. 0-300V AC 0-1KV DC Resistance up to 500Mohms £60/£95
- Voltmeter No. 3 C1 208 TF 955 AC 100mV-50V multiplier extends AC range to 1.5KV DC 50mV-100V Freq. Range 20Hz-100MHz £55.00
- Valve Voltmeter TF2600 AC 25mV-300V (7 ranges) DC 10mV-1000V (8 ranges) Ohms 0.2 to 59M (7 ranges) 20Hz to 1500MHz Brand new condition £175

- PHILIPS**  
LF Millivoltmeter GM 6012 12 ranges 1mV-300V dB scale on meter Accuracy 2Hz 5% 5Hz-100KHz 2.5% 100KHz-1MHz 0.5% Amplification available 50-70 £65.00
- HF Millivoltmeter GM 6014 Measuring Ranges 1mV-300mV in 6 ranges Accuracy at 30KHz 3% of FSD - Amplitude Char. 1KHz-30KHz flat within  $\pm 5\%$  £55.00
- DC Microvoltmeter GM6020 10-V 1KV Current 10pA-10-A Accuracy 5% (FSD) 0.100-V 3% (FSD) AU other ranges Recorder o/n facility £65.00

- SIGN ELECTRONICS**  
A.F. Voltmeter AM324 £60
- SOLARTRON**  
D.C. Digital Voltmeter LM1420 2 2.5-V-1Kv in 6

On these pages you will find just the briefest selection from the vast range which we hold in stock at any one time.

If you are seeking a specific item and it is not listed, it will pay you to ring us first — we believe we offer the best prices and the best service.

**WORLD WIDE EXPORT.**

Enquiries and tenders welcome from any part of the world.

**HOW TO REACH US**

We are easy to reach, no matter where you live. Minutes away from Kings Cross or St. Pancras main-line stations, and a bus ride from Euston; only just over half an hour from Heathrow Airport. Parking is easy too.

**49-53 Pancras Road, London NW1 2QB**  
Tel: 01-837 7781



- ranges 0.05% DC accuracy £235.00
- D.V.M. Type LM1420 28a DC. true R.M.S. & mean AC sensing. Accurate measurement irrespective of harmonic distortion accuracy = 0.25% Freq. 40Hz-20KHz £350
- D.V.M. Type 7050 £285
- A.C. Converter LM1219 30mV-300V mean reading Freq. range 10Hz-10KHz P.O.A.
- FLUKE**  
Differential Voltmeter 821A For calibration, testing, stability measurements of regulated power supplies. DC Voltmeter calibration  $\pm 0.01\%$  absolute accuracy infinite input resistance at null over entire 0-500V range standard cell reference. Potentiometer in-line readout with automatic lighted decimal. No zero controls. Usable as conventional V.T.V.M. (3% FSD) £165

- AIRMEC/RACAL**  
Wave Analyser 248A 5-300MHz £195-£390
- Wave Analyser 853 30KHz-30MHz Sensitivity 1 $\mu$ V to 1V up to 20 MHz. 4 $\mu$ V to 4V up to 30MHz £95.00
- Wave Analyser 248 Freq. Range 5MHz-30MHz £110
- AIRMEC**  
Modulation Meter 210 £75 to £190
- AMPEX**  
F.M./Direct Recorder/Reproducer SP 300. 4 Channels Speed 1 1/2, 3 1/2, 7 1/2, 15 ips. Freq. response instrumentation 50Hz-40Hz at 15 ips. Aud to 50Hz-18KHz at 15 ips. Special offer £850
- BECKMAN**  
Transfer Oscillator 7580H DC-15GHz with counter. 7.5MHz-15GHz without counter Sensitivity 100mV R.M.S. SPECIAL OFFER £250

## STROBOSCOPES & TACHOMETERS

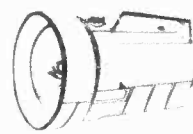
### STROBOSCOPIC TACHOMETER

Two units in one

STROBOSCOPIC FLASH RATE — 290 to 6000 flashes per minute

TACHOMETER SPEED RATE — As above ACCURACY  $\pm 3\%$  better

FLASH DURATION Approx 10 to 25  $\mu$ sec HIGH IMPACT CASE WEIGHT — 27 oz 22 Volts



**£49.50 BRAND NEW**

### "TOUCHLESS" RETRO-REFLECTIVE TACHOMETER

Reads RPM from as far as 24 in. away! Four ranges 0-1000, 3000, 10,000, 30,000 RPM Battery powered Mirror Scale Accuracy 1 1/2% of full scale. Push-button reading

**£89.50**

Carrying Case £12.50 extra. Send for full literature.

**BRAND NEW**

## MISCELLANEOUS

- ADVANCE**  
Resistor Calibrator HC20 £15.00
- AVO**  
Valve Tester CT150 For testing of receiving & low power valves Mutual conductance Emission Electrode insulation & anode current. An I.E. measured. Ministry approved. £60.00

- BELL**  
Subsampler Type 120 complete with Probes P.O.A.
- B.B.K.**  
Deviation Bridge 1505 P.O.A.
- BURNEPT**  
Battery Charger BE370 £30.90
- COSSOR**  
Battery Charger CC 99 £15.90
- DECCA**  
Power Supply for Noise Source MW 61 P.O.A.
- FELONIC**  
Band Pass Filter TBA 140-60-5CC 1.5 Section TNC to IPE connectors 3/4" tubular 60MHz bandwidth 140MHz centre freq. Brand new £20
- TEKTRONIX**  
Probe type P6006 (with UHF plug fitted) £12.50
- PYE**  
Thermocouple test set 7556 £95
- GENERAL RADIO**  
Immittance Bridge 1607A Immaculate Condition in Wooden Transit Case £1040
- Jnd Null Detector 1212A 20Hz-5MHz Log Response with 120dB scale P.O.A.
- HEWLETT PACKARD**  
Distortion Analyser 331A £210
- Digital Recorder 560A £110
- Digital Recorder 561B £140
- HEWLETT PACKARD**  
Directional detector 7870 1.9-4.1GHz £90
- Directional detector 78RC 3.7-8.3GHz £95
- MARCONI INSTR.**  
Attenuator TF 1073A/2S £85
- Out of Limits Indicator TF 2404/2M1. Checks readings from electronic counters and other digital insts. Local and remote visual and electrical indication suitable for use by unskilled personnel and with A.T.E. P.O.A.
- Blank & Sync Mixer TF 290B £90
- Quantization Distortion Tester TF 2343 P.O.A.
- R.F. Power Meter TF 1152/1 £75
- "Q" Meter TF 329G £290
- MARCONI**  
Probe kit TMB120/1 X1 for use with valve voltmeter TF2600 Brand new £50
- RHOE & SCHWARTZ**  
Stereo Coder MSCBN 4192/2 P.O.A.
- Polyscope Swob II £14.90
- Attenuator type DPR Z=60 ohms BN 18042 P.O.A.
- 3 1/2 F. Millivoltmeter Type UR £175
- FELONIC**  
Sweep Generator SM 2000 c/w Plug Ins E.3M, S.6 & S.8M P.O.A.

Shown on these pages are just a few samples of our huge stock of meters you require is in short supply please give us a ring

Add 50p Post & Packing plus VAT (8%) to all above prices

**01-837 7781**

# BROKERS LTD

Carriage and packing charge extra on all items unless otherwise stated.

Please note: All instruments offered are secondhand and tested and guaranteed 12 months unless otherwise stated.

# BI-PAK SEMICONDUCTORS

## COMPONENTS

**CARBON RESISTOR PAKS**  
These Paks contain a range of Carbon Resistors, assorted into the following groups:—

R.1 50 Mixed 100 ohms — 820 ohms 1/4th W	0.60
R.2 50 Mixed 1K ohms — 8.2K ohms 1/4th W	0.60
R.3 50 Mixed 10K ohms — 82K ohms 1/4th W	0.60
R.4 50 Mixed 100K ohms — 820K ohms 1/4th W	0.60
R.5 30 Mixed 100 ohms — 820 ohms 1/2 W	0.60
R.6 30 Mixed 1K ohms — 8.2K ohms 1/2 W	0.60
R.7 30 Mixed 10K ohms — 82K ohms 1/2 W	0.60
R.8 30 Mixed 100K ohms — 820K ohms 1/2 W	0.60

These are unbeatable prices.

**LOW COST CAPACITORS**

500 µF	50V Elect	0.09 each
01 µF	400V	0.03 each

**REPANCO CHOKES & COILS**

RF Chokes CH1 2.5mH 0.27  
CH3 7.5mH 0.29  
CH5 1.5mH 0.26  
CH2 5.0mH 0.28  
CH4 10mH 0.31

COILS DRX1 Crystal set 0.29  
DRR2 Dual range 0.42

**CARBON POTENTIOMETERS**  
Log and Lin 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M.

VC 1 Single Less Switch	0.20
VC 2 Single D.P. Switch	0.40
VC 3 Tandem Less Switch	0.60
VC 4 1K Lin Less Switch	0.20
VC 5 100K Log anti-Log	0.60

**HORIZONTAL CARBON PRESETS**

0.1 Watt 0.09 each  
100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4.7M.

**REPANCO TRANSFORMERS \***  
240V. Primary. Secondary voltages available from selected tappings 4V, 7V, 8V, 10V, 40V, 50V and 25V-0-25V.

Type	Amps	Price	P&P
MT50/1/2	1/2	£3.00	0.45
MT50/1	1	£4.00	0.48
MT50/2	2	£5.00	0.60

**COIL FORMERS & CORES**  
NORMAN 1/4" Cores & Formers 0.07p  
1/4" Cores & Formers 0.09p

**SWITCHES**  
DP/DT Toggle 0.28p  
SP/ST Toggle 0.22p

**FUSES**  
20mm, 100mA, 200mA, 250mA, 500mA, 1A, 1.5A, 2A QUICK BLOW

Anti-surge 20mm only \*0.05p each  
\*0.8p each

**VEROBOARDS\***  
VB 1 containing approx. 50sq. ins. various sizes all 0.1 matrix \*0.60p  
VB 2 containing approx. 50 sq. ins. various sizes all 0.15 matrix \*0.60p

**DECON-DALO 33PC Marker\***  
Etch resistant printed circuit marker pen. Full instructions supplied with each pen \*0.92p

**BATTERY HOLDERS\***  
Takes 6 H.P. 7's complete with terminal clip and lead \*0.31p each

**V.A.T.**  
ALL PRICES EXCLUDE V.A.T.

Please add 8% to all prices marked \*. Remainder add 12 1/2%. Do NOT add V.A.T. to prices marked †.

## INSTRUMENT CASES



(In 2 sections. Black Vinyl covered top and sides and bezel)

No.	Length	Width	Height	Price
BV1	8" x 5 1/4" x 2"	*£1.25		
BV2	11" x 6" x 3"	*£1.62		
BV3	6" x 4 3/4" x 1 1/4"	*£0.92		
BV4	9" x 5 1/4" x 2 1/4"	*£1.39		

## ALUMINIUM BOXES

No.	Length	Width	Height	Price
BA1	5 1/4" x 2 1/4" x 1 1/4"	*0.45		
BA2	4" x 4" x 1 1/4"	*0.45		
BA3	4" x 2 1/4" x 1 1/4"	*0.45		
BA4	5 1/4" x 4" x 1 1/4"	*0.54		
BA5	4" x 2 1/4" x 2"	*0.45		
BA6	3" x 2" x 1"	*0.39		
BA7	7" x 5" x 2 1/4"	*0.79		
BA8	8" x 6" x 3"	*£1.02		
BA9	6" x 4" x 2"	*0.65		

(Each complete with 1/2" deep lids & screws)  
PLEASE ADD 20p POSTAGE AND PACKING FOR EACH BOX

## COMPONENT PAKS

Pak No.	Qty	Description	Price
C1	200	Resistors mixed values approx. count by weight	.60
C2	150	Capacitors mixed values approx. count by weight	.60
C3	50	Precision Resistors mixed values	.60
C4	75	1/4th W Resistors mixed preferred values	.60
C5	5	Pieces assorted Ferrite Rods	.60
C6	2	Tuning Gangs. MW/LW VHF	.60
C7	1	Pak Wire 50 metres assorted colours	*.60
C8	10	Reed Switches	*.60
C9	3	Micro Switches	*.60
C10	15	Assorted Pots & Pre-Sets	.60
C11	5	Jack Sockets 3 x 3.5m, 2 x standard Switch Type	.60
C12	30	Paper Condensers preferred types mixed values	.60
C13	20	Electrolytics Trans. types	.60
C14	1	Pack assorted Hardware-Nuts/Bolts, Grommets, etc.	*.60
C15	5	Mains Side Switches, 2 Amp	.60
C16	20	Assorted Tag Strips Panels	.60
C17	10	Assorted Control Knobs	.60
C18	4	Rotary Wave Change Switches	.60
C19	2	Relays 6-24V Operating	*.60
C20		Sheets Copper Laminate. approx. 200 sq. ins.	*.60

Please add 20p post and packing on all component paks, plus a further 10p on pack nos. C1, C2, C19 & C20.

## AVDEL BOND

**SOLVE THOSE STICKY PROBLEMS!**  
with 

**CYANOACRYLATE G2 ADHESIVE**  
The wonder bond which works in seconds Bonds plastic, rubber, transistors, components, permanently, immediately!

**OUR PRICE ONLY 70p \***  
for 2 gm phial

**CABLES** Per Metre

CP 1	Single lapped screen	*0.08
CP 2	Twin Common Screen	*0.11
CP 3	Stereo Screened	*0.12
CP 4	Four Core Common Screen	*0.21
CP 5	Four Core individually screened	*0.28
CP 6	Microphone Fully Braided Cable	*0.11
CP 7	Three Core Mains Cable	*0.11
CP 8	Twin Oval Mains Cable	*0.08
CP 9	Speaker Cable	*0.06
CP 10	Low Loss Co-Axial	*0.14

  
Postage and Packing add 25p unless otherwise shown. Add extra for airmail. Minimum order £1.00

## ANTEX EQUIPMENT

**SOLDERING IRONS**

x25, 25 watt	*£2.95
Model G, 18 watt	*£3.25
CCN 240, 15 watt	*£3.25
SK2 Soldering Kit	*£4.60

**BITS AND ELEMENTS\***

Bit No.		
102 for model CN240	3/32"	*42p
104 for model CN240	3/16"	*46p
1100 for model CCN240	3/32"	*46p
1101 for model CCN240	3/8"	*46p
1102 for model CCN240	1/4"	*46p
1020 for model G240	3/32"	*46p
1021 for model G240	1/8"	*46p
1022 for model G240	3/16"	*46p
50 for model X25	3/32"	*46p
51 for model X25	1/8"	*46p
52 for model X25	3/16"	*46p

**ELEMENTS \***

Model ECN	*£1.25
Model EG 240	*£1.60
Model ECN240	*£1.60
Model EX 25	*£1.40

**SOLDERING IRON STAND**

ST3 Suitable for all models	*£1.25
Antex heat shunt	*11p

**PLUGS**

PS	Description	Price
PS 1	D.I.N. 2 Pin (Speaker)	0.10
PS 2	D.I.N. 3 Pin	0.11
PS 3	D.I.N. 4 Pin	0.14
PS 4	D.I.N. 5 Pin 180°	0.15
PS 5	D.I.N. 5 Pin 240°	0.15
PS 6	D.I.N. 6 Pin	0.16
PS 7	D.I.N. 7 Pin	0.17
PS 8	Jack 2.5mm Screened	0.17
PS 9	Jack 3.5mm Plastic	0.11
PS 10	Jack 3.5mm Screened	0.17
PS 11	Jack 1/4" Plastic	0.14
PS 12	Jack 1/4" Screened	0.20
PS 13	Jack Stereo Screened	0.33
PS 14	Phono	0.09
PS 15	Car Aerial	0.14
PS 16	Co-Axial	0.14

**INLINE SOCKETS**

PS	Description	Price
PS 21	D.I.N. 2 Pin (Speaker)	0.13
PS 22	D.I.N. 3 Pin	0.19
PS 23	D.I.N. 5 Pin 180°	0.19
PS 24	D.I.N. 5 Pin 240°	0.19
PS 25	Jack 2.5mm Plastic	0.15
PS 26	Jack 3.5mm Plastic	0.15
PS 27	Jack 1/4" Plastic	0.28
PS 28	Jack 1/4" Screened	0.32
PS 29	Jack Stereo Plastic	0.28
PS 30	Jack Stereo Screened	0.45
PS 31	Phono Screened	0.17
PS 32	Car Aerial	0.20
PS 33	Co-Axial	0.20

**SOCKETS**

PS	Description	Price
PS 35	D.I.N. 2 Pin (Speaker)	0.07
PS 36	D.I.N. 3 Pin	0.09
PS 37	D.I.N. 5 Pin 180°	0.09
PS 38	D.I.N. 5 Pin 240°	0.10
PS 39	Jack 2.5mm Switched	0.11
PS 40	Jack 3.5mm Switched	0.11
PS 41	Jack 1/4" Switched	0.19
PS 42	Jack Stereo Switched	0.28
PS 43	Phono Single	0.07
PS 44	Phono Double	0.09
PS 46	Co-Axial Surface	0.09
PS 47	Co-Axial Flush	0.19

## P.C.B. KITS & PENS

**PROFESSIONAL D.I.Y. PRINTED CIRCUIT KIT**  
Containing 6 sheets of 6" x 4" single sided laminate, a generous supply of etchant powder, etching dish, etchant measure, tweezers, etch resistant marking pen, high quality pump drill with spares, cutting knife with spare blades, 6" metal ruler, plus full easy to follow instructions. \*£7.80 per kit

Spare container of etchant for above, complete with instructions. \*70p

**P.C.B. MARKING PENS**  
2 x quality market pens, specifically designed for drawing fine etchant resistant circuits on copper laminate. Complete with full instructions \*£1.53 per pair

## SLIDER PAK

Containing a range of slider pots.

SP1	6 mixed values sliders	0.60
SP2	6 470R Lin. sliders	0.60
SP3	6 10K Lin. slider	0.60
SP4	6 22K Lin. sliders	0.60
SP5	6 47K Log. sliders	0.60
SP6	6 47K Lin. sliders	0.60

## LOW-NOISE CASSETTES

C80	*33p
C90	*44p
C120	*56p

## IT'S NEW—IT'S POWERFUL! IT'S THE AL250

**125 watts R.M.S.**  
The module has a sensitivity of 450mV and frequency response extending from 25Hz to 20KHz whilst distortion levels are typically below 1%. The use of 4, 115w transistors in the output stage makes the unit extremely rugged while damage resulting from incorrect or short-circuit loads is prevented by a four transistor protection circuit.  
The unit is intended for use in many applications such as disco units, sound reinforcement systems, background music players, etc.



**POWER AMPLIFIER**  
Specially designed for use in—Disco Units, P.A. Systems, high power Hi-Fi, Sound reinforcement systems

**SPECIFICATION**  
Output Power: 125 watt RMS Continuous  
Operating voltage: 50-80  
Loads: 4-16 ohms  
Frequency response: 25Hz-20kHz Measured at 100 watts  
Sensitivity for 100 watts output at 1kHz: 450mV  
Input impedance: 33K ohms

**Total harmonic distortion**  
50 watts into 4 ohms: 0.11%  
50 watts into 8 ohms: 0.06%  
S/N ratio: better than 80dBs  
Damping factor, 8 ohms: 65  
Semiconductor complement: 13 transistors, 5 diodes  
Overall size: Heatsink width 190mm, length 205mm, height 40mm

**ONLY £15.95 + 8% VAT**

## BIB HI-FI ACCESSORIES

REF	PRICE	
D	2 Hi-Fi Cable & Flex Tidy	*34p
J	Tape Head Cleaning Kit	72p
P	Hi-Fi Cleaner	*30p
	Model 9 Wire Stripper	*£1.00
	2 1/4" Tape Editing Kit	*£1.80
	2 1/2" Cassette Editing Kit	*£1.84
29A	Salvage Cassette	*44p
32A	Stylus Balance	*£1.28
33	Splicing Tape	*38p
36A	Record & Stylus Cleaning Kit	*32p
41	8 Track Cartridge Head Carrier	89p
	Model 42 Groov-Kleen	*£1.84
	42/S Roller & Brush for REF 42 & 200	*200
		*24p
43	Record Care Kit	*£2.76
45	Auto Changer Groov-Kleen	99p
46	Spirit level	*72p
48	Record Dust-off	*26p
52A	Cassette Tray	*54p
53	Hi-Fi Stereo Test Cassette	*£2.40
56	Hi-Fi Hints & Tips Book	*48p
	Model 60 Groov-Kleen	*£1.72
	160/S Replacement Brush Velvet Pad and Base Sticker for Model 60 *24p	
62	Cassette Head Cleaner (Liquid) 48p	
71	Record 'Dust Off' (Displays of ten)	*66p
71A	Record 'Dust Off' (Bubble Pack)	
		*70p
75	Indexa Record	*£1.50
76	Stylus Cleaner	*36p
78	Cassette Fast Hand Winder	*98p
83	Cassette Title & Container Labels (20 & 10)	*36p

## CERAMIC PAKS

Containing a range of miniature ceramic capacitors in mixed values, unrepeatable value.

MC1 24 ceramic capacitors: 22pF, 27pF, 33pF, 39pF, 47pF, 56pF, 68pF, and 82pF ..... 0.60

MC2 24 ceramic capacitors: 100pF, 120pF, 150pF, 180pF, 220pF, 270pF, 330pF, and 390pF ..... 0.60

MC3 24 ceramic capacitors: 470pF, 560pF, 680pF, 830pF, 1000pF, 1500pF, 2200pF, and 3300pF ..... 0.60

MC4 21 ceramic capacitors: 4700pF, 6800pF, 01µF, .015µF, 0.22µF, .033µF and .047µF ..... 0.60

## MAMMOTH I.C. PAK \*

APPROX. 200 PIECES  
Assorted fall-out integrated circuits, including: Logic, 74 series, Linear, Audio and D.T.L. Many coded devices but some unmarked — you to identify.  
**OUR SPECIAL PRICE £1.00**

## HANDBOOKS

**TRANSISTOR DATA BOOK, DTE 2**  
227 Pages packed with information on European Transistors. Full specification including outlines. Price † £2.95 each

**TRANSISTOR EQUIVALENT BOOK**  
BPE 75 256 Pages of cross references and equivalents for European, American and Japanese Transistors. This is the most comprehensive equivalents book on the market today and has an introduction in 13 languages. Price † £2.68 each

**DIODE EQUIVALENT BOOK DE 74**  
144 Pages of cross references and equivalents for European, American and Japanese Diodes, Zeners, Thyristors, Triacs, Diacs and L.E.D.'s. Price † £1.98 each

**MULLARD DATA BOOK**  
MDB 50p. The latest edition of this popular handbook contains information on Semiconductors, Integrated Circuits, Television Picture Tubes, Valves, Capacitors and Resistors. Included in the 161 informative pages are 21 pages on Semiconductor Comparables. Price † 50p each

**TTL DATA BOOK DIC 75**  
Now complete Data book of 74 series TTL (7400-74132). Covering 13 main manufacturers in U.S.A. and Europe, this book gives full data as well as equivalents. Price † £3.74

**THE WORLD'S BROADCASTING STATIONS WBS 75**  
An up-to-the-minute guide for those interested in DX-ing. Contains all the world's broadcasters on SW, MW and LW, as well as European FM/TW stations. Price † £3.56

A full range of technical books available on request.

# BI-PAK

PO BOX 6 WARE HERTS

# BI-PAK

High quality modules for stereo, mono and other audio equipment.



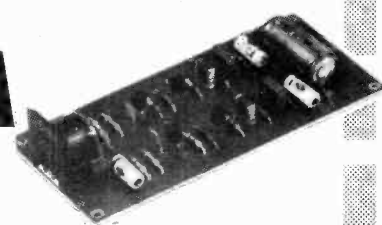
**NEW**  
**PUSH-BUTTON STEREO FM TUNER**

**OUR PRICE ONLY £19.95** Fitted with Phase Lock-loop Decoder

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls. Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461**. The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

- ★ FET Input Stage
- ★ VARI-CAP diode tuning
- ★ Switched AFC
- ★ Multi turn pre-sets
- ★ LED Stereo Indicator

**Typical Specification:**  
Sensitivity 3µ volts  
Stereo separation 30db  
Supply required 20-30v at 90 Ma max.

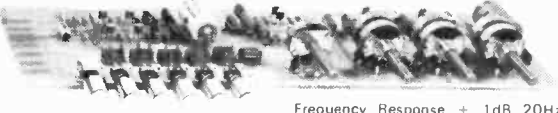


**MPA 30**

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new M.P.A. 30, a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only. It is provided with a standard DIN input socket for ease of connection. Full instructions supplied.

**£2.65**

**STEREO PRE-AMPLIFIER**



**PA 100**  
OUR PRICE **£13.50**

Frequency Response + 1dB 20Hz 20KHz Sensitivity of inputs  
1 Tape Input 100mV into 100K ohms  
2 Radio Tuner 100mV into 100K ohms  
3 Magnetic P.U. 3mV into 50K ohms  
P.U. Input equalises to R1AA curve with 1dB from 20Hz to 20KHz  
Supply — 20-35V at 20mA.

Dimensions — 299mm x 89mm x 35mm

**VAT ADD 12½%**

**POSTAGE & PACKING**  
Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1.00

**AL10-20-30 AUDIO AMPLIFIER MODULES**

The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S. The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the home.

**AL10** 3w R.M.S. **£2.30**  
**AL20** 5w R.M.S. **£2.65**  
**AL30** 10w R.M.S. **£2.95**

**TEAK 60 AUDIO KIT:** plus 62p postage.  
Comprising Teak veneered cabinet size 16¾" x 11½" x 3¾", other parts include aluminum chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc **KIT PRICE £9.20**

**TEK 60 AUDIO KIT:** plus 62p postage.  
Comprising Teak veneered cabinet size 16¾" x 11½" x 3¾", other parts include aluminum chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc **KIT PRICE £9.20**

**SPECIFICATION:**  
● Harmonic Distortion Po=3 watts f=1KHz 02.5%  
● Load Impedance 8-16ohm ● Size: 75mm x 63mm x 25mm  
● Frequency response ±3dB Po=2 watts 50Hz-25Hz  
● Sensitivity for Rated O/P — Vs=25v. RL=8ohm f=1KHz 75mV.RMS

**STEREO 30 COMPLETE AUDIO CHASSIS**



7+7 WATTS R.M.S.

**£15.75** P & P 45p

The Stereo 30, comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel knobs, main switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins).

**TRANSFORMER £2.45** plus 62p p & p  
**TEAK CASE £3.65** plus 62p p & p

**AL 60 25 Watts (RMS)**



★ Max Heat Sink temp 90C. ★ Frequency response 20Hz to 100KHz ★ Distortion better than 0.1 at 1KHz ★ Supply voltage 15-50v ★ Thermal Feedback ★ Latest Design Improvements ★ Load — 3,4,8, or 16 ohms ★ Signal to noise ratio 80db ★ Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast

**£3.95**

**NEW PA12** **£6.50**

**NEW PA12 Stereo Pre-Amplifier** completely redesigned for use with AL10/20/30 Amplifier Modules. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

Frequency Response 20Hz-20KHz (-3dB). Bass and Treble range 12dB. Input Impedance 1 meg ohm. Input Sensitivity 300mV. Supply requirements 24V. 5mA. Size 152mm x 84mm x 33mm.

**Stabilised Power Supply Type SPM80**

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (R.M.S.) per channel simultaneously. With the addition of the Mains Transformer **BMT80**, the unit will provide outputs of up to 1.5A at 35V. Size 63mm. 105mm. 30mm. Incorporating short circuit protection.

**Transformer BMT80**  
**£2.60 + 62p postage**

**£3.00**

**PS12** **£1.20**

Power supply for AL10/20/30, PA12, SA450 etc.

Input voltage 15-20v A.C. Output voltage 22-30v D.C.  
Output current 800 mA Max. Size 60mm x 43mm x 26mm.  
**Transformer T538 £2.30**

# BI-PAK

P.O. BOX 6, WARE, HERTS.



### K.30. THD

The Model K-30 THD has thermal scales provided which directly read temperature. Along with a thermometer probe attached, the meter checks temperature of from -50°C up to 200°C.

- The midget bead thermistor is used as its thermal element accelerates temperatures response, and time lag is minimized compared with conventional thermometers.
- By simply replacing the probe with usual test leads, the meter performs as a circuit tester.
- As a circuit tester the 18-position rotary system range selector switch and individual jacks cover practically all measurement requirements.
- The collapsible stand angles the meter to facilitate use of the meter.

#### Technical Data

DC volts 0.25-1000V in 6 ranges (10k Ω/V).  
AC volts 10-1000V in 5 ranges (5k Ω/V).  
DC milliamperes 0.25-250mA in 4 ranges.  
DC ohms: RX1 -RX1000 in 4 ranges (min. 2 Ω) & max. 10MΩ Ω).  
Decibels -20-+62 dB.  
Temperature -50°C -100°C & 0-200°C -50-200°F & 30-400°F.  
**Accuracy:** DC ±3% AC ±4%.  
**Weight:** 590g.  
**Size:** 144 x 96 x 45mm.  
**Old price:** £23.98 (B)  
**Old price:** £32.13

HIGH VOLTAGE PROBE AVAILABLE

### K-30D

This is a pocket-size circuit tester of versatile performance equipped with a 70μA meter movement. The combination of an 18-position rotary range switch and separate jacks covers practically all measurement needs.

The diode circuit automatically safeguards the movement against inadvertent overload. For easy reading and convenience operation, the meter can be positioned tilted by snapping open the collapsible stand fitted on the back. High voltage probes of 10kV and 25kV ratings are separately available for alignment of colour as well as black-and-white television circuits.

#### Measurement Ranges Available

DC voltage 0.25V, 2.5V, 10V, 50V, 250V, 500V, 1000V  
AC voltage 10V, 50V, 250V, 500V, 1000V  
DC current 0.1mA, 2.5mA, 25mA, 500mA  
Resistance Range - RX1 -RX10, RX100, RX1K, Midscale - 96Ω, 960Ω, 9.6kΩ, 96kΩ. Maximum - 10kΩ, 100kΩ, 1MΩ, 10MΩ.  
Volume level -20-+62dB  
Capacity 0.0001-0.6μF Use external power  
Megohm Ω -200MΩ Meter **£18.41 (A)**  
Meter with case **£28.08**



### EM-800

A new type of circuit tester of super high sensitivity using FET devices. The internal impedance for each DC voltage range is maintained at 12 meg ohms and at 1 meg ohm for each AC voltage range. The frequency coverage extends to 5MHz. The instrument can be used as a galvanometer by adjusting the pointer for centre-zero reading.



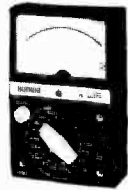
±DCV 0.3(3MΩ) 1.2 3 12 30 120 300 1.2k (12MΩ) ±4% 30kV (w/HV probe).  
±DCA 0.1μA 1.2mA 12mA 300mA (300mV) ±4%.  
ACV: 1.2 3 12 30 120 300 1.2k (1MΩ) ±4%; Freq. -30Hz-5MHz at 1.2V.  
Ω) X1 X100 X1k X100k (max. 1000M).  
dB -20-+63.  
225 x 150 x 84mm. 1.1kg.  
Price **£55.78 (C)**  
Old price **£80.46**

HIGH VOLTAGE PROBE AVAILABLE

### YX-360TR

Comparable with high-grade meters in performance. Universally accepted as a most versatile standard tester and used extensively by electrical and radio engineers. Accurately checks transistor circuits on the low DC voltage ranges for their high internal resistance.

Apart from its function as a wide range circuit tester, the SANWA model YX-360TR also serves as a simplified semi-conductor checker. Provided with LI and LV scales, the meter tests the characteristics of practically all types by semi-conductors, diodes, thermistors, etc.



#### Measurement ranges available:

DCV 100mV, 0.5, 2.5, 10, 50, 250, 1kV (20kV Ω/V), (25kV with HV Probe)  
ACV 10, 50, 250, 1kV (8k Ω/V)  
DCA 50-5A, 2.5mA, 25mA, 0.25A (250mV), 100mV for 50-5A Ω).  
Range x1, x10, x1k, x10k. Maximum 2k, 20k, 2M, 20M. Mid-scale 20, 200, 20k, 200k.  
dB -10-+22 (for 10V AC)  
hFE 0-1000  
ICEO 0-150μA (x1kΩ), 0-15mA (x10Ω), 0-150mA (x1Ω)  
**Accuracy:** ±3% f.s.d. for DC ranges ±4% f.s.d. for AC ranges. ±3% of scale length for Ω ranges ±3% of scale length for hFE. ±5% of scale length for ICEO  
**Old price:** £16.09 (A) **Old price:** £21.76 (A)  
**Size and weight:** 100 x 150 x 57mm and 420g.



### P2B

DC voltage 10V, 50V, 250V, 500V, 1000V (2k Ω/V)  
AC voltage 10V, 50V, 250V, 500V, 1000V (2k Ω/V)  
DC current 0.5mA, 10mA, 250mA  
Resistance Range 0-5k Ω, 0-500k Ω, Midscale 50Ω, 5kΩ  
Minimum 1 Ω, 100 Ω  
dB -20-+22dB & +20-+36dB  
Megohm 0.1-50M Ω  
Capacity 0.0002-0.3μF & 0.01-0.6μF  
Externally Powered

**Accuracy:** DC ±3% FSD AC ±4% FSD  
**Resistance:** ±3% of scale length  
**Battery:** 1 x 1.5V  
**Size:** 120 x 88 x 40mm **Weight:** 365g

The P-2B is a general purpose testmeter. Ruggedly built connections are made by Pinjacks. Clear easy-to-read scale.  
**Old price:** £12.69 (A)  
**Old price:** £17.28 (A)



### AT-45

The AT-45 is a transistor tester capable of checking readily and efficiently not only the leakage current of all types of transistors, but also their DC current amplification factor.

**SPECIFICATIONS**  
**Measurement Ranges:**  
Reverse leakage current (on ICEO scale)  
0-5mA (X100-5A)  
0-50mA (X1mA)  
Accuracy Within ±5%  
DC current amplification factor (on hFE scale)  
0-250 (X5)  
0-1000 (X20)  
Accuracy Within: 1 scale division.  
Meter Moving-coil (Sensitivity-55μA)

**Size and Weight:** 180 x 120 x 39mm. 670g.  
**Accessories:** Test lead pair and 3 clipped cords.  
**SCR check:** The ON/OFF test of an SCR is available by connecting it to the instrument.  
**FET check:** The activity and impedance conversion capacity of an FET can be measured on the instrument.  
**Old price:** £20.81 (B) **Old price:** £25.00  
**Old price:** £23.64 (B) **Old price:** £31.00

### N-401

The N-401 MULTITESTER has two outstanding advantages. Firstly, a taut-band meter movement of 5μA is introduced. In sensitivity, it is close to that of a galvanometer. Secondly, an original automatic cut-out device provides exceptional safeguard.



#### SPECIFICATIONS:

**Measurement Ranges Available:**  
DCV (Ω) 0.16 0.4 1.6 4 16 40 160 400 800  
1.6kV Input impedance 200kΩ/V for 40V & below, 16MΩ for 160V, 40MΩ for 1.6kV, 20MΩ for 400V & 800V  
DCA (-) 8μA 40μA 400μA, 1.6mA 4mA 16mA 40mA 160mA 1.6A 16A. Voltage drop 400mV (500mV for 160mA)  
ACV 4V 8V 16V 40V 160V 400V 1.6kV Input impedance 5kΩ/V for 16V & above at 50Hz  
ACA 1.6A 16A. Voltage drop 400mV Ω) Range x1 x10 x100 x1k x10k Maximum 5kΩ 50kΩ 500Ω 5 50MΩ  
**Accuracy:** Within ±2% f.s.d. for DC ranges. Within ±3% f.s.d. for AC ranges. Within ±2% of scale length for Ω ranges.  
**Frequency error:** Within ±1dB -50Hz-250kHz (4V & 8V AC) 50Hz-5kHz (other ranges)  
**Size and Weight:** 252 x 191 x 107mm & 1.95 Kg.  
**Old price:** £39.87 (C). **Old price:** £57.40

### SP-10D

A small pocket instrument of robust construction with meter movement protection, rugged shockproof resin rear case, low ohms range minimum 0.2Ω, 20Ω midscale.



#### SPECIFICATIONS:

**Measurement ranges:**  
DCV 0.25, 10, 50, 250, 500, 1000 (4k Ω/V)  
DCmA 0.25, 25, 500 (250mV drop)  
ACV 10, 50, 250, 500, 1000 (4k Ω/V)  
Ω) Range -x1, x10, x1k, Midscale -20, 200, 10k, Maximum -500, 5k, 1M  
Battery -1.5V x1  
dB -20-+22 +20-+36  
Ω) 0.1-50M  
μF 0.0001-0.02 0.01-0.3 } Using external power

**Accuracy:**  
Within ±2.5% f.s.d. for DCV & DCmA  
Within ±3.5% f.s.d. for ACV & dB  
Within ±3% of arc for Ω)  
**Size and Weight:** 140x95Wx440 mm. 310 gr.  
**Old price:** £14.38 (A)  
**Old price:** £19.49

### N-201

The N-201 incorporates a transistor amplifier circuit which provides a high input impedance of 200k ohms per volt for 0.3V to 120V and 20k ohms per volt for 600V and upwards for DC measurements.



**High Sensitivity and Ruggedness:** A Solid-state amplifier circuit permits the use of an 80-μA meter movement. In ruggedness, therefore, it surpasses usual high sensitivity meter movement. Fast response is another advantage. **Wide, Mirror Scale.** The scale has a wide angle operation of nearly 100° which is not usual with conventional meters.

**SPECIFICATIONS:**  
**Measurement Ranges Available:**  
DCV 0.3 1.2 3 12 120 (200k Ω/V), 600, 1200, 3000 (20k Ω/V)  
ACV 3 12 120, 300, 600 (10k Ω/V)  
DCmA 0.006 0.12, 3, 30, 600 (300mV)  
DCA 3 (300mV)  
Ω) Range -x0.1, x1, x10, x1k, Midscale -10, 100Ω, 1kΩ, 10kΩ. Maximum -5kΩ, 500kΩ, 5MΩ, 50MΩ.  
Ω) 30mA 0.3mA 0.03mA  
LV 1.5V, 1.5V, 1.5V  
dB -20-+57  
**Size and Weight:** 60 x 118 x 157mm and 740g  
**Accuracy:** DCV & DCA Within ±3% f.s.d.  
ACV & dB Within ±4% f.s.d. (±6% for 25V)  
Ω) Within ±3% of arc  
**Old price:** £27.65 (C) **Old price:** £38.50

### 460-ED

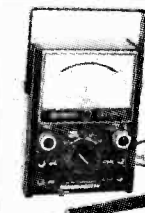
This is a circuit tester of the highest sensitivity with a 10 microampere meter movement of 100 K ohm/volt internal resistance, meeting the ever demanding needs of electronic industry. Double protection of the meter movement against overload and shock. Minimum measurement loss. Unique AC current range. Polarity Switch - This not only converts polarity but determines if the voltage measured is positive or negative. This is a factor indispensable for aligning electronic circuits.



#### Measurement Ranges:

DC voltage: 0.3V 3V 12V 30V 120V 300V (100k Ω/V), 1.2kV 6kV 30kV (with probe) 16.6k Ω/V).  
DC current: 12μA 0.3mA 3mA 30mA 300mA 1.2A 12A (300mV).  
AC voltage: 3V 12V 30V 120V 300V 1.2kV (5k Ω/V).  
AC current 1.2A 12A  
Resistance Range - X1 X10 X100 X10K  
Midscale - 40 Ω, 400 Ω, 4k Ω, 400k Ω. Maximum - 5k Ω, 50k Ω, 500k Ω, 50M Ω).  
Volume level: 20-+63dB

**Accuracy:** ±2% DC ranges ±3% AC ranges  
**Frequency coverage:**  
50Hz - 100kHz for AC 30V and below (±3%).  
10kHz for other AC voltage ranges  
**Size:** 184 x 134 x 88mm **Old price:** £30.93 (B) **Old price:** £40.69  
**Weight:** 1.3kg **Old price:** £12.41 **Old price:** £15.23  
**Current:** £37.94 & £49.93



### TH-500

The temperature probe thermometer quickly responds to change of temperature. It is readily indicated on the easy-to-read double LO/HI mirror scale. The instrument also performs as a two-range voltmeter reading 150V and 300V AC at full scale. The ohms range provided measures resistance up to 100kΩ.

#### SPECIFICATIONS

**Measurement Ranges**  
Temperature (F) (LO) -50-230 (HI) 215-570-  
AC voltage (V) 0-150V 0-300V (4k Ω/V)  
Resistance (Ω) 0.3100k (midscale-abt. 2.5k)  
**Batteries:** 1.5V (JM-3) x2 & 9V (PP3) x1  
**Accuracy:** Within ±2% of arc for temperature  
Within ±4% f.s.d. for AC voltage. Within ±3% of arc for resistance  
**Size & Weight:** 157 x 118 x 45mm & 830g w/accessories  
**Old price:** £56.00 (C) **Old price:** £81.86



### PDM-500 SERIES

The SANWA DM and PDM instruments are automatic battery operated Insulation Resistance Testers. Solid state circuitry provides marked advantage over conventional automatic and hand-driven insulation meters. The dial is designed for easy and accurate reading.  
**Size and weight:** 174 x 122 x 73mm & 960gr.  
**Models available:**

Type	Price	Rated Voltage & Resistance	Effective Scale Range
PDM-100	£41.22 (C)	100V/20 mΩ	0.02-20-50 mΩ
PDM-250	£41.22 (C)	250V/50 mΩ	0.05-50-100 mΩ
PDM-500	£41.22 (C)	500V/100 mΩ	0.1-100-200 mΩ
DM-500	£39.31 (C)	500V/1000 mΩ	1-1000 mΩ
DM-1000	£45.65 (C)	1000V/2000 mΩ	2-2000 mΩ

Old price PDM 100-500 £59.78. DM 500 £56.36. DM 1000 £66.04

To celebrate the transfer of ownership of the Company, its move to new premises, we have decided to offer a selection from the range of SANWA meters at **REDUCED PRICES**. We have achieved this by arranging to supply those items marked (C) after the price only direct from **QUALITY ELECTRONICS LTD.**, while those marked (B) are available from selected wholesale/retail outlets only. Instruments marked (A) are widely available through normal wholesale/retail channels. Details of new **QUANTITY DISCOUNTS** are available on application. All prices include VAT at 8%. **Postage and Packing** on this introductory offer is **free**. Full Sanwa catalogue and price list available on receipt of S.A.E.

Sole U.K. Importers:

## QUALITY ELECTRONICS LTD.

24 HIGH STREET, LYDD, KENT TN29 9AJ  
(FORMERLY OF KINGSTON, SURREY). TELEPHONE: LYDD 20252. TELEX: 965265 (A/B Servolydd)

In association with SERVO & ELECTRONICS SALES LTD. at the same address

Specialist suppliers of Alps Panel Meters, Synchros, Servomotors, Electrical Connectors Test Equipment and Computer Peripherals.

WW-062 FOR FURTHER DETAILS

**AT THE APRS 76 EXHIBITION**

**PHILIP DRAKE ELECTRONICS**

will be exhibiting a new

**DIGITAL EFFECTS UNIT**

and a

**STUDIO TALKBACK SYSTEM**

★

For these products and our other manufacturing and installation services

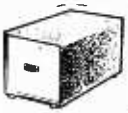
**SEE US ON STAND 17**

★

**PHILIP DRAKE ELECTRONICS LTD.**  
165 Lancaster Road, New Barnet Herts  
Telephone: 01-445 1144

**A.S.P.** (Dept. WW4), SIMMONDS ROAD WINCHEAP, CANTERBURY, KENT Tel: (0227) 52436

**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. Plugs extra.



**TRANSFORMERS**

**30 VOLTS** See catalogue for full range  
PRIMARY 200/240V  
SECONDARY 12, 15, 20, 24, 30V  
AMPS Ref. Price Post  
0.5 No. E 17 £ 0.61

**50 VOLTS** See catalogue for full range  
PRIMARY 200/240V  
SECONDARY 19, 25, 33, 40, 50V  
AMPS Ref. Price Post  
1 No. 103 3.67 0.76  
2 No. 104 5.57 0.85

**60 VOLTS** See catalogue for full range  
PRIMARY 200/240V  
SECONDARY 24, 30, 40, 48, 60V  
AMPS Ref. Price Post  
0.5 No. 126 2.72 0.72  
1 No. 128 4.06 0.72  
2 No. 127 5.53 0.85

**SAFETY ISOLATING** See catalogue for full range  
Prim 120/240V Sec 120/240V Centre Tap with screen  
PRICE Plugs PRICE PRICE Post  
Cased 2 Pin + 1 Earth Open

VA (WATTS)	REF	PRICE Cased	PRICE 2 Pin + 1 Earth	PRICE Open	Post
60	145	0.46	0.95	0.02	0.72
200	151	12.87	0.95	0.07	0.97
250	152	14.47	0.95	10.81	1.18

**AUTO TRANSFORMERS** See catalogue for full range  
VA Ref. PRICE Plugs PRICE PRICE Post  
(Watts) No. Cased 2 & 3 pin Open

1500	93	£24.37	0.95	20.13	0A
------	----	--------	------	-------	----

**MINIATURE & EQUIPMENT** See catalogue for full range  
Primary 240V with Screen  
VOLTS Sec 1 Sec 2 MILLIAMPS No. REF PRICE Post  
3.0 1 200 238 1.75 0.34  
3.6 0.6 500 234 1.75 0.34  
3.6 0.6 1000 212 2.33 0.46  
3.6 1 1000 13 1.75 0.34  
0.5 0.9 330 235 1.75 0.34

**12 and 24 VOLTS PRIMARY 200-240 Volts** See catalogue for full range  
AMPS 24V REF PRICE Post  
0.1 No. 242 1.56 0.34  
0.5 No. 111 1.60 0.46  
1 No. 213 1.90 0.61  
2 No. 71 2.64 0.61  
3 No. 18 3.17 0.82  
4 No. 70 4.82 0.72  
5 No. 3 5.65 0.85

**2" AND 4" PANEL METERS** See catalogue for full range  
2" SIZE: 50mm Wide x 45mm High x 40mm Deep  
4" SIZE: 110mm Wide x 82mm High x 43mm Deep  
All meters are complete with detectors. Modern wide view 25% VAT. Price £3.30  
Post 10p. Price 4" £4.10. Post 10p. Lamps 60p per set. Plus 8% VAT

**BRIDGE RECTIFIERS**

ONE AMP	Price	FOUR AMP	Price
50 P.I.V.	0.25	100 P.I.V.	0.60
100 P.I.V.	0.30	200 P.I.V.	0.65
200 P.I.V.	0.35	400 P.I.V.	0.80
600 P.I.V.	0.40	800 P.I.V.	1.10

**TWO AMP** Price **SIX AMP** Price  
50 P.I.V. 0.40 50 P.I.V. 0.70  
100 P.I.V. 0.45 100 P.I.V. 0.75  
200 P.I.V. 0.50 200 P.I.V. 0.90  
400 P.I.V. 0.55 400 P.I.V. 0.95  
Add 25% VAT on all prices

**SPECIAL OFFER!**  
**2 KVA ISOLATORS**  
Fully impregnated & screened  
2 primary windings 110V each  
2 secondary windings 115V each  
(2 matching transformers)  
**£29.50 plus carr. & VAT**

★ PLEASE ADD 8% VAT ON ALL TRANSFORMERS & METERS

**NEW CATALOGUE 25p**

**Audio Connectors**

Broadcast pattern jackfields, jackcords, plugs and jacks.

Quick disconnect microphone connectors Amphenol (Tuchel) miniature connectors with coupling nut.

Hirschmann Banana plugs and test probes XLR compatible in-line attenuators and reversers.

Low cost slider faders by Ruf.

**Future Film Developments Ltd.**  
90 Wardour Street  
London W1V 3LE  
01-437 1892/3

WW—036 FOR FURTHER DETAILS

**QUADRAPHONIC KIT MODULES**

The following modules, currently being described in Wireless World, are offered. Each kit comprises of glass fibre PCBs and Components. Each module functions independently, but a universal system may be constructed by means of a master switch into which the boards may be plugged.

**CD-4 DEMODULATOR** £32 + VAT (£4.00)  
CD-4 is a registered trade mark of the VICTOR COMPANY OF JAPAN LTD

**QS VARIOMATRIX DECODER SYNTHESIZER** £28 + VAT (£3.50)  
QS, QS Variomatrix and QS Synthesizer are registered trade marks of SANSUI ELECTRIC COMPANY LIMITED OF JAPAN

**SO DECODER (Type L3A)** £27 + VAT (£3.38)  
(Variable Blend + Wave Matching Logic)  
SQ is the registered trade mark of CBS INC.

**MASTER SWITCH KIT** £8.50 + VAT (£1.06)  
Add £1 postage packing and insurance per parcel. Overseas customers neglect VAT, but add £3.20 per kit to cover airmail postage.  
For enquiries please send S.A.E. to:

**COMPOR ELECTRONICS LIMITED**  
9 DELL WAY, LONDON W13 8JH  
or telephone 01-998 8221 on weekdays between 7.30 p.m. and 10 p.m. only

Buy it with Access

WW—092 FOR FURTHER DETAILS

**COMPUTER APPRECIATION**

**Castle Street, Bletchingley, Surrey RH1 4NX. Godstone (088 384) 3106**

**EKCO M5138** Digital Ratemeter. High precision 6 digit TTL counter-timer, counting freq. to 10MHz and timing with a resolution of 1 microsec. Very extensive range of I/O (incl. analogue output. NEW AND packaged. £48.

**EKCO** Field Ratemeter. All solid state multi-range instrument with fluid sampling and end-window beta probes. NEW. £45.

**RUSTRAK** 2-channel chart recorder. NEW. £30.

**HONEYWELL** P112 key-to-card printing punches; V126 verifiers. About 40 available. Prices from £85 one-off to around £30 per unit for the consignment.

**G.E.** 9-track Data Recorders. £95.

**FLEXOWRITER** Model 2305 with full ASCII character set. £575 (Other Flexos. from £95).

**ITEL** Paper Tape Golfball Typewriter. ex-demo. £290.

**VIATRON** Data Prep. Units comprising VDU & twin Philips cassettes under microprocessor control. £190.

**PDP 8L**, 4k processor with ASR 33. £1,050.

**ASR 33** Teletypes sometimes available at £325.

**BURROUGHS** E2100 Computer with typewriter. £79.

**HONEYWELL** 120 processor with 16k x 8 2 microsec. memory. All manuals. £135

**FACIT 4001** Tape Reader. £390. 4015 spooler, £75. PE 1001 Reader. £175.

**PRINTEC** 100 C.P.S. ASCII printer. Ex-demo. £450.

VDU Kit and MOTOROLA 4K Computer Kit — see other ad

WW—077 FOR FURTHER DETAILS

# SUMMER SALE

**DEDUCT 10% FROM THE PRICES SHOWN HERE. OFFER CLOSES JULY 31st 1976** min. CWO £1.

## LINEAR ICs

CA3089E	1.94	7805KC	1.75*
KB4402	1.94	7805UC	1.55*
TDA1200	1.94	78L12	0.45*
HA1137W	2.20	78M12	1.20*
CA3090AQ	3.75	TDA1412	0.95*
MC1310P	2.20	7812	1.55*
KB4400	2.20	7815	1.55*
CA3053	0.40	78M20	1.20*
CA3089E	1.50	78M24	1.20*
LM1496	1.02	uA723	0.80*
		NE550	0.80*
MC1350P	0.70	LS8038	3.10*
SN7666ON	0.75	NE555	0.70*
TBA120AS	1.00	NE560	2.50
TBA651	1.81	NE561	2.50
uA720PC	1.40	NE562	2.50
uA753	0.99	NE565	2.50
TDA440	1.75	NE566	2.55*
LM380	1.00	NE567	2.50*
LM381N	1.81	MVAM2	1.05
LM3900	0.68*	BA102	0.30
MC3401	0.68*	BA121	0.30
uA741	0.40*	MV104	0.45
TBA810AS	1.09	MEM615	0.38
TCA940E	1.80	MEM616	0.50
TDA2020	2.99	11C90	14.00*

## DISCRETE

ZTX107n	0.14
ZTX108n	0.14
ZTX109n	0.14
ZTX212p	0.16
ZTX213p	0.16
ZTX214p	0.16
ZTX413n	0.18
ZTX551p	0.18
ZTX451n	0.18
BF224n	0.22
BD515n	0.27
BD516p	0.30
BD165n	0.50
BD166p	0.54
BD535n	0.52
BD536p	0.53
BD609n	0.70
BD610p	1.20
BD377n	0.29
BD378p	0.32
1N4001	0.06
1N4004	0.10
1N4148	0.07
OA91	0.08
DL704	0.95*
SLA1	1.25*

## Modules, tuners

5600	Varicap Mosfet with 4 tuned RF ccts.	11.00
EC3302	Varicap FET/Bipolar min. tunerhead.	5.50
9001	Frequency meter, scale 88 - 108.	2.50
9002	Strength meter, scale 0 - 10.	2.50
9007	Tuning meter, scale 3 - 0 - 3	2.50
7700	'Off-air' UHF TV sound receiver Varicap tuned, with interstation muting, and sound detection at 38 MHz (Built), inc. P.S.U.	26.00
8011	6 station electronic station selector for any positively tuned varicap tuner system, incorporating a muting output, AFC lock and scan tuning. Built.	14.99
7252	Top quality tuner VHF to audio Varicap tuned with 3 meter outputs.	24.00
7253	Tuner with built-in stereo decoder. Varicap tuned.	24.00
8319	Dual Mosfet tunerhead as used in 7252.	12.00
2020k	TDA2020 stereo amplifier kit.	7.85
2020HS	Heatsink for one TDA2020 (only with IC).	0.75
8001k	55kHz low pass filter (birdy filter) for stereo radio (between detector and decoder).	1.75

Suffix 'k' indicates kit, otherwise supplied built and tested.

### NEW MODULES (EDGE TERMINATED)

5619	6 stage, dual mosfet UHF tunerhead.	£12.50
7020k	10uV FM IF system with muting, agc, main tuning voltage AFC system.	£4.50
92310k	Comprehensive 1310 decoder, with notch filters and 5x gain.	£5.35

# ambit

INTERNATIONAL

General Terms: CWO please, official bodies and companies please note min. invoice £7.50. PP for CWO orders 22p per order. (UK and Eire). Overseas customers please include sufficient for postage. VAT is not included, and must be added at 12½%, but where items are marked \* only add 8%. In stock orders despatched within 48 hours.

25 High Street, Brentwood, Essex. Tel: (0277) 216029, Telex: 995194.

## NOW TELETYPE 35RO ASC11 CODE

HEAVY DUTY CONTINUOUS OPERATION with 240Volt Power Supply and Paper Feed. Circuits, Diagrams, Information supplied with all purchases.

**A MUST AT £50 each**

To all purchasers of the Teletype 35RO we offer a Re-Buildable Electronic Keyboard. In addition to the conventional keyboard layout there are 21 separate push-button function switches. Circuits of the internal logic and core system are provided. Power requirements obtainable from P.U. supplied with 35RO.

Price £10 ONLY.

AND NOW the LOW COST Approach to the IN-OUT problem of the Micro Processor -- Means this is a MUST if you can't afford a Teletype 35

Attractive cast alloy front panel, vertical mount. Size 16½ x 15½ x 5½" containing 72 push buttons with manual or electrical reset (28V) with provision for labelling with your code. 65 illuminated symbols or functions (complete with 28V lamps) which again you can change. 15 bit front panel microswitch assembly to enable your coded cards to be read (sample card supplied) and host of other electronic parts. Limited quantity -- so rush your order **£15 each**.

TALLY P/120 Panel mounted perforator	£120
AMPEX IM7 (7211) Nice condition	£350
AMPEX FR600 Recorder (FM)	£250
POLARAD Receiver Model FIM-B2 Complete 1-10GHZ	£750
UNIVAC Buffer Processor 8K Core Store Full info	£100
LOCKHEAD ELECTRONICS 4 Channel Audio Recorder	£65
12 CHANNEL CHARD RECORDER FSD 5V 20MA per channel	£35
MARCONI ADAPTOR TM6113 for TF2700; TF1313; TF868B	£45
RHODE & SCHWARZ Gen. BN41022 300-100MHZ	£220
HEWLETT PACKARD Gen. 608D 10-420MHZ	£170
AIRMEC 4 trace scope type 279. Large screen	£150
TELEONIC 4 Watt Sweeper PD3. 100-250MHZ	£120
TELEONIC Sweeper 2000-1 with LA-1M 20HZ-20KHZ	£140
TEKTRONIX 180A Time Mark Generator	£120
TEKTRONIX 181 Time Mark Generator	£60
MARCONI TF1101 Oscillator 20c/s-20kc/s	£95
ROHDE & SCHWARZ Admittance Meter BN3511 As new	£75
CREED Model 92 8 hole reader	£40
CREED 8 hole punch	£65
SOLARTRON VF252 AC Millivoltmeter 1 5mv-150V full scale in 10 ranges. 6" meter ± 1%	£35

COME AND LOOK ON OUR SHELVES -- HUNDREDS OF OTHER ITEMS TO INTEREST YOU. TOO FAR AWAY? THEN SEND FOR LISTS.

EX MIN SCOPES CT436 DB6 meg £85 ea. May other types available. Stocks always changing Contact us ONLY £10 EACH STABILISED POWER SUPPLY 240V 50HZ input Outputs -15V @ 10A, +15V @ 4A, -4 5V @ 12A, -21 5V @ 15A Size 16 x 20 x 9" Auto overload trips on each voltage rail with push-button resets Many OTHER POWER SUPPLIES -- call and see

\* TELEPHONES. Post Office style 74.5 Black or two-tone grey £6.50 ea. Modern style 706 Black or two-tone grey £4.50 ea. P&P 75p ea.

19" Alloy Blank Rack Panel 8¾" high 75p ea. P&P 75p

MUFFIN FANS. 115V Size 5 x 5 x 1½" Superbly quiet and reliable Ex-eq but tested £1.50 ea. P&P 75p

PHOTOMULTIPLIER type 931A £4 ea. P&P 75p. Other types available also suitable Power Supplies

\* POTENTIOMETERS -- All 5p ea. P&P extra Metal bodied AB Linear PCB Mount Brand New. 10K; 100K ganged. 250K ganged. 100K ganged concentric shafts

\* BEEHIVE TRIMMERS 3/30pf Brand New 10 off 40p P&P 15p. 100 off £3.50 P&P 75p. 500 off £15 P&P £1 25. 1,000 off £25 P&P £1 50

LARGE RANGE ELECTROSTATIC VOLTMEASURES. From 0-300V 2" £3 to 20KV Max General guide 5KV 3½" £5 Thereafter £1 per KV P&P 75p

VARIACS 240V input 0-270V output 2A ex-eq £4 ea. P&P £1 25. BA £18 ea. plus carr 20A £30 ea. plus carr

\* 4.43MHZ CD Crystal 25p ea. P&P 15p

50KHZ Crystal B7/Octal base £4 ea. P&P 50p EHT Transformer 26KV AC 10MA 240V 50HZ Single phase input £60 ea. Many other EHT transformers and EHT capacitors available

TRANSFORMERS -- All 240V 50HZ inputs. Type A 17-0-17V 250MA 7.5 0-7.5V 250MA. 0-20V 5A. 0-4V 5A. 0-1-1.5V 5A. £2 ea. P&P £1 25 Type B 17-0-17V 250MA

8-0-8V 250MA. 0-12 5-13 5V 5A. 0-1-5-2V 5A. £1.50 ea P&P £1. Type C 19-0-19V 250MA. 8-0-8V 250MA. 0-7 5V 5A. 0-1.4V 5A. £1.25 ea. P&P £1 25 Type D 34V 4A. 19V 4A. 17V 4A £3 ea. P&P £1 25 Type E 3V 1A 25p ea. P&P 50p Type F 17V 1A 85p ea. P&P 50p Type G 20-0-20V 200MA. 0-6V 100MA 75p ea. P&P 75p

TUBES. All Brand New Boxed Electrostatic deflection Type 408A 1½" dia 7½" long Blue Trace £2.50 ea. P&P 75p. Type CV1526 (3EG1) 3" dia £4 ea. P&P £1. Type DG7/36 3" dia (Replacement for Teletype 531) £15 ea. P&P £1 50 Magnetic Deflection 12DP7 12" round Blue with yellow after glow £1 ea. AND FOR THE VDU BUILDER M38-111GH Rectangular 30x20cm Green trace Superb value £12 or Economy type CME 24 x 18 cm White Trace £9 ea.

DON'T FORGET YOUR MANUALS. SAE with requirements

20HZ to 200KHZ SINE & SQUARE WAVE GENERATOR. In four ranges Wien bridge oscillator thermostat stabilised. Separate independent sine and square wave amplitude controls 3V max sine 6V max square outputs. Completely assembled PC Board ready to use 9 to 12V supply required. £8.85 ea. P&P 35p Sine wave only £6.85 ea.

WIDE RANGE WOBBLULATOR. 5 MHZ to 150MHZ (Useful harmonics up to 1 5GHZ) up to 15MHZ sweep width Only 3 controls preset RF level sweep width and frequency Ideal for 10 7 or TV IF alignment filters, receivers Can be used with any general purpose scope Full instructions supplied Connect 6 3V AC and use within minutes of receiving All this for only £6.75 P&P 35p (Not cased, not calibrated)

Minimum Mail Order £2. Excess postage refunded.

Unless stated -- please add £2.50 carriage to all units

VALUE ADDED TAX not included in prices -- Goods marked with \* 12½% VAT, otherwise 8% Official Orders Welcomed, Gov./Educational Depts., Authorities, etc., otherwise Cash with Order Open 9 a.m. to 5.30 p.m., Mon. to Sat.

# CHILTMHEAD LTD

7/9 ARTHUR ROAD, READING, BERKS. (rear Tech. College, King's Road). Tel.: Reading 582605



# Wilmslow Audio

**THE firm for speakers!**



Baker Group 25, 3, 8, or 15 ohm	£8.64
Baker Group 35, 3, 8 or 15 ohm	£10.25
Baker Deluxe, 8 or 15 ohm	£12.38
Baker Major, 3, 8 or 15 ohm	£10.89
Baker Regent, 8 or 15 ohm	£9.00
Baker Superb, 8 or 15 ohm	£16.31
Celestion HF1300 8 or 15 ohm	£6.98
Celestion MH 1000 horn, 8 or 15 ohm	£13.50
Decca London and X over	£36.25
Decca DK30 and X over	£24.00
EMI 5" Mid range	£3.15
EMI 6 1/2" d/cone roll surr. 8 ohm	£3.93
EMI 8 x 5, 10 watt, d/c. roll/s 8 ohm	£3.56
EMI 14" x 9" Bass 8 ohm	£11.92
Elac 59RM 109 15 ohm, 59RM 1148 ohm	£3.38
Elac 6 1/2" d/c roll/s 8 ohm	£3.83
Fane Pop 15 watt 12"	£5.25
Fane Pop 33T 33 watt 12"	£9.25
Fane Pop 50 watt, 12"	£12.50
Fane Pop 55, 12" 60 watt	£15.50
Fane Pop 60 watt, 15"	£17.95
Fane Pop 70 watt 15"	£18.75
Fane Pop 100 watt, 18"	£27.95
Fane Crescendo 12A or B, 8 or 15 ohm	£37.95
Fane Crescendo 15, 8 or 15 ohm	£49.95
Fane Crescendo 18, 8 or 15 ohm	£67.95
Fane 80T7 8" d/c. rolls/s, 8 or 15 ohm	£5.18
Fane 80T1 8" d/c roll/s 8 ohm	£8.96
Goodmans 8P 8 or 15 ohm	£5.95
Goodmans 10P 8 or 15 ohm	£6.25
Goodmans 12P 8 or 15 ohm	£14.95
Goodmans 12P-D 8 or 15 ohms	£16.95
Goodmans 12P-G 8 or 15 ohms	£16.50
Goodmans Audiom 200 8 ohm	£13.46
Goodmans Axent 100 8 ohm	£7.60
Goodmans Axiom 402 8 or 15 ohm	£19.80
Goodmans Twinaxiom 8" 8 or 15 ohm	£9.50
Goodmans Twinaxiom 10" 8 or 15 ohm	£9.86
Kef T27	£5.18
Kef T15	£6.25
Kef B110	£6.75
Kef B200	£7.85
Kef B139	£15.08
Kef DN8	£2.08
Kef DN12	£5.39
Kef DN13	£4.05
Richard Allan HP88 8" 45 watt	£11.93
Richard Allan CG8T 8" d/c roll/s	£7.65
STC 400 1 G super tweeter	£5.90
STC 400 1 K super tweeter	£5.90
Baker Major Module, each	£13.28
Goodmans Mezzo Twinkit, pair	£42.47
Goodmans DIN 20, 4 ohm, each	£13.28
Helme XLK35, pair	£26.75
Helme XLK40, pair	£38.50
Helme XLK30, pair	£21.95
Helme XLK50, pair	£55.50
Kefkit 1, pair	£44.10
Kefkit III, each	£39.38
Richard Allan Twinkit, each	£13.46
Richard Allan Triple 8, each	£20.25
Richard Allan Triple, each	£25.16
Richard Allan Super Triple, each	£29.25
Richard Allan RAB kit, pair	£37.80
Richard Allan RAB2 kit, pair	£59.40
Wharfedale Linton 2 kit (pair)	£20.81
Wharfedale Glendale 3 XP kit, pair	£47.70
Wharfedale Dovedale 3 kit, pair	£59.40
All Radford, Gauss, Castle, Jordan Watts, Eagle, Lowther, Peerless Tannoy units in stock	

Prices correct at 26.4.76

**ALL PRICES INCLUDE VAT**

Cabinets wadding, Vynair, Crossovers etc.  
Send stamp for free booklet "Choosing a Speaker"  
**FREE with all orders over £10 — HiFi Loudspeaker Enclosures Book**  
All units are guaranteed new and perfect  
Prompt despatch  
Carriage. Speakers 50p each, 12" and up 75p each, tweeters and crossovers 30p each, kits 80p each (£1.60 pair).

## WILMSLOW AUDIO

Dept. WW

Loudspeakers & Export Dept: Swan Works, Bank Square, Wilmslow, Cheshire SK9 1HF. Discount HiFi, PA etc: 10 Swan Street, Wilmslow. Radio, Hi-Fi, TV: Swift of Wilmslow, 5 Swan Street, Wilmslow. Tel. (Loudspeakers) Wilmslow 29599, (HiFi, etc.) Wilmslow 26213.

WW — 017 FOR FURTHER DETAILS

GIRO NO1331 7056. Access and Barclaycard accepted. C.W.O. only  
Terms of business: as in our catalogue  
Export Order enquiries welcome (£5 min.)  
Official Orders accepted from Educational & Government Departments  
ALL PRICES INCLUDE VAT & P & P  
Shop hours: 9-12.30, 1.30-5 p.m. 5 days  
Except Wednesday

**1976 ISSUE 66 PAGES — 3000 ITEMS**  
FULLY ILLUSTRATED  
\* 20p CREDIT VOUCHERS  
\* ALL NEW STOCK  
\* SATISFACTION GUARANTEE  
\* DISCOUNTS  
\* NEW PRICE LIST — S.A.E. FOR CAT. 4a

**20p plus 10p postage**

**TRANSFORMERS SEMICONDUCTORS MODULES — AUDIO HEATSINKS — S-DEC AUDIO ACCESSORIES TOOLS — TEST METERS CALCULATORS — AUDIO LEADS—BATTERIES—KITS RESISTORS — CAPACITORS CASES — COILS — BOOKS CONNECTORS — VEROBOARD PC MATERIALS — HARDWARE BOXES — SCREWS — KNOBS POTS—STORAGE UNITS.. ETC., ETC**

**SPECIAL RESISTOR KITS (CARBON FILM 5%)**  
(Prices include post & packing)  
10E12 1/2W or 1/4W KIT 10 of each E12 value  
22ohms—1M a total of 570 £5.29 net  
25E12 1/2W or 1/4W KIT 25 of each E12 value. 22 ohms —1M a total of 1425 £12.64 net

**SPECIAL CAPACITOR KITS**  
C280 Kit—PC Mounting polyester 250V 5 of each value 0.01, 0.022, 0.047, 0.1, 22µF, 2 of 0.47, 1µF £1.98 net.  
C295 Kit—Tubular polyester 400V 5 of each value 0.01, 0.022, 0.047, 0.1, 0.22µF, 2 of 0.47µF £2.67 net.  
Ceramic Kit—square plaque 50V 5 of each value 22, 33, 47, 100, 220, 330, 470, 1000µF, 2200, 4700µF, 0.01µF £1.66 net.  
250V Paper Kit—Tubular metal case, 3 of each value 0.05, 0.1, 0.25, 0.5 µF £1.41 net.  
500V Paper Kit—Tubular metal case, 3 of each value 0.025, 0.05, 0.1, 0.25, 0.5µF £1.41 net.  
1000V Paper Kit—Tubular metal case, 3 of each value 0.01, 0.025, 0.05, 0.1µF £1.63 net

### B.H. COMPONENT FACTORS LTD.

**MULTIMETER U4341**  
27 Ranges plus Transistor Tester  
16 700! Volt  
Vdc -0.3 -900V in 8 ranges  
Vac -1.5 -750V in 6 ranges  
Idc -0.06 -600mA in 5 ranges  
Iac -0.3 -300mA in 4 ranges  
Resistance—2K! -2M! in 4 ranges  
Accuracy—dc—2 1/2%  
ac -4% of F.S.D  
hfe -10 -350 in 2 ranges  
Size—115 x 215 x 90mm  
Complete with steel carrying case, test leads and battery PRICE £12.10 net P&P 75p

U4341

**MULTIMETER U4313**  
33 ranges! Knife edge with mirror scale  
20 000! Volt High accuracy mVdc—25mV  
Vdc -1.5 -600V in 9 ranges  
Vac -1.5 -600V in 9 ranges  
Idc -60 -120 microamps in 2  
Idc -0.6 -1500mA in 6 ranges  
Iac -0.6 -1500mA in 6 ranges  
Resistance—1K! -1M! in 4 ranges  
db scale—10 to +12db  
Accuracy—dc—1% ac—2 1/2%  
Size—115 x 215 x 90mm  
Complete with steel carrying case test leads and battery  
PRICE £16.09 net P&P 75p

U4313

**MULTIMETER U4323**  
27 Ranges plus AF IF Oscillator  
20 000! Volt  
Vdc -0.5 -1000V in 7 ranges  
Vac -2.5 -1000V in 6 ranges  
Idc -0.05 -500mA in 5 ranges  
Resistance—5! -1M ! in 4 ranges  
Accuracy—5% of F.S.D  
OSCILLATOR—1 KHz and 465 KHz (A M) at approx 1 Volt  
Size -160 x 97 x 40mm  
Supplied complete with carrying case, test leads and battery  
PRICE £9.95 net P&P 75p

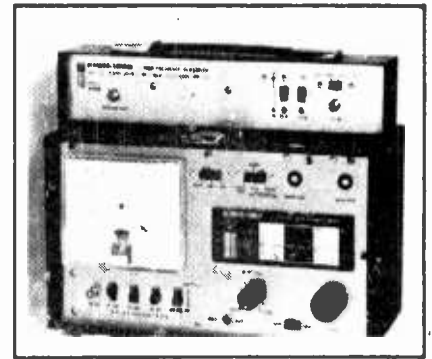
U4323

**MULTIMETER U4324**  
34 Ranges High sensitivity  
20 000! Volt  
Vdc -0.6 -1200V in 9 ranges  
Vac -3 -900V in 8 ranges  
Idc -0.06 -3A in 6 ranges  
Iac -0.3 -3A in 5 ranges  
Resistance—25! -5M! in 5 ranges  
Accuracy—dc and R—2 1/2% of F.S.D  
ac and db 4% of F.S.D  
Size—167 x 98 x 63mm  
Supplied complete with storage case test leads, spare diode and battery  
PRICE £11.72 net P&P 75p

U4324

(WW), LEIGHTON ELECTRONICS CENTRE, 59 NORTH STREET, LEIGHTON BUZZARD, LU7 7EG. Tel Leighton Buzzard 2316 (Std code 05253)

# Quality Products Made in America



**Blonder-Tongue Field Strength Meter - FSM2**  
Superb quality and performance. Complete line of MATV and CATV products available.

**Astatic** - Choose from over 60 different microphones for public address, studio, commercial sound and recording microphones. Quality sound reproduction since 1930. Complete line of Astatic cartridges, needles and arms.

**Atlas Loudspeaker** - complete line of public address speakers and microphone stands.

**Trusonic** - speaker systems to meet every indoor and outdoor requirement.

**Irish Tape** - premium quality tape available in cassette, 8-track, open reel and video.

**Gromes Precision** - public address amplifiers

**Consolidated Wire and Cable**

**AVA** - coaxial connectors

**Teleco** - telephone answering instruments

**Perma Power** - portable PA Systems

**Utah** - complete line of hi-fi speakers and accessories

**Automatic Garage Doors, TV Tube Brighteners, Remote Controls**

Write for illustrated catalog and specifications for these products.

**Morhan Exporting Corp.**

270-278 Newtown Road  
Plainville, N.Y. 11803  
Cable Address: Morhanex, N.Y.  
Telex: 96-7880

WW — 071 FOR FURTHER DETAILS

# KINNIE COMPONENTS

70, NĒLMES WAY, HORNCHURCH  
ESSEX RM11 20Z  
HORNCHURCH 45167

## CIRCUIT BOARD

P.C.B. 1/16. 1 oz. COPPER  
FORMICA

Dim. 8.4 x 7.7 in 3 pcs., **80p**  
Dim. 9.4 x 8.1 in 3 pcs., **90p**  
Dim. 10.1 x 7.9 in 3 pcs., **£1.00**  
Dim. 13.1 x 9.4 in 3 pcs., **£1.20**  
Dim. 17.0 x 9.0 in 2 pcs., **£1.20**  
Post & Packing 35p each pack.

## BARGAIN PACK

10 pcs. 10.1 x 7.9 in. Plus free 1/2 lb etching  
Xtals **£3.10** P.P. 65p.

## FIBRE GLASS P.C.B.

Dim. 6 x 6 in. **50p** each  
Dim. 12 x 6 in. **75p** each  
Dim. 12 x 12 in. **£1.30** each  
Equals less than **1p** sq. in.  
Post & Packing 15p per sheet.

## RESIST COATED P.C.B. FORMICA

10.1 x 7.9 in. **65p** ea.  
13.1 x 9.4 in. **75p** ea.

## RESIST COATED P.C.B. FIBRE GLASS

6 x 6 in. **65p** ea.  
12 x 6 in. **£1.35** ea.  
12 x 12 in. **£2.00** ea.

Post & Packing 10p per sheet.

## BLUE P.C.B. INK

Etch resist use with any pen. Much cheaper  
than ready loaded pens.  
50 c.c. **55p**. P.P. 10p.

## FERRIC CHLORIDE ETCHING XTALS

1 lb - 1 litre pack, **70p** P.P. 35p.  
5 lb - 5 litre pack, **£2.20** P.P. 65p.

## PRINTED CIRCUIT KIT

The no frills all value kit. Containing 4 pcs 8 x  
7 Formica laminate, 1 pce 6 x 6 Fibre glass  
laminate, 1 lb Etching Crystals, 50 c.c.  
Resist ink, with instructions.  
**£2.40** P.P. 65p.

## BARGAIN PACK FIBRE GLASS P.C.B.

200 sq. in. all usable pieces **£1.25** P.P. 25p.

## EDGE CONNECTORS. 54 WAY

1 Vero size etc. Can be cut to any length.  
**55p** P.P. 10p. Side Guides to suit above **15p**  
each.

## OVERLOAD CUT OUTS

Panel mounting 800 M/A 1.8 amp. 10  
amp. **55p** ea.

## TELEPHONE DIALS

(New) **£1** P.P. 25p.

## EXTENSION TELEPHONES

(Type 706). Various colours.  
**£3.95** P.P. 75p.

## 12V MINIATURE

## UNISELECTOR

11 ways. 4 bank (3 non bridging, 1 homing),  
**£2.50** P.P. 35p.



H.T. TRANSFORMERS. Prim. 110/240v.  
Sec. 400v. 100 m/a **£3**. P.P. 65p.  
L.T. TRANSFORMER. Prim. 240v. Sec.  
27-0-27 at 800 m/a. **£2.35**. P.P. 50p.  
L.T. TRANSFORMER. Prim. 110/240v.  
Sec. 50v. at 10 amp. **£10**. P.P. £1.50.  
L.T. TRANSFORMER. Prim. 240v. Sec. 18v.  
at 1.5 amp. & 12v. at 1 amp. **£2.25**. P.P.  
65p.  
L.T. TRANSFORMER. Prim. 240v. Sec. 18v.  
1 amp. **£1.10** P.P. 35p.  
L.T. TRANSFORMER. Prim. 240v. Sec. 12v  
at 1 amp. **£1** P.P. 25p.  
L.T. TRANSFORMER. Prim. 110/240v.  
Sec. 23/24/25v. at 10 amps **£7**. P.P. £1.  
L.T. TRANSFORMER. Prim. 110/240v.  
Sec. 20/21/22v. at 8 amp. **£6**. P.P. £1.

## UNISELECTORS

(New) 25 way. 12 Bank (Non bridging), 68  
ohms. **£6.50** P.P. 50p.

## MINIATURE UNISELECTOR

(Ex. Equip.) 6 Bank (5 non bridging, 1  
bridging) 100 ohms 24-30 V.D.C. **£1.50**  
P.P. 50p.

## 1,000 TYPE KEY SWITCHES

Single 2 x 2 c/o Locking. **50p**. P.P. 10p  
Bank of 4-2 x 4 c/o each switch (one biased),  
**£1.20** P.P. 25p.

## MULTICORE CABLE

6-core (6 colours) 14/0076 Screened P.V.C.  
**30p** per yard; 100 yards at **£16.50** P.P. 2p  
a yard, 7-core (7 colours) 7/22. mm.  
Screened P.V.C. **30p** per yard; 100 yards  
**£16.50** P.P. 4p per yard.

## RIBBON CABLE

(8 colours); 10m. **£1.65**. P.P. 25p. 100m.  
8-core x 14/0.19mm. Bonded side by side  
**£11.50** P.P. £1.

## P.T.F.E. CONNECTING WIRE

1/20 Black or White 100 m. Drum **£2.50**  
P.P. 30p.

## H.D. ALARM BELLS

6in. Dome. 6/8v, d.c. Heavy cast housing for  
exterior/interior use. **£3.75** P.P. £1.  
Connecting wire (twin/twisted) 220yd. reel  
**£3** P.P. 75p.

## HIGH CAPACITY ELECTROLYTICS

250mfd/63 volt, **20p** P.P. 8p.  
1,000mfd/100 volt, **70p** P.P. 25p.  
2,200mfd/100 volt, **90p**. P.P. 25p.  
4,700mfd/25 volt, **65p**. P.P. 20p.  
6,800mfd/16 volt, **50p**. P.P. 15p.  
10,000mfd/25 volt, **75p**. P.P. 25p.  
25,000mfd/40 volt, **£1.25**. P.P. 30p.  
47,000mfd/40 volt, **£2.00**. P.P. 50p.  
100,000mfd/10 volt, **£1.50**. P.P. 50p.  
160,000mfd/10 volt, **£2.00**. P.P. 50p.

## BULK COMPONENTS OFFER

Resistors/capacitors 600 new components  
**£2.75**. P.P. 36p.  
Trial order 100 pcs **75p**. P.P. 20p.

## SMITHS GEARED MOTORS 240V AC

3 rev. per min. **£1.50**. P.P. 25p.  
4 rev. per min. **£1.50**. P.P. 25p.  
6 rev. per min. **£1.50**. P.P. 25p.  
2 rev. per hour. **£1.50**. P.P. 25p.  
6 rev. per hour. **£1.50**. P.P. 25p.

## HIGH-SPEED MAGNETIC COUNTERS

4 digit (non reset) 24v or 48v  
(state which)  
4 x 1 x 1 in. **£1**. P.P. 20p.  
5 digit (non reset) 24v. **£1.50**. P.P. 20p.  
3 digit 12v (Rotary Reset) 2 1/4 x 1 1/4 x 1 1/4  
**£1.40**. P.P. 15p.  
6 digit (Reset) 220v. a.c. **£3.50**. P.P. 25p.



## RESET COUNTER (BRAND NEW)

6 digit 24v. 25 I.P.S. **£5** P.P. 25p.

## TRANSFORMERS

L.T. TRANSFORMER. Prim. 110/240v.  
Sec. 0/24/40v. at 1 1/2 amp. (Shrouded).  
**£1.95**. P.P. 50p.  
L.T. TRANSFORMER. Prim. 200/250v.  
Sec. 20/40/60v. at 2 amp. (Shrouded). **£3**.  
P.P. 70p.  
L.T. TRANSFORMER. (H.D.) Prim.  
200/250v. Sec. 18v. at 27 amp; 40v. at  
9.8 amp; 40v. at 3.6 amp; 52v. at 1 amp;  
25v. at 3.7 amp. **£17.50**. P.P. £2.50.  
L.T. TRANSFORMER. Prim. 240v. Sec. 20v.  
at 2.5 amp. **£2**. P.P. 65p.  
L.T. TRANSFORMER ('C' CORE).  
200/240v. Secs. 1-3-8-9c. All at 1.5 amp.  
50v. at 1 amp. **£2.50**. P.P. 50p.

## SIEMENS MINIATURE RELAYS

6v.4 c/o **65p**. 24v.2 c/o **50p**.

## MINIATURE RELAYS

(1 3/8 x 1 1/4 x 1/2) 24 v.4 c/o **35p**. P.P. 5p.

## MAINS RELAY 240v.a.c.

3 c/o 10 amp. contacts **80p**. with base P.P.  
20p

## 24v a.c. RELAY (PLUG IN)

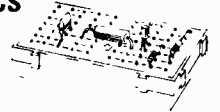
3 pole c/o **75p**. P.P. 15p.  
2-pole c/o **55p**. P.P. 15p.

## MINIATURE REED RELAY

(1 x 1/4) 12v. 1 c/o **50p**. P.P. 10p.

## S-DECS AND T-DECS

S-DEC **£1.90**.  
U-DEC A **£4.20**.  
T-DEC **£3.60**.  
U-DEC B **£6.90**.



## S.T.C. CRYSTAL FILTERS

(10.7Mhz) 445-LQU-901A (50 Khz spac-  
ing). **£3**. P.P. 20p.  
445-LQU-901B (25 Khz spacing). **£4**. P.P.  
20p. 10.7 Mhz Canned I.F.s. Size 1 x 1/2 x 1/2  
in. (with data) **65p**. P.P. 10p.

## 3 GANG TUNING CAPACITOR

8.5 PF, to 320 P.F. **80p**. P.P. 20p.

## V.H.F./U.H.F. POWER TRANSISTORS

(type BLY 38). 3 watt output at 100-500  
Mhz. **£2.25**. P.P. 10p.

## AM/FM TUNING METER

125-0-125  $\mu$ A Edgewise 1 1/2 x 1/2, **£1.10**

## SIGNAL STRENGTH METER

250  $\mu$ A (illum.) Edgewise 1 1/2 x 1/2, **£1.10**

## OUTPUT METER CLEAR PLASTIC

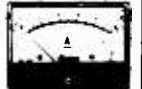
500  $\mu$ A 1 1/2 x 1 1/2, **£1.30**

## MINIATURE METERS

500 micro-amp (level stereo beacon, etc)  
scaled half back/half red. Size 1 x 1 in. **65p**.  
P.P. 15p.

## PANEL METERS

2 3/8 in. x 1 3/8 T8 500mA  
T1 50 $\mu$ A T9 1amp  
T2 100 $\mu$ A T10 50v.a.c.  
T3 500 $\mu$ A T11 300v.a.c.  
T4 1mA T12 50/0/50fIA  
T5 10mA T13 100/0/100 $\mu$ A  
T6 50mA T14 500/0/500 $\mu$ A  
T7 100mA All at **£3.75**. P.P. 15p.



## PANEL METERS

4 1/2 ins. x 3 1/4 D3 200 $\mu$ A  
D1 50 $\mu$ A D4 500 $\mu$ A  
D2 100 $\mu$ A All at **£4.60**. P.P. 15p.

## S.C.R.

1 amp. 400 P.I.V. **35p**  
5 amp. 400 P.I.V. **40p**

## ETCH RESIST

Pens **55p**. P.P. 5p

## MINIATURE "ELAPSED TIME" INDICATORS

(0.5000 hours) 45 x 8mm **75p**. P.P. 15p.

MAIL ORDER ONLY. PERSONAL CALLERS BY APPOINTMENT

# Appointments

Advertisements accepted up to 12 noon Monday, May 31, for the July issue, subject to space being available.

**DISPLAYED APPOINTMENTS VACANT:** £6.50 per single col. centimetre (min. 3cm).  
**LINE advertisements (run on):** £1 per line, minimum three lines.  
**BOX NUMBERS:** 45p extra. (Replies should be addressed to the Box Number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London SE1 9LU.)  
**PHONE: Owen Bailey on 01-261 8508 or 01-261 8423.**  
*Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.*

## TEST AND LIAISON ENGINEERS

Ferranti in Edinburgh have a number of Ministry of Defence contracts involving the design and development of advanced avionic equipment for military aircraft in an international market.

We have vacancies for test and liaison engineers who will probably be qualified to HND level in electronic engineering with some years' experience in design, test or support of modern avionic equipment. A knowledge of digital and analogue techniques is essential.

Close liaison with design/development teams currently engaged on inertial navigation and display systems will be necessary and the work will entail factory acceptance testing, fault diagnosis and system commissioning on a variety of sophisticated equipment.

There will be opportunities for some of these engineers after a period of in-house training to be selected for technical liaison duties at locations in the U.K., Europe, Middle and Far East.

The Company offers an attractive employment package which includes 22 days holiday and membership of a life assurance and pension scheme. Incoming personnel will qualify for housing under the Scottish Special Housing Association scheme and realistic assistance will be given with relocation expenses where applicable.

Apply in writing giving details of age, experience and qualifications to:

THE STAFF APPOINTMENTS OFFICER  
 FERRANTI LIMITED  
 FERRY ROAD  
 EDINBURGH EH52XS

# FERRANTI

### UNIVERSITY OF STRATHCLYDE AUDIO VISUAL UNIT TELEVISION ENGINEER Grade 6

required with experience in the maintenance of television and sound equipment. In addition to supervision of staff, the work includes the running of an electronic workshop and operational duties as a Senior member of the studio crew for television recordings. Candidates should have experience in a television studio, preferably as vision control engineer or sound mixer and should hold an H.N.C., City & Guilds or R.T.E.B. Certificate.

Salary Scale £3156 - £3762 per annum  
 Applications in writing, QUOTING REFERENCE AV 4, giving details of age and qualifications, should be made to The Personnel Officer, University of Strathclyde, Royal College Building, 204 George Street, Glasgow G1 1XW (5397)

### SENIOR TEST ENGINEER

To fault find on interesting and varied circuits for a range of equipments. Produced in small batches. Experience of digital and analogue circuits is essential. Above average salary and good promotional prospects. The Company is rapidly expanding with positive management. We have a full order book, mainly for export World Wide.

Please contact in confidence Mr. D. Hemsley

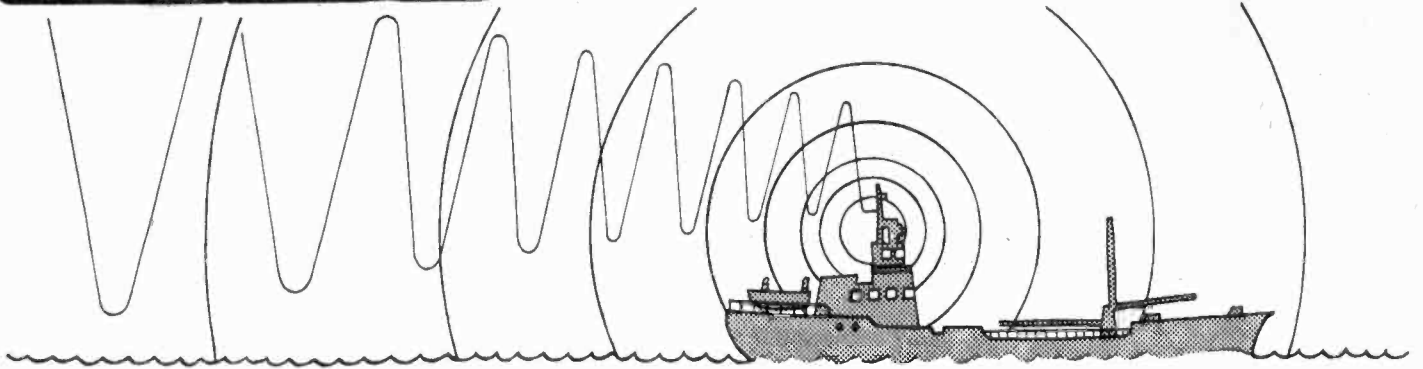
**DIGITAL ELECTRONICS LTD.**  
 Holywell Industrial Estate  
 Watford, Herts  
 Tel: 45991

(5519)

### **ema** Opportunities in the ELECTRONICS FIELD

We have selected from many vacancies those which offer exceptional career prospects and job interest. If you have experience in design, test, sales or service and wish to progress your career, please telephone Mike Gerret B.Sc. who is advising on these opportunities.

E.M.A. Management Personnel Ltd.  
 Burne House, 88/89 High Holborn  
 London WC1V 6LR  
 01-242 7773 1360



## Radio Officers—now you can enjoy the comforts of home.

Working for the Post Office Maritime Services really makes sense. You still do the work that interests you, but with all the advantages of a shore-based job: more time to enjoy home life, job security and good money. To qualify, you need a United Kingdom Maritime Radiocommunication Operator's General Certificate or First Class Certificate of competence in Radiotelegraphy, or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic.

Starting salaries, at 25 or over, are £2905 rising to £3704 after three years service. Between 19 and 24, the starting salary varies from £2234 to £2627

according to age. You'll also receive an allowance for shift duties which at the maximum of the scale averages £900 a year and there are opportunities to earn overtime. There's a good pension scheme, sick pay benefits and prospects of promotion to senior management.

Right now we have vacancies at some of our coastal radio stations, so if you're 19 or over, write to: ETE Maritime Radio Services Division (L687), ET 17.1.1.2., Room 643, Union House, St. Martins-le-Grand, London EC1A 1AR.

Post Office Telecommunications

93

## Engineer Technicians

**EMI have all kinds of future for you at Hayes**

With several different EMI industries concentrated at Hayes, Middlesex, the Company offers you work on a wide variety of equipments – plus opportunities to win promotions in one direction or another without ever having to move out of the Hayes area.

And, since the entire EMI Group is constantly expanding – and, indeed, looks likely to continue to expand for years to come – these opportunities may be expected to come up frequently.

Recent practical electronics experience associated with maintenance, commissioning, fault finding, testing or calibration, either in industry or with HM forces is essential.

Ideally, it will have involved work on advanced and complex electronic devices.



The international music, electronics and leisure Group.

(5381)

Certainly you'll need a good technical background with knowledge equivalent to ONC.

Given these minimum conditions, Engineer Technicians of all levels are required – and you're starting salary will faithfully reflect the experience you have accumulated to date.

Terms and conditions of employment at EMI are everything you would expect of a major international organisation, and assistance towards relocation expenses will be considered where necessary.

To apply, please write to Bill Clark, Personnel Department EMI Limited, 135 Blyth Road, Hayes, Middlesex.

Or telephone him on 01-573 3888 extension 639 or Record-a-call anytime on 01-573 5524.

UNIVERSITY LABORATORY OF PHYSIOLOGY OXFORD

### ELECTRONICS TECHNICIAN

PHGY 3770

Opportunity to join a small team providing an electronics service to a number of research and teaching groups. The work involves the full range of activities from initial discussion through design, construction, installation, modifications and maintenance.

Candidates must have at least 5 years experience in the construction and application of electronic equipment including analogue and digital techniques. H.N.C. standard is required and the ability to work with a minimum of supervision is essential. Familiarity with medical electronics would be advantageous.

Salary on University Technical Scale Grade 5, £2751 x 5 - £3207.

Letters of application stating age, qualifications, experience and the names of 2 referees to:

Administrator  
University Laboratory of Physiology  
Parks Road, Oxford OX1 3PT

Further details from Wilf Laycock, Supervisor Electronics Group, Oxford 57451 (5367)

### ELECTRONIC TECHNICIAN

DEPARTMENT OF CHEMISTRY

ELECTRONIC TECHNICIAN GRADE 5 required to join a team concerned with the development and maintenance of a wide range of electronic equipment encountered in chemical research. Experience of electronic equipment maintenance and development an advantage. Salary in range £2,751 to £3,207 + £465 London Weighting. Application form from Personnel Officer (Technical Staff CE5), University College London, Gower Street, WC1E 6BT. Closing date 28 May 1976.

(5520)

MEXICO ~~OR~~ **AND** MELBOURNE  
~~OR~~ **AND** PEKING ~~OR~~ **AND** KUALA  
 LUMPUR ~~OR~~ **AND** GOTHENBURG

### SERVICE AND INSTALLATION ENGINEERS

M.E.L., part of the Philips Organisation, has recently achieved outstanding success in gaining new markets for its highly successful range of medical Linear Accelerators - used in the fight against cancer.

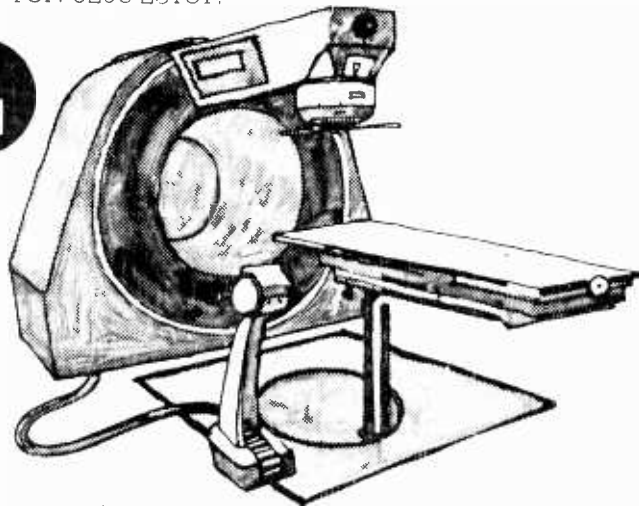
This expansion has created new opportunities for skilled engineers to install these highly sophisticated equipments in all parts of the world. As a member of a specialist team, you will be required to carry out installation projects (of up to three months' duration), service equipment and trouble-shoot - wherever your skills are needed.

You must be adaptable and self-reliant, qualified to at least ONC level or equivalent and have a good knowledge of semi-conductor circuitry. Preferably, you will also have worked on such equipment as modern high-power radar systems.

We offer a progressive salary, bonus and pension scheme, generous expenses and twenty three days' holiday. If appropriate, assistance will be given in moving to this attractive part of Sussex, situated mid-way between Brighton and London.

Please write or telephone for an application form to Diana Hill, Personnel Officer, M.E.L. Equipment Company Limited, Manor Royal, Crawley, Sussex. Tel: 0293 28787.

**M E L**



## TEST GEAR ENGINEERS

Rediffusion, a major British company in television manufacture, is developing a new, state of the art receiver at its Chessington laboratories. To support this project we require additional Test Equipment Design and Development Engineers at senior and intermediate levels to help produce our sophisticated production test equipment. Rediffusion test equipment leads the industry and uses both analogue and digital techniques along with an up-to-date approach to jiggng.

Applications are invited from well qualified and experienced test equipment engineers, who will be offered the opportunity to join a young and energetic team. Our work is usually demanding, often under pressure but always stimulating, using new ideas to speed production testing whilst reducing the demands on our test operators.

Salaries, which will depend on experience, are excellent and assistance with relocation will be given where appropriate. Some travelling to our production factories in Co. Durham will be necessary from time to time to assist in the installation and commissioning of new equipment since our design engineers are expected to be responsible for all aspects of their project.

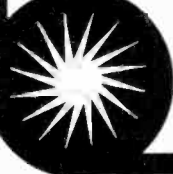
If you are a high calibre engineer and wish to have your ability recognised and rewarded, come and join us.

Write or 'phone to:

A. J. Litteck,  
Test Equipment Group Leader,  
Rediffusion Consumer Electronics Ltd.,  
Fullers Way South,  
Chessington, Surrey.  
Phone 01-397-5411

## REDIFFUSION

(5313)



### LEICESTER POLYTECHNIC School of Chemistry ELECTRONICS TECHNICIAN

To be responsible for

(a) the design, development and construction of prototype electronic equipment for chemical applications;

(b) the maintenance of existing equipment. Successful applicant must have a knowledge of analogue and digital electronics and will probably have at least two years' experience subsequent to taking a Full Technological Certificate, HND, or a degree in Electronics.

Salary: £2,922 - £3,702 p.a., plus qualification allowance for certain qualifications.

Apply in writing, giving full details, to Staffing Officer, Leicester Polytechnic, P.O. Box 143, Leicester LE1 9BH

(5380)

### London Borough of Barking Barking College of Technology LECTURER GRADE I IN MARINE RADIO/COMMUNICATIONS

required as soon as possible, principally for full-time courses in Marine Radio and for City and Guilds of London Institute Telecommunications Certificate. Applicants should have appropriate qualifications and experience. Burnham Scale salary £2,429 to £4,377, plus £351 London Addition. Requests for application forms and further details should be accompanied by a stamped addressed envelope and sent to The Registrar, Barking College of Technology, Dagenham Road, Romford, Essex, RM7 0XU. Completed forms to be returned to him within 14 days of the appearance of this notice.

(551D)

### THE UNIVERSITY OF MANCHESTER HESTER ADRIAN RESEARCH CENTRE Anson House Pre-School Project for Mentally Handicapped Children

A vacancy exists for a  
**TECHNICIAN**  
(Grade 3)

in the above project. The successful applicant will work in the pre-school facility which is one mile from the University, but will have access to electronic and mechanical workshops in the University itself. The major requirement will be that the technician will be responsible for the operation of an extensive CCTV system and will undertake the editing of tapes. Experience with CCTV is therefore important. Subsidiary functions will involve some electronic and mechanical work. UNC is essential and HNC (Electronics or Physics) (or equivalent qualification) desirable.

Salary scale £2,325 - £2,655 p.a.

The post is at present vacant and the successful applicant could start on a date to be arranged.

Applications with full details of age, qualifications and previous experience should be addressed to Dr. J. Hogg, Hester Adrian Research Centre, The University, Manchester M13 9PL

(5398)

### CIRCUIT DESIGN ENGINEERS SYSTEMS TEST ENGINEERS SALES AND CONTRACTS ENGINEERS



**MALLA  
TECHNICAL STAFF**

334 Euston Road  
London NW1 3BG  
01-387 1043

(5243)

### STROBE EQUIPMENT LTD.

Manufacturers of High Powered Studio Electronic Flash Equipment, which is used all over the world by top photographic companies, require

### SERVICE/CONSTRUCTION MECHANICS

To be generally involved in maintaining and building power units, accessories and allied devices. Basic electronic knowledge is sufficient but applicants should be capable of handling bench tools and light machinery and hold a current driving licence.

Phone or write (preferably):  
Mr. Cecil, Strobe Equipment Ltd  
56 Turnmill Street, London, EC1  
M5QR

01-253 0791 / 3

(5364)

### RESEARCH, DESIGN & DEVELOPMENT

We are expanding our Electronics Laboratory and can offer rapid results in all electronic departments. We have 15 years experience working for the Government and industry generally. Give our Technical Director, E. A. Falkner a ring on 01-572 0933.  
**R.C.S. Electronics, National Works, Bath Road, Hounslow, Middlesex**

## Opportunities for Electronics Engineers

To change to wider fields of electronics  
— join the EMI Service Team at Hayes.

Vacancies exist on repair and calibration of a wide range of electronic test gear including oscilloscopes, DVMs, pulse generators, power supplies etc.

Also

Servicing and commissioning closed circuit television equipment including cameras, VTRs, Monitors etc.

Applicants should have at least 5 years practical experience.

These positions offer varied and interesting work. Attractive starting salaries, subsidised lunches, 4 weeks holiday and excellent sick pay and pension schemes.

For further details telephone or write to - M. Ford, 01-573 3888, Ext. 2167, EMI Service, 254 Blyth Road, Hayes, Middlesex.



The international music, electronics and leisure Group

(5320)

# OMAN

## Dhofar Region Television Service

- Very Good Salary
- Free Family Passage
- No Income Tax payable in Oman
- Free furnished Accommodation
- Special End of Contract Bonus
- We pay Local Education Fees
- Comprehensive Free Insurance, Health, Dental, etc.
- Hard work is necessary

We are recruiting on renewable one year contracts and have vacancies for the following and other positions:

### **PROGRAMME STAFF**

- Production Direction
- News
- Film Editing
- Transmission Controller

### **OPERATIONS STAFF**

- Telecine
- V.T.R.
- Sound Dubbing and Mixing
- Film Processing

### **ENGINEERS**

- Studio
- Transmitters
- Microwave
- O/B Van

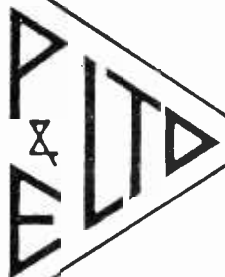
### **PLUS**

- Aerial Rigger
- Electricians

Let us discuss with you your abilities for these interesting and important positions.

Phone: Tony Towers, 01-573 8333 for more information

**PERSONNEL & ELECTRONICS LTD.**



## Radio Technology TELECOMMUNICATIONS OFFICERS

... for a Radio Station in Hertfordshire. The work is mainly concerned with the installation and maintenance of electronic equipment such as radio receivers, spectrum analysers and direction-finding equipment and involves the use of a wide range of test equipment.

Candidates (aged at least 23) must have ONC in Engineering (with a pass in Electrical Engineering 'A') or in Applied Physics, or an equivalent qualification. In addition, they should have had experience in the operation of radio receiving equipment and have a knowledge of current operational systems of radio communications.

Salary starting between £3,145 and £3,790 (according to age) and rising to £4,090. A shift system is worked and a shift disturbance allowance is payable. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 14 June 1976) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours) or London 01-839 1992 (24-hour answering service). Please quote T/9292/3.

HOME OFFICE

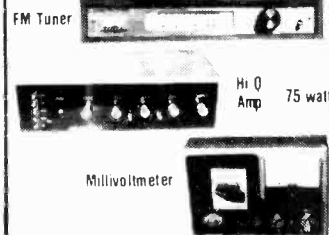
(5495)

### TELERADIO HI FI OFFER L. LINSLEY HOOD HIGH QUALITY AMPLIFIERS AND TEST EQUIPMENT

30 75 Watt Amplifier	Kit £12.00	Made £15.95
Pre-Amplifier	Kit £7.50	Made £10.00
Power Supply Unit	Kit £13.70	Made £15.30
F.M. Tuner (stereo)	Kit £40.00	
Low Distortion Audio Oscillator	Kit £14.00	Made £18.00
Milli Voltmeter Kit	Kit £15.25	
T.H.D. Analyser	Kit £18.50	
Reg. P.S.U.D.-60V, 1A	Kit £17.30*	
Frequency meter	Price to be announced	

\*Tax 8%, Other Items 25%

FOR DETAILED AND ILLUSTRATED LISTS SEND S.A.E.



325 Fore St., Edmonton, London N.9  
01-807 3719 Closed Thursdays (5210)

## Electronics Engineers

VOL is the worlds largest operator of commercial work submersibles. A number of these units are involved in underwater surveying, primarily for the off-shore oil industry.

As a part of our continuing expansion we have vacancies for Electronics Engineers to operate and maintain the computers, data logging and underwater acoustic systems, used in this developing technology.

Past experience should include either underwater navigation, surveying systems or data recording and computer maintenance. Familiarity with DEC PDP11 machines would be particularly useful.

Applicants should be of HNC standard and be able to work on their own initiative in a challenging environment. Off-shore and base training will be provided for suitable applicants. These positions are based at VOL's Leith Base and would involve periods of work at sea, usually not exceeding 3 weeks.

Please write for an application form to the:-

Personnel Officer,  
Vickers Oceanics Ltd.,  
P.O. Box 215  
East Old Dock,  
Leith Docks,  
Edinburgh EH6 6PH  
Tel: 031/554/0676



((5387))

## International Broadcast Sales Engineers

RCA Broadcast Division has openings for Sales Engineers to assume responsibility for the marketing and sale of our range of professional television and radio studio and transmitter equipment in areas of Europe, Africa and the Middle East.

The positions will be based either in Sunbury on Thames, England, or if appropriate on the continent of Europe, and each salesman/woman will have direct responsibility for the aggressive promotion and sale of our products.

As a considerable amount of time has to be spent in the countries concerned, applications are invited only from persons willing to spend up to 50% of their time in their sales territory.

Ideally, we seek people with past experience of selling broadcast or associated products, preferably internationally. However, we will also consider for training, candidates with experience in the operation and maintenance of broadcast equipment who are interested and keen to enter commercial and selling activity.

We are looking for people who are interested in overseas travel and who have the initiative, dedication and personality to operate effectively in the challenging environment of international sales. A knowledge of French and/or German would be an asset for some posts.

Salaries are negotiable but will certainly be in keeping with the responsibilities and demands of these posts. Competitive Company fringe benefits etc., exist.

Applications outlining past experience, age etc., should be sent as early as possible to:

Pam Torma, RCA International Ltd.,  
50 Curzon Street,  
London, W.1,  
England.



((5528))



**THE BRITISH COUNCIL**  
**SAUDI ARABIA**  
**AUDIO-VISUAL**  
**SPECIALISTS**

The British Council will require extra staff from July or August, 1976, for established Projects in Communication Skills in English at universities in Saudi Arabia.

The Projects, which are designed to teach English to students of Engineering, science, architecture and medicine, are supported by extensive audio-visual facilities. Vacancies will exist for suitably qualified Specialists in Audio-Visual Techniques and for Electronic Engineers with experience of CCTV.

Contracts will be for 12 months in the first instance. Total emoluments will be within the range £6,000 - £9,000 p.a. depending on the post and the circumstances of the candidate. They will be free of Saudi income tax. Free furnished accommodation will be provided.

Further particulars and forms of application are obtainable from Overseas Educational Appointments Department, The British Council, 65 Davies Street, London W1Y 2AA. Please quote reference 76 AU 30-60.

(5379)

# CCTV Engineer

EMI Service require an experienced CCTV Engineer to supervise a team engaged in the servicing and commissioning of CCTV systems and equipment. For this position, which offers varied and interesting work, applicants should have at least 5 years' practical experience in CCTV.

There's an attractive starting salary, subsidised lunches, 4 weeks holiday and excellent sick pay and pension schemes. For further details telephone or write to M. Ford on 01-573 3888 ext. 2167. EMI Service, 254 Blyth Road, Hayes, Middlesex.



The international music, electronics and leisure Group.

## TWO INSTRUCTORS IN MARINE RADIO

are required by

**COLLEGE OF I.M.R. COMMUNICATIONS**  
**160-176 CHORLTON ROAD, MANCHESTER M16 7WT**

One will be required to instruct morse sending and receiving to trainee radio officers, and the other will teach the theoretical syllabus for the Home Office General Certificate course.

Qualifications and experience will determine the position on a salary scale £2,112 to £3,945.

(5524)

## SCOTTISH HOME AND HEALTH DEPARTMENT

# WIRELESS TECHNICIAN

Applications are invited for a post of Wireless Technician in Scottish Home and Health Department.

**Location:**

Montreathmont Moor (near Montrose)

**Qualifications:**

HNC in Electrical or Electronic Engineering or City and Guilds Certificate desirable.

**Experience:**

3 years' appropriate experience.

**Starting Salary:**

£2,010 (age 17) to £2,905 (age 25 or over) scale maximum £3,385. In addition a supplement of £313.20 per annum is payable for staff aged 18 or over (£261.00 per annum for staff aged 17). Applicants should have sound theoretical and practical knowledge of Radio Engineering and Radio Communications equipment in HF, VHF and UHF bands. The work involves installation and maintenance of equipment located at considerable distance from headquarters. A clean current driving licence and ability to drive private and commercial vehicles are essential.

Appointment is unestablished initially but there is prospect of an established (ie permanent) appointment after 1 year's satisfactory service.

Application forms and further information are obtainable from Scottish Office Personnel Division, Room 105, 22/25 Queen Street, Edinburgh EH2 1LY (quote ref: PM(PTS)2/5/76 (031-556 9222, ext. 727).

Closing date for receipt of completed application forms is 27 May, 1976.

(5389)

## LEEDS CITY COUNCIL

Department of Education

Leeds Polytechnic — Education Technology Unit

# T.V. ENGINEER (Temporary)

(Ref. 13/23)

T3 £2922 - £3282

The holder of this post works with the media production team in the operation of the colour television studio and related recording facilities and assists in the maintenance of equipment.

Application forms (quoting ref. no.) together with further details, should be obtained from the Administration Officer, Leeds Polytechnic, Calverley Street, Leeds LS1 3HE. Please enclose S.A.E.

(5378)



## Anglian Water Authority

# ELECTRICAL AND MECHANICAL ASSISTANT

Ref: W1032

Grade 7

£4,650-£5,016

Applications are invited for the above post based at Milton Keynes Office, Old Stratford.

The successful candidate will be responsible for the operation, maintenance and installation of all electrical, electronic and mechanical equipment in the area, including modern processor operated telemetry.

Relocation expenses payable in appropriate cases and an essential car users allowance will be attached to the post.

NJC for Water Service Staffs Conditions of Service apply.

Further details available from: The Area Manager, Cosgrove Road, Old Stratford. Telephone: Stony Stratford 2481.

Applications in writing to: The Divisional Manager, by May 30th, 1976.

BEDFORD WATER DIVISION  
 Cambridge Road, Harrowden, Bedford, MK42 011

*Looking  
for  
a  
new  
job?*

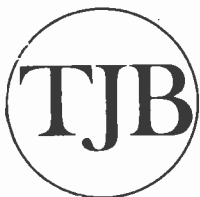
## Perhaps we can help!

We have regular contact with hundreds of electronics and electrical companies needing qualified electronics engineers and technicians and TV service engineers.

We can, therefore, help you to find an interesting and well paid job. All you need to do is to return the coupon below or give us a ring. Our service is confidential and costs you nothing.

**TJB Electrotechnical  
Personnel Services  
12 Mount Ephraim  
Tunbridge Wells, Kent**

**Tunbridge Wells (0892) 39388**



TJB Electrotechnical Personnel Services is a division of Technical & Executive Personnel Ltd. and is solely concerned with job placement in the Electronics and Electrical Industries

*Please note that this service is available only for engineers who are (or will be) available in the U.K. for interview.*

Please send me an "Application for Registration" form

NAME .....

ADDRESS .....

.....

..... (90)



Phillips Petroleum Company, operator for the Phillips Norway Group of companies, is establishing a major crude oil processing, natural gas liquid fractionating and terminalling project at Seal Sands, Cleveland, which will create employment opportunities for high calibre personnel

## TECHNICIANS

(WW/1/76)

An integral and important part of our operations capability at our oil stabilisation and NGL fractionating plant presently under construction will be sophisticated computer and communications controls.

Daniels, Kent, AAI computers will be used extensively to optimise plant control functions with the metering and loading of products into sea going tankers.

Communications equipment centres around at Tropospheric scatter shore station and micro wave link with the Ekofisk oil field in the North Sea. In plant radio and telephone systems will also be in operation.

We now wish to establish a small group of technicians to maintain and repair this wide range of equipment and invite applications from candidates who can offer relevant practical experience with preferably a H.N.C. qualification

These appointments offer competitive commencing salaries, and conditions of service are those one would expect from a major organisation such as Phillips Petroleum Company.

If you are interested in these vacancies, please write for an application form (quoting job reference No.), to: Mr. A. Jackson, Personnel Officer

(5395)



**PHILLIPS PETROLEUM COMPANY**

Teesside Operations, Seal Sands, Middlesbrough, Cleveland TS2 1HD Tel: 0542 546411

**WEST BIRMINGHAM HEALTH DISTRICT**

## TECHNICIAN

**For the Electronics and Bio-Medical  
Engineering Section**

The successful applicant must have sound knowledge and experience of maintenance and development of electro medical respirators, ventilators, laboratory and other electro-mechanical equipment

Salary. Technician III £2931-£3834 (increase pending).

Technician II £3558-£4581 (increase pending).

Starting salary dependent on qualifications and previous experience.

Application form and job description from District Works Officer, Dudley Road Hospital, Birmingham B18 7QH. Telephone 021-554 3801, Ext. 4838

Please quote ref. 840/WW

(5506)



Wellcome

## SENIOR TECHNICIAN Bioengineering

An opportunity has occurred in our Pharmacology Department for a Senior Technician to work in the Bioengineering field. There will be some troubleshooting and general maintenance but principally the work concerns the design, construction and servicing of electronic apparatus. The successful candidate, who will join a small and specialised team, must be able to work with both analogue and digital electronic circuits and should be familiar with multichannel equipment used for recording bioelectric signals.

Education is likely to be to H.N.C. level or possibly a technical qualification at a lower level in electronics.

Our Laboratories are situated in pleasant parkland surroundings within easy reach of Bromley and Beckenham, and about 12 miles from Charing Cross. Conditions of employment are attractive and include 4 weeks' holiday, a subsidised canteen and excellent sports and social facilities.

Please write, quoting reference ZH.652, and giving brief details of qualifications and experience to:

N. J. Michell  
Personnel Officer  
The Wellcome Research Laboratories  
Beckenham  
Kent BR3 3BS



(5396)

## INSTRUMENTATION SECTION LEADER

c. £4,500

Michelin seek a graduate or HND engineer (of either sex) to head a small technical group working on vehicle instrumentation systems at Stoke-on-Trent

Applicants must have at least five years instrumentation experience with road vehicles or aircraft. Knowledge of both digital and analogue data handling is essential, and ability in FORTRAN would be an advantage.

As leaders in radial tyre manufacture, Michelin reflect their favourable world market position in excellent service conditions including five weeks annual holiday, pension and life assurance schemes, and relocat on assistance.

Please write, with full details of career to date, to

Recruitment Manager (SPS), (M.322/WW)  
Michelin Tyre Co. Ltd.  
Stoke-on-Trent ST4 4EY

# MICHELIN



(5508)

**RESEARCH, DESIGN & DEVELOPMENT.** We are expanding our Electronics Laboratory and can offer rapid results in all electronic department. We have 15 years experience working for the Government and industry generally. Give our Technical Director, E. A. Falkner a ring on 01-572 0933. R.C.S. Electronics, National Works, Bath Road, Hounslow, Middlesex. (5500)

### UNIVERSITY OF LEEDS TELEVISION SERVICE

Applications are invited for the post of SENIOR AUDIO ENGINEER, based at the University Television Service in Leeds, where the facilities include two television studios, one film studio, an audio-dubbing suite, a mobile television unit and a number of other portable camera/VTR units.

An active interest and competence in practical sound recording at an appropriate professional level is essential, and the duties include the operation and engineering maintenance of film and television audio recording and dubbing equipment, together with the supervision of, and close working involvement with, other members of staff.

Evidence of ability will be required and practical tests will be arranged for those interviewed.

Salary will be within the range £3,156-£3,762 per annum and the conditions of employment for those applying to full time University technical staff.

Details, applications should be sent as soon as possible to The Deputy Director (Technical Services), University Television Service, The University of Leeds, Leeds LS2 9JT. (5502)

**V.H.F. RADIO TELEPHONE.** Both bench and field engineers required for maintenance and installation. 5-day week salary, £2,500-£3,500 p.a. depending on experience. Must be capable of using own initiative. 01-573 4541. (5523)

**RADIO-Telephone Service Engineer/Manager** wanted for workshop in Croydon. Must be experienced in Pye, GEC, etc., mobile radio equipment. Enormous potential for the right applicant. Salary according to ability and experience. 01-680 1010. (5518)

## AUDIO/ COMMUNICATIONS CONSULTANT

A leading firm of consultants in the Entertainment Industry are looking for a Specialist to expand their team dealing with theatres, conference halls and studios in the U.K. and abroad. Practical experience in communications systems, sound reproduction and reinforcements, recording and television is appropriate and an ability to define equipment and installation details is required. Based in Central London.

Applications in confidence to Box No 5511.

## The Polytechnic of North London

Department of Electronic  
and Communications  
Engineering

### Two Technicians (Grade 11B)

Applications are invited for the posts of two Technicians (Grade 11B) in the Department of Electronic and Communications Engineering. Duties will include provision of general assistance to students as directed and construction, modification and servicing of electronic test equipment, under supervision.

2 to 3 years' similar previous experience is desirable and suitably recognised qualifications.

Salary scale: £2583-£2910 inclusive of London Weighting.

Application forms obtainable from the Establishment Officer, The Polytechnic of North London, Holloway Road, London, N7 8DB. (5516)

### University of Glasgow Department of Music ELECTRONIC MUSIC STUDIO

#### A TECHNICIAN Grade 5

is required to maintain, modify and build equipment for the Electronic Music Studio in the Department of Music.

Applicants should be interested in digital and audio electronics, be able to maintain analogue and digital audio equipment and have at least an ONC and seven years' of relevant experience.

The studio is developing a course as part of the University's B.Mus. degree and provides facilities for professional composers. Equipment includes 16-track recording facilities, based on an Ampex 1000 and including Dolby noise reduction, quadrophonic and stereo playback, a computer-controlled (PDP8/A) Synthi 100 and other synthesizing equipment.

Salary range: £2751-£3207.

Further information from, and all applications including a curriculum vitae and the names of two referees, to: The Personnel Officer, The University of Glasgow, Glasgow G12 8QQ, not later than 4th June, 1976. (5496)

**THERMIONIC VALVE** expert specialising in "Rats Nests" required by famous film school desperate for maintenance assistance. Little money, much enthusiasm and satisfaction. Hours 9.30-6 p.m. weekly or by arrangement. — Apply to: The Administrator, The London International Film School, 24 Shelton Street, London, WC2.

**V.T.R. ENGINEER** required by C.C.T.V. Company. Applicants should have at least 5 years experience in the V.T.R. field and be fully conversant with all helical scan V.T.R.'s. Salary will be negotiable. Applicants should write giving full details of experience, qualifications and give an indication of salary required to Box No. 5530. (5530)

**RADIO TELEPHONE** Service Engineer wanted for work-shops in South London. Must be reliable and experienced with Pye, GEC, and other mobile radio equip. Salary Neg. 680-1010. (5329)

Required a **TECHNICAL REPRESENTATIVE** to sell the Electro Voice range of sound reinforcement products in the United Kingdom.

Ideally the person selected will be a graduate Engineer in Physics, Electronics or Acoustics aged between 25 and 30 years having industrial experience with a company in the electro-acoustical, recording or sound reinforcement fields. Selling experience to Recording Studios, National Broadcasting Companies and/or the entertainments industry will be a distinct advantage.

Remuneration will be on a basic salary plus commission basis and there is ample scope for promotion for the successful applicant, who can successfully demonstrate an ability to build good business for our products in the UK. Please write or telephone Wendy Hunter, Gulston Europe Ltd., The Hyde, Lower Bevedean, Brighton BN2 4JU, Sussex, England. Tel. Brighton (0273) 66271. (5390)

### CA CAPITAL APPOINTMENTS LTD.

#### FIELD SERVICE ENGINEERS (ELECTRONICS)

If you're not earning over **£3,500** p a plus a car — then you had better contact us!

(5360)

34 Percy Street, London, W.1  
01-636 9659 (day) or  
550 0836 (evening)



**ARTICLES FOR SALE**

**Economise on Semiconductors**

All prices include VAT — by return service

★ Lower price 741C

★ Lower price CMOS

	1+	10+	25+	TTL Mixed prices		CMOS Prices	
				1+	25+	1+	25+
723C + data 14 pin DIL	70	68	64	7400	11	4000	16
741C + data 8 pin DIL	21	21	20	7402	12	4001	15
748C + data 8 pin DIL	34	33	31	7403	12	4002	15
LM308 + data 8 pin DIL	95	89	85	7404	13	4006	100
CA3046 14 pin DIL	80			7405	13	4007	16
TDA 1415 15V 450mA	70	68	65	7410	12	4008	95
BC107, 108, 109, 109C	10	10	9	7413	28	4009	45
BC182, 184	12	11.5	11	7420	12	4008	96
BC212, 214	13	12.5	12	7430	11	4010	45
HP D.2 LED red + clip	20	19	18	7442	60	4011	15
HP 1/4" LED red	19	18	17	7447	80	4012	15
DIL low profile	8 pin	12	11	7473	28	4013	42
Sockets	14 pin	13	12	7474	30	4014	90
	16 pin	14	13	7476	30	4015	80
HP 5082-7740 red cc digit	170			7486	28	4016	48
MT 242CS 12-0-12 Transformer	130			7490	45	4017	83
				7492	55	4023	15
				7493	42	4024	65
				74121	32	4025	15
						4027	45
						4028	78
						4030	45
						4040	90
						4046	110
						4049	45
						4050	45
						4068	16
						4071	15
						4078	16
						4081	15
						4507	50
						4511	130
						4520	112

BC177	21	2N3702	11	1N4002	4.5
BC179	22	2N3704	12	1N4004	6
BF244B	30	2N3708	8	1N4006	7
BFY51	15	2N3055	4	1N4148	4
BZY88C-3V3-15	11	1N914	49	1N4148(10 off)	33
		1N4001	4		

AY-5-1224 16 pin digital clock IC + data + circuit ..... 4.00  
 Clock IC + 4 HP D.3" digits ..... 10.00  
 Clock IC + 4 digits + transformer + transistors ..... 11.50  
 TC4940 10W audio amp + data + circuits ..... 1.90  
 TA0100 radio IC + IF filter + circuit ..... 1.65  
 Carbon film high stab resistor 1/4W 5% E12 values 10ohm - 2M2: 1.1p ea., 10 for 10p. 100 90p same value

All prices include VAT P&P (UK) 15p. Overseas at cost. All goods new. Full spec devices from Motorola, Mullard, TI, SGS, etc. Schools, colleges supplied on credit. By return service

**SILICON SEMICONDUCTOR SERVICES**  
 41 Dunstable Road, Caddington, Luton LU1 4AL

(40)

**EXCLUSIVE OFFER**

**WORLD-WIDE RANGE NEVER BEFORE OFFERED**  
**PHILCO HC-150 POINT-TO-POINT STRIP RADIO HF RECEIVERS** 2/30 m/cs. Ten fully tuneable channels to 0.5 kcs with synthesizers. Single and diversity reception on ISB, DSB, SSB with 4 sub-bands to each channel. Full details and prices on application.

**HIGHEST QUALITY 19" RACK MOUNTING CABINETS & RACKS**

Our Ref.	Height in ins	Width in ins	Depth in ins	Rack Panel Space in ins	Price
CR	69	30	20		£24.00
FA	85	22	36	180	£22.00
FC	52	25	22	47	£17.00
FH	15	21	17	11	£12.00
FJ	15	21	15	12	£12.00
LL6	11	21	17	9	£15.00
LL7	16	20	12	14	£15.00
LL8	19	20	10	9	£15.00
LL9	17	21	17	14	£15.00
LL10	52	21	18	46	£15.00

Also Consoles, twin and multi-way Cabinets

**OPEN RACKS**

Our Ref.	Height in ins	Channel Depth	Panel Space	Base	Price
RG	66	2	51	14	£9.00

Full details of all above on request

We have a large quantity of "bits and pieces" we cannot list — please send us your requirements, we can probably help — all enquiries answered.

- \* Belling Lee 75ft. Sky Tower, self supporting £475.00
- \* Rhode & Schwarz SBR sig gen, 1.6/2.4 gmc. £70.00
- \* Airmec 702 sig gen 30 cyc 30 kcs. £26.00
- \* Muirhead D669 Analysers £70.00
- \* S.E. 4000 System Units P.U.R.
- \* Large Aerial Turning Units P.U.R.
- \* Muirhead Hydraulic Relays P.U.R.
- \* Lavoie OS-62 Oscilloscopes 115v 15 m/cs. £65.00
- \* S.T.C. Rx 5 Receivers 0.5/25.0 m/cs Dual. Dirty
- \* 45 feet Uniradio 4 Coxax 50 ohms £90.00
- \* Stelma RTT Scopes £20.00
- \* Baluns Professional Exterior 600/75 ohms £6.00
- \* Telegraph Distortion Test Sets £30.00
- \* 25ft Telescopic Aerial Masts £24.00
- \* Advance LI Signal Generator 300/1000 m/cs £70.00
- \* Addo 5/8 Track Tape Punches P.U.R.
- \* Digital Cassette Recorders 1/2" 1000 bps £250.00
- \* OS-8 Oscilloscopes 115v £30.00
- \* 1600ft 16 m/m Film Spools ally (unused) 10 for £4.00
- \* Quality electric Weather Vanes 8 contacts (unused) £15.00
- \* Large Aerial Rotators for Coaxial £18.00
- \* B.N.C. Connectors 200 for £42.00
- \* Video Cross Hatch TV Generators £17.00
- \* Racal MA-175 I.S.B. Modulators (new) £45.00
- \* Collins KWT-6 SSB Transceivers 500 watts 2/30 m/cs P.U.R.

- \* Inslide Cabinet Shelf Sliders £3.00
- \* DG-7/32 and DG7/5 C.R.T.'s £3.00
- \* Remscope Storage Scope with tracer £115.00
- \* M.V.R. Action Replay 20 sec. Videodisc Unit P.U.R.
- \* Advance H1 Signal Generators, 15-50Kcs £18.00
- \* Varian VA175EA Backward Wave Oscillators P.U.R.
- \* Tally 5/8 Track Tape Readers 60 cps £48.00
- \* Tally 5/8 Track Tape Readers 120 cps £65.00
- \* 2 KV A Auto-Transformers £22.00
- \* 15 foot 12 inch Lattice Steel Mast Sections £28.00
- \* Cintel 2 KV Power Supplies £35.00
- \* Cawtell FU 4 Band Pass Filter Testers £60.00
- \* Avo Geiger Counters (new) £7.50

We have a quantity of Power Transformers 250 watts to 15KVA at voltages up to 40KV. Best quality at low prices. Lists available

- \* Racal RA-63 SSB Adaptors, new £70.00
- \* Racal RA-237 L-W Converters, new £70.00
- \* 19 Blank Rack Panels 8 1/2 inch high, new £1.00
- \* Aspeco Dial a Copy Photo Copier Electrostatic £60.00
- \* Hewlett Packard 524C Digital Counter P.U.R.
- \* Portable Mains Battery Floodlights £24.00
- \* 400 channel Pulse Height Spectrum Analysers £600.00

We have a varied assortment of industrial and professional Cathode Ray Tubes available. List on request.

**AUDIO AND INSTRUMENTATION-TAPE RECORDER-REPRODUCERS**

- \* Plessey ID33 Digital Units, 7 track
- \* Plessey M5500 Digital Unit, 7 tracks
- \* Ampex FR-1100, 6 speeds, stereo 1/2"
- \* Ampex FR600, 4 speeds, 7 tracks 1/2"
- \* Ampex FR600, 4 speeds, 7 tracks 1/4"
- \* D.R.I. RMI, 4 speeds, 4 tracks 1/2"
- \* EMI TR30 2 speeds, 1 track 1/2"
- \* EMI BTRI, 1 speed, 1 track 1/2"
- \* EMI R301G, 2 speeds, 2 tracks 1/2"
- \* Mincom CMP-100, 6 speeds, 7 tracks 1/4, 1/2, 1"
- \* Leavers Rich DA-2P, 2 speeds, 2 tracks 1/2"

Prices of above £70 to £400

Also Transport Decks only available

**COMPUTER HARDWARE**

- \* LINE PRINTER, High speed 1000 lines c.p.m.
- \* TAPE READER, High-speed 5/8 track 800 c.p.m.
- \* CARD READER 80 col. 600 c.p.m.

Prices on Application

PLEASE ADD CARRIAGE AND V.A.T.

AT APPROPRIATE RATE TO ABOVE

**P. HARRIS**  
 ORGANFORD — DORSET  
 BH16 6BR  
 BOURNEMOUTH (0202) 765051

**SAVE IT! BARGAIN**  
**500 WATT DIMMER SWITCH**  
 (not suitable for fluorescent lights)  
 Basic Module with 1" Knob £2 00  
 Complete on MK switch plate £2 50  
 Large 2" knob (BULGIN) 25p extra.  
 P&P 25p  
 Please add 8% VAT to all orders inc. P&P  
**FRASER-MANNING LTD.**  
 40 TUNHAM ROAD, IPSWICH IP4 2SL (35)

**QUARTZ CRYSTAL UNITS** from

- 10 000 MHZ
- FAST DELIVERY
- HIGH STABILITY
- TO DEF 6271-A

WRITE FOR LEAFLET AT 1  
**McKNIGHT CRYSTAL Co. Ltd.**  
 HARDLEY INDUSTRIAL ESTATE, HYTHE, SOUTHAMPTON SO4 6ZY  
 TEL HYTHE 848961 STD CODE 0703

**Quartz Crystal Units**  
 ACCURATE RELIABLE

Private enquiries, send 10p in stamps for brochure  
**THE QUARTZ CRYSTAL CO. LTD.**  
 Q.C.C. WORKS, WELLINGTON CRESCENT, NEW MALDEN, SURREY. Tel: 942 0314 x 2488

**THE SCIENTIFIC WIRE CO**  
 Copper — Nickel — Chrome — Eureka — Litz — Manganin Wires  
 Enamelled — Silk — cotton — Tinned Coverings.  
 \* No minimum charges or quantities  
 \* Trade and export enquiries welcome  
 \* S.A.E. brings List  
**P.O. BOX 30, LONDON E4 9BW**

**RIVERSIDE ELECTRONICS**  
 Wholesalers and other large users of consumer electronic components are invited to send for our monthly list of special offers. We stock semi-conductors, i.c.s, capacitors, resistors, etc. Export enquiries welcome.  
**P.O. BOX 4, WISBECH, CAMBS.**  
**Telephone: 0945 4188**  
 (5521)

**MICROPHONE PREAMPLIFIER**  
 Small pc board (70x90mm) accepting two 30-600 ohm microphones (balanced input) and feeding loads down to 5 Kohm. Board plugs into 12-way gold edge connector (supplied) and has presets for gain 1.5dB noise figure. Supply + 24V. Board built and tested £37 Ktt £29

**STEREO DISC AMP**  
 FOR BROADCASTING AND DISC MONITORING  
 Magnetic cartridge to balanced lines with HF and LF filtering. Excellent distortion and overdrive performance. MEETS IBA SPECIFICATION. £110.

**10-OUTLET DISTRIBUTION AMP**  
 One balanced input — 10 isolated balanced outputs GENERAL STUDIO WORK + FEEDING MULTIPLE SLAVE PA AMPLIFIERS \* DRIVING FOLDBACK HEADPHONES  
 Meets IBA signal path specification Complete and boxed unit £100  
 Set of parts excluding case and all XLR connectors £62.

**STABILIZER**  
 FOR HOWL REDUCTION, BALANCED AND UNBALANCED VERSIONS BOXED OR RACK MOUNTING  
**PUBLIC ADDRESS: SOUND REINFORCEMENT**

+ 5Hz Fixed Shift Circuit Boards for WW July 1973 article.  
 Small enough to be built inside the cabinets of many amplifiers.  
 Complete kit and board £24 including PSU & designer board built and aligned E31 mains transformer approved DESIGNER APPROVED  
**SPECTRUM SHIFTER**  
 Variable shifts 0.1 — 1000Hz for weird special effects on speech or music

**CRYSTALS**  
 Fast delivery at prototype and production quantities to your application. EG

100 KHz	0.005"	HC13.0	£2.50 each	£1,900 per 1,000
1 MHz	0.005"	HC6.0	£2.50 each	£1,800 per 1,000
2.097152 MHz	0.0025"	HC5.0	£3.05 each	£1,500 per 1,000
3.2768 MHz	0.0025"	HC5.0	£2.70 each	£1,500 per 1,000
10 MHz	0.002"	HC18.0	£2.00 each	£1,100 per 1,000

Also Statak LF crystals in TO-5 package many stock frequencies in the range 10 240 KHz. e.g. 10 12 8 16 384 32 768 & 100 KHz. prices from £2.55 each. £1 400 per 1 000  
 Please send for further details  
**INTERFACE QUARTZ DEVICES LTD.** 29 Market Street, Crewkerne, Somerset. Telephone: (046031) 2578 Telex: 46283

**DISCO UNIT**  
 Consisting of two KF Speakers, output 100w each. Two turntables, one Garrard and the other B.S.R. plus DJ Disco amplifier with Microphone and Headphones £200 for quick sale  
 Also comprehensive record selection available with unit  
**For further details**  
**Phone 01-440 4153 or 01-886 7026**  
 (5512)

**INVERTERS**  
 To operate mains equipment from 12v to 24v DC on automatic stand-by

Sine wave. Square wave. Self driven or Frequency controlled. Suitable for maintaining mains supply during power failure, running equipment where the mains is not available, or insulation from the mains. **Controlled battery charging incorporated.**  
**MAINS-STORE**  
 Send for information to  
**Interport Mains-Store Ltd.**  
 30 Old Bond Street, London W1  
 Tel. 01-727 7042 or 0225 3916  
 (5399)

## ARTICLES FOR SALE

**VACUUM** is our speciality, new and secondhand rotary pumps, diffusion outfits, accessories, coaters, etc. Silicone rubber or varnish outgassing equipment from £40. V. N. Barrett (Sales) Ltd., 1 Mayo Road, Croydon. 01-684 9917. (24)

**FOR SALE.** Heathkit receiver K/SB 303 in perfect order, £300. I. G. Hughes. 01-407 4411 Ext. 240. (5377)

**COMPONENT BARGAINS.** Full spec. 741 20p, 555 37p, 7447 decoders 58p, BD142 (Motorola 115W 40V) 25p, BC108 6p, Mullard polyesters, 50 mixed 1 & 2.2 microfarads 250V, tested but some cosmetic imperfections so £1. Mixed electrolytics, 500 untested £1. Minimum order £1, s.a.e. for discounts and full list, add 40p p.p. for capacitors or 20p for rest. — R. Wardle, 3 Erpingham Road, London SW15 1BE. (5393)

**OSCILLOSCOPE.** Dynamco D7100 1 x 2 and 1Y2 amplifiers, £185. — Carlisle 20776.

**CCTV EQUIPMENT.** Aston SPG1 sync pulse generator £70, vision mixer and effects unit. — Phone Carlisle 20776.

**QUANTITY OF MARCONI SIGNAL GENERATORS.** Type TF 1449, £25 each. Cash with order. Carriage forward. Contact Neil Brady, Ascot 23422. Office hours. (5369)

**VALVES RADIO TV TRANSMITTING INDUSTRIAL** 1936 to 1975, many obsolete types, list 20p s.a.e. for quotation. Postal export service. We wish to buy all types of valves new and boxed. Wholesale. Dealers, etc. stocks purchased. Cox Radio (Sussex) Ltd., The Parade East Wittering, Sussex, West Wittering 2023. (5392)

**QUANTITY OF MARCONI SIGNAL GENERATORS,** type TF144G. £25 each. Cash with order. Carriage forward. — Contact Neil Broady, Ascot (Berks) 23422. Office hours. (5369)

**100 MHz TWIN BEAM,** dual time-base oscilloscope as new £450.00 o.n.o. Ring Bristol 294186 a.m. or Weston super Mare 412178 p.m. (5388)

**TELEPRINTERS CREED.** Envoy 5-Unit receive only in good working order in CABINETS. Tel Communications Department 01-353 1515. (5498)

**60 KHz MSF RUGBY RECEIVERS.** BCD TIME-OF-DAY OUTPUT. High performance, phase locked loop radio receiver. 5V operation with LED indication. Kit complete £9.50; assembled and tested unit £11.12 (prices include postage and V.A.T.) Also available low power receiver with signal and audio outputs. Send for details Toolax, Sherborne (4359) Dorset. (21)

**SIGNAL GENERATOR M.I. TF887A,** 15 kHz to 30MHz. £90.00. — Tel. Hedingham 60599.

**PRINTED CIRCUIT BOARDS.** High quality, fast deliveries. — Photo-techniques, 11 Old Witney Road, Eynsham, Oxford. Tel. Oxford (0865) 880645. (5525)

**INSTRUMENT TURNSCREWS (SCREWDRIVERS).** Precision made with hardened tool steel blades and brass bodies. Set of five, blade sizes 0.8mm to 2.4mm, packed in strong plastic wallet. To prove BRITISH can still be BEST send only £1.35 (incl. V.A.T., P. & P.) to Dunbar Marketing, Stamford House, Stamford New Road, Aittrincham, Ches. WA14 1BL. (5529)

**R.T.T.Y. GEAR.** For ham or computer enthusiast. Buyer collects. — Details ring Mr. Radley 01-953 1918. (5531)

**VARIACS** 240v I/P with driving motor, O/P 0 to 240v at 20 amps cont with 120v tap by Foster Elec £40. Veeders Counters 5 digit with reset coil 12/24v DC £1.30. Blower Motors small double ended 6 to 27v DC new £3.60. H.F. Trans Tx type 73w 75 to 600 ohm in case new £0.40. Meter Unit dual aircraft type as 270ft 1 ma & 100-0-100uA in same case 3 1/2 sq. £4.50. Spectrum Filter provides 20 channels in range 3 to 20Kc ea with its own o/p, use 20 pot cores, in box 6 1/2 sq. £4.30. Crystal Filters 10.7 Mc/s STC size 38 x 16 x 18mm 12Kc b.w. £1.60. 30Kc b.w. £1.30. New Tape Decks with amps ex language lab equip. Type A with BSR deck type TD. 2.2 chan. amp with erase osc. mixer & o/p stage provision for rec & playback on both chan. two chan are mixed to give one o/p for phones. Units are complete except for P.U. req 24v DC smoothed for amps. with circ £9.50 also type B similar but valve circs req ext H.T. & L.T. with circ £6.50. Aerial System 8 element Yagi for use on Satellite chan 183.6Mc/s for use with 50 ohm coax N type termination. boom approx 11ft new in cases £21.60. Vidicon Tube standard lin. type tested £9.60. Ind Unit small sector scan P.P.I. with P7 tube 4 1/2in dia with scan and focus coils in case 14in x 6in x 6in, needs ext eht £7.50. Radar Ass with 2J42 mag. Klystron, TR cells, balanced mixer. 715C, I.F. strip, etc with w.g. for X band £25. Marconi TF942 pulse scope, intended for high speed pulses, trig t.b. int cal marks, mains operated with circ £26. Trans Pria 120v 50c/s sec 34v at 60 amps supplied in pairs for 240v to give 34/120a or 68/70a £30 per pair. Selsyns 230v 50c/s power type £25 per pair. Goods are ex equip unless stated new. prices inc VAT and carr UK. A. H. Supplies, 122 Handsworth Road, Sheffield. S9. 4AE. Phone. 444278 (0742) (5501)

**LINSLEY-HOOD** 75 watt amplifier interference suppression kit — reduces effects of mains borne/rf interference and parasitic oscillation, virtually eliminates click from filter switch and now contains components to reduce preamp noise (available separately). Full fitting instructions supplied — £1.35. Headphone socket kit, with instructions. £1.45. Sescosem BDY56 £1.65. Motorola BD529 55p. BD530 55p. BF259 35p. 2N5457 35p. 2N5459 45p. MC1310P £2.30. Texas. BFR39 25p. BFR79 25p. Inclusive prices. P & P 10p. All components brand new. guaranteed and despatched by return. List SAE. I. G. Bowman (Dept WW), 59 Fowey Avenue, Torquay, S. Devon. (5499)

**CT 381 LABORATORY SWEEP GENERATOR SYSTEM** for IF/RF alignment, 10KHZ - 33MHz comprising PSU, generator, and scope, with handbook, spare PSU and scope. £85. Advance 7000 3 1/2 digit DPM. new. £15. Selectroboard programming panels 24 x 32 matrix. with 60 diode pins, new. £15. Additional pins 10p each. Heathkit Goldstate voltmeter IM 16 £12. — G3YLQ. Luton 25595. (5365)

**DAWE U.L.F. OSCILLATOR** 0.01 Hz to 1KHz, 90 degrees and ref phase O/P terminals, £30. Lapmaster monochromatic light unit £25. Gretsch Complex ratio bridge CRB B1, mint, 6 decades phase 4 real £300. Wayne Kerr Mod/Demod Unit SA400 £35. Wayne Kerr transfer function computer £200. Airmec 853 wave analyser 30kHz to 30MHz £65. Cossor motor driven oscilloscope camera unit £60. Marconi D.F.M. T.F. 142E £25. Solartron Synchro test unit JM 555.2 £40. B.P.L. megohmmeter RM175-LZ Mk 2 £30. Telegquipment 33C Amp plug in unit £20. Polaroid oscilloscope camera, mint, £60. P.S.U.s A.P.T. fully stabilised 20V @ 10A Variable + or - 10%V £12, 10V @ 10A £10. Terms C.W.O. V.A.T. at 8%. S.A.E. for your electronic components lists — "Q" Services Electronic (Camberley) Ltd., 29 Lawford Crescent, Yateley, Camberley, Surrey (0252) 871048. (5366)

**RACAL SA505** frequency counter, 7 digit DC-40 MHz with adaptor, handbook, good condition. £20. Ultrasonic cleaner, solid state 60W Generator plus 2 tanks, new £40. Cathodeon BP4706/1 1.4 MHz SSB filters, unused £5. Amplitude modulator TF 1102/1 £5. Wanted Philips LBB5000 pocket radio paging receivers. G3YLQ Luton 25595. (5504).

**OSCILLOSCOPES** telegquipment DC-15 MHz. 2 trace £150. Fairchild DC-25 MHz. 2 Trace 2 time base £270. Both with manuals Wargrave 2788. (5503)

**STEREO CASSETTE MECHANISMS.** Similar to those used in low-noise cassette deck WW May. Choice of side or top loading. Complete with heads and full technical data. Send S.A.E. Box. No. 5497.

**PYE, GEC, ITT** mobile radio equipment for sale. New and second hand mobiles and base stations ex stock. Crystals 2 weeks delivery. Finglas mobile and base station antennas available ex stock at very competitive prices. While you wait fitting service. Cash waiting for surplus r/t and test equipment. 01-680 1010. (5517)

**WE INVITE ENQUIRIES** from anywhere in the World. We have in stock several million carbon resistors 1/4, 1/2, and 1 watt. 1/2 million wire wound resistors 5 and 10 watt — 1 million capacitors — 1 million electrolytic condensers — 1/2 million transistors and diodes, thousands of potentiometers, and hosts of other components. Write, phone or call at our warehouse — Broadfields & Mayco Disposals Ltd., 21 Lodge Lane, N. Finchley, London. N.12. 01-445 0749, 445 2713. (5097)

**WATTMETERS.** Four multirange models covering ranges from 60W to 3KW. Further details from E.M.S. 21 Mount Road, Benfleet, Essex. SS7 1HA. (5363)

**TELEQUIPMENT** oscilloscope, dual beam, Model D43, Plug-in high gain Y amplifiers. TV line and frame sync: 15 M/Cs bandwidth. Manual. Little used £110. AVO valve tester Mk. 2. Manual, £70. E.H.T. transformer, mains input, 15 K.V. centre tapped at 20 mA, Parmeko hermetically sealed, as new. £20. — Tel. Erith (Kent) 30556. (5362)

## TAPE RECORDING ETC.

### RECORDS MADE TO ORDER

DEMO DISCS  
MASTERS FOR  
RECORD COMPANIES

VINYLLITE  
PRESSINGS

Single disc, 1 20, Mono or Stereo, delivery 4 days from your tapes. Quantity runs 25 to 1,000 records. PRESSED IN VINYLITE IN OUR OWN PLANT. Delivery 3-4 weeks. Steeves/Labels. Finest quality NEUMANN STEREO/Mono Lathes. We cut for many studios UK/OVERSEAS SAE list

### DEROY RECORDS

PO Box 3, Hawk Street, Carnforth Lancs  
Tel: 2273 (82)

### NEW GRAM

**GLASGOW.** Hi Fi, Cassette Decks, Tape Recorders, Video Equipment, always available we buy, sell and exchange for Hi Fi sets and photographic equipment. **VICTOR MORRIS** Audio Visual Ltd., 340 Argyle Street, Glasgow, G1, 8/10 Glassford Street, Glasgow, G1, 8/10 Sauchiehall Street. Tele: 041-221 8958. (11)

## ARTICLES WANTED

### WANTED!

all types of scrap and  
**REDUNDANT  
ELECTRONIC &  
COMPUTER  
MATERIALS**  
with precious metal content

### TRANSISTORS & PRINTED CIRCUIT BOARDS TO COMPLETE COMPUTERS

The **COMMERCIAL  
SMELTING &  
REFINING Co. Ltd.**  
171 FARRINGTON ROAD  
LONDON EC1R 3AL  
Tel. 01-837 1475.  
Cables: COMSMELT, EC1  
Works: FLECKNEY, nr. LEICESTER (5116)

### ★ MINICOMPUTERS ★ PERIPHERALS ★ INSTRUMENTATION

For fastest, best CASH offer, phone

**COMPUTER APPRECIATION**  
Godstone (088 384) 3106

**WANTED,** all types of communications receivers and test equipment. Details to R. T. & I. Electronics Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley 4986. (63)

**B-D ELECTRONICS** offer prompt settlement for your surplus components. Our main field of interest is consumer electronics. Please telephone our Miss Hughes, Sandy (0767) 81616. (22)

**REQUIRED** from Ministry of Defence and other sources Plessey models P.T.R. 371, also 691, 692 and 693. Please post full details to John F. Learney, 16 Pine Walk, Carshalton Beeches, Surrey. (5226)

**SURPLUS COMPONENTS.** Equipment and Computer panels wanted for cash. Ring Southampton 772501. (16)

**WANTED.** Agent to purchase Mono and Colour T.V.'s transistor radios, vacuum cleaners, washing machines, cookers, etc. New and second-hand, Box No. 5328.

**AVO VCM163 VALVE TESTER.** Wormald, 39 Greenside Lane, Cullingworth, West Yorkshire BD13 5AP. 0274-33466, Ext. 423 (Day) 053-58-2971 (evenings). (5515)

### LICENCE OFFERED

**ACOUSTICALLY ADJUSTABLE LOUDSPEAKERS.** We wish to appoint licensees to manufacture the world's first Monitor Loudspeaker with acoustic adjustability; the revolutionary Omal Ambionic TL6. It has no competition and its many unique features include a variable transmission line (patented) giving uncoloured sound reproduction of outstanding quality. For full details (Principals only), write to: — Managing Director, Omal Group Ltd., Omal House, North Circular Road, London, NW10 7UF, England.

### VALVES WANTED

**WE BUY** new valves, transistors and clean new components, large or small quantities, all details, quotations by return. — Walton's, 55 Worcester St., Wolverhampton. (62)

**VALVES.** Good prices. Types CV2797, CV2798, CV2792, CV2130, CV2131, CV345, CV450. Phone 021-373 4357. (5522)

SERVICES

and NOW

from ONE source

# SEENSEE

If you are an Engineer or Buyer in any of the following, write for our Catalogues

Manufacturing,  
Public Authorities  
Laboratories,  
Universities,  
Contracting,  
Maintenance.

*SERVICE*, you can obtain many other Technical Products including Electrical, Mechanical and Tools in addition to the Electronic components that we have been distributing to Industry for over 30 years.

Large duplicate stocks are kept in LONDON and SCOTLAND to give you quick service.



**CABLES & COMPONENTS LTD**

Park Avenue, London NW10 7XN

## COURSES

## The Polytechnic of North London

### Department of Physics B.Sc(Hons.) THE PHYSICS AND TECHNOLOGY OF ELECTRONICS

A sandwich course offering specialisation in Microwave Physics, or Theory and Practice of Computers, or Electrical Processes in Gases and Associated Spectroscopy.

#### HNC IN APPLIED PHYSICS

2-year day-release course with special topics in electronics.

#### CERTIFICATE OF SUPPLEMENTARY STUDY

3 one-term day-release courses (Further Electronics, Nuclear Radiation and Counting Techniques, Experimental Atomic Spectroscopy).

#### M.Sc. THE PHYSICAL BASIS OF ELECTRONICS

This course is available as a full-time, part-time or an evening only course for graduates in Physics, Electrical Engineering and allied disciplines.

Specialisation is offered in Semiconductor Physics and Devices, Plasma and Laser Physics, Electromagnetic Waves and Communication Theory.

Details of these courses from:  
The Head of the Physics Dept.  
(Ref. WW2)

THE POLYTECHNIC OF NORTH  
LONDON

Holloway Road, London, N7 8DB  
(Tel. 01-607 6767, ext. 305) (5391)

## SOUTHALL COLLEGE OF TECHNOLOGY

Beaconsfield Road, Southall, Middx. UB1 1DP

01-574 3448

### CEI PART II PART-TIME COURSE

in Electrical/Electronic Engineering Subjects

For full details please contact Head of Department of  
Electrical & Electronic Engineering

(5373)

## EQUIPMENT WANTED

### BROADFIELDS AND MAYCO DISPOSALS

21 Lodge Lane, N. Finchley  
London, N12 8JG  
Telephone:  
01-445 2713

01-445 0749

01-958 7624

MAY WE ASSIST YOU TO DISPOSE OF YOUR SURPLUS AND REDUNDANT STOCKS?

We will call anywhere in the British Isles, and pay SPOT CASH for Electronic Components and Equipment.

(5330)

## CAPACITY AVAILABLE

**BATCH** Production Wiring and Assembly to sample or drawings. Deane Electricals, 19B Station Parade, Ealing Common, London, W.5. Tel: 01-992 8976. (23)

**T.W. ELECTRONIC CONTRACTORS.** Wiring and assembly specialists. For instrument assy. Sub assy. P.C.B. assy. Cableforms etc. For service. Tel. 01-500 1708. (5334)

**RADIO** and Radar M.P.T. and C.G.L.I. Courses. Write: Principal, Nautical College, Fleetwood, FY7 8JZ. (25)

## RECEIVERS AND AMPLIFIERS

**HRO** Rx5s, etc., AR88, CR100, BRT400, G209, S640, etc., etc., in stock. R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E11. Ley 4986. (65)

**SIGNAL** Generators, Oscilloscopes, Output Meters, Wave Voltmeters, Frequency Meters, Multi-range Meters etc., etc. in stock. R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E11. Ley 4986. (64)

## SERVICES

**REVOX** could you do without one. Service repairs and modification (24 hours service). Please ring 01-902 6560. (5505)

**AUDIOMASTER BACKGROUND MUSIC** . . . service, sales. Tape programmes. P. J. Equipments. 3 Onslow Street, Guildford 4801. (12)

### PRINTED CIRCUITS and HARDWARE

Readily available supplies of Constructors hardware Aluminium sheet and sections Printed circuit board top quality for individual or published designs

Prompt service

Send 15p for catalogue

#### RAMAR CONSTRUCTOR SERVICES

Masons Road, Stratford-on-Avon  
Warwicks. Tel: 4879

## EURO CIRCUITS

Printed Circuit Boards — Master layouts — Photography — Legend printing — Roller tinning — Gold plating — Flexible films — Conventional fibre glass — No order too large or too small — Fast turnaround on prototypes. All or part service available NOW

## EURO CIRCUITS TD.

Highfield House  
West Kingsdown  
Nr. Sevenoaks, Kent. WK2344

**LABELS, NAMEPLATES, FASCIAS** on aluminium or plastic. Speedy delivery G.S.M. Graphic Arts Ltd., 1-5 Rectory Lane, Guisborough (02873-4443), Yorks, U.K. (5305)

**THOR-HOLE CONVENTIONAL P.C.B.'s** gold plating, roller tinning. Prototypes, silk screening, drilling. All or part service. — **ELECTRO-CIRCUITS (P.C.) LTD.**, Delamare Road, Cheshunt, Herts. Tel. Waltham Cross 38600 or 20344. (84)

**TUBE POLISHING**, scratched faces on your tubes can be repaired for £6.88 total cost, V.A.T. and return carriage included. — Retube Ltd., North Somercotes Louth, Lincs. — Phone N/S 300 (Std. 050785).



Available from Selected Stockists. Write or phone for list.

# INCREDIBLE VALUE IN PRECISION TEST METERS

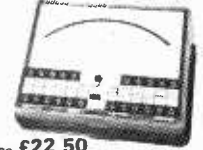
## MICROTEST 80 — I.C.E.

**20,000 OHMS/VOLT 40 RANGES**  
 20,000 ohms/Volt 4,000 ohms/Volt (AC) 2% accuracy  
 V DC 100mV to 1KV (6 Ranges) I DC 50µA to 5A (6 Ranges)  
 V AC 1.5V to 1KV (5 Ranges) I AC 250µA to 2.5A (5 Ranges)  
 Ohms Low ohms ohms x 1 ohms x 10 ohms x 100  
 Power Output Measurements 1.5V to 1000V (5 Ranges)  
 4 6dB to 62dB (5 Ranges)  
 Capacitance 25µF to 25,000µF (4 Ranges)  
 1000 times overload protection (on OHM ranges)  
 Meter movement diode protection  
 Size (without case) 90 x 70 x 18 mm  
 Electronic zero non-parallax mirror scale Unbreakable carrying case and probes supplied  
 Full After Sales Service available  
 Price **£14.50**. Post & Packing 50p VAT @ 8% £1 20. SEND TOTAL £16 20

**All Equipment Brand  
 New & Fully Guaranteed  
 for 12 Months**

## SUPERTESTER 680R — I.C.E.

**20,000 OHMS/VOLT 80 RANGES**  
 20,000 ohms/Volt 1% D.C. 2% A.C. V DC 100mV to 2KV (13 Ranges) V AC 2 to 2KV (11 Ranges) I DC 50µA to 10A (12 Ranges) I AC 250µA to 5A (10 Ranges) R ±1, ±100 ±1000 ±10,000 and Low ohms Detector Reactance 0-10 M ohms Freq Measurement 0.5000 Hz (2 Ranges) Power Output 10-2000V (9 Ranges) Decibels -24 — +70 dB (10 Ranges) Capacitance 0.500,000 pF (2 Ranges using mains supply) 0-20,000 µF (4 Ranges using internal 3 Volt battery) 1000 times overload protection on ohms ranges, and meter movement diode protection 10 Fields of Measurement and 80 ranges Size 128 x 95 x 32 mm Non parallax mirror scale Unbreakable carrying case supplied which contains probes, mains lead crocodile clips and shorting link



Price **£22.50**  
 Post & Packing 75p  
 VAT @ 8% £1.86  
 SEND TOTAL £25 11

**ACCESSORIES FOR 880R AND MICROTEST 80 (EXTRA)** (\*denotes item not usable on Microtest 80)  
**AMPERCLAMP A.C.** 2.5A to 500A (8 Ranges) 3% £13.50 **H.V. PROBE MOD. 18:** 25KV (MAX I/P Z = 500 M ohms (Nom) £5.98 **LIGHT METER PROBE MOD. 24:** 2 — 20,000 Lux £13.50 **RESISTANCE MULTIPLIER MOD. 25:** Multiplying Factor x 100,000 R. Range (with 680R) 0 — 100M £5.95 **GAUSSMETER PROBE MOD. 27:** 0.15 Kilogauss £12.50 **PHASE SEQUENCE INDICATOR MOD. 28:** 100-400V (A.C.) 50-500 Hz £5.95 **D.C. CURRENT SHUNTS MOD. 32 SERIES:** 10A, 25A, 50A and 100A £5.50 each **TEMPERATURE PROBE MOD. 38:** -50° C to +200° C £12.50 **SIGNAL INJECTOR MOD. 41:** Same D.C. lines 500KHz and 1KHz £8.55 **CURRENT TRANSFORMER MOD. 61B:** 250mA to 100A £8.50 **TRANSISTOR TESTER 682 I.C.E. Iife 5,000,000.** Measures I<sub>cb0</sub>, I<sub>eb0</sub>, I<sub>ccs</sub>, I<sub>ccs</sub>, V<sub>ce sat</sub>, V<sub>be</sub>, I<sub>hfe</sub>, V<sub>F</sub> and I<sub>F</sub> £13.50 **ELECTRONIC VOLTMETER 680B:** Full spec request £39.50 **AMPERTEST 680:** £39.50  
 Add 50p Post & Packing, plus VAT (8%) to all above prices.

**ELECTRONIC BROTHERS LTD.**

49-53 Pancras Road, London NW1 2QB  
 Tel: 01-837 7781

WW—086 FOR FURTHER DETAILS

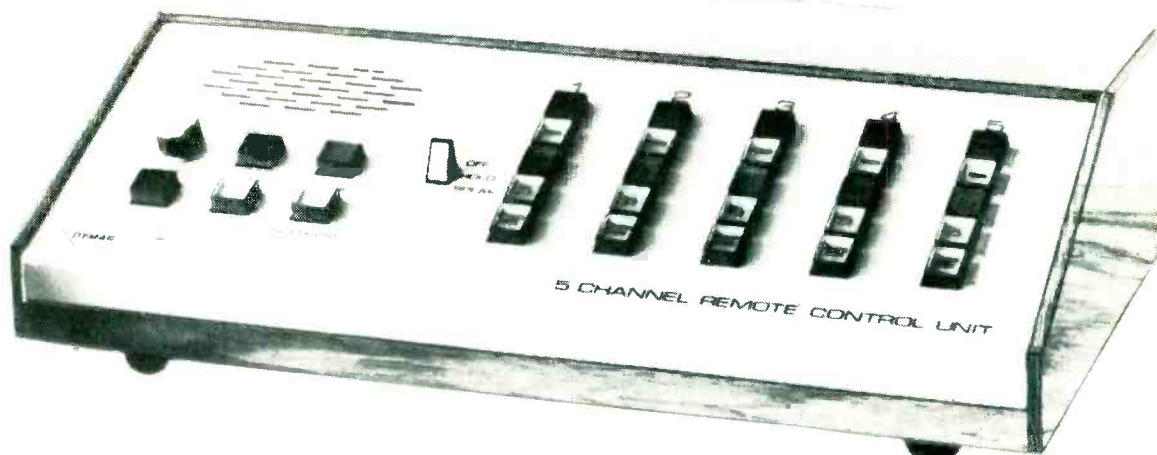
# INDEX TO ADVERTISERS

## Appointments Vacant Advertisements appear on pages 123-135

	PAGE		PAGE		PAGE
Aero Electronics Ltd.	6, 24, 26	Gould Advance Ltd.	27	Radford Laboratories Ltd.	15
Alben Engineering Co. Ltd.	26	Gramplan Reproducers Ltd.	22	Radio Component Specialists	109
Alice (Stancoil) Ltd.	6	Greenwood Electronics Ltd.	25, 29	Radio Shop, The	94
Ambit International	120	Harmsworth Townley & Co. Ltd.	Readers Card	Raindirk Ltd.	87
Antex Products Ltd.	96	Harris Electronics (London) Ltd.	15, 20	Raife, P.	106
Arrow-Hart (Europe) Ltd.	8	Hart Electronics	104	Rank Film Equipment	22
A.S.P.	119	Hatfield Instruments Ltd.	18	R.C.S. Electronics	12
Aspen Electronics Ltd.	26	Hayden Laboratories Ltd.	3	R.E.W. Audio Visual Ltd.	87
Audio Fair	95	Heath (Gloucester) Ltd.	13	Rotex	28
Audix Ltd.	13	Henry's Radio Ltd.	106	R.S.T. Valves Ltd.	108
Avo Ltd.	5	H/H Electronic	16		
Barr & Stroud	16	Icon Designs	20	Samsons (Electronics) Ltd.	112
Barrie Electronics Ltd.	93	I.P.L. Electronics Ltd.	97	S.C.S. Components	112
Bentley Acoustic Corp. Ltd.	111	Imtech Products Ltd.	24	Scopex Insts. Ltd.	21
Beyer Dynamics (Gt Britain) Ltd.	23	Industrial Tape Applications Ltd.	103	Scott, James (Elex. Engineers) Ltd.	96
B.H. Component Factors Ltd	121	Integrex Ltd.	90, 91	Semiconductor Supplies Ltd.	108
Bi-Pak Semiconductors Ltd.	116, 117	Kinnie Components Ltd.	122	Service Trading Co.	105
Bi-Pre Pak Ltd.	100	Lan Electronics Ltd.	28	Servo & Electronics Sales Ltd.	118
Boss Industrial Mouldings Ltd.	29	Leavers-Rich Equipment Ltd.	25	SGS-Ates (U.K.) Ltd.	74
Brenell Eng.	10	Levell Electronics Ltd.	1	Shure Electronics Ltd.	Bound-in-insert
Bywood Electronics	18	Lexor Electronics Ltd.	86	Sintel	107
Cambridge Learning	14	Linstead MFG Co. Ltd.	10	Soundcraft Electronics Ltd.	83
Case Systems	28	Lloyd J. J. Instruments Ltd.	17	Special Products Ltd.	12
Catronics	94	Lynx (Electronics) London Ltd.	110	Strumech Eng. Ltd.	10
Chiltmead Ltd	120	MacInnes Laboratories Ltd.	8	Sugden, J. E. & Co. Ltd.	24
Cintec Ltd.	9	Maplin Electronic Supplies	89	Swanley Electronics Ltd.	87
Colomor (Electronics) Ltd.	102	McLennan Eng. Ltd.	14	Technomatic Ltd.	113
Combined Precision Components Ltd.	88	Marconi Instruments Ltd.	Cover ii	Tektronix (Equipment) Ltd.	30
Compcor Electronics Ltd.	119	Marshall, A., & Sons (London) Ltd.	103	Teleprinter Equipment Ltd.	24
Computer Appreciation	86, 119	Mills, W.	111	Teleradio Electronics	113
Computer Sales & Service	110	Modern Book Company	132	Thomson CSF	11
D.M.W. Associates (Electronics) Ltd.	26	Morhan Exporting	121	Time Micro & Electronics	86
Dema Electronics International	94	Motorola Electronics Ltd.	18	Trampus Electronics	107
Dolby Laboratories Inc.	19	Multicore Solders Ltd.	Cover iv	Turner Electronic Industries Ltd.	28
Dolby Noise Unit	90, 91	Nicholls, E. R.	92	T.O. Supplies (Teonex)	25
Drake, Philip, Electronics Ltd.	119	Nombrex Ltd.	20	United-Carr Supplies Ltd.	32
Dymar Electronics Ltd.	Cover iii	Olson Electronics Ltd.	29	West Hyde Developments Ltd.	92
Eagle International Ltd.	16	Orchard Electronics	93	Whiteley Electrical Radio Co. Ltd.	12
Electronic Brokers Ltd.	114, 115, 136	P.B. Electronics Ltd.	85	Wilkinson, L. (Croydon) Ltd.	86
Electronics Weekly	Loose insert	Powertran Electronics	98, 99	Wilmot Breedon Electronics Ltd.	21
Electrotime Ltd.	101	Precision Petite Ltd.	29	Wilmslow Audio	121
Electrovalue Ltd.	93	Pulse Electronics Ltd.	13	Wireless World Circuit Designs	84
Electronic Windings (Ldn) Ltd.	14	Pye Unicam	7		
EMI Sound & Vision Equipment Ltd.	2			Z. & I. Aero Services Ltd.	23, 104, 113
English Electric Valve Co. Ltd.	73			Zettler (U.K.) Division	22
Evershed & Vignoles Ltd.	5				
Farnell Instruments Ltd.	4				
Fi-Comp Electronics	108				
Future Film Developments Ltd.	119				
Fylde Electronic Labs. Ltd.	15				



# 'Phone-in Programme



**When you can reach them. And they can reach you.  
Any time. You've got a Dymar system.**

Computer controlled VHF radiotelephone network. Sounds great. The coming thing. At Dymar it's come! And that's the Dymar difference.

Dymar designs systems that take all the local conditions into account. Terrain. Geographical distribution of the labour and the customers available to the user. Emergency situation control. Channel congestion. The lot.

Dymar does it with common frequency coverage using quasi-synchronous transmitters. With a CCIR compatible selective calling system. With automatic signal level selection. With computer control of signal routing.

Tomorrow's systems today. It's what you'd expect from a company 100% devoted to the radiotelephone business... and nothing else.

Discover the Dymar difference. Make contacting Dymar part of today's programme.

**DYMAR**

**the name in radiotelephone systems**

Dymar Electronics Limited, Colonial Way, Radlett Road, Watford,  
Herts. WD2 4LA. Tel. Watford 37321. Telex 923035.  
Cables: Dymar Watford.

WW-002 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)

# Multicore Solder Creams are oxide free!

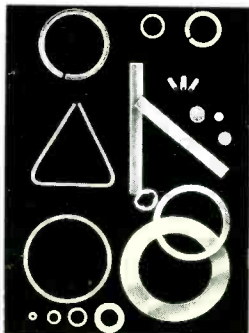
Multicore's newest solder creams are designed specifically for hybrid microcircuits P.C.B's and critical component joints. Unlike ordinary creams - which suffer from the problem of oxide around each atomised solder powder particle - they're completely oxide-free. The advantage is faster soldering with clear flux residues and no solder globules.

The new range can be made in any quantity and with a very wide variety of soft solder alloys, fluxes, particle sizes and viscosities. They're suitable for screen printing, stencilling or application by automatic precision dispensers. Add to that the speed, simplicity, reliability and low application cost of solder creams in many operations and you have a product that takes the art of soldering one step further.

Multicore's solder cream can often be used instead of solder preforms. No tool costs are involved and inventories of individual shapes are avoided. The cream can often be applied more quickly and has more uniform flux content than preforms. But for those assemblies where preforms are preferred...

## ...don't forget Multicore preforms

These precision-made solder preforms come in virtually any size and shape. Rings, washers, discs, pellets and lengths of solder tape in most soft-solder alloys, with or without flux cores, are easily placed between the parts to be soldered.



Whether cream or preforms are used, just raise the temperature of the metal surfaces to around 50°C above the melting temperature of the solder. The solder cream or preform does the rest. Heating techniques can include gas flame, hot plate, oven conveyor, induction coils, resistance/electrode soldering, hot gas and infra-red.



**Multicore Solders Limited,**

Maylands Avenue, Hemel Hempstead, Herts. HP2 7EP  
Telephone: Hemel Hempstead 3636. Telex: 82363

Multicore Solders Ltd are Ministry of Defence Registered Contractors and on Qualified Products List QQ-S-571E of U.S. Defense Supply Agency for solder creams and preforms.

