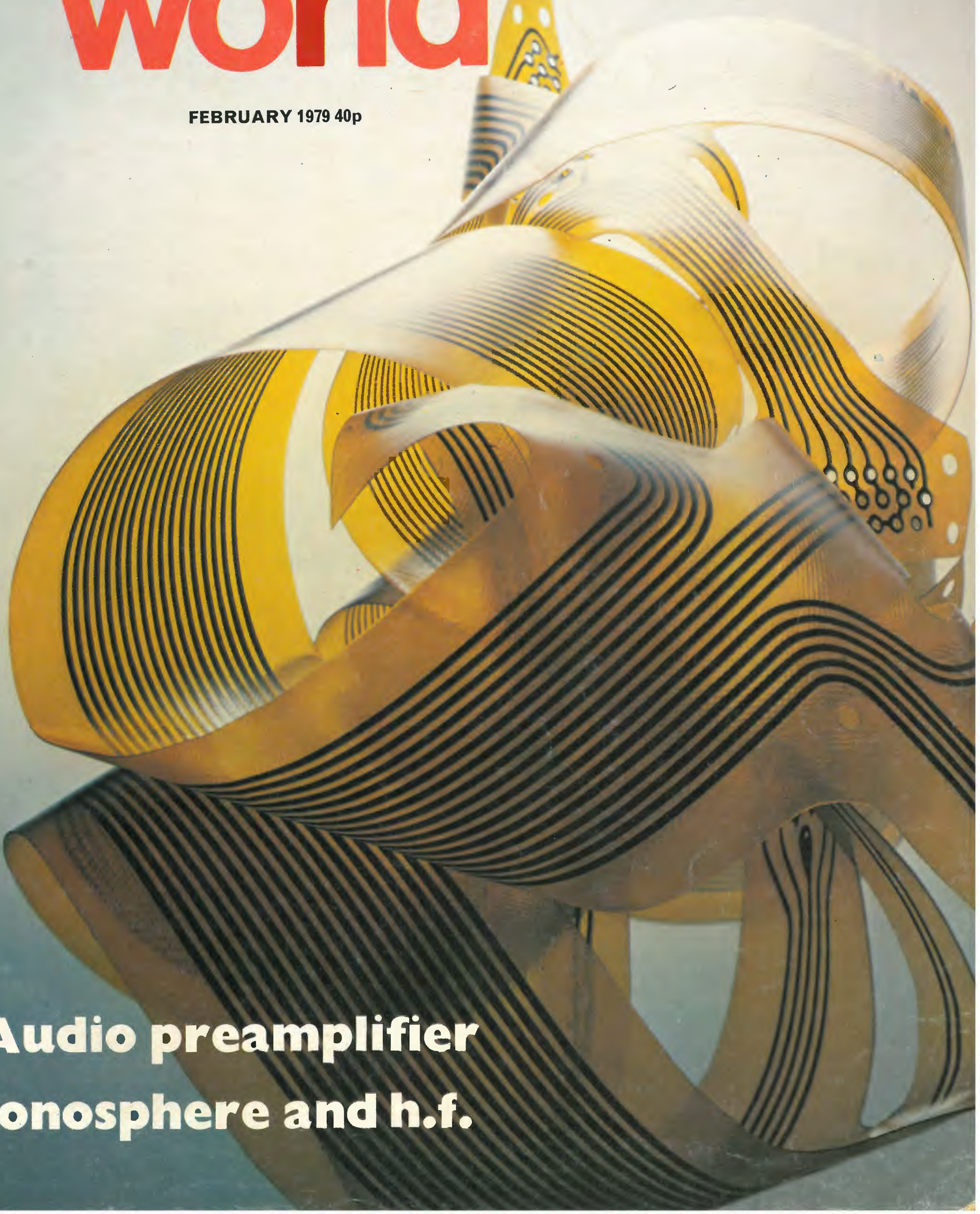
wireless world

Australia $A1.25
Canada $1.75
Denmark Kr. 11.00
Germany Dm. 4.00
Greece Dr. 47.00
Holland Dfl. 4.50
Italy L. 1100
New Zealand $NZ 1.50
Norway Kr. 11.00 incl. moms
Singapore M $3.25
Spain Ptas. 80.00
U.S.A. $1.65

FEBRUARY 1979 40p



Audio preamplifier

Ionosphere and h.f.

Also available from Electroplan

Value for money.

10Hz to 80MHz, 10Hz to 200MHz and 10Hz to 560MHz models.

The many good quality benefits offered by the competitively priced TF 2430 Series make these frequency meters of outstanding value.

Simple to use—no sensitivity controls. Just connect the signal and select the range.

Two year Guarantee—with special LSI chip, our counters have the lowest 'component count' on the market. Couple this with our "Autotest" production equipment, which checks every component of every instrument, and you can see why we have confidence in their reliability.

Wide dynamic range—high sensitivity *and* acceptance of mains voltages on all high impedance inputs.

Resolution to 0.1 Hz—560 MHz can be measured to 0.1 Hz resolution

High Stability—a choice of internal frequency standards is available. Or external standards may be used.

Excellent r.f.i. performance—all models are of robust construction and tested to meet military specifications.

Meets IEC 348 and BS 4743 safety requirements—in full! And all three designs meet our rigorous environmental specifications of bump, vibration, temperature and humidity.

For further information write or 'phone:

mi MARCONI INSTRUMENTS

Marconi Instruments Limited · Longacres · St. Albans · Hertfordshire · England AL4 0JN · Tel: (0727) 59292 · Telex: 23350
Marconi Electronics Inc · 100 Stonehurst Court · Northvale · New Jersey 07647 **USA** · Tel: (201) 767-7250 · Twx: 710-991-9752
Marconi Instruments · 32 avenue des Ecoles · 91600 Savigny-Sur-Orge · **France** · Tél: 996.03.86. · Télex: 600541.F
Marconi Messtechnik GmbH · 8000 München 21 Jörgstrasse 74 · **West Germany** · Tel: (089) 58 20 41 · Telex: 5 212642

A GEC-Marconi Electronics Company WW—001 FOR FURTHER DETAILS

Front cover shows flexible printed circuit material made using Du Pont KAPTON by M. B. Metals of Portslade. Photo by Roles & Parker.

IN OUR NEXT ISSUE

Novatexts. **Start of a series in which tutorial information on electronics is presented in a new way. Devised by Peter Williams of the Circards team.**

Logic analyser. **Diagnostic instrument for construction monitors signal points and displays real time data on their logic states. On-line, it will detect faults.**

H.f. synthesizer **for amateur use covers 1.5 to 28.5MHz in 500 kHz bands. Construction design includes a digital p.l.l., oscillator and mixer.**

Current issue price 40p, back issue (if available) 50p. at Retail and Trade Counter, Paris Garden, London SE1. Available on microfilm: please contact editor.

By post, current issue 55p, back issues (if available) 50p, order and payments to Room CP34, Dorset House, London SE1 9LU.

Editorial & Advertising offices: Dorset House, Stamford Street, London SE1 9LU.

Telephones: Editorial 01-261 8620. Advertising 01-261 8339.

Telegrams/Telex: Wiworld Bisnespres 25137 BISPRS G. Cables: Ethaworld, London SE1.

Subscription rates: 1 year: £7.00 UK and $23.40 overseas ($24 USA and Canada).

Student rate: 1 year, £3.50 UK and £4.50 overseas ($11.70 USA and Canada).

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

Subscriptions: Oakfield House, Perrymount Road, Haywards Heath, Sussex. RH16 3DH. Telephone 0444 59188. Please notify a change of address.

USA mailing agents: Expediters of the Printed Word Ltd, 527 Madison Avenue, Suite 1217, New York, NY 10022, 2nd-class postage paid at New York.

ISSN 0043 6062

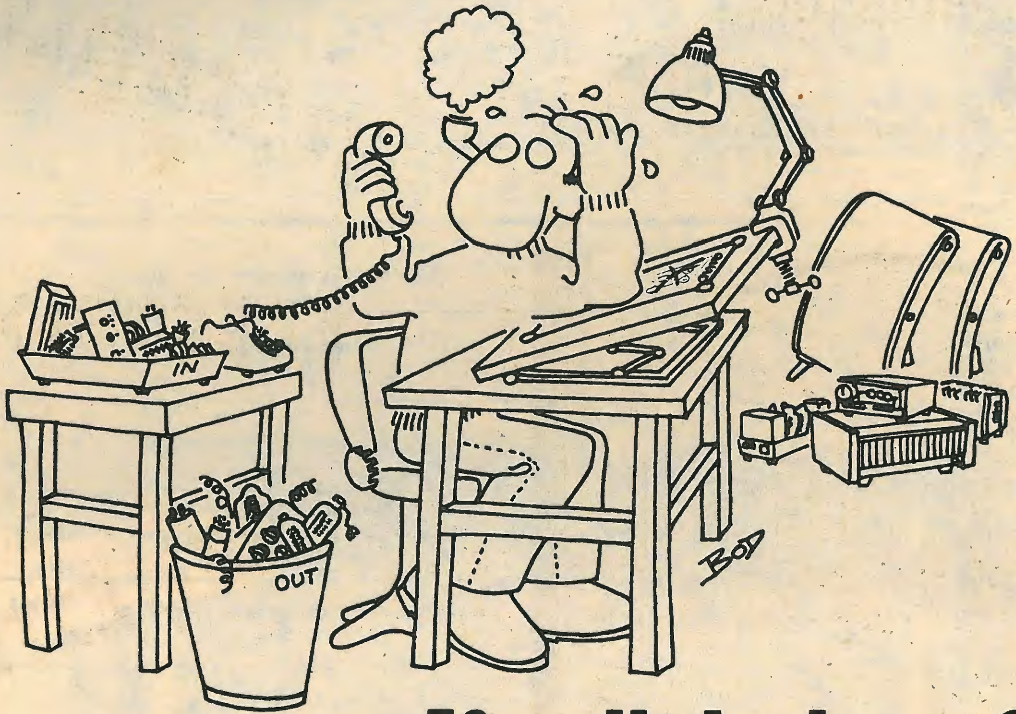
ibpa
International Business Press Associates

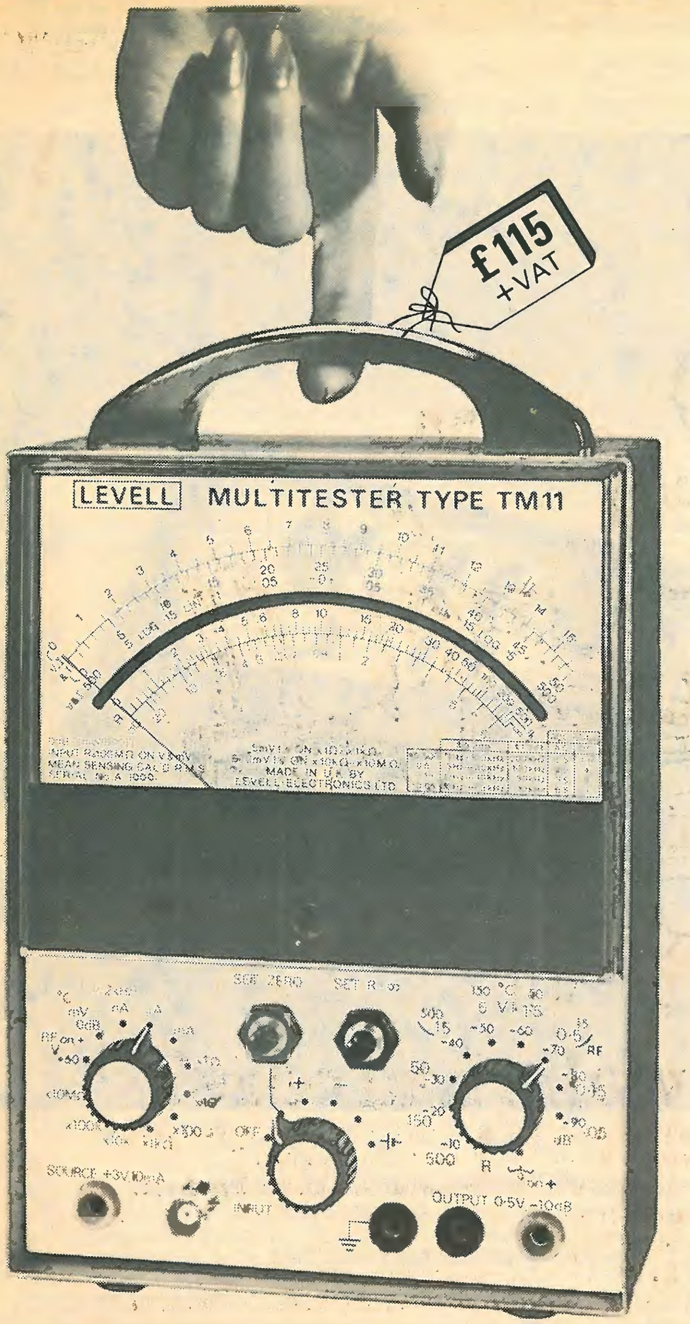
ABC
Member of the Audit Bureau of Circulations

wireless world

ELECTRONICS/TELEVISION/RADIO/AUDIO

FEBRUARY 1979 Vol 85 No 1518


IN
OUT



VERSATILE ELECTRONIC MULTITESTER

120 BASIC RANGES

AC V, I & dB	:	50µV/500V fsd, 50pA/500mA fsd, -90dB/+50dB mid scale. Acc.±1.5% fsd above 500µV & 500pA. Response 3Hz/200kHz above 500µV and 500nA. Input R = 100MΩ on volts.
DC V, I & NULL	:	150µV/500V fsd, 150pA/500mA fsd, polarity reversible. Acc.±1.5% fsd above 500µV & 500pA. Input R = 100MΩ on volts. 5 Null ranges have centre zero lin/log scale covering ±4 decades.
RESISTANCE	:	0.2Ω/10GΩ in 7 ranges, polarity reversible. Low test voltage for solid state circuits.
LEAKAGE at 3V	:	Uses 3V source with current ranges to test capacitors, diodes and resistance up to 100GΩ.
VOLT DROP at 10mA	:	Uses 10mA source with voltage ranges to test diodes, LED's and resistance down to 10mΩ.

30 OPTIONAL RANGES

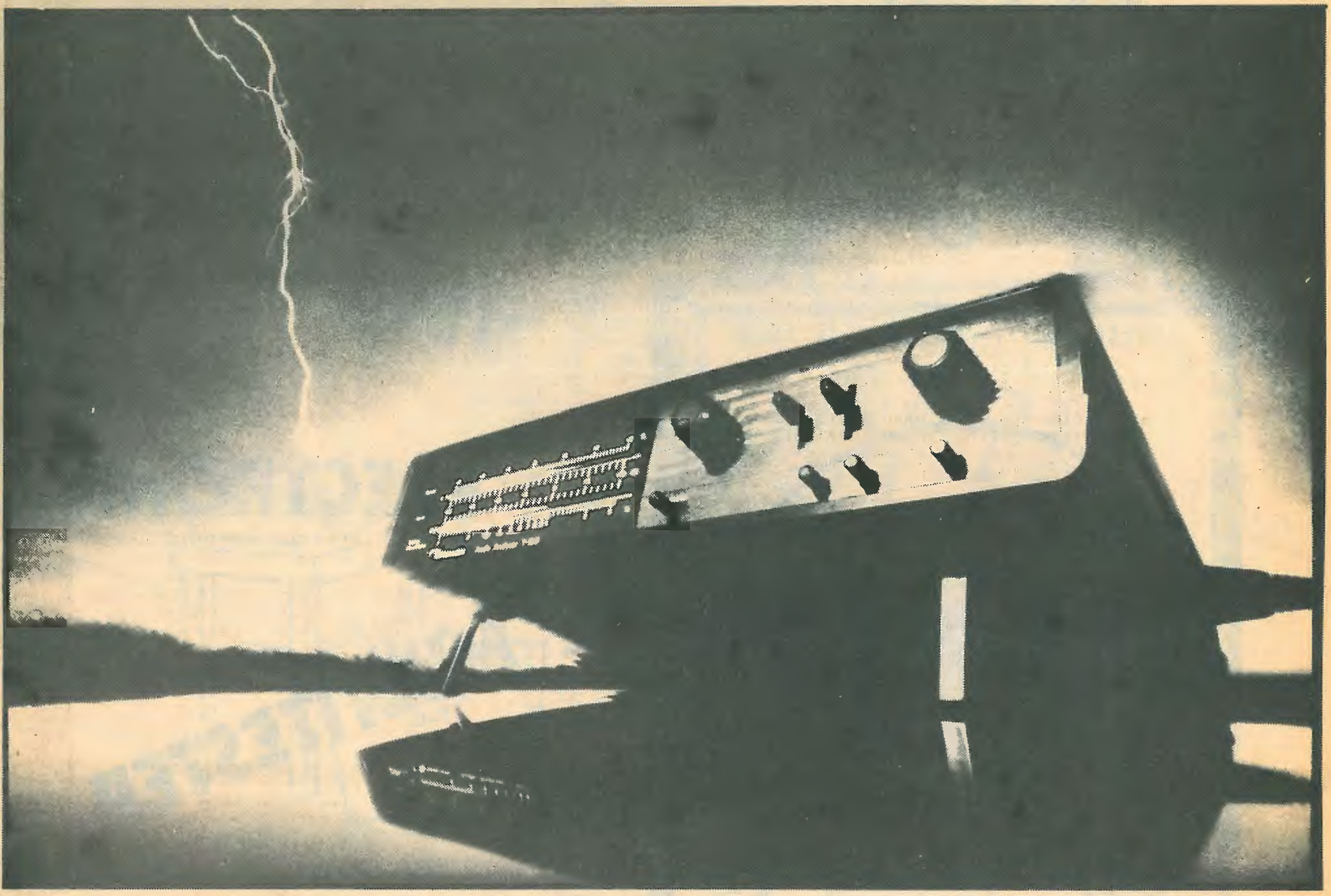
RF VOLTS	:	0.5V/500V fsd, 10kHz/1GHz, using RF Probe. Price £24 + VAT.
HIGH VOLTS	:	1.5kV/50kV fsd, AC/DC, using HV Probe. Price £17 + VAT.
HIGH CURRENT	:	1.5A/50A fsd, AC/DC, using Current Shunt. Price £16 + VAT.
TEMPERATURE	:	-150°C/+500°C fsd in 7 ranges using Temperature Probe. Price £39 + VAT.

The instrument operates from a 9 volt battery, life 1000 hrs., or, AC mains when optional Power Supply Unit is fitted. Size is 240mm x 150mm x 80mm. Weight is 1.75 kg. Meter scale length is 140mm. Leather case is available at £14 + VAT.

LEVELL ELECTRONICS LTD.

MOXON STREET, BARNET, HERTS., ENGLAND, EN5 5SD.
TEL: 01-449 5028/440 8686
WW — 042 FOR FURTHER DETAILS

A flash of brilliance from Nakamichi illuminates audio analysis.



Smaller and lighter than a telephone directory. Yet the equal of a pile of test instruments many times its size and weight.

The Nakamichi T-100 is everything you've been wanting in an audio analyser.

And maybe a bit more.

It contains built-in oscillator with 21 frequencies from 20 to 20,000Hz; a pink-noise generator; a level meter featuring a lightening-fast dual plasma display with choice of "VU" or peak ballistics; a speed, wow and flutter meter with the option of unweighted or DIN peak weighted measurements; a fully automatic 400Hz distortion analyser; an A-weighting filter for noise measurements, a watt-scale graticule for power level indication.

It's rugged, versatile and accurate. An instrument that sustains infallible diagnosis.

Service and laboratory professionals, equipment reviewers, dealers, salespeople . . . and incurable audiophiles, the T-100 has arrived.

Enlightening audio analysis.

Write for more information to Natural Sound Systems Ltd.
10 Byron Road, Wealdstone, Harrow: Middlesex HA3 7TL.

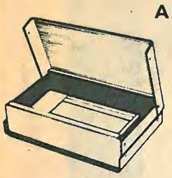
Nakamichi

Products of unusual creativity and competence . . .

YOUR COMPLETE RANGE OF ELECTRONIC HARDWARE...

BIMENCLOSURES

ALL METAL BIMCASES

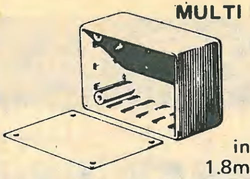


Red, Grey or Orange 14swg Aluminium removable top and bottom covers. 18 swg black mild steel chassis with fixing support brackets.
BIM 3000
(250x167.5x68.5mm)
£14.58

MINI DESK BIMCONSOLES

Orange, Blue, Black or Grey ABS body incorporates 1.8mm pcb guides, stand-off bosses in base with 4 BIMFEET supplied. 1mm Grey Aluminium panel sits recessed with fixing screws into integral brass bushes.
BIM 1005 (161 x 96 x 58mm) £2.18
BIM 1006 (215 x 130 x 75mm) £3.05

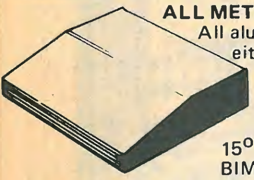
MULTI PURPOSE BIMBOXES



Orange, Blue, Black or Grey ABS with 1mm Grey Aluminium recessed front cover held by screws into integral brass bushes. 1.8mm pcb guides incorporated and 4 BIMFEET supplied.

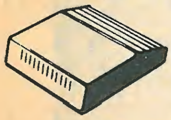
BIM 4003 (85x56x28.5mm) £1.18
BIM 4004 (111x71x41.5mm) £1.62
BIM 4005 (161x96x52.5mm) £2.19

ALL METAL BIMCONSOLES



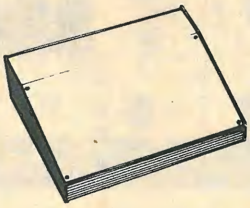
All aluminium, 2 piece desk consoles with either 15° or 30° sloping fronts, sit on 4 self-adhesive non-slip rubber feet. Ventilation slots in base and rear panel for excellent cooling. See latest catalogue for new styles and sizes

Colour Code	Top Panel	Base
A	Off White	Blue
B	Sand	Green
C	Satin Black	Gold



15° Sloping Panel	30° Sloping Panel	
BIM7151 (102x140x51[28] mm)	BIM7301 (102x140x76[28] mm)	£10.67
BIM7152 (165x140x51[28] mm)	BIM7302 (165x140x76[28] mm)	£11.44
BIM7153 (165x216x51[28] mm)	BIM7303 (165x183x102[28] mm)	£12.61
BIM7154 (165x211x76[33] mm)	BIM7304 (254x140x76[28] mm)	£13.82
BIM7155 (254x211x76[33] mm)	BIM7305 (254x183x102[28] mm)	£15.36
BIM7156 (254x287x76[33] mm)	BIM7306 (254x259x102[28] mm)	£16.67
BIM7157 (356x211x76[33] mm)	BIM7307 (356x183x102[28] mm)	£17.58
BIM7158 (356x287x76[33] mm)	BIM7308 (356x259x102[28] mm)	£18.55

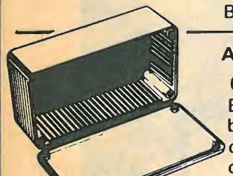
LOW PROFILE BIMCONSOLES



Orange, Blue, Black or Grey ABS body has ventilation slots as well as 1.8mm pcb guides and stand-off bosses in base. Double angle recessed front panel with 4 fixing screws into integral brass bushes. 4 BIMFEET supplied.

BIM 6005 (143 x 105 x 55.5 [31.5] mm) £2.37
BIM 6006 (143 x 170 x 55.5 [31.5] mm) £3.08
BIM 6007 (214 x 170 x 82.0 [31.5] mm) £4.12

ABS & DIECAST BIMBOXES

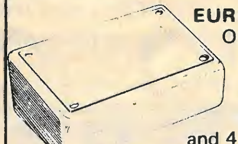


6 sizes in ABS or Diecast Aluminium. ABS moulded in Orange, Blue, Black or Grey. Diecast Aluminium in Grey Hammertone or Natural. All boxes incorporate 1.8mm pcb guides, stand-off supports in base and have close fitting flanged lids held by screws into integral brass bushes (ABS) or tapped holes (Diecast).

	ABS		Diecast	Hammertone	Natural
(50x60x31mm)	N/A		BIM5001/11	TBA	£1.02
(100x50x25mm)	BIM2002/12	£0.96	BIM5002/12	£1.46	£1.19
(112x62x31mm)	BIM2003/13	£1.13	BIM5003/13	£1.78	£1.46
(120x65x40mm)	BIM2004/14	£1.35	BIM5004/14	£2.24	£1.82
(150x80x50mm)	BIM2005/15	£1.52	BIM5005/15	£2.84	£2.28
(190x110x60mm)	BIM2006/16	£2.37	BIM5006/16	£3.94	£3.33

Also available in Grey Polystyrene with no slots and self-tapping screws
BIM 2007/17 (112x61x31mm) £1.00

EUROCARD BIMCONSOLES

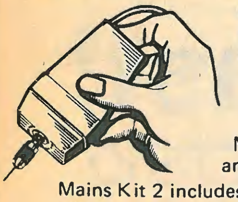


Orange, Blue, Black or Grey ABS body accepts full or ½ size Eurocards, with bosses in the base for direct fixing. 1.8mm wide pcb guides incorporated and 4 BIMFEET supplied. 1mm Grey aluminium lid sits flush with body top and held by 4 screws into integral brass bushes.

BIM 8005 (169x127x70[45] mm) £4.12
BIM 8007 (243x187x103[66] mm) £6.10

BIMTOOLS + BIMACCESSORIES

MAINS BIMDRILLS

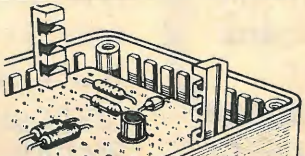


Small, powerful 240V hand drill complete with 2 metres of cable and 2 pin DIN plug. Accepts all tools with 1mm, 2mm or .125" dia. shanks Drills brass, steel, aluminium and pcb's. Under 250g, off load speed 7500 rpm. Orange ABS, high impact, fully insulated body with integral on/off switch £10.53

Mains Accessory Kit 1 includes 1mm, 2mm, .125" twist drills, 5 burrs and 2.4mm collet £2.48

Mains Kit 2 includes Mains BIMDRILL as above, 20 assorted drills, mops, burrs, grinding wheels and mounted points, 1mm, 2mm, 2.4mm and .125" collets. Complete in transparent case measuring 230x130x58mm £22.14

BIMDAPTORS



Allows pcb's to be flat mounted sandwich fashion in BIMBOXES, BIMCONSOLES, and all other enclosures having 1.5mm wide vertical guide slots. One plastic BIMDAPTOR on each corner of pcb(s) enables assembly to be simply slid into place. 54mm long, 10 slots on 5mm spacing and can be simply snipped off to length. £1.08 per pack of 25.

BIMFEET

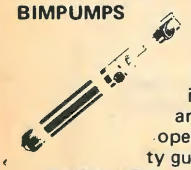
11mm dia. 3mm high, grey rubber self-adhesive enclosure feet.
£0.77 per pack of 24

12 VOLT BIMDRILLS

2 small, powerful drills easily hand held or used with lathe/stand adaptor. Integral on/off switch and 1 metre cable.
Mini BIMDRILL with 3 collets up to 2.4mm dia. £ 8.10
Major BIMDRILL with 4 collets up to 3mm dia. £13.60

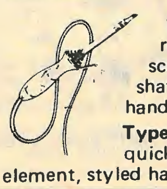
Accessory Kits 1 have appropriate drills and collets as above plus 20 assorted tools. Mini Kit 1 – £15.12, Major Kit 1 – £19.44. Accessory Kits 2 have appropriate drills, collets plus 40 tools and mains-12V dc adaptor. Mini Kit 2 – £34.02, Major Kit 2 – £39.42. Accessory Kits 3 as appropriate Kits 2 plus stand/lathe unit. Mini Kit 3 – £45.36, Major Kit 3 – £50.76.

BIMPUMPS



2 all metal desoldering tools provide high suction power and have easily replaceable screw in Teflon tips. Primed and released by thumb operation with in-built safety guard and anti-recoil system.
BIMPUMP Major (180mm long) £7.99
BIMPUMP Minor (150mm long) £6.80

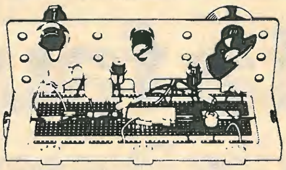
BIMIRONS



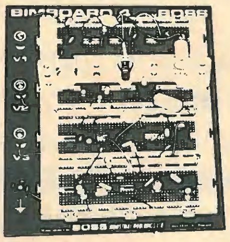
Type 30 General Purpose 27 watt iron with long life, rapid change element, screw on tip, stainless steel shaft and clip on hook. Styled handle with neon. £4.05

Type M3 Precision 17 watt iron, quick change tip, long life element, styled handle with clip on hook. £4.43

BIMBOARDS



DIL COMPATIBLE BIMBOARDS



Accept all sizes (4-50 pin) of DIL IC packages as well as resistors, diodes, capacitors and LEDs. Integral Bus Strips up each side for power lines and Component Support Bracket for holding lamps, switches and fuses etc. Available as single or multiple units, the latter mounted on 1.5mm thick black aluminium back plate which stand on non slip rubber feet and have 4 screw terminals for incoming power.

BIMBOARD 1 has 550 sockets, multiple units utilising 2, 3 and 4 BIMBOARDS incorporate 1100, 1650 and 2200 sockets, all on 2.5mm (0.1") matrix.

BIMBOARD 1 £ 8.83
BIMBOARD 2 £21.01
BIMBOARD 3 £29.84
BIMBOARD 4 £38.79

DESIGNER PROTOTYPING SYSTEM

1, 2, or 3 BIMBOARDS mounted on BIM 6007 BIMCONSOLE with Integral Power Supply (±5 to ±15Vdc @ 100mA and fixed +5Vdc @ 1A) All O/P's fully isolated. Short circuit and fast fold back protection. Power rails brought out to cable clamps that accept stripped wire or 4mm plug.

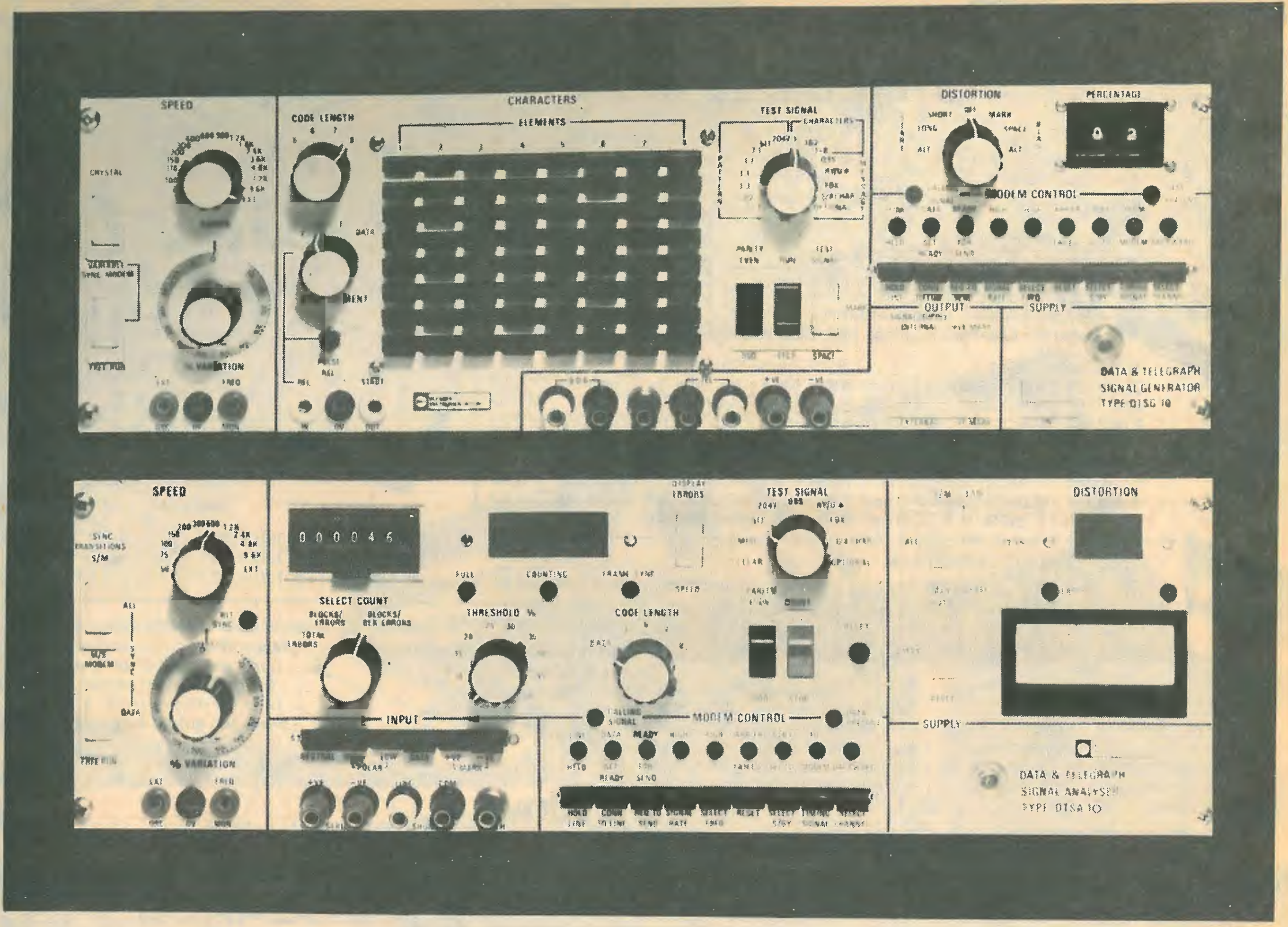
DESIGNER 1 £55.62
DESIGNER 2 £61.02
DESIGNER 3 £66.42

...FROM BOSS

INDUSTRIAL MOULDINGS LIMITED

All quoted prices are 1 off and include Postage, Packing and VAT. Terms are strictly cash with order unless you have authorised BOSS account. For individual data sheets or short form catalogue on all BOSS products send stamped, self addressed 4¼ x 8½" envelope.

2 Herne Hill Road, London SE24 0AU
Telephone: 01-737 2383
Telex: 919693 Answer Back: 'LITZEN G'
Cables & Telegrams: 'LITZEN LONDON SE24'



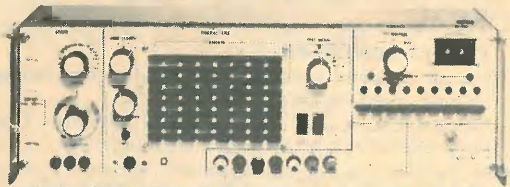
Data faults sorted-fast!

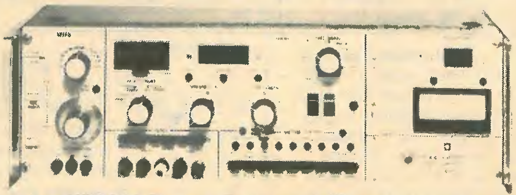
using the Plessey Data & Telegraph Test Set DTTS10

This compact and highly versatile equipment enables you to locate and quickly isolate faults and problems by substituting the DTTS10 for your terminal (circuit looped) or using the units at either end of your channel.

The generator DTSG10 provides a wide range of CCITT recommended test signals and patterns and also includes a push button matrix, useful for special pattern or polling addresses.

The associated signal analyser DTSA10 offers facilities for measuring speed or bit, block/bit and block/block errors and also measures peak and bias distortion. Both units include modem and control facilities, valuable when testing end-to-end.


The DTSG10 Data & Telegraph Signal Generator


The DTSA10 Data & Telegraph Signal Analyser

PLESSEY CONTROLS

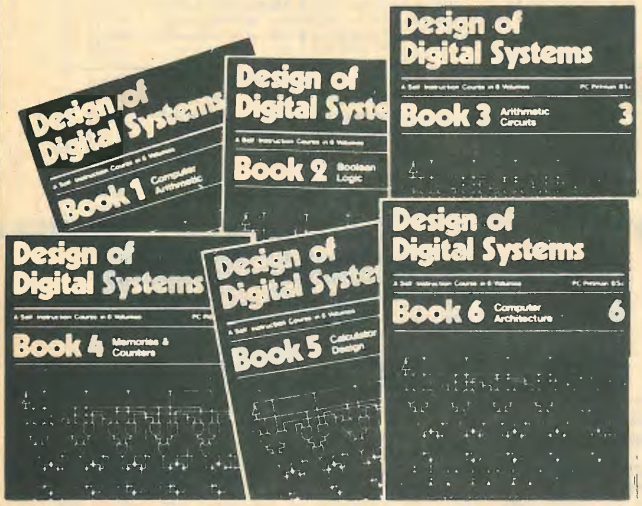
Plessey Controls Limited, Sopers Lane, Poole, Dorset, United Kingdom, BH17 7ER
Telephone: Poole (02013) 5161 Telex: 41272

WW—059 FOR FURTHER DETAILS

600 2 264

Understanding Digital Electronics

New teach-yourself courses



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

The contents of Design of Digital Systems include:

Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.

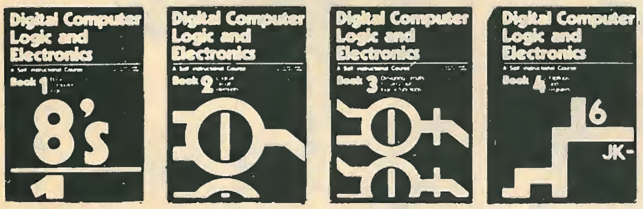
Book 2 OR and AND functions; logic gates. NOT, exlusive OR. NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.

Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.

Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).

Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.

Book 6 Central processing unit (CPU); memory organisation; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.



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

Contents include: Binary, octal and decimal number systems conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; De Morgans Laws; design of logic circuits using NOR gates; R-S and J-K flip flops, binary counters, shift registers and half adders.

CAMBRIDGE LEARNING ENTERPRISES, UNIT 35, RIVERMILL SITE,
FREEPOST, ST. IVES, HUNTINGDON, CAMBS. PE17 4BR, ENGLAND
TELEPHONE: ST. IVES (0480) 67446
PROPRIETORS: DAYRIDGE LTD. REG. OFFICE: RIVERMILL LODGE, ST. IVES
REGD. IN ENGLAND No. 1328762

In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your vehicle speed and petrol consumption; you could be calling people by entering their name into a telephone which would automatically look up their number and dial it for you.

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

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

The six volumes of Design of Digital Systems cost only: £8.10 } + 90p post & packing
And the four volumes of Digital Computer Logic and Electronics cost only: £4.60 }
But if you buy both courses, the total cost is only: £12.00 + £1 post & packing

Price includes surface mail anywhere in the world — Airmail extra.

Flow Charts & Algorithms

HELP YOU PRESENT
safety procedures, government legislation, office procedures, teaching materials and computer programs by means of YES and NO answers to questions.

THE ALGORITHM WRITER'S GUIDE explains how to define the questions, put them in the best order and draw the flow chart, with numerous examples shown. All that students require is an aptitude for logical thought. Size A5, 130 pages. This book is a MUST for those with things to say.

£2.95 + 45p post & packing by surface mail anywhere in the world. Airmail extra.

GUARANTEE
If you are not entirely satisfied your money will be refunded.
Please allow 21 days for delivery

Cambridge Learning Enterprises, Unit 35, Rivermill Site
Freepost, St. Ives, Huntingdon, Cambs. PE17 4BR
England

Please send me the following books
......sets Digital Computer Logic & Electronics @ £5.50, p&p included
......sets Design of Digital Systems @ £9.00, p&p included
......Combined sets @ £13.00, p&p included
......The Algorithm Writer's Guide @ £3.40, p&p included

Name ....
Address ....
....
....

I enclose a *cheque/PO payable to Cambridge Learning Enterprises for £.......
Please charge my *Access/Barclaycard Visa Eurocard/Mastercharge/Interbank account number ....

Signature .... *deleted as appropriate

Telephone orders from credit card holders accepted on 0480-67446 (ansafone) Overseas customers should send a bank draft in sterling drawn on a London Bank. WW35

ambit® international

Production of the new catalogue has been held up for a few weeks - since we have just been appointed as distributors for two of the most exciting ranges of radio components products yet : The Micrometals range of iron dust torroids cores and formers, and the OKI range of VLSI for digital frequency displays for receivers.
We apologize for any inconvenience, but these two ranges are really worth the wait, and include some products you will find hard to believe, like the MSM5523 IC, an IC with less than ten external components that gives AM frequency readout to 1kHz from LW to 39.999MHz, FM frequency readout in 100kHz steps - (all usual IF offsets programmable by diodes), a 24 hour format clock with 12 hour display, independent on and off timers, time signals on the hours, stopwatch facility and a sleep timer. This costs £14 with its timebase crystal, and makes all that has gone before an expensive and time wasting excercise. Rather like the way the Intersil ICM7216 has revolutionized the instrument counter market. (See the OSTS ad.) And those of you familiar with Amidon and IG dust torroids, favoured in many new RF designs, will be pleased to know Ambit will be stocking a broad range of the Micrometals types for applications from EMI filters to RF PA stages.

OKI frequency counter ICs: details in cat2

MSM5523	for CA LEDs with RHDP such as FND507	£14 inc xtal
MSM5525	for 3½ digit LCD AM/FM with direct segment drive. no clock or timers	£11 inc xtal

Other types for fluorescent displays etc OA

Other new semiconductor additions:

KB4437	pilot cancel mpx decoder	4.35
KB4438	muting stereo preamp	2.22
HA1370	supercedes TDA2020	2.99
TDA1090	HiFi AM/FM	3.35
TDA1220	low cost AM/FM	1.45

PRICES DOWN ON VMOS: as expected, this new technology in power transistorsis getting cheaper. 120v comp pairs /100W for £10.00

Price reduction on CA3189E ....now £2.20

New varicaps: to add to the biggest range.....

KV1211 2:9v bias to tune MW, like the KV1210, but a double diode £1.75

New pilot tone filters from TOKO...............

208BLR series, individual per channel with a 26/38kHz version for pilot cancel decoder applications. Flat to 15kHz £0.90

New crystal filter for amateur NBFM..........

TOYO 10M4B1 with over 90dB adjacent ch. rejection for 2m NBFM. 10.7MHz £14

New ceramic IF filters for 455kHz..............

CFM455H 6kHz/6dB, 15kHz max /60dB - ideal for MC3357 etc. £10

A brief summary of some of our range of ICs:

TDA1062/1.95; TDA1083/1.95; HA1197/£1.40 CA3123E/£1.40; TBA651/£1.81; CA3089/1.94 HA1137/£2.20; MC1310/£2.20; HA1196/£3.95 KB4424/£2.75; KB4423/£2.53;SD6000/£3.75 K84412/£2.55; KB4413/£2.75; KB4417/£2.55 MC1495L/£6.86*; MC1496P/£1.25 LM381N/£1.81; LM1303/£0.99; ULN2283B/ £1.00; LM380N/£1; TBA810AS/£1.09 TCA940E/£1.80; TDA2002/£1.95; ICL8038CC/£4.50*; NE566/£2.50*; NE567/ £2.50*; NE560B/£3.50; NE5618/£3.50; NE562B/£3.50*; NE565A/£2.50*

SEE THE OSTS ADVERT FOR CMOS/TTL REGULATORS, OPTO DISPLAYS, and other types of linear devices.

Some transistors for RF specifically:

BF256LB/0.34; 40822/0.43*; 40823/0.51 * 40673/0.55* ; BF900/961/0.80*; BF960/1.60* BF224/0.22; BF274/0.18; BF195/0.18; BF240/0.22; BF241/0.22; BF362/0.70; BF479/0.86; BF679S/0.70; BFY90/0.90*

PIN and other Varicap diodes:

BA102/0.30; BA121/0.30; ITT210/0.30 BB104B/0.40; MVAM2/£1.48; MVAM115/ £1.05; MVAM125/1.05; KV1210/£2.75 BA479/0.35; TDA1061/0.95; BA182/0.21

METER MADE low cost panel meters : 3 x 930 series with blanks and dry transfer sheet of scales and ledgends for £12.5 *

At last, DIY HiFi which looks as if it isn't.

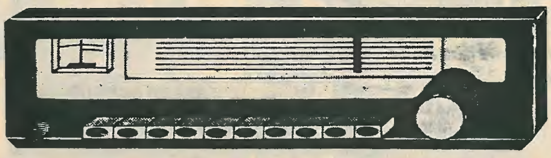
That's not to say it doesn't look like HiFi - just that it doesn't look like the usual sort of thing you have come to associate with DIY HiFi. The Mk3 outstrips and outperforms all British made HiFi tuners, and most imported ones too. Certainly at the price, there isn't one near it. But more than that, it looks superb . A small pic here would be an insult, so send an SAE for details on the kit that looks as if isn't. It's something else.............

- ★ Exceptionally high performance - exceptionally straightforward assembly
- ★ Baseboard and plug-in construction. Future circuit developments will readily plug in, to keep the MkIII at the forefront of technical achievement
- ★ Various options and module line-ups possible to enable an installment approach to the system

and now previewing the matching 60W/channel VMOS amplifier:

- ★ Matching both the style and design concepts of the MkIII HiFi FM tuner
- ★ Hitachi VMOS power fets - characterized especially for HiFi applications
- ★ Power output readily multiplied by the addition of further MOSFETs
- ★ VU meters on the preamp - not simply dancing according to vol level
- ★ Backed with the usual Ambit expertise and technical capacity in audio

The PW Dorchester·LW,MW,SW,& FM stereo tuner



In much the same way as we have swept away the 'old technology' in frequency/timer counters - with the OKI and Intersil single IC counters, we now offer a single IC "All Band" radio tuner. Don't confuse this one chip radio with things like the ZN414 - for this is a genuine superhet receiver with a mechanical AM IF filter, and ceramic IF filters for FM.
The AM section employs a balanced input mixer section, covering all broadcast bands - plus a BFO and MOSFET product decetor for SSB/CW - though at this price, the tuner is not intended as a "communications receiver" - although we know of many lesser designs that make that claim. The AM sensitivity is nevertheless better than 5uV, and FM sensitivity is 1.2uV for 30dB S/N. As a multiband broadcast superhet receiver, it is a unique constructor project that fulfills the requests we very frequently get for a general coverage circuit that isn't over complicated. The set has CA3089E FM performance, with mute etc., and a PLL stereo decoder with full pilot tone filtering.

The tuner board - with "on board" PCB mounted switching, all components etc : £33.00
The case/cabinet with PSU, meter and mechanics etc £25.00
An SAE for full details please. See the feature article in Practical Wireless (Dec/Jan)

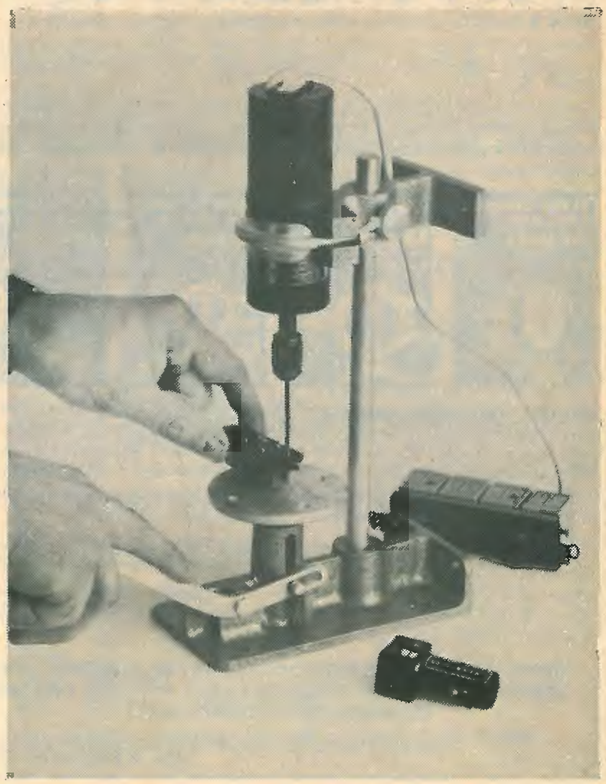
TERMS etc: CWO please, VAT on Ambit Items is generally 12½%, except where marked (*). Catalogue part 1:45p, part 2 50p all inclusive. Postage 25p per order, carriage on tuner kits £3. Phone Brentwood (0277) 216029/227050 9am-7pm. Callers welcome inc. Saturdays .

2 Gresham Road, Brentwood, Essex.

WW—045 FOR FURTHER DETAILS

A. D. BAYLISS & SON LTD.

Behind this name there's a lot of real POWER!



Illustrated right is a **TITAN DRILL**

Mounted in a multi-purpose stand. This drill is a powerful tool running on 12v DC at approx. 9000 rpm with a torque of 350 grm. cm. Chuck capacity 3:00 m/m.
The multi-purpose stand is robustly constructed of steel and aluminium. The base and bracket are finished in hammer blue.
Also available for use in the stand is the RELIANT DRILL which is a smaller version of the Titan. Approx. speed 9000 rpm, 12v DC, torque 35 grm. cm. Capacity 2.4 m/m.

TITAN DRILL & STAND **£21.45**
+ 8% VAT = £23.17 + £1 P&P

TITAN DRILL ONLY **£9.79** + 8% VAT = £10.57 + 35p P&P

RELIANT DRILL & STAND **£18.44**
+ 8% VAT = £19.92 + £1 P&P

RELIANT DRILL ONLY **£6.34** + 8% VAT = £6.85 + 35p P&P

TITAN MINI DRILL KIT **£16.25**
Drill Plus 20 Tools
+ 8% VAT = £17.55 + 50p P&P

RELIANT MINI DRILL KIT **£13.20**
Drill Plus 20 Tools
+ 8% VAT = £14.26 + 50p P&P

TRANSFORMER UNIT **£9.40**
+ 8% VAT = £10.15 + 75p P&P

These are examples of the extensive range of power tools designed to meet the needs of development engineers, laboratory workers, model makers and others requiring small precision production aids.
To back up the power tools, Expo offer a comprehensive selection of Drills, Grinding Points and other tools.
SEND STAMP for full details to main distributors.

A. D. BAYLISS & SON LTD., Pfera Works, Redmarley, Glos. GL19 3JU

Stockists Richards Electric, Gloucester; Hoopers of Ledbury; Hobbs of Ledbury; D&D Models, Hereford; Bertella, Gloucester; J. Power Services & Co. Ltd., Worcester

OSTS

Since AMBIT introduced the "One Stop Technology Shop" to our service, we have been pleased to see just how many users of electronic components appreciate our guarantee to supply goods only from BS9000 approved sources. More than ever, professional and amateur electronics engineers cannot afford to waste time on anything less than perfect pedigree products.

SEE THE AMBIT AD TOO!

CD4000 CMOS

4000	17p	4059	563p	4522	149p
4001	17p	4060	115p	4527	157p
4002	17p	4063	109p	4528	102p
4006	109p	4066	53p	4529	141p
4007	18p	4067	400p	4530	90p
4008	80p	4068	25p	4531	141p
4009	58p	4069	20p	4532	125p
4010	58p	4070	20p	4534	614p
4011	17p	4071	20p	4536	380p
4012	17p	4072	20p	4538	150p
4013	55p	4073	20p	4539	110p
4016	52p	4075	20p	4541	141p
4017	80p	4076	90p	4543	174p
4018	80p	4077	20p	4549	399p
4019	60p	4078	20p	4553	440p
4020	93p	4081	20p	4554	153p
4021	82p	4082	20p	4556	77p
4022	90p	4085	82p	4557	386p
4023	17p	4086	82p	4558	117p
4024	76p	4089	150p	4559	388p
4025	17p	4093	50p	4560	218p
4026	180p	4094	190p	4561	65p
4027	55p	4096	105p	4562	530p
4028	72p	4097	372p	4566	159p
4029	100p	4098	110p	4568	281p
4030	58p	4099	122p	4569	303p
4031	250p	4160	90p	4572	25p
4032	100p	4161	90p	4580	600p
4033	145p	4162	90p	4581	319p
4034	200p	4163	90p	4582	164p
4035	120p	4174	104p	4583	84p
4036	250p	4175	95p	4584	63p
4037	100p	4194	95p	4585	100p
4038	105p	4501	23p		
4039	250p	4502	91p		
4040	83p	4503	69p		
4041	90p	4506	51p		
4042	85p	4507	55p		
4043	85p	4508	248p		
4044	80p	4510	99p		
4045	150p	4511	149p		
4046	130p	4512	98p		
4047	99p	4513	206p		
4048	60p	4514	260p		
4049	55p	4515	300p		
4050	55p	4516	125p		
4051	65p	4517	382p		
4052	65p	4518	103p		
4053	65p	4519	57p		
4054	120p	4520	109p		
4055	135p	4521	236p		

Micromarket

PRICES SLASHED

6800 series	
6800P	6.50
6820P	£6
6850P	2.75
6810P	£4
6852	3.65
8080 series	
8080	6.30
8212	2.30

8216	1.35
8224	3.50
8228	4.78
8251	6.25
8255	5.40
MEMORIES	
2102	£1.70
2112	£3.40
2513	£7.54
4027	£5.78

2114	£10
2708	£10.55
Development	
MEK6800	£220
TK80	£306

AMI, Signetics, TI, Intersil, Harris etc. OA

Voltage Regs

NEW LOW PRICES

7800 series UC TO220 package 1A	all 95p
7900 series UC TO220 package 1A	all £1
78MUC series TO220 package ½A	all 90p
78LCP series TO92 100mA	all 35p
L200 up to 3A/adjustable V&A	195p
78MGT2C ½amp adjustable volts	175p
79MGT2C ½amp adjustable volts	175p
723C precision controller	65p

MAINS FILTERS FOR NOISE/RFI etc

1 amp in IEC connector	£4.83
5 amp in 'wire in' case	£3.87
NE550A	73p

LINEARS non-consumer

BIMOS			
CA3130E	84p	LM339N	66p
CA3130T	90p	LM348N	186p
CA3140E	35p	LM3900N	60p
CA3140T	72p	709HC to5	64p
CA3160E	90p	709PC dil	36p
CA3160T	99p	710HC to5	65p
Op amps		710PC dil	59p
LM301AH	67p	723CN	65p
LM301AN	30p	741CH to5	66p
LM308H	121p	741CN 8dil	27p
LM308N	97p	747CN	70p
LM318H	279p	748CN	36p
LM318N	224p	NE531T	12Cp
		NE531N	105p

OPTO 7 seg displays

0.43" High Efficiency HP:

5082-	7650	red CA	233p
5082-	7653	red CC	
5082-	7660	yellow CA	
5082-	7663	yellow CC	
5082-	7670	green CA	
5082-	7673	green CC	

0.3" Standard HP

5082-	7730	red CA	147p
5082-	7740	red CC	

0.5" Fairchild

FND500	red CC	150p
FND507	red CA	150p

TTL : Standard AND LP Schottky

	'N'	'LSN'		'N'	'LSN'		'N'	'LSN'		'N'	'LSN'		LSN
7400	13	20	7455	35	24	74126	57	44	74185	134		74377	124
7401	13	20	7460	17		74128	74		74188	275		74378	93
7402	14	20	7463			74132	73	78	74190	115	92	74379	130
7403	14	20	7470	28		74133		29	74191			74386	37
7404	14	24	7472	28		74136		40	74192	105	180	74390	140
7405	18	26	7473	32		74138		60	74193	105	180	74395	139
7406	38		7474	27	38	74139		60	74194	105	187	74396	133
7407	38		7475	38	40	74141	56		74195	95	137	74398	180
7408	17	24	7476	37		74142	265		74196	99	110	74399	150
7409	17	24	7478			74143	312		74197	85	110	74445	92
7410	15	24	7480	48		74144	312		74198	150		74447	90
7411	20	24	7481	86		74145	65		74199	160		74490	140
7412	17	24	7482	69		74147	175		74248		90	74668	110
7413	30	52	7483A			74148	109		74249		93	74670	249
7414	51	130	7484	97		74150	99		74251		90		
7415		24	7485	104	99	74151	64	84	74253		105		
7416	30		7486		40	74153	64	54	74257		108		
7417	30		7489	205		74154	96		74258		153		
7420	16	24	7490	33	90	74155	54	110	74259		420		
7421	29	24	7491	76	110	74156	80	110	74260		153		
7422	24	24	7492	38	78	74157	67	55	74261		353		
7423	27		7493	32	99	74158		60	74266		40		
7425	27		7494	78		74159	210		74273		124		
7426	36	27	7495A	65	99	74160	82	130	74275		312		
7427	27	29	7496	58	120	74161	92	78	74279		52		
7428	35	32	7497	185		74162	92	130	74283		120		
7430	17	24	74100	119		74163	92	78	74290		90		
7432	25	24	74104	63		74164	104		74293		95		
7433	40	32	74105	62		74165	105		74295		120		
7437	40	24	74107	32	38	74166			74298		100		
7438	33	24	74109	63	38	74167	20		74324		157		
7440	17	24	74110	54		74168			74325		242		
7441	74		74111	68		74169		200	74326		247		
7442	70	99	74112	88		74170	230	200	74327		237		
7443	115		74113		38	74172	625		74352		100		
7444	112		74114		38	74173	170		74353		100		
7445	94		74116	198		74174	87	120	74362		715		
7446	94		74118	83		74175	87	110	74365		49		
7447	82		74119	119		74176	75		74366		49		
7448	56	99	74120	115		74177	78		74367		43		
7449		99	74121	25		74180	85		74368		49		
7450	17		74122	46		74181	165	350	74373		77		
7451	17	24	74123	48		74182	160		74374		77		
7453	17		74124			74183		210	74375		60		
7454	17	24	74125	·38	44	74184	135						

MISCELLENY

NE555	30p
NE556	78p
NE558	180p
ICM7217	950p
ICM7208	1495p
ICL7106CP - LCD DVM IC	955p
LCD DVM KIT	2480p
3½ digit LCD display	1150p
ICL7107 LED DVM kit	2065p
ICM7216 - 8 digit 10MHz DFM/ timer (for LED C.Cath)	£19.82

SCALAR ICs

8629 150MHz divide by 100	420p
95H90DC	780p
11C90DC	1400p
8618 -new-divide by 100 or 10 for 120/60MHz	450p

The ICL7216BIPI is still the cheapest way to make a full 8 digit/ 10MHz frequency counter/timer, and with 10 external components + display - it is also one of the simplest. For £19.82, it takes a lot of beating. The mains filters have been extended now to include a 6amp IEC version at £5.10, and with the amount of electronic noise on the average supply (next door's fridge, for instance) it is a really worthwhile addition to any sensitive equipment. LPSN TTL now includes many more of latest types, all - of course - are absolutely prime first quality types. And don t forget our range of OPTO displays includes Hewlett Package high efficiency 0.43" types in all colours - renowned as the finest quality in the market. For other types of component - discrete LEDs, radio and audio devices, tuner modules, kits etc., see our other advertisement for more details - or send for the AMBIT catalogue system. Part one (45p) includes details of our background 'standard' items, and the new part two includes all the latest introductions and developments, plus a rundown on OSTS.

TERMS: CWO pse., VAT to be added at 8% (inland), pp 25p per order. When ordering from the OSTS and Ambit - a single combined remittance and pp charge is sufficient. Account details OA.

2 Gresham Road, Brentwood, Essex.

WW—044 FOR FURTHER DETAILS

100,000,000,000,000 Ohms

The AVO RM290 is a bench type megohmmeter with a resistance range that goes up to $10^{14}\ \Omega$:making it ideal for those applications where there is a need to measure the electrical resistance of non- conducting materials...accurately!

You can use the RM290 for tests on insulating components in electronic assemblies or on capacitor dielectrics. Resistance measurements can be made at test voltages of 100, 250, 500 or 1000 V. Readout from the single resistance scale on the meter is direct, irrespective of the test voltage selected.

You'll find the AVO RM290 a great asset. Get in touch with us today and we'll let you have the full facts.

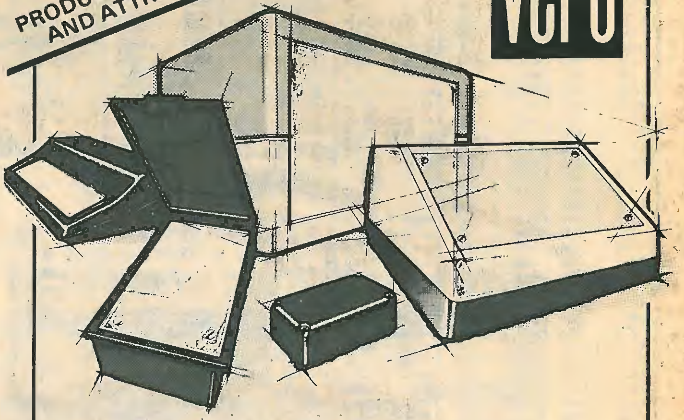
You'll never meet a better meter

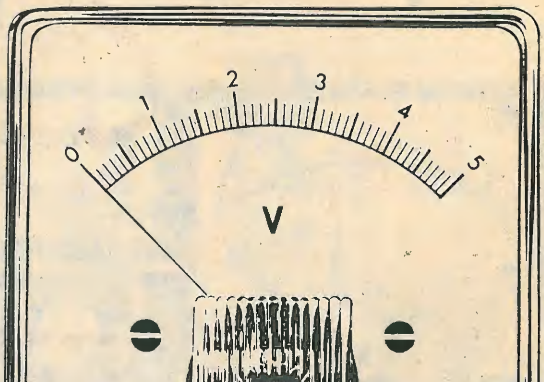
AVO Limited, Archcliffe Road,
Dover, Kent, CT17 9EN
Tel: 0304 202620 Telex: 96283

Thorn Measurement & Components Division

WW—058 FOR FURTHER DETAILS


BEYER DYNAMIC

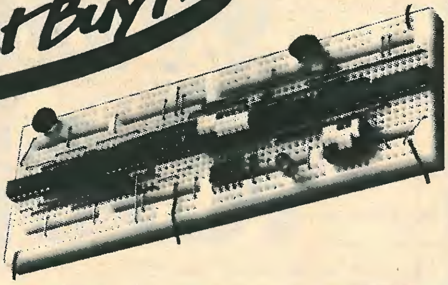



0
1
2
3
4
5
V

FAST AND EASY FAST AND EASY FAST AND EASY FAST AND EASY

Britain's Best Breadboard Buys!

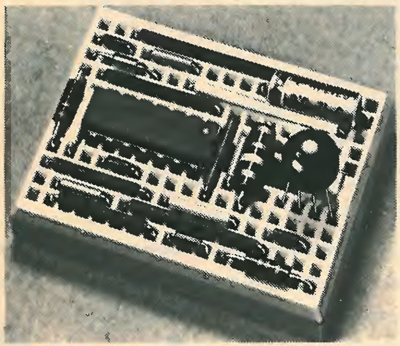
Best Buy 1.



Lektrokit Super Strip SS2

Only £11.05 inc. p & p and VAT

Super Strip accepts *all DIP's*—as many as nine 14-pin at a time—and/or TO-5's and discrete components. With interconnections of any solid wire up to 20 AWG. *And no soldering.* Super Strip has 840 contact points, combining a power/signal distribution system with a matrix of 640 contacts in groups of 5. Distribution system has 8 bus-bars, each with 25 contact points.



Best Buy 2-8

Lektrokit Breadboards and Bus Strips

From £3.25 inc p & p and VAT

The modular, solderless system! Breadboards that link together for any size, any configuration. With pitch of 0.1" to accept all IC's. Just take each component, choose its hole and push it in.

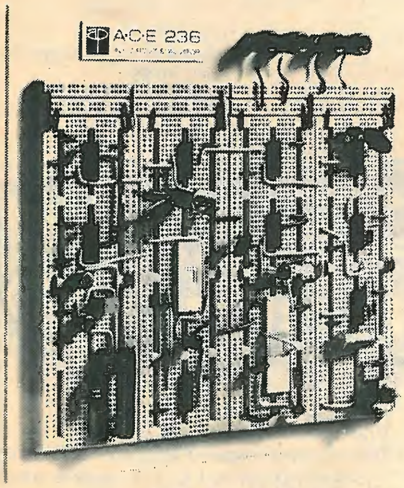
BREADBOARDS

Model	*Contacts*	*Price, each*
264L	640	£8.32
248L	480	£6.65
234L	340	£5.75
217L	170	£3.25

(All prices include p & p and VAT)

BUS STRIPS

Model	*Price*
212R	£1.78
209R	£1.62
206R	£1.45



Best Buy 9-15

Lektrokit All-Circuit Evaluators

Seven ACE models from £12.53 —all prices inc p & p and VAT

Just plug in components and make connections with ordinary 22-gauge solid wire. No soldering. Build any working project *complete* as fast as you could lay out a circuit diagram before.
ACE 200-K (728 contacts: £12.53) and ACE 201K (1,032 contacts: £16.75) come in kit form.

Lektrokit's policy is the right product, whatever the project, at the right price. And it's backed by a nationwide network of retailers.
Send for the name of the dealer nearest you—plus a FREE full-colour catalogue.

Write to:- LEKTROKIT LTD., London Road, Reading, Berks. RG6 1AZ. Or send coupon.

LEKTROKIT

To Lektrokit Limited, London Road, Reading, Berks, RG6 1AZ.
Tel. Reading (0734) 669116/7.
Please send me the name of my nearest Lektrokit dealer—plus FREE catalogue.
Please supply the following (list items required)

....

.... I enclose P.O./cheque for £ ......

(Allow 28 days for delivery. All prices above include packing, postage and VAT).

Name ....

Address ....

....

(WW4)

COMPLETES THE CIRCUIT

WW — 007 FOR FURTHER DETAILS

MHz electronics

2111 WEST CAMELBACK SUITE B PHOENIX , ARIZONA USA (602) 242-3037

R F Transistors

Type	Price	Type	Price	Type	Price
2N1561	$15.00	2N5637	$20.70	HEPS3006	$19.90
2N1562	15.00	2N5641	4.60	HEPS3007	24.95
2N1692	15.00	2N5643	20.70	HEPS3010	11.34
2N1693	15.00	2N5764	27.00	HEPS5026	2.56
2N2857JAN	2.45	2N5862	50.00	MMCM918	1.00
2N2876	12.35	2N5913	3.25	MMT72	.61
2N2880	25.00	2N5922	10.00	MMT74	.94
2N2927	7.00	2N5942	49.50	MMT2857	1.43
2N2947	17.25	2N5943	1.75	MMT3960A	6.25
2N2948	15.50	2N5944	7.50	PT4186B	3.00
2N2949	3.90	2N5945	10.90	PT4571A	1.50
2N2950	5.00	2N5946	13.20	PT8659	10.72
2N3287	4.30	2N6080	5.45	PT9784	24.30
2N3300	1.05	2N6081	8.60	PT9790	41.70
2N3302	1.05	2N6082	9.90	PT9847	26.40
2N3307	10.50	2N6083	11.80	J04030	15.60
2N3309	3.90	2N6084	13.20	40281	10.90
2N3375	7.00	2N6094	5.75	40282	11.90
2N3553	1.80	2N6095	10.35	40290	2.48
2N3818	6.00	2N6096	19.35	TA7994	50.00
2N3824	3.20	2N6097	28.00		
2N3866	1.09	2N6136	18.70		
2N3866JAN	4.14	2N6166	36.80		
2N3866JANTX	4.85	2N6439	43.45		
2N3924	4.00	MM1500	32.20		
2N3925	6.00	MM1550	10.00		
2N3927	11.50	MM1552	50.00		
2N3950	26.25	MM1553	56.50		
2N3961	6.60	MM1601	5.50		
2N4072	1.70	MM1602	7.50		
2N4073	2.00	MM1607	8.65		
2N4135	2.00	MM1620	17.50		
2N4427	1.24	MM1661	15.00		
2N4430	20.00	MM1669	17.50		
2N4440	8.60	MM1943	3.00		
2N4957	6.30	MM2605	3.00		
2N4958	4.35	MM2608	5.00		
2N4959	2.12	MM8002	2.05		
2N4976	19.00	MM8006	2.12		
2N5070	13.80	MRF245	31.05		
2N5090	6.90	MRF304	43.45		
2N5108	3.90	MRF501	.49		
2N5109	1.55	MRF504	6.95		
2N5160	3.34	MRF509	4.90		
2N5177	20.00	MRF511	8.60		
2N5179	.68	MRF646	20.70		
2N5184	2.00	MRF5177	20.70		
2N5216	47.50	MRF8004	1.90		
2N5589	4.60	HEP76/S3014	4.95		
2N5590	6.30	HEPS3002	11.30		
2N5591	10.35	HEPS3003	29.88		
		HEPS3005	9.55		

FET,s

40673	1.39 or 10/10.00
3N128	1.35 or 10/10.00
2N5248	.60 or 10/ 4.50
MPF102	.45 or 10/ 3.50
MEM631	.63 or 10/ 5.30

TERMS :

All CHECKS and MONEY ORDERS ARE IN US FUNDS !!!

ALL ORDERS SENT AIRMAIL DAY

Pleasa Include $2.50 Minimun for postage.

ALL PRICES IN US DOLLARS.

ALL PARTS PRIME/GUARANTEED.

BANK AMERICARD/VISA/MASTERCHARGE

Your Number;

Exp. Date

Your Signature

IC,s

MC1550G	1.50
MC1590G	6.50
MC4024P	3.27
TMS4024	10.00

MHZ Electronics Kits :

Kit # 1

Motorola MC14410CP CMOS Tone Generator.

CMOS Tone Generator uses 1 MHZ crystal to produce standard dual frequency dialing signal. Directly compatible with 12 key Chomeric Touch Tone Pads. Kit includes the following.:

1 Motorola MC14410CP Chip
1 1 MHZ Crystal
1 PC Board

And all other parts for assembly. NOW ONLY $15.70

Kit # 2

Fairchild 95H90DC Prescaler 350MHZ.

95H90DC Prescaler divides by 10 to 350 MHZ. This kit will take any 35MHZ Counter to 350 MHZ. Kit includes the following.:

1 Fairchild 95H90DC Chip
1 2N5179 Transistor
2 UG-88/U BNC Connectors
1 PC Board

And all other parts for assembly. Now Only $19.95

Kit # 3

Fairchild 11C90DC Prescaler 650MHZ.

11C90DC Prescaler divides by 10/100 to 650 MHZ. This counter will take any 65 MHZ Counter to 650MHZ. or with a 82S90 it will take a 6.5 MHZ Counter to 650MHZ. Kit includes the following.:

1 Fairchild 11C90DC Chip
1 2N5179 Transistor
2 UG-88/U BNC Connectors
1 LM/MC7805 Voltage Regulator
1 50volt 1Amp Bridge
1 LED Indicator
1 PC Board

And all other parts for assembly. Now Only $29.95

FAIRCHILD VHF and UHF Prescaler Chips

95H90DC	350MHZ Prescaler Divide by 10/11	$ 8.95
95H91DC	350MHZ Prescaler Divide By 5/6	8.95
11C90DC	650MHZ Prescaler Divide By 10/11	15.95
11C91DC	650MHZ Prescaler Divide By 5/6	15.95
11C83DC	1GHZ Divide by 248/256 Prescaler	29.90
11C70DC	600MHZ Flip/Flop with reset	12.30
11C58DC	ECL VCM	4.53
11C44DC	Phase Frequency Detector (MC4044P/L)	3.82
11C24DC	Dual TTL VCM (MC4024P/L)	3.82
11C06DC	UHF Prescaler 750MHZ D Type Flip/Flop	12.30
11C05DC	1GHZ Counter Divide by 4	74.35
11C01FC	High Speed Dual 5-4 Input NO/NOR Gate	15.40

Crystal Filters. Tyco 001-19880 same as 2194F

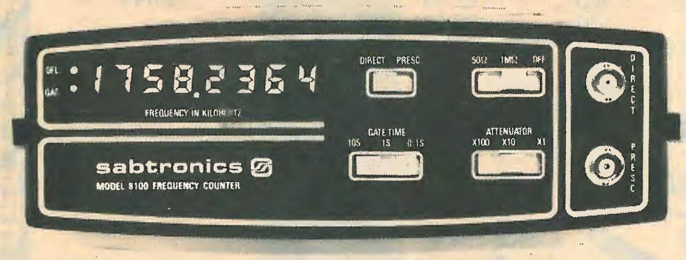
10.7MHZ Narrow Band Crystal Filter

3 db bandwidth 15khz minimum 20 db bandwidth 60khz minimum 40 db bandwidth 150khz minimum

Ultimate 50 db : Insertion loss 1.0db Max. Ripple 1.0db Max. Ct. 0+ - 5pf. Rt. 3600 Ohms.

Now Only $ 5.95

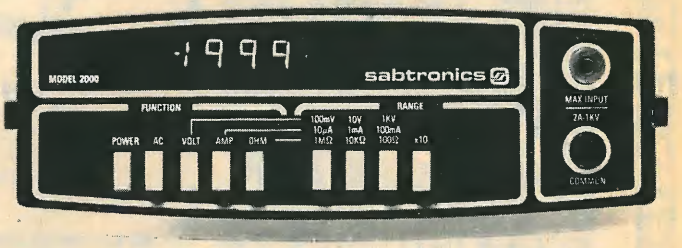
WW—027 FOR FURTHER DETAILS



Model 8100 Frequency counter
Kit £ 69.95
assembled tested: £ 84.95
(plus p.p. £ 3.50 and VAT at 8%)

sabtronics

Model 2000 3½ Digit DMM
Kit £ 49.95
assembled: £ 69.95
(plus p.p. £ 3.00 and VAT at 8%)



The Winners

These two products are our best sellers!

The two products shown above from Sabtronics are our best selling products. Both these products compare with similar equipment selling for atleast £ 150.00. Is there more to these products than value? Let's take a closer look.

The Frequency Counter Model 8100
It employs LSI Technology, has the performance and characteristics you demand, guaranteed frequency range of 20 Hz to 100 MHz; selectable hi/lo impedance; superior sensitivity; selectable resolution and selectable attenuation. Plus an accurate time base with excellent stability. An 8 digit LED Display features floating decimal point, leading zero suppression and overflow indicator.

Brief specifications:
Frequency Range: 20 Hz to 100 MHz guaranteed, (10 Hz to 130 MHz typical) – Sensitivity: 10 mV RMS, 20 Hz to 50 MHz (5 mV typical); 15 mV RMS, 50 MHz to 100 MHz (10 mV typical) – Selectable impedance: 1 MΩ/25 pF or 50Ω – Attenuation: X1, X10 or X100 – Accuracy: ± 1 Hz plus time base accuracy – Aging Rate: ± 5 ppm/yr – Temperature Stability: ± 10 ppm, 0° to 50° C – Resolution: 0.1 Hz, 1 Hz, 10 Hz selectable – Display: 8-digit LED, floating DP, overflow indicator – Overload Protection – Power Requirement: 9-15 VDC.
Optional prescaler will be available from around March 1979.

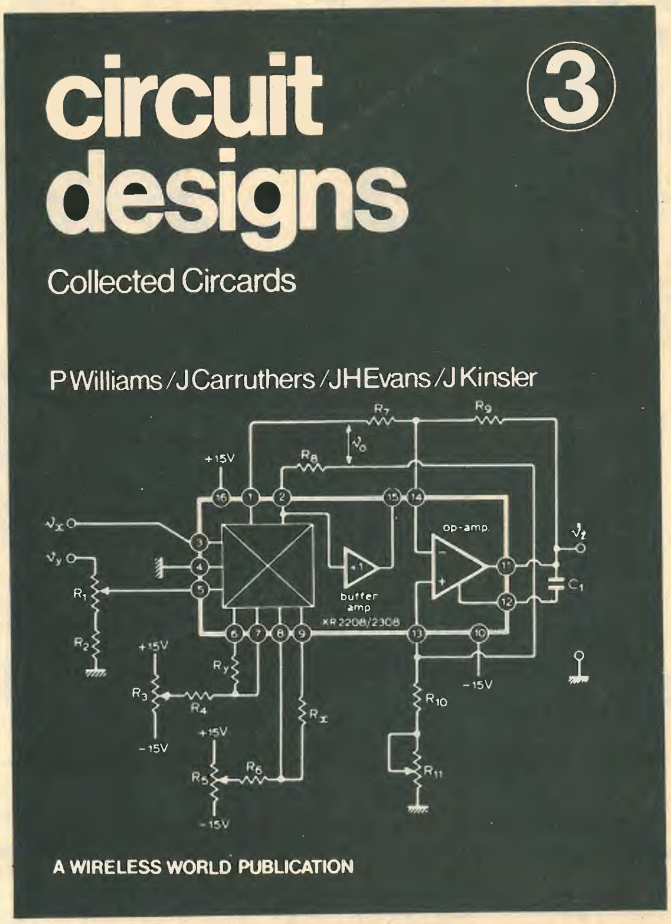
The DMM Model 2000
The model 2000 is all solid-state, incorporating a single LSI circuit and high quality components.
It has five functions and a total of 28 ranges. Input overload protection, auto polarity and auto zero are provided on all ranges and a basic DCV accuracy of 0.1% ± 1 digit.

Brief specifications:
DC volts in 5 ranges: 100 μV to 1 kV – AC volts in 5 ranges: 100 μV to 1 kV – DC current in 6 ranges: 100 nA to 2A – AC current in 6 ranges: 100 nA to 2A – Resistance: 0.1Ω to 20 MΩ in 6 ranges – AC frequency response: 40 Hz to 50 kHz – Display: 0.36" (9,1 mm) 7-segment LED – Input impedance: 10 MΩ – Size: 8" W×6.5" D×3" H (203×165×76 mm) – Power requirement: 4 "C" cells (not included).

Order yours now! Write to:
Timwood Ltd.
Prospect Road, Cowes,
Isle of Wight, England Telex 86892.
Send payment with your order.

WW — 014 FOR FURTHER DETAILS

...and now No.3!


circuit designs ③

Collected Circards

P Williams / J Carruthers / J H Evans / J Kinsler

A WIRELESS WORLD PUBLICATION

This third book in Wireless World's popular series will be welcomed by all concerned with designing, using and understanding electronic circuits.
It comprises information previously included in the third 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.
The book follows on from Circuit Designs Nos. 1 and 2. It is magazine size in hard cover and contains ten sets of Circards plus additional information and an explanatory introduction. Like its predecessors, it may soon be difficult to obtain, so you are advised to order your copy without delay.

Voltage to frequency converters.
Amplitude modulators.
Reference Circuits.
Voltage regulators.
RC oscillators—part 1.
RC oscillators—part 2.
C.M.O.S.—part 1.
C.M.O.S.—part 2.
Analogue multipliers.
R.m.s./ log./ power law circuits.

A book from wireless world

General Sales Department, IPC Business Press Ltd.,
Room CP34, Dorset House, Stamford Street, London SE1 9LU.

ORDER FORM
To: General Sales Department,
IPC Business Press Limited, Room CP34, Dorset House,
Stamford Street, London SE1 9LU.

Please send me......copy s of
Circuit Designs — Number 3 at £14.50 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 Ltd.
Registered No. 677128. Regd. office: Dorset House, Stamford Street,
London SE1 9LU.

NEW LITESOLD C35 CORDLESS SOLDERING IRON

Convenient – solders anywhere
Quick heating – under 7 secs.
Leakage free – no earthing
Twin spotlights
Complete safety
Up to 350 joints/charge
Interchangeable tips
Recharges in 8 hours.

The LITESOLD C35 cordless rechargeable iron is indispensable where an electrical supply is not available or a connecting lead is inconvenient.

It is ideal for domestic, servicing and outside work and can be safely used on the most delicate electronic components.

The iron recharges completely in 8 hours from its main power unit, and cannot be overcharged. The built-in nickel cadmium batteries give operating temperature within 7 seconds of pressing the operating button, which is fitted with a safety lock. Twin spot lights give clear, shadowless illumination of the work and an additional light in the body shown when the iron is operating and also when it is on charge.

Soldering capacity per charge is approximately 100 joints intermittently, or 350 joints in intensive use. The interchangeable long-life tips are available in standard and 2 alternative shapes. Operating temperature is approximately 350°C.

The C35 cordless iron comes complete with mains power unit, standard tip C35D for work up to 2.5 sq.mm.detachable light fittings, cleaning sponge and miniature screwdriver for tip changing.

Spare tips C35F for joints up to 1.5 sq.mm. and C35G (6 sq.mm) are available separately, or may be supplied extra with the iron.

Light Soldering Developments Ltd.

97-99 Gloucester Road, Croydon, Surrey CRO 2DN. England.
Telephone 01-689-0574 Telex 8811945

WW—068 FOR FURTHER DETAILS

OUR LATEST NUMBER

The AVO DA116 is a multimeter that offers many benefits to those measuring amps, volts and ohms. For a start, it's a digital instrument that gives you large easy-to-read results in any light. Powered by four ordinary zinc carbon 1.5V batteries (that last for more than 500 hours), it offers 30 ranges (up to 1000V and 10A on both a.c. and d.c. ranges with six resistance ranges measuring up to 20 MΩ); a high speed ohms facility (around 10 times faster than normal resistance ranges), and a special Junction Test range (for testing of diodes and semiconductors in circuit).

The AVO DA116 is housed in a tough case that takes a simple snap-on protective cover (which also doubles as a support stand and test lead holder). And to cap it all, it's made by AVO, which in itself is your guarantee of quality. You might expect to pay a small fortune for all this. Not so. The AVO DA116 is really competitively priced.

Get in touch with us today for the full facts
We'll tell you all about our latest number

AVO Ltd., Archcliffe Road, Dover, Kent CT17 9EN.
Tel: (0304) 202620 Telex: 96283

Thorn Measurement & Components Division
You'll never meet a better meter

AVO DA116

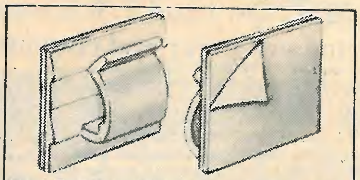
WW—047 FOR FURTHER DETAILS

HARMSWORTH

FASTENERS FOR ELECTRONICS

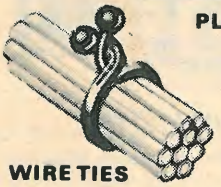
FASTEX

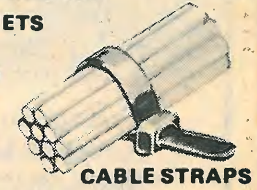

HOLE PLUGS


SELF-ADHESIVE CABLE CLIPS

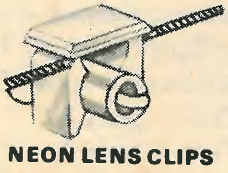

DRIVE FASTENERS

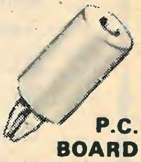

PLASTIC GROMMETS


WIRE TIES


CABLE STRAPS


PLASTIC RIVETS

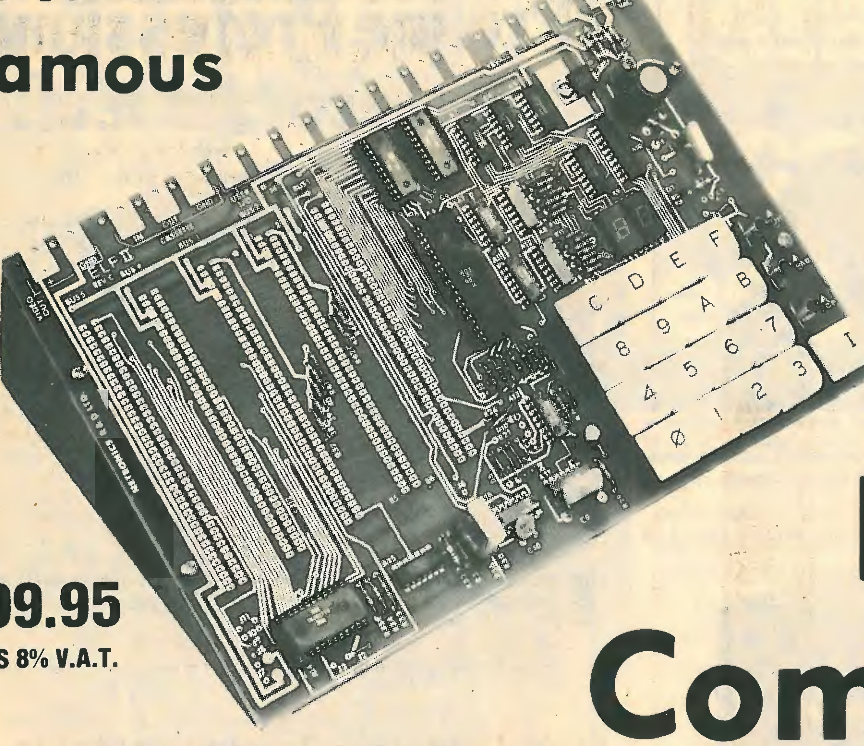

NEON LENS CLIPS


P.C. BOARD STAND-OFFS

One piece mouldings made from thermoplastic materials for mechanical strength, high electrical and vibration resistance. Fast to install. Reduced in-place costs. Leaflets on request.

HARMSWORTH, TOWNLEY & CO. LTD.
HAREHILL TODMORDEN LANCS OL14 5JY
Phone TODMORDEN 2601 (STD 070-681 2601)

This Is The Famous ELF 11 Computer



£99.95

PLUS 8% V.A.T.

SPECIFICATIONS

The £99.95 ELF II computer features an RCA COSMAC COS/MOS 1802 8-bit microprocessor addressable to 64K bytes with DMA, interrupt, 16 registers, ALU, 256 byte RAM expandable to 64K bytes, professional hex keyboard fully decoded so there's no need to waste memory with keyboard scanning circuits, built-in power regulator, 5 slot plug-in expansion bus (less connectors), stable crystal clock for timing purposes and a double-sided, plated-through pc board plus RCA 1861 video IC to display any segment of memory on a video monitor or TV screen along with all the logic and support circuitry you need to learn every one of the RCA 1802's capabilities

Stop reading about computers and get your hands on one! With ELF II and our new *Short Course* by Tom Pittman, you can master computers in no time at all ELF II demonstrates all 91 commands an RCA 1802 can execute and the *Short Course* quickly teaches you how to use each of the 1802'a capabilities.

Elf II's video output lets you display an alphanumeric readout or graphics on any TV screen or video monitor and enjoy the latest video games.

But that's not all. Once you've mastered computer fundamentals, ELF II can give you POWER with add-ons that are among the most advanced found anywhere. American IEEE chapters plus hundreds of universities and major corporations have chosen the ELF II to introduce their students and personnel to microprocessor computing!

Learn The Skill That May Soon Be Far More Important Than Your College Degree!

The ability to use the computer may soon be more important to your earning power than a college degree. Without a knowledge of computers, you are always at the mercy of others when it comes to solving highly complex business, engineering, industrial and scientific problems. People who understand computers can command MONEY and to get in on the action, you must learn computers. Otherwise you'll be left behind.

ELF II Is The F-A-S-T Way to Learn Computer Fundamentals!

Regardless of how minimal your computer background is now, you can learn to programme a computer in almost no time at all. That's because Netronics has developed a special *Short Course on Microprocessor And Computer Programming* in non-technical language that leads you through every one of the RCA COSMAC 1802's capabilities so you'll understand *everything* ELF II can do . . . *and how to get ELF II to do it!*

All 91 commands that an 1802 can execute are explained to you, step-by-step. The text, written for Netronics by Tom Pittman, is a tremendous advance over every other programming book in print.

Keyed specifically to the ELF II, it's loaded with "hands on" illustrations. When you're finished, ELF II and the 1802 will no longer hold any mystery for you.

In fact, not only will you be able to use a personal computer creatively, you'll also be able to *understand* computing articles in the technical press.

If you work with large computers, ELF II and our *Short Course* will help you to understand what makes them tick.

A Dynamite Package For Just £99.95 Plus 8% V.A.T.!

With ELF II, you learn to use machine language — the fundamental language of all computers. Higher level languages such as FORTRAN and BASIC must be translated into machine language before a computer can understand them. With ELF II you build a solid foundation in computers so you'll really know what you're doing, no matter how complicated things get.

Video output also makes ELF II unique among computers selling such a low price. Attached to your TV set, ELF II becomes a fabulous home entertainment centre. It's capable of providing endless hours of fun for both adults and children all all ages! ELF II can create graphics, alphanumeric displays and fantastic video games.

Only a low cost RF modulator is required to connect ELF II to your TV's aerial socket! (To order see below.)

ELF II's 5-card expansion bus (connectors not included) allows you to expand ELF II as your needs for power grows. It you're an engineer, or hobbyist, you can also use ELF II as a counter, alarm, lock, thermostat, timer, or for countless other applications.

ELF II Explodes into A Giant!

Thanks to ongoing work by RCA and Netronics, ELF II add-ons are among the most advanced anywhere. Plug in the **GIANT BOARD** and you can record and play back programmes, edit and debug programmes, communicate with remote devices and make things happen in the outside world. Add **Kluge Board** to get ELF II to solve special problems such as operating a more complex alarm system or controlling a printing press. Add **4k RAM** board and you can write longer programmes, store more information and solve more sophisticated problems.

Expanded, ELF II is perfect for engineering, business, industrial, scientific and personal finance and tax applications. No other small computer anywhere near ELF II's low price is backed by such an extensive research and development programme.

The **ELF-BUG Monitor** is an extremely recent breakthrough that lets you debug programmes with lightning speed because the key to debugging is to know what's inside the registers of the microprocessor and, instead of single stepping through your programme, the ELF-BUG Monitor, utilising break points, lets you display the entire contents of the registers on your TV screen at any point in your programme. You find out immediately what's going on and can make any necessary changes. Programming is further simplified by displaying 24 bytes of RAM with full address, blinking cursor and auto scrolling. A must for serious programmers!

Netronics will soon be introducing the ELF II **Colour Graphics & Music System** — more breakthroughs that ELF II owners will be the first to enjoy!

Now BASIC Makes Programming ELF II Even Easier!

Like all computers, ELF II understands only "machine language" — the language computers use to talk to each other. But, to make life easier for you, we've developed an **ELF II Tiny BASIC.** It talks to ELF II in machine language for you so that you can programme ELF II with simple words that can be typed out on a keyboard such as PRINT, RUN and LOAD.

"Ask Not What Your Computer Can Do . . . But *What Can It Do For YOU!*

Don't be trapped into buying a dinosaur simply because you can afford it and it's big. ELF II is more useful and more fun than "big name" computers that costs a lot more money.

With ELF II, you learn to write and run your own programmes. You're never reduced to being a mere keypunch operator, working blindly with someone else's predeveloped software.

No matter what your speciality is, owning a computer which you really know how to use is sure to make you a leader. ELF II is the fastest way there is to get into computers. Order from the coupon below!

H. L. AUDIO, 138 KINGSLAND ROAD, LONDON, E8 8BY

SEND TODAY FOR DETAILS OR ORDER

NOW AVAILABLE FOR ELF II —

☐ Tom Pittman's *Short Course On Microprocessor & Computer Programming* teaches you just about everything there is to know about ELF II or any RCA 1802 computer. Written in non-technical language, it's a learning breakthrough for engineers and laymen alike. **£5.00*** post paid!

☐ Deluxe metal **cabinet** with plexiglas dust cover for ELF II. **£29.95*** plus £1.50 p&p.

☐ **RF Modulator** for use with TV set. **£3.00*** post paid.

☐ **GIANT BOARD** kit with cassette I/O. RS 232-C/TTY I/O. 8-bit P. I/O decoders for 14 separate I/O instructions and a system monitor/editor. **£39.95*** plus £1.00 p&p.

☐ **Kluge** (Prototype) **Board** accepts up to 36 IC's. **£17.00** plus 50p, p&p.

☐ **4k Static RAM** kit. Addressable to any 4k page to 64k. **£89.95*** plus 50p. p&p.

☐ Gold plated **86-pin connectors** (one required for each plug-in board). **£5.70*** post paid.

☐ Professional **ASCII Keyboard** kit with 128 ASCII upper/lower case set, 96 printable characters, on board regulator, parity, logic selection and choice of 4 handshaking signals to mate with almost any computer **£64.95*** post paid.

☐ Deluxe metal cabinet for ASCII Keyboard. **£19.95*** plus £1 50 p&p.

☐ ELF II **Tiny BASIC** on cassette tape. Commands include SAVE, LOAD, + x, (), 26 variables A-Z, LET IF/THEN, INPUT PRINT, GO TO, GO SUB, RETURN, END, REM, CLEAR, LIST, RUN PLOT, PEEK, POLE, Comes fully documented and includes alphanumeric generator required to display alphanumeric characters directly on your TV screen without additional hardware. Also plays tick-teck-toe plus a drawing game that uses ELF II's hex keyboard as a joystick, 4k memory required. **£14.95*** post paid.

☐ Tom Pittman's **Short Course on Tiny BASIC** for ELF II. **£5.00*** post paid.

☐ **Expansion Power Supply** (required when adding 4k RAM). **£19.95*** plus £2.00 p&p.

☐ **ELF-BUG Deluxe System Monitor** on cassette tape. Allows displaying the contents of all registers on your TV at any point in your programme. Also displays 24 bytes of memory with full addresses, blinking cursor and auto scrolling. A must for the serious programmer! **£14.95*** post paid.

Coming Soon: A-D D-A Converter. Light Pen, Controller Board, Colour Graphics & Music System . . . *and more!*

Call or write for wired prices!

H.L. AUDIO LTD., Dept. W.W.
138 Kingsland Road, London E8 8BY
Tel: 01-739 1582
Sole European Distributors for Netronics R & D Ltd., U.S.A.

Yes! I want to run programmes at home and have enclosed. ☐ **£109.56** including postage and V.A.T. for **RCA COSMAC ELF II kit,** ☐ **£5.94** including postage and V.A.T. for power supply (required). ☐ **£5.95** for RCA, 1802 User's Manual. ☐ **£5.95** including postage and V.A.T. for *Short Course on Microprocessor Computer Programming.*

☐ **I want mine wired and tested with power supply. RCA 1802 User's Manual and *Short Course* included for just £164.10** including postage and V.A.T.

☐ I am also enclosing payment (including postage and V.A.T.) for the items checked at the left.

Total Enclosed £ . . . .

USE YOUR ☐ ACCESS ☐ BARCLAYCARD

Account No . . . .

Signature . . . . Exp. Date . . . .

PHONE ORDERS ACCEPTED 01-739 1582

Print Name . . . .

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

DEALER ENQUIRIES INVITED

WW—039 FOR FURTHER DETAILS

NEC

NIPPON ELECTRIC

RADIO AMATEUR COMMUNICATION EQUIPMENT

CQ-P-2200E
137-150 Mhz

2 meter FM 12 channel portable/mobile 1/3 watt transceiver

Features: battery cartridge system, all 12 channels X-tal fitted, 1750 Hz tone-call system, AXC or RIT switchable, highly efficient squelch, high (3 watts) low (1 watt) output power switchable, lamda 1/4 or 5/8 telescopic antenna selectable. Provisions for: external power 13.5 V DC, external antenna, earphone, external speaker. NEW: Professionel plug-in moduls construction, with all units shielded, selected high quality parts secure long life. Range: up to 50 KM. direct, up to several hundreds of kilometers over repeaters. Universality: mobile or portable (with the snip of a finger). High sensitivity: 0.2 uV for 20 db S/N.

CQ-R-700
170 Khz-30.0 Mhz

G band general coverage receiver with ultra high sensitivity (0.1 uV for 15 db S/N on 30 Mhz)

Features: vFO patent allows perfect frequency read- off and tune-in with ease. Selectivity selectable wide/narrow. Modes: SSB (USB/LSB), CW or AM. Noise-blanker incorporated, large, illuminated two colour S-meter, 500 Khz and 50 Hz calibration facility. Modern electronical layout. A true solution for all searching a reliable mean for short range or continuous long haule receiption.

CQ-LINE
1.6 - 30.0 Mhz

300 - 3000 watts HF-LINE. Modes: USB/LSB, CW, AM, RTTY (FSK), FAX in full digital readout.

In many thousands of applicationes the CQ-LINE has proven their reliability and sturdiness. Its versalilty and high power make the CQ - LINE a true partner for long distance communication. Even with simple antenna from home or car, world- wide contacts are no problem.

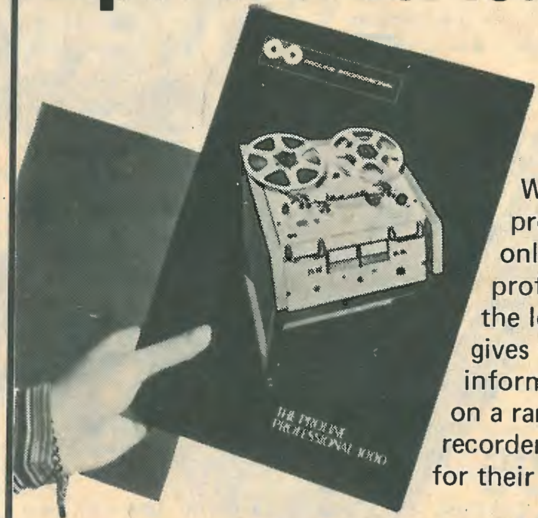
UK: please contact our distributor Messrs. William Munro, Invergordon, High Street 100, telef.: 349-852351-4 - Telex: 75265.

CEC

SOLE DISTRIBUTOR EUROPE OF **NEC**
RADIO AMATEUR AND CB EQUIPMENT
VIA VALDANI, 1, CH 6830 CHIASSO/SWITZERLAND,
TELEF. 091/446464, TELEX 64077 CEC CH

WW — 031 FOR FURTHER DETAILS

Get your copy of the Proline Professional tape recorder leaflet.



Written by professionals only for the professional, the leaflet gives full information on a range of recorders, noted for their

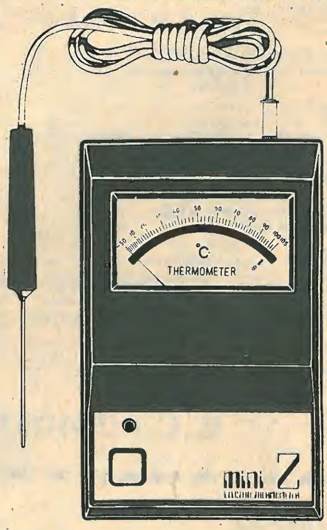
SOPHISTICATION WITHOUT COMPLICATION

Fill in the reader enquiry card or write to:

TONY COSTELLO OR JOHN ROBINSON
LEEVERS-RICH EQUIPMENT LTD
319 TRINITY ROAD LONDON SW18 3SL
01-874 9054

WW—052 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 oper scale meter. Supplied with carrying case, Probe and internal 1½ volt standard size battery.

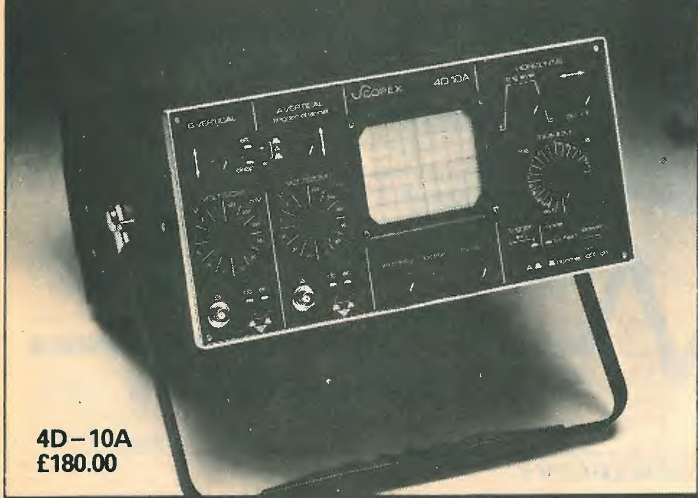
Model "Mini-Z 1" measures from—40° C to + 70° C. Price £30.00
Model "Mini-Z 2" measures from—5° C to + 105° C Price £30.00
Model "Mini-Z Hi" measures from + 100° C to 500° C £33.00
(VAT 8% EXTRA)

Write for further details to

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

WW — 011 FOR FURTHER DETAILS

Scopex vital statistics: 2% more in accuracy, around 20% less in price.



4D–10A
£180.00

4D–25
£285.00

4S–6
£125.00

Greater accuracy, lower cost plus something more – a wide range covering dual trace, 10 and 25MHz, long persistance, rack mounted – single trace 6MHz, long persistance and battery portable models, plus a wide variety of accessories and probes.

The figure of 3% accuracy compares very favourably with the 5% claimed by our competitors. As does the Scopex reputation for producing reliable, easy to use oscilloscopes for just about every application.

Take the 4D – 10A dual trace model. Guaranteed 3% accuracy achieved by a stabilised power supply including the EHT. 10mV – 50V/cm sensitivity, TV field trigger and trace locate. £180.00*

Or the 4D – 25. Dual trace model with DC – 25MHz bandwidth and 10mV/cm sensitivity. Signal delay allows you to trigger from and see the leading edge of any signal. Trigger level and slope are selected on one dual function control. £285.00*

For more details of these and the full Scopex range simply return the coupon. Remember what you gain in accuracy, you lose in price.

*U.K. list price excluding VAT.

SCOPEX

Scopex Sales
Pixmore Avenue, Letchworth, Herts SG61JJ
Tel: (04626) 72771

Please send me full details of the Scopex range of oscilloscopes.

Name ____________________

Company ____________________

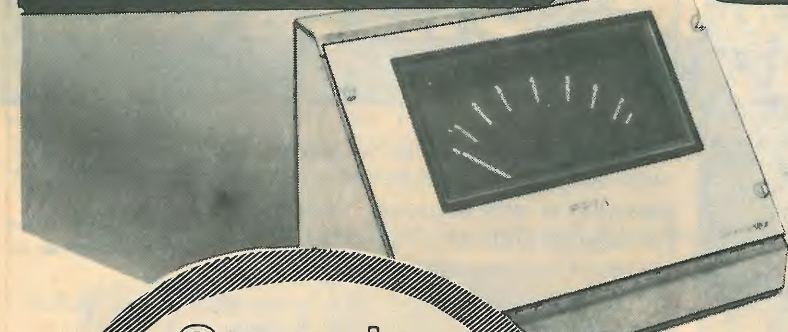
Address ____________________

Tel.: ____________________

WW2/79

WW—038 FOR FURTHER DETAILS

Scale the peaks with precision.



If your sound system calls for high precision in audio signal metering, the Soundex PPM is for you. It meets the stringent BS4297 and CCIR 468 specifications, with sophisticated electronics packaged in a rugged little case An illuminated scale gives you either PPM or dB readings, and each unit comes with its own calibration certificate. Frequency response is 15Hz to 35KHz, and a power supply is available. For all the figures . . . ask for a leaflet.

Now available: an additional version meeting the specification of DIN45406.

Soundex

PEAK PROGRAMME METER

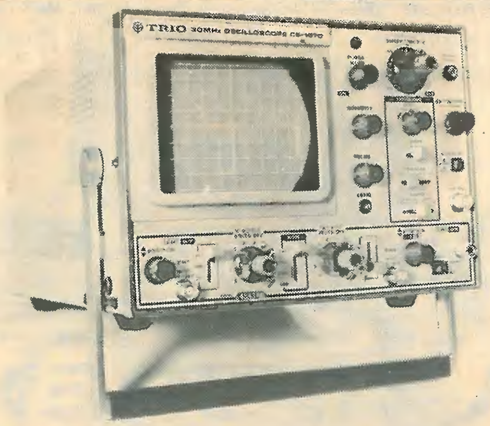
Bulgin Electronics

One of the Bulgin Group of Companies Soundex Ltd
Park Lane, Broxbourne, Hertfordshire. Tel: Hoddesdon 64455

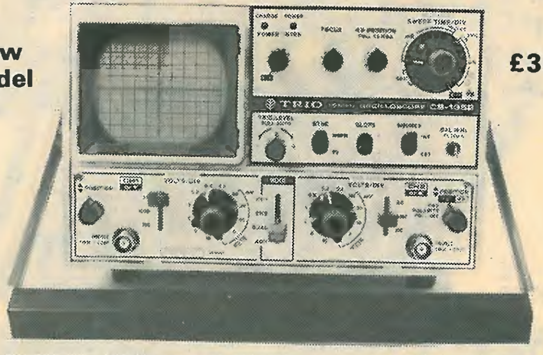
WW — 067 FOR FURTHER DETAILS

LOWE ELECTRONICS LTD.

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



New Model



£389

CS1352 DC—15MHz and 2mV/CM **AND** portable AC/DC/Internal battery

TRIO

OSCILLOSCOPES

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

CS-1570

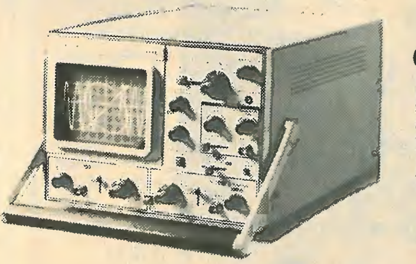
130mm DUAL TRACE TRIGGERED SWEEP OSCILLOSCOPE

£512 + 8% VAT
including two X10
Full Bandwidth Probes

- 130mm mesh PDA
- DC-30MHz/5mV
- Delay line
- Auto level triggering
- Display modes (CH1 CH2 DUAL ADD)
- Trigger modes (AC LF Rej HF Rej DC)

▪ SPECIFICATION

Bandwidth.	DC to 30MHz (−3dB)
Deflection factor.	5mV/div to 5V/div
Input R.C.	1MΩ, 24pF
Risetime.	11.7nsec
Overshoot:	Better then 3%
Signal delay	160nsec
Polarity.	CH2 can be inverted
Sweep time	0.2µs/div to 0.5s/div
Magnifier	x 5
Linearity.	Better than 3%
Calibrator:	0.5Vpp (1kHz square wave)
Intensity modulation	More than 5Vpp
Phosphor	P31
Power	AC100/120/220/240V 50/60Hz, 25W
Dimensions	W260 x H190 x D375 (mm)
Weight:	



CS 1575

Unique 4 function audic analysis scope.
Shows not only two channels but also phase relationship between them.
DC—5MHz 1mV/CM
A must for the audio engineer/repairman

£288

Also available

CS1560A 15MHz	**£352**
CS1562 10MHz	**£290**

And many more items of Trio Equipment
55p for full catalogue and price list

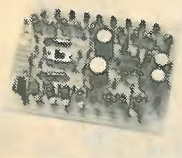
FOR FULL DETAILS ON THESE AND OTHER MODELS, CONTACT THE SOLE AGENTS, LOWE ELECTRONICS

WW—025 FOR FURTHER DETAILS

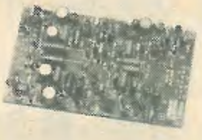
TOTAL AMPLIFICATION FROM **CRIMSON ELEKTRIK**

WE NOW OFFER THE WIDEST RANGE OF SOUND PRODUCTS —

STEREO PRE-AMPLIFIERS



MC 1



CPR 1

CPR 1 — THE ADVANCED PRE-AMPLIFIER. The best pre-amplifier in the U.K. The superiority of the CPR 1 is probably the disc stage. The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.I.A.A. is accurate to 1dB; signal to noise ratio is 70dB relative to 3 5mV; distortion <.005% at 30dB overload 20kHz.

Following this stage is the flat gain/balance stage to bring tape, tuner, etc. up to power amp. signal levels. Signal to noise ratio 86dB; slew-rate 3V/uS; T.H.D. 20Hz—20kHz <.008% at any level.

F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is 138x80x20mm. Supply to be ± 15 volts.

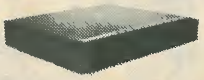
MC 1 — PRE-PRE-AMPLIFIER. Suitable for nearly all moving-coil cartridges. Sensitivity 70/170uV switchable on the p.c.b. This module brings signals from the now popular low output moving-coil cartridges up to 3.5mV (typical signal required by most pre-amp disc inputs). Can be powered from a 9V battery or from our REG 1 regulator board.

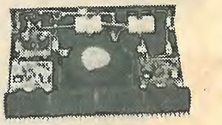
REG 1 — POWER SUPPLY. The regulator module, REG 1 provides 15-0-15v to power the CPR 1 and MC 1. It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate it.

POWER AMPLIFIERS. It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc. who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification. T.H.D. typically .01% any power 1kHz 8 ohms; T.I.D. insignificant; slew rate limit 25V/uS; signal to noise ratio 110dB; frequency response 10Hz-35kHz, —3dB; stability unconditional; protection drives any load safely; sensitivity 775mV (250mV or 100mV on request), size 120x80-25mm.

POWER SUPPLIES. We produce suitable power supplied which use our superb TOROIDAL transformers only 50mm high with a 120-240 primary and single bolt fixing (includes capacitors/bridge rectifier).

POWER AMPLIFIER KIT. The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply. It is contemporarily styled and its quality is consistent with that of our other products. Comprehensive instructions and full back-up services enables a novice to build it with confidence in a few hours.





POWER AMPLIFIER MODULES

CE 608 60W/8 ohms 35-0-35v	**£16.30**
CE 1004 100W/4 ohms 35-0-35v	**£19.22**
CE 1008 100W/8 ohms 45-0-45v	**£23.22**
CE 1704 170W/4 ohms 45-0-45v	**£29.12**
CE 1708 170W/8 ohms 60-0-60v	**£31.90**

TOROIDAL POWER SUPPLIES

CPS 1 for 2xCE 608 or 1xCE 1004	**£14.47**
CPS 2 for 2xCE 1004 or 2/4xCE 608	**£16.82**
CPS3 for 2xCE 1008 or 1xCE 1704	**£17.66**
CPS4 for 1xCE 1008	**£15.31**
CPS5 1 for 1xCE 1708	**£22.68**
CPS6 for 2xCE 1704 or 2xCE 1708	**£23.98**

HEATSINKS

Light duty, 50mm, 2 C/W	**£1.30**
Medium power, 100mm, 1-4 C/W	**£2.20**
Disco/group, 150mm, 1-1 C/W	**£2.85**
Fan, 80mm, state 120 or 240v	**£18.50**
Fan mounted on two drilled 100mm heatsinks 2x.4 C/W, 65 C max. with two 170W modules	**£29.16**

THERMAL CUT-OUT, 70 C	**£1.90**

POWER AMP KIT	**£32.40**

PRE-AMPS:
These are available in two versions — one uses standard components, and the other (the S) uses MO resistors where necessary and tantalum capacitors.

CPR1	**£29.49**
MC1	**£18.50**
CPRIS	**£39.98**
MC1S	**£29.49**

POWER SUPPLY:

REGi	**£6.75**	TR6	**£1.75**

BRIDGE DRIVER, BDI
Obtain up to 340W using 2x170W amps and this module.

BD1	**£5.40**

CRIMSON ELEKTRIK

1A STAMFORD STREET, LEICESTER LE1 6NLL. Tel. (0533) 537722

All prices shown are UK only and include VAT and post. COD 90p extra, £100 limit. Export is no problem, please write for specific quote. Send large SAE or 3 International Reply Coupons for detailed information.
Distributor Minic Teleproduckter, Box 12035, S-750 12 Uppsala 12, Sweden.

WW—032 FOR FURTHER DETAILS

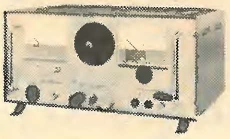
PRODUCTION TESTING

DEVELOPMENT

SERVICING

POWER UNITS

Now available with 3 OUTPUTS



Type 250VRU/30/25

OUTPUT 1: 0-30v, 25A DC

OUTPUT 2: 0-70v, 10A AC

OUTPUT 3: 0-250v, 4A AC

ALL Continuously Variable

Valradio

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

WW—054 FOR FURTHER DETAILS

Catronics **for VALUE & VARIETY in**

FREQUENCY COUNTERS

In addition to our popular 250MHz and 500MHz counters we have produced a NEW 200MHz COUNTER KIT specially for home constructors

Our new K200 counter, although small, is a no-compromise design. It offers:

- ★ **A full 8-digit LED display.**
- ★ **A frequency range of 10Hz to 200MHz.**
- ★ **An accuracy of 10Hz at 30MHz, 50Hz at 150MHz in normal home environments.**
- ★ **5/6 volt operation from batteries of mains PSU.**
- ★ **Power consumption of only 1W maximum at maximum frequency.**
- ★ **A crystal oscillator at 5MHz which doesn't need any special setting up equipment.**
- ★ **Small size 4" × 2" × 1"**
- ★ **Uses only 4 i.c.s.**
- ★ **Assembly time of about two hours.**
- ★ **Full illustrated assembly instructions.**

The K200 consists of 2 PCB assemblies, one being the complete input and counter unit, the other, the display unit. Both units are available in kit or assembled/tested module form. Prices, INCLUDING VAT:

Input/Counter Kit	**£59.00**	**Display Kit**	**£12.96**
Input/Counter Module	**£68.50**	**Module**	**£16.64**

(Add 75p for Post and Packing)

This NEW CATRONICS model K200 complements our DFM5, a 250 MHz, 7 DIGIT MAINS/12v HIGH QUALITY Frequency Counter, and the DFM 500 — a REAL 500 MHz — try some of the others actually at this frequency.

Both are absolute value for money and are available now with better than 1 in 10 reference oscillators as/S models.

SPECIAL PRICES INCLUDING VAT

DFM5	**£148.50**	**DFM5/S**	**£191.70**
DRM500	**£177.12**	**DFM500/S**	**£220.86**

Add £5 for Special Packing & Securicor

Catronics

CATRONICS LTD. (Dept. 922)
Communications House
20 WALLINGTON SQUARE
WALLINGTON, SURREY.
Tel. 01-669 6700

WW — 922 FOR FURTHER DETAILS

KGM TV CAMERAS

the big choice

Type 130 is a compact 2/3 inch camera with an unusually high specification for a camera of this size. It is a sturdy, reliable camera of great versatility.

Type 113 is an extremely rugged camera designed for critical applications of a very wide nature. Resolution is better than 800 lines.

Type 118 is a day and night camera based on Type 113 but with many unique features to enhance its performance in difficult light conditions.

KGM cameras and monitors are backed by KGM's many years' experience of designing and building CCTV equipment for large industrial users and leading public authorities. *Send for your data sheets now.*

KGM ELECTRONICS LIMITED

Clock Tower Road, Isleworth, Middlesex TW7 6DU
Tel: 01-568 0151. Telex: 934120

WW — 069 FOR FURTHER DETAILS

When components are small and space is tight use our

T-7 MICRO SOLDERING STATION

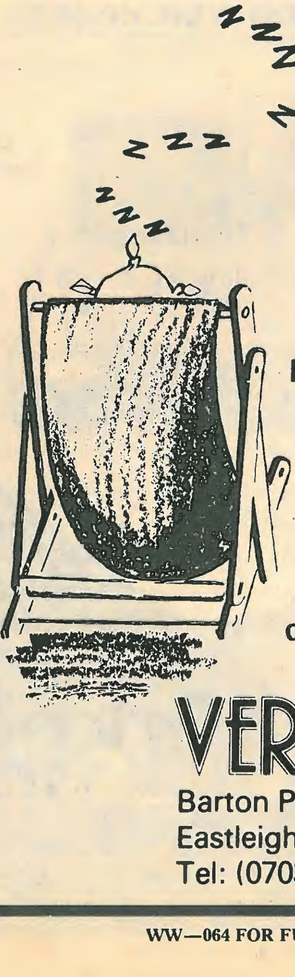
T-7 is a 12-watt continuous duty instrument for production line, lab or protoshop. Heating element in **soldering tip** puts heat right where needed. Accurate, stepless dialing, 175° to 910°F (79°-487°C). Work protected by solid-state, line-isolating circuitry and grounded element. Two interchangeable, reshapeable tips, plus slip-on tips for special needs. Ideal for soldering, rework, fine touch-up; working wax and plastic; heat-etching various materials.

AMERICAN BEAUTY

Available from
Special Products Distributors Ltd.
81 Piccadilly, London W1V 0HL
Tel: 01-629 9556
Cables: Speciprod, London W.1

Slip-on tip in use. 2/3 actual size.

WW—012 FOR FURTHER DETAILS



TAKE A DAY OFF

R & D Effort, Production Holdups, Machine down time etc. by securing your copy of the New Autumn '78 VEROSPEED fully priced catalogue of stocked components from

VEROSPEED

Barton Park Industrial Estate,
Eastleigh, Hampshire SO5 5RR
Tel: (0703) 618525

WW—064 FOR FURTHER DETAILS

THINK OF A SHAPE

S 500D — dual channel
up to 500W/RMS per
channel DC-20 KHZ

Whatever it is, the H|H 'S' range of power amplifiers will handle it

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

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

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

A complete range of matching transformers and peripheral equipment for closed loop, constant current and voltage use are available.
Alternative input and output termination to order. Rack case for bench use built to specifications. For complete data write or call.

Kirkham Electronics

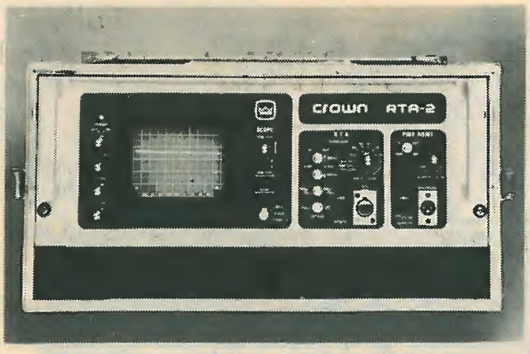
MILL HALL, MILL LANE, PULHAM MARKET, DISS, NORFOLK IP21 4XL
DIVISION OF K.R.S. LIMITED
TELEPHONE (037 976) 639/594

FRANCHISED COMMERCIAL AND INDUSTRIAL AGENTS FOR H|H ELECTRONIC

WW — 071 FOR FURTHER DETAILS

New from AMCRON

Real Time Analyser RTA2



The Amcron RTA2 Real Time Analyser is designed as much for use as a production tool as it is for on-site audio analysis of theatres, and recording studios. A flight case is available.

- ★ 5" CRT Display
- ★ Internal Pink Noise Source
- ★ ⅓ or 1 octave Display
- ★ Frequency range 20 - 20kHz
- ★ Outputs for X-Y Recorders
- ★ Compatible with any microphone
- ★ Price £1,960 ex. VAT

POWER AMPLIFIER D75

The AMCRON D75 power amplifier replaces the previous model D60. Employing completely new type circuitry it offers also many new features but without any increase in the price.

- ★ New Amcron IOC comparator.
- ★ Balanced XLR input connectors.
- ★ Signal Presence indicators.
- ★ Separate Signal/chassis earth.
- ★ 45 watts into 8 ohms per channel.
- ★ Price £230 ex. VAT.

Other AMCRON products include:

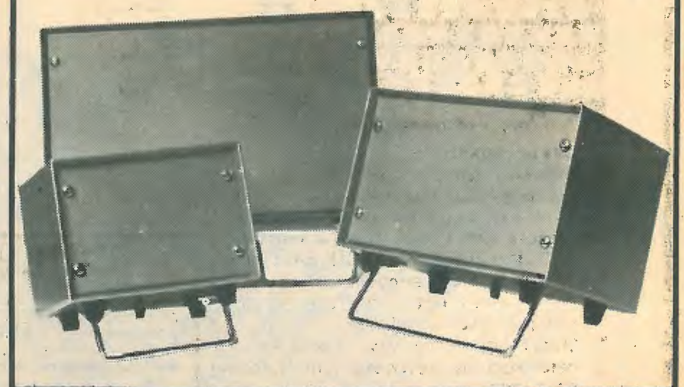
DC300A amplifier 500 watts/chan.	£550
D150A amplifier 200 watts/chan.	£350
VFX2A Electronic Variable Filter	£270
EQ2 Equaliser	£599
IC150A Pre-amplifier	£260
IMA Intermodulation Distortion Analyser unit	£610

MACINNES LABORATORIES LTD.
Carlton Park Industrial Estate
Saxmundham, Suffolk, IP17 2NL
Tel. Saxmundham (0728) 2262/2615

WW—028 FOR FURTHER DETAILS

OLSON

MINICASES



Type	Overall Dimension Width	Height	Depth	Case no vents	Case with vents	Chrome leg
21	6½"	4½"	4½"	—	5.88	1.15
22	8½"	5½"	5½"	—	6.50	1.15
23	10½"	6½"	6½"	—	7.70	1.30
24	12½"	7½"	7½"	—	8.45	1.30
25A	6½"	4½"	4½"	5.60	6.20	1.30
25B	6½"	4½"	6¼"	6.00	6.60	1.30
26A	8¾"	5¾"	6¼"	7.90	8.50	1.30
26B	8¾"	5¾"	8¼"	8.25	8.85	1.30
27A	12¼"	7½"	5½"	8.65	9.35	1.30
27B	12¼"	7½"	8"	9.35	10.05	1.30
28A	14"	10½"	6½"	10.20	10.90	—
28B	14"	10½"	8½"	11.15	11.85	—
29A	10"	4"	6"	7.15	7.75	1.30
29B	10"	4"	8"	7.53	8.13	1.30
30A	12"	5"	6"	7.80	8.50	1.30
30B	12"	5"	8"	8.15	8.85	1.30
31A	14"	6"	6"	8.50	9.20	1.30
31B	14"	6"	8"	8.93	9.63	1.30
61	15½"	7½"	9½"	—	13.00	—
62	17½"	8½"	9½"	—	15.00	—
63	16½"	9½"	9½"	—	15.00	—
64	15½"	7½"	12½"	—	15.00	—
65	17½"	8½"	12½"	—	17.15	—
66	16½"	9½"	12½"	—	17.15	—

Postage & VAT extra

INSTANT TRUNKING SYSTEM!

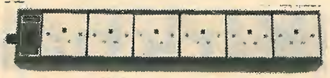
Ready to use. Internal wiring suitable for 30 amp

TR6 — 6 sockets switched	**£21.50**
TR9 — 9 sockets switched	**£25.50**
P&P £1.85	+VAT

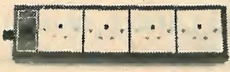
PORTABLE POWER DISTRIBUTION FOR INSTANT MAINS!

NEW! 10 sockets switched in sloping box

Type 13A/10SW **£27.50.** P&P £1.85 + VAT



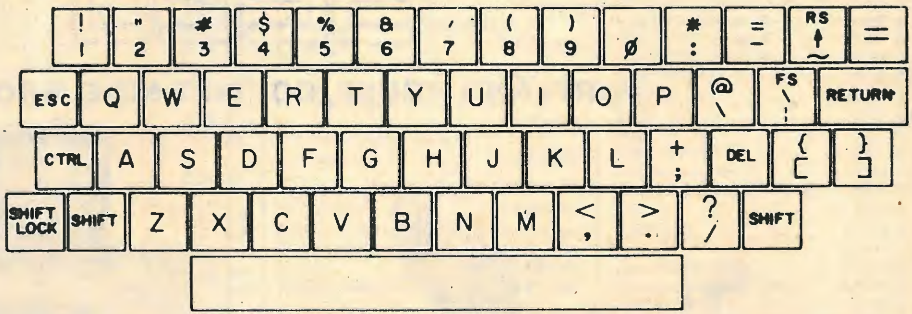
COMPLETE WITH 6FT. CABLE AND 13 AMP FUSED PLUG

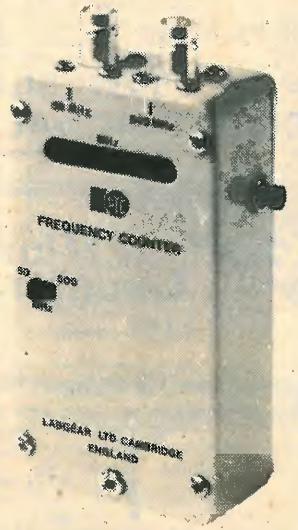


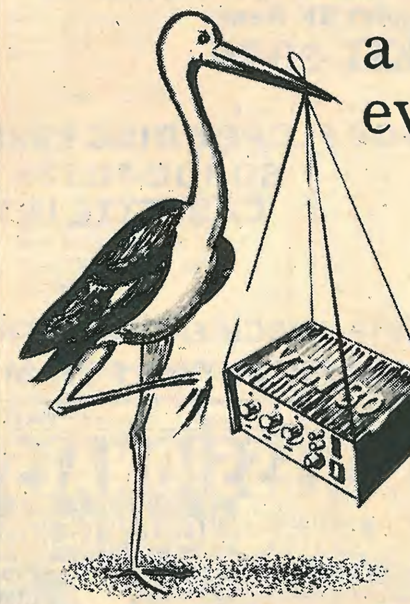
4 sockets 13A	**£12.15**
6 sockets 13A	**£14.30**
4 sockets 13A switched	**£13.75**
6 sockets 13A switched	**£15.95**

ALL DISTRIBUTION PANELS ARE FITTED WITH MK SOCKETS & PLUG
Send for details of complete range + postage 85p each + 8% V.A.T.
OLSON ELECTRONICS LTD., FACTORY NO. 8, 5-7 LONG ST., LONDON E2 8HJ
TEL: 01-739 2343

WW—046 FOR FURTHER DETAILS


! 1 " 2 # 3 $ 4 % 5 & 6 ' 7 (8) 9 ø * : = − RS ↑ ~ =
ESC Q W E R T Y U I O P @ \ FS \ ; RETURN
CTRL A S D F G H J K L + ; DEL { [}]
SHIFT LOCK SHIFT Z X C V B N M < , > . ? / SHIFT


MHz
FREQUENCY COUNTER
50
500
LABGEAR LTD CAMBRIDGE ENGLAND



Transformers

Efficient design and manufacture ensures that all our transformers have a low heat-rise at full load, making a more reliable and safer product. Safety is also the reason behind our clip-on terminal insulators, which can make our transformers 'touch-proof' in use.

Lascar Components
Billericay (02774) 3394
P.O. Box 12 Second Avenue Billericay Essex

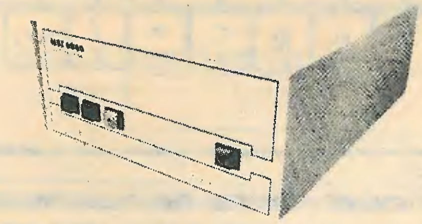
- 3VA to 50VA miniature mains Transformers, Clamp and Printed Circuit mounting.
- Large Standard Range stocked in depth.
- 'Blue Riband' service gives 7-14 day delivery on custom wound transformers.
- 'Blue Star' service for OEM's, top quality transformers custom-wound at really competitive prices (from 89p at 500 up).

WW—048 FOR FURTHER DETAILS

---

seed

PORTLAND HOUSE, COPPICE SIDE, BROWNHILLS



MSI 6800
with 8K Ram.
KIT £375

SYSTEM ONE
16K Ram Single Mini Floppy
Keyboard & 9" Monitor
£1289.50

FD8 FLOPPY DISC £935. BFD68 MINI FLOPPY £522
SOROC 1Q120 TERMINAL £699 ASS.
CASSETTE INTERFACE KIT £18.95

Send S.A.E. for full brochure

STRUMECH ENG. ELECTRONICS DIV. BROWNHILLS 4321
SOLE U.K. DISTRIBUTOR FOR MSI & SMOKE SIGNAL BROADCASTING

WW—043 FOR FURTHER DETAILS

"THE PROFESSIONALS"

NEW MODEL CTR-2A • 500 MHz & 1 GHz COUNTERS

NEW Period Measurement
1 us to 1 sec.

NEW Built-in Pre-Amp
10 mv @ 150 MHz

The New Model CTR-2A Series Counters are designed and built to the highest standards to fulfill the needs of commercial communications, engineering labs and serious experimentors. With an accuracy of + .00005%, the CTR-2A can handle the most critical measurements and is about half the cost of other commercial counters.

If you need a reliable counter at an affordable price, the CTR-2A is the answer.

- Built-in Pre-Amp 10 mv @ 150 MHz
- :8 Digit .3 LED Display
- High Stability TCXO Time Base
- Built-in VHF-UHF Prescaler
- Automatic Dp Placement
- TCXO Std. ± 2 ppm
- Period Measurement (Optional)
- Input Diode Protected
- 12V-DC Operation (Optional)
- Oven Controlled Crystal ± .5 ppm
- Selectible Gate Times—.1 & 1 sec.

NEW!

600 MHz Mini Counter
£145 + 8% VAT

General Purpose Low Cost Counter Without the Sacrifice of Basic Performance

"Check the features we have that some other low-cost counters don't have"

- All Metal Cabinet
- 8 Digit .4 LED Display
- Input Cable Included
- 12V Input Jack
- Sensitivity 10 MV at 60 MHz
- 240V or 12V Operation
- Push Button Controls
- Gate Light
- Completely Auto Decimal Point
- Selectible Gate Times (1 sec & .1 sec)
- Built-in Preamp
- Crystal Time Base 1 ppm

Prices CTR-2A-500 **£280** & VAT 8% CTR-2A-1000 **£420** & VAT 8%

We are exclusive UK Distributors for **DAVIS ELECTRONICS,** NY, U.S.A. and European Distributors for **LUNAR ELECTRONICS,** San Diego California, U.S.A. (Linear Amplifiers & Receive Preamplifiers)

TRADE & EXPORT ENQUIRIES WELCOME

SOTA COMMUNICATION SYSTEMS LTD.
26 CHILDWALL LANE, BOWRING PARK, LIVERPOOL L14 6TX. Tel: 051-480 5770

WW—019 FOR FURTHER DETAILS

WILMSLOW AUDIO

The firm for Speakers

HI-FI DRIVE UNITS

HD12 9D25	£6.00
HD13 D34H	£12.00
HD20 BZ5J4	£9.45
HD20 B25H4	£11.98
HD11 P25EBC	£5.56
Baker Superb	£22.50
Castle 8RS/DD	£12.35
Chartwell CE205 8" bass, matched pairs only . . . pairs	59.90
Coles 4001	£6.25
Coles 3000	£6.25
Celestion HF1300 II	£8.25
Celestion HF2000	£9.95
Dalesford D10 tweeter	£8.25
Dalesford D20/105 4"	£10.95
Dalesford D30/110 5"	£10.95
Dalesford D50/153 6½"	£11.95
Dalesford D50/200 8"	£11.95
Dalesford D70/250 10"	£24.95
Dalesford D100/310 12"	£34.95
Decca London	£41.25
Decca CO/1000/8	£8.95
Decca DK30	£27.50
E.M.I. type 350 4 ohm	£9.25
E.M.I. 14A/770 14" x 9"	£16.95
E.M.I. 8" x 5" d/c 10 watt	£3.95
Isophon KK10/8	£8.25
Isophon KK8/8	£7.50
Jordan Watts Module	£17.95
Jordan 50mm Unit	£22.50
Jordan CB Crossover	£22.50
KEF T27	£8.50
KEF B110	£10.95
KEF B200	£11.95
KEF B139	£24.95
KEF DN13	£4.95
KEF DN12	£7.25
KEF DN22 . . . pair	£36.00
Lowther PM6	£49.95
Lowther PM6 MKI	£52.00
Lowther PM7	£86.50
Peerless DT10HFC	£9.75
Peerless K010DT	£8.95
Peerless K040MRF	£11.75
Radford BD25 II	£26.95
Radford MD9	£14.50
Radford MD6	£17.95
Radford FN8/FN831	£19.95
Richard Allan CG8T	£9.95
Richard Allan CG12T Super	£22.45
Richard Allan HP8B	£15.50
Richard Allan LP8B	£10.35
Richard Allan HP12B	£25.25
Richard Allan DT20	£7.25
Richard Allan DT30	£7.45
Seas HO86	£8.75
Shackman Electrostatic C/W polar network & X/O . pair	£112.00
Tannoy HPD 295A	£91.50

PA GROUP & DISCO UNITS

Tannoy HPD 315A	£102.95
Tannoy HPD 385A	£119.95
Baker Group 25	£13.00
Baker Group 35	£14.50
Baker Group 50/12	£21.00
Baker Group 50/15	£33.00
Celestion G12M	£13.50
Celestion G12H	£17.95
Celestion G18C	£41.95
Celestion G12/75 (alum. dome)	£22.50
Celestion G12/75 (d/cone)	£24.50
Celestion G12M/50 (cambric edge)	£16.95
Celestion G15/100 (alum dome)	£32.50
Celestion MH1000	£13.50
Celestion Powercell 12"/100	£45.95
Celestion Powercell 15"/100	£48.95
Celestion Powercell 15"/125	£51.95
Fane Pop 40	£10.95
Fane Pop 50H	£12.50
Fane Pop 75	£16.95
Fane Pop 65	£19.95
Fane Pop 80	£21.95
Fane Pop 100	£35.95
Fane J44 horn	£6.50
Fane J104 horn	£13.75
Fane J73 horn	£9.75
Fane Guitar 80L	£19.75
Fane Guitar 80B	£19.95
Fane Disco 80	£21.50
Fane PA80	£19.50
Fane Bass 85	£29.95
Fane Crescendo 12A	£42.95
Fane Crescendo 12B	£44.95
Fane Crescendo 15/100	£54.95
Fane Crescendo 15/125	£64.95
Fane Crescendo 18	£75.95
Fane 920 II Horn	£45.95
Fane HPX1/HPX2	£2.50
Goodmans 8PA	£4.25
Goodmans 12P	£19.75
Goodmans 12PD	£22.50
Goodmans 12PG	£21.25
Goodmans 18P	£45.50
Goodmans 50HX	£20.50
McKenzie C1280	£22.95
McKenzie GP15	£32.95
McKenzie TC15	£32.95
McKenzie CG15 Bass	£55.95
Motorola Piezo Horn	£8.50
Richard Allan HD8T	£14.50
Richard Allan HD10T	£15.75
Richard Allan HD12T	£20.95
Richard Allan HD15	£36.95
Richard Allan HD15T	£37.95

WILMSLOW AUDIO

KITS FOR MAGAZINE DESIGNS etc.

Kits include drive units, crossovers, BAF/Long fibre wool, etc. for pair of speakers.

Carriage £3.50

Practical Hifi & Audio PRO9-TL (Rogers)	£118.00
Felt panels for PRO9-TL	£5.50 + £1.50 p&p
Hifi Answers Monitor (Rogers)	£129.00
Hifi News State of the Art (Atkinson)	£161.00
Popular Hifi Mini Monitor (Colloms)	£63.00
Popular Hifi Round Sound (Stephens) including complete cabinet kit	£68.00
Popular Hifi (Jordan)	£91.00
Practical Hifi & Audio Monitor (Giles)	£119.00
Practical Hifi & Audio Triangle (Giles)	£86.00
Practical Hifi & Audio BSC3 (Rogers)	£60.00
Practical Hifi Mini Triangle (Giles)	£99.00
Hifi News Tabor (Jones)	£59.75
Hifi News Tabor (with H4 bass units)	£65.00
Wireless World T.L./KEF (Bailey)	£112.00
Wireless World T.L./Radford (Bailey)	£154.00
HiFi News Minilink (Atkinson)	£43.00

SMART BADGES FREE WITH ALL ABOVE KITS (TO GIVE THAT PROFESSIONAL TOUCH TO DIY SPEAKERS!)

Send 3 x 7p stamps for reprints/construction details of any of above designs.

CARRIAGE & INSURANCE

Tweeters/Crossovers	**40p** each
Speakers up to 10"	**75p** each
Speakers 12"	**£1.25** each
Speakers 15"	**£2.00** each
Speakers 18"	**£2.95** each
Speaker Kits	**£2.50** pair
Mag. design kits	**£3.50** pair

SPEAKER KITS

Prices per pair. Carriage £2.50.

Dalesford System 1	£52.90
Dalesford System 2	£55.75
Dalesford System 3	£101.75
Dalesford System 4	£108.00
Dalesford System 5	£139.00
Dalesford System 6	£93.00
Eagle SK210	£15.00
Eagle SK215	£29.00
Eagle SK320	£37.00
Eagle SK325	£67.00
Eagle SK335	£91.00
Goodmans DIN20	£31.50
Goodmans Mezzo Twinkit	£51.95
Kef Kit I	£59.50
Kef Kit III	£119.95 (carr. £5)
Lowther PM6 Kit	£103.00
Lowther PM6 MKI Kit	£108.00
Peerless 1060	£71.95
Peerless 1070	£122.00
Peerless 1120	£139.00
Peerless 2050	£49.95
Peerless 2060	£65.95
Radford Studio 90	£154.00
Radford Monitor 270	£208.00
Radford Studio 270	£275.00
Radford Studio 360	£390.00
RamKit 50 (makes Ram 100)	£69.95
Richard Allan Tango Twin Assembly	£43.50
Richard Allan Maramba T.R.8	£61.50
Richard Allan Charisma T.R.12	£90.00
Richard Allan Super Triple	£73.00
Richard Allan RA8	£46.50
Richard Allan RA82	£74.00
Richard Allan RA82L	£79.95
Seas Mini	£17.90
Seas 203	£35.50
Seas 302	£43.90
Seas 303	£73.90
Seas 503	£119.90
Wharfedale Denton 2XP	£26.95
Wharfedale Linton 3XP	£41.95
Wharfedale Glendale 3XP	£56.95

Everything in stock for the speaker constructor!
BAF, long fibre wool, foam, crossovers, felt panels, components, etc.
Large selection of grille fabrics.
(Send 15p in stamps for fabric samples)
(Prices correct at 1/10/78)

SWIFT OF WILMSLOW
The firm for Hi-Fi
5 Swan Street,
Wilmslow, Cheshire.

Send 15p stamp for free 38 page catalogue 'Choosing a Speaker'

Telephone: Speakers, Mail Order and Export:
0625 529599. Hi-Fi: 0625 526213

Lightning service on telephoned credit card orders!

WILMSLOW AUDIO
The firm for Speakers
Swan Works, Bank Square,
Wilmslow, Cheshire.

QUALITY COMPONENTS BY RETURN

Buy it with Access

Linear Circuits by RCA, National etc.

709 DIL14	25p	LM382N	105p
741 DIL8	22p	LM1303	110p
741 DIL14	35p	LM3900	50p
747C DIL14	50p	LM3909	60p
748C DIL8	30p	MC1310P	150p
CA3011	80p	MC1312P	160p
CA3014	130p	MC1314P	300p
CA3018	80p	MC1315P	620p
CA3020	160p	MC1330	100p
CA3028	125p	MC1458N	35p
CA3035	140p	MC1496N	60p
CA3036	170p	NE555	25p
CA3042	170p	NE556	60p
CA3043	180p	NE560	300p
CA3046	55p	NE561B	350p
CA3052	150p	NE562B	350p
CA3054	115p	NE565A	120p
CA3075	180p	NE566V	150p
CA3080	70p	NE567V	170p
CA3081	125p	SN76003N	200p
CA3089	180p	SN76013N	140p
CA3090	400p	SN76023N	140p
CA3123	150p	SN76033N	200p
CA3130	90p	TAA621A	215p
CA3140E	70p	TBA120S	65p
LM300H	130p	TBA540	200p
LM301AN	28p	TBA641	240p
LM304H	70p	TBA800	70p
LM308N	65p	TBA920	320p
LM318N	125p	TCA270SQ	200p
LM324N	50p	TDA1002	450p
LM339	50p	TDA1022	570p
LM380N	75p	TDA2020	320p
LM381N	105p	ZN414	75p

CMOS from RCA, National etc.

4000	15p	4040	68p
4001	15p	4042	54p
4002	15p	4043	55p
4007	15p	4046	100p
4008	65p	4049	28p
4009	35p	4050	28p
4010	35p	4051	55p
4011	15p	4052	55p
4012	15p	4066	40p
4013	35p	4068	20p
4015	60p	4069	16p
4016	35p	4070	16p
4017	55p	4071	16p
4018	65p	4072	16p
4020	60p	4073	16p
4022	55p	4075	16p
4023	16p	4078	16p
4024	45p	4081	16p
4025	15p	4510	70p
4026	95p	4511	70p
4027	35p	4516	65p
4028	52p	4518	65p
4029	60p	4520	65p
4030	35p	4585	70p

TTL from National, Texas, ITT etc.

7400	12p	7496	50p
7401	12p	7497	140p
7402	12p	74100	90p
7403	12p	74104	50p
7404	13p	74105	40p
7405	13p	74107	25p
7406	24p	74109	30p
7407	24p	74110	35p
7408	14p	74111	45p
7409	14p	74116	95p
7410	12p	74118	82p
7411	19p	74119	140p
7412	17p	74121	25p
7413	25p	74123	40p
7414	48p	74125	35p
7416	24p	74126	35p
7417	24p	74132	50p
7420	12p	74141	58p
7421	22p	74142	200p
7422	18p	74145	58p
7423	22p	74147	110p
7425	22p	74148	90p
7426	24p	74150	70p
7427	24p	74151	50p
7428	28p	74153	50p
7430	12p	74154	85p
7432	23p	74155	52p
7433	32p	74156	52p
7437	22p	74157	53p
7438	22p	74160	60p
7440	13p	74161	65p
7441	52p	74162	65p
7442	43p	74163	65p
7443	75p	74164	70p
7444	75p	74165	70p
7445	70p	74166	80p
7446	55p	74167	180p
7447	55p	74170	125p
7448	58p	74172	400p
7450	14p	74173	95p
7451	14p	74174	68p
7452	13p	74175	65p
7454	14p	74176	58p
7460	14p	74177	58p
7470	28p	74178	80p
7472	24p	74181	145p
7473	25p	74182	60p
7474	25p	74185	110p
7475	32p	74190	72p
7476	28p	74191	72p
7483	60p	74192	64p
7485	70p	74193	64p
7486	24p	74194	60p
7489	145p	74195	55p
7490	32p	74196	55p
7491	45p	74197	55p
7492	35p	74198	110p
7493	34p	74199	110p
7494	80p		
7495	52p		

Transistors

AC125	18p	BC558	12p	ZTX304	25p	2N3704	8p
AC126	18p	BC559	13p	ZTX310	13p	2N3705	9p
AC127	17p	BCY70	14p	ZTX311	14p	2N3706	9p
AC128	16p	BCY71	14p	ZTX314	22p	2N3707	9p
AC176	18p	BCY72	14p	ZTX341	21p	2N3708	8p
AC186	24p	BD115	52p	ZTX500	16p	2N3709	8p
AD161	38p	BD131	35p	ZTX501	16p	2N3710	8p
AD162	38p	BD132	35p	ZTX502	20p	2N3711	8p
AF124	27p	BD133	44p	ZTX503	20p	2N3715	10p
AF125	27p	BD135	38p	ZTX504	25p	2N3819	22p
AF126	27p	BD136	38p	ZTX530	30p	2N3823	65p
AF127	27p	BD137	38p	ZTX550	24p	2N3824	75p
AF139	36p	BD138	38p	2N696	32p	2N3866	55p
AF239	40p	BD139	35p	2N697	12p	2N3903	8p
BC107	8p	BD140	35p	2N698	28p	2N3904	8p
BC107B	10p	BF244B	36p	2N699	50p	2N3905	8p
BC108	8p	BFX29	25p	2N706	13p	2N3906	8p
BC108B	8p	BFX84	23p	2N706A	13p	2N4037	30p
BC108C	10p	BFX87	20p	2N708	20p	2N4058	12p
BC109	8p	BFX88	20p	2N914	22p	2N4059	10p
BC109C	10p	BFY50	15p	2N918	30p	2N4060	12p
BC147	7p	BFY51	15p	2N919	50p	2N4061	12p
BC148	7p	BFY52	15p	2N920	54p	2N5179	50p
BC149	8p	BU105	170p	2N929	25p	2N5457	32p
BC157	9p	BU205	140p	2N930	20p	2N5458	30p
BC158	9p	BU208	160p	2N1131	23p	2N5459	32p
BC159	9p	MJ2955	98p	2N1132	23p	2N5777	50p
BC167	8p	MPF102	36p	2N1302	38p		
BC168	8p	MPSA06	30p	2N1303	54p	**Diodes**	
BC169	8p	MPSA56	30p	2N1304	54p	0A47	10p
BC169C	9p	TIP29	40p	2N1613	22p	0A91	5p
BC170	9p	TIP29A	44p	2N1671	130p	0A200	6p
BC171	9p	TIP29B	40p	2N2160	100p	1N914	4p
BC172	7p	TIP29C	60p	2N2243	28p	1N916	5p
BC173	9p	TIP30	40p	2N2297	45p	1N4001	4p
BC177	14p	TIP30A	48p	2N2368	15p	1N4002	4p
BC178	14p	TIP30B	55p	2N2369	16p	1N4006	6p
BC179	14p	TIP30C	70p	2N2484	22p	1N4148	3p
BC182	10p	TIP31	50p	2N2846	70p		
BC182L	10p	TIP31A	50p	2N2904	22p	**Regulators**	
BC183	10p	TIP31B	60p	2N2094A	23p	7805	60p
BC183L	10p	TIP31C	65p	2N2905	22p	7812	60p
BC184	10p	TIP32	55p	2N2905A	22p	7815	60p
BC184L	10p	TIP32A	60p	2N2906	22p	7818	60p
BC207	10p	TIP32B	75p	N2906A	22p	7824	60p
BC208	8p	TIP32C	80p	2N2907	22p	78L05	30p
BC209C	10p	TIP33	75p	2N2907A	25p	78L12	30p
BC212	10p	TIP33A	80p	2N2926G	10p	78L15	30p
BC212L	10p	TIP33B	103p	2N2926R	8p	7905	80p
BC213	10p	TIP33C	116p	2N3011	22p	7912	80p
BC213L	10p	TIP34	98p	2N3053	18p	7915	80p
BC214	10p	TIP34A	95p	2N3054	50p	7918	80p
BC214L	10p	TIP34B	128p	2N3055	50p	7924	80p
BC477	19p	ZTX107	14p	2N3121	25p	79L05	70p
BC478	18p	ZTX108	14p	2N3133	25p	79L12	70p
BC479	18p	ZTX109	14p	2N3440	80p	79L15	70p
BC547	11p	ZTX300	16p	2N3441	120p	LM309K	110p
BC548	10p	ZTX301	16p	2N3442	135p	LM317K	300p
BC549	11p	ZTX302	23p	2N3702	8p	LM323K	530p
BC550	14p	ZTX303	23p	2N3703	8p	LM723	40p

Carbon Film Resistors

High stability, low noise, 0.25W 5% E12 series from 4.7 ohms to 10 Megohms. Any selection

each	100+	1000+	5000
1p	**0.9p**	**0.8p**	**0.75p**

Special development pack of 10 of each value 4.7 ohms to 1 Megohm, a total of 650 resistors **£5.70**

Potentiometers

Carbon track. Log and Linear values.

5K — 2M2 single gang **26p**

5K — 2M2 single gang switched **60p**

5K — 2M2 dual gang stereo **75p**

Preset Potentiometers

Subminiature type available in horizontal or vertical mounting. 0.1W rating. 100 ohms to 2M .... **6p each**

Special development of 5 of each value from 100 ohms to 2M, a total of 70 presets (please state vertical or horizontal) **£3.95**

Ceramic Capacitors

Miniature plate type. 50V PC mounting. Available from 22pF to 1000pF in E12 series and 1500pF to 0.047uF in E6 series .... **2p each**

Polyester Capacitors

Mullard C280 series. 250V PC mounting.

0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1, **5p;** 0.15, 0.22, **7p;** 0.33, 0.47, **10p;** 0.68, **14p;** 1.0, **17p;** 2.2µF, **28p each.**

Special development pack of 5 of each value **£6.20**

Tantalum Capacitors

0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2 @ 35V ... **9p**

4.7 @ 25V, 6.8 and 10 @ 25V **13p**

22 @ 16V, 47 @ 6V, 68 @ 3V, 100 @ 3V **16p**

Development pack 5 of each value **£8.30**

Optoelectronics

LEDs	Red	Green	Yellow
0.125 in	**9p**	**15p**	**18p**
0.2 in	**9p**	**13p**	**18p**

Displays DL707 **90p** DL704 **90p**

DIL Sockets

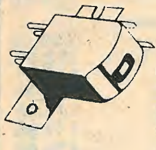
8 pin **11p** 14 pin **12p** 16 pin **13p** 24 pin **30p**

Quantity discounts on any mix. TTL, CMOS and Linear Circuits 25+ 10%, 100+ 15%. All orders despatched by return. Prices VAT inclusive. Please add 30p for carriage. All components guaranteed brand new and full specification from leading manufacturers. Callers most welcome at our premises 8.30am to 6pm Monday to Saturday. All prices valid to April 30, 1979. Send 12p stamp for our new illustrated catalogue. Official orders welcome from colleges, universities etc.

C. N. STEVENSON (W1) 236 High Street, Bromley, Kent BR1 1PQ. Tel: 01-464 2951/5770

MONOLITH

THE MONOLITH ELECTRONICS CO. LTD.



QUALITY REEL TO REEL & CASSETTE TAPE HEADS

POPULAR UNIVERSAL CASSETTE HEADS

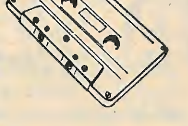
B12-01	MONO PLAYBACK	£1.60	B22-02	TWIN HALF TRACK RECORD PLAYBACK	£5.06
B24-01	STEREO PLAYBACK	£2.80	C44RPS02	QUAD QUARTER TRACK RECORD/PLAYBACK	£7.95
B24-RP	STEREO GLASS FERRITE RECORD/PLAYBACK	£9.84	C22ES02	TWIN HALF TRACK ERASE	£4.00
E12-09	MONO/STEREO ERASE	£1.60			

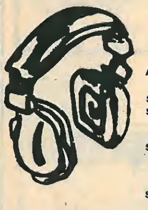
R44RH01	QUAD QUARTER TRACK GLASS FERRITE REEL TO REEL RECORD HEAD	£13.86
R82RP2ES01	COMBINED 8 TRACK CARTRIDGE RECORD/PLAYBACK/ERASE	£7.27

MAGNETIC RECORDING TAPES

	C60	C90	C120
STANDARD Fe_2O_3	.51	.72	1.00
SUPER CrO_2	1.23	1.56	2.10
HI-GRADE FeCr	1.38	1.83	-

ALL OTHER TAPES SUPPLIED TO ORDER





AUDIO AND HI-FI PRODUCTS

SE500	STEREO HEADPHONES	£3.65	FF4	7 METRE COILED HEADPHONE EXTENSION LEAD	£2.28
SE560	STEREO HEADPHONES WITH INDIVIDUAL VOLUME CONTROLS	£6.87	JB3	HEADPHONE TO LOUD-SPEAKER JUNCTION UNIT, WITH WIRING AND CHANGE-OVER SWITCH	£1.05
SE660	HI-FI STEREO HEADPHONES WITH CONTROLS AND COILED LEAD	16.89	DM81	MICROPHONE FOR CASSETTE MACHINES, WITH REMOTE START SWITCH, 200 Ω	£1.73
SY3	JUNCTION UNIT FOR TWO HEADPHONE SETS	£2.35	TD83	TAPE HEAD DEMAGNETISER	£4.25

FULL CATALOGUES ON COMPLETE PRODUCT RANGES:-
HEADS + TAPES 25p AUDIO & HI-FI (80 PAGE FULL COLOUR) 50p

PLEASE ENCLOSE 30p P&P WITH ORDER, FOR PROMPT RETURN. ALL PRICES INCLUDE VAT

5/7 CHURCH ST., CREWKERNE, SOMERSET, ENGLAND. TEL. (0460) 74321

WW—066 FOR FURTHER DETAILS

Only Valves are good enough for this customer.

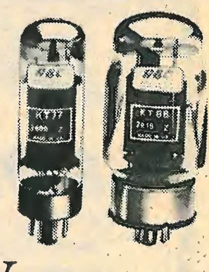
As the demand for high quality sound increases, so does the need for M-OV valves.

Valves, and only valves, can provide the level of performance many listeners now demand.

M-OV Beam Tetrode KT77 and KT88 valves meet all audio market requirements from 30-200 watts.

KT77 is especially rugged and ultra linear.

KT88 is a proven long-life valve that is at home in your quality equipment.



Get in touch with us now for technical data and details of worldwide distribution.

M-OV

A MEMBER OF THE GEC GROUP

GEC

S 666

THE M-O VALVE CO LTD, HAMMERSMITH, LONDON, ENGLAND W6 7PE.
TELEPHONE 01-603 3431. TELEX 23435. GRAMS THERMIONIC LONDON

WW—022 FOR FURTHER DETAILS

THE LATEST BARGAINS

TEST EQUIPMENT

Carston Electronics Ltd

Issue No 15

MANUFACTURER	TYPE No.	DESCRIPTION	PRICE £
Pressure & Displacement Transducers			
Schaevitz	P700	Pressure sensor. Gas & liquid pressures. Ranges ± 100 to 3000 PSI.	30.00
Electro Mechanisms	LVDT	DC linear variable. Differential transformer. Displacement ranges ± 2.00 ± 5.00 ± 0.050 inches.	25.00
Recorders & Signal Conditioning Equipment			
Brush	260	Six channel. 80Hz response. Ink writing. 10mV – 10V sensitivity. Portable style.	2400.00
Hewlett Packard	7035B	8½" x 11". 0.4mV – 4V/cm.	500.00
	17108A	Time base for 7035B. 0.2 – 20s/cm.	70.00
	17502A	Plug-in for 7100 series recorder temperature module for t'couples type J. K. R. S. T.	75.00
Metrawatt	RA6	6 channel U.V. Recorder with conditioning amplifiers. 1mV – 100V input. 700Hz B. W. 1 – 30 x 10^3µ strain. 120 – 350Ω.	850.00
SE Labs	3006DLT	12 channels. 1250mm/sec – 25mm/min. 6" chart. U.V. Recorder.	450.00
	A100	Galvo 60Hz. 3.7µA/cm.	30.00
	A2500	Galvo 1600Hz. 2.5mA/cm.	30.00
	B420	Galvo 300Hz. 50µA/cm.	30.00
	B450	Galvo 300Hz. 50µA/cm.	30.00
SE Labs	8/4	8 track tape recorder. 7FM 1DR ½" tape 30, 15, 1⅞ I.P.S. DC – 10kHz FM 30Hz – 60kHz DR.	1800.00
Smiths	RE551.20	X – Y Plotter A3. 50µV – 500mV/cm sens on both axis. Time base fitted.	575.00
Siemens	Oscillostore	4 channel digital storage sytem with output to U.V. Recorder. Event marker max/min. Trigger levels. Auto trigger. (System capacity 8 channel U.V. Recorder included in price.)	5850.00

Items listed here are just a sample of the range of high quality test equipment now available from our stocks.
We cover all leading manufacturers and are constantly expanding our range.

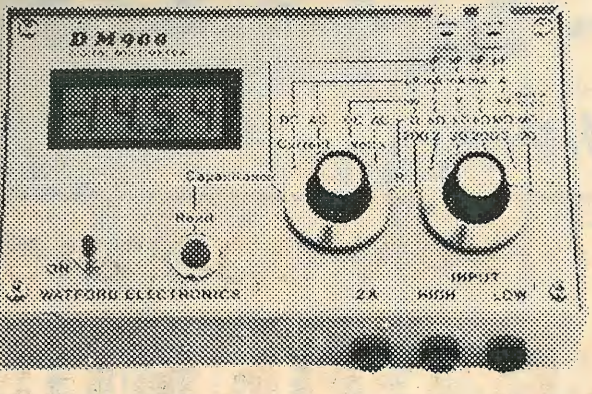
We are pleased to announce our latest sales list. This contains our greatest ever range of test equipment and offers it for sale at the best prices on the market. We are also on the look-out to buy good quality test equipment. So if you have some for sale, let us know. Make certain of getting your FREE copy of the sales list now.

Phone:
01-267 4257

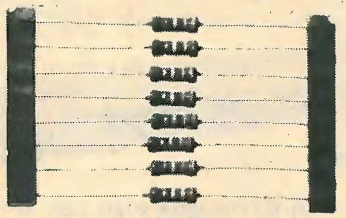
- ✳ Prices and quality no one else can match.
- ✳ All equipment sold calibrated to manufacturers' specification.
- ✳ Full inspection may be carried out at our premises.
- ✳ Full handbook and circuit diagrams supplied with each item.
- ✳ Keenest prices offered for your own surplus equipment.

Carston Electronics Limited

Shirley House 27 Camden Road
London NW1 9NR Telex 23920


DM900
CAPACITANCE
RESET
ON
WATFORD ELECTRONICS
2A
INPUT
HIGH
LOW


AEL



Design,
manufacture &
installation

Audix Limited
Station Road, Wenden
Saffron Walden
Essex CB11 4LG

Tel: Saffron Walden
(0799) 40888
Telex: 817444

audix

Sound & Communications systems

Please send me details

☐ Sound reinforcement/ public address equipment

☐ Theatre sound equipment

☐ Hospital distribution and nurse call systems

☐ Intercom systems, commercial & industrial

☐ Hotel entertainment systems

☐ Simultaneous interpretation and conference systems

Name ____________________

Address ____________________

____

Revolutionary manually operated portable CUT-BEND MACHINE

- High capacity production: up to 40.000 pcs/hr
- Low capital investment
- New, fully adjustable pitch and leg length
- Pitch size is transposed directly from board to machine
- Neat and compact size
- Any adjustment can be made in seconds

You can produce 20,000 cut-bends whilst others are setting-up their machines!

COME AND TRY THEM AT

The All-Electronics Show.
Stand No: 49
FEB.27th– 1st MAR.

PLEASE SEND ME MORE DETAILS AND PRICE

NAME ....

ADDRESS ....

....

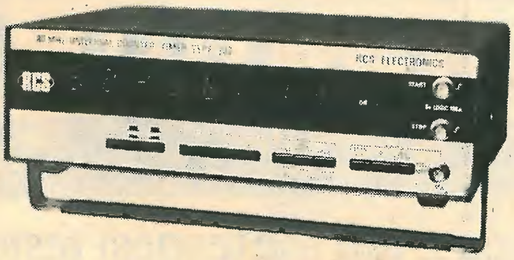
POST THIS COUPON NOW TO: WW
ADCOLA PRODUCTS LTD, ADCOLA HOUSE, GAUDEN ROAD,
LONDON, SW4 6LH Tel 01-622 0291/3 Telex 21851 ADCOLA

WW — 065 FOR FURTHER DETAILS

A NEW ADDITION TO A WELL-KNOWN RANGE OF FREQUENCY COUNTERS THE FIRST OF THE SERIES

TYPE 702
80 MHz

£250



UNIVERSAL COUNTER TIMERS
BRIGHT 8 DIGIT LEDs

7 Segment 0.6" Numerical Indicators
Sensitivity 10mV R.M.S.
Stability 3 parts in 10^9 (ovened crystal)
Average Period Facility
Stop/Start
Two Tone Blue Case

WE'VE COUNTED FOR YEARS

RCS ELECTRONICS, 6 WOLSEY ROAD, ASHFORD, MIDDX. ASHFORD 53661

WW—013 FOR FURTHER DETAILS

A complete signal source for £251?

The FG601 gives you nine decades of frequency from 1MHz down to 0.001Hz. For performance like that you'd hardly expect to pay as little as £251 (plus VAT).

Nor would you expect it to offer three waveforms – sine, square and triangle simultaneously – all from the front panel. (That means no more testy fiddling round the back of the instrument).

The Feedback Function Generator FG 601 is only one of a superb range of instruments designed and manufactured to provide high performance at a reasonable price. It's backed by over 20 years of Feedback experience and **a two-year guarantee.**

The 600 range is available direct from Feedback Instruments Ltd. Or contact our distributors

electroplan P.O. Box 19, Orchard Road,
Royston, Herts. SG8 5HH.

Please send further information on the FG 601 and the other 5 instruments in the range.

Name

Position

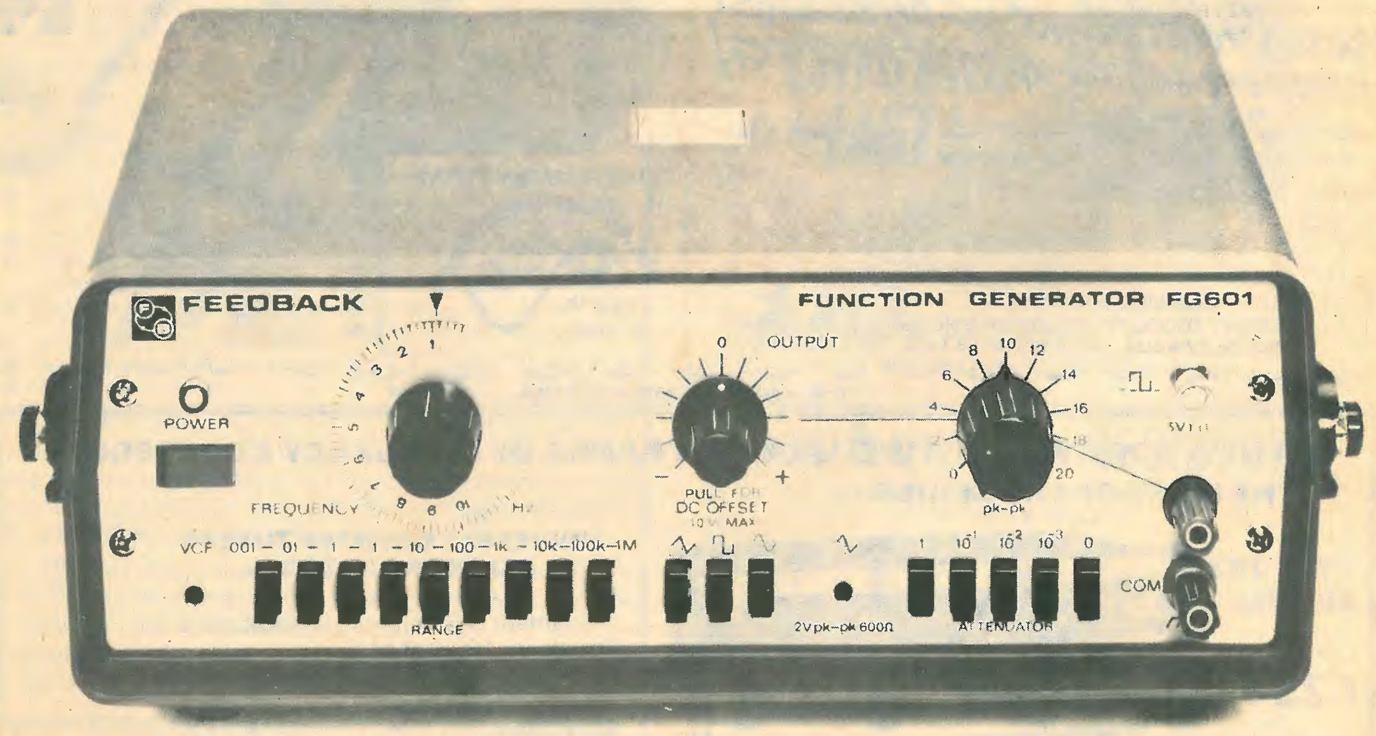
Company

Address

Telephone

Feedback Instruments Limited

Park Road, Crowborough, Sussex TN6 2QR.
Telephone: Crowborough (08926) 3322.
Cables: Feedback Crowbr. Telex: 95255.



The Feedback FG 601 will make even the testiest tester smile!

WW — 005 FOR FURTHER DETAILS

wireless world

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

Projects Editor:
MIKE SAGIN
Phone: 01-261 8429

Communications Editor:
RAY ASHMORE, B.Sc., G8KYY
Phone 01-261 8043

Drawing Office Manager:
ROGER GOODMAN

Production:
D. R. BRAY

Advertisement Controller:
G. BENTON ROWELL

Advertisement Manager:
BOB NIBBS
Phone 01-261 8622

DAVID DISLEY
Phone 01-261 8037

Classified Manager:
BRIAN DURRANT
Phone 01-261 8508 or 01-261 8423

BARRY LEARY *(Classified Advertisements)*
Phone 01-261 8508

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

Publishing Director:
GORDON HENDERSON

The map is not the territory

One can't help wondering why some of the controversies in our correspondence columns about physical realities in electronics seem to get so involved. The disputants seem to be men of intelligence and probity, so why can't they get at the truth, the reality, which must be lurking in there somewhere? Ah, but here's the rub. The truth is one thing, the reality another. As the semanticist Korzybski observed, the map is not the territory. In electronics, as in all of science, what carries the truth (or its antithesis) is a statement or expression in words, mathematics or diagrams, a product of the mind alone; the reality is something out there beyond the mind which we can only approach in a restricted way through the senses, either directly or indirectly by using them to observe meter readings, oscilloscope traces and so on. It does seem that some of our correspondents get confused between these two very different things, especially when they use the word "truth" for rhetorical purposes.

Unfortunately "truth" is an extremely woolly word. Its meanings can range from the spiritual ("I am the way, the truth . . ." of Jesus; "Beauty is truth, truth beauty" of Keats) to the strictly formal (as in deductive logic and the truth tables of our electronic logic systems). Somewhere between, perhaps, comes the everyday idea of truth, as used in law and described technically as the "correspondence theory" of truth. In our scientific terms this is the correspondence between the conceptual model or hypothesis (the map) and the set of sometimes disconnected experiences or observations we get from the real world (the territory). Aristotle's version of truth (in the *Metaphysics*): "To say of what is that it is not, or of what is not that it is, is false; while to say of what is that it is, or of what is not that it is not, is true" doesn't seem to get us very far and is apparently tautologous. But it does have the virtue of distinguishing between statements and reality. And in fact it has been used by the 20th-century philosopher Tarski as the basis of a precisely defined correspondence theory of truth.

Some thinkers have claimed that human beings, their consciousness and thoughts, don't have to come into the matter of truth at all. Frege, the logician, for example, said " . . . the thought, for example, which we expressed in the Pythagorean theorem is timelessly true, true independently of whether anyone takes it to be true." He seemed to have forgotten that logic itself is a human invention. With the phenomena of reality, however, we certainly have only ourselves to depend on. Bishop Berkeley went so far as to suggest that there might not be anything material around beyond the phenomena we experience. How can we be sure that material objects actually exist when all we have is our notoriously unreliable perceptions to go by? Kant said this was absurd because it implied that there can be appearance without anything that appears, and he went on to postulate "noumena" or things-in-themselves (the real stuff), as distinct from mere phenomena.

One of our great difficulties may be the fact that the very principle of objectivity, so dear to science, is itself really an article of faith, a product of the human mind and therefore of subjectivity. The rigidly "scientific" point of view is both naive and dishonest because it takes for granted, without explicitly mentioning it, the point of view of human consciousness, by which the world must be *my* world. As such objectivity has its limitations. We still don't know, for example, whether the electron is a particle or a packet of waves.

Computer buses

Conventions of communication between the components of a computer

by Ian H. Witten, M.A., M.Sc., Ph.D., M.I.E.E.
Department of Electrical Engineering Science, University of Essex.

Subsystems of a computer are usually connected together by a common bus, instead of by connecting each subsystem to every other one individually. A bus is a passive device — just a bundle of wires. However, to make it work, a logical superstructure of protocol and convention must be adopted, and observed correctly by every device connected to the bus. If any one device fails to observe the protocol, it can disrupt all communications along the bus. This is the price of a common bus.

THE COMPONENTS of a computer system include a processing unit (often a microprocessor chip), a store, and input-output interfaces to enable it to communicate with the world outside. The diagram of Fig. 1, where the processor is at the centre, communicating with the store on one side and input-output interfaces on the other, illustrates the way that early computers were organized. However, it is apparent that in this configuration the processor constitutes a bottleneck, for usually the input-output data is placed into or taken out of store rather than being processed immediately. This leads to the inclusion of the dashed line in the figure, as a "direct memory access" channel. Early minicomputers were built in this way.

This kind of interconnection, where every device is connected to every other, quickly becomes cumbersome as more devices are added to the system. Recent minicomputers, and almost all microprocessor systems, use the alternative structure of Fig. 2, where a common bus is used to connect the various devices. "Bus" is a contraction of the Latin "omnibus", which means "for all" – indicating that the bus is used for all data transfers between subsystems.

It may seem that the bus structure has re-introduced the bottleneck of the processor-centred computer model, only now it is the bus and not the processor which is responsible for the blockage. This is perfectly true, but since the bus is such a simple device – just a bundle of wires – the bottleneck can be relieved by making data transfers on it go very fast, whereas transfers through the processor are much slower.

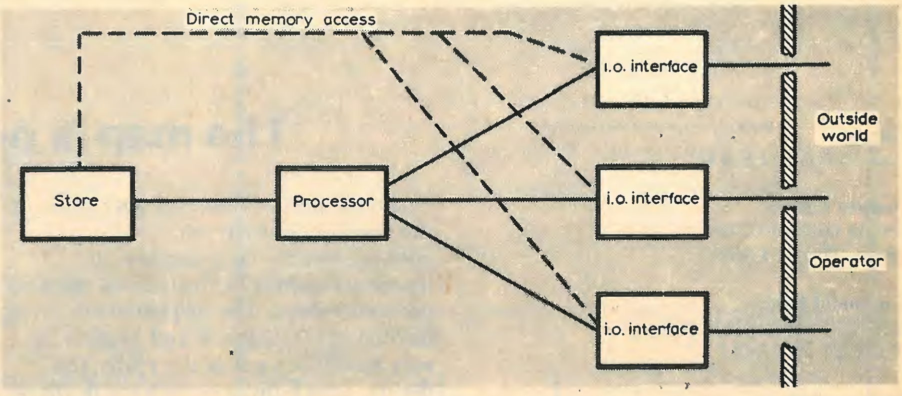


Fig. 1. *Processor-centred computer model.*

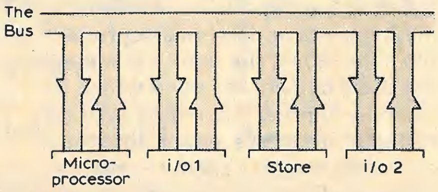


Fig. 2. *Bus-centred computer model.*

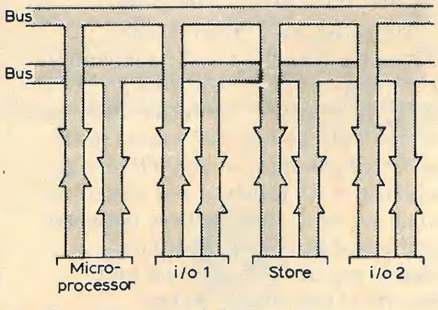


Fig. 3. *Address and data buses.*

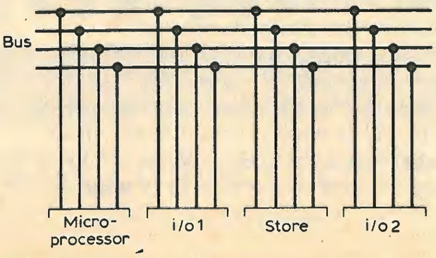


Fig. 4. *Individual lines of a 4-bit bus.*

It is obviously important that transfers along the bus are received only by the device for which they are intended. If i/o device 1 transfers data to the store, for example, it should not be received by i/o device 2 as well (or instead!). This is usually accomplished by dividing the bus into two parts: an *address bus* and a *data bus*, as in Fig. 3. A sending device puts the address of the intended receiver on the address bus, and the data for it on the data bus. Devices ensure that they only accept the data from the bus when the address bus indicates that they are the intended recipient. Addresses, like data, are simply binary numbers with a specified number of bits. Typically, the address bus is 16 bits wide and the data bus is 8 bits wide. This allows for addressing up to $2^{16} = 65,536$ different devices. There is hardly likely to be this number of separate devices on the bus, of course: the number is so large because some devices – notably stores – often incorporate many different addresses. A single store may easily contain $2^{15} = 32,768$ separate locations, each of which is addressable individually on the bus and would use up half of the "address space" of a 16-bit address bus.

The bus of Fig. 2 is redrawn in Fig. 4 to show the individual lines, assuming that it is 4 bits wide. Notice that although two channels are used in Fig. 2 to show the information coming off the bus separately from that going onto it, both channels are implemented on the same piece of wire in Fig. 4. The information on the wire is *bi-directional.* Of course, there is nothing special about the wire itself – any piece of wire can be driven from either end. It is the way that it is driven that makes it bi-directional. The bi-directional nature of the lines makes ordinary t.t.l. gates unsuitable for putting information on to buses, and there are two commonly-used alternative methods: open-collector gates and tri-state gates.

Driving a bus

Ordinary transistor-transistor logic (t.t.l.) suffers from the disadvantage that the outputs of two logic gates cannot be connected together. Thus if two devices are connected to the bus as in Fig. 5 and each may at some time put a signal on to it, ordinary t.t.l. gates cannot be used to drive the bus.

The reason is as follows. T.t.l. gates can only assume logic states 0 or 1. Suppose that device 2 does *not* want to put data on to the bus during a certain period of time. If it tries to put logic 0 on the bus through its bus driver, and if device 1 – which *does* want to put data on to the bus – assumes logic 1, the two devices will be fighting for the bus, one trying to pull it up to 1 while the other tries to pull it down to 0. Similarly, if device 2 tries to detach itself from the bus by driving it with logic 1, it will terfere with a device which wishes to to drive the bus to logic 0.

T.t.l. gates are not designed for this situation, and it is not possible to forecast the result of such a fight by considering the gates as logic elements. One must look at the detailed circuitry of the output stage of a gate, shown in Fig. 6. Two transistors are arranged in a "totem-pole" configuration, one providing active pull-up through the top transistor when the output is to be high, and the other providing active pull-down through the bottom one when it is to be low. This arrangement is used to increase the switching speed of the device from one logic level to the other, and to ensure that the drive capability of the device is the same whether it is in a high or a low state. The figure is annotated to show the input and output levels and the states of the transistors, when the output is high (upper annotations) and low (lower annotations).

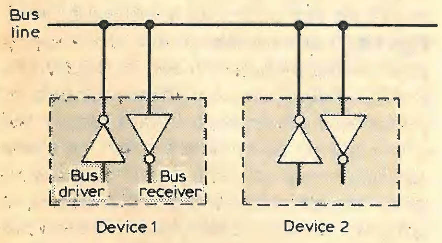


Fig. 5. *Two devices connected to a bus line.*

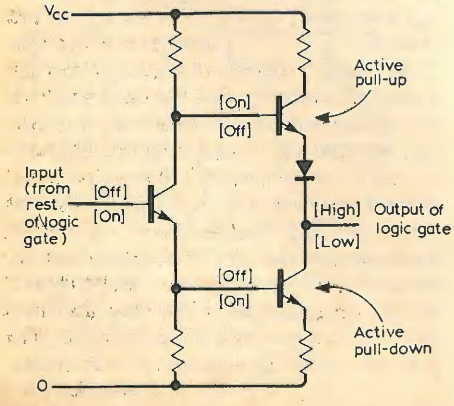


Fig. 7 sketches the totem-poles of two gates whose outputs are connected together by a bus line, annotated with the states that occur when device 1 is putting a high level on to the bus and device 2 is driving it low. The result will be a large current flow, as shown by the arrow. Its value can be calculated as V_{cc} minus twice the collector-emitter drop minus one diode drop, divided by the resistor value – about 30mA with normal component values. The bus line will probably end up at a low logic level, but this will depend on how it is loaded by other devices. Both output stages will get hot and may fail – with 30mA between a 5 volt V_{cc} and ground, 150mW must be dissipated. T.t.l. is just not designed to operate in this way.

Open-collector gates. One solution to the problem is to use "open-collector" gates to drive the bus. These are t.t.l. gates which do *not* have active pull-up. Instead, the output is taken from the collector of the pull-down transistor, which is otherwise left open, as shown in Fig. 8.

Somewhere on the bus line, a bus termination resistor is supplied to pull the line up to V_{cc}. Then, if any of the open-collector gates which drive the bus has its output transistor ON, this active pull-down will overcome the pull-up resistor to bring the line to a low state. Only if all the gates which drive the bus have their output transistor OFF will the line float up to a high level. Thus a device can (logically) detach itself from the bus by turning its output transistor OFF, when it will not interfere with a device which wishes to drive the bus.

The table in Fig. 9 shows that if A is high, B's level is transferred faithfully to the bus, and vice versa. The table is that of the logical AND function, if the levels are interpreted in positive logic (LOW=logic 0, HIGH=logic 1), and the configuration is often called a "wired-AND" since the AND operation has been accomplished simply by a piece of wire. (The term "wired-OR" refers to exactly the same phenomenon, with a "negative logic" interpretation.)

Tri-state gates. There are two drawbacks to the use of open-collector gates to drive buses, both of which stem from the lack of active pull-up. Firstly, they are slow; and secondly, they are susceptible to noise. A simple alternative, which has only appeared recently with the advent of c.m.o.s. (complementary metal-oxide semiconductor) logic, is the tri-state gate. The c.m.o.s. logic family is often used for microprocessors, rather than t.t.l., and it turns out to be natural in c.m.o.s. to give gates a third, "disabled", state in which they do not affect the bus. The idea of a tri-state gate

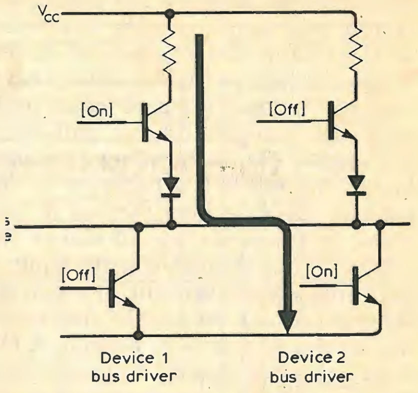


Fig. 6. *T.t.l. "totem-poles" fighting for the bus.*

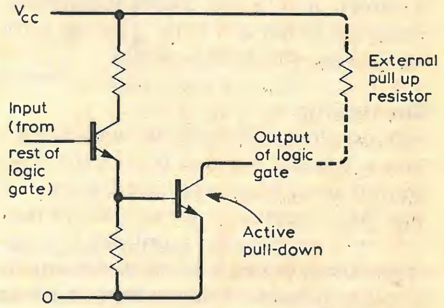
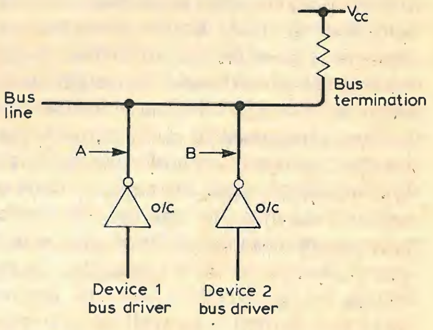


Fig. 8. *Open-collector output stage.*



A	B	bus line
low	low	low
low	high	low
high	low	low
high	high	high

Fig. 9. *Open-collector gates driving bus.*

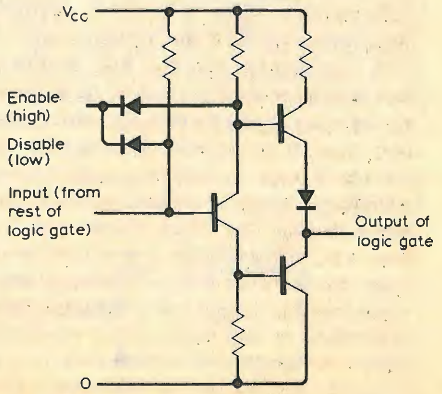


Fig. 10. *Tri-state output stage.*

proved so useful that a t.t.l. implementation was subsequently invented, which retains the totem-pole output stage of ordinary t.t.l., but adds an extra "disable" input to the gate which turns both the pull-up and the pull-down transistors off, over-riding the logic input. The result is effectively to disconnect the gate from the bus if "disable" is asserted. Fig. 10 shows the circuit. If the enable/disable input is high, the diodes prevent any current leakage through the enable/disable line and so the gate acts as normal. A low level on enable/disable, however, holds the base of the two transistors down and keeps them off. This automatically ensures that the third transistor is also off.

The symbol for several tri-state gates is shown in Fig. 11. Buses are almost always driven by this type of gate nowadays, wherever possible.

Bus timing

Suppose device 1 wants to send data to device 2 along the bus. It puts the data on the data bus, and then puts the address of device 2 on the address bus. Device 2 constantly monitors the address bus for its own address. As soon as it sees it, it reads the data from the data bus. Once the data has been read, it may be thought that device 1 can stop driving the address and data buses, and do something else, but there are two problems with such a procedure. Firstly, how does device 2 know when the address on the address bus is valid? Say the bus has just 3 lines (3-bit addresses). Then if it is initially at <100> and device 1 changes it to <010> to address device 2, there is a good chance that it will transiently pass through <110> or <000> during the change. If all the devices on the bus continually monitored the addresses, then the data would be incorrectly sent to device <110> or <000> as well as to device <010>. The second problem is, how does device 1 know when device 2 has read the data bus? Until it is sure, it must not remove the data from the bus.

Synchronous buses. One solution to both these problems is to have a common clock for all the devices. The clock produces the signal shown in Fig. 12.

All devices obey two conventions:

1. – they only look at the bus when the clock is high. Thus, if device 1 changes the address lines, it must ensure that it does so when the clock is low, and that the lines have settled to their new levels by the next clock pulse. The clock line may as well be another bus line, as in Fig. 13. This adds another group of lines to the bus, the control lines, which so far contains just the clock. More control lines are needed for asynchronous buses, and to deal with bus contention.

This solves the first problem. The address lines are only valid at clock pulses, and when a bus device is addressed, it recognises its address at the next pulse. It seems reasonable to suppose that it will be able to read the data from the bus at the same pulse, leading to

2. – a device takes one clock pulse to read from the bus. The sequence of events when device 1 sends data to device 2 is shown in Fig. 14.

A circuit to read from the bus will need an "address decoder" to detect when the address lines are set to select the device, and a register to receive the value that is read from the data lines at the next clock pulse. Such a circuit is

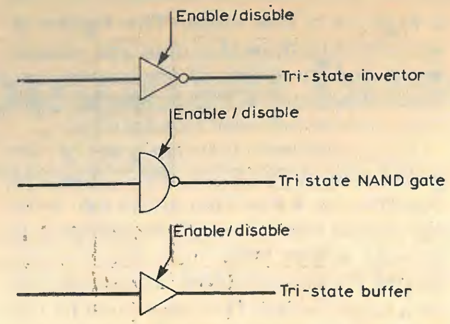


Fig. 11. *Logic symbols for tri-state gates.*

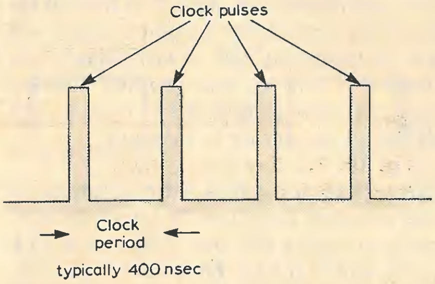


Fig. 12. *Clock signal for synchronous buses.*

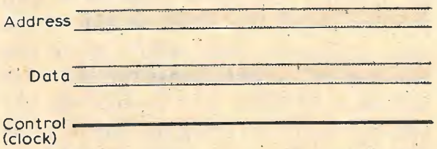


Fig. 13. *Synchronous bus.*

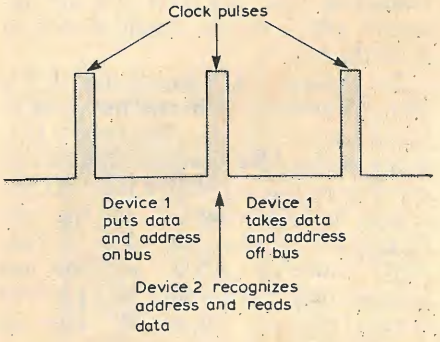


Fig. 14. *Transmission on a synchronous bus.*

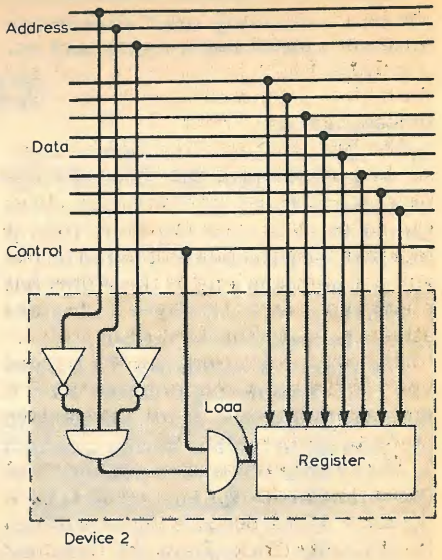


Fig. 15. *Reading from a synchronous bus.*

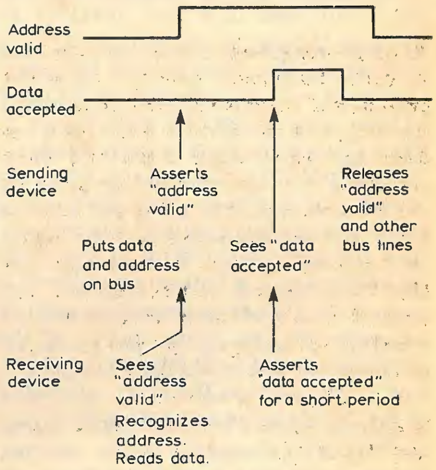


Fig. 16. *Transmission on an asynchronous bus.*

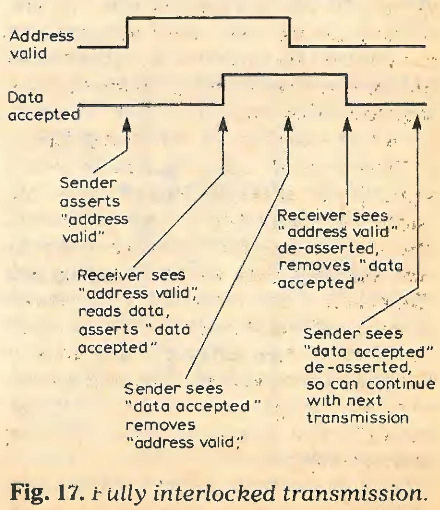


Fig. 17. *Fully interlocked transmission.*

shown in Fig. 15. There are three address lines, and the address of the device is <010>. Eight data lines are used, and the 8-bit register within the device holds the last data word read.

The bus structure that has been described is called a synchronous bus because each device on it is driven from the same clock: the two conventions together form the bus protocol. The bus will only work as long as the protocol is observed correctly by all devices attached to it. The idea of a protocol (dictionary definition: "terms agreed upon as the basis of a formal treaty") is an important one in all interactive communications systems.

The disadvantage of a synchronous bus is that all devices on it must work at the same speed, because they are driven by the same clock. Thus, the bus must go at the speed of the slowest device on it. For example, if a store module with an access time of 500ns (fast store) is attached to the bus, and another with an access time of 2μs (slow store), the bus will need 2μs clock and will not gain any advantage from having the fast store.

Asynchronous buses. The two problems posed by bus synchronisation were: the presence of spurious addresses during a transition of the address lines, and the need to know when data had been accepted by a device. The first problem can be overcome by having an "address valid" control line which is set to logic 1 by the sending device when it is sure that the address lines have settled. The second needs a "data accepted" line which is set to logic 1 by the receiving device as soon as it has read the data.

This allows for devices of different speeds to operate sensibly on the same bus. When the sending device has put data and address on to the bus, and after it has waited for a short time (typically 200ns) to ensure that the lines have settled, it asserts "address valid". This is the signal for all devices on the bus to examine the address lines to see if the data is for them. If it is, they read the data immediately, and then assert "data accepted", the time taken for this operation depending on the speed of the device. In either case, as soon as the sending device sees "data accepted" it can release the bus lines and proceed to its next operation. Fig. 16 shows the sequence of events.

This protocol is called "handshake" or "interlocked" transmission. It uses a signal from the sender to assert that the address and data lines have been set up, and a response from the receiver to indicate that data has been accepted. The result – transmission at the maximum speed possible for the two devices. The price – two extra control lines in the bus, and the risk of "hanging up" for ever if things go wrong – if, for example, the receiving device did not work properly.

In practice, the possibility of hanging up for ever can be rather embarrassing.

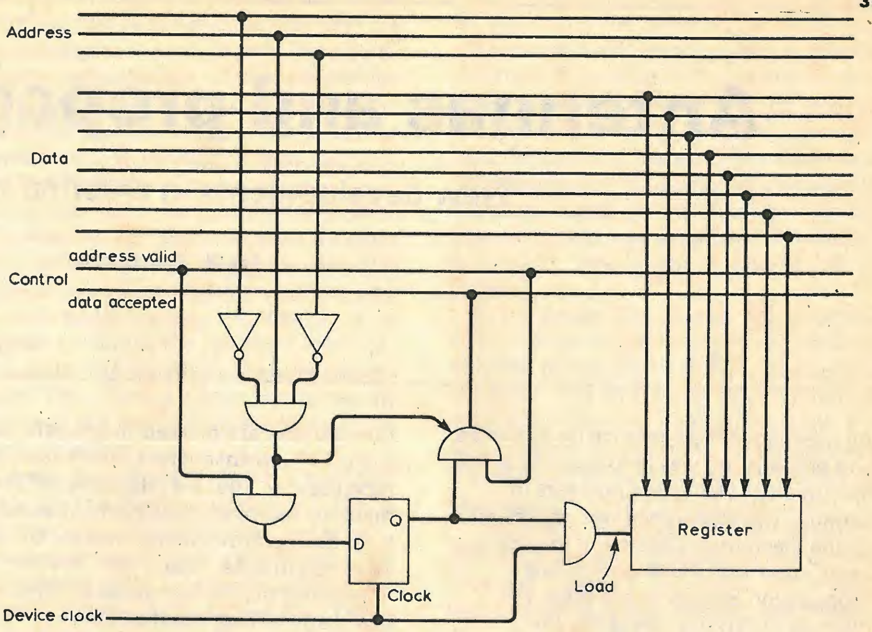


Fig. 18. *Reading from a fully interlocked bus.*

It only needs someone to run a program which attempts to communicate with a non-existent device, or to unplug a module from the bus, to bring the whole system to a halt. Sometimes this is considered so dangerous that the sender implements a time-out, where if the receiver has not responded after a certain maximum time (say 10μs) the sender takes control again, probably to report a fault condition. The time-out idea is important in all systems which "fail soft", that is, do not collapse completely when something goes wrong. People, of course, implement time-outs automatically when, say, no one answers one's knock on the door.

The only difficulty with the protocol described is that the time for which the receiver asserts "data accepted" has not been specified. If it asserts it for a very short time, it may be missed by the sender. If it is asserted for too long, the sender may be doing its next transmission and falsely conclude that this too has been accepted. A solution is for the receiver to assert "data accepted" until it sees that "address valid" is no longer asserted. The sender should then wait for the receiver to de-assert "data accepted" before using the bus again. This protocol is called "fully interlocked" transmission, and is shown in Fig. 17.

Fig. 18 shows a circuit to read from mission. Note that the use of an asynchronous bus does not necessarily imply that the devices attached to it employ asynchronous logic: normally, as in the figure, the devices have their own internal clocks. When the receiver sees its address on the bus with "address valid" asserted, it awaits the next clock pulse, and uses it to set a flip-flop and load the bus data into the register. Since this will happen virtually instantaneously, it simultaneously gates "address valid" back on to the "data

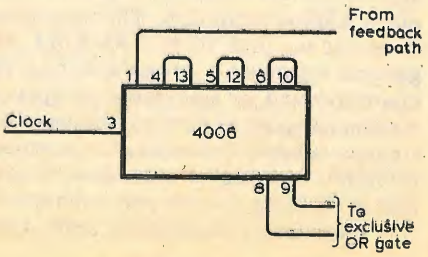
accepted" during transients.)

Since this will happen virtually instantaneously, it simultaneously gates "address valid" back on to the "data accepted" bus line. If the load operation were to take longer, the device could be designed to wait until its completion before asserting "data accepted" to prevent the sender from altering the state of the bus. Note the use of a tri-state gate to drive the bus; the driver is enabled whenever the address lines are recognised. (This may result in driving the bus line during address transients, but no harm will come because the sender will not be loking at "data accepted" during transients. □

To be continued

The Chatterbox — 4006

Owing to an oversight, we did not publish the pin connections to the 4006 shift register used in the noise generator section of the Chatterbox speech synthesizer (December 1978 issue, p. 41). Apologies to readers for this error. The required pin connections are shown below.



Antennas and propagation — 1

New developments in antenna technology

by R. Ashmore

An international conference on antennas and propagation was held recently at the Institution of Electrical Engineers in London. The conference was organised by the Electronics Division of the IEE in association with the Antennas and Propagation Society of the IEEE, the Institute of Physics, the IERE, the Institute of Mathematics and its Applications, and the International Union of Radio Science. A large number of papers were presented; at least 97 on antennas and 39 on propagation. The following text is based on extracts from some of the papers on antennas.

THREE authors from the University of Oulu in Finland say that the characteristics of h.f. systems are analogous to industrial processes and in their paper[1] they describe a systems engineering approach to finding solutions for increasing the performance of radio communication systems.

In process control, unwanted effects have been combated by using steady-state optimization and real-time control methods, this being made feasible in the 1970s because of the dramatic advances made in microcomputers and the theoretical tools available. Some twenty scientists and engineers at the University of Oulu have been carrying out experimental work towards applying this approach to radio communication (mainly h.f.) systems since 1970.

The disadvantages of h.f. due to ionospheric propagation, large variations in path attenuation, channel imperfections, noise and interference, limit the usefulness of this frequency band as an economical low-capacity communication medium. Modern solutions for increasing the performance of radio communication have included automatic frequency and gain control, propagation channel and station identification, the introduction of new modulation and signal processing methods, the use of feedback channels and/or central control stations and multichannel reception. The solutions have, according to the authors, in general followed a pragmatic course characterized by unrelated improvements emerging as new technology becomes available. This kind of unplanned evolution, although common, does not lead to optimum overall performance.

In the systems engineering approach, the systems are broken down into subsystems — transmitters, antennas, and receivers — and a systematic effort is made to improve their performance. In h.f. communications most of the improvements can be made by improving the performance of receiving and transmitting antennas.

The requirements of h.f. antennas cannot be met by any type of classical h.f. antenna which is designed for average conditions.The antennas required must possess intelligence, so that they may follow the changes of propagation path and the signal and noise environment. For this reason, a new h.f. array configuration, suitable for controllable and adaptive operation, was developed during the university's project. The configuration comprises a planar array of horizontally polarized directive yagi- or log-periodic-type arrays supported by a single rotatable guyed tower. This configuration gives a low-angle main-lobe suitable for medium and long distances (over 1000km) together with high gain and simple beam steering.

Based on the results of tests on the experimental beam, the authors conclude that intelligent equipment needed for large-scale use could be manufactured very economically in the 1980's using v.l.s.i. circuits. Low power analogue and digital circuits would even make mobile and portable operation possible. The main difficulties, they say, lay in the selection and implementation of adaptive methods and algorithms suitable for the h.f. environment and therefore this formed a major part of their project.

In the future the adaptive solutions for the lowest levels could be combined with overall real-time control of entire h.f. links and the operation of these h.f. links could in turn be actively coordinated in real-time by regional and world-wide centres. H.f. communications, say the authors, could be developed into a complex, integrated, adaptive system where individual links would be able to adopt to changes in their environment.

Circular array with 360° null steering

Radio communications to and from moving platforms such as aircraft, ships and land vehicles, generally require omnidirectional coverage. However, this makes the system particularly vulnerable to directional interference. One way round this problem is to design an omnidirectional antenna having one or more directional nulls which can be electronically steered to minimize any such interference. A paper[2] by D. E. N. Davies and M. S. A. S. Rizk from University College London, describes such an antenna based on a four-element circular array, having a very small radius of 0.04λ. This small radius allows the complete array to be housed in a thin cylinder or whip structure. The antenna pattern permits omnidirectional coverage with a null which may be electronically steered through 360° of azimuth by means of a single phase shifter. Fig. 1 shows the experimental pattern of the antenna.

To confirm some theoretical predictions, described in the paper, a four element null-steering array was constructed for the frequency 153MHz. Since the antenna has a very small radius there is a reduction of antenna gain and some degradation of bandwidth performance, compared with larger arrays. Also, the form of the directional pattern changes with null pointing angle in azimuth. There is also a deterioration of null depth when the antenna is operated away from its design frequency of 153MHz. The results

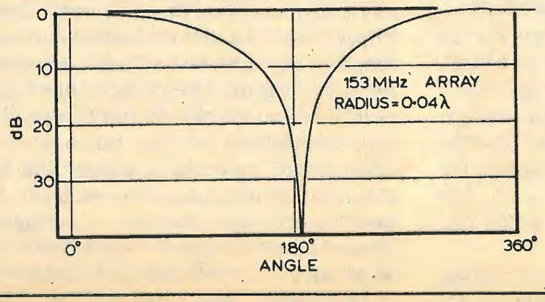


Fig. 1. *An experimental pattern of a four-element null steering array having a radius of 0.04λ. See Ref. 2.*

indicated that the effective bandwidth limitation of the array for a fixed 50Ω termination of the mode was in the region of ±10%.

It was found that one reason for the bandwidth limitation of the experimental results was a resonant effect due to the centre mast of the structure which supported the array. This was because the mast was designed to work as a single dipole for other purposes.

Although the null steering antenna system may operate in either a transmit or receive mode, the principal interest of rejecting interference is obviously confined to receiving only. This type of array can also operate as a directionally sensitive receiving antenna by connecting the output of the two modes — zero or null — to a phase sensitive detector. The output of the p.s.d. can then be calibrated in angle of arrival of any received wave. In addition, this means that this signal may be used directly as the information source needed to steer a null on to any required signal where automatic or adaptive null steering performance is wanted.

The paper shows that a simple four-element null-steering antenna intended for wideband operation may be modified to be used as a highly compact, small radius, null steering antenna. Null depths on the experimental antenna were in the region of −40dB, at the centre frequency of 153MHz, and over the ±10% bandwidth the depth was not worse than −25dB. The configuration gives an antenna gain 5.3dB worse than an ordinary dipole.

This work was supported by the Ministry of Defence Procurement Executive.

Satellite communications

The capacity of a communications link can be doubled by transmitting independent signals within the same frequency band in orthogonal polarizations. This technique, which is being used more and more in satellite communications (e.g. *Wireless World*, December 1978 issue, p.63), is the basis of work described in a paper[3] by D. H. Brandwood from the Plessey Company at Roke Manor. This work was carried out for the International Telecommunication Satellite Organisation.

When using orthogonal polarizations there is always a certain amount of cross-coupling between the channels caused by imperfect antenna alignment or when the signals pass through heavy rain or ice crystal layers. One method of reducing the cross-polarization is to modify the polarization within a waveguide at the receiver, before the orthomode transducer, a device which separates the signals in the two polarizations. Alternatively, the depolarized signals can be received unmodified at the transducer and a cancellation technique removes interference from a receiver channel by adding in an equal amplitude, antiphase version of the interference waveform*.

In the orthogonal polarization case there are two receiver channels and the copolar signal in each channel is used to achieve cancellation of the crosspolar signal in the other channel. Since the crosspolarization varies with weather conditions it is necessary that the system be adaptive.

One technique for obtaining control information for the adaptive double cancellation system requires that the satellite transmits two pilot tones, one in each polarization. However, it is possible to obtain the required information from the satellite signals themselves. The Plessey paper discusses an outline of the analysis of the pilot independent system.

For the experimental work a receiver was constructed to operate with a microwave cancellation network. Laboratory tests were carried out on this receiver using a network to produce suitable cross-coupling levels. Tests were then carried out at realistic signal-to-noise ratios using travelling-wave tubes to produce simulated receiver noise.

The associated theoretical work showed that in principle crosspolarization discrimination could be improved to the required level by a cross-coupled cancellation technique which does not require transmission of pilot tones by the satellite. In conclusion, Mr Brandwood says that this cancellation technique is directly applicable to any two-channel system with cross-coupling, however this cross-coupling may be caused. The receiver design could also be modified for use with t.d.m.a. signals and cancellation could be carried out in other frequency bands (the experiments used frequencies between 2.5 and 75MHz) or at i.f. if cancellation were not required over the whole r.f. band.

H.f. and the amateur service

Les Moxon, G6XN of the Radio Society of Great Britain, says in his paper[1] that there is a considerable number of differences between amateur and other communication services operating in the h.f. band of the frequency spectrum. A number of engineering problems arise because of these differences and the solutions to the problems are unique to the amateur field.

Firstly, in amateur communications, continuous service is not required. The amateur also has, in general, no freedom in the choice of location, but has to make the best use he can of a particular, usually small, area of ground subject to various technical and planning constraints. In most cases he is severely restricted in regard to antenna size and height, and he is often affected by screening and local noise sources. Amateur operation is also restricted to a small number of harmonically-related frequency bands. In addition, the amateur is usually forced, by financial limitations, to use low power and simple antennas, and by the terms of his licence, to use output powers restricted to a mean level in the region of 100 to 150W.

In his paper, Les Moxon draws attention to some engineering developments inspired by the above differences, and to evidence that in solving the problem of very-long-distance communication, despite severe restrictions, amateurs are making use of the chordal hop mode of propagation (more about this later).

The effect of height on performance over long distance paths depends on the required angle of radiation, on which there is little data. Ideally the height must be sufficient to allow in-phase combination of the direct and reflected waves at the required angle, but in most cases it must suffice to erect the antennas as high as possible, typically 10 to 20 metres, compared with a desirable figure of at least 40 metres.

Despite this, daily antipodal communication is possible with typical amateur installations over most of the sunspot cycle. Much better results are of course obtainable when the ground slopes in the desired direction, and it has been shown that when ground slopes down steeply to the sea, or a flat plain, up to 12dB gain may be obtained from the two ground reflections. Using portable equipment to seek out slopes of this kind, regular communication with antipodes has been achieved with dipole antennas at heights of only 3 to 8 metres, s.s.b. transmission, and p.r.ps of between 0.5 and 1.5W. This, says Mr Moxon, suggests the possibility of relatively low-cost commercial installations for ranges upwards of 3000km, by using cliff or mountainside locations.

To be continued

References

1. Lehto, S., Kekäläinen, J., and Kajava, J., University of Oulu, Finland, The development of adaptive h.f. communications, pp36.40, Part 1.
2. Davies, D. E. N., and Rizk, M. S. A. S., University College London, A small radius circular array antenna with 360° null steering capability, pp60-64, Part 1.
3. Brandwood, D. H., The Plessey Company Limited, Roke Manor, Romsey, Hampshire, Cross-coupled cancellation system for improving cross-polarization discrimination, pp41-45, Part 1.
4. Moxon, L. A., Radio Society of Great Britain, High-Frequency antennae and propagation modes in relation to the amateur service, pp83-86, Part 1.

All IEE Conference Publication Number 169, Antennas and Propagation, from International Conference on 28-30 November, 1978.

---

*This may be a clue to the technique used in the Plessey Groundsat repeater, described on page 71 of the November '78 issue. It is interesting to note that the new technique used on this repeater was discovered while designers were working on other projects. Both of these works were by engineers at Roke Manor.

NEWS OF THE MONTH

Proposal to make Carfax and ARI compatible

A proposal by Robert Bosch Ltd, concerning the possibility of making Carfax and ARI compatible, has been presented to the BBC's research division.

Readers who have been following the progress of Carfax and ARI in the UK will probably be left wondering whether Bosch has finally thrown in the towel, or whether, in an attempt to clutch at the last straw, they are taking the attitude that if you can't beat 'em, join 'em. For the benefit of those who have not been following the subject, radio equipment for the ARI (automotive road information) system (see p73, October '78 issue) is manufactured by Blaupunkt Radio, who are owned by Robert Bosch, for the Continental road traffic information service, and Carfax, which is the BBC's answer to road traffic information, is presently being developed and tested by the BBC for the UK. The Carfax system is described in the Jan '78 issue, p28).

Bosch suggests that the UK should adopt traffic information services in three stages. Firstly, the company believes that there is compelling evidence to justify the introduction and installation of ARI immediately in the UK. This introduction, which would be stage one, would cost only £25,000 to install "overnight" in Britain. The next stage is best described as it was put to *Wireless World* by Andrew Rodger of Bosch, as follows: "As stage two, and if we can afford the cost of installing the necessary 80 to 120 transmitters, we consider Carfax could be installed on f.m. between 100 and 104MHz. It could then be internationally compatible with ARI." It is worth noting here that the additional proviso in the first sentence is one of the main reasons why the pro-ARI are so anti-Carfax.

Stage three of Bosch's plan would then involve the installation of a system like ALI (the Driver Guidance and Information Service which is now being installed and tested in the Ruhr) which would provide drivers with individual guidance and information on a dashboard display via induction loops built into the road.

The proposal, which if implemented will enable the car radio equipment of several million motorists from the Continent to work satisfactorily in the UK, and the Carfax receivers from the UK to work satisfactorily on the Continent, was first put to the International Broadcasting Convention in September by G. Bolle, director of research and development at Blaupunkt Werke GmbH, West Germany. He agreed that there was no doubt that the principle of the Carfax system, to install a separate network of stations, was an ideal way to build up a network for the transmission of traffic information. In fact, he said, such a plan to create a network of independent stations had existed in West Germany about ten years ago but this had to be delayed because the constitution of the FRG does not permit anyone other than the ten German radio companies to transmit broadcast-type material and because there were no available frequencies for a new transmitter network. The ARI system was the result of engineers making use of the existing transmitter network.

Mr Bolle continued by saying that if it is possible in the UK to run such an information network without the aid of the radio station, and if there was sufficient money available to run a completely independent network, then Carfax would be the ideal system and ARI, in fact, only a "mini-Carfax". In order to avoid the problems of possible incompatibility between the two systems, the Carfax system would have to be run in the v.h.f band at a frequency between 100 and 104MHz, and Mr Bolle believed that a special frequency in this range could certainly be found in the UK.

As far as Bosch knew, there was not much chance that the WARC '79 Conference would allocate a frequency for Carfax in the medium frequency range because these frequencies were reserved exclusively for stations for large area service. Using a frequency in the v.h.f. band would considerably reduce co-channel interference, and one of the excellent features of the Carfax system, the capture effect, would at least be maintained if not improved.

One possible problem is that the ARI system depends on the fact that the carrier of the traffic information station is permanent and to overcome this the Carfax transmitters would also have to run constantly. According to Bosch, the power consumption for the 90 Carfax stations in the UK, about 5000kW/day, which is equivalent to approximately 300 medium sized cars, is reasonable. ☐

Computers and privacy

The subject of the effect of computer systems on the privacy of individuals is continuing to attract a large amount of public interest. When a special committee was set up recently by the National Electronics Council to investigate the social and economic impact of using computers, one of the first themes to be taken up concerned the possible effect of computers and computer systems on the privacy of individuals. At an IEE colloquium, held in November and entitled "The interaction between computer technology and society" some of the eight papers presented discussed the social implications of computers, and one paper, by Sir Norman Lindop, director of Hatfield Polytechnic (see further), dealt specifically with the privacy aspect.

In December, the Government released "The Data Bank report", a report of the Committee on Data Protection, headed by Lindop. This disclosed that Sweden has refused to send data to the UK because of the lack of data-protection control in the latter country. Now, another White Paper has been promised for the spring of 1979. A bibliography has also been compiled by a member of the IEE's library staff to inform researchers of a wide range of papers dealing with privacy and computers. This brings together about 250 citations covering a period from January 1969 to July 1978.

An article, "Computers and Individual Privacy" by F. J. M. Laver, in the NEC's journal, *National Electronics Review* (Nov./Dec. 1978) recalls some of the events leading up to the present situation. The first time the subject attracted a vast amount of public interest was in 1966 when it was proposed that a central installation should be established to bring together information held separately on the computer tapes of various US government agencies. Then, in Britain, after two abortive attempts at legislation by private members, a government committee under Sir Kenneth Younger, produced a White Paper (5012) in July 1972. After a long pause and following some public pressure, the Home Office responded by publishing two White Papers (6353 and 6354) in December 1975. They also appointed Sir Norman Lindop as chairman of the then newly formed Data Protection Committee (DPC) to examine the need for, and the nature of, legislative or administrative measures to protect the privacy of the individual or individuals. It was in August 1976 that the DPC invited the views of representative bodies, including the NEC.

Mr Laver's article is intended to highlight a few of the points that occupied the NEC's Social and Economic Impact Committee during 1976 and 1977. The Council's interest in privacy derives from its belief that there is, risk that, over-reacting in its anxiety to allay the fears expressed, the Government might be persuaded to construct a legal apparatus of control which would hamper the future development of computers in the UK. If this was to happen, says the article, heavy costs and complex procedures would be imposed on many computer users in order to guard against carelessness or malpractice by an irresponsible few, and it could restrict the growth of social service applications, in particular, and cut off large benefits which the intelligent use of computers alone could bring. Economic and commercial advantages could also be delayed or diminished and as a result electronic technology would be prevented from contributing as fully as it could to the UK's economic and social health. It would particularly and adversely affect the UK electronics industry's competitiveness in international markets because this industry would be denied opportunities of developing and demonstrating its competence in important fields.

The NEC article suggests that, in the interests of fair competition, as well as to protect the individual, it is highly desirable that a common, or at least a compatible, control regime should be established within the EEC, and preferably also in Japan and the USA. As a minimum it suggests the use of some form of international convention to discourage the exploitation of differences between national regulations, and to prevent easy-going countries from seeking to attract data banking business.

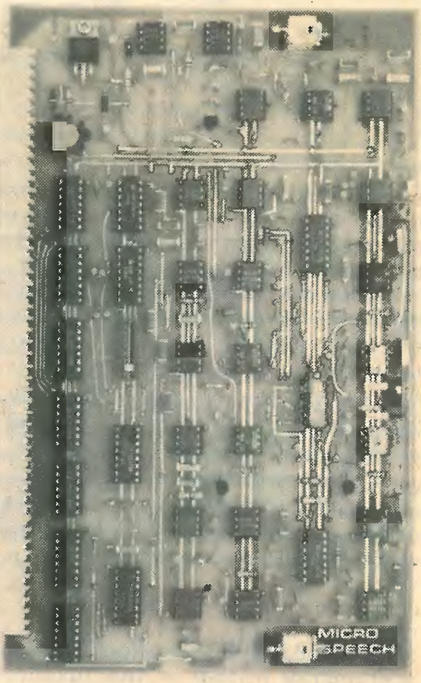
First low cost speech synthesizer in UK

Until recently, electronic speech synthesizers have been very limited or very expensive and this has restricted their use. The recent speak and spell device from Texas, although not a true synthesizer, does provide high quality speech very cheaply, and has opened the door to more versatile pre-programmed units.

Microspeech from Costronics, however, is a true speech synthesizer, priced at around £300, which has been designed to operate directly with the standard SS50 bus as used on the South West Technical Products 6800 microcomputer. The microspeech package contains a speech synthesizer with separate nasal and fricative branches, a digital noise source, and a voltage controlled oscillator. To complement this board, software is supplied on a floppy disc. This translator program occupies about 4K of memory and converts phonetic code into sets of data which control the synthesizer. This data produces nine control parameters which in turn determine pitch, amplitudes, and resonant frequencies. In operation, the characters from the phonetic text are compared with a phoenem look-up table. If a match is not possible, a one character match is attempted while at the same time checks are made for the end of text character and for the pitch control characters. If a pitch control character is encountered, internal updating takes place as necessary. When a phoenem is recognised, the parameter store for that sound is released. This store defines the starting and stopping values of eight vocal tract parameters together with the phoenem and type of interpolation to be used for the resonances and amplitudes. Each time a new frame of data is produced during the interpolation, it updates the speech synthesizer. When the phoenem has finished, a short interpolation is made between the end values of the current phoenem and the starting values of the next one. The whole process then repeats until the text has finished.

An important feature of Microspeech is its real-time operation. This means that there are no gaps in the speech and the device can be arranged to operate directly from a keyboard. Alternatively, speech can be stored, around 90s for each 1K of buffer space, without the need for a large memory to accommodate the control parameters.

Although the speech quality is by no means perfect, the system is theoretically capable of synthesizing any voice provided that the circuitry is controlled correctly. For this reason, most of the current development is taking place on the software.



Video disc system now marketed in USA

The Philips and MCA optical videodisc system is now being marketed in the USA, according to an announcement made recently by the Magnavox Consumer Electronics Company, a subsidiary of North American Philips. This move, which actually began in December last year, is presently restricted to the Atlanta market, but distribution is to be extended in 1979 to other markets in the United States.

While this action is unlikely to immediately affect consumers in the UK, Mr Gerrit Jeelof, the Chairman and Managing Director of Philips Industries UK, said that Britain might be the second country to have this development and that they would be trying to get it on the market in the UK as early as possible in 1980.

This particular system has a videodisc player manufactured and marketed by North American Philips' Magnavox subsidiary under the trade name Magnavision, and pre-recorded video discs manufactured and marketed by MCA Incorporated under the trademark and tradename MCA Discovision.

It has been suggested by officials from Magnavox that the videodisc player will cost about £350 ($695), and according to MCA a typical half-hour videodisc programme will be sold at a retail price of about £3 ($5.95). Complete two-hour recent feature films are expected to retail at about £8 ($15.95).

The Philips and MCA system attaches to a home television receiver and the videodiscs are grooveless and resemble a long-playing record. The optical system on the Magnavision player uses a tiny, low-power laser light beam which relays images and sound from the videodisc to the viewer's television screen. No needle or stylus ever touches the disc, so repeated handling or use will not wear out or diminish the videodisc quality. The system's discrete stereo sound tracks can also be played through a home stereo amplifier to offer a sound which is much better than that obtainable from the television sound system.

One of the advantages of the Magnavision player is that the transmissions of picture and sound are equal to the best available from broadcast tv reception and superior to home videotape playback. In the standard play mode the system also allows the user to stop, slow or reverse the programme at any point on the disc. Related to this are the advantages of rapid access, fast motion, instant replay (no need to wind back tapes) and frame by frame readout. Another advantage, that of the disc's durability, has already been described.

Audio writer award presented

The 1978 Audio Writer Award has been awarded to Barry Fox who writes under the pen name Adrian Hope. The award, a silver tuning fork mounted on a mahogany base and a cheque for £300, was presented by the international conductor, Charles Mackerras, in London during November.

Barry Fox, who started writing for publications about twenty years ago when he made a contribution to *Punch*, was an Oxford graduate in biology who became a patents consultant. It was not until a few years ago that writing became a major source of income for him and prompted him to become a consultant and writer on audio, video and patents. Now, he writes for many audio and video publications and he is a regular columnist in *New Scientist* and *She*. He is also the author of two books on inventions and audio.

Largest order ever for UK electronics firm

Racal Electronics Group has received an export order worth £20 million, the largest ever in its 28 year history. The order has been placed by a Middle Eastern country for the supply of radio communications systems.

The Group is to supply a number of fully-equipped and custom-built transportable communications shelters and mobile workshops. The shelters house all the radio and terminal equipment needed for a complete, fixed communication station and can be re-deployed to any site within hours. This feature satisfies a particular demand for flexibility in a nationwide network.

Racal Communications Ltd will undertake all the systems engineering and the equipment itself will be supplied by several companies in the Group, including Racal-Tacticom Ltd, Racal-Datacom Ltd, Racal-Dana Instruments Ltd, Racal Thermionic Ltd and Racal Communications Ltd. The order includes the largest ever logistic support contract so far achieved by Racal.

According to a Racal statement, early delivery is essential and the whole order is expected to be fulfilled by the end of 1979.

● An interim report from Racal Electronics Ltd shows that their unaudited pre-tax net profit for the half-year ended 30th September, 1978, amounted to £24,323,000. This compares with a 1977 figure of £19,398,000, an increase of 25.4%. Turnover during the half year was £99,894,000 and the previous half-year was £89,886,000, up 11.1%.

News continued on page 74

High-performance preamplifier

Low-cost design with active gain control

by **D. Self,** M.A., M.Sc.

In his previous article Doug Self described a no-compromise preamplifier which was designed using high voltage transistors to give exceptional performance. This new design sacrifices very little of that performance and uses a small number of low-cost transistors to significantly reduce the cost. A novel active gain control makes best use of the dynamic range and removes the problem of volume control placement.

THIS PREAMPLIFIER offers a similar performance to that of the advanced preamplifier published previously[1], but with a simpler design that reduces the parts count and hence cost. In normal use, the signal levels are kept around 50mV by exchanging the normal potentiometer volume control, which acts as an attenuation control, for an active gain control. Therefore, the signal receives only the amplification required for a given output and so makes best use of the amplifier's dynamic range.

The distortion performance is also improved because unwanted gain will be used to give higher negative feedback and thus greater linearity. The active gain control uses a shunt feedback circuit where the volume control varies the resistance of a feedback arm as shown in Fig. 1. The disc input stage has a relatively low gain of +20dB at 1kHz which allows a very high input overload margin. This is followed by a third-order high-pass filter which removes subsonic signals while they are still at a low level. Both bass boost and treble cut portions of the RIAA equalisation take place in the first stage. The gain control stage is positioned after the input switching and has a maximum voltage gain of +20dB. This is followed by a Baxandall tone control which has unity gain at 1kHz.

The use of an active gain control eliminates the problems associated with a normal volume control. If all of the gain is placed before the control, the supply voltage limits the overload margin. If some gain occurs after the volume control, then the signal-to-noise ratio is degraded because noise generated in the later stages does not undergo attenuation. The use of two controls, one early and one late in the signal chain, is one method of avoiding this compromise[1] but a true gain control is considered to be a more elegant solution.

Preamplifier specification

Input sensitivity
for 500mV output

Disc	5mV at 47kΩ
Line 1	100mV at 20kΩ
Line 2	100mV at 20kΩ
Line 3	500mV at 100kΩ

Disc input overload level
1.1V r.m.s. at 1kHz
3.8V r.m.s. at 10kHz

Outputs
Main output
500mV r.m.s. at 100Ω source impedance
Tape output
50mV r.m.s. at 1kΩ source impedance
Maximum possible level from main output
8.5V r.m.s.

Frequency response
Disc input (RIAA equalisation)
±1.0dB 20Hz to 20kHz
±0.5dB 100Hz to 20kHz
Line inputs (flat)
+0, to −0.5dB 20Hz to 20kHz

Total harmonic distortion
From disc input to main output, at 1kHz with the gain control set to ×6
less than .008% at 8V r.m.s.
less than .005% at 5V r.m.s.
Because the output signal level will normally be around 500mV the t.h.d. level will be much lower.

Noise

Disc input	better than 68dB below 5mV r.m.s.
Line inputs	below −75dBm at full gain
Residual	below −90dBm at zero gain

Tone controls

Bass	±14dB at 50Hz
Treble	±10dB at 10kHz

Power consumption
Approx 78mA each channel from a +38V supply.

Because a low-cost, single unregulated power supply is used with first-order RC smoothing to reduce ripple, all sections of the preamplifier are designed with high ripple-rejection performance.

Disc input stage

The most difficult stage to design in a preamplifier is the disc input, and the problems are compounded if, as in this case, the gain of the stage is low to allow a high overload margin. A low voltage gain at 1kHz means that the feedback network which defines the gain and RIAA equalisation will have a relatively low impedance, and thus appear as a heavy load to be driven by the disc amplifier. This situation becomes worse at higher frequencies when the reactance of the equalisation components falls. Therefore, as a large voltage swing at the output is desirable, a large amount of current must be able to flow into and out of the feedback network at high frequencies. A second, and related problem, is that if the gain at 1kHz is low, the gain at 20kHz must be 19.3dB lower due to the RIAA equalisation, which makes it close to unity. Therefore, it becomes more difficult to set the top end of the RIAA curve accurately. For this reason an extra low-pass section, with a −3dB frequency of about 22kHz, is added after the disc amplifier to ensure that the high-frequency gain continues to fall at a steady rate. It should be noted that if the correct turn-over frequency is chosen for the final low-pass network, the RIAA amplitude and phase curves are obtained exactly.

Another consequence of the fall in closed-loop gain at high frequencies is that the compensation for Nyquist stability is more difficult, and in this design it was necessary to add a conventional RC step-network to the normal dominant-pole compensation. The dominant-pole capacitor is kept as small as possible to preserve the slew-rate capability of the stage.

The basic disc input stage is shown in Fig. 2. In this series-feedback configuration almost all of the voltage gain is provided by the second transistor, which has a bootstrapped collector load for high open-loop gain and linearity. The final transistor is an emitter-follower for unity-gain voltage buffering. This configuration allows the use of a p-n-p input transistor for optimum noise performance, but it also means that the collector current must flow through the feedback resistance R_F. This places another constraint on the design of the feedback network because an excessive voltage drop must be avoided.

As the disc input amplifier must be capable of sourcing or sinking large peak values of current to drive the capacitive feedback loop at high frequencies, the conventional emitter-following output circuit in Fig. 2 is not suitable because the sink current causes a voltage drop in R_E. Lowering the value of R_E reduces the effect, but this is a poor solution as it leads to a high quiescent power dissipation. Replacing R_E with a constant-current source is more effective because the maximum sink current becomes equal to the standing current of the stage. However, this would still limit the output of the disc stage at high audio frequencies due to an inability to sink sufficient current. For this reason, the push-pull class A configuration in Fig. 3 was chosen. The bottom transistor is a current-source which is modulated in anti-phase to the top emitter-follower, via the current-sensing resistor R_A and a capacitor. This can also be considered as a negative-feedback loop that attempts to keep the current in R_A constant. However, the open-loop gain is only unity and so with 100% negative feedback the current variations in the top transistor are reduced to one half by the capacitor. Due to the anti-phase drive of the lower transistor, this stage can sink a peak current of twice the standing current, and therefore give twice the output swing at high frequencies.

A practical circuit of the disc input amplifier and its associated subsonic filter is shown in Fig. 4. All of the d.c. bias voltages are provided by the potential divider R_2, R_3, R_4, D_1 and D_2. This chain is heavily decoupled by C_2 to prevent supply-rail ripple entering this sensitive part of the circuit. Note that Tr_3 and Tr_5 are isolated from the bias voltage by R_{14} and R_{22} to simplify any fault-finding.

The RIAA equalisation is provided by R_{10}, R_{11}, C_6 and C_7 in the feedback loop, and R_7C_4 forms a step network that aids h.f. stability. Resistor R_{17} and C_{11} make up the low-pass section that corrects the top octave of the RIAA curve. The subsonic filter is a 3-pole Butterworth type with an ultimate slope of 18dB/octave. Although the frequency response shows a loss of only 1.5dB at 20Hz, the attenuation is increased to more than 14dB at 10Hz. The unity-voltage gain element of the filter is formed by Tr_5 and Tr_6 arranged as an emitter-follower with a current-source load. This configuration was chosen for its excellent linearity. An output of about 50mV is available for tape recording although the exact voltage will depend on the cartridge sensitivity. Resistor R_{24} prevents damage to Tr_6 if the tape output is shorted to earth, and resistor R_{25} maintains the output of the disc stage at 0V d.c., and also prevents switching clicks.

The total harmonic distortion from input to tape output at 6V r.m.s. is below 0.004% from 1kHz to 10kHz but because the anticipated signal level here from most cartridges is about 50mV r.m.s. the distortion during use will be even lower. The disc input will accept more than 1V r.m.s. at 1kHz, and about 3.8V r.m.s. at

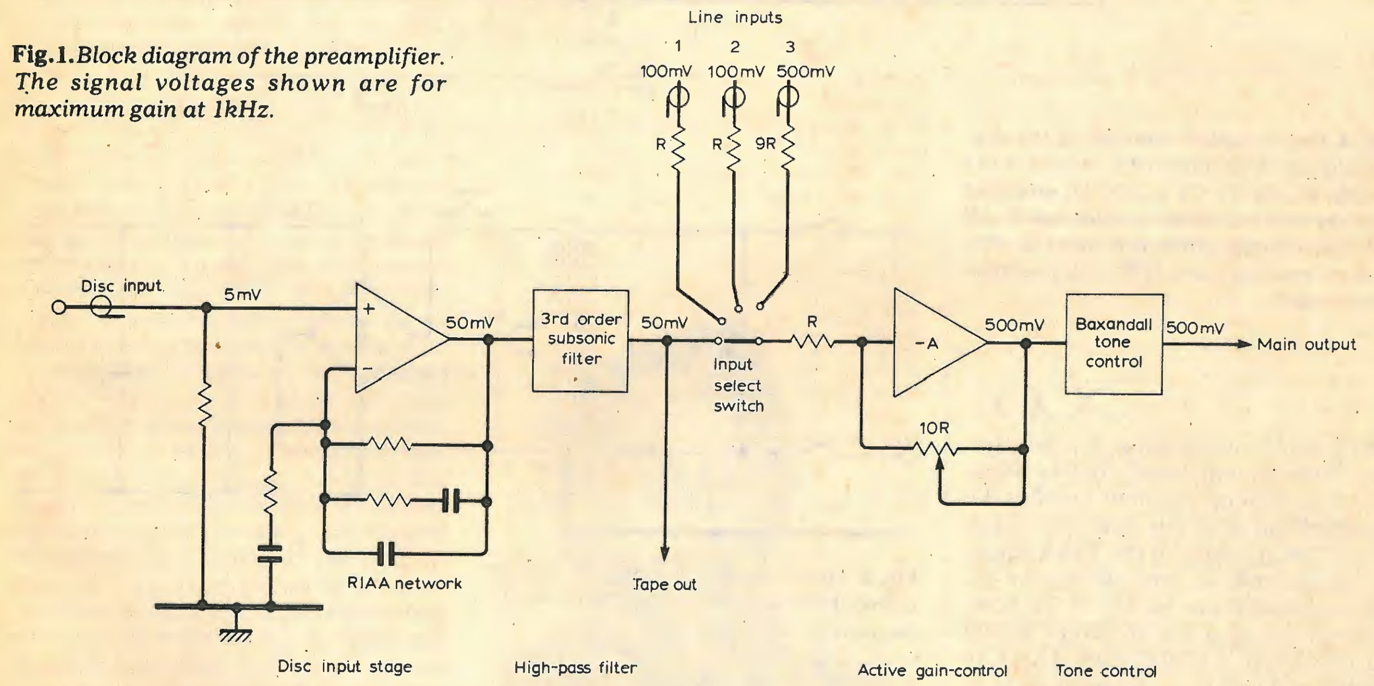


Fig. 1. *Block diagram of the preamplifier. The signal voltages shown are for maximum gain at 1kHz.*

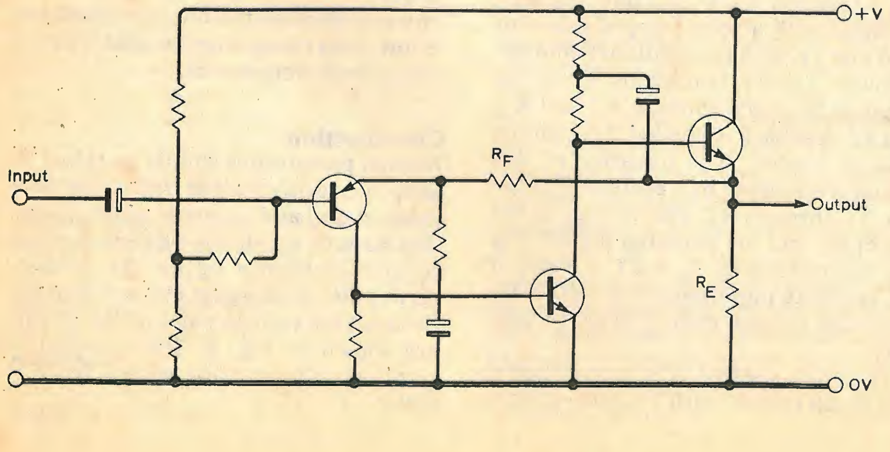


Fig. 2. *Series-feedback disc input amplifier with an emitter-follower output.*

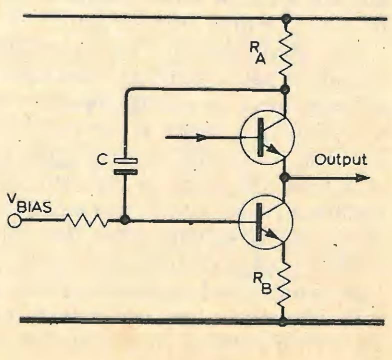


Fig. 3. *Improved push-pull class A output stage.*

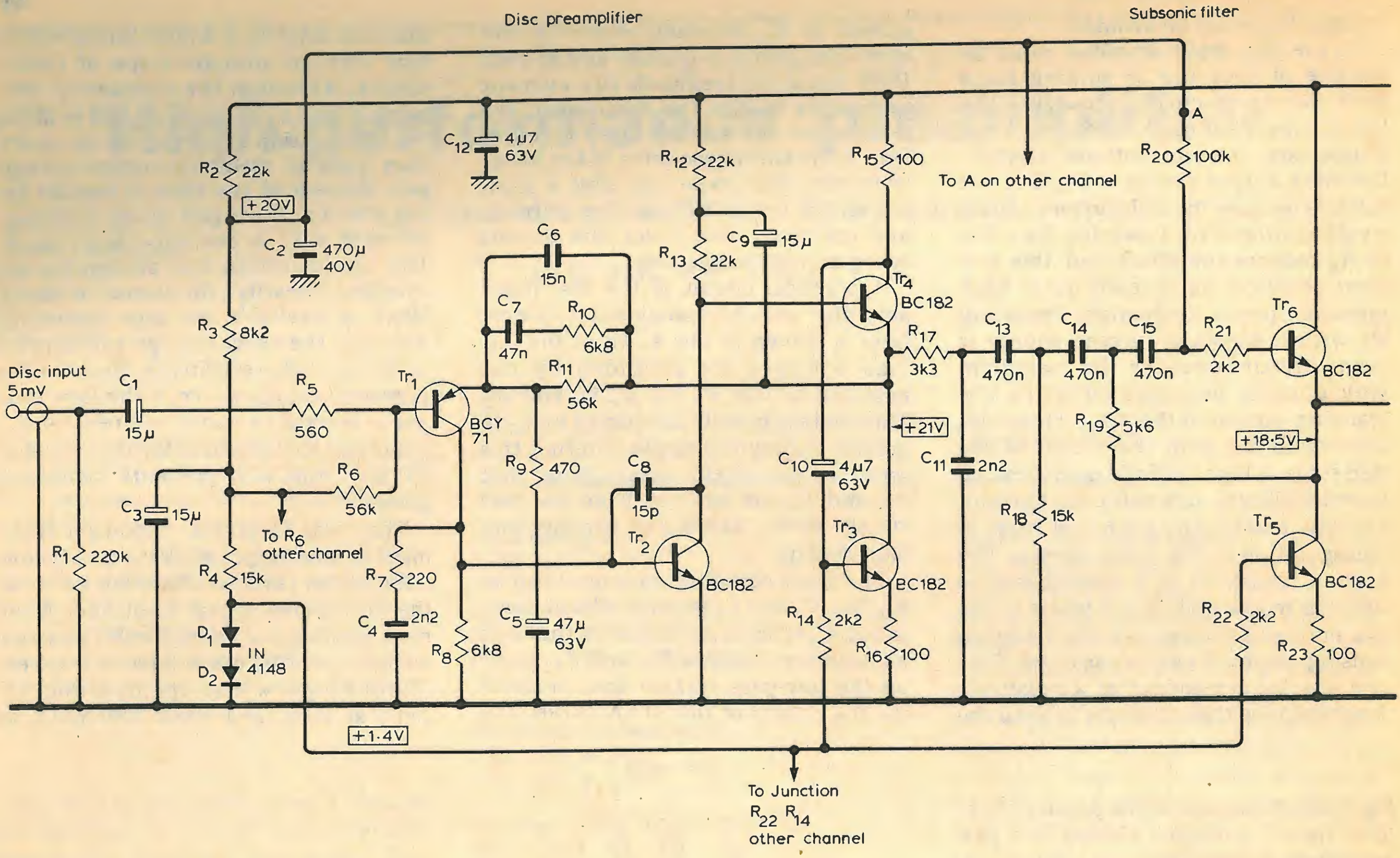


Fig. 4. *One complete channel of the preamplifier. Components in the bias suppy, R_2, R_3, R_4, C_2, C_3, D_1, D_2 and also C_{12}, are not repeated in channel 2. All electrolytic capacitors are rated at 40V and all resistors are ¼W unless otherwise stated.*

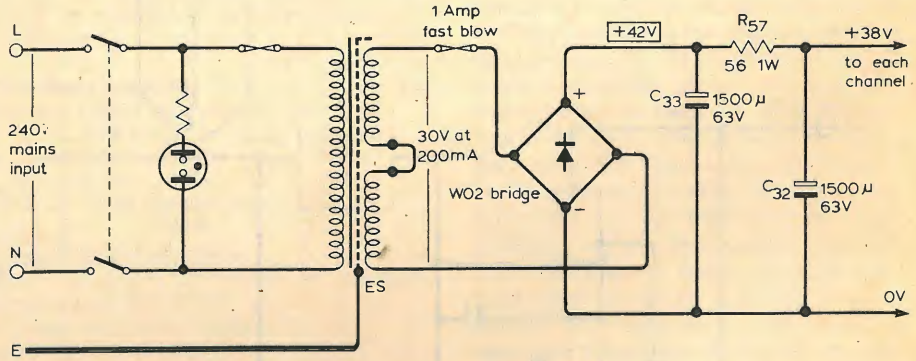


Fig. 5. *Power supply. If a higher voltage transformer is used, R_{57} should be increased accordingly.*

10kHz before overloading. It is felt that the improvement these figures show over conventional methods justifies the complication of a low-gain disc input stage. The accuracy of the RIAA equalisation depends on how closely the RC time-constants can be set. If 5% components are used the deviation should be less than ±0.5dB from 1kHz to 15kHz, and within ±1dB from 20Hz to 20kHz. The signal-to-noise ratio for a 5mV r.m.s. input at 1kHz is better than 68dB.

The remaining part of the preamplifier comprises an active gain-control and the tone-control stage. The input switching is simple and requires only one switch section per channel. Also, any line input of suitable sensitivity can be used as a tape monitor return.

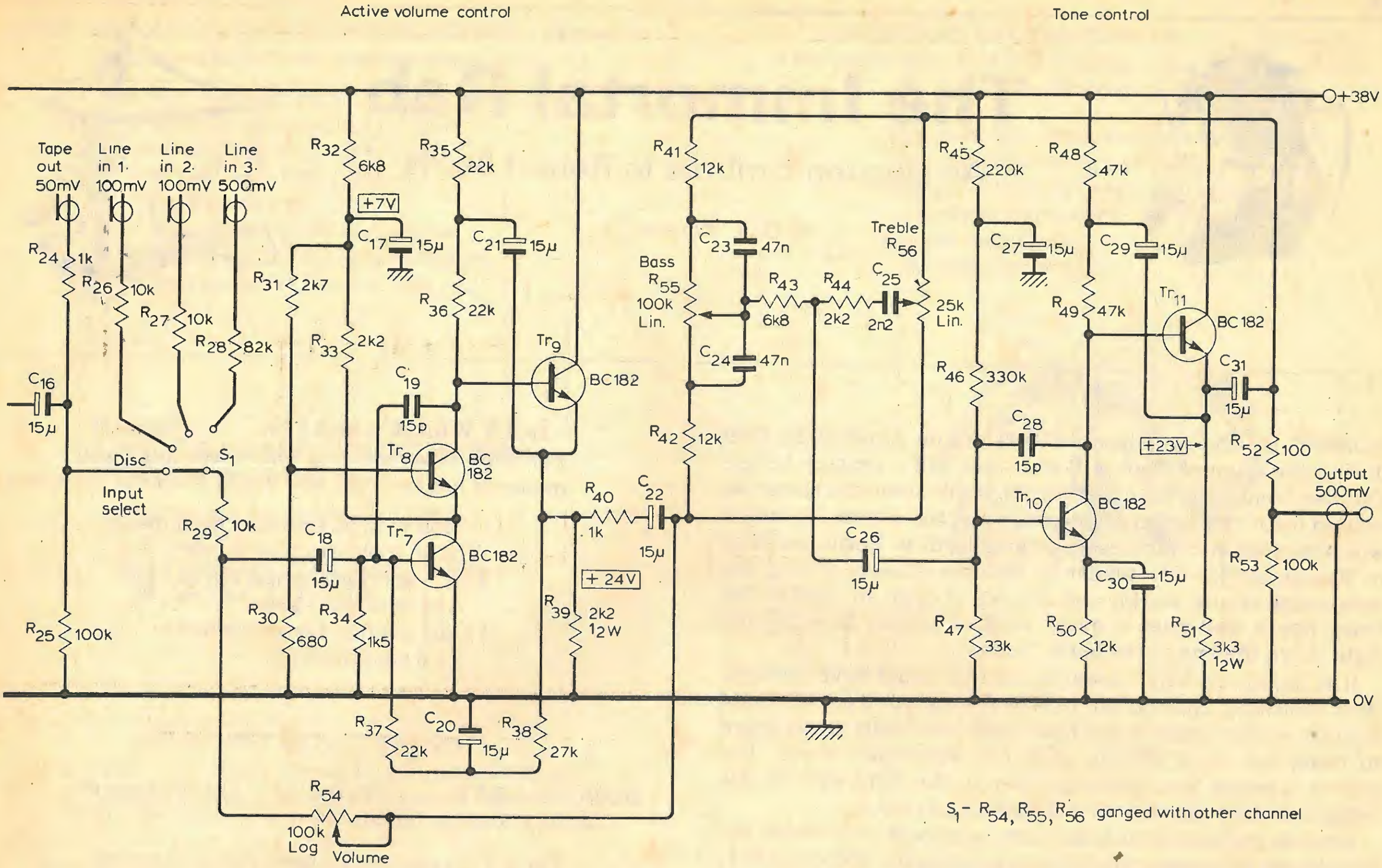
The shunt-feedback configuration of the active gain control enables each line input to have its sensitivity defined by the value of a single series input resistor. The maximum voltage gain available from the stage is the ratio of the feedback resistance to the input resistance, and is +20dB when the volume control is at maximum resistance. This gain is only used in the disc mode. The most sensitive line input is rated at 100mV for a 500mV output and the least sensitive input has unity gain. Any sensitivity between these two limits may be provided by using the appropriate series resistor value.

The gain control comprises Tr_7 and Tr_8 arranged as a cascode voltage amplifier with a bootstrapped collector load and Tr_9 as a conventional emitter-follower. The d.c. conditions are set by negative feedback through R_{37} and R_{38}, and a.c. feedback is applied through the volume control. The linearity of this circuit is increased by a current injected into Tr_7 through R_{33}. The voltage at the top of R_{33} and the potential divider R_{30}, R_{31}, is smoothed by R_{32} and C_{17}. Resistor R_{40} prevents high-frequency instability when the volume control is set to zero gain.

The tone-control is a conventional Baxandall circuit, with Tr_{10} providing a high voltage-gain by its bootstrapped collector load. Transistor Tr_{11} is another emitter-follower which buffers the high impedance at the collector of Tr_{10}. The output is taken through R_{52}, which protects the output against short-circuits. Because the output impedance is low, long cables may be used without loss of high frequencies.

Construction

Normal precautions should be taken to keep a.c. power away from the disc input stage, and to avoid earth loops. The leads to R_{54} should be kept short to prevent hum pick-up on the virtual-earth point of the gain control. Typical voltages for various parts of the circuit are shown in Fig. 4. These measurements should be made with a 20kΩ/V meter.



Several modifications can be made to the preamplifier to suit individual requirements. Firstly, the treble turnover frequency of the tone-control section can be increased from 2kHz as shown in Fig. 4, to 5kHz, for example, by reducing C_{25} to 1000pF. For variable turnover frequencies C_{25} can be made switchable. Some purists may feel that the provision of a tone-control is unnecessary, and even undesirable. In this case, the output should be taken from the junction of C_{22} and R_{54}, but R_{52} and R_{53} should be retained at the output. Because the current drawn by the preamplifier will now be less, it is advisable to raise the value of R_{57} to keep the supply rail at +38V.

In the circuit of Fig. 4, no balance control is included. This function was performed in the prototype by a dual-concentric volume control. If, however, a conventional balance network is required this can be added at the output of the preamplifier although the low output impedance will be sacrificed.

Printed circuit board

A glass fibre p.c.b. which accommodates two audio channels is available for £5.00 inclusive from M. R. Sagin at 23 Keyes Road, London N.W.2.

Reference

Self, D., Advanced preamplifier, *Wireless World*, Nov. 1976, p.41.

The author

Douglas Self studied engineering at Cambridge and also obtained an M.Sc in experimental psychology at Sussex University, where he examined the perception of speech, and some related problems of psychoacoustics. In 1974 he entered the audio industry as a design engineer and has been involved in the development of a wide range of audio equipment. He has spent the last few years working for Electrosonic Ltd, where he designed several types of audio mixing desk. More recently, Doug has been engaged in the design of high-quality audio modules for the home construction market.

BOOKS RECEIVED

A First Course in Computer Technology, by Michael Hartley and Martin Healey, looks at the subject of computing in broad outline, introducing the complete range of computing systems and techniques; each being treated in sufficient depth to afford a good grounding for more advanced work. The first chapter is a particularly interesting and useful survey of the development of computers from Babbage to integrated-circuit microcomputers and is immediately followed by a general section which provides a rationale of computers and computing; with a look at the organization of component parts in a typical system. Further chapters continue with more detailed exposition of computer systems and the development and handling of software, the final section being devoted to calculators and microprocessors. Many of the chapters contain problems for the interested reader to solve, and each chapter has a useful set of references, particularly that concerned with computing history. The book is published at £4.95 in paperback by McGraw-Hill Book Company (UK) Ltd, Shoppenhangers Road, Maidenhead, Berks.

Video Yearbook 1979 is a mass of information, compiled in a way that allows relatively easy access to a large variety of equipment references. All types of equipment which could possibly be collected under the "video" umbrella are covered, together with a glossary of jargon and several lists of programme production companies, organizations and services. The second part of this fairly expensive, 545-page yearbook is devoted to indexes of addresses, abbreviations and commercial information. Angus Robertson edited it. Blandford Press, Link House, West Street, Poole, Dorset BH 15 1LL. Price £12.50, only in hard back.

The Immortal Rab

An electronic tribute to Robert Burns

by D. T. Walker

ROBERT BURNS was born in Ayrshire on January 25, 1759 during the reign of George II and over half a century before Faraday conducted his experiments. In his colourful career he poured forth all manner of ode and lyric, the content of which was adequate in comradeship to give birth to Burns societies in Russia, sufficiently tender to become classics among the love songs of the world, and diverse enough to display the fears, hopes, and grief in every walk of society from royalty right down the line to the lowly "louse".

It is highly unlikely, however, that he could have foreseen their following application, in which excerpts from his more popular works (and others) have been minimally re-arranged to bring out their affinity with our electronic world. The author, a fellow Scot, presents them in this light with all due respect to the poet's immortal memory.

English readers with computer access should resist the temptation to process the following into it for decoding. ICL, IBM and the like would never forgive you. Any self-respecting library will provide a glossary of terms.

ADDRESS TO THE DE'IL (Verse 3)

To those with transmitters and morse keys

Great is thy power and e.r.p.
Far kenn'd and noted for f_c
Makes spots and splurges on tv
Stops housey housey
But faith thou are baith lag and lame
Your morse is lousy

UP IN THE MORNING EARLY

and again

Up in the mornin's no for me
This field day stunt's too early
Who plugged my transformers into d.c.
And tried my patience sairly

THE EXCISEMAN (To the tune . ....)

To the hams among us

CQ among the QRM
Captured by the DX man
His XYL cried "its only a 'G' "
Why don't you sell your TX, man

You M.O's off tune, your aerial's doon
Your feeder's mis-matched, DX man
Why don't you sign off, you muckle great loon
And try out a new CX, man

HOLY WILLIE'S PRAYER (Verse 1)

For those who replace aviation warning lights on masts (and oil rigs) and a plea from our storemen

O thou who up the mast doth dwell
Wha as it pleases best thysel'
Tak a' oor mast lamps, ten or twel'
And cock your snoot
I must confess I wish tae hell
Ye'd sign them oot

DUNCAN GRAY (Verse 1) (To the tune of .....)

To the television broadcasting engineers among us

The S.S.E's (or S.M.E's) cam here tae tweek
Ha, ha, the tweekin' o't
With S.B.A. he looked real chic,
Ha ha, the tweekin' o't.
With pulse and bar, and staircase too,
We'll soon be on full power the noo,
Ye've never sung a song more true,
Ha, ha, the tweekin' o't.

TO A MOUSE

Valves (No 1)

Wee sleekit 4CX250
Oh what a panic's in thy breastie
Don't go into self-osc. sae hasty
Wi' parasitics
I wad be laith tae hae tae 'neut' ye
Wi' electrolytics

ON A SUICIDE

In memory of valves (No 2)

Earthed up here lies an imp o' hell
A parasitic 807
Poor silly tetrode's damn'd himsel'
And missed the gates o' heaven

TO A HAGGIS (Verse 1)

In a moment of huff towards chief engineers with parallel operated transmitters

Great puddin' o' the chieftain race
O' what a frown is on thy face
Man, dinna glower
Tae save ye frae complete disgrace
There's aye half power

FIRST BALLAD ON MR HERON'S ELECTION (Verse 1)

Dedicated to the P.O. engineers among us

Whom will you send to London town
To Gresham Street, and a' that
Wha in a' the country round
Will get 'exec' and a' that
For a' that and a' that
We upward grind and a' that
Where is the laird or belted knight
Who'll make H.Q. and a' that

A BOTTLE AND AN HONEST FRIEND

Valves (No 3) and hams

Here's a bottle, an honest friend
A 4CX250
Wha' ken's before its life may end
My share o' CQ's nifty

THE HENPECKED HUSBAND

Some sympathy for those among us whose DIY efforts are denied free rein on the living room table

Cursed be the ham, the poorest wretch in life
The crouching vassal to the tyrant wife
Who without her say has no transmission
Who has no 807 but in her possession.
And if a junk sales dare buy or sell
Suffers domestic ragchew from his XYL
Were such the wife had fallen to my part
I'd break her spirit or I'd break her heart
I'd charm her with the magic of a switch
And some kV's, and electrocute the bitch!

TO A LOUSE (2nd and last verse)

Speaking generally

Ye ugly creepin' blastit sneaker
Detested, shunned by true fault seeker
Ye electronic duff gen reeker
O' simple brain
Awa and plop that itchin' tweeker
And pu' the chain

Oh wad some power the giftie gie us
Tae see oorsel's as ithers see us
It wad frae mony a blunder free us
And foolish notion
Technical incompetence will lea'e us
Nae promotion

ADDRESS TO THE TOOTHACHE (Verse 3)

For union members and productivity deal enthusiasts, and those who like their annual 'flu jag

When temper burns and goodwill freezes
Well injected 'gin the sneezes
Instead o' workin in their threeses
Staff outwards drift
Comes then the hell o' a' diseases
The two man shift

TAM O'SHANTER (Verses near the end)

For those of us with unattended stations to maintain by mobile maintenance teams

The station had barely made its mark,
When in an instant all was dark,
And scarce the teledac had rallied,
When out the hellish legion sallied.

Like bees wi' low intent they thundered,
In their Austin 1800,
Alang the roads, ower field and dyke,
Assail'd the gremlin in their byke.

Once more translators wail and banter,
Like Tam, playin' dirges on his 'shanter'.

AND FINALLY . . .

Needing no introduction

Should auld acquaintance be forgot
When gaun to ither station
Should auld acquaintance be forgot
When spread throughout the nation
With you I've climbed promotion's ladder
An' pu'd the switches fine
But we've wandered many a weary shift
And separated syne.

LETTERS TO THE EDITOR

ESSEN-TIALS OF RELATIVITY

It is about 15 years since Dr Essen and I last aired our different views on the merits of Special Relativity (*Nature*, 203, 395-6, 1964), and though it is clear from Dr Essen's article that there is still a difference in our fundamental beliefs, I must concur with some of his comments in the October issue of *Wireless World*. In particular I agree that students have had to swallow a lot of dogma and that relativity has become too much the province of mathematicians.

I further agree with Dr Essen that there are many cases when the *observed* rate of timekeeping is given by the relativistic Doppler shift and not simply by the second order dilatation factor. As an example of this I can quote an example erroneously interpreted by the science correspondent of the *Daily Telegraph* on 16th April, 1978. Adrian Berry described "What a high speed astronaut would see when travelling towards the earth, if by means of a fabulous telescope he could watch the hands of Big Ben. He would see the hands move round very slowly, just as he would see them move on his outward trip". Now this is pure nonsense, a high speed astronaut travelling *towards* the earth would see the hands of the clock of Big Ben spinning round very rapidly indeed and not very slowly as claimed by Adrian Berry. Mr Berry forgot the relativistic Doppler shift which includes the time dilatation that he was trying to illustrate but which also contains a predominant term proportional to the velocity of approach. Adrian Berry's example would have been perfectly correct if he had stated that the astronaut was *passing* the earth but not if he was approaching or receding. When I wrote to Adrian Berry pointing out his slip he replied "I must tell you that I absolutely stand by what I wrote". So much for spreading the gospel of true science!

There is much of Dr Essen's article with which I cannot agree but I will take up just two points:

(i) "more ticks are transmitted than received"; this is not correct, the length of time for which the whole series of ticks is received varies proportionately and the total number of events is conserved.

(ii) "Einstein's prediction contains no mention of the ordinary Doppler Effect"; this is a remarkable statement; Einstein *derived* the electromagnetic Doppler effect in his 1905 paper and showed that it differed from the classical Doppler effect by the second order term. I quote directly from his paper:

"... the frequency ν' of the light perceived by the observer is given by the equation

$$\nu' = \nu \frac{1 - \cos \phi . \nu / c}{\sqrt{(1 - \nu^2 / c^2)}}$$

This is Doppler's principle for any velocities whatever. When $\phi = 0$ the equation assumes the perspicuous form

$$\nu' = \nu \sqrt{\frac{1 - \nu / c}{1 + \nu / c}}$$

We see that, in contrast with the customary view, when $\nu = -c, \nu' = \infty$."

It is possible to take this equation as a starting point for the whole of special relativity and it then appears much more homely than the usual formal approach of progression from the rather abstract Lorentz transformations. There is an unfortunate tendency to regard special relativity as a formal discipline and general relativity as a separate discipline, whereas both are really only a small part of the science of measurement. Common sense relativity recognises no barriers. It is surprising how much can be derived by using simple physics, the invariance of the local (two way) speed of light and Euclidean geometry to account for and predict local observations. This has had much success in the treatment of kinematically accelerated systems where formal special relativity is not strictly valid and where general relativity is entirely the wrong tool, for it can be applied only by invoking the equivalence principle from which general relativity itself was derived.

R. C. Jennison (Professor)
Electronics Laboratories
University of Kent at Canterbury

SPECTRA OF TONE BURSTS

I note that Mr C. F. Coleman has replied, in your December 1978 letters, to my explanation of the tone burst signal published in June 1978. Mr Coleman still pins his faith on some quoted formula, when it is his own interpretations that should concern him. He does not accept, even intuitively, that when the carrier sinewave is shifted an amount h with respect to the start of the burst, this must produce a change in the phase spectrum of the carrier which is essentially equal to h, with proportionate, linear, phase changes in all other harmonic terms. He cannot deduce, even with his presently restricted knowledge and a little common sense, that the value of the function at the start of the burst, sin (h), could not possibly be arrived at from the tiny amplitude and phase changes to which he refers.

I now see that Mr Coleman does not begin to understand that an audible phase effect results from an *instantaneous* spectral amplitude change, which may also be viewed as a change in the time description of a signal. He points, instead, to the spectral amplitude changes due to a small order term in the expression for the tone burst spectrum as being significant, and insists that the dominant term in this expression is to be ignored. Far worse than his mistaken belief is the totally false argument, accusation and theory that he provides to support it.

He dismisses the linear phase shift mentioned above because he says it results from, and is equivalent to, a translation of the entire tone burst function by a time corresponding to h. He then suggests that my undergraduate has confused the two and made an error in his computation.

It was quite clear from my analysis, and made as clear in an earlier letter (July 1977) that it was the argument of the carrier that was varied, not the position in time of the total function. This is confirmed by my undergraduate, who says that "no mistake was made; the computation involved sampling the signal over its fixed period, using the starting point as reference zero, which does not change as h is changed".

Mr Coleman's false accusation does not conceal his totally false argument that a shift of the carrier with respect to the square wave is equivalent to a time translation of the total function. In the former case, the one I have demonstrated, the reference zero is preserved, the waveform changes and with it the *instantaneous* amplitude spectrum of the signal. In the latter case, any reference time is lost (Coleman certainly ignores it), the waveform does not change and so its instantaneous spectrum is preserved. The phase shift I have demonstrated does not greatly affect the amplitude spectrum of the tone burst, but it importantly and audibly affects the amplitude spectrum with *time*, as is evident in the 'running' transform of the signal, a concept of which Mr Coleman is totally ignorant.

We have long since formed the impression that Coleman's views are unaffected by experience (for they are not even theoretically sound), but we can and do challenge him, or any more informed reader, to provide evidence that the minute effects he favours could be reliably reproduced, let alone detected, in preference to the changes we have demonstrated both in the theory and experiment.

If any further indication is needed of Coleman's shaky hold of this subject, it is surely to be found in his penultimate paragraph (still December 1978 letter). In this, his latest example of hand-to-mouth learning, he asserts that my analysis 'collapses' because I do not consider every ω (as the transform requires!) in my approximation for the physical spectrum. In fact for all real functions f (t), the transform has the property that $F(\omega)$ and $F(-\omega)$ are conjugates, with identical modulii, so that in general $f(t)$ may be precisely recovered from its transform by considering only positive (physical) values of ω, in the inverse relation

$$f(t) = \frac{1}{\pi} . \text{ Real } \int_0^\infty F(\omega) . e^{i\omega t} d\omega .$$

We do not suppose that Mr Coleman will be any the wiser, but perhaps a little better informed.

Roger C. Driscoll
The Polytechnic of North London
London N7

DISPLACEMENT CURRENT

The explanation given by Messrs Catt, Davidson and Walton (December 1978, p.51) of the flow of current 'through' a capacitor without resorting to Maxwell's concept of displacement current is attractive to me, because notwithstanding my immense respect for Maxwell I have always felt that displacement current was a kind of subterfuge to get over a logical difficulty*. But before wholeheartedly accepting this alternative I would like to be given certain reassurances.

At the foot of column 1 the authors point out that the parallel elements of the disk capacitor depicted can be regarded as transmission lines whose characteristic impedance (Z_0) is continuously decreasing towards the far end. So there would be gradual reflection all the way. But in the mathematical proof Z_0 is treated as constant and there is reflection only at the far end. This made me feel I was being conned.

According to Ampère's Law, the connecting leads carrying the charging current must be everywhere encircled by a magnetomotive force numerically equal to the current. In the authors' Fig. 1 the leads are horizontal and the plates are in vertical planes, parallel to one another and also to the n.n.f. around the leads. But what about the m.m.f. in the space between the plates, due to what we have become accustomed to calling displacement current? This current, being a continuation across the capacitor gap of the external circuit current, one naturally sees its m.m.f. also as in a vertical plane. Can the authors show clearly how this follows from the geometry of their transmission line currents, which flow everywhere at right angles to the current in the leads? This aspect is of some importance, since the propagation of radio waves depends on it. Can the authors convincingly get rid of displacement currents in space?

M. G. Scroggie,
Bexhill,
Sussex.

*But I never had, or heard of, a difficulty created by imagining current having to flow across the capacitor plates faster than light. Where did the authors get that idea? And why wouldn't it apply also to the current in the leads?

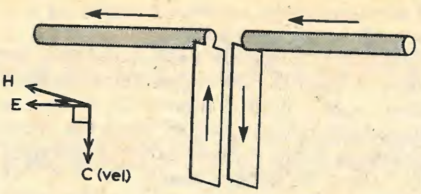
The authors reply:

The article discusses a circular capacitor. The appendix discusses a rectangular capacitor in order to minimize mathematical complexity. The appendix proves that if a voltage source is switched across a resistor and a rectangular capacitor in series, a waveform results which approximates to an exponential. As Mr Scroggie points out, it does not prove the same for a non-rectangular capacitor.

If you ask us to resolve paradoxes in classical theory, you are asking us to say that we are saying nothing that is fundamentally new; you are asking us not to publish anything. Do you believe that "new" information is only acceptable if it indicates no flaws in the conventional wisdom, i.e. if it is not really new?

As to the m.m.f. in the space between the plates, this have never been measured. If it had been measured it would have been found to be non-uniform, and the revered B. I. Bleaney and B. Bleaney ("Electricity and Magnetism," Clarendon, 1957, p.238) and others would not have written ". . . . the field in between the plates is uniform . . .", which of course it is not; a TEM waveform advancing between the plates of a capacitor (≡ transmission line) creates a field behind itself but not ahead of itself.

The last paragraph of Mr Scroggie's letter is crucial. If the capacitor were rectangular and oriented much as shown in our Fig. 1(c) then no m.m.f. in the vertical plane would result from current in the capacitor plates. Vertical m.m.f. would mean that the waveform was not TEM, but we know that it *is* TEM and travelling vertically downwards between the capacitor plates. That is, *E* and *H* fields are at right angles to the (downwards) direction of propagation, and therefore are horizontal. This is no more paradoxical than trying to apply Ampère's Law to a TEM step travelling along any transmission line.



Ampère did not know that a TEM wave ($E \times H$) travels forward between two wires at the speed of light. He did not know that a capacitor is a transmission line; he did not know about transmission lines.

These matters will be discussed further in a forthcoming article in *Wireless World*. A paper "The Heaviside Signal" will further clarify the situation (see "Electromagnetic Theory Vol 1," published by C.A.M. Publishing, 17 King Harry Lane, St Albans).

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

Further letters on this subject will be published later. Ed.

FERRITE ROD AERIALS

I have been reading with interest the article by Professor H. Sutcliffe in your December 1978 issue entitled "The effective length of ferrite rod aerials." The lack of treatment in the literature which Professor Sutcliffe finds is perhaps due to the fact that he appears to have renamed the parameter which is usually known as effective height. His own result seems to incorporate the Q factor for the resonant circuit in the form of a loss resistance so that the figure he arrives at is about 100 times the usually quoted results. The reader concerned with the design of ferrite rod aerials is recommended to refer to the article by Mr W. A. Everden in *Wireless World* September 1954, pp.440 to 444, which contains a number of useful graphs and information which enables the effects of different rods and coils to be calculated.

N. C. Helsby
Department of Electrical Engineering Science
University of Essex

Professor Sutcliffe replies:

I agree with Mr Helsby that 'effective height' is in more common use than 'effective length' in expressing the relation between an electric field strength and the voltage in a circuit associated with an aerial. Nevertheless the word 'height' with its suggestion of elevation above ground or sea level appears to me to be misleading when applied to radio receivers with ferrite rod aerials and would be incorrect for horizontal polarization. With regard to the second comment it is of course important to distinguish between the two definitions of circuit voltage, the coil e.m.f. or the capacitor voltage at resonance, and as Mr Helsby points out these are in the ratio I:Q. The article by Everden (*WW* Sept 54) certainly provides detailed information for designers but it uses the wholly artificial concept of 'effective permeability' which has to be presented by graphs and charts as a function of several variables. I believe that the concept of 'equivalent magnetic dipole length,' with an associated current generator Hl/n across the n turns of the coil, is simpler and more useful. As I pointed out in my article, l is in practice about one-third of the full length of the rod. If the equivalent circuit in series form is preferred then the Thevenin-Norton theorems show that for coil inductance L the corresponding magnitude of series e.m.f. is Hl/n times ωL. Since L is proportional to n^2 the e.m.f. is proportional to n as we expect from the concept of linked flux.

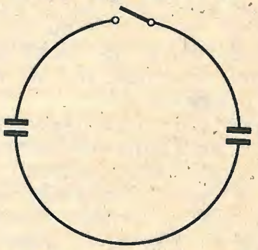
H. Sutcliffe

"DID YOU KNOW?"

Despite having found Epsilon's article in the December 1978 issue most interesting, I feel that the explanation of his problem concerning two parallel capacitors (Fig. 1) is rather obvious.

Two different perfect voltage generators connected in parallel produce an indeterminate resultant voltage. The same applies to two similarly connected capacitors, because a charged capacitor is initially a voltage generator. Therefore Fig. 1 is a mathematical impossibility (?!)

Furthermore, while it may be possible to achieve zero circuit resistance *and* have a perfect switch, inductive effects will *always* be present. Hence Fig. 1 becomes



which is an LC loop and this will allow the energy difference to radiate away into the surrounding space, without violating any of the two laws mentioned in the article.

P. Holy
Worthing
Sussex

Editor's note: We have received other letters commenting on this article but are waiting till the author (who lives abroad) can reply before we publish them.

"SOFTWARE DABBLERS"

I would like to comment on the article "Software dabblers may take over electronic system design" in your (December 1978 issue, p. 49) concerning Professor H. Barker's comments on the lack of circuit design technique required in today's digital systems.

I would agree that the number of discrete components within a system has diminished drastically; however, I cannot admit that circuit design technique suffers to the extent expressed in the article. Indeed modern Schottky t.t.l. requires that good r.f. practice be introduced into circuit design and layout. Many new techniques have evolved simply due to the fast edge speeds and data rates of logic signals.

Professor Barker than moves on to 'software' and expresses concern over its general availability; is this an application of the old adage 'A little bit of knowledge' or is he worried over some form of non-professional encroachment into the subject? Unfortunately the second seems to hold sway, as he goes on to say that dabblers contribute nothing with their amateur approach. This I cannot hold with; very often it is the person 'dabbling' in a subject, other than his own, who will make important advances in knowledge.

As to the professor's call for unification, I would go further, and unify the 'hardware' and 'software' design functions as much as possible; very often a lack of communication between these two areas causes many unnecessary problems. A typical example of this co-ordination would be in the design stage of some form of computer using micro-programming techniques. The software requirements, in terms of instruction set, would be the guidelines followed in the hardware design and vice versa.

The professor also states that many engineers would be quite happy for 'software' to start and end at assembler level; why not? High level languages tend to separate the engineer from the hardware he is trying to control.

Finally, it must be asked, is the professor falling into the 'technology trap', a psuedo-religion based on the 'worship' of high technology; expressed in buzz words, total devotion and the exclusion of the untrained? This trap will finally spring when we are unable to see that our rate of pure advance is almost non-existent, we console ourselves with merely re-decorating the things that have already been invented, and use new terminology to hide the fact.

"The architecture of the modern computer is not significantly different from those of the 1940s" *(Computer Worship;* I. Catt.).

We must remember that man has, up to now, survived by being non-specialist; specialism could be the modern ice age, bringing with it stagnation.

M. A. I. Wilson,
Swindon,
Wilts.

ELECTRONIC ORGAN TONE SYSTEM

Dr Ryder is to be congratulated on his interesting and elegant design for an electronic organ tone generating system (October issue) using additive synthesis techniques. However, I feel he dismisses rather too readily the alternative technique, that of subtracting unwanted harmonics from a complex waveform such as a sawtooth. He justifies this by commenting on the variations in loudness and tone quality which occur if a single tone-forming filter is used for each stop. These effects do, of course, occur but there are various well known ways to ameliorate the situation. Also (and contrary to what he says) many pipe organ stops exhibit similar effects!

Whilst I cannot enter here into lengthy debate over the pros and cons of additive versus subtractive synthesis, the constructor who is contemplating building an electronic organ would be well advised to pursue the matter further before he begins to invest heavily in hardware. In particular I would emphasise the following points:

1. A chorus of fully preformed tones using subtractive (e.g. diapasons of pitches 16, 8, 4, 2⅔ and 2 feet plus mixture) is very much more satisfying than the equivalent number of sinewave ranks, which sound cloying and "electronic" by comparison.
2. The "bite" of the reeds and mixtures of the classical organ is quite impossible to simulate using only a limited number of sinewave pitches per key, particularly when the upper frequency limit of the instrument is only 10kHz as in Dr Ryder's design.
3. The subtractive technique enables some delicate and beautiful effects to be obtained using resonant circuits which imitate the characteristic formant bands of real organ pipes or orchestral instruments. This is not possible with a sinewave instrument, where realistic synthesis is limited to flute and possibly diapason sounds.
4. In general, stops can be combined more successfully with a subtractive tone system than with an additive one. This facilitates a better imitation of the tonal building possibilities of the pipe organ.

These points can best be illustrated by comparing a sine-wave organ tonally similar to Dr Ryder's (e.g. a sine-wave Hammond) with one of the many subtractive instruments in existence. Local dealers are usually most accommodating!

Finally, having designed and built an organ using subtractive tone forming methods, I am convinced that the extra complexity required to generate sawtooth waves is amply justified, and that my preference for this method stems from practical experience and not mere academic considerations.

C. E. Pykett
Malvern
Worcs

Dr Ryder replies:
In reply to Dr Pykett's letter, I can only echo his advice to hear as many organs as possible before investing. One lesson I have learnt is that it is not possible to say generally that one method is good and another bad. Almost everything depends on the finer points of design, and good results are not achieved without attention to detail. (Perhaps this is where the home constructor has a real advantage.) In my own case, I concluded that a modernised synthesis approach offered the most direct – and economical – route to a "musical" instrument, especially one using full-size keyboards, and the prototype has not failed to please those who have played it, by now a considerable number. The limitations of this particular design are quite specifically mentioned in the articles, but this does not mean that the synthesis method is itself limited, as witness the achievements of Compton. (In my view, Hammonds are not comparable.)

Amongst the options, there is a brief discussion of the use of pulse waveforms, subtractively filtered, primarily to help with reed tones. Mixtures do not present the same problem, and sparkling upperwork can be obtained even with pure sines limited to 10kHz. This is one object of the suggested coupling circuits.

The combining of stops is a subtle effect, depending on many aural cues, and again, I do not think one can safely generalise. Too-perfect blending is undesirable, and small frequency/phase differences, such as result from using more than one set of generators, are probably more important than precise waveforms. I have not seen a satisfactory discussion of this question, which would have to start by defining some rather elusive concepts.

I confess that I am much concerned with regulation and balance which, like evenness of touch, are important ingredients of a satisfying instrument, perhaps more important than is generally realised. I did not say that all pipe organs are satisfactory in this respect, but the better they are, the less obstacle there is between the player – or listener – and the music. Pipe organs are regulated in detail to suit their final siting; electronic organs also have the loudspeaker problem, and it was a particular object of my design to provide for note-by-note regulation as well as overall balance. In this respect, a sinewave Hammond, as suggested by Dr Pykett, may not be heard to the best advantage. I am not familiar with all their models, but I believe that some at least had only a limited number of frequencies, and so "borrowed" the harmonics, a practice which does appear to contribute significantly to an "electronic" sound. It also weakens the effect of deriving mutations from another department, if indeed this was done by Hammond. I really must protest against Dr Pykett's suggestion that my design may be judged by listening to a veteran electro-mechanical instrument in a music shop! For obvious reasons I have made available a recording, but I am arranging personal trial where it is practicable.

The judgement of value for money/effort must be an individual one. I personally believe that the additive method is the most effective, but there is no reason why subtractive voices should not be used as well, perhaps based on pulse waveforms, which are easily generated and keyed. My design is essentially a foundation to build on, and I hope that in due course constructors will be able to communicate improvements they have made.

David Ryder

RADIO AMATEURS' EXAMINATION

I feel I must reluctantly disagree with Pat Hawker (October issue), and try to ease the minds of would-be candidates. The new examination is not more difficult, but it does cover the whole syllabus.

Valves have been left out for two reasons: there is already plenty of material in the syllabus; and valves (with few exceptions) are out of date.

Your readers should not be alarmed by the use of microcoulombs. On page 61 of your October issue I read "The capacitor is of course a component for storing charge, $C = Q/V \ldots$". Knowing this equation and the meaning of μ, a candidate will find the question to be quite easy. (Perhaps some of your advertisers should take a course of instruction. Whilst PF and pf are absurdities, the use of mF as a trade description could lead to an error of 1000 times!) Incidentally the instrument on page 61 is marked "Capacity". When I was a lad we measured capacity in jars!

Let us get up to date! According to the Advisory Council for Applied Research and Development, "all the available evidence suggests that only 5% of British firms are aware of and are exploiting the new semiconductor technology".

I'll now go and listen-in on my Japanese solid-state wireless set.

G. C. Oxley
Chesterfield, Derbyshire

Microwave duplexing for radar systems

And a discussion of mixer noise in radar receivers

by **Alan G. Hood,** M.Sc., M.I.E.E. Kingsway Technical College, Dundee

WITH FEW EXCEPTIONS pulsed radars have always used some form of TR-cell duplexer[1]. The TR cell is a resonant chamber filled with an appropriate mixture of gases at low pressure. A coupling aperture or window is provided at either end sealed with a dielectric which is usually glass but occasionally ceramic.

The two main types of cells are narrow-band but tunable, and broad-band fixed tuned. The tunable cells consist of a re-entrant resonant cavity with non-resonant windows, while the broad-band type have resonant windows with one or more resonant irises suitably spaced along the waveguide body. Breakdown gaps are provided in both types of cell, and to ensure rapid ignition at high power, a supply of ions is maintained in the gap by a continuous weak auxiliary discharge. This discharge requires an extra electrode, known as the "keep-alive" or primer which draws about 100 μA from a high impedance d.c. source. A small quantity of radioactive gas, usually tritium, included in the gas filling also acts as a primer.

In the gaps the electric field builds up to a much greater intensity than in the normal waveguide. If the field in the gap is insufficient to cause breakdown, as in the case of the echo signals, the cell transmits the incident wave from the antenna in its frequency band to the receiver with little attenuation. Under the influence of the transmitter pulse, however, the cell becomes intensely ionized. A plasma usually forms across the input window and the de-tuning effect reflects almost all of the incident r.f. power effecting a switching action which connects the antenna to the transmitter.

On de-ionization, the antenna is again switched back to the receiver. Ionization time is very short, while de-ionization or recovery time may be several microseconds or longer. The recovery characteristic of a duplexer determines the short-range performance of a radar. Too long a recovery period will prevent detection of small targets at short range, while too short a recovery time may result in receiver overload with short-range targets.

The branched duplexer and the balanced duplexer are the most widely used gas tube duplexers. The branched duplexer shown in Fig. 1 uses a TR cell together with a second gas-filled cavity resonator called an ATR cell placed on a stub line, or directly in the wall of the main line, between the transmitter and the branch leading to the TR cell.

During the transmission period both cells ionize and cause little reflection of the transmitter wave. The ATR cell is resonant at the transmitter frequency and it is tightly coupled to the input line. As a result a high standing-wave ratio for low-level signals is produced in the main line between the TR cell and the ATR cell. The spacing between the two branches is chosen so that the received signal power is coupled into the receiver with little reflection or absorption due to the line terminating in the transmitter.

The branched duplexer has certain

The need for duplexing

The applications of modern radar are vitally important as the eyes of today's complex weapons and navigational systems. In operation, most radar transmitters send out a short pulse of microwave energy, which may strike a reflecting target that scatters it. The scattered wave, still in the form of a short pulse, although very much reduced in amplitude, is picked up by the radar receiver which detects it. The majority of transmitters generate trains of these pulses at peak powers in the range 1k to 1MW. The range of the target is obtained from the length of time between transmission of the pulse, and reception of the echo, while the direction is found from the orientation of the antenna when the echo is received.

The relation between the power P_t of the transmitted pulse and the power P_r of the received echo is well-known as the radar equation, which is

$$P_r = \frac{P_t G A \sigma}{16\pi R^4}$$

where G is the gain, A the effective area of the radar antenna, and the target has a scattering cross section σ. The maximum range R at which a target can be detected is obtained from this equation if the value of P_r corresponding to the minimum detectable signal and the other system parameters are inserted.

It is common practice in radar systems to use a single antenna for both transmitting and receiving whenever possible. This is done not only to ensure collimation of the transmitting and receiving patterns of the small but highly directive scanning antennae used in microwave systems, but to minimize space and weight requirements of the antenna system, a critical factor particularly in airborne system design. To use a common antenna for both transmitting and receiving poses a severe receiver isolation problem because of the extreme difference in signal level between the strong transmitted signal and the feeble echo return from a distant target. Some form of duplexer is required.

The prime function of a duplexer is to protect adequately the vulnerable radar receiver – which generally contains semiconductor devices such as point-contact diodes, Schottky-barrier diodes, tunnel diodes, or varacter diodes – from the paralysing power of the transmitter with a minimum insertion loss to both transmitted and received signals. Because of the extremely fragile nature of the best receiver elements, great effort must be made to achieve adequate isolation. A radar duplexer may be required to isolate a 100kW pulse from a mixer crystal which would deteriorate if exposed to 100mW pulses. This is a power ratio of a million-to-one, indicating the need for more than 60dB isolation between transmitter and receiver for the duration of the transmitted pulse.

Where transmission and reception take place sequentially, as in pulsed systems, this high isolation is achieved using transmitter-actuated gas tube switches of one form or another, usually TR (transmit-receive) cells supplemented in some cases by ATR (anti-transmit-receive) cells, pre-TR tubes, or by solid-state devices such as ferrite circulators or varactor limiters. Duplexing in f.m. and c.w. systems, on the other hand, cannot be accomplished by switching as transmission and reception are simultaneous and continuous; so other means must be sought. Pulsed systems are by far the most common however, and require a duplexing system which is amplitude selective.

Introductory reading

Airborne Radar by D. J. Povejsil, R. S. Raven & P. Waterman. Van Nostrand, 1961.

Principles of Radar by J. F. Reintjes & G. T. Coates. McGraw Hill, 1952.

disadvantages, notably rather limited bandwith. In its de-ionized state the ATR cell presents a serious mismatch to the magnetron, and under certain phasing conditions troublesome "moding" can occur[2]. For this reason the magnetron-to-ATR spacing becomes important in a branched duplexer.

The balanced duplexer now being used extensively offers several advantages. The ATR cell together with its mismatch problem are eliminated, better receiver protection is achieved, and the insertion loss can be lower. The balanced duplexer employs two TR cells suitably mounted between two 3dB hybrid junctions in a bridge arrangement. Several types of hybrid junctions can be used, but the slot hybrid duplexer[3] has found widest acceptance because of its compactness and unexcelled broadband performance. A dual TR cell having a common gas filling is used to obtain best bandwidth through closely balanced characteristics.

The signal path in a slot hybrid duplexer for the transmit condition is shown in Fig.2(a). Transmitter power is split by the 3dB hybrid and on ionizing the TR cells is reflected, but because of the quadrature phase characteristic of the slot hybrid, the power leaves by the adjacent antenna port. After recovery, the received echo signals follow the paths shown in Fig.2(b). The load on the fourth arm of the duplexer serves only to absorb the leakage power during transmission.

★ ★ ★

THE IDEAL DUPLEXER is a matched, lossless three-port device in which the first port couples only to the second, and the second couples only to the third. The microwave ferrite circulator[4], if perfect, would be the ideal duplexer for either c.w. or pulsed radars. In practice, circulators can provide 30dB isolation and insertion losses of a fraction of a decibel up to moderate powers. A duplexing arrangement using a four-port circulator is shown in Fig.3; a differential phase-shift type[5] is commonly used because of its superior power handling capability.

To achieve high isolation the antenna must be exceptionally well matched. The leakage through the circulator will depend more on the quality of antenna match than on circulator performance and is likely to be between 15 and 20dB down on the transmitter power, the shape being essentially the same as the transmitter output except that the leading and trailing edges of the pulse may be slightly modified due to mismatches in the antenna run. A TR cell is used for receiver protection.

The advantage of this duplexing system is that the power incident on the TR cell is greatly reduced, which prolongs cell life. Also, the reduced ionization intensity in the cell improves the recovery time and gives better close-range reception of weak signals. The circulator provides load isolation for the transmitter, as the antenna reflections are absorbed in the fourth port load during transmission.

At higher powers balanced gas duplexers are preferable as the insertion loss of a circulator increases with power level due to ferrite non-linearity. TR cells may be used alone at peak power levels of up to about 100kW, depending on the frequency band and the life required from the cell before replacement. At higher levels it is advisable to use pre-TR tubes which reduce the power incident on the cell and provide the extra isolation needed with the higher power. The pre-TR tube is very often a sealed coaxial quartz tube with a low-pressure gas filling and is used mounted in an iris across the waveguide.

Recently a solid-state device has been proposed which may ultimately be competitive with the TR cell at the lower power levels. Lax & Button describe an X-band ferrite-varactor limiter[6] which operates up to 10kW and has a leakage comparable with a TR cell.

To obtain a deeper insight into duplexing and receiver diode burn-out a discussion of radar receivers is needed.

Noise figures of radar receivers

Microwave radar receivers[7] must be able to detect the weakest possible echo signals from distant targets which may be comparable with, or even weaker than, the noise in the system. The level of atmospheric noise is very low, so it is essential to do everything possible to reduce the receiver internal noise, and to reduce losses in the input circuits. Almost every common type of receiver has found application at some time, but the superheterodyne receiver embodying a point-contact diode mixer[8] is now used almost universally.

Crystal mixer development has been the subject of a great deal of effort, and until recently no microwave r.f. amplifier to precede the mixer could be made to give a better overall receiver noise figure than a crystal mixer used directly. Because of the conversion loss associated with the passive mixer, the noise figure is fairly high, and an intermediate frequency in the range 30 to 60MHz is usually chosen to achieve the lowest-noise i.f. amplifier.

The noisiness of a crystal mixer is characterized by the amount of noise produced by the mixer compared with the noise from a resistance at the same temperature, expressed as a noise temperature ratio t_m. The noise factor of a superheterodyne radar receiver is

$$F_{rec}=1+\frac{T}{T_a}(L_t-1)+\frac{T}{T_a}L_t[(t_m-1)+(F_{rF}-1)]$$

assuming a negligible noise contribution from the local oscilator which is realistic if a filter or a balanced mixer is used. In this expression t_m-1 is the excess noise of the mixer, $F_{IF}-1$ is the excess i.f. amplifier noise, and L_t is the product of the conversion loss of the mixer and loss in the microwave transmission circuitry between the antenna and mixer expressed as a power ratio, T is the temperature of the receiver, T_a is the temperature of the antenna, and noise figure is $10\log_{10}$ of the noise factor. A radar receiver is however connected to a directional antenna which can be represented as an equivalent generator at less than room temperature when the antenna is directed toward space. An antenna temperature under this condition may be about 4°K, and from the above equation the noise figure of the best radar sets is about 30dB.

Noise figure is usually defined with respect to room remperature, about 290°K, and under such a definition T/T_a is unity. The equation then reduces to

$$F_{rec}=L_t(t_m+F_{IF}-1)$$

which represents the condition under which the noise figure of a crystal mixer is measured in the laboratory. The input termination, usually a noise tube in the unfired state, is at room temperature and L_t is the product of the conversion loss of the mixer and the insertion loss between the noise tube and the mixer. A good mixer diode has a noise figure of about 6dB at X-band (8.2 to 12.4GHz) which includes a noise contribution from the following i.f. amplifier.

A radar receiver commonly employs a balanced mixer which has the advantage of local-oscillator noise cancellation, and in addition each mixer diode is exposed to only half the duplexer leakage.

Because of the conversion loss of the crystal mixer, the receiver noise figure is highly dependent on a low i.f. noise figure. While in some applications improvement in receiver noise figure may be relatively unimportant due to a high level of external noise, the operating frequencies of most radars are in the spectral region where external noise is low, and a low noise figure can be fully used.

The range of an ideal pulsed radar in terms of its system parameters is

$$R=\sqrt[4]{\frac{P_t\sigma A^2\tau}{\lambda^2kT_0F_{op}}}$$

where P_t is peak transmitted power, σ effective target scattering cross section, A effective antenna area, ζ pulse duration, λ wavelength, k Boltzmann's constant, T_0 290° K, and F_{op} operating noise factor. The range is a slowly varying function of noise figure; for example, a 6dB improvement in F_{op} yields only a 40% increase in range, but a reduction in noise figure can be as effective as an increase in transmitter power or antenna aperture. Often a 3dB improvement in noise figure may be more economical to achieve than doubling the transmitter power or increasing the antenna area by 40% especially for high power radars.

From a consideration of the noise figure of cascaded networks, a large available power gain in the first stage minimizes the noise contributions of the later networks. A low-noise r.f. amplifier preceding the crystal mixer would provide the power gain required to offset the loss of the mixer. RF amplifiers that could be used are the travelling-wave-tube amplifier, the simpler, low-noise parametric amplifier[9], or more recently the field effect transistor amplifier.

The noise factor of two cascaded networks with noise factors F_1 and F_2 and available power gains G_1 and G_2 is

$$F=F_1+\frac{F_2-1}{G_1}$$

If the first network is a parametric amplifier, noise factor F_p, and gain G_p, and the second a crystal mixer and i.f. amplifier, the expression for receiver noise factor F_{rec}, can be substituted into the above to give a new receiver noise factor of

$$F_{rec}=F_p+\frac{1}{G_p}[L_t(t_m+F_{1F}-1)-1]$$

This shows that if a parametric amplifier with a noise figure of 4dB and a gain of 20dB is followed by a mixer and i.f. amplifier with a 12dB noise figure, the overall receiver noise figure is still less than 4¼dB.

In general, parametric devices are frequency converters; they are amplifiers when the output is at the same frequency as the input, and they use non-linear varactor diodes which act as voltage-dependent capacitors drawing energy from a pump source which is usually much higher in frequency than the signal for a low noise figure. The reflection type of amplifier is most common and requires a ferrite circulator to separate the input and output signals.

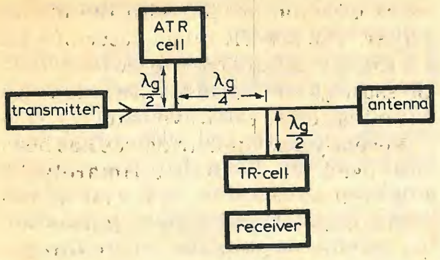


Fig. 1. *One of the most widely used gas duplexers is the branched duplexer using a TR cell and a second gas cavity resonator on a stub (ATR cell).*

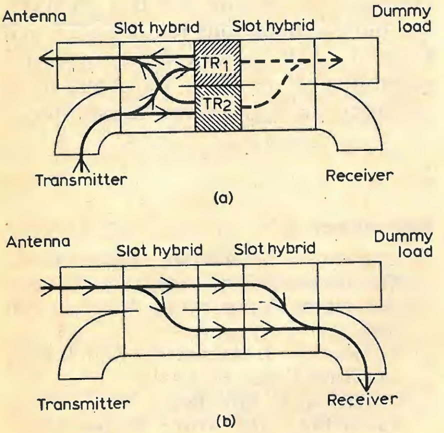


Fig. 2. *Balanced duplexer avoids the use of an ATR cell using two TR cells between two hybrid junctions. Transmitter power is reflected by the TR cells and leaves by the adjacent port (a). Lower figure shows echo return route after cell recovery (b).*

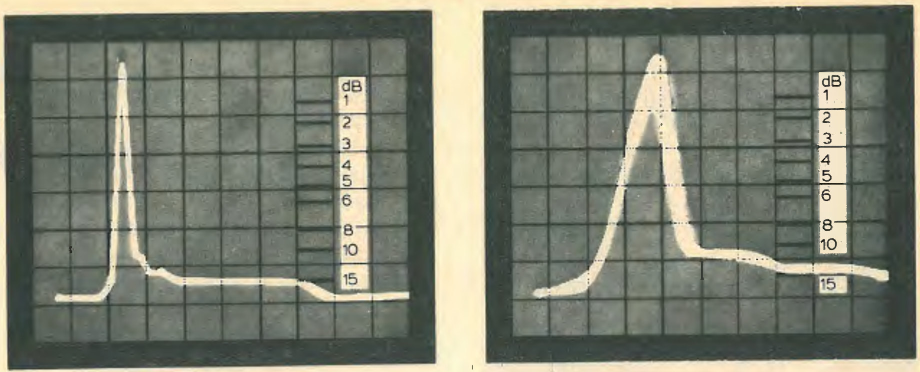


Fig. 4. *TR cell leakage, shown above from a sampling oscilloscope trace-one with expanded time scale showing random variation of spike leakage energies, is the most common cause of microwave diode burn-out.*

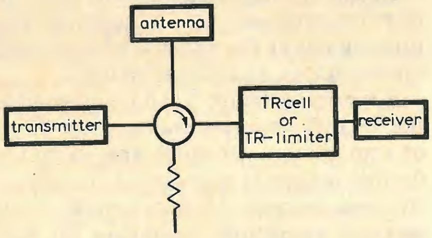


Fig. 3. *Up to 30dB of isolation can be provided by a four-port ferrite circulator with only a fraction of a dB insertion loss.*

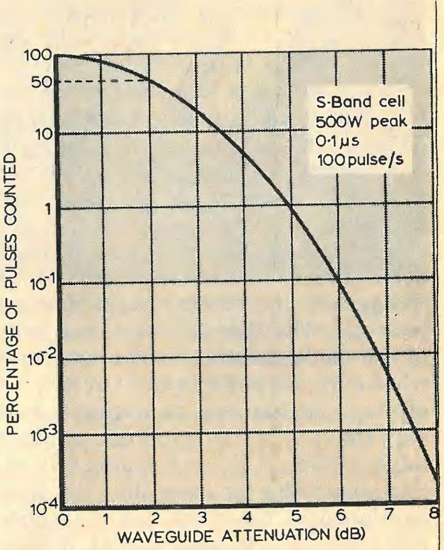


Fig. 5. *Cumulative distribution of cell spike language energies.*

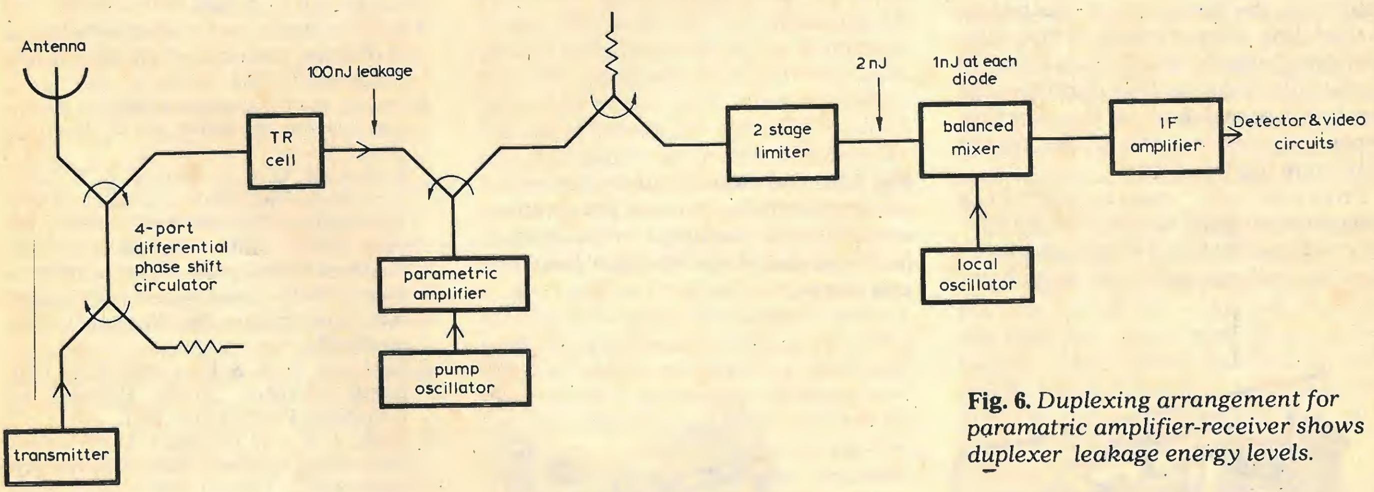


Fig. 6. *Duplexing arrangement for paramatric amplifier-receiver shows duplexer leakage energy levels.*

Duplexer leakage and receiver burn-out

The problem of "burn-out" is of prime concern to microwave diode users, and may be defined as a change in the rectifying and converting properties of crystal rectifiers as the result of excessive electrical overload. Overload may be due either to accidental static discharge through the diode, or to microwave or pulse power delivered to the diode. Because the rectifying element is highly sensitive, it is subject to damage when excessively high current densities pass through the rectifying barrier. Lower frequency diodes with a larger junction area are therefore more resistant to burn-out.

The most common cause of burn-out is duplexer leakage power. The TR cell in a duplexer requires a finite time to ionize and attain full attenuation under the influence of the transmitter pulse. Thus the leakage through the cell consists of a short but high pulse called the spike immediately followed by a long low-amplitude pulse called the flat. At X-band the spike duration is typically 2 to 10 ns, at its half-power point, and depends on the amplitude and rate of rise of the magnetron pulse. A sampling oscilloscope is required to view such short pulses, and a photograph of a TR cell spike and flat leakage is shown in Fig. 4, and the spike on a reduced time scale next to it.

The leakage from a TR cell is not constant from pulse to pulse. Due to the random nature of ionization of the gas[10], breakdown occurs at different levels, and the spike leakage energies for a train of pulses have a statistical distribution, the width of which will depend on the operating conditions, on the cell type, and on the shape of the leading edge of the transmitter pulse. As a result, the mean spike leakage energy for a cell may be a 20nJ per pulse which occasional spike pulses can have energies as high as 500nJ per pulse depending on the particular operating conditions.

Some measurements of spike leakage energy distribution for cells in S-band are shown, with cumulative distribution shown in Fig. 5. Cell leakage distributions are skew with a sharp cut-off at the lower energies. At high energies the frequency of occurrence normally decreases rapidly with increasing energy and approximates to a log-normal distribution. In addition to the steady-state distribution of spike energies, high energy pulses are also generated in the transient conditions of switching the magnetron modulator on and off.

McMillan & Wiesner[11] conclusively demonstrated that the spike part of the leakage was the primary cause of mixer burn-out. The thermal relaxation time of the diode junction is of importance when burn-out is due to short pulses. An effective value can be estimated or experimentally determined, and for mixer diodes at X-band is about 10 ns. For pulses shorter than this, the heat developed at the diode junction does not have time to appreciably diffuse away and the temperature reached is determined solely by the energy dissipated at the contact and by the thermal capacities involved. Therefore, if the pulses are shorter than 10 ns their energy content, and not their shape determine the temperature reached at the junction and the extent of burn-out. For leakage pulses longer than about 10 ns the pulse shape is of importance; the temperature reached at the junction depending on the peak power rather than on the pulse energy.

Burn-out in radar receivers sometimes consists of a sudden deterioration caused by a rare very high energy duplexer leakage pulse, but often however it consists of a gradual deterioration which takes place over several hundred hours of operation. Damage of this type is not a direct result of heating, but may be associated with the diffusion of impurities in the semiconductor or a chemical reaction at the junction. Such processes consuming a great deal of time at room temperature would be accelerated by the high temperatures attained during a leakage pulse.

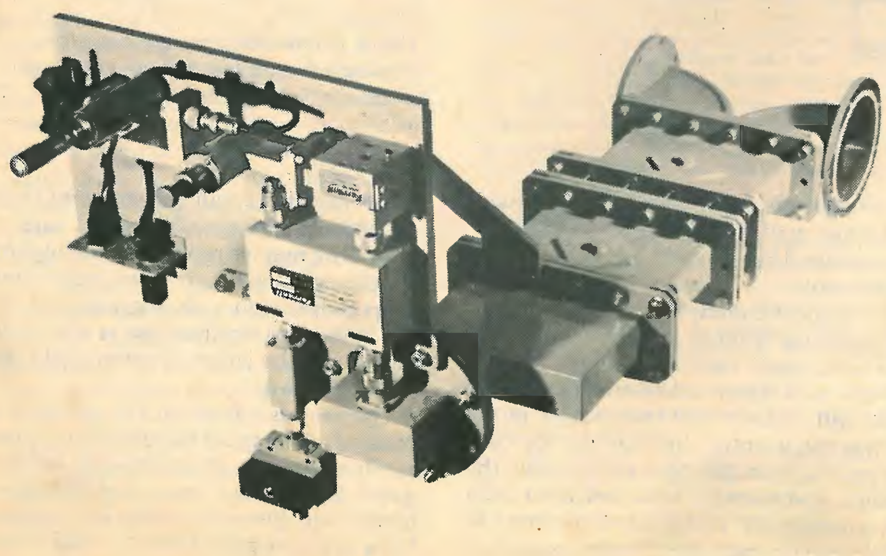
The leakage from a TR cell will depend on the particular application for which the cell has been designed. A cell intended to protect mixer diodes may have a spike leakage energy of 10nJ or less, while a cell intended for parametric amplifier protection can be made to have a lower insertion loss and be run without priming, because leakage of a few hundred nanojoules per pulse can be tolerated. Cell design is always a compromise between leakage energy during transmission, and attenuation of the echo during reception. The leakage can be reduced by increasing the priming but at the expense of increased insertion loss, and primer noise[12].

A varacter limiter[13] can be used after the TR cell where extended mixer life is of importance. Because the varactor limiter action is non-linear, its effectiveness increases proportionally with leakage amplitude. Isolation for flat leakage may be only 3dB, but for high amplitude spikes isolations of about 15dB can be attained, and the statistical fluctuation of spike energies is reduced. Although this leakage reduction is achieved at the expense of increased insertion loss adding to the receiver noise figure, a TR limiter is often the optimum device for mixer protection in a duplexing system.

The optimum duplexing arrangement for a receiver using a parametric amplifier is shown in Fig. 6. A low insertion loss TR cell with a high leakage can be used for parametric amplifier protection and a varactor limiter for mixer protection placed after the parametric amplifier where the extra insertion loss has little effect on the overall receiver noise figure.

In certain special systems a TR cell may not be necessary; for example, if the maximum peak power is only a few watts, a circulator and limiter may be adequate protection for the receiver. But most applications require a TR cell even if only to guard against the possibility of receiver burn-out by a neighbouring high power transmitter.

Fig. 7. *S-band duplexer and receiver assembly showing in co-ax parametric amplifier with circulator and X-band pump oscillator and varacter limiter and mixer.*



References

1 Smullen, L. D. & Montgomery, C. G. Microwave Duplexers, Radiation Laboratory Series vol.14. McGraw Hill 1948.

2 Harrison, N. J. Magnetrons and Travelling Wave Tubes. RCA 1956.
Collins, G. B. Microwave Magnetrons, Radiation Laboratory Series vol.6. McGraw Hill 1948.

3 Riblet, H. J. Short-slot bybrid junction, *Proc.IRE* vol.39 1942 pp180-4.

4 X-band ferrite duplexer, *Electronic Design.* Aug. 1956.

5 Lax, B. & Button, R. J. Microwave ferrites and Ferrimagnetics. McGraw Hill 1961.

6 Lax, B. & Button, R. J. X-band ferrite varactor limiter *IEEE Trans. on Microwave Thoery and Techniques* (correspondence), April 1969.

7 Van Voorhis, S. N. Microwave Receivers Radiation Laboratory Series vol.23. McGraw Hill 1948.

8 Pound, R. V. Microwave Mixers Radiation Laboratory Series, vol.16. McGraw Hill 1948.
Messenger, G. C. & McCoy, C. T. Low-noise figure microwave crystal diode IRE Conventional Record Part 8 1955 p.68. And Theory and operation of crystal diodes as mixers, *Proc. IRE,* Sept.1967.
Strum, P. D. Some aspects of crystal mixer performance *Proc.IRE* vol.41 1953. pp.876-89.

9 Blackwell, L. A. & Kotzebue, K. L. 1961 Semiconductor Diode Parametric Amplifiers. Prentice Hall 1961.

10 Meek, J. M. and Graggs, J. D. Electrical Breakdown of Gases. Oxford University Press, 1953.

11 McMillan, F. L. and Wiesner, J. B. Radiation Laboratory Report no. 53-24, Massachusetts Institute of Technology 1943.

12 Goldie, H. Effects of noise-contributed by TR devices on low-noise receivers *Proc.IEE,* vol.116, no.3 1969.
Goldie, H. Effect of TR devices on Modern Radar Receivers, North-East Electronics Research and Engineering Meeting Record, 1967. p.106.
Goldie, H. Noise generated in igniters of TR tubes *IEEE Trans.* Vol. GED-13 1966, pp.362-70.

13 Uhlir, A. Potential of semiconductor diodes in h.f. communications. *Proc. I.R.E.* vol. 46 1958, pp. 1099-115.

Some milestones in electronics

An interview with Professor Bernard Tellegen

by Arthur Garratt

In this article Professor Bernard Tellegen, inventor of the pentode, discoverer of the Luxembourg Effect, pioneer of the gyrator and great figure in the history of radio talks to Arthur Garratt, a British scientific and industrial consultant now living in France.

BEFORE the invention of the transistor, the three most significant inventions in radio were the diode (Ambrose Fleming, 1904), the triode (Lee de Forest, 1906) and the pentode by Bernard Tellegen in 1926.

The pentode originated in the Philips Research Laboratories, the *Natuurkundig Laboratorium* or *Nat Lab* as it is generally called, at Eindhoven in the Netherlands.

The Nat Lab was set up in January 1914 under the directorship of Dr Gilles Holst, who had previously worked in Leyden with Kamerlingh Onnes – one of the great figures in low temperature research. Holst soon had an assistant, Dr Ekko Oosterhuis, who became Holst's second-in-command. (Oosterhuis, incidentally, was the grandfather of the British golfer, Peter Oosterhuis.) After the first world war the Nat Lab grew apace and among other well-known members of its staff were Balthasar van der Pol who published some two hundred papers on theoretical aspects of radio, with particular emphasis on relaxation oscillations, and Klaas Posthumus who, as we shall see, was a co-discoverer of negative feedback and also carried out pioneer work on split-anode magnetrons. Apart from Bernard Tellegen, a prolific generator of ideas who still comes to the Nat Lab regularly to "work on things which interest him" and Klaas Posthumus, the other men we have mentioned are now dead.

Arthur Garratt visited the Nat Lab at Eindhoven and recorded an interview with Bernard Tellegen who explained how the pentode and gyrator came into being and also traced the history of wave interaction in the ionosphere, the so-called Luxembourg Effect.

Bernardus Dominicus Hubertus Tellegen, to give him his full name, was born in 1900 and trained as an electrical engineer at Delft Technical University, graduating in 1923. After completing his military service he joined the Nat Lab in May 1924 and spent his entire working career with Philips. Arthur Garratt asked him if he immediately joined Van der Pol's radio group:

TELLEGEN Not immediately, this happened a few years later. When I first joined Philips I worked with Oosterhuis. One of my first assignments was a tungsten arc lamp which had recently been developed in the Nat Lab. This operated well on d.c. and we tried to make it work on a.c. by using some kind of transformer – unfortunately this was not successful. After that I worked on the development of a battery eliminator; this was taken over by someone else who carried it through to production.

It was after this that I joined Van der Pol. From the beginning I was more theoretically than practically minded and this naturally caused me to gravitate towards Van der Pol, and I started in the field of radio about which I didn't know a great deal at that time. However, I studied a paper of Van der Pol's – a general paper on electron paths; this was my introduction to radio. I then began to study amplification. W. Schottky had written some papers on screen grid tubes (tetrodes) and these interested me very much. I also read papers on the use of triodes as output tubes and I observed that the triode should have a low internal resistance in order to get the maximum output. Then I put the two tubes together in my mind – I realised that with the tetrode you move the anode-current/grid voltage characteristics over to the left and this was clearly a desirable thing to do. I did some calculations – nothing about secondary emission at this stage – and I came to the conclusion that a screen grid tube, notwithstanding its high internal resistance, was very well fitted to the role of an output tube. You must remember that these were the days when the anode supply was from dry batteries and we wanted the maximum output from a given battery voltage. From this starting point I saw that one should not only get a higher output but also greater stage gain and less frequency distortion because the current in the loudspeaker should then be proportional to the control grid voltage. Putting all these things together led me to the conclusion that a tetrode should make an excellent output tube.

Professor Bernard Tellegen, now aged 79, at the Natuurkundig Laboratorium in Eindhoven, Netherlands

Of course, when you try this out you immediately come up against the problem of secondary emission. Secondary electrons are always emitted when primary electrons strike an electrode with an energy above about 10eV. In a triode they have no effect because they are drawn back to the electrode from which they are emitted, but in a screen grid tube secondary electrons emitted from the anode are attracted to the screen grid when the anode potential falls below that of the screen. This produces impossible distortion if the tube is driven hard – as an output tube must be. So I introduced a suppressor grid between the screen grid and the anode – this prevented the exchange of secondary electrons between the anode and the screen grid.

I talked with Holst about other means of suppressing secondary emission and he proposed some methods which were put into the patent – this was the reason that the patent itself is under the names of both Holst and me. In fact Holst's suggestions were never put into practice, the suppressor grid was successful and that was that.

GARRATT When you first constructed a tube with a suppressor grid, did it work right away or did you have to do more experiments?

TELLEGEN We had to do some experiments to measure anode current as a function of anode voltage at various values of suppressor voltage. You can find these in the original paper together with some of the results. The optimum dimensions for the suppressor grid were later studied by Jonker in the Nat Lab, but at the beginning we did not have much difficulty in finding a reasonable construction for the suppressor grid.

GARRATT When you found this was a satisfactory tube, had you any realisation at that time of the implications of the pentode to the radio industry?

TELLEGEN Well the effect it would have on the industry was too big a world for me! As far as I was concerned it was a tube which could be used practically in a radio receiver. It was just at this time that the first receivers that Philips had decided to build were under construction and new ideas were coming in from every side. Not only was there the pentode, but also the indirectly heated triode as a detector and what was called the 'Hull tube' (named after A. W. Hull who had studied a screen grid tube designed to have a very low anode/grid capacitance). Hull had stated in the paper describing this tube that it was purely experimental and was not intended as a production tube. It was Posthumus who developed the idea into a practical tube. So our first commercial mains set had a screen grid r.f. amplifier tube with a very low anode/grid capacitance, an indirectly heated triode and a pentode output tube.

GARRATT Was the pentode indirectly heated as well?

TELLEGEN No, the pentode was directly heated off a.c. There were actually two sets, a battery version which was, of course, d.c. throughout and the a.c. mains version.

GARRATT This was the a.f. pentode. How did the r.f. pentode come into being?

TELLEGEN I think the first r.f. pentodes were constructed by Bell Telephones who needed rather high r.f. voltages. They realised the importance of the pentode for r.f. amplification – this was also covered by the original patent.

GARRATT The patent is interesting. Philips patented the pentode in eighteen countries, but it was never patented in the Netherlands – why was this?

TELLEGEN The reason was that some date was overlooked. When you apply for a patent in the Netherlands you get a letter back saying, "We have such and such objections and we want certain information" before a certain date. Because of some administrative error, the expiry date was overlooked. Despite efforts to get permission from the Dutch Patent Office to extend the time, they refused and this is why the patent was not granted in the Netherlands.

GARRATT This was a patent immense importance to Philips. It raised a great deal of money . . .

TELLEGEN Yes, and it opened doors – the doors of other important electronics firms.

GARRATT It was about this time that your colleague, Posthumus, was working on negative feedback. Negative feedback is generally attributed to H. S. Black of Bell Telephones, but Posthumus was working on it almost simultaneously.

TELLEGEN You can say "simultaneously" and quite unknown to each other.

GARRATT In fact there was an interesting difference. Black used a bridge circuit while the circuit Posthumus developed was much more like the feedback circuitry used in radio today.

TELLEGEN Yes, Black concentrated largely on telephone applications where a bridge was necessary, while Posthumus was interested in radio sets – so the two men had rather different points of view.

GARRATT Negative feedback took some time to get into commercial practice.

TELLEGEN It was used in radio sets because there were objections that pentode output tubes gave third harmonic distortion due to the impedance of the loudspeaker rising with frequency. This could be overcome by applying negative feedback but it took a number of years before it was used generally in radio receivers.

GARRATT What about its use in telephony?

TELLEGEN At that time Philips were not in the telephone business while Bell, on the other hand, were primarily interested in telephones and, I believe, they used negative feedback commercially before Philips.

GARRATT At that time, at the end of the twenties and beginning of the thirties, the Philips Nat Lab was very much in the front row. In electronics, you had produced the pentode, Posthumus had produced negative feedback simultaneously with Black and he had also done pioneer work on the magnetron, Van der Pol was doing a great deal of important theoretical work – this must have been a remarkable time and place to be doing research?

TELLEGEN That's right. It was very stimulating to work on these problems and it was not very difficult to make progress in different directions and to find new applications for one's ideas. It was very exciting for all of us.

GARRATT A little later on came the beam tetrode output tube, another way of avoiding the effects of secondary emission . . .

TELLEGEN And a way of avoiding the patents!

The Luxembourg Effect

GARRATT You were also a pioneer in the discovery of what was originally called the 'Luxembourg Effect'.

TELLEGEN Yes, it's now called "wave interaction". After some time with Van der Pol I had moved to work in the group headed by Oosterhuis. Van der Pol and I looked at things from a different point of view. He was a physicist, I am an engineer. Van der Pol was almost exclusively interested in understanding things, I thought understanding was no use if you didn't *apply* the results in the right way – that's the point of view of an engineer. This is why after some years I joined Oosterhuis's group which was busy developing radio receivers. One problem we faced was cross-modulation, so we built straight sets with two tuned circuits in front of the first tube – by increasing the selectivity before the first tube we reduced the cross-modulation. We had built such an experimental receiver in which we were quite certain we had eliminated all cross-modulation and I tested this out at home. I found that when I was listening to the Swiss station Beromünster I could hear another station faintly in the background. This puzzled me a lot. I thought to myself this can't be cross-modulation as we had taken every possible measure to eliminate it. I could only hear the second station when there was silence in the Beromünster programme. I tuned around and found that the interfering programme was being broadcast by Radio Luxembourg.

GARRATT Which was a long-wave station.

TELLEGEN Yes, a long-wave station. I called my friend Rinia and told him to listen in. He did so and got the same effect. At first we thought it might perhaps be something complex happening in the electric light mains. So we went outside the town and repeated the experiment . . . and got the same results. I then realised that Luxembourg was just about half way between Eindhoven and Beromünster and was a very powerful station transmitting a lot of energy into the ionosphere and something must be happening in the ionosphere that affected the signal from Beromünster on its way to Eindhoven, and this was the reason for the interference.

The ionosphere was outside my field but when people reported similar experiences with other receivers it became obvious that the effect was not caused by something in the receiver but must occur in the ionosphere. So I wrote a letter to *Nature* which was duly published. G. W. O. Howe wrote an editorial about it in the *Wireless Engineer* and he called it the "Tellegen Effect", but that didn't stick and it became known as wave interaction. It was V. A. Bailey in Australia, a man working on the ionosphere, who eventually explained exactly what was happening – the mean-free path of the electrons in the ionosphere was being influenced by an external field, the r.f. field, and so one transmission was modulated by the other.

GARRATT What did you do during the war, when there were Germans in the Nat Lab?

TELLEGEN Having worked on circuit problems in connection with radio receivers, I had become interested in circuit theory. We used to run courses for each other in the laboratory – I gave a course on circuit theory, one of my colleagues took notes and it was later reproduced and I eventually extended it into a book. The notes came into the hands of one of the professors of electrical engineering at Delft Technical University. He suggested to me that I should come to Delft and lecture in this field. As a result I became an Extraordinary Professor there in 1947 – Extraordinary in this sense means part-time. It was the policy of Delft University to have some specialists from industry to lecture on their particular specialities to the students in order to establish closer ties between the university and industry. This was how I first came to Delft and I continued there for twenty years.

GARRATT And you received a doctorate from Delft?

TELLEGEN I retired from Delft in 1968 and the following year I was awarded a doctorate in electrical engineering. Needless to say this pleased me very much.

The Gyrator

GARRATT As though the pentode and the Luxembourg Effect were not enough for one man, you worked in several other areas?

TELLEGEN Yes, first of all on receiving tubes, then on complete receivers and later, on circuit theory which led to the gyrator.

GARRATT How did the concept of the gyrator arise?

TELLEGEN Around 1930 I was studying the properties of loudspeakers. The first equations concerning loudspeakers and telephones were developed by Poincaré. They are electro-mechanical systems, that can be described as systems with two ports – an electrical one and a mechanical one, which are related to each other by the telephone system. When you write down the equations something very curious happens depending on how you relate the electrical and mechanical quantities. If we say a current corresponds to a velocity and a voltage corresponds to a force and you write the two-port equations in these quantities for an electromagnetic telephone, you get a set of equations which don't obey reciprocity, but if you do this for an electrostatic telephone the equations *do* obey reciprocity. Reciprocity, which is a property of a two-port, can be expressed as a mathematical relationship between the equations which link the current through one port to the voltage across the other port when the two-ports consist of standard circuit elements, namely resistors, capacitors and inductors.

Reciprocity is one of the important general properties in electrical networks – of course I was aware of these properties – but the telephone introduced equations which were of a different type. I realised that you could combine an electromagnetic and an electrostatic telephone in such a way that you have an electrical input and an electrical output; in principle, at least, you could imagine an electrical two-port which did not obey reciprocity. This led to the concept of two sets of equations; one pair defined an ideal transformer, which is a separate network element, the other pair defined another separate network element which I called a *gyrator*. In the transformer there is a proportionality between primary and secondary voltages and also between primary and secondary currents. In the gyrator there is a proportionality between primary voltage and secondary current and also between primary current and secondary voltage. The gyrator is thus defined but I had no means of realising it in the field in which I was working, i.e. radio receiver design. But I kept it in mind and during the war I pondered over the possibility of trying to find some means of actually realising it without mechanical means – I had been carrying the equations around for some years on a small piece of paper. Well eventually I found a means by using the gyromagnetic effects in ferrites and I carried out some experiments. When the war was over I wrote a paper about it – the time was then ripe for publication. During the war I had written a number of laboratory notes about the gyrator and I remember that when the Germans came around I collected all these notes and put them away so that they wouldn't get into Nazi hands.

The gyrator is connected in a way with a very famous book, *A Treatise on Natural Philosophy*, by Thomson and Tait, which was very well known among physicists at the end of the nineteenth century. It was Thomson and Tait's book which had everything about mechanics in it. It discussed vibrations of small amplitude which are described by linear equations. In these equations special terms may occur, called by the authors "gyroscopic" or "gyrostatic" terms because they occur when flywheels in a state of rapid rotation form part of the system by being mounted on frictionless bearings connected through a framework with other parts of the system, and because they occur when the motion considered is motion of the given system relative to a rigid body revolving with a constrained constant angular velocity round a fixed axis. What I did was related to this and, as a result, I found a good name for the element – *gyrator*, the *gyra* from *gyroscope* and the final *tor* from many other electrical words like *capacitor, inductor* and *transformator* (Dutch). Gyrator is a practical word and can be used equally well in English, German and French – it's short and the *tor* implies that it is electrical. If you want to popularise a concept it is very important to have a good name for it. This did a lot to arouse interest in the concept of the gyrator.

GARRATT So you were the inventor of the gyrator as well as the pentode?

TELLEGEN It depends what you mean by inventor. The gyrator has been the subject of some patent applications. As I said before, I realised in 1930 that by combining electrostatic and electromagnetic loudspeakers you can, at least on paper, find pairs of equations that are non-reciprocal. I didn't publish it at the time; it was published by E. M. McMillan in the United States some years before my paper on the gyrator. So whether you call me the inventor is up to you, but certainly I invented the name.

GARRATT When was the gyrator first used practically?

TELLEGEN It was first put into practice by Bell Telephones. They realised before I did that you could use gyromagnetic effects in microwave technology – Casimir (one of the Directors of the Nat Lab at the time) was not very happy about this! I had missed the point, but then I was always thinking more about the frequencies used in ordinary radio receivers than about microwaves – these were not my special field. Perhaps it was stupid of me not to have looked into this. I had realised that the gyromagnetic effect could be very much greater at high frequencies than at lower ones, but they took this very much farther at Bell and introduced ferrites and waveguides and various other things related to gyrators. There are several things you can do with gyrators in waveguides and so introduce non-reciprocal effects.

Gyrators are now very popular and can be realised in an extremely efficient manner using solid-state components. This did not interest me at first because the gyrator itself is a passive element. With active networks the field is very much broader and, at first, there is very little reason to limit yourself to producing a passive element by active means. But it turns out that it is valuable even in active networks; for filters, for example, it has proved very useful.

Sunspots, the ionosphere and h.f. propagation

Records of F2 layer critical frequencies, hour-by-hour over three years

by Kurt Feldmesser, Appleton Laboratory

IT must have been almost an international sigh of relief that greeted the improved ionospheric conditions last autumn, following the lean years of sunspot minimum. The charts reproduced here are a record of the F2 layer critical frequencies during those years. They illustrate the well-known behaviour of the ionosphere rather strikingly and allow a rapid mental picture to be formed of probable propagation conditions which could otherwise only be acquired by years of experience.

Before discussing details it is relevant to mention the source of the measurements. Appleton's experiments in this country and Breit and Tuve's in the USA, which established the presence of the ionized regions in the upper atmosphere, thanks to whose presence Marconi's Poldhu transmission had proved successful, are classics of radio history. Perhaps not so familiar is the fact that these measurements, begun routinely in 1931 at Slough by the Radio Division of the National Physical Laboratory, have been carried on continuously under different administrations, supported by other observatories in other countries until well in excess of one hundred stations as well as various 'topside' sounding satellites monitoring the ionosphere.*

For the routine measurements Breit and Tuve's pulse echo sounding method was adopted almost universally as providing more readily interpreted records. It is these measurements, mostly made hourly, that form the basis of the several ionospheric prediction systems in use.

In Fig. 1 the monthly median values of critical frequency, i.e., the highest frequency returned from a vertically incident signal, are plotted for the three regular reflecting layers E, F_1 and F_2, at noon. The well-known dependence of the F2 layer ionization on sunspot activity is readily recognized. The seasonal variation of critical frequency seen in Fig. 1 and the "180° phase shift" between the F1 and F2 layers prompted the construction of another form of diagram which would allow the plotting of every single hourly observation.

Since measurements are normally made to 0.1 MHz accuracy for the F_2 layer critical frequency, a compromise had to be adopted, namely that the numerical values had to be quantized to the nearest MHz. In practice this has proved quite satisfactory since hour-to-hour changes are frequently in excess of this.

A graph of sunrise and sunset with time of day as ordinate and day number as abscissa looks like Fig. 2, where in addition to ground level sunrise and sunset. the times for these events at 100 km and at 300 km are also plotted. If we assume that a measurement of critical frequency is valid for plus and minus half an hour and assign a colour to each integral value of MHz, plotting to the same co-ordinates produces the diagrams in Fig. 3. The colour code used is — naturally — the resistance colour code, modified to allow values in excess of 10 MHz to be represented. (The modifications were, in fact, hardly needed until 1978.) Thus one may select any hour of any day between 1975 and 1977 and instantly locate the critical frequency that obtained at the time — over Slough! For communication within the British Isles this would also be the maximum usable frequency and radio operators might care to compare their log books.

The aerial system at South Uist in the Outer Hebrides. Two rhombics are used, firing vertically, one covering the frequency range 250kHz to 4.5MHz and the other 4.5 to 20MHz. In the small hut, the equipment is a Swedish Magnetic AB ionosonde, Type 1005W, which consists of frequency-swept transmitter and receiver, marker generators and recording equipment, producing a 35-mm film record. Film is processed and analysed in South Uist by a local housewife, who also happens to be a geographer, and sent to Slough for correlation. One of the functions of the Hebridean station is to act as backup for ionospheric sounding rockets.

**The data thus acquired are currently deposited at (and available from) World Data Centre C1 at the Appleton Laboratory in this country and from W.D.Cs. at Boulder in the U.S.A., Moscow in the U.S.S.R. amd Tokyo, Japan.*

1000 Series
The new generation Oscilloscopes

It had to happen…the NEW 1000 series
a new generation of easy-to-use, economy line 'scopes
offering the flexibility that you the customer
demanded and from who else but Telequipment, world
leaders in low cost 'scopes.

TELEQUIPMENT

WW—049 FOR FURTHER DETAILS

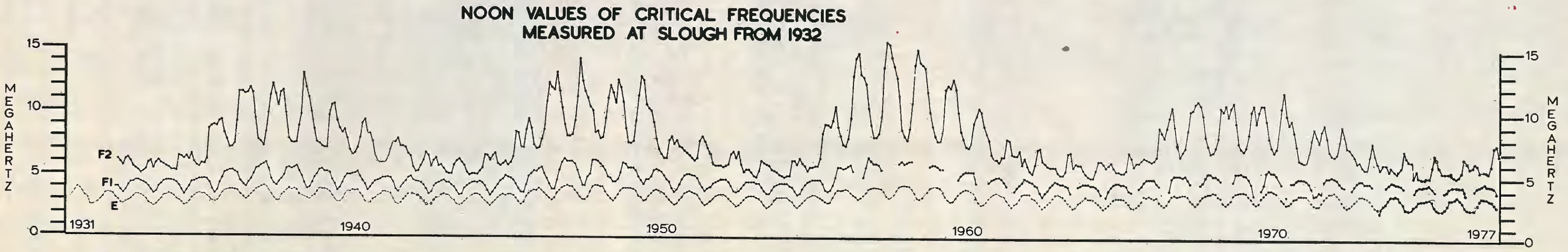


Fig. 1. Highest value of frequency returned (critical frequency). Large peaks in F_2 layer frequencies correspond with the periods of sunspot maxima. Note inversion between F_1 and F_2 layers.

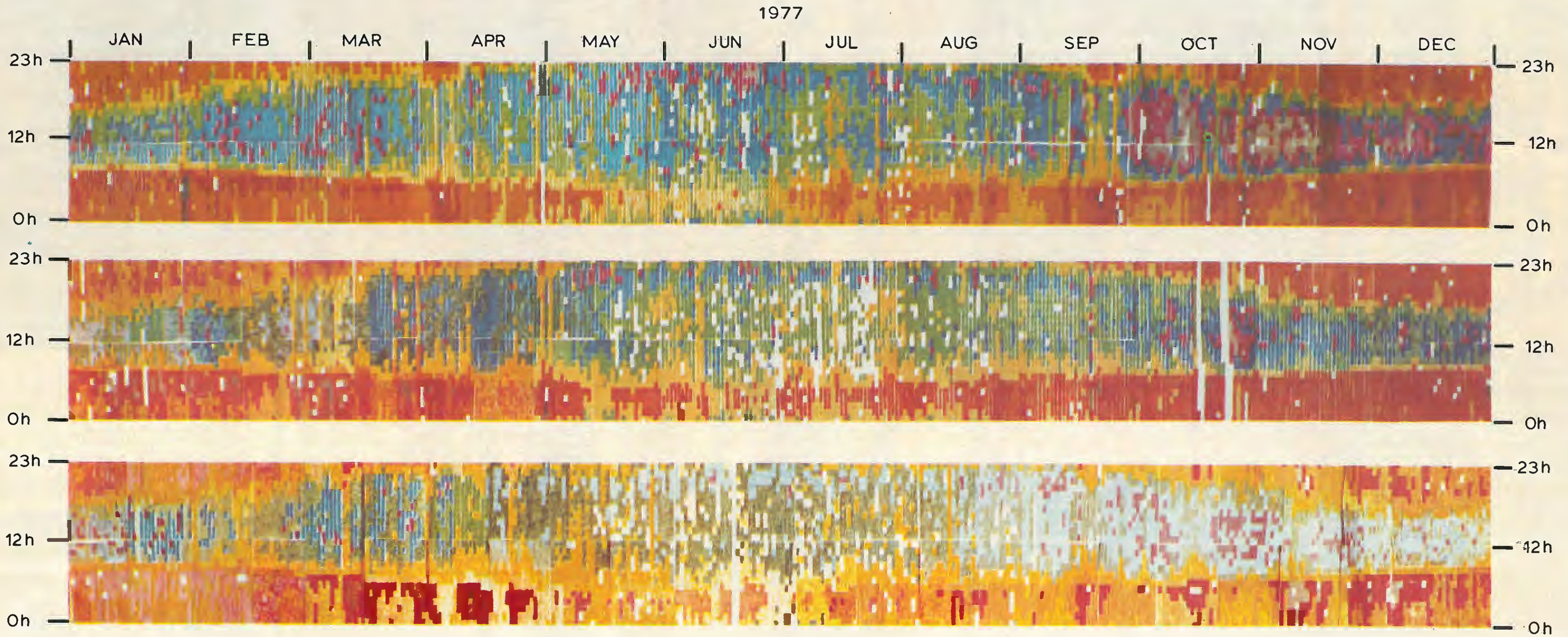
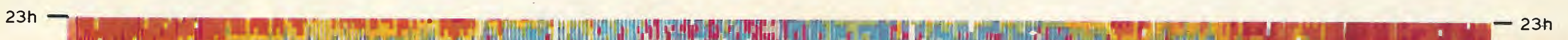


Fig. 3. Critical frequencies for each hour of 1975, 1976 and 1977. Colour code is the resistor code; e.g., brown is 1MHz ± 0.5MHz, orange 3MHz, ± 0.5MHz. Note the similarity in shape between Figs. 2 and 3.



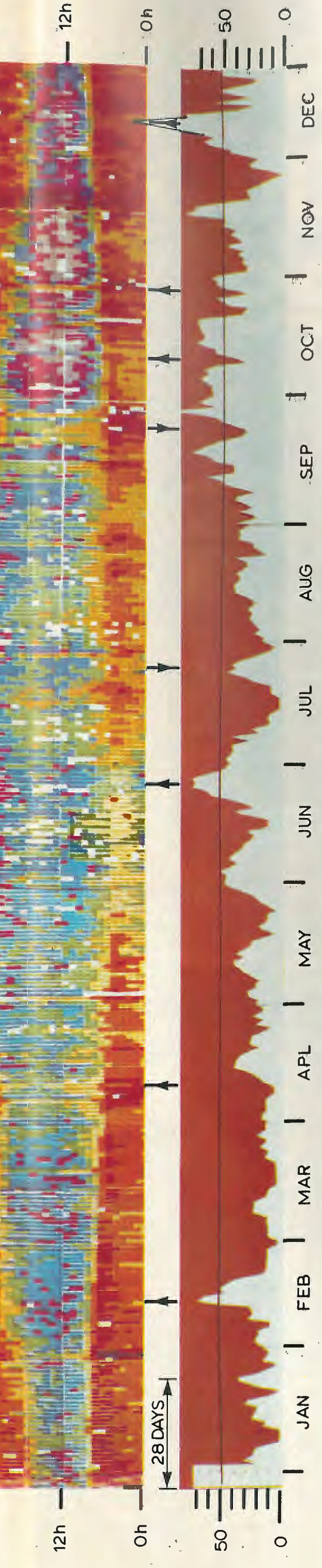


Fig 4. This illustrates the correlation between sunspot number and critical frequency. Downward pointing arrows show apparent contradictions.

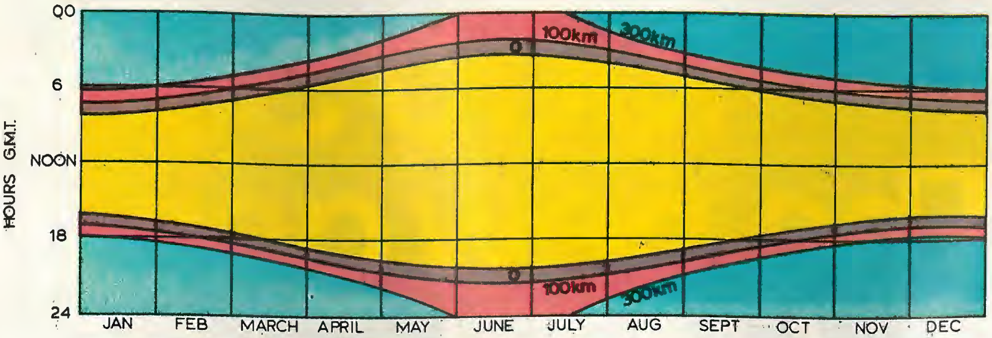


Fig. 2. Graph of sunrise and sunset for a complete year at sea level, 100 and 300km.

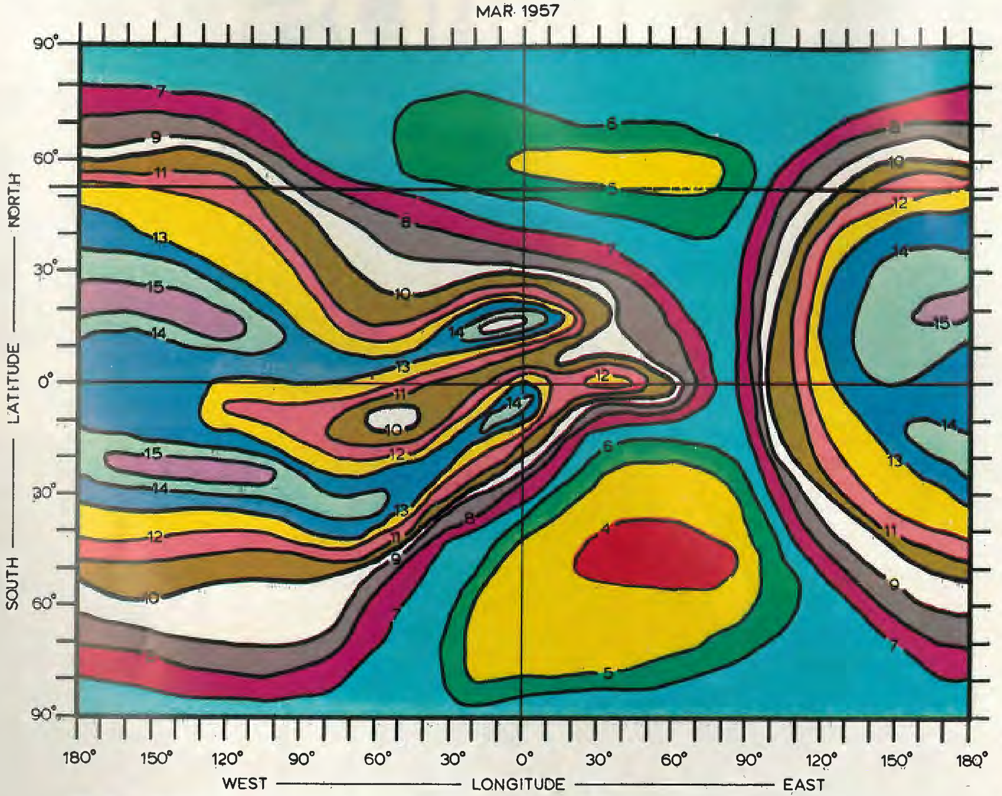
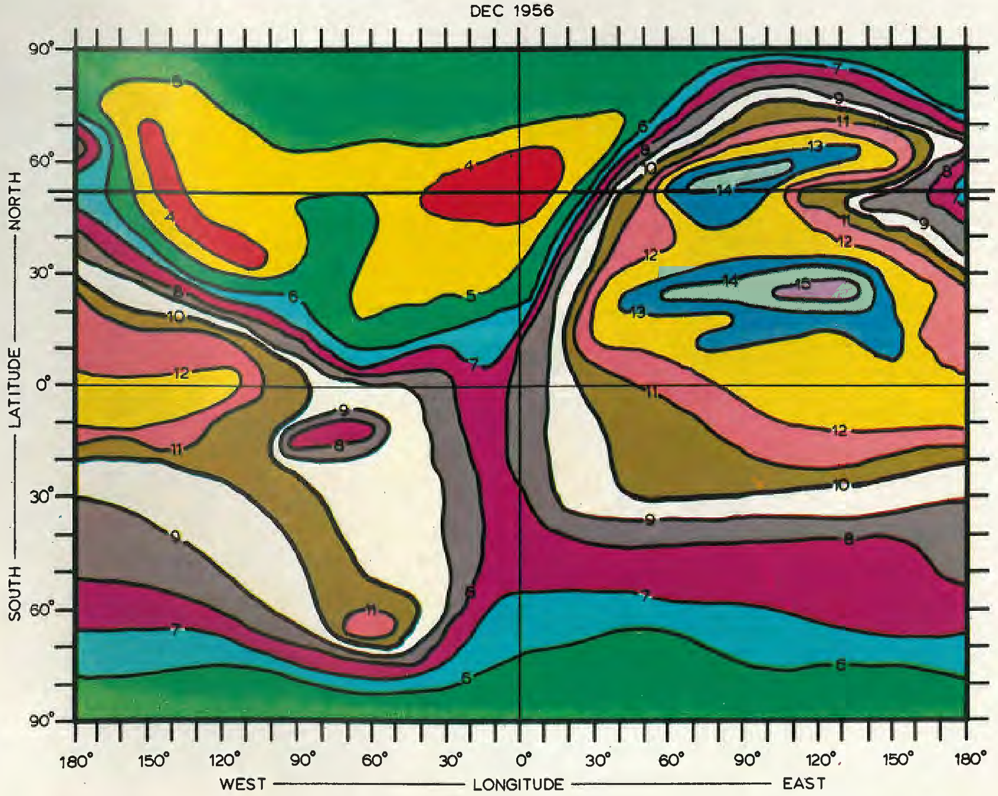


Fig. 5. Distribution of critical frequencies over the earth's surface, measured during the International Geophysical Year.



Our catalogue even includes some popular car accessories at marvellous prices.

A genuine 150W per channel stereo disco to build yourself. Full specification in our catalogue.

Speakers from 1½ inch to 15 inch; megaphone, PA horns, crossovers etc. They're all in our catalogue. Send th coupon now!

Our catalogue describes a wide range of plugs and sockets, all at marvellous prices. See cat. pages 114 to 129 for details.

61-note touch-sensitive piano to build yourself. Full specification in our catalogue.

These are just some of the metal cases we stock. There are dozens of plastic ones to choose from as well. See pages 52 to 57 of our catalogue.

A digitally controlled stereo synthesiser the 5600S with more facilities than almost anything up to £3,000. Build it yourself for less than £700. Full specification in our catalogue.

A very high quality 40W per channel stereo amplifier with a superb specification and lots of extras. Full construction details in our catalogue.

Multimeters, analogue and digital, frequency counter, oscilloscopes, and lots, lots more at excellent prices. See cat. pages 106 and 183 to 188 for details.

MAPLIN

ELECTRONIC SUPPLIES LTD

All mail to:–
P.O. Box 3, Rayleigh, Essex SS6 8LR.
Telephone: Southend (0702) 554155.

Shop: 284 London Road,
Westcliff-on-Sea, Essex.
(Closed on Monday).
Telephone: Southend (0702) 554155.

A hi-fi stereo tuner with medium and long wave, FM stereo and UHF TV sound! Full construction details in our catalogue.

A 10-channel stereo graphic equaliser with a quality specification at an unbeatable price when you build i yourself. Full specification in our catalogue.

A massive new catalogue from Maplin that's even bigger and better than before. If you ever buy electronic components, this is the one catalogue you must not be without. Over 280 pages – some in full colour – it's a comprehensive guide to electronic components with hundreds of photographs and illustrations and page after page of invaluable data.

Our bi-monthly newsletter contains guaranteed prices, special offers and all the latest news from Maplin.

A superb range of microphones and accessories at really low prices. Take a look in our catalogue – send the coupon now!

Post this coupon now for your copy of our 1979–80 catalogue price 75p.

Please send me a copy of your 280 page catalogue as soon as it is published (8th Jan. 1979). I enclose 75p but understand that if I am not completely satisfied I may return the catalogue to you within 14 days and have my 75p refunded immediately. If you live outside U.K. send £1 or ten International Reply Coupons.

NAME ______________________

ADDRESS ______________________

____

WW—050 FOR FURTHER DETAILS

Sample plots have shown that very similar diagrams are obtained at 10° East when allowing for local time, although variations are already apparent in comparison with measurements made in Scotland, especially at night. Thus for control points due East and West one would expect to be able to form estimates of maximum usable frequency by making allowance for local time and for the shallower angle of incidence. The latter will give an increase up to three times the measured frequency depending on the launch angle and F2 layer height at the time.

In the diagram at Fig. 3, the hour of sunrise is readily recognized. One can assume as a good rule of thumb 4MHz as a typical value of critical frequency at that time, although, because of tilting in the layer anomalous propagation is expected. The same applies about one hour after sunset in winter. As the seasons advance the deionization time increases so that the 'centre of gravity' of the diagram is shifted towards the evening hours — a well known phenomenon!

As Fig. 2 shows, at 300 km the sun does not set for about six weeks in midsummer (over Slough) and partly because of this, high frequencies are maintained well past midnight. Throughout the year, the lowest critical frequencies are found just before dawn. Apart, that is, from days that don't fit the pattern. These are readily apparent from the diagram and for supporters of the 28-day recurrence theory a 28-day scale is shown in Fig. 3(c). A pair of compasses will yield ample evidence. The most common type of "abnormal" day is one in which the critical frequency never exceeds 4 or at most 5 MHz. Such days seem to be particularly common in the vicinity of the equinoxes, though they can also be seen in midsummer. On those days sounder echoes are obtained from the regularly formed F1 layer, but the F2 layer electron density never exceeds that of the F1 layer and thus cannot be 'seen' by the sounder, nor is it available to carry radio traffic.

To put these diagrams in perspective, it is helpful to see the variation of the F2 layer critical frequency on a global scale (Fig. 5) — note the concentric subsolar contours and the 'tail' extending into the night-time zone. The charts themselves are section of the global maps for a single latitude (in the present case 51°30′ N approximately). The fact that a substantial measure of 28-day recurrence could be found among days of lower electron density prompted the plotting of Fig. 4 where for 1977 the plot of the F2 layer critical frequency is aligned with a graph of daily sunspot number. Considerable correlation even on a day-to-day basis is readily apparent. Of particular interest is the peak in critical frequencies in the second half of July (sunspot number near 40) and the trough in critical frequencies in the second half of September (sunspot number near 40). Critics of the correlation between sunspot number and critical frequency would find justification for their view in this, until we note that in the first instance we are looking at a short period maximum sunspot number and in the second instance a short period minimum. Thus a significant parameter would seem to be not only the absolute sunspot number but also the rate of change of sunspot number.

This article is published by permission of the Director of the Appleton Laboratory. The author would also like to thank his colleagues for much advice, freely given, and the Photographic Department for their annual painstaking work.

The author

Kurt Feldmesser came to this country in June 1939 after beginning his secondary education in Vienna, which he eventually completed in Cornwall. He interrupted a degree course in science to volunteer for the Royal Air Force as meteorologist. In 1948 he resumed studies in engineering at the then Plymouth and Devonport Technical College.

He began radio engineering commissioning Standard Telephones and Cables' Precision Approach Radar, and following two years with the General Electric Company's Stanmore Laboratories joined Marconi Instruments where he engineered the B.B.C.'s v.h.f. admittance bridge into production. He also patented one form of digital display device whilst with the company.

A keen amateur cinematographer, he was chairman of the M.I. film society for several years. This interest led him to join an audio-visual company in London where he was responsible for the engineering of the first commercially produced language laboratories. Returning to radio engineering with Rank-Bush-Murphy he jointly patented a high-resolution pico-ampere generator at the Welwyn Garden City laboratory. For the past eleven years he has been with the Science Research Council and for the last seven he has been concerned with the ionospheric observations at Slough and South Uist in the Outer Hebrides.

Literature Received

Test leads, probes of various kinds including d.i.p. types, and the range of E-Z-Hook components in a catalogue from Special Products Division, British Central Electrical Co. Ltd, New Street, Ringwood, Hants WW401

Colour television still picture recorder, the Arvin Echo, described in a leaflet from Crow. Hundred frames per side of magnetic disc. Crow of Reading Ltd, P.O. Box 36, Reading, RG1 2NB .... WW 402

General electronic components, materials, tools and equipment in Greenweld catalogue, which includes prices and quantity discounts for schools or private customers. Greenweld, 443 Millbrook Road, Southampton, SO1 0HX. Price 45p by post.

Connectors by Amphenol, in Circular Environmental range, to EL2112 Patt. 602. Def. Stan. 59-56 and Panavia Spec. 6432-1 in new catalogue from Amphenol Ltd, Thanet Way, Whitstable, Kent CT5 3JF .... WW 403

Quarterly-updated stock list from Crellon includes stock level and price of components from G.I.M., International Rectifier, Keyswitch, Motorola, Plessey, RCA, Sprague and Waycom (WIMA capacitors). Crellon Electronics Ltd, 380 Bath Road, Slough, Berks .... WW 404

Fibre-optic systems and kits from Belling-Lee, designed for computer peripherals, power control, etc., described in catalogue P.832C, obtainable from Publicity Department, Belling and Lee Ltd, Great Cambridge Road, Enfield, Middlesex .... WW 405

Programmable semiconductor devices described and techniques of programming explained in booklet from Data I/O. Somewhat unrestrained title shortened to "Jungle book". Obtainable from Microsystem Services, Duke Street, High Wycombe, Bucks .... WW 406

Catalogue sections from Bulgin now available on fuses and fuseholders, lampholders, code switches and digital displays. Sections available from A. F. Bulgin and Co. Ltd, Bypass Road, Barking, Essex IG11 OAZ ... . WW 407

Add-on memory for 158, 168, 3031 and 3032 c.p.us described in brochure from Storage Technology Corp. Maintenance panel which displays and diagnoses errors for up to 36 locations also described. STC, 2270 South 88 Street, Louisville, Colorado 80027, USA ... . WW 408

Miniature magnetic circuit breakers, intended for close protection, down to individual p.c. boards, described in catalogue from Highland Electronics Ltd, Highland House, 8 Old Steine, Brighton, Essex Sussex BN1 1EJ .... WW 409

R.f. and microwave components, such as couplers, mixers, rotary joints, in 240-page catalogue by Sage Laboratories, with application information. Obtainable from R.E.L. Equipment and Components Ltd, Croft House, Bancroft, Hitchin, Herts SG5 1BU .... WW 410

A low-cost digital frequency meter — 2

Power supply and constructional details

by M. Tooley, B.A. and **D. Whitfield,** B.A.

The first part of this article described the main circuit of the digital frequency meter and included a list of the components required. This concluding part describes the power supply and the meter construction, and illustrates the printed-circuit board track and component layout details.

THE METER is designed to operate from a single unregulated d.c. power supply in the range 6.5 to 14V. In principle, it is possible to power all of the circuits from a single voltage rail but in practice a number of considerations (powere dissipation, isolation, decoupling, etc.) lead to the use of two separate regulated voltage rails. Figure 7 shows the circuit diagram for the power supplies.

The e.c.l. circuits are supplied from a 5.6V rail, the regulator for which consists of a single-transistor, series regulator arrangement, D_5/Tr_7. The remainder of the meter is supplied from a 5V fixed regulator i.c., which incorporates current and thermal overload protection circuits. Overall protection of the meter against reverse polarity and voltage transients is provided by D_4

Practical details

Construction of the digital frequency meter should not be attempted without the use of the recommended double-sided printed circuit board layout. The component side of the printed circuit board is employed as a common earth plane and the other side of the board is printed. This not only simplifies construction and ensures unconditional stability but also allows the keen constructor to produce his own p.c.b. A true double-sided board would prove to be extremely difficult to make due to problems associated with the correct alignment of the opposite sides of the board.

The simplest method of producing the printed circuit board is with the use of double-sided copper clad board, one side of which is coated with a suitable positive photoresist. A transparent mask should be made, according to the p.c.b. layout given, and this laid over the coated side of the board and then exposed to ultra violet light. The other side of the board is completely masked using self adhesive p.v.c. tape and remains masked during the developing and etching of the track side. After cleaning and drilling the board, holes to non-earthed components and i.c. lead-outs are cleared to approximately 3mm diameter by means of a standard countersink drill. Component and i.c. leads to be earthed are soldered directly to the copper foil. The usual precautions should be observed when handling and soldering the c.m.o.s. devices. After completing the assembly of the board it is recommended that the component side be cleaned using a solvent cleanser and then treated with a light coating of protective lacquer spray.

Adequate decoupling at all frequencies is essential for both supply rails and this is accomplished by the use of a mixture of miniature ceramic and tantalum capacitors. Test points are provided at the supply rails, buffered clock oscillator output, and at the output of the time standard divider – the waveforms at the latter two points being five volts peak to peak at 1MHz and 250Hz respectively. Further test points are provided in order to monitor the signal waveform after the input amplifier and at the output of the level translator (input frequency divided by four). The MC10231 is rated as having a typical maximum toggle rate of 225MHz, and is pin-compatible with the MC10131 which has a typical maximum toggle rate of 160MHz for approximately half the cost of the faster device. Tests indicate that the MC10131 is capable of satisfactory operation up to approximately 180MHz.

Provision has been made in the p.c.b. layout for the display to be wired for use with right- or left-hand decimal point indicators. In normal use a DL707 is used for IC_{16} and its right hand decimal point is returned to 0V by means of a 220Ω resistor in order to produce a read-out in MHz. If indicators having left hand decimal points are used, then the decimal point of IC_{15} is returned to 0V by means of a 220Ω resistor. The decimal point wiring may, of course, be completely ignored if a read-out in kHz is desired. For full six-digit display operation it would be necessary to replace IC_{12} by a decade counter and a

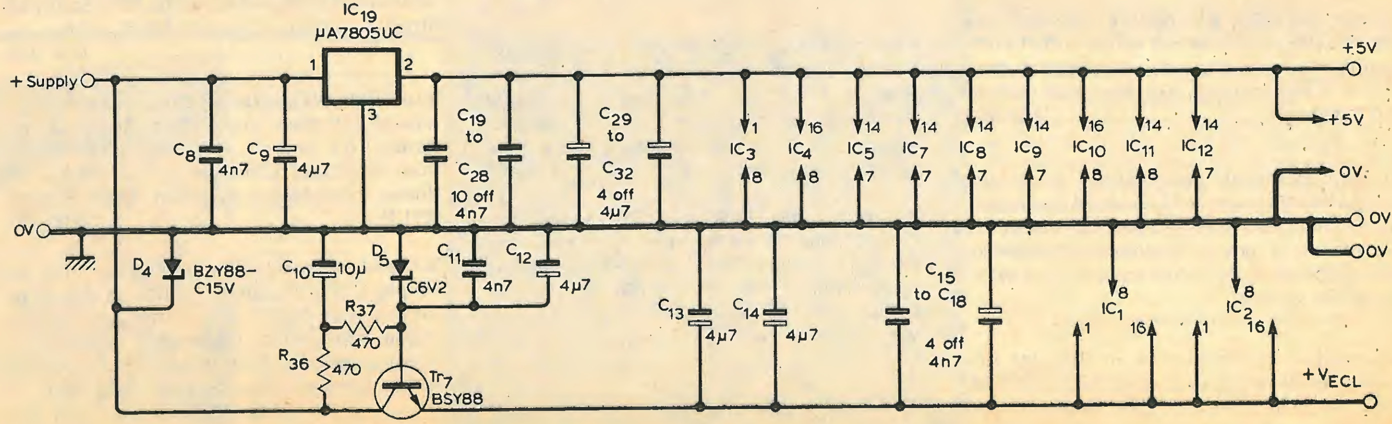


Fig. 7. *Power supply.*

suitable latch/decoder, such as those listed for IC_9 and IC_{10}. If this modification is incorporated, it should be noted that IC_{18} should be altered to the same type of display as IC_{13}.

Since the d.c. supply voltage input may take any value between 6.5V and 13.5V, adequate provision for heat sinking the regulators must be included. The 5V regulator, IC_{19}, makes use of the copper earth plane and this is adequate for supply voltages up to 12V. Above this value, the dissipation of the device should be increased by means of a simple vaned heat sink of around 20°C/W. Tr_7 requires a push-fit heat sink of 85°C/W for inputs not exceeding 10V, and 50°C/W above this value.

It has been found that some types of crystal require a small value capacitor, around 22pF to 47pF, connected in series with the crystal in order to allow the oscillator frequency to be adjusted to exactly 1MHz. The total cost of all components required for the digital frequency meter is around £40, inclusive of v.a.t. and a single source for all the semiconductors is Semiconductor Supplies (Croydon) Ltd.

Performance

The performance of a prototype meter with an MC10231 fast prescaler i.c. was measured using an 8V regulated power supply, a Racal type 365A signal generator, a Racal type 835 digital frequency counter and a Hewlett-Packard oscilloscope type 1722B with two model 10017A 10:1 probes. The oscilloscope was used in its unrestricted bandwidth (275MHz) mode.

Figure 10 shows a graph of the minimum input voltage to the counter against frequency for satisfactory triggering over the range 1MHz to 220MHz. Waveforms for the operation of the input stages are shown for 12MHz in Figs. 11 & 12 and for 100MHz in Figs. 13 & 14. In all cases the upper trace is the input signal waveform and the lower trace is either the output of the input amplifier at test point 1 (Figs. 11 & 13) or the output of the level translator at test point 2 (Figs. 12 & 14).

In operation, the counter draws a maximum supply current of approximately 650mA, with a standby (zero display) drain of approximately 400mA.

Acknowledgement

The authors would like to thank their colleagues for all the help and encouragement received during the development of the meter described in this article. Particular thanks are due in this respect to Mr T. Y. Chan, Mr I. A. Laurence and Mr C. P. Orwell of EMI Medical Limited, and to Mr A. Stables of Brooklands Technical College.

Printed circuit board see Part 1.

The authors

Mike Tooley is a senior lecturer in electronic engineering at Brooklands Technical College at Weybridge in Surrey. He is responsible for higher certificate courses in electronics and is tutor for the Advanced Level Course in Electronic Systems. His interests include amateur radio (G8CKT), particularly the microwave bands, and constructional projects. Mike, who is also an assessor for the expedition section of the Duke of Edinburgh's Award Scheme, was editor of *FM News*, the journal of the UK FM Group (London), for over 3½ years.

David Whitfield is a senior development engineer for EMI Medical Ltd at Hayes in Middlesex. He obtained his engineering degree (BA) at Cambridge and has, since this article was commissioned, had a medical electronics and physics degree (M.Sc, London) conferred on him. His interests include amateur radio (G8FTB), constructional projects, photography, and hi-fi.

Both authors are also involved in youth work, as scout leaders.

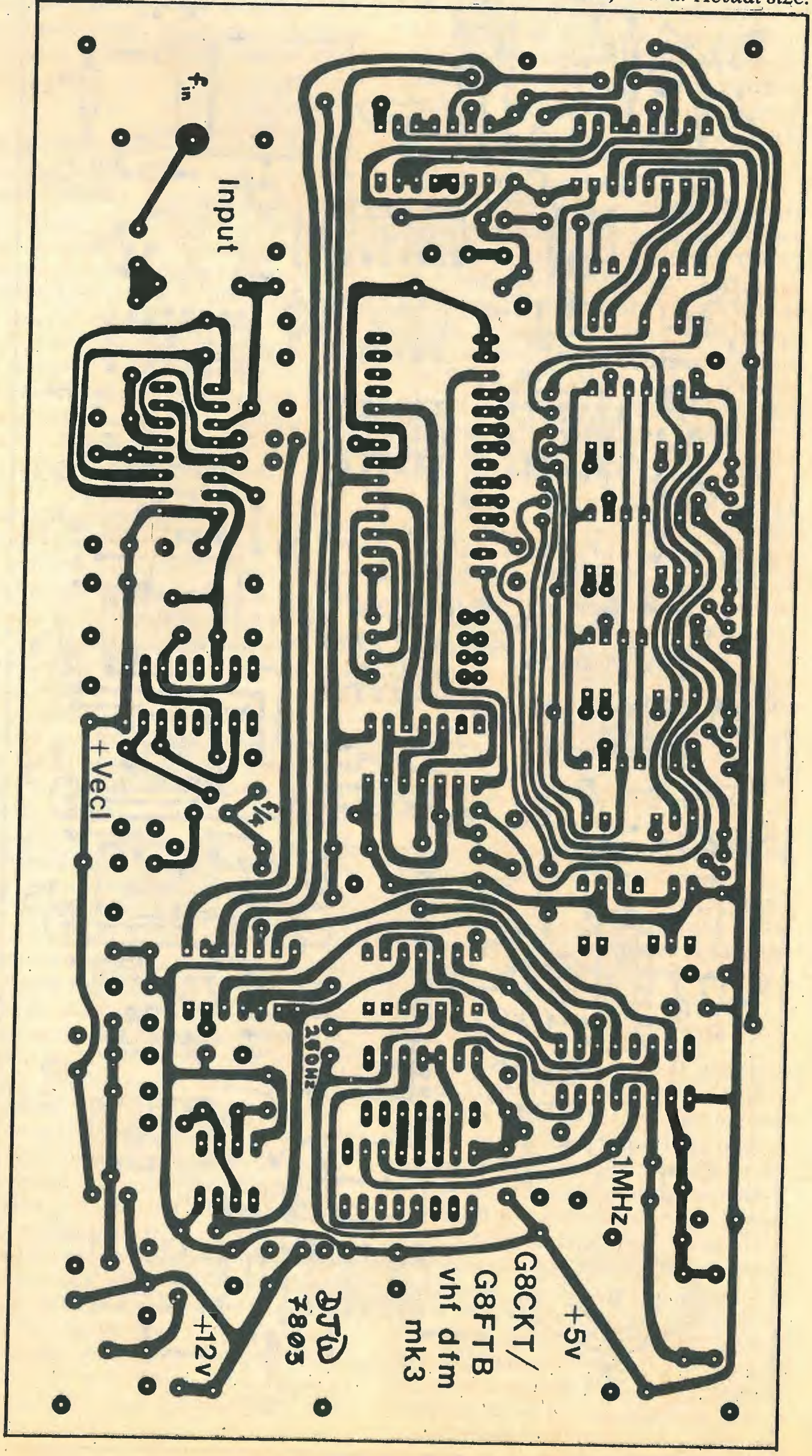


Fig. 8. *P.c.b. copper track pattern viewed from etched side of board. Actual size.*

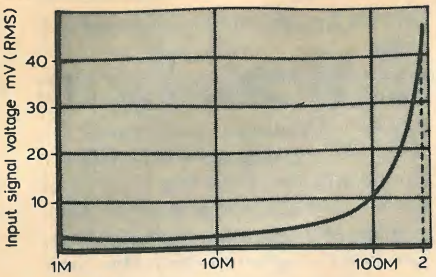
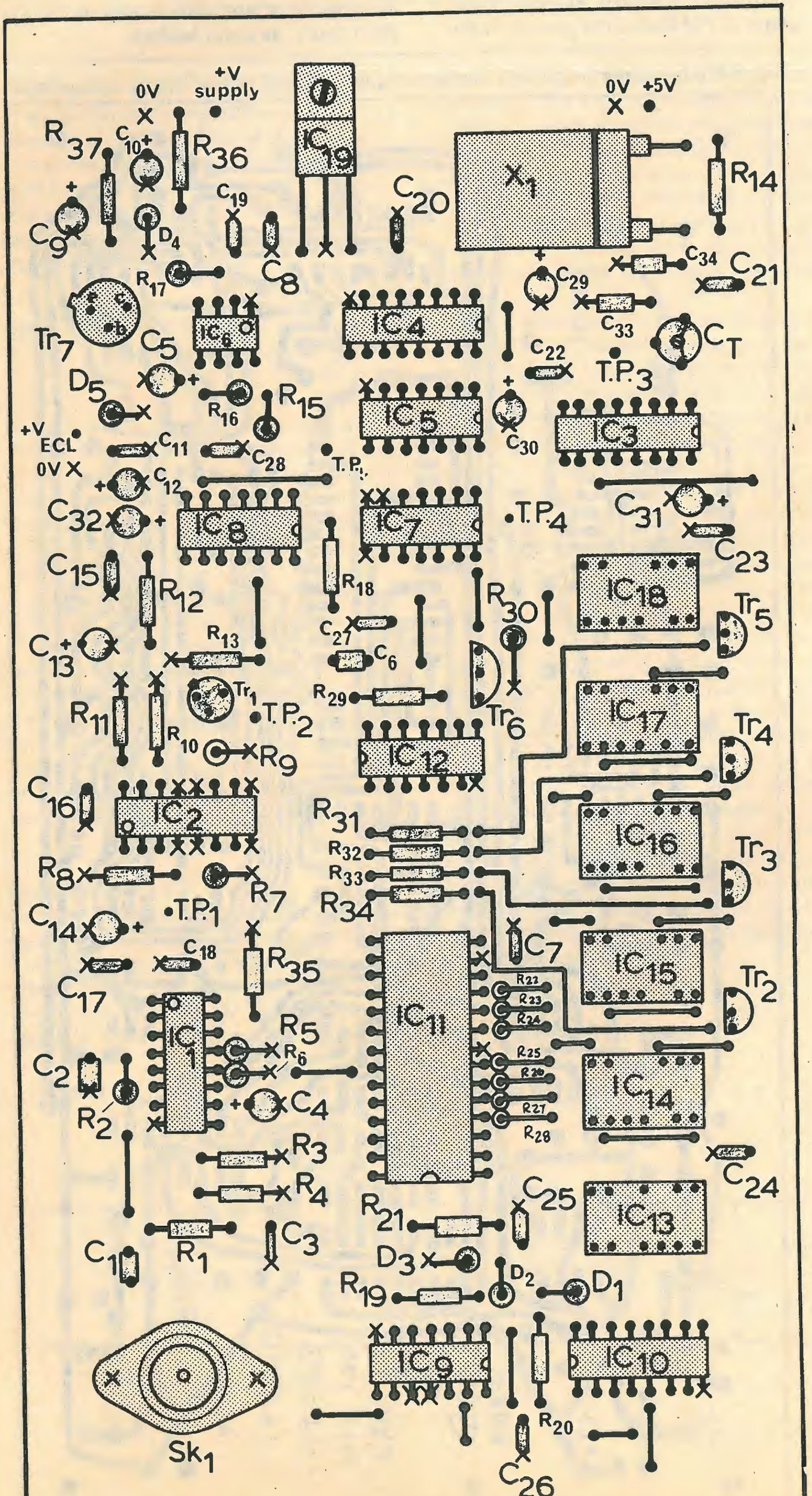


Fig. 10. *Input sensitivity of frequency meter shown as a function of frequency.*

Fig. 9. *P.c.b. component layout viewed from component side (earth-plane side). Crosses indicate connections to earth plane and all others are to have clearance through earth plane. Approximately actual size.*



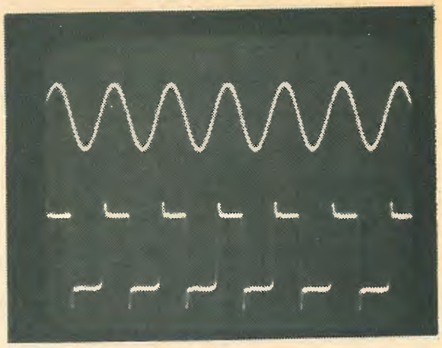


Fig. 11. *12MHz oscilloscope traces: upper, input signal at SK1; lower, output of input amplifier at test point 1. 50ns/div. 100mV/div. (upper) and 500mV/div. (lower).*

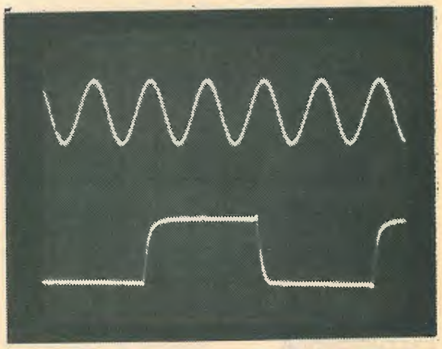


Fig. 12. *12MHz oscilloscope traces: upper, input signal at SK1; lower, output of level translator at test point 2. 50ns/div. 100mV/div. (upper) and 2V/div. (lower).*

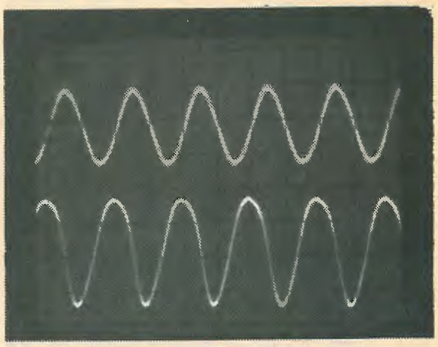


Fig. 13. *100MHz oscilloscope traces: upper, input signal at SK1; lower, output of input amplifier at test point 1. 5ns/div. 100mV/div. (upper) and 500mV/div. (lower).*

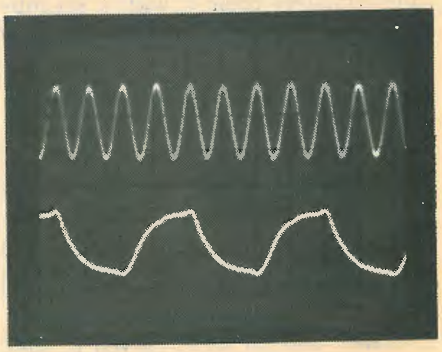


Fig. 14. *100MHz oscilloscope traces: upper, input signal at SK1; lower, output of level translator at test point 2. 10ns/div. 100mV/div. (upper) and 2V/div. (lower).*

The technique of technical writing

Its value as an aid to thought

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

To some technical workers the task of writing reports is a chore more to be endured than enjoyed. Such workers may claim, for example, that their skill is in electronic design not literary composition and that their time is better devoted to the next design than to writing up the previous one. This attitude to technical writing is understandable but it shows a lack of appreciation of the purpose and value of technical reports and ignores the advantages that can be obtained from writing them. The mental discipline (chiefly the need for logical thought) essential in successful writing can help in design work and usually improves understanding of the subject. In this article the author gives some useful information on the processes involved in technical writing and hopes to show that it can offer challenges as exciting and rewards as satisfying as those of electronic design.

THERE ARE many possible reasons for a lack of enthusiasm for technical writing. For example, technical staff may feel that they have been asked for a literary masterpiece and that writing is not their speciality. The mistake here is to suppose that technical literature is read for the beauty of its language. It serves, in fact, a strictly utilitarian purpose — to provide technical information as clearly and concisely as possible. The facts in technical literature are more important than the way in which they are presented i.e. the content is more important than the style.

In great literature, on the other hand, the most significant quality is the beauty of the language i.e. the style is more important than the factual content. For example the story of Macbeth can be told in a few pages but without Shakespeare's English it would make dull and pointless reading. The distinction between the two types of literature stems from a difference in purpose: technical literature is intended to inform; the Shakespeare play is for entertainment (a view unlikely to be shared by young schoolboys!).

Although content is the most important factor in technical literature, style must not be dismissed as of minor concern. On the contrary style matters considerably because it determines the readability and thus how easy it is to understand the technical content. Much of this article is concerned with style and it is probably true that more of the shortcomings in modern technical literature stem from errors in style than from poor selection or arrangement of facts.

The specification

A second reason which may cause engineers difficulty in technical writing is the need for a specification. An engineer asked to design an amplifier cannot begin work until he knows what kind of amplifier is required: he needs information on, for example, the gain, output power, load resistance, frequency range and permissible distortion. Such a detailed specification is the starting point from which design begins. Yet the need for a specification for a piece of technical writing is often overlooked or insufficiently appreciated. In fact an engineer's instructions may simply amount to a request for a report! It is true that some information on the type of technical content and style may be available from reports on previous designs but this is an unsatisfactory and secondhand way of deducing the specification.

A specification for a piece of technical writing is as necessary as one for a piece of technical equipment and should include information on a number of factors. Obviously the subject matter must be made clear and this must be defined with precision. If certain aspects of the subject need not be included, this must be stated. Equally important if not so obvious is information on the readers. For whom is the literature intended? Who needs the information which has been so carefully defined? What are the general technical backgrounds of the readers? Information on this is vital because it determines the technical standard and the form of presentation to adopt in the writing. The author also needs to know the purpose of the literature. Often it is simply the provision of technical information but there are other possibilities: for example a research report may compare two methods of solving a technical problem and may be required to decide and state which is the better. But the most important questions which the specification must answer are usually "who wants to read this literature and why?"

The questions are easy to answer if, for example, one is writing a textbook on a specific subject and aimed at students of a particular level of academic standard. Here the subject matter is laid down in a syllabus and the readers' background is known. Similarly a research report published in the proceedings of a learned institution is usually intended for readers with a background and technical standard similar to those of the author. Technical writing is particularly difficult where the age, experience and technical standard of the readers covers a wide range. A good example of such a piece of writing is this article! The only thing we know for certain about *Wireless World* readers is that they are interested in electronics. It would therefore be a good idea to give an electronic flavour to all the examples in the article.

Vagueness of purpose is another difficulty which sometimes plagues the technical author. An example arises in the accounts of laboratory experiments which students at college or university are required to write. For whom are these accounts intended? Clearly not the instructional staff for they will learn nothing from them nor the students because they are unlikely to open their laboratory notebooks after leaving the college. No-one else is likely to read the reports. Perhaps the best that can be said is that preparing these reports gives the students some practice in technical writing and in keeping records of work done. These reports are in the same category as students' lecture notes which are usually ignored when the relevant examination has been passed.

Structure

Once the specification for a piece of technical writing is known the author can begin collecting and selecting the facts to be included. It can take time to amass a relevant and comprehensive set of facts because to find them the author may need to consult technical books, articles, reports, specifications or other literature, to talk to experts, to build equipment or to carry out experiments. When the facts are ready they must be classified i.e. those relating to a particular aspect of the subject must be gathered together and the groups so obtained must be arranged to give a smooth flow of information. There are many ways of doing this. The obvious method is to put the ideas down on paper and to build up the required order by insertions, deletions and transpositions. In doing this the draft usually becomes untidy and a number of rewrites (or retypes) are needed before a satisfactory arrangement is achieved. A second method is to write the facts (in the form of brief notes) on cards which can be shuffled to give a suitable order.

Whilst the author is concentrating on achieving a satisfactory arrangement of technical content (sometimes called structure) he cannot normally pay much attention to details of style but this does not matter because style can be tidied up afterwards. The most satisfactory structure is normally one which has a logical step-by-step progression of ideas and the search for such an order can have a number of useful consequences:

(a) Any gaps in the sequence of ideas become obvious and to fill these the author may need to renew his fact-finding research to discover the information needed to complete his story.

(b) The division of the subject into sections, subsections and sub-subsections usually becomes clear and this helps considerably in choosing appropriate headings and subheadings.

(c) The search for suitable groupings and arrangements of facts or for suitable headings sometimes produces delightful surprises: This illumination of dark corners of knowledge is one of the rewards of technical writing.

Some authors divide their work into five or six generations of heading. This is useful in clarifying and classifying the author's thoughts but it is unwise to include so many generations in the final draft because they would be confusing to the reader and would make cross-references complex and difficult to find. As a general rule it is better to use no more than three generations and the number can usually be reduced to one by repeating one or more key words. In the example illustrated below two generations are reduced to one by repeating the words 'feedback' and 'derived':

Derivation of feedback
By series connection
By parallel connection

can be replaced by

Series-derived feedback
Parallel-derived feedback

Once the structure of a piece of technical writing has been settled the author may be tempted to think that the major part of his job is done. The setting down of ideas in words is often regarded as a straightforward process calling for no great skill and thus insufficient attention is paid to this aspect of the task. An author may argue that any reader who finds his work difficult to understand should concentrate more because all the information is present and is, moreover, arranged in logical order. This is a comforting philosophy for the author because it shifts to the reader the responsibility for extracting the meaning from a difficult text. It is, however, the author's responsibility to see that his work is easy for the intended reader to understand and this usually requires that as much attention is paid to the style as to the selection and arrangement of facts. The author should not forget that his words may remain in print for the rest of time as a monument to his success or failure.

Style

Style usually implies such considerations as choice of words and sentence length. Certainly these are two important factors which contribute to the readability of text. But in technical literature text is not the only means of conveying ideas: extensive use is made of other aids such as illustrations (photographs, circuit and block diagrams, graphs), lists, tables, mathematics, calculations and any other means at our disposal for recording ideas on a piece of paper. All these factors are aspects of style and frequently a given series of facts can be presented in many different ways. The author has to decide which form of presentation to use and his choice depends primarily on the type of subject matter and on the reader's knowledge and background.

To quote a simple example, many *Wireless Word* articles are concerned with electronic circuits and detailed information on circuitry is always given by circuit diagrams. This is the natural way of conveying such information and is the method the reader expects. It is a most powerful way of presenting circuit information: anyone who has attempted to describe a circuit diagram in words (e.g. over the telephone) will know how difficult and time-consuming a task this is. Because the circuit diagram conveys most of the information required by the reader, there is no need to describe the circuit in words also. It is useful to point out any unusual or new aspects of the circuit but the author's and reader's time is wasted by duplicating in words information which is obvious from the diagram.

As another example, in a contribution to the proceedings of a learned society mathematical presentation is generally acceptable. Here again equations are a shorthand way of expressing ideas which are sometimes inexplicable in words. But in an article on the same subject to technicians, an author would probably present the facts in the form of graphs or abacs: the technician is usually more interested in the applications of ideas rather than their derivation.

"A good illustration is worth 500 words". "We like to have at least one diagram per page." Advice such as this is of little value. To what extent diagrams should be used depends on the subject matter and on the reader's background. Articles on electronic circuitry naturally abound in circuit diagrams. In fact experiments are being carried out at the moment to see if it is possible in literature on electronic equipment to dispense with conventional text and to give explanations which require words in little boxes within the circuit diagrams: some examples of such diagrams were given in *Wireless World* for October 1973. This is an example of one extreme where technical writing consists almost entirely of circuit diagrams. At the other extreme there are some technical subjects where there is no need for diagrams at all: this article is an example.

Another recommendation which is in practice impossible to follow strictly is that each paragraph should embody one idea. Some ideas, it is true, can be dealt with satisfactorily in a few lines, a convenient length for a paragraph. Other ideas require a page or more of description and it is a little offputting to a reader to see a solid page of text unrelieved by headings or paragraph breaks. So in practice breaks are deliberately introduced at intervals down the page. Where you pause to take breath, start a new paragraph!

There is a popular misconception to the effect that writing, to be authoritative, must be pompous, legal-sounding and liberally sprinkled with long words preferably of Latin extraction. A third reason why engineers may not enjoy technical writing could be that they feel that they cannot write this kind of high-flown English. There is no need: to carry conviction writing should be simple and direct. This need stems directly from the main purpose of technical writing – to give information. It should be possible for the reader to obtain the information he wants quickly and accurately: there should be no need to wrestle with involved syntax, puzzle over vague phrases or to refer to the dictionary. The greatest boon authors can confer on their readers is to present them with a clear and simple story which tells them accurately and unambiguously what they want to know. Long sentences liberally endowed with dependent clauses are better broken up into simpler sentences. Long words of Latin derivation so beloved by politicians and the Civil Service are better replaced by shorter Anglo-Saxon equivalents. Wordy phrases (such as "in the majority of instances") should be reduced to a single word ("usually") or omitted altogether. These common errors of style are enumerated in greater details in the appendix to this article which also gives preferred alternatives.

There is a simple way of avoiding these errors. Examine the words in every sentence one by one and ask yourself whether each contributes anything useful to the meaning. If not, throw them out. It is true that a ruthless application of this policy may lead to a concentrated staccato style which makes reading slow and indigestible but this difficulty can readily be overcome by inserting at the beginnings of sentences words such as 'but,' 'however', 'nevertheless' etc. to link the sentences together. This does not contradict the advice quoted earlier that each word should pull its weight: the promotion of smoothness in reading is a worthy purpose for any word.

The rules for ensuring good style can be summarised thus:

(a) See that every word is contributing usefully to the meaning
(b) Choose the simplest word
(c) Prefer sense to elegance.

Spoken and written English

These rules for good style apply only to written English. The effect of applying them to spoken English would be disastrous – making many of us speechless for long periods! In speaking we continually use vague and meaningless phrases to give us time to think out what we are going to say next. Speech is therefore strewn with 'Be that as it may', 'As a matter of fact' etc which perform a useful service in promoting continuity of speech (although the best speakers do not use them). But these phrases have no place in written English where they dilute the facts and make reading unnecessarily long and tedious. Repetitions, too, are commoner in spoken than in written English. A teacher or lecturer punctuates his lectures or lessons with statements of basic principles, summaries of what has been said and information on forthcoming attractions. This is good teaching practice but frequent repetitions are unnecessary in a book or article: the reader can also turn the pages forward or backward if necessary.

Degrees of perfection

No example of technical writing is ever perfect. It is always possible to improve the readability or clarity, and the degree of perfection achieved depends on how many times the author is prepared or allowed to rewrite the text to improve the style. Each new version is better than the previous but the improvement becomes less obvious with each successive rewrite. This is an example of an asymptote (Fig. 1): the curve approaches 100% (perfection) as new versions are prepared but perfection is never achieved. This is why it is always possible to suggest improvements to any piece of technical writing. This does not mean that the piece was badly written but that the author did not devote infinite time to its preparation. This is a good point for the author of this article to make because it provides the answer to any critic who feels moved to write suggesting improvements! This point can be summarised by saying that smoothness rarely arises from inspiration: it is more usually the result of perspiration.

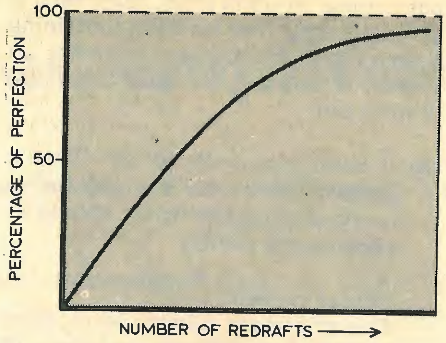


Fig. 1. The style of a draft improves with every redraft but perfection is never reached.

At what point then does one give up polishing? This is often decided on economic grounds e.g. two articles each 70% perfect are better value than one 95% perfect which might take the same time to prepare.

As mentioned earlier it is easy to criticise style. Indeed when comments are invited on drafts it is usually small stylistic alterations which are offered. These may be useful in improving readability and perhaps clarity but are not so valuable as comments on the technical content. Doubtless this is because there is no need to be an expert on the subject to be able to comment on style but a good knowledge of the technology and a detailed study of the draft are necessary before structural comments can be offered.

Accuracy and clarity

Several times in this article we have implied that clarity and readability are important aspects of technical literature. But factual accuracy is also important and circumstances can arise where the interests of clarity and accuracy clash. Which is then sacrificed to the other? The answer depends on the subject matter and on the technical standard of the writing. In an elementary textbook, for example, it is almost impossible to make any statement without calling to mind a number of exceptions or important conditions which ought to be mentioned. To include all these would probably not help the young reader and would certainly rob the statement of much of its punch. In such writing it is usually better to forget the qualifications and so sacrifice accuracy to achieve clarity. But in describing, say, the sequence of starting-up operations for a high-power transmitter where an error could lead to delay or even to damage of the equipment, technical accuracy is clearly essential and, if necessary, clarity should be sacrificed in its interests.

APPENDIX: COMMON ERRORS OF STYLE

Use of vague phrases

Perhaps because authors are paid according to the length of their contributions or because they write as they speak, there is a tendency to use unnecessary words and phrases. Such verbal padding dilutes the meaning and is best avoided. Some of the commonly-used phrases, with preferred alternatives, are given below: this list is by no means complete.

vague phrase	preferred alternative
at this point in time	now
in the vast majority of instances	usually
in the event that	if
owing to the fact that	because
according as to whether or not	if
a considerable amount (or number) of	most
referring to the diagram it can be seen that	the diagram shows
in the first place	firstly
from the practical point of view	in practice
when it comes to	in
it should be noted at this junction be that as it may in point of fact as a matter of fact	(omit)

Overuse of impersonal phrases

Continual use of phrases such as "it can be shown that . . ." "it is important to note that . . ." make text dull and monotonous. Most can easily be avoided (and a saving of words achieved) as the following examples show.

impersonal phrase construction	possible alternative
It is essential that the receiver be retuned after each adjustment	retune the receiver after each adjustment.
It will be noted that, as far as the carrier frequency is concerned, the circuit is basically a bridge.	At the carrier frequency the circuit has the form of a bridge.

Use of complex syntax

It takes time for readers to appreciate the grammatical structure of a sentence with a number of dependent clauses and this delays understanding of the meaning. Moreover there is a danger that a clause, if not carefully placed in the sentence, may be taken as qualifying the wrong word. Such sentences should preferably be recast as a number of simpler sentences.

Unnecessary use of long words of Latin extraction

As mentioned earlier the use of long words is sometimes believed to give written work an air of authority. This is quite wrong: the equivalent Anglo-Saxon words are usually shorter and have more impact. The following are few examples.

Latin-based word	simpler equivalent
initiate	begin, start
terminate*	end, finish
visualise	think, picture
facilitate	aid, help
necessitate	need
elucidate	explain
utilise	use

Unnecessary use of abstract nouns

One of the common ways of using more words than is necessary to convey the meaning is to introduce an abstract noun as in the following examples.

wordy phrase	simpler equivalent
incurs a heavy cost penalty	is expensive
in the low-loss category	is of low loss

Use of 'former', 'latter' and 'respectively'

These words cause the reader to look at the previous sentence to find out what words are meant. This distraction interrupts the flow of the argument. Often 'respectively' can be omitted without risk of confusion. If, however, there is any danger of misunderstanding it is better to repeat the key words.

Punctuation

Anything which is likely to distract the reader should be avoided. Complex constructions which rely on punctuation marks to convey the desired meaning are better recast as simpler sentences. But hyphens linking words in adjectival phrases can improve clarity e.g. a "high-value low-loss capacitor" is easier to read than a "high value low loss capacitor."

To conclude this appendix here are some examples taken from textbooks containing errors in style. After each is given an error-free version (containing approximately half the number of words) which is easier and clearer to understand.

(a) It is very difficult to lay down a precise value for the minimum receiver passband which should be allowed. (19 words)

Recast version
The minimum allowable receiver passband is difficult to assess. (9 words)

(b) Although it is generally accepted practice to lay the earth plates in a regular pattern, cognizance must be taken of the fact that the earth resistivity may vary over a given area . . . (32 words)

Recast version
Earth plates are normally laid in a regular pattern but the earth resistivity may vary over a given area. . . (19 words)

(c) Although there does not appear to be much to choose between silicon and germanium transistors as far as electrical characteristics are concerned . . . (23 words)

Recast version
The electrical characteristics of silicon and germanium transistors are similar . . . (10 words)

Further reading

Readers seeking further information on the presentation of technical information may find the following publications useful:

P. Wright, "Presenting Technical Information: A Survey of Research Findings", Medical Research Council, Applied Psychology Unit, Cambridge, CB2 2EF.

H. J. Tichy, "Effective Writing for Engineers, Managers, Scientists" John Wiley, New York.

---

* But a transmission line is terminated: 'ended' would be wrong here.

More letters

MICROCOMPUTER BUSES

Some months ago, in quest for a suitable universal bus for a computer system, having already rejected S100 as primitive and incompatible (even with itself!), I came across reference to such a bus designed in this country, namely E78, outlined by Mr Aylward in December 1978 letters. Further investigation revealed a very active committee working on the bus specification and they were only too pleased to give detailed information about it.

E78 has been designed with all current and future microprocessors in mind, and appears fully compatible with 8-to-16-bit systems, to the extent that a system running as an 8-bit system can be instantly upgraded to a 16-bit system, just by substituting the 8-bit c.p.u. card for a 16-bit c.p.u. card plus the relevant software. The specification includes descriptions of all bus signals and their timing, and great care has gone into important areas such as power requirements, transmission line effects and future expansion possibilities. The specification supports single or double Eurocards using one or two indirect connectors, depending on system complexity.

I am a little alarmed to see that another bus has been proposed by Mr Borril (October 1978 letters). I only hope that these two groups can get together quickly on amicable terms, because I and several others have already committed designs to paper, using the E78 system, and will be manufacturing equipment in the near future.

It seems the fate of British designers to suffer indecisions on standards, particularly at a time when to delay may mean lost business and the perpetuation of inferior standards such as S100!

M. A. J. Hutchings
Chatham
Kent

NORWEGIAN 2M REPEATER

As mentioned in "World of amateur radio" in the December 1978 issue, we would like to inform you that LA6ER is not a beacon, but a 2-metre repeater transmitting/receiving on the European repeater channel R5. Power to charge the batteries comes from a solar panel and from a small windmill.

We are enclosing full technical information of the equipment, which we believe is the first repeater at least in Scandinavia to be powered by the sun and wind. [Readers interested may obtain photo-copies from this office by sending a stamped, addressed envelope — Ed.]

The repeater is well known to British amateurs and can easily be started with just a little bit of "lift" by stations in Scotland.

O. Lindberg, LA5WT
President NRRL group.
Egersund
Norway

Audio power amplifier design — 6

More on negative feedback and non-linearity distortion — a continuation of part 5

by Peter J. Baxandall, B.Sc.(Eng.), F.I.E.E., F.I.E.R.E.

Part 5 (December issue) discussed the theory of non-linearity distortion in an ideal feedback amplifier having a parabolic forward transfer characteristic. Attention is now turned to distortion in circuits using ordinary junction transistors*, having exponential transfer characteristics. The concept of "inverse distortion" is introduced, leading to a useful distortion theorem.

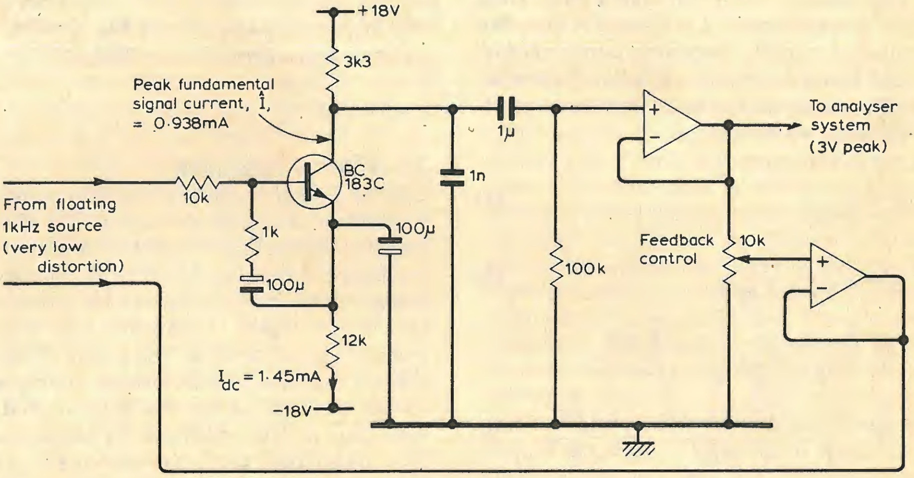


Fig. 1. *Circuit used for distortion measurements.*

THE CIRCUIT USED for obtaining the experimental results presented below is shown in Fig. 1 and is the same as for the f.e.t. tests in Part 5, except for two small modifications. The 1nF capacitor was found necessary to prevent high-frequency oscillation when full feedback was applied, and the resistive attenuator in the base circuit was added to reduce loop gain, for convenience, to a similar range of values to that applying to the f.e.t. version of the circuit. The measured current gain (β_{dc} or h_{FE} of the transistor used was 580 at, an I_b of 1μA.

Throughout the measurements the fundamental output voltage was kept constant at three volts peak, corresponding to a ratio of peak signal current to direct working current of 0.647 – the same conditions as for the f.e.t. tests in Part 5. The results are shown by the full-line curves in Fig. 2, and exhibit some fascinating features when compared with the earlier f.e.t. results. A great deal of thought, both of a formally analytical and also of a more intuitive type, has been devoted to trying to understand these features, and considerable enlightenment has resulted.

A junction transistor has the great virtue, at sufficiently low values of collector current, that it follows in practice, with high accuracy, the relationship

$$I_c = I_o \exp\frac{qV_{be}}{kT} \quad (1)$$

where I_c is collector current, V_{be} base-to-emitter voltage, and the other symbols are constants. (The tendency always to regard junction transistors as current-operated devices, and the current gain as the basic parameter for design purposes, should be most strongly discouraged, in my opinion.)

A practical junction transistor would be expected to follow the above law much more closely than an f.e.t. would be expected to follow a parabolic law, so that there seemed good reason for thinking that the curious wiggles in the Fig. 2 curves might be theoretically explicable on the basis of equation 1.

Determining transfer characteristic

For analysis the circuit may be simplified to that shown in Fig. 3, in which the transistor is assumed to follow equation 1. It may be shown that the incremental signal input and output voltages of the circuit are related by

$$v_{out} = -R_L I_{dc}\left[\exp\frac{qv_{in}}{kT}\times\exp\frac{q\beta v_{out}}{kT} - 1\right] \quad (2)$$

where q is the electronic charge (1.60×10^{-19} coulomb) k Boltzmann's constant (1.38×10^{-23} joules/deg C) and T absolute temperature. To be able to calculate the harmonics in v_{out} when v_{in} in equation 2 is put equal to $\hat{V}_{in}\sin\omega t$, the relation must be expressed in the form of a power series:

$$v_{out} = a_1 v_{in} + a_2 v_{in}^2 + a_3 v_{in}^3 + a_4 v_{in}^4 + \ldots \quad (3)$$

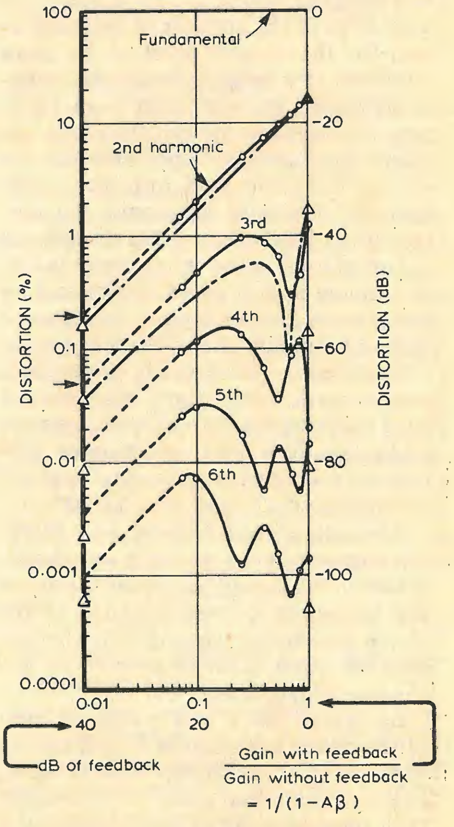


Fig. 2. *Measured and calculated results for the Fig. 1 circuit.*

---

*Sometimes called bipolar junction transistors or b.j.t. because their operation involves both polarities of charge carrier. The usual type of f.e.t. is also a junction device, but it is unipolar because only one polarity of charge carrier is involved.

The values of the coefficients a_1, a_2, a_3 etc may be found by using Maclaurin's theorem, which says

$$a_1 = \left[\frac{dv_{out}}{dv_{in}}\right]_{vin=0}$$

$$a_2 = \frac{1}{2!}\left[\frac{d^2v_{out}}{dv_{in}{}^2}\right]_{vin=0}$$

$$a_3 = \frac{1}{3!}\left[\frac{d^3v_{out}}{dv_{in}{}^3}\right]_{vin=0}$$

By successively differentiating equation 2 and putting $v_{in}=0$ in the resultant expressions, the coefficients may thus be determined. Unfortunately the algebra rapidly becomes cumbersome, and being no mathematician, I gave up after determining the first three coefficients, which are

$$a_1 = \frac{A}{1-A\beta} \qquad (4)$$

$$a_2 = \frac{1}{2!}\frac{q}{kT}\frac{A}{(1-A\beta)^3} \qquad (5)$$

$$a_3 = \frac{1}{3!}\left(\frac{q}{kT}\right)^2 A\left[\frac{1}{1-A\beta} - \frac{3|A\beta|}{(1-A\beta)^2} + \frac{3|A\beta|^2}{(1-A\beta)^3} - \frac{|A\beta|^3+3|A\beta|}{(1-A\beta)^4} + \frac{3|A\beta|^2}{(1-A\beta)^5}\right] \qquad (6)$$

In these equations β is positive and $A=-g_mR_L$, where g_m is the transistor mutual conductance when $v_{in}=v_{out}=0$ and the collector current is I_{dc}.

Determining the harmonics

Knowing the value of v_{in} ($=\hat{V}_{in}\sin\omega t$), as a function of the amount of feedback in use, for the output level of 3V peak adopted, the output harmonic magnitudes may be calculated from equation 3 on the assumption that only the square-law term is responsible for the second harmonic and only the cubic term for the third harmonic. Because the output level is large, this simplifying assumption leads to appreciable, though not unduly gross, errors, and for better accuracy the production of some second harmonic due to the presence of a fourth-power term needs to be taken into account, etc. A fairly high output level was adopted in the experiments to make the high-order harmonics sufficiently large for straightforward measurement, i.e. well over 0.0001%.)

The calculated second and third-harmonic curves are shown chain-dotted in Fig. 2, and lie somewhat below the measured curves because of the above simplifying assumption. The reasons for other detailed differences will become apparent later on.

In view of the + and − signs in front of the terms in equation 6, and on the supposition that the expressions for a_4, a_5 etc. will contain even more terms of both signs, one can at least say that it is hardly surprising that the measured curves for the higher-order harmonics in Fig. 2 are of a more complex type.

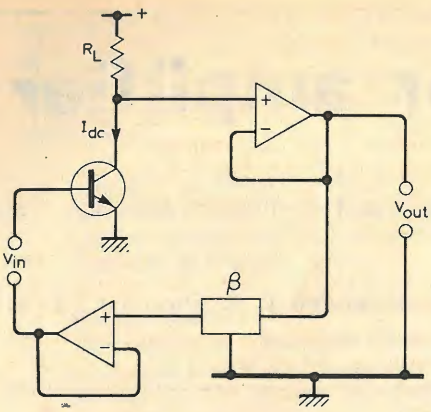


Fig. 3. *Simplified version of Fig. 1 with d.c. bias arrangements omitted.*

Alternative approach

The method of analysis presented above basically involves determining the transfer characteristic for the complete feedback amplifier, and then calculating the harmonic magnitudes when a sine-wave input is handled via this transfer characteristic. The shape of the overall transfer characteristic changes as the amount of feedback is altered, resulting in the observed variation in the magnitudes of the various harmonics. It should be emphasized that no intermodulation concept is involved in this approach when the input to the complete circuit is a single sine-wave signal.

An alternative approach, which is very helpful in providing further insight, involves thinking simply in terms of the invariant transfer characteristic of the forward amplifying device. Intermodulation effects then *do* have to be taken into account, for the forward amplifying device receives inputs from both the sine-wave input signal and also via the β-network from the amplifier output, the last-mentioned contribution containing harmonics which intermodulate with the fundamental and with each other.

In particular, the second harmonic and fundamental intermodulate to produce a component at third-harmonic frequency, and careful consideration of the waveform polarities involved shows that this third-harmonic component is in antiphase with that produced by straightforward third-harmonic distortion of the fundamental. The null in the curve for total third-harmonic distortion thus occurs when the amount of feedback is such as to make these oppositely-phased third-harmonic components of equal magnitude. The fact that in the measured third-harmonic curve, a minimum rather than a perfect null is observed, is believed to be because slight phase errors in the experimental circuit prevented the two-third-harmonic components from being exactly in antiphase.

A further intermodulation effect is that the fundamental and third harmonic intermodulate to produce a second-harmonic component which, though of considerably smaller magnitude than that produced by straightforward second-harmonic distortion of the fundamental, nevertheless slightly modifies the shape of the second-harmonic curve.

The percentage of second harmonic generated within the transistor, at constant output, is proportional to the third-harmonic voltage fed back into the base circuit, but the percentage output distortion is reduced $(1-A\beta)$ times relative to this by negative feedback. For working conditions to the left of the null in the third-harmonic curve, this intermodulation-generated second harmonic is in the same phase as that produced by straightforward second-harmonic distortion. Its magnitude at the amplifier output, with enough feedback to bring the working point onto the approximately constant-slope part of the third-harmonic curve, is such as to lift the position of the second-harmonic curve by a constant distance, and the calculated spacing is of the order shown.

It is instructive to compare the Fig. 2 curves with those of Fig. 7 in Part 5. There are two basic differences (a) the f.e.t. curves show no nulls or minima; and (b) the measured f.e.t. second-harmonic curve does not exhibit the departure from linearity evident in the Fig. 2 curve. The reason for (a) above is believed to be that, for the f.e.t. specimen used, the harmonic-distortion-generated third-harmonic component was in phase, rather than in antiphase, with the component generated by intermodulation. The high-order terms in the transfer characteristic for an f.e.t., unlike those for a junction transistor, seem to vary from one specimen to another – the one used for the Fig. 7 (Part 5) results had been selected for low third harmonic. It may well be that some other speciments would give curves with nulls, but this has not been investigated.

The reason for difference (b) above is simply that the signal level was too low to make the effect noticeable. Though the f.e.t. and the junction transistor were both worked at the same ratio of peak signal to direct working current, the f.e.t., because of its different type of transfer characteristic, gave less second-harmonic distortion in the absence of feed-back – see equations 16 and 17 in Part 5. On turning up the signal level in the f.e.t. circuit for 4V rather than 3V peak output, an appreciable departure of the second-harmonic curve from linearity was observed.

High-feedback theory

It is a characteristic of the Fig. 2 curves that all their complex features disappear when enough feedback is applied, and this fact suggests that maybe the high-feedback parts of the curves at the left could be calculated in a manner devoid of the above complications. This indeed turns out to be the case, and it is thought that appreciation of this fact is of considerable engineering value, for in the majority of practical applications one is really only interested in the performance with plenty of feedback applied.

Any amplifier, without feedback, can in principle be made to give a perfectly sinusoidal output voltage, at a specified level, by feeding an appropriately distorted waveform to its input. With negative feedback applied, this same totally undistorted output voltage can be maintained if V_{in} (Fig. 4) is arranged to contain the necessary distorted error voltage, as above, plus some extra fundamental to cancel the fundamental being injected negatively into the input circuit via the β-network. (With undistorted output, the feedback voltage is, of course, also perfectly sinusoidal.) Thus, as β is increased, V_{in} has to supply a constant-amplitude harmonic spectrum plus an increased amount of fundamental. The magnitude of the required fundamental input, for the specified constant output voltage V_{out}, is given by the usual feedback formula.

$$\frac{V_{out}}{V_{in}}=\frac{A}{1-A\beta}$$

which for the present purpose is more conveniently arranged as

$$V_{in}=V_{out}\frac{1-A\beta}{A}$$

Since the harmonic part of the input is quite constant, the percentage input distortion is inversely proportional to the amount of fundamental input voltage, i.e. it is proportional at $1/(1-A\beta)$, and this applies at every harmonic frequency. It also applies whether the amount of feedback is large or small.

It is thus seen that the distortion situation for a feedback amplifier is really very much simpler when viewed on this basis of percentage input distortion for a pure output, than when considered on the more usual basis of the output distortion for a pure sinusoidal input. At this point the reader may well object that, while it may indeed be easier to consider the feedback mechanism on this basis, the concept is artificial and not related to the way amplifiers are used in practice. The utility of the approach, however, lies in the fact that, *provided there is plenty of feedback*, the distortions become practically identical whether expressed on a distorted-input/pure-output basis, or on the usual distorted-output/pure-input basis. Thus if the percentage distortion with no feedback is calculated on a pure-output/distorted input basis – which turns out to be relatively easy – then the distortion with plenty of feedback applied, expressed in the customary manner, is equal to the just-mentioned no-feedback percentage divided by $(1-A\beta)$, the output level being kept constant. This applies both to total harmonic distortion and also to all individual harmonics of practical significance, provided only that the amount of feedback is sufficiently large. For the working conditions relevant to Fig. 2, or Fig. 7 of Part 5, it is evident that 20 to 26dB of feedback would be "sufficiently large."

It is now necessary to justify the statement that the distortion with plenty of feedback is practically the same whether expressed on a distorted-input/pure-output basis, or on a distorted-output/pure-input basis. With reference to Fig. 4, consider the state of affairs when V_{in} is of pure sine waveform, suitably adjusted in magnitude to maintain a constant output voltage no matter how much feedback there is. With no feedback, V' will be equal to V_{in} and will be sinusoidal, V_{out} being highly distorted. As the amount of feedback is increased, V_{out} becomes more and more nearly sinusoidal, which requires that the V' waveform must approximate more and more closely to that specific highly-distorted waveform, characteristic of the particular forward amplifier, which will make it deliver a perfectly sinusoidal output. The whole of the distortion in V' – call it V_{dist} – is supplied from the β-network, since V_{in} is pure. When the amount of feedback is large, the fundamental output from the β-network, injected into the input circuit, is very nearly equal in magnitude to V_{in}. Hence the percentage distortion in the output from the β-network, and therefore also in the amplifier output voltage, which feeds the β-network, is very nearly $(V_{dist}/V_{in}) \times 100\%$. If now, with this large amount of feedback applied, a slight harmonic content is introduced into the V_{in} waveform so as to make the *output* perfectly sinusoidal, neither the magnitude of V_{in}, nor the harmonic content of the V' waveform, will change by more than a tiny amount, so that the distortion will still be given quite closely by $(V_{dist}/V_{in})\times 100\%$. Thus the larger the amount of feedback, the more nearly does the percentage output distortion for pure input become equal to the percentage input distortion for pure output.

Another argument to support the statement that the percentage distortions, with a large amount of feedback applied, are virtually the same when expressed on either basis mentioned above, is as follows. Referring to Fig. 4 again, suppose V_{in} contains the necessary harmonics to make V_{out} perfectly sinusoidal. Now, with these input harmonics still present, imagine that we add a further set of input harmonics, each of equal magnitude to, and in antiphase with, the corresponding harmonic already there. The result will be to cancel all the input harmonics, but introduce harmonics into V_{out}. If the harmonics thus introduced into V_{out} are simply the result of the faithful amplification of the additional set of harmonics fed in, then it follows that the percentage distortions must be the same whether considered on a distortionless input or a distortionless output basis. Whether this is nearly enough the case for practical purposes depends on how low is the intermodulation distortion introduced by the complete feedback amplifier when fed with these small-amplitude additional input harmonics in the presence of a large fundamental input, and clearly the more feedback there is, the less significant will be any "false harmonics" introduced by intermodulation – intermodulation between the fundamental and the second harmonic might introduce some third harmonic, for example.

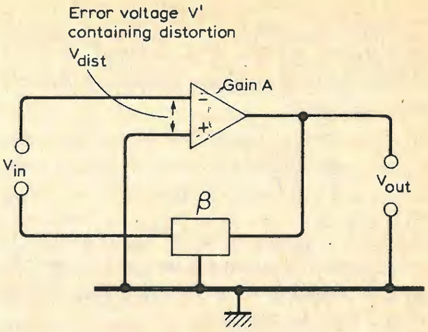


Fig. 4 *Basic feedback amplifier configuration.*

Thus, once again, the conclusion is reached that, *provided there is enough feedback*, harmonic-distortion percentages will be very nearly the same whether expressed on the normal pure-input basis, or on the inverse basis of input distortion for pure output.

A distortion theorem

The ideas discussed above may be formulated as a distortion theorem, applicable to total and to individual-harmonic distortion:

"The percentage harmonic distortion in the output of an amplifier having a large amount of feedback and a sine-wave input, is very nearly equal to the percentage input distortion for distortionless output without feedback, divided by (1–Aβ)."

The usefulness of this theorem is dependent on knowing the input distortion required to give distortionless output without feedback, for common amplifying devices and circuits, but fortunately the theory required is relatively simple. Such distortion can be termed "inverse distortion."

Junction transistor inverse-distortion theory

A simple single-ended junction-transistor stage will be considered first, the transistor being assumed to follow equation 1. When V_{be} is such as to cause I_c to vary sinusoidally,

$$I_{dc}+\hat{I}_c\sin\omega t=I_o\exp\frac{qV_{be}}{kT} \qquad (7)$$

in which V_{be} has the appropriate special waveform which it is desired to find. When $\hat{I}_c\sin\omega t$ passes instantaneously through zero

$$I_{dc}=I_o\exp\frac{qV_{dc}}{kT} \qquad (8)$$

where V_{dc} is the value of V_{be} required to establish the mean collector current I_{dc} in the absence of a signal input. Equation 7 may be written

$$\log_e\left[\frac{I_{dc}+\hat{I}_c\sin\omega t}{I_o}\right]=\frac{qV_{be}}{kT}$$

from which may be derived

$$V_{be}=\frac{kT}{q}\left[\log_e\frac{I_{dc}}{I_o}+\log_e\left(1+\frac{\hat{I}_c}{I_{dc}}\sin\omega t\right)\right] \qquad (9)$$

But from equation 8,

$$\log_e\frac{I_{dc}}{I_o}=\frac{qV_{dc}}{kT},$$

so that equation 9 becomes

$$V_{be}=V_{dc}+\frac{kT}{q}\log_e\left(1+\frac{\hat{I}_c}{I_{dc}}\sin\omega t\right)$$

We now use the fact that

$$\log_e(1+x)=x-x^2/2+x^3/3-x^4/4+\ldots$$

which leads to

$$V_{be}=V_{dc}+\frac{kT}{q}\left[\frac{\hat{I}}{I_{dc}}\sin\omega t-\tfrac{1}{2}\left(\frac{\hat{I}}{I_{dc}}\right)^2\sin^2\omega t\right.$$

$$\left.+\tfrac{1}{3}\left(\frac{\hat{I}}{I_{dc}}\right)^3\sin^3\omega t-\tfrac{1}{4}\left(\frac{\hat{I}}{I_{dc}}\right)^4\sin^4\omega t+\right. \qquad (10)$$

On the assumption that $\hat{I}/I_{dc}$ is not so large that, for example, the second harmonic generated by the $\sin^4\omega t$ term is large enough to cause serious error, equation 10 yields harmonic percentages as given in the middle column of Table 1. Since $g_m=qI_{dc}/kT$ and $\hat{I}=g_m\hat{V}_{in}$, we may replace $\hat{I}/I_{dc}$ by $q\hat{V}_{in}/kT$. At 290 K, which is approximately relevant to low-level stages at least, kT/q is 25mV. These facts enable the results in the right-hand column of Table 1 to be calculated.

Table 1. **Theoretical input distortion percentages for pure sinusoidal output from ideal junction transistor without feedback.**

Harmonic number	Distortion %	Distortion (%), alternative formulae for 290K (V_{in} in mV)
2	$25(\hat{I}/I_{dc})$	$\hat{V}_{in}$
3	$8.33(\hat{I}/I_{dc})^2$	$1.33\times10^{-2}\hat{V}_{in}^2$
4	$3.13(\hat{I}/I_{dc})^3$	$2.00\times10^{-4}\hat{V}_{in}^3$
5	$1.25(\hat{I}/I_{dc})^4$	$3.20\times10^{-6}\hat{V}_{in}^4$
6	$0.521(\hat{I}/I_{dc})^5$	$5.33\times10^{-8}\hat{V}_{in}^5$

Comparison with "normal" distortion

It is instructive to compare the Table 1 results with those giving the *output* distortion for an ideal sine-wave-driven junction transistor without feedback. Referring to equation 1, put $V_{be}=V_{dc}+\hat{V}_{in}\sin\omega t$, where V_{dc} is a direct bias voltage. This leads to

$$\frac{i_c}{I_{dc}}=\exp\frac{q\hat{V}_{in}\sin\omega t}{kT}-1 \qquad (11)$$

where i_c is the instantaneous signal component of collector current and I_{dc} the collector current when $\hat{V}_{in}\sin\omega t=0$. This time the required matematical fact is that

$$\exp x=1+x+\frac{x^2}{2!}+\frac{x^3}{3!}+\frac{x^4}{4!}+\ldots$$

which gives

$$\frac{i_c}{I_{dc}}=\frac{q}{kT}\hat{V}_{in}\sin\omega t+\frac{1}{2}\left(\frac{q}{kT}\right)^2\hat{V}_{in}{}^2\sin^2\omega t$$

$$+\frac{1}{6}\left(\frac{q}{kT}\right)^3\hat{V}_{in}{}^3\sin^3\omega t$$

$$+\frac{1}{24}\left(\frac{q}{kT}\right)^4\hat{V}_{in}{}^4\sin^4\omega t+\ldots \qquad (12)$$

The harmonic percentages may then be evaluated on the same basis as for Table 1, as functions of both $\hat{V}_{in}$ and $\hat{I}/I_{dc}$, since

$$\hat{V}_{in}=\frac{\hat{I}}{I_{dc}}\times\frac{kT}{q}$$

Substituting this in equation 12 gives

$$\frac{i_c}{I_{dc}}=\frac{\hat{I}}{I_{dc}}\sin\omega t+\frac{1}{2}\left(\frac{\hat{I}}{I_{dc}}\right)^2\sin^2\omega t+$$

$$\frac{1}{6}\left(\frac{\hat{I}}{I_{dc}}\right)^3\sin^3\omega t+\frac{1}{24}\left(\frac{\hat{I}}{I_{dc}}\right)^4\sin^4\omega t+\ \ldots \qquad (13)$$

From equations 12 and 13 have been calculated the results given in Table 2. As before it is assumed that $\hat{I}/I_{dc}$ is small enough to ensure that a negligible portion of the total second-harmonic generated arises from the presence of the $\sin^4\omega t$ term, etc. However, since the terms in equation 10 fall off in magnitude with increasing order less rapidly than in equation 13, a given high value of $\hat{I}/I_{dc}$ causes larger errors in the inverse-distortion figures of Table 1 than it does under the conditions of Table 2.

Table 2. **Theoretical output distortion percentages for pure sinusoidal input voltage to ideal junction transistor without feedback.**

Harmonic number	Distortion (%)	Distortion (%), alternative formulae for 290 K($\hat{V}_{in}$ in mV)
2	$25(\hat{I}/I_{dc})$	$\hat{V}_{in}$
3	$4.17(\hat{I}/I_{dc})^2$	$6.67\times10^{-3}\hat{V}_{in}^2$
4	$0.521(\hat{I}/I_{dc})^3$	$3.33\times10^{-4}\hat{V}_{in}^3$
5	$0.0521(\hat{I}/I_{dc})^4$	$1.33\times10^{-7}\hat{V}_{in}^4$
6	$0.00434(\hat{I}/I_{dc})^5$	$4.44\times10^{-10}\hat{V}_{in}$

Inverse distortion for parabolic device

For an amplifier having the general parabolic transfer characteristic given by equation 1 of Part 5, repeated here as equation 14, the formulae for input distortion for pure

$$v_{out}=Av'+\alpha(Av')^2 \qquad (14)$$

sinusoidal output without feedback are given in Table 3, middle column. For an ideal f.e.t. there is the restriction that the bottom of the parabola must lie on the zero-drain-current axis, as shown in Fig. 4 of Part 5, and it then follows that $\alpha\hat{V}_{out}$ may be replaced by ¼($\hat{I}/I_{dc}$), giving the formulae in the right-hand column of Table 3. (This substitution may also be made for αV_{out} in Table 1 of Part 5 when applied to an ideal f.e.t.)

Table 3. **Theoretical input distortion for pure output for general parabolic device, and f.e.t. without feedback.**

Harmonic number	Distortion (percentage)	
	General parabolic device	Ideal f.e.t.
2	$50\alpha\hat{V}_{out}$	$12.5\hat{I}/I_{dc}$
3	$50\alpha^2\hat{V}_{out}^2$	$3.12(\hat{I}/I_{dc})^2$
4	$62.5\alpha^3\hat{V}_{out}^3$	$0.977(\hat{I}/I_{dc})^3$
5	$87.5\alpha^4\hat{V}_{out}^4$	$0.342(\hat{I}/I_{dc})^4$
6	$131\alpha^5\hat{V}_{out}^5$	$0.128(\hat{I}/I_{dc})^5$

Comparing the right-hand column of Table 3 with the middle column of Table 1, the input harmonics for the f.e.t., at a given $\hat{I}/I_{dc}$ are smaller and decay more rapidly with increasing order than for a voltage-driven junction transistor. However, in many practical feedback circuits, this apparent disadvantage of the junction transistor will be more than compensated by the fact that it has a much higher mutual conductance, giving a higher feedback loop gain and thus reducing all significant harmonics to a lower level than for the f.e.t.

With regard to the f.e.t. investigation of Part 5, dividing the figures determined from the right-hand column of Table 3 by 100 gives points on the left-hand vertical axis of Fig. 7 in Part 5 which coincide with the intercepts of the chain-dotted curves.

Relationship to experimental results

The distortion theorem formulated above may be used to calculate quickly and easily, the approximate output distortion for a single junction transistor stage having, say, 40dB of feedback, for $\hat{I}/I_{dc}=0.647$ as used in the experiments with the Fig. 1 circuit. The no-feedback inverse-distortion figures are determined from the middle column of Table 1, and are divided by 100 to give the predicted distortion with feedback. The values obtained are indicated by triangles on the left-hand vertical axis of Fig. 2.

As already explained, the Table 1 formulae assume $\hat{I}/I_{dc}$ is small enough for the amount of second harmonic produced by the 4th and 6th power terms in the power series to be ignored, etc. With $\hat{I}/I_{dc}$ as high as 0.647, there is, however, an appreciable error due to this cause. Calculation shows that the amounts of inverse second harmonic arising from the $\sin^4\omega t$ and $\sin^6\omega t$ terms in equation 10 are approximately 21% and 4% of the amount due to the $\sin^2\omega t$ term, the amounts produced by even higher-order terms being relatively negligible. Thus the true second-harmonic figure would be expected to be about 26% higher than that calculated from Table 1, the error becoming rapidly smaller with reduction in signal level. This more accurate theoretical prediction is indicated by the upper arrow at the left of Fig. 2, and ties up well with the broken-line extrapolation of the measured curve.

At the zero-feedback end of the Fig. 2 curves the simple theoretical distortion values are given by the middle column of Table 2, for $\hat{I}/I_{dc}=0.647$, and the values obtained are indicated by the triangles on the right-hand vertical axis of Fig. 2. As already stated, the errors under the Table 2 conditions, caused by working at a rather high signal level, are much less than for Table 1, but there are other causes of errors to be considered. Nevertheless, the calculated second-harmonic percentage agrees quite well with the experimental value. The shape of the second-harmonic curve can thus be explained in terms of the increasing effect of the high-order terms in the power series as the amount of feedback is increased – an alternative but equally sound explanation to that previously given involving intermodulation within the forward amplifier.

The theoretical zero-feedback points, marked by triangles, for harmonics higher than the second do not agree well with the measured values. The reason for this is believed to be that when the Fig 1 circuit is set for nominally zero feedback, a small but finite amount of negative feedback is effectively still in operation, mainly because of the presence of finite resistance in the base circuit. If this resistance, including $r_{bb'}$, totals 1.2kΩ, and assuming β_{ac} or h_{fe} of 500, it is equivalent to a resistance of 2.4Ω in the emitter lead,l causing $1/(1-A\beta)$ to be effectively 0.88 when set for nominally 1.0. To allow for this, the extreme right-hand plotted points on all the experimental curves should be moved to the left to $1/(1-A\beta)=0.88$. The effect of the 2.4Ω is negligible because of the logarithmic scale used in Fig. 2, except toward the right-hand side of the curves. With the curves thus shifted to the left, it seems reasonable to suppose that continuing the patterns of undulations already established, towards the $1/(1-A\beta)=1.0$ axis, would bring the curves approximately to the theoretical values marked by triangles.

When allowance is made for the production of third harmonic by the $\sin^5\omega t$, $\sin^7\omega t$ and $\sin^9\omega t$ terms in equation 10, the magnitude of the third-harmonic distortion voltage is increased by approximately 32%, raising the calculated value to that indicated by the lower arrow in Fig. 2, which again then ties up well with the broken-line extrapolation of the measured curve. The corresponding tedious calculations have not been done for the 4th, 5th and 6th harmonics, but it seems probable that they, too, would raise the levels of the points marked by triangles to give reasonable agreement with the broken-line, 45°, extrapolations of the measured curves.

There is a further small point which must now be mentioned. In Table 2, for a junction transistor without feedback driven by a sine-wave voltage, the factor $\hat{I}/I_{dc}$ appears. $\hat{I}$ is the peak value of the fundamental current and I_{dc} is the value of the collector current at the moment when the input signal voltage goes through zero. It would also be the quiescent current, if the transistor were operated at fixed bias voltage, and the mean current with the signal applied would then be larger than I_{dc} because of the rectifying action. However, the mean current is prevented from rising significantly when the signal is present in the Fig. 1 circuit, owing to the virtually-constant current in the 12kΩ emitter resistor. This results in the distortion being higher than the simple theory predicts. The fact that the measured second-harmonic curve goes through the 16% point predicted by Table 2 at its top end is thus fortuitous. The effect just mentioned tends to raise the level of the point, whereas the fact that there is a little feedback in action, even when the control is set for nominally zero feedback, tends to lower it. Once there is plenty of feedback in action both these effects become negligible.

It can thus be concluded generally that provided plenty of feedback is assumed right at the beginning, the more awkward parts of the theory outlined in this article, though academically interesting, do not need to be taken into account for design purposes. ☐

(To be continued)

Investigating black holes

The part played by radio and electronics in studying black holes — those strange phenomena of the universe in which all resistance to gravity seems to have been overcome — was brought out recently by Professor R. L. F. Boyd, of University College London, in a contribution to the report of the Science Research Council for the year 1977-78. He revealed that scientists at his own university had been using a unique photon counting system to study the velocity dispersion of stars in the giant elliptical active galaxy in Virgo, and that they had obtained results pointing to the existence at its centre of a black hole of more than 10^9 times the mass of the sun. There was here a strong hint that the mysterious energy source at the heart of quasars or in the highly agitated cores of Seyfert galaxies could be of the same nature. Using data from the Ariel V satellite, Leicester University, in collaboration with Sussex University and employing the Anglo-Australian Telescope, had identified 15 strong extragalatic x-ray sources as Seyferts. The x-ray power output of such sources exceeded that of a billion suns. Its correlation with infra-red and optical data showed that it originated close to the nuclei and was probably due to the collision of electrons of relativistic energy with low energy photons (the inverse Compton effect). It also seemed likely from the form of the spectral energy distribution that the so far unresolved cosmic x-ray background was, at least in part, due to these very active galaxies.

Professor Boyd went on to say that quasars "whose unimaginably concentrated energy sources may also be black holes, are important radio objects." The Nuffield Radio Astronomy Laboratory at Manchester University had studied angular structures of radio sources and, in a collaboration with the USA using the very long base-line technique, had found a jet-like feature some 5,000 light years long extending from the very compact core of quasar 3C147. Strong beaming of energy from the core to the distant parts of certain radio galaxies was also suggested by studies at the Mullard Radio Astronomy Observatory at Cambridge University of the radio galaxy NGC 6251 which was found to have a very narrow jet 600,000 light years in length. In our own galaxy compact objects were also important, being formed when stars ran out of nuclear fuel and died — either slowly to become white dwarfs or violently in supernova explosions which led to neutron stars (of mass comparable to the sun but of diameter only 10-20 kilometres) or perhaps sometimes to black holes. The Mullard observatory, continued Professor Boyd, had found such an object at the centre of a vast interstellar shock wave which was a likely candidate for the core of the star which exploded there. Manchester University, using several unique instruments on optical telescopes, notably the Anglo-Australian Telescope, had discovered two new supernova remnants and had obtained data of unequalled quality on structure and motion in the Monoceros remnant. ☐

Technician on PO board

As part of a two-year experiment in industrial democracy, a factory technician, Mr Leonard Willett, has been appointed as a part-time member of the Post Office Board. He was nominated by the Post Office Engineering Union. Mr Willett joined the Post Office in 1935 and the Post Office Engineering Union in 1937 and has been a menber of the union's National Executive Council since 1967. He became secretary of the Post Office London Factories Branch of the union in 1951, secretary of the Factories Unions Regional Council in 1953 and secretary of the Factories Council of Post Office Unions in 1972. Other part-time members of the PO Board serving till the end of the year are: Mr Derek Gladwin, Professor Michael Posner, Mrs J. E. Walsh, Mr Peter Walters and Lord Winstanley. ☐

continued from page 39-

Meteorological satellite one year old

The European Space Agency's meteorological satellite, Meteosat-1 which was launched on 23rd November, 1977, has completed its first year in orbit. After its launch the satellite reached its geostationary position at 0° longitude over the Gulf of Guinea on 7th December, 1977, and transmitted its first visible and infrared images of the Earth on the 9th and 11th of December.

This first year in orbit has shown how extremely well the onboard equipment is working and has satisfied ESA that it is carrying out "to perfection" its image-taking, dissemination and data-collection missions. During this time ground facilities have been set up at the European Space Operations Centre (ESOC) in Darmstadt, Germany, to handle the reception, processing, archiving and dissemination of the meteorological data from the satellite. These facilities gradually became operational and were ready to fulfil all the requirements for the first Global Atmospheric Research Programme (GARP) experiment which began on 1st December, 1978.

Meteosat is now transmitting high quality visible and infrared images of the Earth every half hour and retransmitting about 300 formats, in various digital and analogue forms, to the primary and secondary data user stations (PDUSs and SDUSs). It also acts as a relay for the distribution of image data from the US satellite, GOES-1, which is situated over the Atlantic. These data are transmitted by the Centre de Météorologie Spatiale (CMS) at Lannion at the rate of about 20 formats per day. In addition, November '78 saw the start of the first transmission tests via Meteosat of image data from the US GOES-3 satellite, located over the Indian Ocean. Users of the four PDUSs and the forty or so SDUSs currently in service in the Meteosat coverage area can therefore receive data from three geostationary satellites covering approximately two-thirds of the globe.

Successful experiments have also been carried out between Meteosat and mobile data-collection platforms (DCPs). There are now about 15 operational DCPs, and another ten are expected to be in service early this year.

Space solar power stations could provide energy for Earth

A British Aerospace engineer, in presenting a paper entitled "A review of some critical aspects of satellite power systems" at an energy and aerospace conference held in London during December, suggested the possibility of giant solar space power stations providing energy for domestic and industrial uses on Earth. The engineer, Ivor Franklin, project manager for Solar Power Systems, part of the British Aerospace Dynamics Group, said that if pilot studies to develop solar arrays into space power sources proved economically feasible, by the end of the century giant orbiting solar power stations could be in use. The stations would cover many square miles of space and would be constructed in space from basic units and materials transported from Earth by launch vehicles such as the Space Shuttle.

The conference was organised by the Royal Aeronautical Society and the American Institute of Aeronautics and Astronautics provided a forum so that delegates from many different engineering and scientific disciplines could examine the interactions of aerospace operations and technology on the provision of energy for mankind. The idea for this meeting came from HRH Prince Charles, The Prince of Wales, who delivered the opening speech.

British Aerospace's Dynamics Group at Bristol, who are already committed to an involvement in solar arrays for spacecraft applications, recognise this activity as an expanding business. Under contract to the European Space Agency (ESA) they are designing a 33 square-metre, 4kW solar array to power NASA's space telescope. They are also developing a 6kW lightweight flexible, fold-out array for future communication satellites and proposing to augment the Space Shuttle power using solar power modules of up to 60kW. Arrays to provide up to 500kW have also been proposed as space power sources and these could form modules for 2MW space power station schemes.

Land mobile radio conference in '79

In 1975 the IERE held its first international conference on mobile communications. Since then, there have been so many developments in this field that the institution is now planning to hold another, on the same general theme, in September, 1979.

The aim of the conference will be to provide a forum for an in-depth discussion of the developing technologies and the ways in which they can best be used for land mobile radio.

The institution, which has been inviting offers of papers for the conference, informs us that while initially the call for abstracts of the papers was given an early deadline, in order to permit the most recent work to be incorporated, this was extended to late December. Papers in their final form will therefore now be required by 4th April, 1979, and not by February as was previously announced by the institution.

Soviet rocket designer dies

A November '78 issue of *Soviet News*, a journal published by the Press Department of the Soviet Embassy in London, reports that Professor Konstantin Bushuyev, who was the director of the international Soyuz-Apollo test project for the Soviet side, has died at the age of 64. An obituary, signed by Leonid Brezhnev and other Soviet leaders, notes the great contribution which he made to the exploration of outer space.

Professor Bushuyev worked on the development and building of piloted spaceships and automatic spacecraft for the exploration of near-Earth space, the Moon, Mars and Venus.

Breadboard show, a success

Breadboard '78, "the first show of its kind for the electronics enthusiast" scored a major success in London, say the organisers, Trident Exhibitions Ltd. During its five-day run, over 10,000 enthusiasts and dealers visited the show and the exhibitors were delighted and "not a little overwhelmed" by the response.

Some of the exhibitors were able to sell hundreds of pounds worth of goods on their stands, while others, like Vero Electronics, who were not selling items off the stand, were able to make many new contacts amongst the dealers. In fact, making contact with the dealers seemed to be the main aim of many of the exhibitors at the show.

One exhibitor from Electrovalue was selling equipment on the stand and feeding orders into a computer terminal at the show, to be processed the same day at his company's Surrey headquarters. Another apparently satisfied exhibitor was the managing director of AP Products, he said that he had taken many orders and it was well worth the trip from Germany.

The show director, Angela Larcombe, of Trident, says that in view of the show's success, Breadboard '79 will have to be moved to a bigger venue and that dates and the new venue will be announced in the near future.

Emergency network

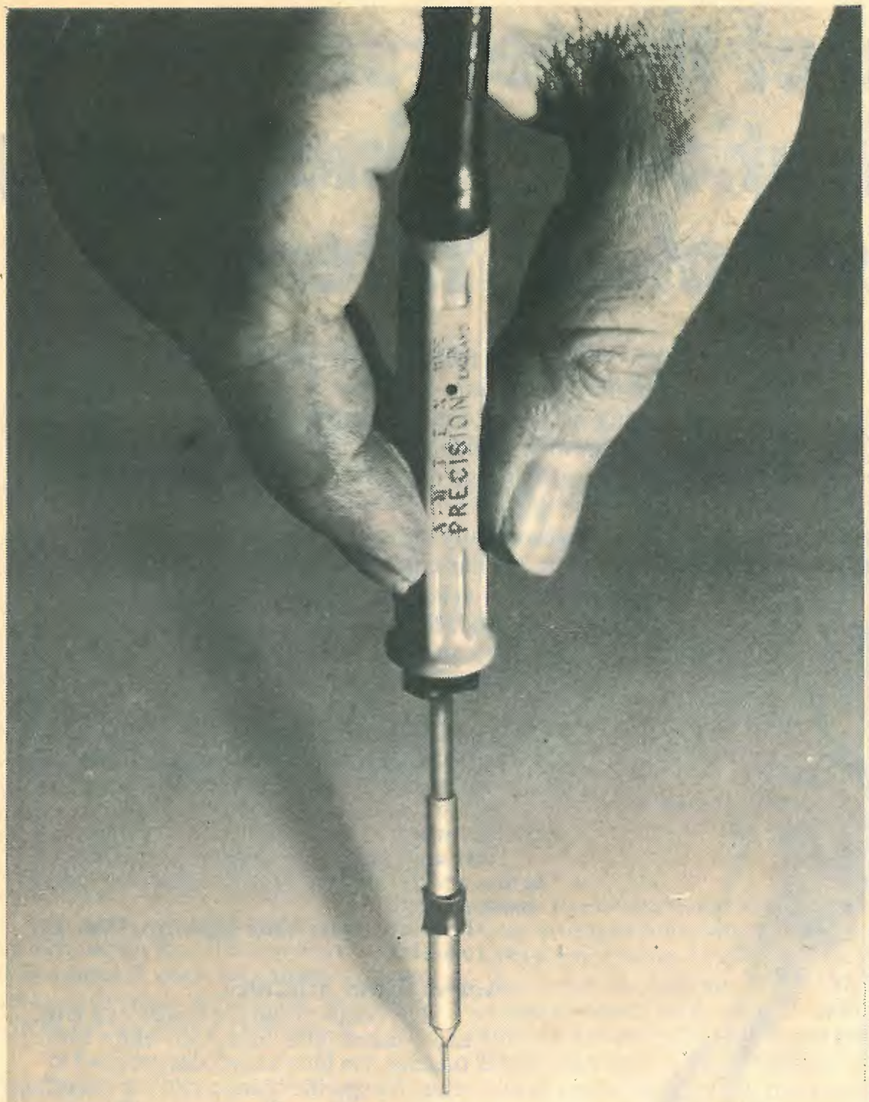
Some 75 members of the Radio Amateurs' Emergency Network (RAEN) provided round-the-clock communications assistance to the St John's Ambulance Service in Birmingham and the West Midlands, dealing with more than 500 emergency calls in the first two weeks. An industrial dispute had left ambulances without their usual radio communications and shifts of four RAEN operators were stationed at the Birmingham headquarters while eight two-man mobile teams accompanied ambulances.

Long distance television

A new edition of Roger Bunney's long-distance television guide has now been published by Bernard Babini Ltd under the new title "long distance television reception (TV-DX) for the Enthusiast." The 120-page booklet (£1.45) is publication number BP52 and now includes a section on reception of transmission from satellites. Details are also given of a number of mast-head pre-amplifiers, receiver requirements for European standards as well as extensive information on receiving aerials and propagation modes for long-distance reception on the television bands.

Register of consulting scientists

A 1978 edition (4th) of the Register of Consulting Scientists has recently been published. The publication, which was edited by E. A. G. Liddiard of the Fulmer Research Institute in Slough, Bucks., lists contract research organisations and other scientific and technical services.



pin-point quickly & efficiently with **ANTEX** soldering irons

You can now combine fingertip accuracy with strict temperature control (within 2%) at the 0.6mm tip of a miniature soldering iron by using the soldering station shown with one of the 24 volt irons.

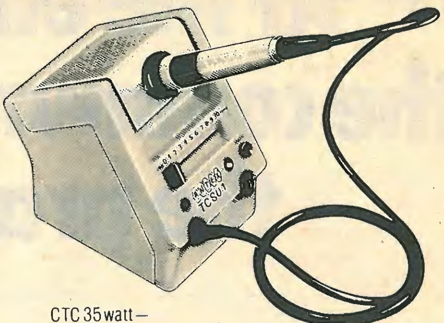
The exceptionally fast recovery time of a miniature iron of 40 watts at the chosen temperature ensures a short exposure or dwell time. If your requirements are less demanding, one of our ordinary miniature or general purpose soldering irons or kits may suit better.

All our soldering equipment is made in England to strict local and international standards of safety. Our name for reliability is spreading from all over Europe to the U.S.A., to Japan and to most other countries.

ANTEX

Mayflower House, Armada Way, Plymouth, Devon Tel: 0752 67377/8 Telex: 45296

Model TCSU1 Soldering Station



CTC 35 watt –

The TCSU1 soldering station with either the XTC 50 watt – 24/26 volt soldering iron or the CTC 35 watt – soldering iron for pin point precision and exceptionally fast recovery time.
We have put at least twice as much power into irons which are already well known for good recovery time. The temperature control stops them from over-heating: the "fail-safe" electronic circuit provides protection even if the thermocouple fails.
TCSU1 soldering station **£38.10** XTC and CTC irons **£14.85** inclusive of VAT and P.& P.

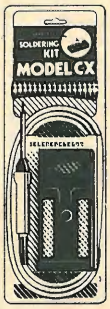
Model CX - 17 watts

a miniature iron with the element enclosed first in a ceramic shaft, then in a stainless steel. Virtually leak-free Only 7½" long Fitted with a 3/32" bit **£4.37** inclusive of VAT and P & P Range of 5 other bits available from ¼" down to 3/64"

Model X25 - 25 watts

A general purpose iron also with a ceramic and steel shaft to give you toughness combined with near-perfect insulation. Fitted with 1/8" bit and priced at **£4.37** inclusive of VAT and P & P. Range of 4 other bits available.

Model SK3 Kit



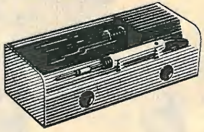
Contains both the model CX230 soldering iron and the stand ST3. Priced at **£6.21** inclusive of VAT and P.& P.
It makes an excellent present for the radio amateur, modelmaker or hobbyist.

Model SK4 Kit

With the model X25/240 general purpose iron and the ST3 stand, this kit is a must for every toolkit in the home Priced at **£6.21** inclusive of VAT and P.& P.

Model SK1 Kit

This kit contains a 15 watt miniature soldering iron, complete with 2 spare bits, a coil of solder, a heat sink and a booklet 'How to solder'. Priced at **£6.48** inclusive of VAT and P.&P.



Model MLX Kit

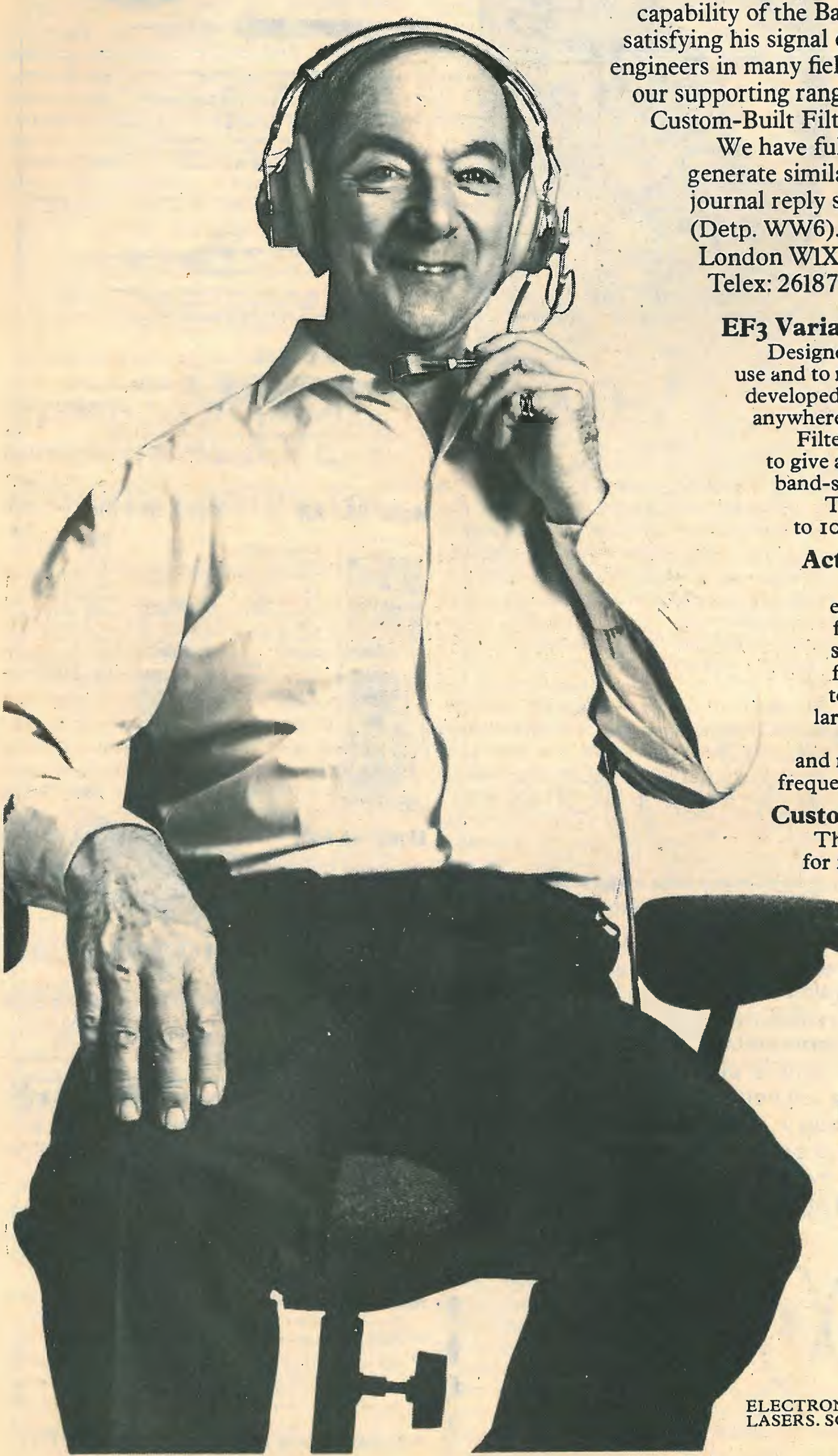
The soldering iron in this kit can be operated from any ordinary car battery. It is fitted with 15 feet flexible cable and battery clips. Packed in a strong plastic envelope it can be left in a car, a boat or a caravan ready for soldering in the field. Price **£4.83** inclusive of VAT and P.& P.

Please send the following ....
....
Please send me the Antex
colour brochure .... ☐
I enclose cheque/P.O./Giro No. 258 1000
Name ....
Address ....
....
....

WW 2.79

Antex Ltd. Freepost, Plymouth PL1 1BR Tel. 0752 67377

At the end of the test session the communications engineer sang the praises of our filters.



"What performance" he said, referring to the capability of the Barr & Stroud EF3 Filter System in satisfying his signal conditioning needs. He and other engineers in many fields are equally complimentary about our supporting range of Active Filter Modules and our Custom-Built Filter Service.

We have fully descriptive literature which will generate similar enthusiasm in yourself. Use the journal reply system or call us, Barr & Stroud Limited, (Detp. WW6). Melrose House, 4-6 Savile Row, London W1X 1AF. Telephone: 01-437 9652. Telex: 261877.

EF3 Variable Filter System

Designed on a modular basis to give flexibility in use and to match your budget. A plug-in system developed for use in labs., test departments, anywhere where signal conditioning is required.

Filter units can be used separately or combined to give a wide variety of functions from low-pass to band-separate.

The current pass-band capacity is from d.c. to 10 MHz.

Active Filter Modules

The ready-to-use convenience of small, encapsulated filter units, each with a basic function. No filter knowledge required to set up for specific characteristic or cut-off frequency. These filters are equally suited to the one-off lab. application and the large quantity production requirement.

Available in low-pass, high-pass, universal and notch designs with a range of cut-off frequencies and attenuation rates.

Custom-Built Filters

The basis of our filter activity, this service has for 20 years provided solutions to customers specific requirements. Based on in-house computer facilities and an extensive programme library we can design and manufacture the filters not provided in our standard range.

Designs can be passive or active with cut-off rates up to several hundred dB per octave in a frequency range up to around 70 MHz.

Barr & Stroud

adds to your resources

ELECTRONIC FILTERS. OPTICAL FILTERS. FIBRE OPTICS.
LASERS. SCIENTIFIC AND MEDICAL INSTRUMENTATION.

WW — 070 FOR FURTHER DETAILS

Electronic organ tone system — 4

Reproduction, coupling and tonal variations

by **A. D. Ryder**, M.A., Ph.D., F.I.E.E.

This article starts the description of optional additions. Although they are intended for the basic design, some of the circuits may be useful in other organ applications.

A VISIT to a reasonably modern church organ will help in deciding on the mechanical details. Whether an existing console is used or new parts are obtained, it is likely that key dimensions and spacing will be standard. The pedalboard should be correctly set laterally, with its middle D accurately in line with the middle D manual keys. Standard key-operating forces are 4 oz for the manuals and 4 lb for pedals because very light keyboards are hard to control. The most important playing requirement is that the contacts make at the same point for every key, and halfway down the stroke is about right. It is useful if each keyboard with its contacts is made detachable so that it can be set precisely on the bench.

Sustain

To provide a slow decay of the tone after a key is released, the pull-down voltage in Fig. 14 may be raised towards ground. A wider range can be achieved by increasing the 100kΩ resistor and hence the maximum pull-down path of an n-p-n transistor with its base connected to ground. More elaborate shaping may of course be used, and the light loading presented by the gates simplifies the design. The muting time-constant in Fig. 34 must be adjusted to suit the envelope in use, and for low pull-down currents the 10kΩ base resistor of the second transistor in Fig. 32 will need to be increased to achieve correct KD operation.

Alternative reference generator

Sets of approximations to the e.t. scale were published by R. Staplefeld in 1970. The GIM device uses a 9-bit set with a worst case error of about 0.1% or 1000 p.p.m., and the set includes two perfect fifths, which are a drawback for some of the options. The 4040 c.m.o.s. counter can be used to obtain the 12-bit set, which has a worst case error of 80 p.p.m., and no perfect fifths. In the absence of any frequency modulation (to be discussed later) this greater accuracy does appear to produce an improvement in sound quality. Table 10 shows the divisors and the departures from an exact scale with A 880Hz, for an input frequency of 2,041,667Hz.

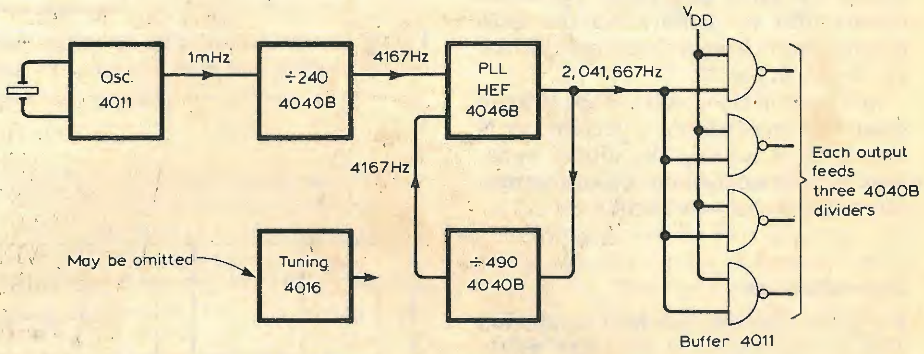


Fig. 37 *Reference generator using 12-bit divisors.*

In the block diagram of Fig. 37, the crystal oscillator is the same as in Fig. 4. The HEF4046B p.l.l. will operate at 2MHz with the same or similar component values as used for the standard 4046. Alternatively, a device such as the 561 may be used with appropriate circuit modification. In Fig. 4 the low-pass filter capacity should be increased to 22nF. For fixed tuning, the remaining i.cs comprise a second 4011 used as a buffer, and 14 4040 counters. The generated reference frequencies are two octaves below those of table 2. Each gate card input capacitor is increased from 1nF to 10nF and its p.l.l. comparator input is taken from pin 6 rather than pin 4 of the upper 4520 in Fig. 12. This gives an overall division of 240 instead of 60. In Fig. 10, the three resistors associated with the vibrato input are doubled, and the 100pF capacitor is increased to 4.7nF.

To achieve large divisions, a modified premature reset circuit is used, as shown in Fig. 38. The counter increments on negative-going clock edges and the count or clock low on which the AND node N goes high to charge the 10pF capacitor, is determined by the outputs connected via diodes to N. On the succeeding clock high the capacitor charge is shared with the R input stray capacitance and produces a reset pulse, during which the high at N is lost. The next clock low terminates the reset pulse and discharges the capacitor. The

Table 10 Divisors for alternative reference generator. The binary numbers are one less than the decimal because the reset pulse suppresses one count. The last two columns relate to an input frequency of 2, 041, 667 Hz (1MHz x 49/24). An asterisk shows the pin used for the output. Reference outputs have 22kΩ buffer resistors as in Fig 4.

Note	Decimal divisor	2048 (pin 1)	1024 (pin 15)	512 (pin 14)	256 (pin 12)	128 (pin 13)	64 (pin 4)	32 (pin 2)	16 (pin 3)	8 (pin 5)	4 (pin 6)	2 (pin 7)	1 (pin 9)	Output frequency	Error p.p.m.
C	3902	1*	1	1	1	0	0	1	1	1	1	0	1	523.24	−29
C'	3683	1*	1	1	0	0	1	1	0	0	0	1	0	554.35	−30
D	3476	1*	1	0	1	1	0	0	1	0	0	1	1	587.36	+54
D'	3281	1*	1	0	0	1	1	0	1	0	0	0	0	622.27	+25
E	3097	1*	1	0	0	0	0	0	1	1	0	0	0	659.24	−23
F	2923	1	0*	1	1	0	1	1	0	1	0	1	0	698.48	+39
F'	2759	1	0*	1	0	1	1	0	0	0	1	1	0	740.00	+18
G	2604	1	0*	1	0	0	0	1	0	1	0	1	1	784.05	+76
G'	2458	1	0*	0	1	1	0	0	1	1	0	0	1	830.62	+14
A	2320	1	0*	0	1	0	0	0	0	1	1	1	1	880.03	+33
A'	2190	1	0*	0	0	1	0	0	0	1	1	0	1	932.27	−64
B	2067	1	0*	0	0	0	0	0	1	0	0	1	0	987.74	−23
Xtal	240	0	0	0	0	1*	1	1	0	1	1	1	1	} 4166.67	
P.l.l.	490	0	0	0	1*	1	1	1	0	1	0	0	1		

outputs Q_1 to Q_{12} represent counts of 1, 2, 4, up to 2048 as shown, and to give a division of M, the outputs connected to N total $M-1$. In table 10, each 1 represents a diode to N, and the reference signals are taken from outputs having a mark to space ratio nearest to unity.

Fig. 38 includes 4016 switches for the least significant digits, and with S_1 and S_8 closed as shown, the division is 490. Appropriate switching produces divisions from 485 to 495 which varies the p.l.l. output frequency, and so tuning of the organ from 1% below to 1% above standard pitch in 0.2% steps. The diode connections for generating the 4016 control inputs from a single-pole switch are shown in Fig. 39.

In construction, stray capacitance should be minimised, especially at N and R, by mounting the diodes vertically. Current consumption of the prototype generator was 72mA.

Reproduction

For good reproduction hi-fi equipment may be satisfactory although much depends on the room characteristics. To obtain the benefit of reflected sound, the listening room should not be unduly damped by soft furnishings, and the h.f. speakers should not directly face the listener. Transient response is not of primary importance, and some low-order distortion can be tolerated. The main requirement is a reasonably smooth amplitude/frequency response from the loudspeakers. This can be compensated by adjustment of R_n values, so that individual notes do not stand out or disappear. The better types of small loudspeaker units, although they often have a resonance at around 100Hz, are fairly smooth at higher frequencies. The system adopted for the prototype used an active crossover at 270Hz with a pair of Bailey transmission line speakers, fitted with bass drivers only. The R_n values were adjusted, mainly in the lowest octave, to give the best regulation with the speakers in their final positions. The largest adjustment needed was —8dB at 55Hz.

A pipe organ has as many separate sound sources as there are pipes, and it is advantageous to provide separate h.f. channels as shown in Fig. 40, which also allows independent processing if required. Fig. 41 shows a low-pass filter using the Rauch configuration which can also serve as a mixer if the signal input sources are of low impedance. The 62kΩ resistors are each three times the calculated input resistor value, and the gain is reduced correspondingly. The filter is maximally flat and the overall passband gain is unity for each input. The high-pass filter in Fig 42 also has unity gain and is third-order with a passive output section with the same corner frequency. Both filters operate from a single 12V supply and the working point is set by a suitably decoupled 6V bias. Fig. 43 shows how to adapt the

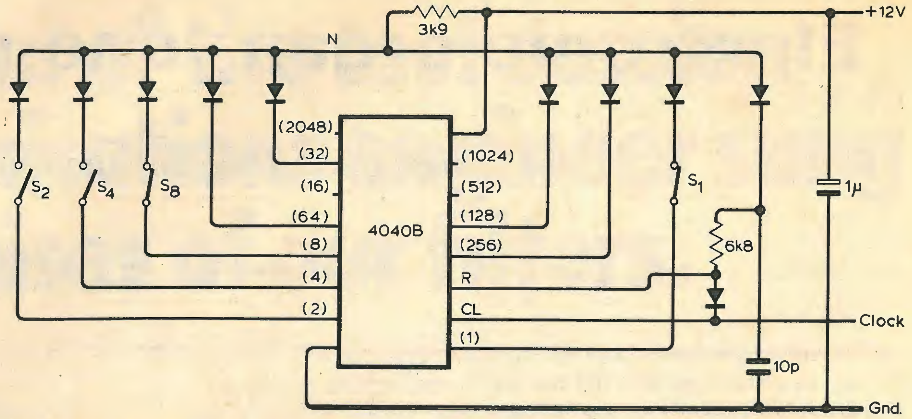


Fig. 38 *Divider circuit. The switches represent 4016 sections used for the optional tuning facility, and apply to the p. l.l. comparator divider only.*

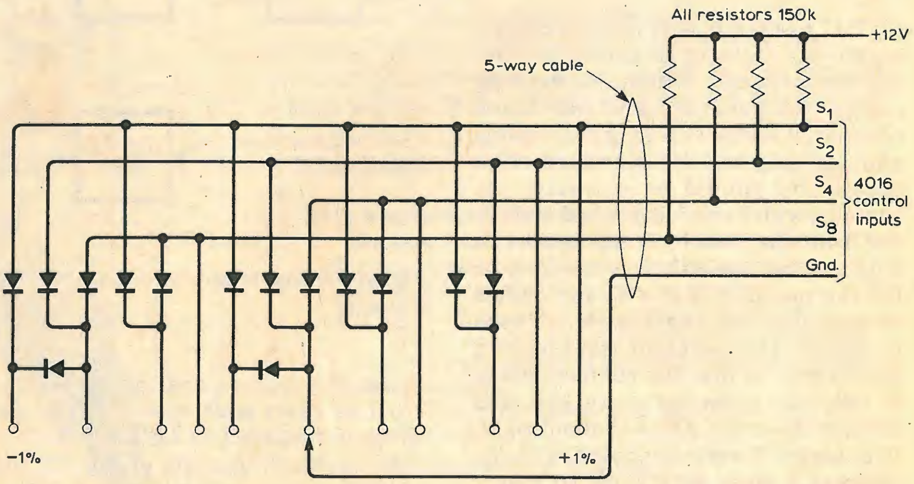


Fig. 39 *Connections for an 11 position tuning switch. The 14 diodes are mounted on the switch wafer.*

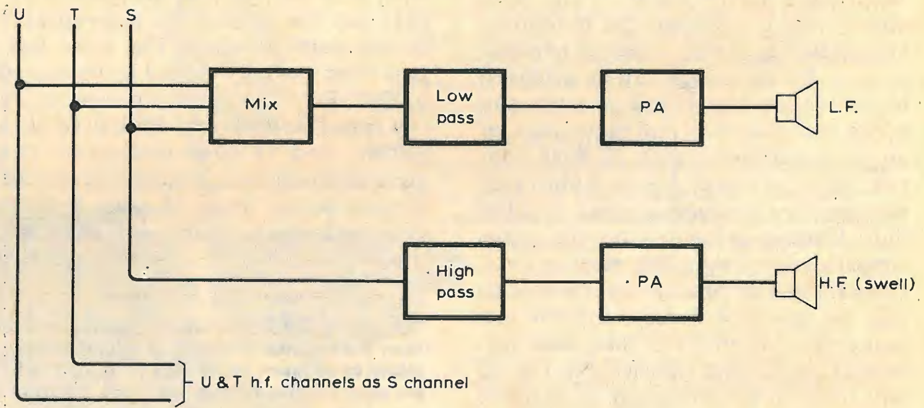


Fig. 40 *Output channels. The prototype cross-over frequency is at 280Hz.*

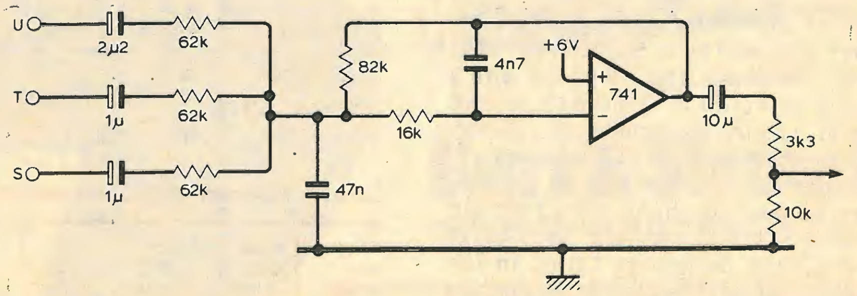


Fig. 41 *Mixer and Rauch 12dB/octave l.p. filter. The 10kΩ resistor may be replaced by a potentiometer for channel balancing.*

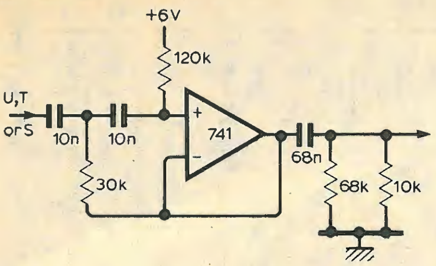


Fig. 42 *Sallen and Key 18dB/octave h.p. filter. The output RC section is 3dB down at 270Hz to produce a maximally flat response with an active section Q=1. The 10kΩ resistor may again be replaced by a potentiometer for channel balancing.*

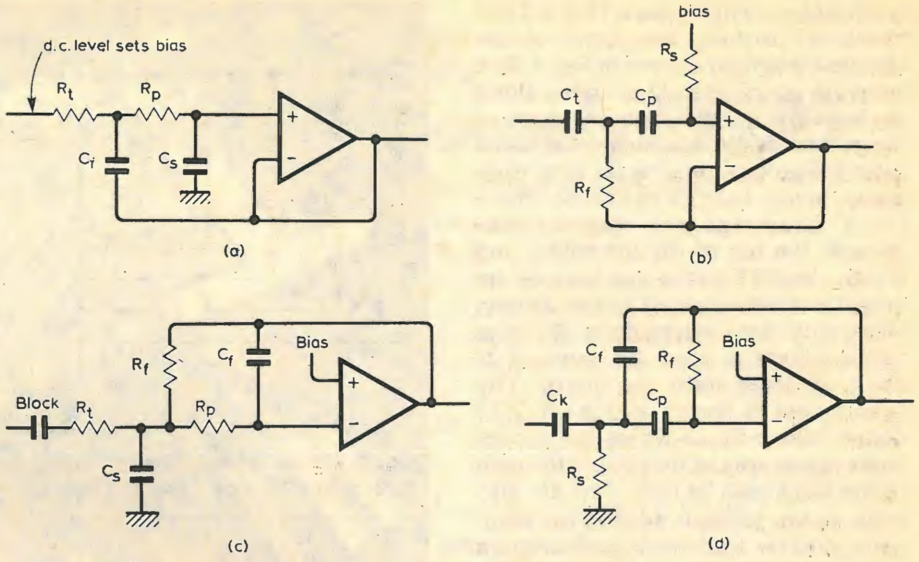


Fig. 43 *Filter design using available capacitor values. (a) Non inverting Sallen and Key l.p.f. with unity gain. Select $C_f/C_s=a$, where $a \geqslant 2$ for $Q=0.707$, $\geqslant 4$ for $Q=1$. $\sqrt{X_f.X_s}=R$, say, $R_t=R\sqrt{b}$ and $R_p=R/\sqrt{b}$ or vice versa where $b=(a-1+\sqrt{a^2-2a})$ for $Q=0.707$, and $b=½(a-2+\sqrt{a^2-4a})$ for $Q=1$.*

(b) Non inverting Sallen and Key h.p.f. with unity gain. Select $C_t=C_p$. $X_t=X_p=R$. $R_f=R/2Q$ and $R_s=2Q.R$.

(c) Inverting Rauch l.p.f. Select $C_s/C_f=p$, which predetermines design gain G. $G=½(p-1)$ for $Q=0.707$, $G=¼(p-4)$ for $Q=1$, $R_f=X_f/2Q$, $R_t=R_f/G$, and $R_p=R_f/(1+G)$.

(d) Inverting Rauch h.p.f. Select $C_t/C_f=G$ and $C_p=C_t$. Then $R_f=d.X_t$ and $R_s=G.X_t/d$, where $d=(2G+1)/Q$.

circuits for individual requirments. The circuit values should be with 5%.

Coupling

As discussed in part 1, coupling is useful both as a playing aid, and to extend the harmonic spectrum. In the prototype eight couplings were used, four from the pedal keyboard — unison (U1U), octave (U2U), great (T1U) and swell octave (S2U), and four from the great keyboard — unison (T1T), octave (T2T), swell (S1T) and swell twelfth (S3T). The unison-off couplers to be described are a necessary part of the design, but also have their own uses. For example, the pedal can be played at 8′ pitch only or, using the swell octave, at 4′ only on the great. If the 8′ sound is taken from the swell only, the upper work provided by the great octave may use a different harmonic mixture as well as a separately-processed channel. The above list is not exhaustive, and other useful couplings could be provided, such as S2T, S2S, and sub-octave couplers such as S½, and S½T. A super octave S4T or S4U could be used for extra brilliance, but this would need to break back to the octave at G′4. The situation is similar to that of a small extension or unit organ which uses a limited number of ranks at several pitches, with the additional facility of coupling at reduced strength where required.

The most direct method of coupling is to use additional key-contacts, with diodes to prevent switching of unselected common lines when the same key is pressed on both keyboards. Semiconductor switching avoids the practical problems of multiple contacts, and reduces the interconnecting wiring. In Fig. 44, UCL1 is the contact operated by the C1 pedal, and UCK1, UCK2, etc are keying inputs on the C gate. (In the basic system, ICL1 is supplied from +5.6V and is only connected to UCK1. A particular coupling is selected by energising the appropriate common line, and its strength is controlled by the applied voltage. Allowing for the diode drop, full amplitude is reached at about 6.2V. Each line may be supplied from a circuit as shown in Fig. 32 except that only one KD circuit is needed per department. The collector of each previous transistor is supplied from the transistor base of the coupled department. Therefore, current drawn by the U1U or U2U lines must switch UKD, T1U current must switch TKD, and S2U current must switch SKD. The bias line is supplied from a circuit using T1 only.

The great couplers use a similar circuit where TCL1, for example, can drive TCK1, TCK2, or SCK1 under control of T1T, T2T, or S1T. However, for, the twelfth coupler S3T, it is necessary that UCL1 drives SGK2, UC′L1 drives SG′K2 and so on up to UCL5 and SGK6. It is more convenient physically to mount the SGK2 gate adjacent to those associated with TGL2, and to wire its base resistor separately to TCL1, and so on. Table 11 summaries the eight couplings which use a total of 355 gates. Fig. 45 shows the coupling assembly for

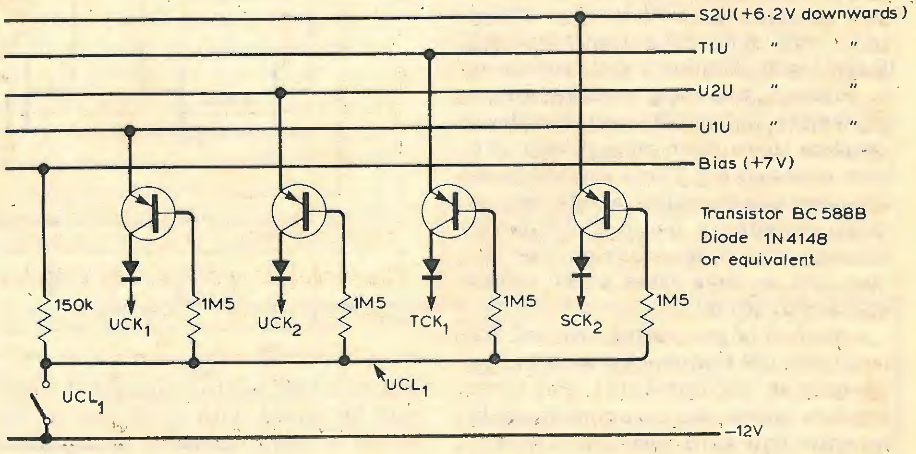


Fig. 44 *Coupling from C1 pedal key.*

Table 11 Summary of couplers used in the prototype.

Coupler	U1U	U2U	T1U	S2U	T1T	T2T	S1T	S3T
Start	UCK1	UCK2	TCK1	SCK2	TCK1	TCK2	SCK1	SGK1
Ends	UGK3	UGK4	TGK3	SGK4	TCK6	TGK6	SCK6	SGK6
Gates	32	32	32	32	61	56	61	49
Groups	C-G G′-B	3 groups each 2 groups each	} 32		C C′-B	6 groups 5 groups each	} 61	

the prototype which uses a 17.9″×7.05″ Veroboard to form the plinth of the complete assembly shown in Fig. 1. The gates are arranged in 12 columns along the length, and in the same sequence as the gate cards. Within each column the gates are grouped in octaves with each group having four gates except where the T couplings are discontinued towards the top of the keyboard, and where the S3T gates are located by output position as noted above. Keying interconnections are made in 33 s.w.g. which is kept in place by loops of 24 s.w.g. soldered onto the board. The basic layout is shown in Fig. 46. The dotted lines indicate where the copper strips below are cut except for through connections such as bias. Cuts are also made at the points e, so that the transistor emitter leads can pass through without making contact. These leads are connected underneath by runs of 33 s.w.g. to the buses U1U, U2U, etc. It is convenient to use the outermost plain strips of copper on the veroboard for this purpose. The resistors are mounted vertically with appropriate L connections made to their upper ends. Terminal pins are used for K connection points, and most of the diodes can be accommodated with suitable track-cutting, in the area to the right of the transistors, the remainder being mounted on the copper side. If the swell keyboard is supplied with a fixed +5.6V, it is not necessary to use diodes between the swell keyboard contacts and swell K inputs. The T1U and S2U diodes are mounted with the U groups, and the connections to TK and SK pins are made with 33 s.w.g. on the copper side. In Fig. 45 the C column is at the left, and the pedal groups are towards the top.

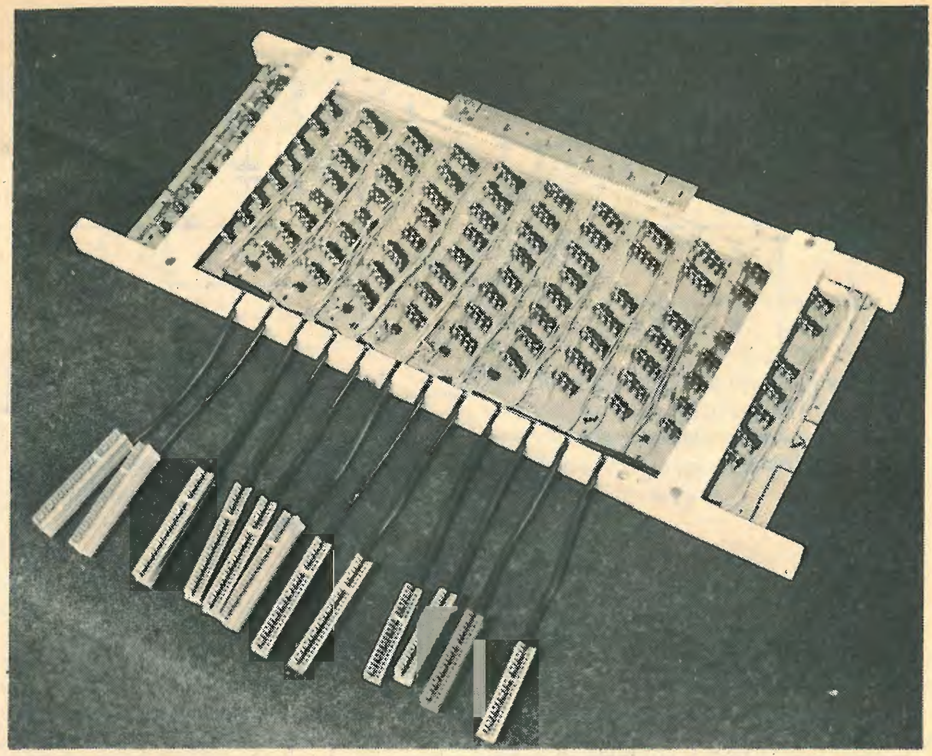


Fig. 45 *Assembled coupling circuits from prototype. This section forms the plinth of Fig. 1, and shows the edge connectors used to bring keying signals to the gate cards.*

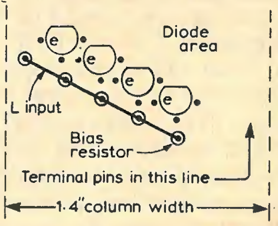
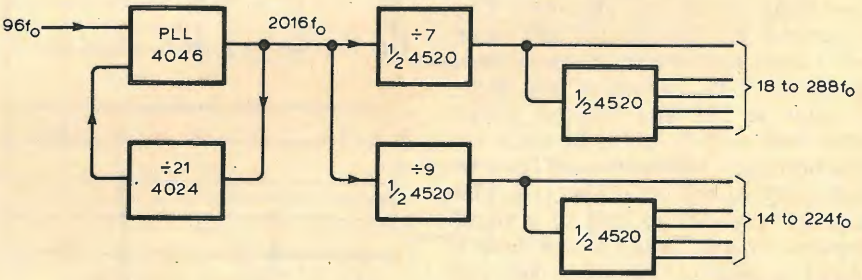


Fig. 46 *Transistor and resistor layout of coupling groups viewed from the component side.*

Fig. 47 *Generation of the 7th and 9th harmonics.*



Division	Device	Diodes to pins	O/p pin
21	4024	5, 9, 12	6
7	4520	3, 4, 5	4
9		11, 14	13

R_1 and R_2 values should be double those for the main PLL of which the VCO runs at $3840f_0$

Tonal variations

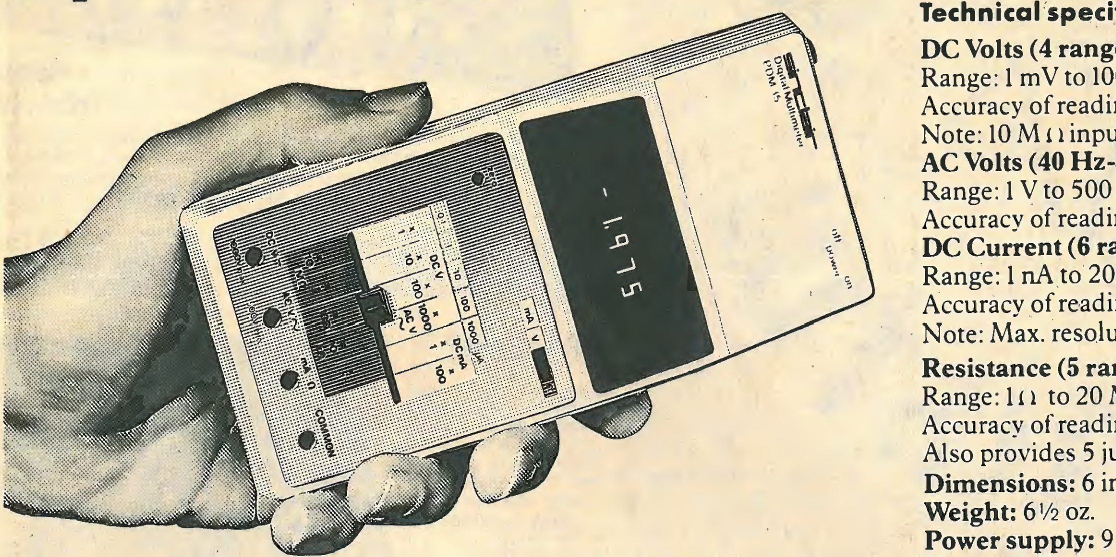
Apart from what is needed for the basic system, the EO1 card provides eight spare input and output positions, 16 spare gate positions, and four spare i.c. positions, including tracking for an additional p.l.l. The EO2 card provides a complete spare filter section, and two spare connections. These unused positions can accommodate a selection of additions without using more cards, although wire connections may be needed, and in some cases a few tracks will have to be cut.

A method of generating 7th and 9th harmonics (60 frequencies each in Fig. 47), uses an additional p.l.l. and three counters which are accommodated in the spare gate-card positions. The $96f_0$ output in Fig. 20 is used as a reference, and the non-binary divisions are obtained by premature reset as in Fig. 12. The R_n values and filter components may be the same as in the 6th and 8th harmonics respectively because a somewhat lower output is acceptable for these pitches. The 7th can be taken up to GK5, 10.98kHz, and the 9th to EK5, 11.8kHz. The $1.5f_0$ output in Fig. 20 enables a 10⅔′ bus to be provided which may be mixed with a 16′ bus in the lowest octave to generate a subjective 32′ bass as sometimes found in pipe organs. Levels will need adjustment note by note, and additional low-pass filtering may be beneficial. Ideally, a separate speaker channel should be used for the quint.

In Fig. 26, if C_3 is omitted the filter slope becomes 6 dB/octave. If the resonant frequency of the first stage is then raised to the working band, the action becomes similar to that of the low-Q LCR filters used in subtractive designs, with R_6 providing the main control of Q. Input R_n values will need to be graded differently, varying less widely, and more convenient levels will result from reducing R_3 to say 47kΩ. Further tonal modification is possible by re-introducing a smaller value of C_3 and/or reducing C_2. The resultant tone may be supplemented by specific harmonics from the sinewave buses.

To be continued

The Sinclair PDM35.
A personal digital multimeter for only £29.95 (+8% VAT)



Now everyone can afford to own a digital multimeter

A digital multimeter used to mean an expensive, bulky piece of equipment.

The Sinclair PDM35 changes that. It's got all the functions and features you want in a digital multimeter, yet they're neatly packaged in a rugged but light pocket-size case, ready to go anywhere.

The Sinclair PDM35 gives you all the benefits of an ordinary digital multimeter – quick clear readings, high accuracy and resolution, high input impedence. Yet at £29.95 (+8% VAT), it costs less than you'd expect to pay for an analogue meter!

The Sinclair PDM35 is tailor-made for anyone who needs to make rapid measurements. Development engineers, field service engineers, lab technicians, computer specialists, radio and electronic hobbyists will find it ideal.

With its rugged construction and battery operation, the PDM35 is perfectly suited for hand work in the field, while its angled display and optional AC power facility make it just as useful on the bench.

What you get with a PDM35

3½ digit resolution.
Sharp, bright, easily read LED display, reading to ± 1.999.
Automatic polarity selection.
Resolution of 1 mV and 0.1 nA (0.0001 μA).
Direct reading of semiconductor forward voltages at 5 different currents.
Resistance measured up to 20 MΩ.
1% of reading accuracy.
Operation from replaceable battery or AC adaptor.
Industry standard 10 MΩ input impedance.

Compare it with an analogue meter!

The PDM 35's 1% of reading compares with 3% of full scale for a comparable analogue meter. That makes it around 5 times more accurate on average.

The PDM35 will resolve 1 mV against around 10 mV for a comparable analogue meter – and resolution on current is over 1000 times greater.

The PDM35's DC input impedance of 10 MΩ is 50 times higher than a 20 kΩ/volt analogue meter on the 10 V range.

The PDM35 gives precise digital readings. So there's no need to interpret ambiguous scales, no parallax errors. There's no need to reverse leads for negative readings. There's no delicate meter movement to damage. And you can resolve current as low as 0.1 nA and measure transistor and diode junctions over 5 decades of current.

Technical specification

DC Volts (4 ranges)
Range: 1 mV to 1000 V.
Accuracy of reading 1.0% ± 1 count.
Note: 10 MΩ input impedance.
AC Volts (40 Hz-5 kHz)
Range: 1 V to 500 V.
Accuracy of reading: 1.0% ± 2 counts.
DC Current (6 ranges)
Range: 1 nA to 200 mA.
Accuracy of reading: 1.0% ± 1 count.
Note: Max. resolution 0.1 nA.
Resistance (5 ranges)
Range: 1Ω to 20 MΩ.
Accuracy of reading: 1.5% ± 1 count.
Also provides 5 junction-test ranges.
Dimensions: 6 in x 3 in x 1½ in.
Weight: 6½ oz.
Power supply: 9 V battery or Sinclair AC adaptor.
Sockets: Standard 4 mm for resilient plugs.
Options: AC adaptor for 240 V 50 Hz power. De-luxe padded carrying wallet. 30 kV probe.

The Sinclair credentials

Sinclair have pioneered a whole range of electronic world-firsts – from programmable pocket calculators to miniature TVs. The PDM35 embodies six years' experience in digital multimeter design, in which time Sinclair have become one of the world's largest producers.

Tried, tested, ready to go!

The Sinclair PDM35 comes to you fully built, tested, calibrated and guaranteed. It comes complete with leads and test prods, operating instructions and a carrying wallet. And getting one couldn't be easier. Just fill in the coupon, enclose a cheque/ PO for the correct amount (usual 10-day money-back undertaking, of course), and send it to us.

Sinclair Radionics Ltd, London Road,
St Ives, Huntingdon, Cambs., PE17 4HJ,
England. Regd No: 699483.

To: Sinclair Radionics Ltd, London Road, St Ives, Huntingdon, Cambs., PE17 4HJ.

Please send me ________ (qty) PDM 35(s) @ £32.35 (incl. VAT) each.................. £________
________ (qty) De-Luxe carrying cases @ £3.24 (incl. VAT) each.................... £________
________ (qty) AC adaptor(s) for 240V power @ £3.24 (incl. VAT) each.......... £________
Post and packing (please add)............ £0.65
I enclose cheque/PO made payable to Sinclair Radionics Ltd for (indicate total amount)...................... £________

Name..

Address..

....

.... WW2

I understand that if I am not completely satisfied with my PDM 35, I may return it within ten days for full cash refund.

sinclair
World leaders in fingertip electronics

WW—010 FOR FURTHER DETAILS

NEW PRODUCT • BULLETIN •

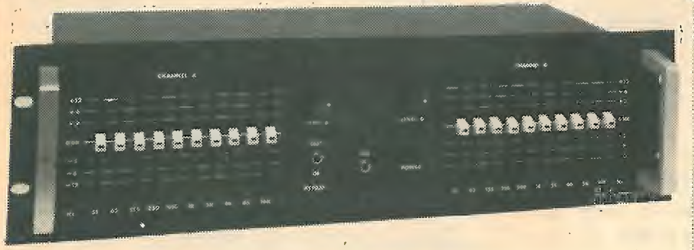
ITA

ORBAN from USA

Dual channel multispring reverb unit. Each channel features four springs — far smoother than single spring systems. "Twang" and "boing" are virtually eliminated by incorporating a floating threshold limiter. Bass, mid-range EQ and bandwidth controls. The best compact reverb unit available.

ITAM 882

New Stereo Mixer, built to a specification not a price! Ultra low noise, —128dB. 8 inputs + 8 direct outputs, 2 outputs with VU meters. 2 limiters. XLR mic inputs (balanced). 3 band EQ + mid sweep.
£395 + VAT



ITAM Graphic Equalizer

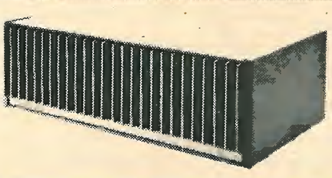
A fully professional graphic equalizer at a reasonable price. Stereo, with 10 bands per channel, 19 inch rack mounting.
£280 + VAT.

AMPEX ATR-700

Now every studio can afford legendary Ampex performance and reliability. Fully professional specification including balanced inputs/outputs, Cannon connectors, variable tape speed, sel sync. The price will fit this year's budget, not next year's! Sole distribution by ITA.

OTARI DP4050 OCF IN CASSETTE DUPLICATOR

Now with 3¾ + 7½ master capability and Ferrite heads. Duplicates 6 cassettes each run at 8 times speed. Over 80 stereo C60 per hour. Unquestionably the finest in cassette copier available from the world's largest duplicator manufacturer.



QUAD

The new 405 power amplifier is now in stock. 100 watts per channel — simply the best, for £££'s less! Immediate Delivery!

ITA

1-7 Harewood Avenue, Marylebone Road, London NW1.
Tel: 01-724 2497 Telex: 21879

FRANCE. Son Professionnel, 2 Rue des Tennerolles,
92210 Saint Cloud (Paris). Tel 602 6815.

WW—073 FOR FURTHER DETAILS

WORLD OF AMATEUR RADIO

Amateurs and plasma bubbles

A new theory to account for the 1977-78 transequatorial-type propagation experienced for the first time on the 144 and 432MHz bands has been put forward in Europe and the United States. J. Roettger, DJ3KR, in *Radio Communication* suggests that the basic mode is scatter propagation due to plasma bubbles which occur in equatorial spread-F conditions and rise to altitudes of 400 to 1000km. Joseph Reisert, W1JR, and Gene Pfeffer, KOJHH, in *QST* put forward a generally similar concept, although they have adopted the term FAI (field aligned irregularities) to describe this propagation mode. It is clear that the amateur work that resulted in these long-distance contacts on 144MHz (and a few reception reports on 432MHz) in South and Central America, in Europe and Africa, and in Japan and Australia have uncovered propagation modes previously unobserved and unexplained. The prospects in favourable countries for more late-evening long-distance contacts using these plasma bubble modes during the present peak of the sunspot cycle appear promising.

Is amateur radio booming?

Although the number of American amateur licences is now at an all-time high of over 365,000, the American Radio Relay League with 170,000 members has recently reported a significant decline in the demand for its technical publications. As a result it has been forced to cut back on expenditure, including trimming some 20 people from its staff. The current inflation rate in the United States is thought to contribute materially to the difficulty ARRL is experiencing in breaking even, and the hardening yen/dollar exchange rate is also expected to have an effect on equipment sales this year.

However a rather different note is struck by *Electronics* staff writer Vincent Biancomano, WB2EZG, in an article "That boom you hear is ham radio." He forecasts an expanding market to meet the needs of the 28,000 additional amateurs licensed in 1978. Although, he says, the "old names" like Collins Radio, National Radio Co, Hallicrafter Co and Hammarlund "are all but gone," arisen to take their place are such firms as Trio-Kenwood and Yaesu Musen both of Japan and new American firms such as Dentron, Wilson Electronics Corporation (a new aerial firm), Lunar Electronics (v.h.f. amplifiers) etc. He notes that interest is shifting upwards to include u.h.f. as well as v.h.f. factory equipment.

He suggests that the gap between citizens' band radio and amateur radio is closing and that "those who would wish to preserve the spirit and self-image of amateur radio must now deal with the consequences of popularity." Official FCC c.b. licences have reached the staggering total of 14-million-plus with more than one million licensees in Texas alone. Some 2.5-million new licences were issued during 1978.

Dr Dain Evans, G3RPE, president of RSGB, following a recent visit to talk to amateurs in the United States has returned convinced that it is high time that the Americans renewed their former interest in microwaves. Whereas, he points out, a few years ago American amateurs held five out of the six "world microwave records" they now hold only one, despite the almost ideal topography and high incidence of ducting. Although a number of American amateurs have built 30ft. dish aerials for moonbounce etc, he feels that they just do not succeed in putting it all together so far as co-ordinated microwave activity is concerned, and contrasts this with Europe where activity on 10GHz is rapidly increasing.

What may have been the first 10GHz amateur contact to be effected by tropospheric scatter was made between G3JVL, Hayling Island, and G3YGF/A at Oxford, a distance of 110km, last October. Both stations used s.s.b. by means of transverter techniques to obtain p.e.p. outputs of 6 and 15 watts.

Here and there

Problems that have arisen over the past year in using the predicted orbital data for Oscar 8 are now believed to have been due mainly to errors caused by radar tracking of the nose cone of the rocket in mistake for the amateur communications satellite, and also due to the greater effect of "drag" caused by the lower orbit of Oscar 8 compared with Oscars 6 and 7. However by autumn 1978, Amsat-UK were confident that their revised estimates were sufficiently accurate to allow them to issue a revised list of orbital data.

"I know that c.w. is obsolete and dead. I was told this when I first started to learn the code in 1947. Nevertheless there are a large number of stations who apparently do not know that c.w. is dead, for they persist in using it." — John H. Smith, VK3IQ.

Canada has now started issuing a new "Amateur Digital Radio Operator's Certificate" which gives the holder operating rights on 144MHz and above basically similar to the British Class B licence. The U.S.A. remains one of the few countries where no "no-code" licences are issued but has a novice licence requiring a code speed of only about 5 words per minute. Some American novices start early: Neil Rapp, WB9VPG (formerly WN9VPG) held an FCC novice licence at the age of 5 years, moving on to a general licence at six years of age.

In brief

The South African 144MHz beacon station ZS6DN was positively heard and identified by SV1DH in Athens between 1715 to 1725 GMT on November 5, a distance of over 7100 km . . . Tropospheric openings on November 6 brought 144MHz contacts between Scotland and Austria, the distance of some 1450km being among the best tropo contacts by British amateurs during 1978 . . . Sunspot activity declined sharply during most of November but should peak up again early in 1979 . . . Naomi Uemura, JG1QFW who made a remarkable solo trip to the North Pole during the summer of 1978 depended for much of his communications on amateur stations . . . Charles D. Tandy, the Fort Worth millionaire who created the Tandy Corporation and associated Radio Shack chain from a faltering group of amateur radio stores in the Boston area, has died . . . The RSGB 1979 National VHF Convention is to be held on March 10 at The Winning Post, Twickenham, and will include lectures on "Slow scan television" (Grant Dixon), "Tropospheric propagation" (Ray Flavell) and "Sporadic E" (Professor Martin Harrision) as well as the usual convention events . . . A special 10th anniversary "Worked All Britain" award (the "10 × 10 Decade Award" is being offered for contacts made this year; any profits will go to the Radio Amateurs Invalid and Bedfast Club . . . Some 550 amateurs attended the 1978 Scottish Amateur Radio Convention in Aberdeen . . . The high cost of the British maritime mobile amateur (£16.40) is to be reviewed by the Home Office . . . It is now hoped that the extremely high power radar transmissions (Pave Paws project) planned for near 432MHz may be moved elsewhere, the system operates on a number of discrete frequencies . . . A total of 104 v.h.f. repeater licences has now been issued by the Home Office to the RSGB and a number of new repeaters have been brought into operation recently . . . Larry Le Kashman, W2IOP, a former editor of *CW* and a prominent contest operator, has died.

PAT HAWKER, G3VA

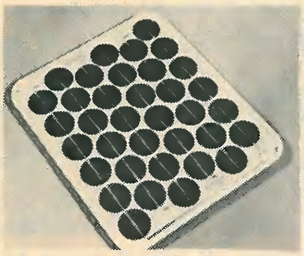
NEW PRODUCTS

Professional readers are invited to enter codes on the reply-paid card bound in at pages 116/117

Solar power panel

The MST300 solar power panel contains 36 silicon cells, each 3 inches in diameter, series connected to give an output of 1.1 amps at 14.4 volts. It measures 560mm x 480mm and is 130mm deep. Its aluminium construction serves as a heat sink and makes the module suitable for use in high ambient temperature zones. A recessed aluminium extrusion, into which the base plate and cover are fitted, provides a hermetic seal and prevents moisture from getting into the resin filled space containing the silicon cells. The panel has a protective cover of fibre reinforced polyester. Additional silicon cells can be incorporated as required by the customer. Ferranti Electronics Ltd, Fields New Road, Chadderton, Oldham OL9 8NP.

WW 301

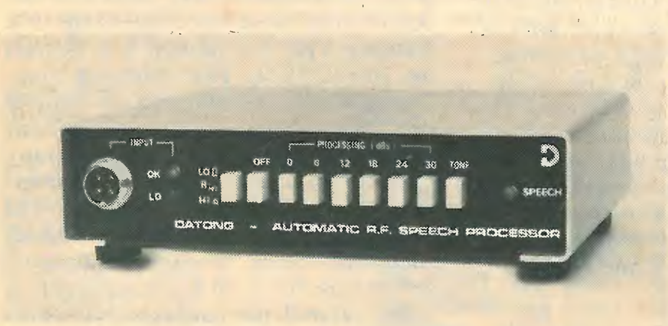


WW301

Speech processor

Intended for s.s.b., f.m. and a.m. radio systems, telephone and public address systems and similar applications, the model ASP speech processor is designed to improve the effectiveness of peak-power limited speech equipment, firstly by allowing an increase in the average radiated power while maintaining a constant peak power, and secondly by increasing the intelligibility of speech in noise. Taking an audio signal input, it generates a s.s.b. signal. This is clipped, filtered and demoducated back to audio, giving instantaneous compression of dynamic range "without harmonic distortion." An unusual feature is an audio a.g.c. system before the main processor. This adapts to changing input levels and maintains the degree of speech enhancement at push-button-selected values from 0 to 30 dB in 6dB steps. Datong Electronics Ltd, Spence Mills, Mill Lane, Bramley, Leeds LS13 3HE.

WW 302

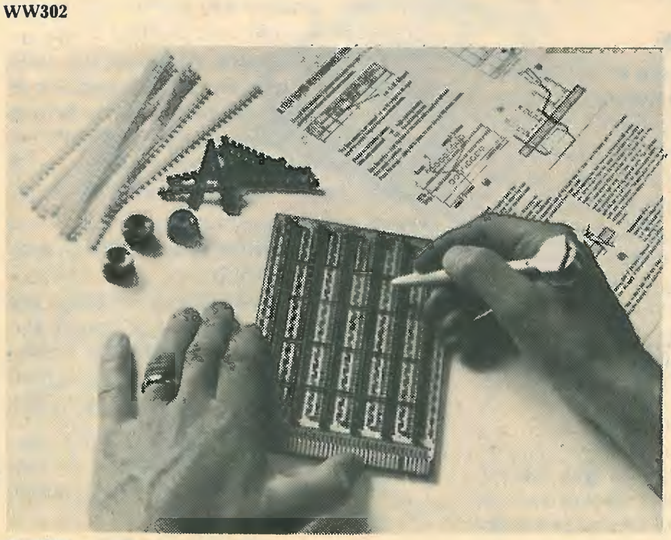


WW302

Prototype circuit board system

The Roadrunner prototype wiring system uses a special wiring instrument and press-fixed or glue-fixed distribution strips. The wiring instrument feeds a quick soldering enamelled wire from interchangeable bobbins. Special features are a simple threading system which allows fast bobbin changes and a means for adjusting wire tension. The castellated distribution strips will retain a large number of wires in position without affecting the low profile of the finished boards. The strips have no posts to impede access when wiring. The system is normally supplied in kit form but individual components are available separately. A typical introductory kit costs £8.50. TJB Associates, Unit 116b, Blackdown Rural Industries, Haste Hill, Haslemere, Surrey GU27 3AY.

WW 303



WW303

Musical instrument microphone

The SM17 moving-coil microphone is designed for attaching to musical instruments in recording studios and for on-stage professional sound reinforcement. Based on the makers' SM11 microphone, it is supplied with a 10ft cable and three types of mounting. The first is an expansion mount for fitting to the tailpiece of instruments of the violin family, while the second is an edge-mounting clip for attachment to a guitar sound-hole or to a suitable edge of a brass instrument. The third mounting is a complete lavalier assembly, with a cord and cable clips. The microphone is claimed to give good isolation from other instruments and freedom from feedback. Price excluding v.a.t. is £45.60. Shure Electronics Ltd, Eccleston Road, Maidstone, Kent ME15 6AU.

WW 304

L-band magnetron

The M5169 tunable magnetron is claimed to have better performance than that of fixed frequency tubes in current service for high power surveillance radars. A successor to the maker's M554/M586 series, it has been designed to be electrically and mechanically interchangeable with them. The design, which includes a rigid cathode structure and 15MHz tuning mechanism, offers a stable m.t.i. performance in microphonic environments, precise setting of radar operating requency, and a.f.c.-tuning to crystal controlled local oscillator. Frequency range is 1260 to 1365 MHz, while output power is 2.6MW (typical). English Electric Valve Company Ltd, Waterhouse Lane, Chelmsford, Essex CM1 2QU.

WW 305

Error rate tester

The bit error rate in digital communication, fibre optic and magnetic storage systems can be measured at data rates up to 150Mb/s by two new modules from Tau-Tron. The MN-301A transmitter and MB-301A receiver operate at rates from 1Mb/s to 150Mb/s and use pseudo-random data patterns as test signals. Two sequence lengths are used: 127 bits and 32767 bits. In addition to these, the transmitter will generate an alternating 1100 . . . . . test pattern. Errors can be injected into the pseudo-random data internally at a rate of 2 errors per 100 bits of data or at an externally determined rate. Output data and clock amplitude is at 1 volt into 50 ohms and gives compatibility with e.c.l. Bit-by-bit error detection, using an internally generated reference pattern, is provided by the receiver. Synchronization may be manual or automatic. Bit error rate or cumulative errors may be shown by the four-digit l.e.d. display. The instrument has a variable display hold time and a b.c.d. printer output. Tau-tron Inc, 11 Esquire Road, North Billerica, Mass. 01862, USA.

WW 306

Colour tv camera

The CY-8800E colour camera made by JVC uses three tubes, 2/3in Plumbicons or Saticons, with electromagnetic focus and deflection. It has a 1.5in adjustable electronic viewfinder and a 10-to-1 zoom lens with automatic iris control. Minimum illumination required is 300 lux, f/1.9. Signal-to-noise ratio of 49dB is achieved at 3,000 lux, f/4, with centre resolution in excess of 500 lines. For low light levels, the camera has a sensitivity switch with +6 dB and +12 dB steps. There is circuitry for horizontal and vertical contour correction, auto white balance and colour temperature adjustment. A filter system provides for different light levels, and an intercom system for studio use. The lens aperture can be controlled by a built-in level switch, giving ½ f-stop adjustments, and through a built-in video signal indicator. Other features are a colour bar generator, a battery warning indicator, a tally light and fast warm-up capability. On the hand grip are a recorder stop-start switch, an open/close switch for the zoom lens and an "aux" video switch. Power is supplied through an a.c. adaptor or external +12V d.c. source. Bell & Howell A-V Ltd, Alperton House, Bridgewater Road, Wembley, Middx HA0 1EG.

WW 307

Pulse oscillator/amplifier

A high-power amplifier/pulsed oscillator is available for applications requiring r.f. pulsed or c.w. signals. The pulsed r.f. output is continuously variable up to 400 watts peak and covers the frequency range 0.18 to 190 MHz. Called the PG-650-C, it can amplify and modulate externally generated signals which are already phase, frequency or amplitude modulated. Four models are available. Other features are: continuously variable pulse durations from 1.5 to 20µs or fixed at 0.5µs; r.f. phase stability of about 1ns with respect to trigger; small to "unmeasurable" interpulse noise; and a.c. line input regulation and positive or negative adjustable trigger level. Arenberg Ultrasonic Inc, 94 Green Street, Jamaica Plain, Mass. 02130, USA.

WW 308

Video monitors

The PMC 50/S/RGB colour video monitor has a 20-inch screen and the PMC/35/S/RGB monitor a 14-inch screen. Both use red, green, blue video input signals with separate mixed syncs inputs and are intended primarily for computer graphics. They have phosphor-stripe cathode-ray tubes, capable of resolving 490 lines per picture width. Beam separation is claimed to be better than 0.5mm vertically and one stripe width horizontally. The monitors have wide-band gain-stabilized amplifiers (−1dB at 9MHz). Differential gain distortion is less than 2% and the black level stability is better than 1% for a 100% black to peak white change in picture level. Size stability of the raster is better than 5%. The monitors can be set for 525-line or 625-line scanning standards without modification. Raster geometry controls are accessible, and there is a built-in test signal source, providing six test patterns. Cotron Electronics Ltd, Rockland Works, Eagle Street, Coventry CV1 4GJ.

WW 309

Data acquisition device

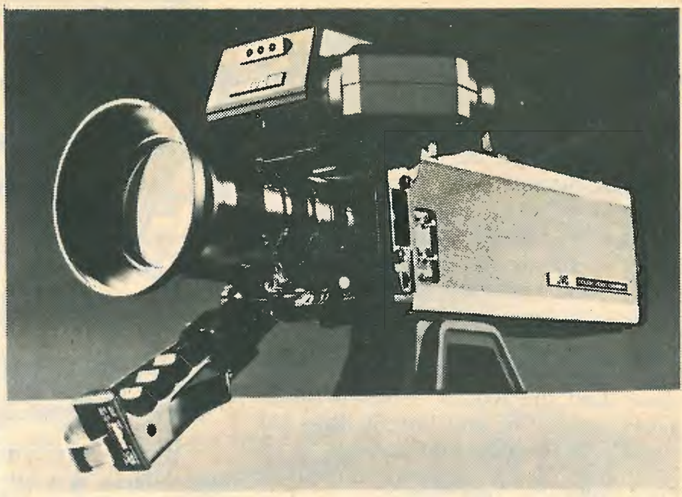
A self-contained data-acquisition module will multiplex 16 channels of physical variables from sensors and convert them to digital information. Known as the Zeltex SMP1000, the device offers 12-bit resolution at rates of up to 50,000 channels per second. It can handle 16 single-ended or eight full differential inputs with a voltage range of ±10V. Housed in a case measuring 11.68 × 7.62 × 0.95 cm, the device has an input impedance of 100MΩ and an analogue/digital conversion time of 12µs. Inputs and outputs are compatible with t.t.l. circuitry. The operating temperature range is 0°C to +70°C. Walmore Electronics Ltd, 11-15 Betterton Street, Drury Lane, London WC2H 9BS.

WW 310

Epoxy impregnant

Eccoseal W19-FR is a fire retardant expoxy impregnant. The low viscosity of the material (2-5 poise) makes it suitable for impregnating coils, transformers and other electronic components. When tested in accordance with the underwriters' laboratory VL94 vertical burning test it meets the V-O specification in 1/16in thickness when cured with catalyst 11. It can also be used as a casting resin as it contains no solvents. Large castings can be produced in conjunction with filler A-21 or other types. It can be cured with catalyst 9 to give a room temperature cure or with catalyst 11 for high temperature properties. Emerson & Cuming (UK) Ltd, Colville Road, Acton, London W3.

WW 311



WW307

WW308

Headset tester

A headset and audio accessories tester provides means for subjective evaluation of equipments having electromagnetic or carbon microphones with outputs in the range 1-300mV. Earphones or receivers are checked using speech side tone or an internal oscillator. Visual indication of microphone output level is given by a meter, which also allows more precise microphone measurements to be made using a small artificial voice supplied with the instrument. A total of six combinations of electromagnetic and carbon systems (3 each) can be tested on one unit. Connections and sensitivities can be specified by the user. Isolation between microphone, receiver and exposed metal parts is shown by an l.e.d. indicator. The unit has its own self-checking facility and is designed for use by both skilled and non-technical people. Tone Dynamics Ltd, 110 Midland Road, Luton, Beds LU2 0BC.

WW 312

Analogue function generator

Described misleadingly by its makers as a "linear microprocessor" the LH0094 packaged circuit generates an analogue output voltage E_o given by the equation: $E_o = E_1 \times (E_2 / E_3)^m$. The inputs E_1, E_2, E_3 can be any voltages from 0.1V to 10V while m, a resistor ratio, sets the power in a range from 0.1 to 10. A thin film network included in the circuit allows squaring and square rooting by strapping pins. Accuracy is claimed to be 0.05%. Housed in a hermetic 16-pin package, the device operates from power supplies of ±5V to ±22V, and has a 10kHz bandwidth. National Semiconductor Ltd, 301 Harpur Centre, Horne Lane, Bedford MK40 1TR.

WW 313

SIDEBANDS

by Mixer

Fashion waggon

My first car was pretty basic. It had a speedometer and a petrol gauge and that was about it. As far as I was aware, all kinds of mayhem were going on under its bonnet, but the idea of concerning myself with temperatures, charging rates, r.p.m. and all that stuff didn't come high on my list of priorities. It did 60 m.p.h. downhill, with a following wind and what more could anyone want? (This is all a long time ago.) Then, of course, I entered the rat race and got hold of a year-old Zephyr, which had the works — temperature gauge, ammeter, and lots of little coloured lights that would have been invaluable if I'd had the instruction book.

I think my first grey hair showed up around that time. Now I knew that the engine had a temperature, I began to watch it, worrying when it approached 'H'. If the ammeter didn't do the right thing at the right time I knitted my brow. Driving became a race between the engine seizing solid and the battery going flat, neither of which contingency could have caused me a moment's concern without the instruments.

Now, the microcomputer is with us, of course, and all the more private and personal foibles of one's engine can be displayed. Cadillac's new Seville uses a computer to increase the driver's worry level to new heights, exposing to his horror-stricken gaze all manner of vital information without which he would have been driving peacefully along, humming nonchalantly. It is all available 'on request' by pushing a button.

Well, I suppose it's all right for the man who has everything; but the thought of anyone actually pushing a button to ask the computer for the inside story on how the oil is doing, or how long it is since one left home is an odd one. When are you supposed to consult the thing, I wonder. Personally, I'm usually fairly preoccupied with staying out of trouble and when the road is reasonably clear I listen to music. At no time, I can state with confidence, does it occur to me to do any more than glance quickly at the oil pressure, temperature and fuel level every ten miles or so, and that's during the break between movements. If I had a Cadillac, I would feel entitled to assume that everything would work correctly without supervision from me.

Future uncertain

I'm a bit worried. Not about Jim, although heaven knows he can be very trying, but more about our inescapably microscopic future. Every time we get a note from a company to tell us about their latest bit of nonsense, it's become pocket-sized or even credit-card-sized. If it goes on like this, we'll be walking around with pockets bulging to such an extent that we'll need handbags to relieve the strain.

But, really, this fascination with smallness is a bit of a puzzle. A telly with a two-inch screen is a pretty good piece of engineering when you consider the low power needed and the size of the case, and the performance is very good, too, but watching a two-inch diagonal picture holds about as much attraction, for me at least, as shark fishing in the bath. Minute calculators, too, aren't a lot of use if your fingers are too big to press one key at a time. If you have to find a pencil to prod them with, you may as well do the calculation with it.

The way round all this, of course, is to go in for a programme of forced evolution – or genetic engineering, to give it its more with-it title. It is becoming fairly clear that all this machinery we are faced with is not going to take kindly to being messed about by clumsy, error-prone, unadaptable and altogether regrettable humans.

So, equally clearly, we are going to have to change. Twenty-six very small fingers on each hand might be a good first objective, to conform with computer keyboards; and if we could only buck our ideas up a bit to conform with a decent clock rate we could save an awful lot of time and expenses in interfacing. We can't let people stand in the way of progress; either they pull themselves together or they will have to go.

Jack and his master, both

Using all the tact and diplomacy of a wounded buffalo, the IEE recently addressed itself to the economic and social problems of the day. The Institution aligned itself with views expressed by the CBI on the role of trade unions and delivered itself of the following Thought. "... the Institution commends to the Trade Union movement and industry as a whole the standards of service and responsibility to the community displayed by the professions as being now the standards appropriate to so powerful a movement."

There are at least three assumptions in that one sentence, any one of which ought to send the blood pressure of a reasonably observant trade unionist up to somewhere near the danger level. First, what right has the Institution, admirable a body as it is, to commend anything to anyone? Second, the implication that the professions are exemplars of responsibility and service to the community is hardly likely to find a sympathetic response from the public, who are accustomed to being treated like inconvenient morons by the medical profession (which strikes when it wants to, like anyone else) and as part of a game of poker by the legal brotherhood (which doesn't strike because it is doing very nicely out of its clients as it is). Thirdly, assuming the IEE meant to say that the professions exhibit high standards, are they therefore implying that the unions don't?

Oh, dear! How very unfortunate. Perhaps if the Thought had been addressed a little more wholeheartedly to management as well as unions (the 'industry as a whole' is fairly clearly an afterthought) it would have carried more conviction. Management's grief at being restrained by Government from paying employees the rewards they would 'like to' must call for a good deal of acting ability in public, and an act as cynical as that is surely not in the tradition of professonal behaviour.

Calling the tune

Half the fun of listening to the radio, I've always thought, is choosing your programme and tuning it in. The pleasure of catching and savouring the ether-borne sounds — Freud might have called it aural eroticism–is greatly intensified by all the excitement and uncertainties of the chase. So what am I to make of the latest technological marvel they're now working on that will do away with most of this? It's called programme labelling. Of course, it's put forward in the name of progress — that brilliant arrow which points towards a marvellous collective future but forgets to indicate that each individual goes through a drastic molecular change on the way. But I suspect it's really just a plot on the part of the i.c. merchants, aided by the broadcasters and the desperate set makers, to sell us even more chips in our consumer electronics boxes. Or it might come from a neurotic obsession with tidiness, a bureaucratic notion that everything has to be identified with a type number and if it can't be understood by a computer it has no right to exist. Perhaps I go too far. But I really do object to the implication that you should be able to tick off in advance all the programmes you can expect yourself to like, according to specification, and then set a machine to preselect them and automatically tune them in to trickle into your head like manufactured parts onto a conveyor belt. If it's not an insult to intelligence it will certainly put the mockers on spontaneity. One has a vision of the tape machines inexorably rolling at the transmitting end and the digital electronics ticking away obediently at the receiving end in superb synchrony. Do the people really matter?

EMI SPEAKER BARGAIN

Stereo pair 350 kit. System consists of 13" x 8" approx. woofer with rolled surround; 2½" approx. Audax tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS. 20 watts max. 8 ohm impedance.

£14.95 Per stereo pair + £3.40 p&p.

As above but complete with all woodwork in kit form, finished in simulated teak veneer, with instructions.
Size approx 20" x 11" x 9½" **£28.00** Per stereo pair + £5.00 p&p.

BSR Manual single play record deck with auto-return and cueing lever, fitted with stereo ceramic cartridge 2 speeds with 45 r.p.m. spindle adaptor ideally suited from home or disco use. OUR PRICE **£10.95** p&p £2.55

TURNTABLE BARGAINS FOR PERSONAL SHOPPERS

GARRARD 86SB Deck **£26.95** | **GARRARD** SP25 MKIV Deck with Shure head. **£25.95**

Plinth and cover for BSR decks **£6.00**

BARGAINS FOR PERSONAL SHOPPERS

PORTABLE STEREO RADIO CASSETTE RECORDER UNREPEATABLE MW, LW, SW and Stereo VHF. 6 watts outpur Battery/Mains operation.	**£69.95**
16o 16 VOLT MAINS TRANSFORMER, 2½ amp.	**£2.50**
Garrard Record auto deck on plinth with stereo cartridge ready wired.	**£18.95**
LED 5 function men's digital watch stainless steel finish	**£5.95**
LCD 5 function men's digital watch stainless steel finish	**£6.95**
LCD 8 Function **CHRONOGRAPH** men's digital watch, stainless steel finish.	**£13.95**
Battery/Mains Cassette Recorder with built-in mic.	**£12.95**

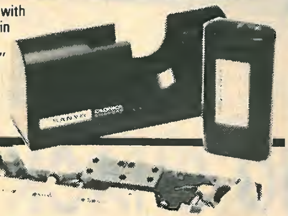
AM/FM DIGITAL CLOCK RADIO Accurate 4 Digit Electronic Clock with ½" LED display. Buzzer and snooze timer.

£11.95

125 Watt Power Amp Module	**£13.95**
Mains power supply for above unit.	**£3.50**
MUSIC CENTRE CABINET with hinged smoke acrylic top, finished in natural teak veneers, size 30¼" x 14½" x 7¼" approx.	**£5.95**
MULLARD Built power supply	**£1.50**
DECCA DC 1000 Stereo Cassette P.C.B. complete with switch oscillator coils and tape-heads.	**£2.95**
DECCA 20w Stereo speaker kit comprising 2 8" approx. bass units + 2 3½" approx. tweeter inc. crossovers	**£20.00**
'VIDEOMASTER' Super Score TV Game with pistol mains operation	**£14.95**
PORTABLE RADIO/CASSETTE RECOROER, AM/FM with clock. LW, MW, SW, VHF mains/battery operation.	**£41.95**
7" TAPE TRANSPORT Mechanism—a selection of models from	**£8.95**

SANYO Nic/cad. battery, with mains charger equivalent in size and replaces 4 SP11 type batts. Size 3¾"x 1¼" x 2" approx.

£7.50 p+p £1.50p



AM/FM STEREO TUNER AMPLIFIER CHASSIS *COMPLETE* WITH DECODER

Ready built. Designed in a slim form for compact, modern installation.
Rotary Controls Vol On/Off, Bass, Treble, Balance.
Push Buttons for Gram, Tape, VHF, MW, LW
Power Output 5 watts per channel Sine at 2% THD into 15 Ohm
7 watts speech and music.
Tape Sensitivity Playback 400mV/30K OHM for max output Record 200mV/50K output available from 25KHz. (150mV/100K) deviation FM signal **Frequency Range (Audio)** 50Hz to 17KHz within ± 1dB
Radio FM sensitivity for 3dB below limiting better than 10 uV
AM sensitivity for 20dB S/N MW 350 uV/Metre LW 1mV/Metre
Size approx length 16" x height 2¾" x depth 4¼"
240 Volts AC Complete with Circuit diagram. **£19.95** p&p £2.55

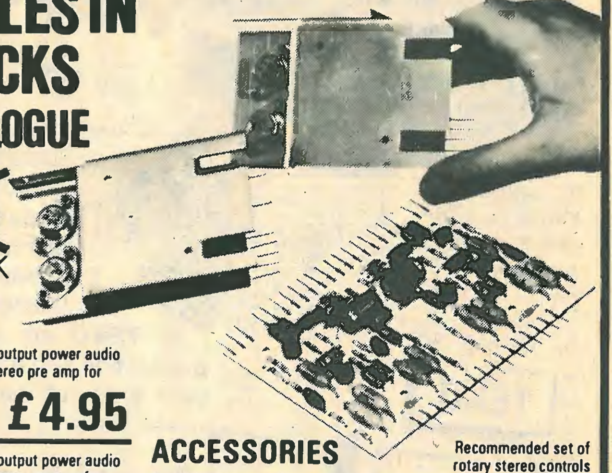
Complete with tuning dial

Mullard

AUDIO MODULES IN BARGAIN PACKS

CURRENT CATALOGUE PRICE £ AT OVER ~~25~~ PER PACK

ACCESSORIES ARE ONLY AVAILABLE TO THOSE CUSTOMERS WHEN BUYING OUR BARGAIN PACKS.



SEE OUR PRICES

1 PACK 1. 2 x LP1173 10w. RMS output power audio amp modules, + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input.
OUR PRICE p+p £1.00 **£4.95**

2 PACK 2. 2 x LP1173 10w. RMS output power audio amp modules + 1 LP1184/2. Stereo pre amp for magnetic, ceramic and auxiliary inputs.
illus. OUR PRICE p+p £1.00 **£7.45**

ACCESSORIES

Suitable power supply parts including mains transformer, rectifier, smoothing and output capacitors. £1.00 p+p **£1.95**

Recommended set of rotary stereo controls comprising BASS, TREBLE, VOLUME and BALANCE. p+p 50p **95p**

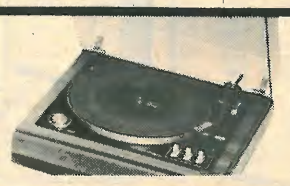
FOR PERSONAL SHOPPERS ONLY

GARRARD BARGAIN

LIST PRICE £~~90.00~~

OUR PRICE **£39.95**

86 SB MKII.
Belt drive,
2 speed turntable module with plinth and cover.



20 x 20 WATT STEREO AMPLIFIER

Viscount IV unit in teak simulate cabinet. Silver fascia with aluminium rotary controls/pushbuttons, red mains indicator and stereo jack socket. Functions switch for mic, magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features two mains outlets DIN speaker and input sockets plus fuse 20x20 watts RMS 40x40 watts peak. For use with 8 to 15 ohm speakers.

£29.90 + £2.50 p&p

SPECIAL OFFER

FOR PERSONAL SHOPPERS ONLY

FREE. 4 dimensional stereo sound adaptor, when purchasing the 20x20 Viscount amplifier.

30x30 WATT AMPLIFIER IN KIT FORM

For the experienced constructor complete in every detail, same facilities as Viscount IV, but with 30x30 output. 60x60 watts peak. For use with 4-15 ohms speakers. **£23.00** without cabinet. **£29.00** complete with cabinet. p&p £2.50 in each case.

£23.00 + £2.50 p&p without cabinet. (NOTE Cabinet not available separately.)

£29.00 + p&p £2.50 complete with cabinet.

SPECIAL OFFER
Complete with case

30x30 WATT AMPLIFIER IN KIT WITH SPEAKERS

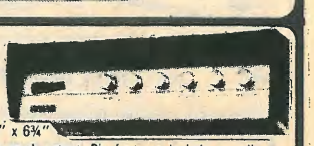
2 Goodman compact 12" bass woofers with cropped size 14,000 Gauss magnet. 30 watt RMS handling + 3¼" approx. tweeters and crossovers. **£49.00** + p&p £4.00

BUILT AND READY TO PLAY

30x30 Viscount. Available fully built and tested. **39.00** + p&p £2.50

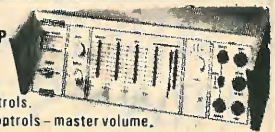
50 WATT MONO DISCO AMP

£29.95
P&P £2.50



Size approx. 13⅜" x 5¼" x 6¾"
50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.
SPECIAL OFFER. The above 50 watt amp plus 4 Goodmans Type 8P. 8" speakers. Package price £45.00 + £4.00 P&P.

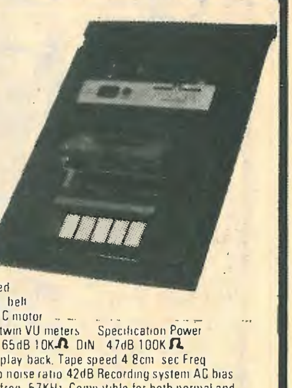
70 & 100 WATT MONO DISCO AMP



Size approx.
14" × 4" × 10¼".
Brushed aluminium fascia and rotary controls.
Five vertical slide controls – master volume, tape level, mic level, deck level, PLUS INTER-DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre-fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level.
Output 100 watts RMS 200 watts peak.

70 watt **£57** p & p £4.00
100 watt **£65**

STEREO CASSETTE TAPE DECK ASSEMBLY



Consisting of ready-built tape transport system mechanism, mated to the electronics Unit is ready built for installing into cabinet of own choice Features include pause control, solenoid assisted auto stop 3 digit tape counter belt driven balanced fly wheel by DC motor with electronic speed control, twin VU meters Specification Power Output, more than 0 5v, mic -65dB 10KΩ DIN 47dB 100KΩ Track 2 channel stereo record play back. Tape speed 4 8cm sec Freq response 50 1200 Hz signal to noise ratio 42dB Recording system AC bias Erasing system AC erase Bias freq 57KHz Compatible for both normal and chrome dioxide tapes Size of mechanism only 4 ." x 6 4" x 11 4" approx included a moulded top plate as illustrated 13 4" x 9 4" approx with circuit diagram **£25.00** P&P £2 50
Opt extras Mains transformer to suite **£2.50** + £1 p & p

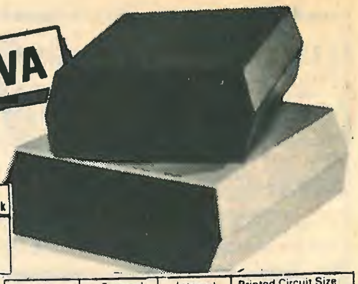
R T V C

323 EDGWARE ROAD, LONDON W2
21A HIGH STREET, ACTON W3 6NG
ALL PRICES INCLUDE VAT AT 12½%

All items subject to availability. Price correct at 20.12.78 and subject to change without notice

Personal Shoppers EDGWARE ROAD LONDON W2 Tel: 01-723 8432. 9.30am-5.30pm. Half day Thursday. ACTON: Mail Order only. No callers GOODS NOT DESPATCHED OUTSIDE UK

MODULOS



NUOVA

WH

WEST HYDE

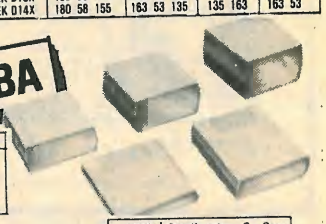
are now sole agents for **TEKO**

NUOVA Specify colour: G = Grey L = Lobster red. W = White. K = Black	1 off	10	50
TEK D12X	1.59	1.35	1.19
TEK D13 X	1.91	1.62	1.43
TEK D14X	2.71	2.30	2.03

	External W	External H	External D	Internal W	Internal H	Internal D	Printed Circuit Size Horizontal		Printed Circuit Size Vertical	
TEK D12X	120	50	90	116	41	70	65	110	61	40
TEK D13X	135	55	150	120	46	130	120	130	120	46
TEK D14X	180	58	155	163	53	135	135	163	163	53

A wide range of small and miniature cases in A.B.S. suitable for anything from digital clocks to audio consoles. Low cost with discounts for quantity. **MODULOS** can be used for encapsulation and come with P.C. boards. **NUOVA** have a clear front panel. The very popular **DESKO & TEKO** are very widely used in both production and amateur use. **ALBA** are cases with grills top and bottom, for speakers or ventilation.

TEKO MODULOS				Specify colour: G = Grey, R = Red, V = Sea Green			
Lgth mm	Wth mm	Hgt mm			1 off	10	50
20	20	20	TEK L20 X	Pk 4	0.93	0.79	0.70
30	20	20	TEK L30 X	Pk 4	0.93	0.79	0.70
40	20	20	TEK L40 X	Pk 4	1.05	0.89	0.79
50	20	20	TEK L50 X	Pk 4	1.05	0.89	0.79
19	12.5	17.5	TEK S19 X	Pk 4	0.93	0.79	0.70
27	12.5	17.5	TEK S27 X	Pk 4	0.93	0.79	0.70
38	12.5	17.5	TEK S38 X	Pk 4	1.05	0.89	0.79
51	12.5	17.5	TEK S51 X	Pk 4	1.05	0.89	0.79
Asst of 8 pieces			TEK SL8 X	Pk 8	1.87	1.59	1.40

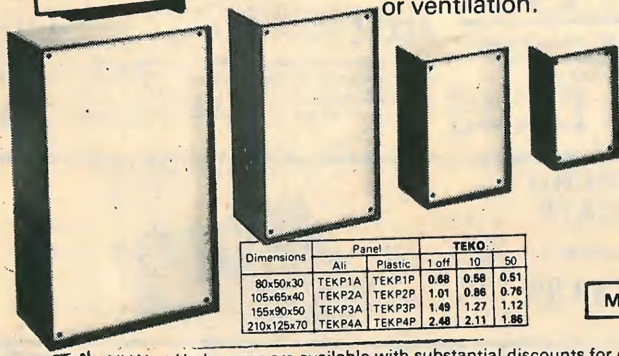


TEKO ALBA

	Lgth	Wth	Hgt
TEK A11	198	180	40
TEK A12	198	180	55
TEK A22	198	180	70
TEK A23	198	180	90
TEK A33	198	180	110

TEKO ALBA	Specify colour: G = Grey, L = Lobster Red		
	1 off	10	50
TEK A11 X	3.15	2.68	2.36
TEK A12 X	3.40	2.89	2.56
TEK A22 X	3.60	3.06	2.70
TEK A23 X	3.85	3.27	2.89
TEK A33 X	4.10	3.48	3.07

TEKO



DESKO

TRADE ENQUIRIES INVITED

Dimensions	Panel		TEKO		
	Ali	Plastic	1 off	10	50
80x50x30	TEKP1A	TEKP1P	0.68	0.58	0.51
105x65x40	TEKP2A	TEKP2P	1.01	0.86	0.76
155x90x50	TEKP3A	TEKP3P	1.49	1.27	1.12
210x125x70	TEKP4A	TEKP4P	2.48	2.11	1.86

MINIMUM ORDER £2.00

L	W	H MAX	H MIN	DESKO	1 off	10	50
161	95	60	40	TEK 362	1.65	1.40	1.24
215	130	75	45	TEK 363	2.48	2.11	1.86
311	169	90	50	TEK 364	5.21	4.43	3.91

NOTE NEW PHONE NO.

All West Hyde cases are available with substantial discounts for quantities. Most cases have discounts at 5, 10 and 25 off with discounts up to 33% at 100 off. Prices include P & P and are less 10% if collected on first two price breaks on cases only. Send for catalogue. Prices correct at press date.

WEST HYDE DEVELOPMENTS LIMITED, Unit 9, Park Street Industrial Estate, AYLESBURY, BUCKS. HP20 1ET. Phone: Aylesbury (0296) 20441. Telex: 83570

WW060—FOR FURTHER DETAILS

½ watt ATTENUATORS TERMINATIONS IMPEDANCE TRANSFORMERS

MANUFACTURED BY ELCOM SYSTEMS INC.

LOW COST *FAST DELIVERIES*

FROM

Aspen Electronics Limited

Communications Equipment and Components
2 KILDARE CLOSE, EASTCOTE, RUISLIP, MIDDLESEX HA4 9UR
Telephone; 01-868 1188. Telex: 8812727

WW—040 FOR FURTHER DETAILS

RADIO SHACK LTD *for* DRAKE

TR-7 Transceiver

Ham Bands with 1.5-30 MHz receive with built-in 150 MHz frequency counter plus option of 0-1.5 MHz receive and/or any transceiving application 1.8-30 MHz.

RADIO SHACK LTD

For Communications equipment including Trio products and Trio testgear.

We are situated just around the corner from West Hampstead Underground Station (Bakerloo line). A few minutes' walk away is West Hampstead Midland Region station and West End Lane on the Broad Street Line. We are on the following Bus routes: 28, 59, 159. Hours of opening are 9-5 Monday to Friday. Closed for Lunch 1-2. Saturday we are open 9-12.30 only. World wide exports.

DRAKE ★ SALES ★ SERVICE

RADIO SHACK LTD

188 BROADHURST GARDENS, LONDON NW6 3AY
Giro Account No. 588 7151. Telephone: 01-624 7174
Cables: Radio Shack, London, NW6. Telex: 23718

LANGREX SUPPLIES LTD

Climax House, Fallsbrook Rd., Streatham, London SW16 6ED

RST Tel: 01-677 2424 Telex: 946708 RST

SEMICONDUCTORS

AA119	0.10
AAY30	0.27
AAY32	0.42
AAZ13	0.18
AAZ15	0.34
AAZ17	0.27
AC107	0.60
AC125	0.20
AC126	0.20
AC127	0.20
AC128	0.20
AC141	0.25
AC141K	0.35
AC142	0.20
AC142K	0.30
AC176	0.20
AC187	0.20
AC188	0.20
ACY17	0.85
ACY18	0.80
ACY19	0.75
ACY20	0.70
ACY21	0.75
ACY39	1.50
AD149	0.70
AD161	0.45
AD162	0.45
AF106	0.45
AF114	0.35
AF115	0.35
AF116	0.35
AF117	0.35
AF139	0.40
AF186	1.20
AF239	0.45
AFZ11	2.75
AFZ12	2.75
ASY26	0.40
ASY27	0.40
ASZ15	1.25
ASZ16	1.25
ASZ17	1.25
ASZ20	1.50
ASZ21	2.00
AU113	1.70*
AUY10	1.70*
AV110	1.70*
BA145	0.13*
BA148	0.13*
BA154	0.09
BA155	0.10
BA156	0.09
BAW62	0.05
BAX13	0.06
BAX16	0.09
BC107	0.12
BC108	0.12
BC109	0.13
BC113	0.12*
BC114	0.13*
BC115	0.14*
BC116	0.15*
BC117	0.17*
BC118	0.10*
BC125	0.16*
BC126	0.20*
BC135	0.14*
BC136	0.15*
BC137	0.15*
BC147	0.09*
BC148	0.08*
BC149	0.09*
BC157	0.09*
BC158	0.08*
BC159	0.10*
BC167	0.12*
BC170	0.11*
BC171	0.10*
BC172	0.10*
BC173	0.12*
BC177	0.15
BC178	0.14
BC179	0.16
BC182	0.11*
BC183	0.10*
BC184	0.11*
BC212	0.13*
BC213	0.12*
BC214	0.15*
BC237	0.09*
BC238	0.12*
BC301	0.25
BC303	0.24
BC307	0.10*
BC308	0.10*
BC327	0.20*
BC328	0.18*
BC337	0.18*
BC338	0.17*
BCY30	1.00
BCY31	1.00
BCY32	1.00
BCY33	0.90
BCY34	0.90
BCY39	3.00
BCY40	1.00
BCY42	0.25
BCY43	0.25
BCY58	0.16
BCY70	0.15
BCY71	0.17
BCY72	0.13
BCZ11	1.50
BD115	0.45
BD121	1.20
BD123	1.20
BD124	1.30
BD131	0.35
BD132	0.38
BD135	0.34*
BD136	0.34*
BD137	0.35*
BD138	0.40*
BD139	0.43*
BD140	0.44*
BD144	2.00
BD181	1.10
BD182	1.18
BD237	0.40
BD238	0.55
BDX10	0.91
BDX32	2.00
BDY20	1.25
BDY60	1.50
BF115	0.25
BF152	0.18
BF153	0.20
BF154	0.17
BF159	0.23
BF160	0.16
BF167	0.20
BF173	0.20
BF177	0.24
BF178	0.24
BF179	0.25
BF180	0.30
BF181	0.30
BF182	0.30
BF183	0.25
BF184	0.25
BF185	0.25
BF194	0.09*
BF195	0.09*
BF196	0.10*
BF197	0.12*
BF200	0.27
BF224	0.20*
BF244	0.28*
BF257	0.24
BF258	0.26
BF259	0.32
BF336	0.30*
BF337	0.30*
BF338	0.31*
BFS21	3.96
BFS28	2.23
BFS61	0.20*
BFS98	0.20*
BFW10	0.65
BFW11	0.65
BFX84	0.22
BFX85	0.23
BFX87	0.21
BFX88	0.21
BFY50	0.26
BFY51	0.26
BFY52	0.26
BFY64	0.26
BFY90	1.25
BSX19	0.21
BSX20	0.20
BSX21	0.20
BT106	1.25
BTY79/400R	3.19
BU205	1.75*
BU206	2.25*
BU208	2.00*
BY100	0.45
BY126	0.14
BY127	0.15
BZX61	0.18
Series	
BZY88	0.13
Series	
CRS1/05	0.45
CRS1/40	0.60
CRS3/05	0.45
CRS3/40	0.75
CRS3/60	0.90
GEX66	1.50
GEX541	1.75
GJ3M	0.75
GM0378A	1.75
KS100A	0.45*
MJE340	0.80
MJE370	1.17
MJE371	0.61
MJE520	0.52
MJE521	0.55
MJE2955	1.25
MJE3055	0.75
MPF102	0.30*
MPF103	0.30*
MPF104	0.30*
MPF105	0.30*
MPSA06	0.24*
MPSA56	0.26*
MPSU01	0.36*
MPSU06	0.46*
MPSU56	0.49*
NE555	0.45
NKT401	2.00
NKT403	1.73
NKT404	1.73
OA5	0.95
OA7	0.55
OA10	0.60
OA47	0.14
OA70	0.30
OA79	0.30
OA81	0.30
OA85	0.30
OA90	0.08
OA91	0.08
OA95	0.08
OA200	0.09
OA202	0.09
OA211	1.00
OAZ200	1.00
OAZ201	1.00
OAZ206	1.00
OAZ207	1.00
OC16	2.00
OC20	2.50
OC22	2.50
OC23	2.75
OC24	3.00
OC25	0.90
OC26	0.90
OC28	2.00
OC29	2.00
OC35	1.50
OC36	1.50
OC41	0.80
OC42	0.75
OC43	2.25
OC44	0.60
OC45	0.55
OC71	0.55
OC72	0.55
OC73	1.00
OC74	0.65
OC75	0.65
OC76	0.55
OC77	1.20
OC81	0.65
OC81Z	1.20
OC82	0.65
OC83	0.65
OC84	0.65
OC122	1.50
OC123	1.75
OC139	2.25
OC140	2.75
OC141	3.25
OC170	1.00
OC171	1.00
OC200	1.50
OC201	1.75
OC202	1.75
OC203	1.75
OC204	2.50
OC205	2.50
OC206	2.50
OC207	1.75
OCP71	1.25
ORP12	0.75
R2008B	1.75*
R2009	2.25*
R2010B	1.75*
T1C44	0.30
T1C226D	1.20
T1L209	0.20
T1P29A	0.41*
T1P30A	0.44*
T1P31A	0.45
T1P32A	0.48
T1P33A	0.69
T1P34A	0.73
T1P41A	0.63
T1P42A	0.70
T1P2955	0.67
T1P3055	0.56
T1S43	0.45*
ZS140	0.25*
ZS170	0.21*
ZS178	0.54*
ZS271	0.23*
ZS278	0.57*
ZTX107	0.11*
ZTX108	0.10*
ZTX109	0.12*
ZTX300	0.12*
ZTX301	0.13*
ZTX302	0.15*
ZTX303	0.17*
ZTX304	0.19*
ZTX311	0.12*
ZTX314	0.20*
ZTX500	0.13*
ZTX501	0.14*
ZTX502	0.16*
ZTX503	0.17*
ZTX504	0.20*
ZTX531	0.20*
ZTX550	0.16*
1N914	0.05
1N916	0.07
1N4001	0.06
1N4002	0.06
1N4003	0.07
1N4004	0.07
1N4005	0.08
1N4006	0.08
1N4007	0.09
1N4009	0.06
1N4148	0.06
1N5400	0.13
1N5401	0.13
1S44	0.04
1S920	0.07
1S921	0.07
2G301	1.00
2G302	1.00
2G306	1.10
2N404	1.00
2N696	0.25
2N697	0.25
2N698	0.30
2N705	1.20
2N706	0.15
2N708	0.20
2N930	0.20
2N1131	0.26
2N1132	0.26
2N1302	0.35
2N1303	0.35
2N1304	0.45
2N1305	0.45
2N1306	0.50
2N1307	0.50
2N1308	0.55
2N1309	0.55
2N1613	0.25
2N1671	1.50
2N1893	0.25
2N2147	1.75
2N2148	1.65
2N2218	0.25
2N2219	0.24
2N2220	0.18
2N2221	0.18
2N2222	0.18
2N2223	2.75
2N2368	0.17
2N2369A	0.21
2N2484	0.20
2N2646	0.55
2N2904	0.25
2N2905	0.25
2N2906	0.21
2N2907	0.21
2N2924	0.21*
2N2925	0.22*
2N2926	0.14*
2N3053	0.25
2N3054	0.50
2N3055	0.70
2N3440	0.60
2N3441	0.80
2N3442	1.10
2N3525	0.80
2N3614	1.50
2N3702	0.11*
2N3703	0.13*
2N3704	0.13*
2N3705	0.13*
2N3706	0.13*
2N3707	0.13*
2N3708	0.10*
2N3709	0.13*
2N3710	0.10*
2N3711	0.10*
2N3771	1.75
2N3772	2.00
2N3773	3.00
2N3819	0.36*
2N3820	0.45*
2N3823	0.55*
2N3866	0.72
2N3904	0.13*
2N3905	0.13*
2N3906	0.13*
2N4058	0.14*
2N4059	0.10*
2N4060	0.12*
2N4061	0.12*
2N4062	0.13*
2N4124	0.15*
2N4126	0.15*
2N4286	0.20*
2N4288	0.22*
2N4289	0.24*
2N5457	0.35*
2N5458	0.35*
2N5459	0.35*
2S017	6.50
2S019	6.50
2S026	12.00
2S103	1.50
2S302	0.75
2S303	0.75
2S322	0.80
2S324	1.25
2S701	1.50
2S703	1.50
2S721	3.00
2S745A	0.35
2S746A	0.35

VALVES

A1834	9.00
A2087	11.81
A2134	6.75
A2293	7.50
A2426	11.19
A2521	10.11
A2900	7.58
A3343	22.23
AZ31	1.10*
AZ41	1.15*
BK448	62.70
BK484	84.70
BS90	27.25
BS810	27.75
BT5	34.30
BT17	61.95
BT19	21.15
BT29	188.90
BT69	193.25
BT75	79.65
BT95	74.35
CBL31	1.50*
CL33	2.00*
CY31	1.00*
C1K	10.00
C3A	10.00
C3JA	20.20
DA41	18.70
DA42	10.70
DA100	46.00
DAF91†	0.40*
DAF96	1.00*
DET22	21.00
DET24	46.00
DF91†	0.40*
DF96	1.00*
DK91†	1.05*
DK92	1.25*
DK96	1.10*
DL92	0.75*
DL94	1.20*
DL96	1.10*
DLS10	8.25
DLS15	10.76
DLS16	10.76
DLS19	10.76
DM70	1.25
DM71	1.25
DM160	1.50
DY86/7†	0.55*
DY802	0.80*
E55L	21.89
E80CC	5.00
E80CF	7.21
E80F	6.32
E80L	5.53
E81CC	5.76
E81L	6.20
E82CC	6.12
E83CC	6.23
E86C	9.31
E88C	5.43
E88CC†	1.00
E90CC	5.46
E90F	5.16
E91H	4.65
E92CC	4.98
E99F	5.61
E130L	16.85
E180CC	5.84
E180F	6.12
E182CC	5.92
E186F	8.04
E188CC	5.05
E280F	18.27
E283CC	7.85
E288CC	12.75
EA52	14.91
EA76	1.50
EABC80	0.55*
EAC91†	0.50*
EAF42	1.25*
EAF801	1.75*
EB41	2.00*
EB91†	0.40*
EBC33	1.75*
EBC41	1.25*
EBC81	1.10*
EBC90†	0.75*
EBF80	0.50*
EBF83	1.25*
EBF89†	0.45*
EBL31	2.50*
EC90†	0.55*
EC91†	2.80*
EC92	1.25*
EC157	218.50
ECC33	3.50*
ECC35	3.50*
ECC40	1.25*
ECC81†	0.50*
ECC82†	0.47*
ECC83†	0.55*
ECC84†	0.60*
ECC85†	0.55*
ECC86	2.00*
ECC88†	0.75*
ECC89	0.80*
ECC91†	0.55*
ECC189	1.66*
ECC807	1.75*
ECC808	2.25*
ECF80†	0.60*
ECF82†	0.70*
ECF86	0.80*
ECH35	2.00*
ECH42	1.15*
ECH81†	0.55*
ECH83	1.25*
ECH84†	0.85*
ECL80†	0.60*
ECL81	0.75*
ECL82	0.60*
ECL83	1.50*
ECL84	1.40*
ECL85	1.12*
ECL86†	0.85*
EF37A†	2.50*
EF39†	1.60*
EF40	1.15*
EF41	1.20*
EF42	2.00*
EF50†	0.60*
EF54	5.00*
EF55	2.50*
EF80†	0.50*
EF83	1.75*
EF85†	0.50*
EF86†	0.60*
EF89	1.60*
EF91†	0.70*
EF92†	0.75*
EF93†	0.50*
EF94†	0.55*
EF95†	0.55*
EF98	1.25*
EF183†	0.70*
EF184†	0.70*
EF804S	6.50
EF805S	7.00
EH90	1.28*
EK90†	0.65*
EL32	1.50*
EL33	3.50*
EL34THN	£1.60
EL34MUL	£2.24
EL36	0.95*
EL41	1.25*
EL42	1.75*
EL81	1.10*
EL83	1.25*
EL84	0.45*
EL86†	0.75*
EL90†	0.80*
EL91	4.35*
EL95†	0.80*
EL156	16.25
EL360	2.75*
EL500/504	1.88*
EL509	3.16*
EL821	6.42
EL822	6.55*
EM80	1.10*
EM81	1.00*
EM84	1.00*
EM85	1.25*
EM87	1.50*
EN32	15.66
EN91†	2.24
EN92	5.81
EY51†	0.75*
EY81	1.65*
EY83	1.75*
EY84	5.33*
EY86†	0.50*
EY88	1.75*
EY500A	1.94*
EY802	0.82*
EZ35	0.55*
EZ40	1.25*
EZ41	1.25*
EZ80†	0.50*
EZ81†	0.50*
EZ90†	0.60*
FW4-500	2.50*
FW4-800	2.50*
G1-371K	8.63
G55-1K	11.00
G180-2M	16.02
G240-2D	11.18
G400-1K	16.77
GN4	4.50
GN4A	4.50
GS16	9.00
GT1C	9.23
GU50	12.15
GU51	12.15
GXU1	10.97
GXU2	17.20
GXU3	23.57
GXU4	28.50
GY501	1.60*
GZ32	1.25*
GZ33	4.00*
GZ34†	1.52*
GZ37	4.00*
KT61	3.50*
KT66	5.00*
KT88	6.25*
KTW61	1.75*
KTW62	1.75*
KTW63	1.75*
M8079	9.04
M8080	6.37
M8081	6.78
M8082	5.58
M8083	5.86
M8091	7.85
M8096	3.75
M8097	3.56
M8098	3.40
M8099	5.20
M8100	6.39
M8136	6.60
M8137	6.80
M8140	4.50
M8141	4.85
M8142	4.75
M8144	3.75
M8149	5.10
M8161	6.12
M8162	5.87
M8163	4.50
M8190	4.60
M8195	3.70
M8196	6.50
M8204	5.72
M8212	9.16
M8223	2.30
M8224	2.80
M8225	2.60
M8248	7.95
MU14	1.00*
MX119	24.75
MX123	45.00
MX145	33.75
MX151	13.50
MX152	80.00
MX161	80.00
MX163	14.55
MX164	14.45
MX166	110.00
MX168	30.00
N78	9.00*
OA2†	0.55
OA3	1.10
OA4	1.10
OB2†	0.60
OB3	0.75
OC2	2.55
OC3	0.75
OD3†	0.75
OZ4	1.60*
PC86†	0.85*
PC88†	0.85*
PC95	0.70*
PC97	1.08*
PC900†	1.00*
PCC84†	0.50*
PCC85	0.60*
PCC88	0.65*
PCC89†	1.05
PCC189†	1.00*
PCC805†	0.95*
PCC806†	0.95*
PCE82†	1.72*
PCF80	0.96*
PCF82†	0.50*
PCF86†	0.75*
PCF87	1.10*
PCF200†	1.15*
PCF201†	1.10*
PCF801†	0.60*
PCF802†	0.88*
PCF805	1.44*
PCF806	1.44*
PCF808	1.44*
PCL82†	0.80*
PCL83†	0.92*
PCL84†	0.75*
PCL85†	0.96*
PCL86†	0.85*
PCL805/85†	0.96*
PD500	3.60*
PE06-40N	27.30
PFL200	1.12*
PL36†	1.12*
PL81	1.12*
PL81A†	1.12*
PL82	0.60*
PL83†	0.55*
PL84†	0.75*
PL504/505†	1.20*
PL508†	1.60*
PL509†	2.72*
PL519†	3.60*
PL801	1.10*
PL802†	3.46*
PY33	1.10*
PY81†	0.92*
PY82	0.80*
PY83	0.70*
PY88†	1.16*
PY500A†	1.60*
PY800	0.92*
PY801	0.92*
QQV02-6	9.90
QQV03-10†	2.00
QQV03-20A†	10.50
QQV06-40A†	13.00
QQV07-50	40.37
QQZ03-20A	27.50
QQZ06-40A	45.20
QU37	11.00
QV03-12	3.00
QV04-7	2.50
QV08-100	89.30
QY3-65	44.50
QY3-125†	12.00
QY4-250	55.14
QY4-400	62.67
QY5-500	132.00
QY5-3000A	228.00
QZ06-20	20.60
R10	5.00
R17	1.65
R18	3.95
R19	1.00
R20	1.44
RG3-250	21.51
RG3-250A	23.28
RG3-1250	22.20
RG4-1250	27.50
RG4-3000	56.65
RR3-250	34.77
RR3-1250	62.37
S11E12	22.36
S130	2.00
S130P	2.50
STV80-40	10.00
STV280-80	20.00
SU41	2.50
SU42	9.00
TD03-10	21.50
TD03-10E	22.75
TD03-10F	24.00
TT15	22.00
TT21	9.63
TT22	9.63
TT100	60.00
TY2-125	49.50
TY4-400	59.30
TY4-500	76.82
TY5-500	160.00
TY6-800	145.00
TY6-5000A	217.85
TY6-5000B	206.00
TY6-5000W	195.80
TY7-6000A	237.60
TY7-6000W	192.50
TZ40	15.00
U18-20	2.50*
U19	9.15
U25	1.16*
U26	1.44*
U37	11.00
UABC80†	0.58*
UAF42	1.25*
UB41	1.25*
UBC41	1.00*
UBF89	0.60*
UCC84	1.10*
UCC85†	0.55*
UCF80	1.15*
UCH42	1.20*
UCH81†	0.65*
UCL82†	0.75*
UCL83	1.44*
UF41	1.00*
UF42	1.25*
UF80†	0.50*
UF85†	0.65*
UF89†	0.55*
UL41	1.60*
UL84†	0.85*
UM80	1.00*
UY41†	0.75*
UY85†	0.65*
VL5631	8.22
XG1-2500	25.25
XG2-6400	72.30
XG5-500	16.80
XGQ2-6400	78.60
XR1-1600A	21.40
XR1-3200	104.54
XR1-3200A	57.25
XR1-6400	65.80
XR1-6400A	122.34
YD1120	206.00
YD1240	206.00
Z759	9.60
ZM1000	4.60
ZM1001	5.38
ZM1020	8.55
ZM1021	7.96
ZM1022	8.23
ZM1023	7.66
ZM1040	11.57
ZM1041	9.67
ZM1042	11.08
ZX1051	87.60
IB3GT†	0.65
IB24	10.00
IB35A	17.00
IB63	45.00
IR5†	0.55*
IS5†	0.40*
IT4†	0.40*
2AS15	10.00
2C39A†	9.00
2C43	18.00
2D21†	0.80
2E26	5.00
2J42	60.00
2J55	175.00
2J70A	235.00
2J70B	250.00
2K25†	10.00
3-400Z	35.00
3-500Z	35.00
3A5	1.35
3B24	5.00
3B28†	4.50
3B29	10.00
3B-240M	15.00
3B241M	15.00
3C23	10.00
3C45†	8.50
3CX100A5	20.00
3E29†	8.50
3S4†	0.75*
3V4†	1.00*
4.65A	23.35
4-125A†	12.00
4-250A	36.00
4-400A	37.00
4B32	25.36
4C35	40.00
4CX250B	17.50
4CX350A	31.35
4CX150A	21.00
4X150D	25.00
5B-254M	13.98
5B-255M	13.98
5C22	40.00
5J-180E	614.79
5R4GY†	1.10*
5U4G	1.52*
5U4GB	2.26*
5V4G†	0.65*
5Y3GT	0.85*
5Z3	1.50*
5Z4G	1.12*
5Z4GT	1.00*
6-30L2	1.56*
6AB4	0.75*
6AB7	0.75*
6AC7	0.75*
6AF4A†	0.70*
6AG7	0.75*
6AH6†	0.95*
6AK5†	0.50*
6AK6	0.95*
6AL5†	0.40*
6AM4	2.30*
6AM5	3.85
6AM6†	0.70*
6AN5	2.50*
6AN8A†	0.70*
6AQ5†	0.85*
6AR5	0.70*
6AS6†	0.80*
6AS7G†	1.50*
6AT6†	0.75*
6AU5GT	4.26*
6AU6†	0.55*
6AV5GT	3.74*
6AV6†	0.75*
6AX5GT	3.10*
6B7	0.75
6B8	0.75
6BA6†	0.50
6BA7	5.12
6BA8A	3.75
6BC4	3.71
6BE6†	0.48*
6BH6†	1.20*
6BJ6†	1.20*
6BK4	4.21*
6BL6	85.00
6BL7GT	3.86*
6BM6	85.00
6BN6	0.80*
6BQ7A	1.55*
6BR7	4.00*
6BR8†	1.20*
6BS7	4.00*
6BW6	3.75*
6BW7	1.40*
6BX7GT	4.96*
6BZ6	1.78*
6C4†	0.55*
6CB6A†	0.55*
6CD6GA	4.90*
6CG7	1.72*
6CH6	4.42*
6CL6†	0.75*
6CW4	7.24*
6D2†	0.40*
6DK6	2.49*
6DQ6B	3.90*
6EA8	2.21*
6EB8	2.12*
6EW6	1.50*
6F6	1.75*
6F23	1.60*
6F28	1.16*
6F33	13.35
6H1	11.75
6H2N	1.05*
6H3N	1.05*
6H6	1.50*
6J4†	1.20*
6J6†	0.55
6J7	0.80*
6K4N	1.25*
6K6GT	1.30*
6K7	1.50*
6K8	1.75*
6KD6	4.79*
6L6G	2.50*
6L6GA	1.50*
6L6GT	0.85*
6L6GC	1.95*
6L7	2.00*
6N2P	1.05*
6N3P	1.05*
6N7	1.05*
6P25	3.60*
6Q7	2.20*
6R7	1.80*
6SA7	1.45*
6SC7	1.50*
6SF7	1.60*
6SH7	1.50*
6SJ7	1.60*
6SK7	1.30*
6SL7GT†	0.70*
6SN7GT†	0.70*
6SQ7	1.30*
6SR7	1.50*
6SS7	1.80*
6U5G	2.00*
6U8†	0.55*
6U8A†	0.55*
6V6GT†	0.65*
6X4†	0.60*
6X5GT†	0.60*
7B7	1.70*
7C5	1.75*
7C6	1.25*
7H7	2.00*
7R7	1.50*
7S7	2.25*
7Y4	1.60*
7Z4	1.85*
11E3	42.89
12AT6	1.20*
12AT7†	0.50*
12AU6	0.65*
12AU7†	0.47*
12AV6	0.85*
12AV7	3.46*
12AX7†	0.55*
12AY7†	0.85*
12B4A†	1.00*
12BA6	0.65*
12BE6	1.60*
12BH7†	0.65*
12BY7†	0.80*
12E1	7.10
12E14	24.59
12E1ITT	54.09
13E1	43.55
19H4	20.96
19H5	22.50
24B9	30.50
30C15	1.56*
30C17	1.56*
30C18	1.44*
30F5	1.60*
30FL1/2	1.12*
30FL12	1.72*
30FL14	1.44*
30L1	0.84*
30L15	1.72*
30L17	1.72*
30P4	0.92*
30P19	1.12*
30PL1	1.32*
30PL13	1.72*
30PL14	1.68*
30PL15	1.72*
35W4	0.60*
50C5	0.70*
75B1	3.30
75C1	1.70
85A1	7.50
85A2	1.65
90AG	7.96
90AV	7.96
90C1	1.70
90CG	13.68
90CV	13.30
92AG	7.26
92AV	7.16
95A1	4.60
150B2	2.15
150B3	3.90
150C2	1.50
150C4	2.30
211	5.00
723AB†	8.00
803	10.00
805	20.00
807†	1.20
811A†	3.80
812A	8.35
813†	10.00
833A	30.00
866A	8.85
872A	13.75
922	4.36
931A	12.24
1624	2.25
1625	1.70
2050	2.50
4212E	118.95
4212H	147.74
5544	54.00
5545	59.00
5551A	69.75
5552A	94.30
5553A	225.30
5642	5.26*
5654	3.61*
5651	180*
5670	2.86*
5675	9.09*
5687	4.30*
5696	1.94*
5718	6.40*
5725	3.40*
5726	3.52
5727	4.80
5749	4.90*
5751	4.66*
5763	3.12*
5814A	2.60*
5840	4.40*
5842	6.90*
5876A	9.38*
5879	4.84*
5886	10.50
5963	1.87*
5965	2.36*
6005	3.65*
6021	4.46
6057	6.23
6058	9.04
6059	4.00
6061	4.25
6062	3.75
6063	3.65
6064	5.86
6067	6.60
6072	5.62
6080	6.85*
6097A×B×C	40.00
6146A	5.12*
6146B	5.58*
6159	6.00
6189	6.08
6201	5.12
6442	15.00
6883B	5.92
6973	3.52*
7025†	1.20*
7551	5.94
7586	11.38*
7587	19.60*
7609	31.80
7868	3.94*
7895	12.90*
8005	30.00
8068	5.50
8122	42.00
8136	2.44*
8417	5.34
18042	5.43
18045	6.17

BASES

B7G unskirted	0.15
B7G skirted	0.30
B9A unskirted	0.15
B9A skirted	0.30
Int Octal	0.20
Loctal	0.55
Nuvistor base	0.55
8 pin DIL	0.15
14 pin DIL	0.15
16 pin DIL	0.17
Valve screening cans all sizes	0.30

CRTs

2AP1*	8.50
2BP1*	9.00
3BP1	8.00
3DP1*	5.00
3EG1*	7.00
3FP7*	6.00
3GP1	6.00
3JP1*	8.00
3JP2*	8.00
3JP7*	10.00
3KP1*	15.00
3RP1*	35.00
5ADP1	35.00
5BP1*	10.00
5CP1*	5.00
5CP1A	40.00
5FP15A	15.00
5UP7*	14.00
DG7-5	25.00
DG7-32	36.00
DH3-91	31.00
DH7-11	68.00
VCR97*	5.00
VCR138*	10.00
VCR138A*	12.50
VCR139A*	8.00
VCR517A*	10.00
VCR517B*	6.00
VCR517C	6.00

Tube Bases 0.75

* = Surplus

VAT 8%

INTEGRATED CIRCUITS

7400	0.16
7401	0.16
7402	0.16
7403	0.16
7404	0.17
7405	0.16
7406	0.40
7407	0.40
7408	0.20
7409	0.20
7410	0.16
7412	0.26
7413	0.32
7416	0.32
7417	0.32
7420	0.17
7422	0.20
7423	0.32
7425	0.30
7427	0.30
7428	0.43
7430	0.17
7432	0.30
7433	0.36
7437	0.32
7438	0.32
7440	0.18
7441	0.85
7442	0.72
7447AN	0.90
7450	0.18
7451	0.18
7453	0.18
7454	0.18
7460	0.18
7470	0.35
7472	0.33
7473	0.36
7474	0.40
7475	0.54
7476	0.40
7480	0.55
7482	0.75
7483	0.90
7484	1.00
7486	0.35
7490	0.52
7491	0.80
7492	0.60
7493	0.60
7494	0.80
7495	0.72
7496	0.80
7497	3.00
74100	1.50
74107	0.45
74109	0.70
74110	0.50
74111	0.70
74116	1.75
74118	1.00
74119	1.50
74120	0.83
74121	0.40
74122	0.60
74123	1.00
74125	0.55
74126	0.55
74128	0.60
74132	0.70
74136	0.55
74141	0.80
74142	2.30
74143	2.50
74144	2.50
74145	0.90
74147	2.00
74148	1.75
74150	1.60
74151	0.85
74154	1.75
74155	0.85
74156	0.85
74157	0.75
74159	2.10
74170	2.30
74172	4.40
74173	1.40
74174	1.50
74175	0.90
74176	1.10
74178	1.25
74179	1.25
74180	1.15
74190	1.50
74191	1.50
74192	1.35
74193	1.35
74194	1.25
74195	1.00
74196	1.20
74197	1.10
74198	2.25
74199	2.25
76013N	1.75*
TAA570	2.30*
TAA630S	3.50*
TAA700	3.91
TBA480Q	1.84*
TBA520Q	2.30*
TBA530	1.98*
TBA540Q	2.30*
TBA550Q	3.22*
TBA560CQ	3.22*
TBA673	2.19*
TBA700	1.52*
TBA720Q	2.30*
TBA750Q	2.07*
TBA800	1.20
TBA920	2.90
TBA920Q	2.99
TBA990Q	2.99*
TCA270Q	2.99*
TCA760A	1.38*

Terms of business: CWO. Postage and packing valves and semiconductors 25p per order. CRTs 75p. Items marked * add 12½% VAT. Others 8%. P&P at 8%.

† Indicates cheap quality version or surplus, but also available by leading UK and USA manufacturers. Price ruling at time of despatch.

Account facilities available to approved companies with minimum order charge £10. Carriage and packing £1 on credit orders.

Over 10,000 types of valves, tubes and semiconductors in stock. Quotations for any types not listed. S.A.E.

Telephone 01-677 2424/7
Telex 946708
E & O.E.

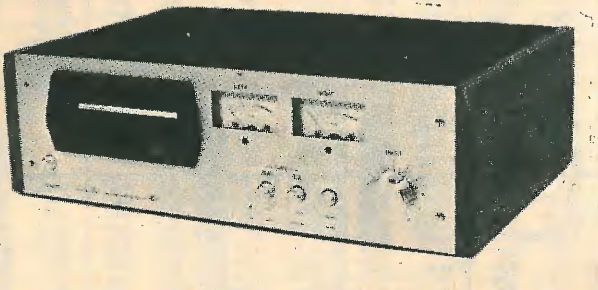
The *Only* Firm for *Quality* Audio Kits

HART ELECTRONICS

Are proud to offer the only DESIGNER APPROVED kit for the

J. L. Linsley-Hood High Quality Cassette Recorder

Now offered with Super Quality Sendust Alloy Head at no extra cost, and incorporating noise reduction modifications given in the postscript article.



As these circuits are capable of such an excellent performance we feel that it is not sensible to sacrifice this potential by designing a kit down to a price. We have therefore spent a little more on professional hardware allowing us to design a very advanced modular system. This enables a more satisfactory electrical layout to be achieved, particularly around the very critical input areas of the replay preamps. These are totally stable with this layout and require no extra stabilising components. Many other advantages also come from this system which has separate record and replay amps for each channel plugging in to a master board with gold-plated sockets. The most obvious is the reduction of crosstalk and interaction which could cause trouble on a single plane board, with our modular system the layout is compact but there is no component crowding. Testing is very easy with separate identical modules and building with the aid of our component-by-component instructions is childlishly simple, but the finished result is a unit designed not to normal domestic standards but to the best professional practice.

All printed circuits are of glassfibre material, fully drilled with a tinned finish for easy and reliable soldering. Component locations are printed on the reverse side of the board and are arranged so that all identification numbers are still visible after assembly.

71x Complete set of parts for Master Board, includes bias oscillator, relay, controls, etc. £9.83 + £1.23 VAT.

72x Parts for Motor Speed and Solenoid Control for Lenco CRV deck. This is the proper board layout as given in the articles. £3.52 + 44p VAT.

73x Complete set of parts for stereo Replay Amps, and VU Meter drive £8.12 + £1.02 VAT.

74x Complete set for stereo Record Amps. £6.74 + 84p VAT.

75x Complete set of parts for Stabilised Power Supply to circuit given in Article. This uses a special low hum field transformer with better characteristics than the commonly used toroid. £8.79 + £1.10 VAT.

700M2 Individual High Quality VU Meters with excellent ballistics. £8.48 + £1.06 VAT. Per Pair.

700C/2 High Quality Custom built steel Case. Complete with Brushed aluminium front plate, mains switch, record microswitch, turned record level knob, plastic cabinet feet, all bolts, nuts and mounting hardware. All necessary holes are punched and all surfaces are electroplated. Complete step-by-step assembly instructions are included. The cover is finished in an attractive black crackle surface. £16.50 + £2.06 VAT.

LENCO CRV CASSETTE MECHANISM — Now fitted with Super Quality Sendust Alloy Head.

High Quality, robust cassette transport for Linsley-Hood recorder. Features fast forward, fast rewind, record, pause and full auto stop and cassette ejection facilities. Fitted with Record / play and erase heads and supplied complete with Data and extra cassette ejection spring for above horizontal use. Price £21.60 + £2.70 VAT.

Total cost of all parts £83.58.

Special offer for Complete Kits £81.50 + £10.19 VAT.

Complete with data and set up notes to achieve best results with the Super Head.

Optional extra solid teak end cheeks, £3 pair + 38p VAT.

Reprint of 3 Linsley-Hood Cassette Recorder articles, 45p post and VAT free.

OTHER CASSETTE SPECIALITIES

LENCO MECHANISMS. For industrial or domestic use. We have in stock SPFF, FFR and CRV with DC and AC motors. Mini TB500, 502, 504 and Mini TB 'U' for endless loop cassettes. Send for details

Super Quality Sendust Alloy R/P Stereo Head for replacement use. £6.50 + 81p VAT.

Set of components and data for optimising L-H Cassette circuits for use with this head, 50p + 6p VAT.

Standard Quality Stereo R/P Head, £4.50 + 56p VAT.

Economy Cassette Stereo R/P Head, £2.80 + 35p VAT.

4-track Cassette R/P Head, £7.40 + 93p VAT.

TEST CASSETTE to enable the user without instruments to easily set up the Head Azimuth, tape speed and VU level, £1.50 inc. VAT.

Blank Cassettes, reliable mechanics and Super Ferric Low Noise tape. C90, 80p inc. VAT; C10, 35p inc. VAT.

Penylan Mill, Oswestry, Salop

Personal callers are always welcome
but please note we are closed all day Saturday

TRANSFORMERS

SAME-DAY DESPATCH

VAT 8%

MAINS ISOLATOR

PRI 120 or 240V Sec 120 or 240V
Centre Tapped and Screened

Ref.	VA (Watts)	£	P&P
07★	20	**4.40**	.79
149	60	**6.70**	.96
150	100	**7.61**	1.14
151	200	**11.16**	1.14
152	250	**13.28**	1.50
153	350	**16.43**	1.84
154	500	**20.47**	2.15
155	750	**29.06**	OA
156	1000	**37.20**	OA
157	1500	**51.38**	OA
158	2000	**81.81**	OA
159	3000	**86.66**	OA

★115 or 240 sec only. State volts required. Pri 0.220-240V.

12 or 24-VOLT

Separate 12V windings Pri 220-240V

Ref	Amps		£	P&P
	12v	24v		
111	0.5	0.25	**2.20**	.45
213	1.0	0.5	**2.64**	.78
71	2	1	**3.51**	.78
18	4	2	**4.03**	.96
85	5	2.5	**5.00**	.79
70	6	3	**5.35**	.96
108	8	4	**7.42**	1.14
72	10	5	**8.12**	1.14
116	12	6	**8.99**	1.32
17	16	8	**10.72**	1.32
115	20	10	**13.98**	2.08
187	30	15	**17.05**	2.08
226	60	30	**36.14**	OA

50 VOLT RANGE

Pri 220-240V. Sec. 0-20-25-33-40-50V. Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40 or 20V-0-20V and 25V-0-25V Screened

Ref.	Amps	£	P&P
102	0.5	**3.41**	.78
103	1.0	**4.57**	.96
104	2.0	**7.16**	1.14
105	3.0	**8.56**	1.32
106	4.0	**15.06**	1.50
107	6.0	**14.62**	1.64
118	8.0	**20.26**	2.08
119	10.0	**24.98**	OA

30 VOLT RANGE

Pri 220-240V
Sec. 0-12-15-20-24-30V
Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V and 15V-0-15V.

Ref.	Amps	£	P&P
112	0.5	**2.64**	.78
79	1.0	**3.57**	.96
3	2.0	**5.77**	.96
20	3.0	**6.20**	1.14
21	4.0	**7.99**	1.14
51	5.0	**9.87**	1.32
117	6.0	**11.17**	1.45
88	8.0	**14.95**	1.64
89	10.0	**17.25**	1.84

60 VOLT RANGE

Pri 220-240V
Sec 0-24-30-40-48-60V. Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48. 60V, or 24V-0-24V and 30V-0-30V

Ref.	Amps	£	P&P
124	0.5	**3.88**	.96
126	1.0	**5.91**	.96
127	2.0	**7.60**	1.14
125	3.0	**11.00**	1.32
123	4.0	**12.52**	1.84
40	5.0	**15.84**	1.64
120	6.0	**18.06**	1.84
121	8.0	**25.56**	OA
122	10.0	**29.55**	OA
189	12.0	**34.06**	OA

SCREENED MINIATURES Primary 240V

Ref.	mA	Volts	£	P&P
238	200	3-0-3	**2.57**	.55
212	1A, 1A	0-6, 0-6	**2.85**	.78
13	100	9-0-9	**2.14**	.38
235	330, 330	0-9, 0-9	**1.99**	.38
207	500, 500	0-8-9, 0-8-9	**2.77**	.71
208	1A, 1A	0-8-9, 0-8-9	**3.53**	.78
236	200, 200	0-15, 0-15	**1.99**	.38
239	50MA	12-0-12	**2.57**	.38
214	300, 300	0-20, 2-20	**2.80**	.78
221	700 (DC)	20-12-0-12-20	**3.41**	.78
206	1A, 1A	0-15-20, 0-15-20	**4.63**	.96
203	500, 500	0-15-27, 0-15-27	**3.99**	.96
204	1A, 1A	0-15-27, 0-15-27	**6.04**	.96

HIGH VOLTAGE

MAINS ISOLATING
Pri 200/220 or 400/440
Sec 100/120 or 200/240

VA	Ref.	£	P&P
60	243	**6.70**	1.32
350	247	**16.43**	1.84
1000	250	**37.10**	OA
2000	252	**61.81**	OA

AUTO TRANSFORMERS

Ref.	VA (Watts)	TAPS	£	P&P
113	15	0-115-210-240V	**2.48**	.71
64	75	0-115-210-240V	**4.01**	.96
4	150	0-115-200-220-240V	**5.35**	.96
66	300	" "	**7.75**	1.14
67	500	" "	**10.99**	1.64
84	1000	" "	**18.76**	2.08
93	1500	" "	**23.28**	OA
95	2000	" "	**34.82**	OA
73	3000	" "	**59.21**	OA
80s	4000	0-10-115-200-220-240	**76.86**	OA
57s	5000	" "	**89.50**	OA

Step Up or Step Down

BRIDGE RECTIFIERS

100v	100A★	**£2.10**
200v	2A	**45p**
400v	2A	**55p**
200v	4A	**65p**
400v	4A	**80p**
400v	6A	**£1.40**
500v	12A★	**£2.35**

★P&P 15p. VAT 12½% ★VAT 8%

CASED AUTO TRANSFORMERS

240V cable input. USA 115V. Flat pin outlets.

		P&P	Ref.
15VA	**£4.96**	.90	113W
75VA	**£7.73**	1.14	64W
150VA	**£10.01**	1.14	4W
250VA	**£9.92**	1.45	65W
500VA	**£19.17**	1.64	67W
750VA	**£23.41**	1.76	83W
1000VA	**£27.88**	2.30	84W
1500VA	**£26.02**	OA	93W
2000VA	**£49.97**	OA	95W

MINI-MULTIMETER
DC1000V, AC-1000V
AC/DC-1000Ω/V
DC-100mA. Res — 150K
Bargain at **£7.20**
VAT 8% P&P 62p

TEST METERS

AVO8 Mk. 5	**£81.70**
AVO71	**£33.50**
AVO73	**£45.20**
AVOMM5 MINOR	**£28.66**
WEE MEGGER	**£66.90**
TT169 (tests transistors in circuit)	**£34.75**
U4315 budget meter (42 ranges) 20kΩ V/DC 1000V AC/DC (9 ranges) 2.5A AC/DC 500K resistance, in robust steel case with leads, full instructions.	**£15.85**
EM272 316Kv	**£53.70**
DA116 Digital	**£102.00**
Megger BM7 (Battery)	**£44.15**
MM5	**£27.56**

Avo Cases and Accessories
P&P £1.15 VAT 8%

PANEL METERS

43mm x 43mm		82mm x 78mm	
0-50μA	**£6.20**	0-50μA	**£6.70**
0-500μA	**£5.95**	0-500μA	**£6.70**
0-1mA	**£5.95**	0-1mA	**£6.70**
0-30V	**£5.95**	0-30V	**£6.70**

VU Indicator Panel 90mm 250μa **£3.36**
VU Indicator Edge 54mm x 14mm μa FSD . **£2.60**
Carriage 65p VAT 8%

Purbeck Oscilloscope Transformer. 250-0-250 at 80mA, 12.9-0-12.9 at 300mA, 6.3 at 600mA. **£6.50.** P&P 90p.

MINIATURE TRANSFORMER

0-CT-15V

Ref.	Amp	Price	P&P
171	500MA	**2.09**	.45
172	1A	**2.96**	.78
173	2A	**3.59**	.78
174	3A	**3.75**	.86
175	4A	**5.73**	.96

NEW RANGE TRANSFORMERS

Pri 0-120; 0-100-120; (120v or 220-240v) Sec. 0-36-48 twice to give 72v or 92v.

2A	12.14	PP	**£1.40**	4A	18.17	PP	**£1.90**
3A	14.70	PP	**£1.50**	5A	26.64	PP	**£2.20**

ELECTROSIL metal oxide low noise resistors.

ABS PLASTIC BOXES

Inset brass nuts, slots to take PC cards (boards) flush fitting lid.

PB1 80mm x 62 x 40	**.65p**
PB2 100mm x 75 x 40	**.73p**
PB3 120mm x 100 x 45	**.87p**
PB4 215mm x 130 x 85	**£2.54**

P&P 29p. VAT 8%

PLUG-IN — SAVE BATTERIES

MVA30. 6, 7.5. 9v at 300mA plugs direct into 13A socket (fused), 4-way multi plug **£4.00**

ALUMINIUM BOXES—with ½lip lid and screws

	L	W	H	Price
B1	5¼	2¼	1½	**62p**
B2	4	4	1½	**62p**
B3	4	2¼	1½	**62p**

P&P29p. VAT 8% other sizes available

ANTEX SOLDERING IRONS

15W **£3.75.** 25W **£3.95**
Stand for above **£1.52.** P&P 46p. VAT 12½%.

PLEASE ADD VAT AFTER P&P

CATALOGUE NOW AVAILABLE
SEND 15p STAMPS
PRICES CORRECT AT 26/10/78

Barrie Electronics Ltd.

3,THE MINORIES, LONDON EC3N 1BJ
TELEPHONE: 01-488 3316/8
NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST.

It's W-W-WINTER S-S

74 SERIES TTL IC's

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.07	7427	£0.21	7472	£0.19	74107	£0.22	74165	£0.65
7401	£0.09	7428	£0.25	7473	£0.22	74110	£0.35	74166	£0.75
7402	£0.09	7430	£0.08	7474	£0.22	74111	£0.55	74167	£2.00
7403	£0.09	7432	£0.20	7475	£0.27	74118	£0.75	74174	£0.80
7404	£0.09	7433	£0.28	7476	£0.22	74119	£1.10	74175	£0.80
7405	£0.09	7437	£0.20	7480	£0.40	74121	£0.22	74176	£0.55
7406	£0.22	7438	£0.20	7481	£0.80	74122	£0.35	74177	£0.55
7407	£0.22	7440	£0.10	7482	£0.65	74123	£0.30	74180	£0.80
7408	£0.12	7441	£0.45	7483	£0.55	74136	£0.50	74181	£1.25
7409	£0.12	7442	£0.38	7484	£0.82	74141	£0.50	74182	£0.55
7410	£0.09	7443	£0.68	7485	£0.65	74145	£0.54	74184	£1.00
7411	£0.15	7444	£0.68	7486	£0.22	74150	£0.65	74190	£0.68
7412	£0.14	7445	£0.64	7489	£1.80	74151	£0.45	74191	£0.68
7413	£0.22	7446	£0.60	7490	£0.30	74153	£0.45	74192	£0.65
7414	£0.45	7447	£0.45	7491	£0.60	74154	£0.80	74193	£0.60
7416	£0.22	7448	£0.52	7492	£0.32	74155	£0.48	74194	£0.55
7417	£0.27	7450	£0.09	7493	£0.28	74156	£0.48	74195	£0.55
7420	£0.09	7451	£0.09	7494	£0.70	74157	£0.48	74196	£0.80
7421	£0.19	7452	£0.09	7495	£0.45	74160	£0.55	74197	£0.58
7422	£0.35	7453	£0.09	7496	£0.48	74161	£0.60	74198	£1.00
7423	£0.20	7454	£0.09	74100	£0.80	74162	£0.60	74199	£1.00
7425	£0.18	7460	£0.09	74104	£0.35	74163	£0.60	74279	£1.00
7426	£0.21	7470	£0.24	74105	£0.35	74164	£0.65		

CMOS IC's

Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0.12	CD4017	£0.65	CD4031	£1.60	CD4055	£1.00
CD4001	£0.13	CD4018	£0.70	CD4035	£0.90	CC4056	£1.15
CD4002	£0.13	CD4019	£0.35	CD4037	£0.78	CD4069	£0.15
CD4006	£0.80	CD4020	£0.80	CD4040	£0.78	CD4070	£0.15
CD4007	£0.14	CD4021	£0.75	CD4041	£0.68	CD4071	£0.15
CD4008	£0.80	CD4022	£0.75	CD4042	£0.68	CD4072	£0.15
CD4009	£0.40	CD4023	£0.13	CD4043	£0.78	CD4081	£0.15
CD4010	£0.42	CD4024	£0.55	CD4044	£0.78	CD4082	£0.16
CD4011	£0.13	CD4025	£0.13	CD4045	£1.15	CD4510	£0.80
CD4012	£0.14	CD4026	£1.00	CD4046	£0.95	CD4511	£0.80
CD4013	£0.35	CD4027	£0.45	CD4047	£0.75	CD4516	£0.85
CD4014	£0.70	CD4028	£0.60	CD4049	£0.35	CD4518	£0.85
CD4015	£0.70	CD4029	£0.40	CD4050	£0.35	CD4520	£0.85
CD4016	£0.35	CD4030	£0.55	CD4054	£0.95		

BOOKS BY BABANI

The following books are offered at 10% off their normal retail price

		Normal Price	Sale price
BP2	Handbook of Radio, TV & Industrial Transmitting Tube & Valve Equivalents	~~£0.60~~	£0.54
BP6	Engineers & Machinists Reference Tables	~~£0.40~~	£0.36
BP7	Radio & Electronic Colour Codes & Date	~~£0.15~~	£0.14
BP10	Modern Crystal & Transistor Set Circuits for Beginners	~~£0.35~~	£0.32
BP14	Second Book of Transistor Equivalents & Substitutes	~~£1.10~~	£0.99
BP15	Constructors Manual of Electronic Circuits for the Home	~~£0.50~~	£0.45
BP22	79 Electronic Novelty Circuits	~~£0.75~~	£0.68
BP23	First Book of Practical Electronic Projects	~~£0.75~~	£0.68
BP24	52 Projects Using IC741 (or equivalents)	~~£0.75~~	£0.68
BP26	Radio Antenna Handbook for Long Distance Reception and Transmission	~~£0.85~~	£0.77
BP27	Giant Chart of Radio Electronic Semiconductor and Logic Symbols	~~£0.60~~	£0.54
BP29	Major Solid State Audio Hi-Fi Construction Projects	~~£0.85~~	£0.77
BP32	How to Build Your Own Metal & Treasure Locators	~~£0.85~~	£0.77
BP34	Practical Repair & Renovation of Colour TVs	~~£0.95~~	£0.86
BP35	Handbook of IC Audio Preamplifier & Power Amplifier Construction	~~£0.95~~	£0.86
BP36	50 Circuits Using Germanium, Silicon & Zener Diodes	~~£0.75~~	£0.68
BP37	50 Projects Using Relays, SCR's and Triacs	~~£1.10~~	£0.99
BP39	50 (FET) Field Effect Transistor Projects	~~£1.25~~	£1.13
BP43	How to Make a Walkie-Talkie	~~£1.25~~	£1.13
BP44	IC 555 Timer Projects	~~£1.45~~	£1.31
BP47	Mobile Discotheque Handbook	~~£1.35~~	£1.22
BP49	Popular Electronic Projects	~~£1.45~~	£1.31
BP160	Coil Design and Construction Manual	~~£0.75~~	£0.68
BP196	AF-RF Reactance Frequency Chart for Constructors	~~£0.15~~	£0.14
BP202	Handbook of Integrated Circuits (ICs) Equivalents and Substitutes	~~£0.75~~	£0.68
BP205	First Book of Hi-Fi Loudspeaker Enclosures	~~£0.75~~	£0.68
BP213	Electronic Circuits for Model Railways	~~£0.85~~	£0.77
BP214	Audio Enthusiasts Handbook	~~£0.85~~	£0.77
BP215	Shortwave Circuits & Gear for Experimenters and Radio Hams	~~£0.85~~	£0.77
BP216	Electronic Gadgets and Games	~~£0.85~~	£0.77
BP217	Solid State Power Supply Handbook	~~£0.85~~	£0.77
BP219	Solid State Novelty Projects	~~£0.85~~	£0.77
BP220	Build Your Own Solid State Hi-Fi and Audio Accessories	~~£0.85~~	£0.77
BP222	Solid State Short Wave Receivers for Beginners	~~£0.95~~	£0.86
BP223	50 Projects Using IC Ca3130	~~£0.95~~	£0.86
BP224	50 CMOS IC Projects	~~£0.95~~	£0.86
BP225	A Practical Introduction to Digital IC's	~~£0.95~~	£0.86
BP226	How to Build Advanced Short Wave Receivers	~~£1.20~~	£1.08

VPS30 Variable Regulated Stabilised Power Supply Module

Incorporating a short circuit protection and current limiting:

Voltage Regulation	2-30v
Regulated Current	0-2A
AC Input Maximum	25v

Eliminates the use of batteries and thus saves £s — can be used time and time again. **ONLY £7.60 + V.A.T.**

BRAND NEW ITT 923 Silicon Diodes 200mA 200v.

100 off	£2.00
500 off	£9.00
1,000 off	£15.00
10,000 off	£130.00

Single-sided Fibre-glass P.C. Board. S143.

12″×3½″ approx. 2 pcs

£0.60

THYRISTORS

No. THY1A/50	1 Amp.	50 volt	TO5	**18p**
No. THY1A/400	1 Amp.	400 volt	TO5	**32p**
No. THY3A/50	3 amp.	50 volt	TO64	**25p**
No. THY3A/200	3 Amp.	200 volt	TO64	**32p**
No. THY3A/400	3 Amp.	400 volt	TO64	**40p**
No. THY5A/50	5 Amp.	50 volt	TO66	**25p**
No. THY5A/400	5 amp.	400 volt	TO66	**40p**
No. THY5A/600	5 Amp.	600 volt	TO66	**50p**
No. C106/4	6 Amp.	400 volt	TO220	**42p**

TRIAC

S84 8 Amp. 400 volt TO220 Plastic **80p**

DIACS

ITT	V413 equt	**12p**
BR100	D32	**12p**

CAPACITOR PAKS

16201	18 Electrolytics	4.7μF — 10μF
16202	18 Electrolytics	10μF — 100μF
16203	18 Electrolytics	100μF — 680μF

All 3 at SPECIAL PRICE of £1.20*

16160	24 Ceramic Caps	22pF — 82pF
16161	24 Ceramic Caps	100pF — 390pF
16162	24 Ceramic Caps	470pF — 3300
16168	24 Ceramic Caps	4700pF — 0.047μF

All 4 at SPECIAL PRICE of £1.60*

RESISTOR PAKS

Order No.		
16213	60¼W.	100 ohm — 820 ohm
16214	60¼W.	1K — 8.2K
16215	60¼W.	10K — 82K
16216	60¼W.	100K — 820K

All 4 at SPECIAL PRICE of £1.60

16217	40½W.	100 ohm — 820 ohm
16218	40½W.	1W — 8.2K
16219	40½W.	1K — 8.2K
16220	40½W.	100K — 820K

All 4 at SPECIAL PRICE of £1.60

VOLTAGE REGULATORS

Positive

No. MVR7805	μA7805	TO220	**55p**
No. MVR7812	μA7812	TO220	**55p**
No. MVR7815	μA7815	TO220	**55p**
No. MVR7818	μA7818	TO220	**55p**
No. MVR7824	μA7824	TO220	**55p**

Negative

No. MVR7905	μA7905	TO220	**75p**
No. MVR7912	μA7912	TO220	**75p**
No. MVR7915	μA7915	TO220	**75p**
No. MVR7918	μA7918	TO220	**75p**
No. MVR7924	μA7924	TO220	**75p**

μA723C TO99 **38p** 72723 14 pin Dil **38p**

LM309K TO3 **£1.20**

SWITCHES

No. 16178	5 x Mains Slide Switches	**40p***
No. S17	5 x Miniature Slide Switches	**40p***
No. S18	4 x Standard Slide Switches	**40p***
No. S19	4 x Miniature Push to Make single hole mounting	**40p***
No. S20	3 x Miniature Push to Break single hole mounting	**40p***
No. S21	Push button Switch Pak 4 x Assorted types multi bank and singles Latching and non-Latching	**£1.00***

AUDIO LEADS

Order No.

127 - Audio lead 5 pin DIN plug to 4 phono plugs	**90p***
29 - Audio lead 5 pin plug to 5 pin DIN plug—Mirror Image	**70p***
130 - 5-metre lead 2 pin DIN plug to 2 pin DIN inline socket	**45p***

AUDIO PLUG AND SOCKET PAKS

Order No.		
S1	5 x 3.5 mm Plastic Jack Plugs	**40p***
S2	5 x 2.5 mm Plastic Jack Plus	**40p***
S3	4 x Std Plastic Jack Plugs	**50p***
S4	2 x Stereo Jack Plugs	**30p***
S5	5 x 5 Pin 180° DIN Plugs	**50p***
S6	8 x 2 Pin Loudspeaker Plugs	**50p***
S7	6 x Phono Plugs Plastic	**50p***
S8	5 x 3.5 mm Chassis Sockets (Switched)	**25p***
S9	5 x 2.5 mm Chassis Sockets (Switched)	**25p***
S11	2 x Stereo Jack Sockets with instruction leaflet for H/Phone connection	**50p***
S12	5 x 5 Pin 180° DIN Chassis Sockets	**40p***
S13	8 x 2 Pin DIN Chassis Sockets	**50p***
S14	6 x Single Phono Sockets	**40p***

P.C. BOARD

S110 Mixed Bundle, P.C.B., Fibre-glass/paper, single and double-sided. Fantastic value **75p**

SPECIAL OFFER!

UNTESTED SEMICONDUCTOR PAKS

Code No's shown below are given as a guide to the type of device. The devices themselves are normally unmarked.

No. 16130	100 Germ. Gold bonded diodes like OA47	**40p**
No. 16131	150 Germ. Point contact diodes like OA70/81	**40p**
No. 16132	100 200mA Sil. diodes like OA200	**40p**
No. 16133	150 75mA Sil. Fast switching diodes like IN4148	**40p**
No. 16134	50 750mA Sil. top hat Rects.	**40p**
No. 16135	20 3 amp Sil. stud Rect.	**40p**
No. 16136	50 400mw Zeners D.O.7 case	**40p**
No. 16137	30 NPN Plastic trans. like BC107/8	**40p***
No. 16138	30 PNP Plastic trans. like BC177/8	**40p***
No. 16139	25 NPN trans. like 2N697/2N1711 TO39	**40p**
No. 16140	25 PNP trans. like 2N2905 TO39	**40p**
No. 16141	30 NPN trans. like 2N706 TO18	**40p**
No. 16143	30 NPN Plastic trans. like 2N3906	**40p***
No. 16144	30 PNP Plastic trans. like 2N3905	**40p***
No. 16145	30 PNP Germ. trans. like OC71	**40p**
No. 16147	10 NPN TO3 Power trans. like 2N3055	**80p**

I.C. SOCKET PAKS

No. S66	11 x 8 pin DIL Sockets	**£1.00**
No. S67	10 x 14 pin DIL Sockets	**£1.00**
No. S68	9 x 16 pin DIL Sockets	**£1.00**
No. S69	4 x 2 pin DIL Sockets	**£1.00**
No. S70	3 x 28 pin DIL Sockets	**£1.00**

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.

Order No. 16223 **£1.00**

MATCHED PAIRS OF PNP GERMANIUM MED. POWER TANS

2 amp 750mW

	VCE	VCB	HFE	
NKT301	40	60	30-100	**35p** per pair
NKT302	40	60	50-100	**35p** per pair
NKT303	20	30	30-100	**25p** per pair
NKT304	20	30	50-150	**25p** per pair

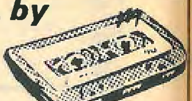
From* U.S.A. *by

DINDY

SCREW CASED

LOW NOISE

CASSETTES



Order No. S53 **10 for £3.50* C90**

HEAD-CLEANING CASSETTE 45p each

RETURN OF THE AL20A AMPLIFIER

By popular demand — this useful 5 watt RMS Power Amplifier is offered at the re-introductory price of **£2.75*** — Hook-up and data supplied.

ETCH RESIST PENS

Order No. 1609 **50p** each

UNIJUNCTION TRANSISTORS

UT46 TIS43 **20p**

FET's

2N3819 **15p** 2N5458 **18p**

2 AMP. BRIDGE RECTIFIERS

Metal Stud Mounting

No. S45	50V	(KBS 005)	**28p**
No. S46	100V	(KBS 01)	**30p**
No. S47	200V	(KBS 02)	**34p**

SILICON BRIDGE RECTS.

S99 Mixed Pak 2 — 5 Amp. 50-600v. All coded. 4 for **£1.00***

SIMILAR IN SILICON RECTS. 4000 SERIES

No. S41	25 Like IN4001 (1A 50V)	**60p**
No. S42	20 Like IN4002 (1A/100V)	**60p**
No. S43	18 Like IN4003 (1A/200V)	**60p**
No. S44	15 Like IN4004 (1A/400V)	**60p**

SALE T-T-TIME again!

SPECIAL OFFER!

COMPONENT PAKS

Order No.	Quantity	
16168	5 pieces Assorted Ferrite rods	40p
16169	2 pieces Tuning gangs MW/LW	40p
16170	50 metres Single strand wire assorted wire	40p
16171	10 Reed switches	40p
16172	3 Micro switches	40p
16176	20 Assorted electrolytics Trans types	40p
16177	1 pack Assorted Hardware nuts/bolts, etc.	40p
16179	20 Assorted tag strips and panels	40p
16180	15 Assorted control knobs	40p
16184	15 Assorted Fuses 100mA 5 amp	40p
16188	60½W resistors mixed values	40p
16187	30 metres stranded wire assorted colours	40p
S100	120 ¼ watt resistors. Pre-formed 1978 Prod. Our mix	60p*
S101	120 ½ watt resistors. Pre-formed 1978 Prod. Mixed values	60p*
S102	250 ⅛ watt resistors. Range 100 ohms-1.8 meg.	£2.00*
S103	220 ½ watt resistors. Range 100 ohms10 meg.	£2.00*
S104	60 Low ohms ⅛ watt resistors 10-100 ohms	60p*
S105	40 Low ohms ½ watt resistors 12-10 ohms	60p*
S106	25 Mixed wirewound resistors	60p*
S107	20 Tantalum bead caps 0.22-100mF. Our mix	£1.00*
S108	High-quality electrolytics 10mF-500mF voltage range 15 50V. Our mix. 40 for	£1.00*
16204	C280 Pak. Contains 50 metal foil caps	£1.00*

POTENTIOMETERS

Slider 40mm TRAVEL

Order Now.

16191	6 x 470 Ohm	LIN Single	40p*
S24	6 x 1K	LIN Single	40p*
S25	6 x 5 K	LIN Single	40p*
16193	6 x 22 K	LIN Single	40p*
16195	6 x 47 K	LOG Sinole	40p*
16194	6 x 47 K	LIN Single	40p*
S27	6 x 100 K	LIN Single	40p*
S28	6 x 100 K	LOG Single	40p*
S29	6 x 500 K	LOG Single	40p*
S32	6 x 50 K	LIN Single	40p*

Slider 60mm TRAVEL

S30	6 x 2.5 K	LOG Single	40p*
S34	4 x 5 K	LOG Dual	40p*
S36	4 x 100 K	LOG Dual	40p*
S37	4 x 1.3 MEG	LOG Dual	40p*
S94	6 x 220 K	LIN Single	40p*
S96	6 x 500 K	LIN Single	40p*

S38 Mixed slider pots—various values and sizes; our mix only £1.00*
S39 6 x Chrome slider knots 40p*

WIREWOUND

S90 Wirewound Pots. Linear 1 Watt rapng. Mixed—useful values; 5 for **£1.00***

CARBON TYPES

S91 Car Radio type. Dual Switched Pot. P.C. mounting
100 K Lin switched
2.5 K Lin each **60p***

DUAL POTS P.C. MOUNTING

6mm Shaft

S92 4 x 100 K Lin. £1.00*
S93 4 x 100 K Log £1.00*
16173 15 Rotary Pot Assorted 40p*
16186 25 Pre-sets Assorted Values 40p*

ZENER PAKS

No. S55	20 mixed values 400mW Zener diodes 3-10V	£1.00
No. S56	mixed values 400mW Zener diodes 11-33V	£1.00
No. S57	10 mixed values 1W Zener diodes 3-10V	£1.00
No. S58	10 mixed values 1W Zener diodes 11-33V	£1.00

SILICON POWER TRANS. N.P.N.

S97 BD371 2 Amp 1.2w. 60Vceo Hfe 40-400, Case TO92 with heat tab — 5 for
S98 2N5293 R.C.A. 36w 4 Amps 75Vceo Hfe 30-120 — 5 for

Crystal Ear Pieces
S126. Less plug **£0.20***

Plugs for above
No. 16106, 2.5 plastic **£0.09***
No. 1697, 3.5 plastic **£0.11**

Mono Crystal Cartridge
S127. GP91/1SC. Special Offer **£1.00***

Nickel Cadmium Rechargeable Batteries, 1.25v
S128. 3500D Cell size = U2 **£2.50**
S129. 900C Cell size = ½U11 **£0.90**
S130. Complete kit of parts to build nickel cadmium charger **£3.50**

Super Save Pak
S124. 6×741P **£1.00**
S125. 5×555 **£1.00**

S138. Surplus/End of Manufacturers Line/Pre-amp, with Bass, Treble, Volume Control & circuit diagram supplied. **ONCE ONLY OFFER, £1.25***.

S137. 20 Assorted Slider Knobs — Chrome/Black **£1.00**

S131. 2×12v Relays, plastic case **£0.70***
S132. 2×24v Relays, plastic case **£0.60***
S133. 1 Switch bank, 5-way, incl. silver knob **£0.75***
S134. 2× Magnets suitable for reed switches **£0.10**
S135. .1 Veroboard pak, 2 pcs 45sq. ins. approx **£0.80**
S136. .15 Veroboard pak, 2 pcs 60sq. ins. approx **£1.10**
16199. .1 Veroboard pak, 30sq. ins. approx **£0.50**
16200. .15 Veroboard pak, 30sq. ins. approx **£0.50**

TOOLS
No. 2011. 5" wire cutters **£1.55**
No. 2012. 5" long wire plier **£1.45**

SUPER DUPER COMPONENT BOX

Min. 3lbs in weight consisting of a fantastic assortment of Electronic Components — Pots, Resistors, Condensers, Switches, Relays, Board-Semiconductors, wire, hardware, etc, etc, etc.

★ This is a large box and is sent separate to your order ★

S140. £2.50 including p&p.

TRANSFORMERS *SALE OFFER*

S141. 0235 240v primary 0-55v at 2Amp secondary, **£4.50*+£1.00 p&p.**
S142. 0349 240v primary 0-20v at 2Amp secondary, **£3.50* + £0.86 p&p.**

COMPLETE AUDIO AMPLIFIER KITS

STA15. 15 watts per channel amplifier kit. CONSISTS: 2×AL60 — 1×PA100 — 1×SPM80 — 1×2034 transformer — 2×coupling capacitors. **£37.70 inc. V.A.T.+85p p&p.**

STA25. 25 watts per channel amplifier kit. CONSISTS: 2×AL60 — 1×PA100 — 1×SPM120/45 — 1×2040 transformer — 1×reservoir capacitor — 2× coupling capacitors. **£41.45 inc. V.A.T.+£1.16 p&p.**

STA35. 35 watts per channel amplifier kit. CONSISTS. 2×AL80 — 1×PA100 — 1×SPM120 — 1×2041 transformer — 1 reservoir capacitor — 2×coupling capacitors. **£48.45 inc. V.A.T.+£1.16 p&p.**

STA50. 50 watts per channel amplifier kit. CONSISTS: 2×AL120 — 1×PA200 — 1×SPM120/65 — 1×2041 transformer — 1 reservoir capacitor — 2×coupling capacitors. **£58.20 inc. V.A.T.+£1.16 p&p.**

STA125. 125 watts per channel amplifier kit. CONSISTS: 2×AL250 — 1×PA200 — 2×SPM120/65 — 2×2041 transformers — 1×reservoir capacitors — 2×coupling capacitors. **£72.85 inc. V.A.T.+£1.25 p&p.**

TRANSISTORS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	25p	BC177	12p	BF194	*9p	TIP32A	34p	2N1613	15p
AC126	14p	BC178	12p	BF195	*9p	TIP32B	35p	2N1711	15p
AC127	16p	BC179	12p	BF196	*12p	TIP32C	36p	2N1893	28p
AC128	16p	BC182	*9p	BF197	*12p	TIP41A	34p	2N2218	15p
AC128K	24p	BC182L	*9p	BF200	25p	TIP41B	35p	2N2218A	18p
AC176	16p	BC183	*9p	BFX29	22p	TIP41C	36p	2N2219	15p
AC176K	24p	BC183L	*9p	BFX84	18p	TIP42A	36p	2N2219A	18p
AC187	16p	BC184	*9p	BFY50	12p	TIP42B	37p	2N2221	15p
AC187K	26p	BC184L	*9p	BFY51	12p	TIP42C	38p	2N2221A	16p
AC188	16p	BC212	*10p	BFY52	12p	TIP2955	65p	2N2222	15p
AC188K	26p	BC212L	*10p			TIP3055	42p	2N2222A	16p
AD161/		BC213	*10p	MPSA05	*22p	ZTX107	*6p	2N2369	10p
162 MP	80p	BC213L	*10p	MPSA06	*22p	ZTX108	*6p	2N2904	14p
AF139	30p	BC214	*10p	MPSA55	*22p	ZTX109	*7p	2N2904A	15p
AF239	30p	BC214L	*10p	MPSA56	*22p	ZTX300	*7p	2N2905	14p
BC107	6p	BC251	*10p	OC44	12p	ZTX301	*7p	2N2905A	15p
BC108	6p	BCY70	12p	OC45	12p	ZTX302	*9p	2N2906	12p
BC109	6p	BCY71	12p	OC71	9p	ZTX500	*8p	2N2906A	14p
BC118	*10p	BCY72	12p	OC72	12p	ZTX501	*10p	2N2907	12p
BC147	*8p	BD115	40p	OC75	10p	ZTX502	*12p	2N2907A	13p
BC148	*8p	BD131	*35p	OC81	14p	2N696	*10p	2N2926G	*8p
BC149	*8p	BD132	*37p			2N697	10p	2N2926Y	*7p
BC154	*16p	BF115	17p	TIP29A	35p	2N706	7p	2N3053	12p
BC157	*9p	BF167	19p	TIP29B	36p	2N706A	8p	2N3055	35p
BC158	*9p	BF173	20p	TIP29C	38p	2N708	8p	2N3702	*7p
BC159	*9p	BF180	25p	TIP30A	36p	2N1302	12p	2N3703	*7p
BC169	*10p	BF181	25p	TIP30B	37p	2N1303	15p	2N3704	*6p
BC170	6p	BF182	25p	TIP30C	38p	2N1304	15p	2N3903	*11p
BC171	*6p	BF183	25p	TIP31A	32p	2N1307	18p	2N3904	*11p
BC172	*6p	BF184	25p	TIP31B	33p	2N1308	22p	2N3905	*11p
BC173	7p	BF185	25p	TIP31C	34p	2N1309	22p	2N3906	*11p

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA119	5p	BAX16/		BYZ16	30p	OA85	7p	IS44	3p
AAZ13	4p	OA202	5p	BYZ17	28p	OA90	6p		
BA100	6p			BYZ18	28p	OA91	7p	IN5400	10p
BA115	5p	BY100	15p	BYZ19	28p	OA95	7p	IN5401	11p
BA144	5p	BY127	*10p	OA47	5p			IN5402	12p
BA148	10p	BYZ10	32p	OA70	5p	IN34	5p	IN5404	13p
BA173	10p	BYZ11	32p	OA79	7p	IN60	6p	IN5406	16p
BAX13/		BYZ12	32p	OA81	7p	IN914	4p	IN5407	17p
OA200	5p	BYZ13	30p			IN148	4p	IN5408	19p

LINEAR I.C.'s

TBA800	*£0.75	uA709	£0.20	748P	*£0.28
TBA810	*£0.85	uA711	*£0.25	uA748	*£0.28
TBA820	*£0.65	uA703	*£0.20	72558	*£0.45
LM380	*£0.80	741P	£0.18	MC1310P	*£1.25
LM381	*£1.25	72741	£0.20	76115	*£1.25
72709	£0.20	uA741C	£0.20	NE555	£0.22
		72747	*£0.55	SL414A	*£1.80

ZN 414 RADIO CHIP 75*

DISPLAYS
No. 1510. 707 LED Display **£0.70**
No. 1511. 747 LED Display **£1.50**
No. 1512. 727 Dual LED Display **£1.55**

LED's
No. S120. .125 Bright Red **£0.09**
No. S121. .2 Bright Red **£0.09**
No. 1502. .125 Green **£0.12**
No. 1505. .2 Green **£0.12**
No. 1503. .125 Yellow **£0.12**
No. 1506. .2 Yellow **£0.12**
No. S82. Clear .2 Illuminating Red **£0.10**

P.O. RELAYS

S85 — 2 Off Post Office relays **40p***

BATTERY HOLDERS

to take 6 x HP7's
Order No. 202 **10p** each

EX-G.P.O. MICROSWITCHES

Order No. S51 4 for **50p**

CABLE CLIPS

S65 50, 25mm round single pin fixing **30p**

OPTOELECTRONICS

2ND QUALITY LED PAKS
No. 1507. 10 Assorted Colours & Sizes **£0.75**
No. S122. 10×.125 Red **£0.60**
No. S123. 10×.2 Red **£0.60**

LED CLIPS
No. 1508/.125 .125 **5 for £0.12**
No. 1508/.2 .2 **5 for £0.15**
No. S139. Infra-red Emitter, Fairchild FP100 **£0.50**

SPECIAL REDUCTIONS

No. 1514 NORP 12 **45p** each
No. S76 OCP71 5 for **£1.00**
No. S83 5 NIXIE Tubes ITT 5870 ST **£2.00** (including Data)
No. S77 Noen Indicator Lamps 230 AC State Colour (Red, Amber and Green) **25p** each

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.
Order No. 16223 **£1.00**

POWER SUPPLY STABILIZER BOARD

Unused ex-equipment stabilizer board. Input 30V. D.C. Output 20V. Complete with circuit diagram.
Order No. S81 **£1.25**

ORDERING

Minimum postage and packing for Sale Orders **£0.50** PLUS any further postage as stated as per this Sale Advertisement.
Overseas Orders — ADD extra for Air-mail.

V.A.T.

Please ADD V.A.T. as follows: 12½% to items marked *. 8% to unmarked items. NO V.A.T. on Books.
Send for your BI-PAK catalogue. 65p post free.

I.C. INSERTION EXTRACTION TOOL
ON 2015
30p each

BI-PAK

DEPT. WW2, P.O. Box 6, Ware, Herts.
COMPONENTS SHOP: 18 BALDOCK STREET, WARE, HERTS.

TRANSMITTER/RECEIVER MK.123. Very compact Army unit for use in range 2.5 to 20 Mc/s, Receiver section 7 valves inc. RF stage and BFO provides O/P for 4K ohm phones, 3 bands with direct calibration 2.5 to 5, 5 to 10 and 10 to 20Mc/s. Tx section 2.5 to 20 Mc/s in 3 ranges O/P 15-25 watts over range C.W. only, 2 valves crystal osc and 5B/251M P.A. will match into the following Ae imp 25, 100, 500 and 1500 ohms as int. tune up meter, reqs. crystals type FT243 in range 2.5/10Mc/s. internal morse key fitted with provision for ext. key. Mains P.U. self-contained suitable for 115 or 200/250v 50c/s overall size inc. Rx, Tx and P.U. 30×9×14 Cm weight 4Kg also supplied ext. invertor unit 12v DC, for mobile use. Supplied in clean condition with 80 page handbook giving circ details etc. (no details of 12v P.U.). Price £54.

INDICATOR UNIT AN/ALA-6. Special purpose airborne indicator 115v 400c/s I/P as int. EHT supply and heaters reqs. ext. HT of 250 and −150 volts. 13 min. valves plus 3WP1 CRT 3" flat face with P.1 trace, this unit normally works with Rx and directional aerial system to give trace similar to CRDF indicator, requires ext. sine cosine resolver to generate scan, in clean condition in case size 10×8×21" with circ. Price £25.

U.H.F. CAVITIES. Equipment spares for UPX-6 equipment for use with 2C39/7289 valves will tune over range 990/1040 Mc/s with int. fittings circ supplied. Price £6.50 also Rx section tunable preselector 1080/1130 Mc/s 4 section with 1N21 mixer diode for 60Mc/s I.F. new with circ. £4.50.

ELECTROSTATIC VOLTMETERS. Range 0 to 15Kv AC or DC usable scale 3 to 15Kv complete in wood carrying case, size 8×9×6" tested. £10.80.

INFRA RED LAMPS. Sealed beam units new spares, 115v 500 watts size 7" dia. 4½" deep American G.E. okay for paint drying etc. Price 2 for £5.40½.

PHOTOMULTIPLIER TUBES. Dumont type 7065 end viewing S.11 response new boxed. Price £15.

TAPE RECORDERS. Made for use in language lab equipment standard 240v I/P uses BSR type TD.10 3 speed deck 5" spools, two chan. transis. amps with separate O/Ps can be used for stereo provision for record and playback. P.U. and circ. boards are mounted below tape deck approx. overall size 12x11x7" intended to work phones. Supplied in clean condition may be less knobs and ind. lamps, some circ. details supplied. No ext. case. Price £13, also valve unit TD.2 deck. Price £8.50.

MOTOR DRIVE AND CONTROLLER. Removed frm Radar Simulators 24v DC P.M. motor driving into 2 stage gearbox the O/P shaft turns a 360° Ind also a sine cosine pot, approx. speed at 24v 1 RPM controller enables speed to be controlled from 0 to Max. in both directions, supplied with mains trans, rect, tranis control amp and circ. Price £10.50.

METER UNIT. Part of test set contains meter 5-0-5 Ua 3" dia. linear scale 5-0-5 contained in neat carrying case size 10×8×7½" also contains pots swts. etc. price £8.50.

APX-6 IFF TRANSPONDERS. Airborne unit for use in 1Km/s band contains tunable cavities for 2C42/6 series valves 60 Mc/s IF strip, blower, high voltage modulator parts, etc. 115v 400 c/s/I/P note supplied less all valves ext. soiled cases with circ. Price £10.80.

RECTIFIER UNIT. General purpose Army unit 200/250v I/P provides 2 DC O/Ps of 12v DC at 3 amps each can be connected for 12v 6 amp or 24v 3 amp will do 4 amps, in case size 17×8×7" with circ were used for 24v teleprinters. Price £10.80.

A. H. SUPPLIES
122 HANDSWORTH ROAD
SHEFFIELD, S94AE
Phone 444278 (0742)

PULSE GENERATORS. Services type CT500 transistorised unit made by Wayne Kerr 200/250v I/P size 17 x 9 x 11" basic freq. 100 c/s to 12 kc with additional range to 60Kc with reduced facilities, pulse width .5 to 7 Us, delay 5 to 1500 Us. O/P 100Uv to 10v neg. or pos. provision for ext. sync. or mod. 60Kc-range O/P var 5/20v. In good condition, regret no information. Price £22.

E.H.T. UNITS. Brandenburg EHT units 200/250v I/P O/P 12 to 15Kv DC stab at 300 Ua, new condition with circ, £25.

X.BAND ATTEN. Variable atten W.G. 16 size about 40 Db approx. 6" long new. Price £4.50.

HELIPOT DIALS. Standard 10 turn type to fit ¼" shaft, size 1¾" dia. Price £1.50, or with 100K helipot £2.

DOME BELLS. American pattern chrome with red base, 11½" dia. 6" deep, these are spring operated with solenoid control were used as supply failure warning solenoid control nom. 220v AC can be adapted for most AC or DC voltages, new unused American manufacture, chrome may be blemished due to storage. Price £25.

AUTO TRANSFORMERS. Nom taps 115/200/220/240v at 2 Kva C core new cond., few only £22.

MISC ITEMS. Dish Aerials approx. 7ft. dia, 15" deep, double skin ali. £54 ea., two only. Q band Tx Rx ass, K band Rx special with trav wave tube, etc, Digital Recorder H.P. type 562A with print out 11 digit with electronics £65. Marconi OA1094 Spec Anylizers 3/30 Mc/s with handbook £65. SKYLARK equipment telementary Tx, Magnetometers, Flux Gates, 3 phase Inv, P.U. motor swts, etc.

IMAGE INTENSIFIER. Medical 9" with optics, transis TV system, 19" monitor, cables, etc. Price £750 nett.

Above prices include carriage and V.A.T. Goods ex. equipment unless stated new. sae for list 21 or enquiry. Shop open Tuesdays through Saturdays.

NEW COMPONENTS — SPECIAL PRICES

CERAMIC CAPACITORS 63V
PLATE TYPE 2.5mm
CLOSE TOLERANCE
Stock Values PF
1; 2.2; 3.3; 4.7; 6.8
10; 12; 15; 18; 22; 1pf
27; 33; 39; 47; 56; 82; 1000pf 04
100; 120; 150; 180; 220; 2200pf 045
270; 330; 390; 470; 560; 3300pf 06
680; 820; 1000/2200; 4700pf 06
3300; 4700; 10,000; 10.000 04

CERAMIC CAPACITORS
5mm Pitch 250V
Stock Values (pf)
15; 47; 56; 100; 1000; 1500; 2200; 2700; 3300; 4700; 5600; 6800; 8200; 10,000
03 each

Aluminium Electrolytic
RADIAL LEAD

[illegible]	50	**.036**	100	25	**.066**
1	50	**.037**	100	50	**.093**
2.2	50	**.038**	220	16	**.073**
3.3	50	**.038**	220	25	**.12**
4.7	35	**.039**	330	10	**.085**
4.7	50	**.040**	330	25	**.10**
10	16	**.034**	470	6.3	**.066**
10	25	**.035**	470	16	**.081**
10	50	**.039**	470	25	**.13**
22	16	**.034**	470	50	**.24**
22	35	**.043**	1000	10	**.13**
22	50	**.05**	1000	16	**.144**
33	16	**.039**	1000	25	**.22**
47	16	**.039**	2200	6.3	**.17**
47	25	**.05**	2200	16	**.27**
47	50	**.061**	3300	10	**.27**
100	10	**.043**	4700	6.3	**.27**
100	16	**.046**			

NOISE SUPPRESSION CAPACITORS 250v AC

RADIAL		PCM 15mm .15 .22 22.5mm	
0.015	**.13**	0.068	**.16**
0.022	**.13**	0.1	**.18**
0.033	**.14**	0.15	**.24**
0.047	**.15**	0.22	**.32**

TANTALUM BEAD

			10—6.3	**.08**
.1	35V	**.10**	10—16	**.10**
.15	35V	**.10**	10—25	**.16**
.22	35V	**.10**	10—35	**.16**
.33	35V	**.10**	15—16	**.14**
.47	35V	**.10**	15—25	**.12**
.68	35V	**.10**	22—10	**.11**
.1	35V	**.10**	22—16	**.18**
1.5	35V	**.10**	22—35	**.20**
2.2	16V	**.10**	33—10	**.18**
2.2	35V	**.11**	47—6.3	**.16**
3.3	16V	**.10**	47—10	**.16**
4.7	10V	**.10**	47—16	**.20**
4.7	25V	**.11**	68—3V	**.16**
4.7	35V	**.125**	100—6.3	**.20**
6.8	35V	**.125**	100—10	**.40**
			220—3V	**.20**

SPECIAL THIS MONTH
BOXES — BLACK ABS
Prices Each. Recessed Lid
With brass screw inserts

B1	75 x 56 x 35	**.50**
B2	95 x 71 x 35	**.55**
B3	115 x 95 x 37	**.70**
B4	210 x 120 x 77	**1.55**

PRESETS (enclosed Vert./Hor. 100R-μM272 **10p** ea.

POLYESTER RADIAL
100V 10%
'MYLAR' ★ 10MM PITCH

.0022	.025	.01★	.03	(100V)
.01	.025	.022★	.03	(200V)
.068	.02	.047★	.035	(200V)
.1	.035	.1★	.04	(100V)
.22	.05	.1★	.045	(200V)
.33	.07	.47	.08	(100V)
.47	.095	.68	.085	(100V)
		2.2 (250V)	.15	

MINIATURE TOGGLE SWITCHES

SPST	**.65**
DPDT	**.75**
DPDT C/off	**.90**

STD TOGGLE 2 amp .50
Push Button Miniature
PTOB **.23** C.W.O. V.A.T. included
PTM **.15** P. & P. 20p — Overseas extra

GREENWAY ELECTRONIC COMPONENTS
(EAST GRINSTEAD) LTD., MAIL ORDER DEPT.
62 Maypole Road, Ashurst Wood, East Grinstead, Sx. RH19 3RB
Tel. 034-282 3712

LINEAR	
AY38500	**450p**
CA3039	**70p**
CA3046	**60p**
CA3060	**225p**
CA3065	**200p**
CA3076	**250p**
CA3080	**75p**
CA3084	**250p**
CA3085	**85p**
CA3086	**60p**
CA3088	**190p**
CA3089	**160p**
CA3090AQ	**360p**
CA3123E	**130p**
CA3130	**100p**
CA3140	**60p**
LF356	**80p**
LF357	**80p**
LM211H	**250p**
LM300TRS	**170p**
LM301AN	**30p**
LM304	**200p**
LM307N	**65p**
LM308T05	**100p**
LM308DIL	**100p**
LM309K	**100p**
LH310T05	**150p**
LM311T05	**150p**
LM317K	**325p**
LM324	**70p**
LM339	**60p**
LM348N	**90p**
LM380	**60p**
LM381N	**90p**
LM382	**90p**
LM391	**180p**
LM555	**25p**
LM709C	**40p**
LM710T05	**60p**
LM710DIL	**65p**
LM723T05	**40p**
LM723DIL	**40p**
LM733	**120p**
LM741	**20p**
LM748	**40p**
LM1303N	**100p**
LM1458	**100p**
LM3080	**75p**
LM3900	**55p**
LM3909N	**65p**
MC1310P	**140p**
MC1312P	**150p**
MC1314P	**190p**
MC1315P	**230p**
MK50398	**650p**
MM5314	**380p**
MM5316	**480p**
NE529K	**150p**
NE555	**25p**
NE556	**90p**
NE562B	**400p**
SAD1024	**1500p**
SL917B	**650p**
SN76003N	**150p**
SN76013N	**110p**
SN76013ND	**125p**
SN76023N	**110p**
SN76023ND	**125p**
SN76033N	**150p**
SN76227N	**160p**
SN/6228N	**180p**
SN76660N	**75p**
TAA300	**100p**
TAA350	**190p**
TAA550	**35p**
TAA570	**220p**
TAA661B	**140p**
TAA700	**350p**
TAA790	**350p**
TAD100	**150p**
TAD110	**130p**
TBA120S	**60p**
TBA120T	**85p**
TBA480Q	**200p**
TBA520Q	**200p**
TBA530Q	**200p**
TBA540	**200p**
TBA550Q	**250p**
TBA560C	**250p**
TBA641A12	**250p**
TBA700	**180p**
TBA720Q	**225p**
TBA750Q	**200p**
TBA800	**80p**
TBA810	**100p**
TBA820	**100p**
TBA920Q	**280p**
TCA270Q	**220p**
TCA270S	**220p**
TCA760	**300p**
TCA4500A	**450p**
TDA1008	**350p**
TDA1034	**450p**
TDA2002	**300p**
TDA2020	**300p**
TL084	**120p**
XR320	**250p**
XR2206	**450p**
XR2207	**450p**
XR2208	**600p**
XR2216	**650p**
XR2567	**250p**
XR4136	**150p**
XR4202	**150p**
XR4212	**150p**
XR4739	**150p**
ZN414	**100p**
95H90	**700p**

In 4148 diodes by I.T.T./Texas 100 for £1.50
Static RAM 2102 1024×1 bit 450 nano sec £1.00 each
2112 256×4 bit 450 nano sec £2.50
Murata ultrasonic transducers 40kHz £2.00 each or £3.50 pair
ALL PRICES INCLUDE POST AND VAT

7400	**10p**	7432	**20p**	7482	**75p**	74126	**35p**	74155	**45p**	74181	**130p**
7401	**10p**	7433	**28p**	7483	**75p**	74128	**60p**	74156	**45p**	74182	**50p**
7402	**10p**	7437	**20p**	7484	**70p**	74130	**120p**	74157	**45p**	74184	**120p**
7403	**10p**	7438	**20p**	7485	**60p**	74131	**90p**	74160	**55p**	74185	**100p**
7404	**12p**	7440	**12p**	7486	**25p**	74132	**45p**	74161	**55p**	74188	**320p**
7405	**12p**	7441	**45p**	7489	**130p**	74135	**90p**	74162	**55p**	74190	**70p**
7406	**25p**	7442	**40p**	7490	**25p**	74136	**80p**	74163	**55p**	74191	**70p**
7407	**25p**	7443	**60p**	7491	**40p**	74137	**90p**	74164	**60p**	74192	**60p**
7408	**12p**	7444	**60p**	7492	**35p**	74138	**100p**	74165	**60p**	74193	**60p**
7409	**12p**	7445	**65p**	7493	**30p**	74141	**50p**	74166	**75p**	74194	**55p**
7410	**12p**	7446	**50p**	7494	**70p**	74142	**180p**	74167	**160p**	74195	**50p**
7411	**15p**	7447	**50p**	7495	**45p**	74143	**270p**	74170	**100p**	74196	**50p**
7412	**15p**	7448	**50p**	7496	**45p**	74144	**270p**	74173	**80p**	74197	**50p**
7413	**25p**	7450	**12p**	7497	**120p**	74145	**55p**	74174	**60p**	74198	**100p**
7414	**45p**	7451	**12p**	74100	**80p**	74147	**100p**	74175	**60p**	74199	**100p**
7416	**25p**	7453	**12p**	74104	**40p**	74148	**90p**	74176	**50p**	74293	**90p**
7417	**25p**	7454	**12p**	74105	**40p**	74150	**65p**	74177	**50p**	741500	**18p**
7420	**12p**	7460	**12p**	74107	**25p**	74151	**45p**	74178	**75p**	745112	**80p**
7421	**20p**	7470	**25p**	74108	**100p**	74153	**45p**	74179	**120p**		
7422	**15p**	7472	**20p**	74109	**25p**	74154	**70p**	74180	**90p**		
7423	**20p**	7473	**25p**	74118	**75p**						
7425	**20p**	7474	**25p**	74120	**80p**						
7426	**22p**	7475	**25p**	74121	**25p**						
7427	**22p**	7476	**25p**	74122	**35p**						
7428	**25p**	7480	**40p**	74123	**40p**						
7430	**12p**	7481	**85p**	74125	**35p**						

T. POWELL
306 St Paul's Road London N1
Telephone 01-226 1489
Barclay/Access credit cards accepted
Shop closed from 21st December to 2nd January

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 47kΩ at 1kHz.

OUTPUTS Tape 100mV; Main output 500mV R.M.S.

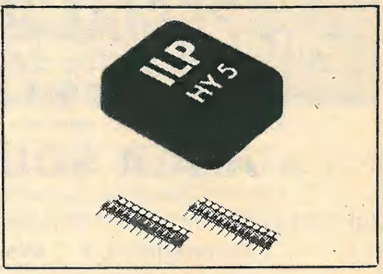
ACTIVE TONE CONTROLS Treble ± 12dB at 10kHz; Bass ± at 100Hz.

DISTORTION 0.1% at 1kHz; Signal/Noise Ratio 68dB.

OVERLOAD: 38dB on Magnetic Pick-up; SUPPLY VOLTAGE ± 16.50V

Price £6.27 + 78p VAT. P&P free.

HY5 mounting board B1 48p + 6p VAT P&P free.



HY30

15 Watts into 8Ω

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.

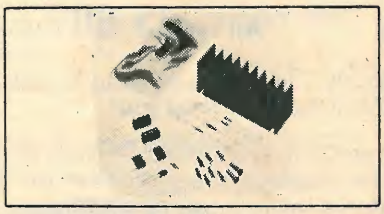
SPECIFICATIONS:

OUTPUT POWER 15W R.M.S. into 8Ω. DISTORTION 0.1% at 15W.

INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz — 3dB.

SUPPLY VOLTAGE ±18V.

Price £6.27 + 78p VAT. P&P free.



HY50

25 Watts into 8Ω

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 in 8Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.04% at 25W at 1kHz.

SIGNAL/NOISE RATIO 75dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB.

SUPPLY VOLTAGE ± 25V. SIZE 105.50.25mm.

Price £8.18 + £1.02 VAT. P&P free.

HY120

60 Watts into 8Ω

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-F — High quality disco — Public address — Monitor amplifier — Guitar and organ.

SPECIFICATIONS:

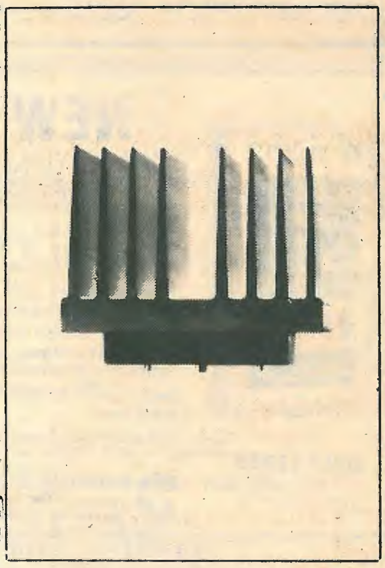
INPUT SENSITIVITY 500mV

OUTPUT POWER 60W RMS into 8Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.04% at 60W at 1 kHz.

SIGNAL/NOISE RATIO 90dB. FREQUENCY RESPONSE 10Hz-45kHz —3dB. SUPPLY VOLTAGE ±35V.

Size: 114 x 50 x 85mm.

Price £19.01 + £1.52 VAT. P&P free.



HY200

120 Watts into 8Ω

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 8Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.05% at 100W at 1kHz.

SIGNAL/NOISE RATIO 96dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE ±45V.

SIZE 114 x 100 x 85mm.

Price £27.99 + £2.24 VAT. P&P free.

HY400

240 Watts into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! 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.

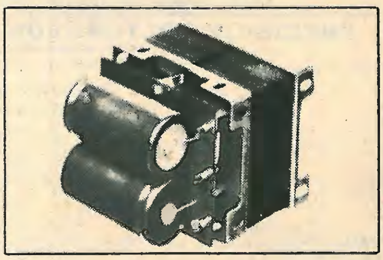
SPECIFICATIONS:

OUTPUT POWER 240W RMS into 4Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.1% at 240W at 1 kHz.

SIGNAL/NOISE RATIO 94dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE ±45V.

INPUT SENSITIVITY 500mV. SIZE 114 x 100 x 85mm.

Price £38.61 + £3.09 VAT. P&P free.



POWER SUPPLIES

PSU36 suitable for two HY30's **£6.44** + 81p VAT
PSU50 suitable for two HY50's **£8.18** + £1.02 VAT
PSU70 suitable for two HY120's **£14.58** + £1.17 VAT
PSU90 suitable for one HY200 **£15.19** + £1.21 VAT
PSU180 suitable for two HY2000's or one HY400 **£25.42** + £2.03 VAT

TWO YEARS' GUARANTEE ON ALL OF OUR PRODUCTS

ILP ELECTRONICS LTD., GRAHAM BELL HOUSE, ROPER CLOSE, CANTERBURY. TEL. (0227) 54779

I.L.P. Electronics Ltd.
Crossland House
Nackington, Canterbury
Kent CT4 7AD
Tel. (0227) 64723

Please Supply____________________
Total Purchase Price____________________
I Enclose Cheque ☐ Postal Orders ☐ Money Order ☐
Please debit my Access account ☐ Barclaycard account ☐
Account number____________________
Name & Address____________________
Signature____________________

WERSI's

SPECIAL OFFER

FROM

AURA SOUNDS

Our 104 page full-colour brochure, price list and Klaus Wunderlich L.P. ''Wersitime 2''

All for £3.60 (Usually £5.60)

Study the range of superb instruments, designed by Wersi to be built by you!

Let Klaus Wunderlich — king of the organ — bring you the fabulous Wersi Sounds on his L.P., specially produced to demonstrate the versatility of the ''Helios'' Organ.

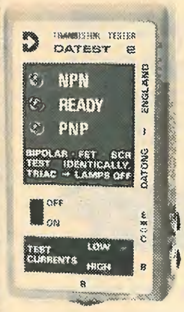
All in the comfort of your own home.

Send £3.60 with your name and address to:

Offer open to U.K. Readers only.
Closing date 28th Feb., 1979.

AURA SOUNDS
Copthorne Bank
Crawley, W. Sussex
Tel. 0342 713338

NEW TESTER



Designed for fast **in-circuit** testing, new **DATEST 2** tests transistors, FETs, SCRs and Triacs even when shunted by resistors **as low as 20 ohms.**

It will usually test every device in even a DC coupled AF power amp. or in a colour TV (except line o/p) **while still in circuit.**

Automatic NPN/PNP indication, foolproof three-LED display, and unique test-probes allow a very high rate of testing even by unskilled users.

Other features include long battery life, low battery warning, rugged die-cast case, reliable six-IC circuit.

Best news of all. DATEST 2 is affordable and available from stock.

Full data sheet free on request.

ONLY £39.50
+ VAT (8%)
WITH PROBES

DATONG ELECTRONICS LIMITED
Spence Mills, Mill Lane, Bramley, Leeds LS13 3HE
Telephone: Pudsey (0532) 552461

WW—017 FOR FURTHER DETAILS

PRECISION POLYCARBONATE CAPACITORS

All high stability-extremely low leakage

440V ac range (+—10%)				63V DC RANGE (£)			
μF	L (mm)	D	£1each	μF	(Tol. +—1%	+—2%	+—5%
0.1	27	12.7	1.34	0.01-0.2	1.80	1.22	0.88
0.22	33	16	1.66	0.22-0.47	1.82	1.24	0.90
0.25	33	16	1.78	1.0	2.26	1.52	1.08
0.47	33	19	2.08	2.2	2.80	1.94	1.42
0.5	33	19	2.24	4.7	4.00	2.72	2.24
0.68	50.8	19	2.48	6.8	4.88	3.36	2.66
1.0	50.8	19	2.64	10.0	6.94	4.68	3.56
2.0	50.8	25.4	3.74	22.0	13.32	9.98	6.80

TRANSISTORS, DIODES, I.C.s, Bridge, Rectifiers, Capacitors, Plugs & Sockets, Vero, etc.

RESISTORS: High stability, low noise, carbon film +—5% tol. ½W @40 C. ⅓@70 C. E12 series only — from 2.2 ohm to 4.7M. All 2p* eacn 15p*/10 of any one value 95p*/100 of any one value £4.35*/500 (may be mixed in 100's). £8*/1000 (may be mixed in 100's).

SPECIAL DEVELOPMENT PACK; 10 off each value 2.2 ohm to 2.2M (730 resistors) £6.50 each. (1W c/f 5%-5p* ea; 2w c/f 5%-8p* ea.).

PRESETS: 0.1W submin. skeleton presets — vertical or horizontal. 100 ohm to 1M 7p* each £3*/50, £5*/100 £22.50*/500, £40*/1000. Values may be mixed.

ZENER DIODES: 400mW ± 5% 3V-33V - 10p; 1W 3V3-200V - 18p.

TANT. BEAD CAPS: μF/V 0.1, 0.22, 0.33, 0.47, 1/35 - 10p*; 2.2/25 - 11p*; 2.2/35 - 12p*; 4.7/35 - 15p*; 6.8/35, 10/25 - 17p*; 10/35, 15/20, 22/15, 33/10, 47/6.3 - 21p*; 68/3 - 17p*; 100/3 - 21p*.

Please add 25p P&P and 8% VAT to all items except those marked * which are 12½%

MARCO TRADING (Dept. W12) The Old School, Edstaston, WEM, Shorpshire
Tel: WHIXALL 464 (STD 094872) (Props Minicost Trading Ltd.)

WW—015 FOR FURTHER DETAILS

FOR RESEARCH MACHINES 380Z COMPUTER SYSTEMS PLEASE SEND FOR INFORMATION AND PRICES

SINTEL

SEND FOR SINTEL FREE CATALOGUE

CMOS
Mainly RCA

		CD4015	0.83	CD4032	0.89	CD4049	0.50	CD4072	0.20	CD4099	1.65
		CD4016	0.48	CD4033	1.25	CD4050	0.43	CD4073	0.20	CD4502	0.81
		CD4017	0.79	CD4034	1.71	CD4051	0.82	CD4075	0.20	CD4510	1.01
		CD4018	0.83	CD4035	1.06	CD4052	0.82	CD4076	1.17	CD4511	1.25
		CD4019	0.50	CD4036	2.86	CD4053	0.82	CD4077	0.39	CD4514	2.47
CD4000	0.15	CD4020	1.11	CD4037	0.85	CD4054	1.04	CD4078	0.20	CD4515	2.82
CD4001	0.17	CD4021	0.90	CD4038	0.96	CD4055	1.18	CD4081	0.20	CD4516	1.01
CD4002	0.17	CD4022	0.82	CD4039	2.78	CD4056	1.18	CD4082	0.20	CD4518	0.97
CD4006	1.04	CD4023	0.18	CD4040	0.97	CD4059	4.29	CD4085	0.64	CD4520	1.04
CD4007	0.18	CD4024	0.70	CD4041	0.75	CD4060	1.00	CD4086	0.64	CD4527	1.43
CD4008	0.87	CD4025	0.20	CD4042	0.69	CD4063	0.98	CD4089	1.39	CD4532	1.21
CD4009	0.50	CD4026	1.55	CD4043	0.88	CD4066	0.55	CD4093	0.80	CD4555	0.78
CD4010	0.50	CD4027	0.44	CD4044	0.84	CD4067	3.35	CD4094	1.69	CD4556	0.78
CD4011	0.18	CD4028	0.77	CD4045	1.26	CD4068	0.20	CD4095	0.94	MC14528	0.93
CD4012	0.20	CD4029	1.03	CD4046	1.20	CD4069	0.20	CD4096	0.94	MC14553	4.43
CD4013	0.43	CD4030	0.50	CD4047	0.89	CD4070	0.46	CD4097	3.35		
CD4014	0.83	CD4031	2.00	CD4048	0.50	CD4071	0.20	CD4098	0.98		

COMPONENTS

SOLDERCON		**CLOCK CHIPS**		**DISPLAYS**		**CRYSTALS**		MEK6800D2	190.00
PINS		AY51202	3.10	TYPE FND500 C.C.	1.30	32.768 KHz	2.95	MC6800	13.88
100	0.50	AY51224	3.45	TYPE TIL 321 C.A.	1.30			MC6820	6.94
1000	4.00	MK50253	5.40	5LT01	4.90	**MEMORIES/μUps**		Z80-CPU	16.80
3000	10.50					2102A-6	1.85	Z80A-CPU	22.40
						2112A-4	1.85	Z80-CTC	10.15
								Z80-PIO	10.15

Free data is available on some of these items. **SEND FOR FREE CATALOGUE**

SOME 74LSTTL NOW AVAILABLE PLEASE SEND FOR LIST

Our offices are at Chapel Street, Oxford, but please do not use this as a postal address

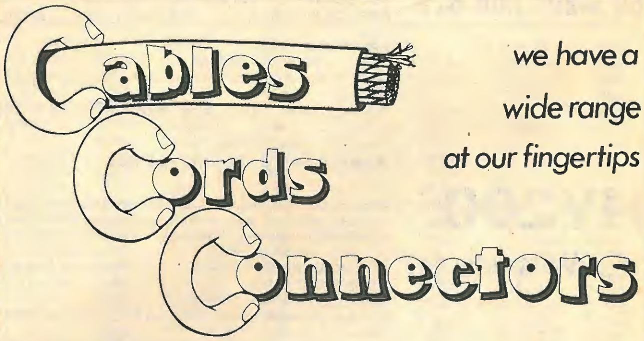
FAST SERVICE. We guarantee that Telephone Orders for goods in stock, received by 4.15 p.m. (Mon.-Fri.) will be dispatched on the same day by 1st Class Post (some heavy items by parcel post) and our stocking is good. Private customers should telephone and pay by giving their Access or Barclaycard number with a minimum value of £5. Official orders no minimum. Official orders, Companies, Govt., Nats. Inds., and Univs.

ORDERS: C.W.O. add VAT at 8% + 35p p&p. TELEPHONE and CREDIT invoiced ORDERS add VAT at 8% + 60p p&p minimum charge (the balance will be charged at cost). Please send FAST SERVICE. EXPORT ORDERS welcome, no VAT but add 10% (Europe), 15% (Overseas) for Air Mail p&p. For export postage rates on heavy tiems—contact us first.

SEND YOUR ORDER TO

SINTEL
PO BOX 75C OXFORD
Tel: 0865 49791

SINTEL

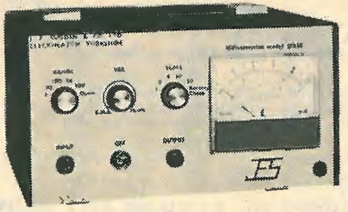


we have a wide range at our fingertips

FUTURE FILM DEVELOPMENTS
36/38 Lexington Street, London W1R 3HR
Telephone 01-437 1892/3 • Telex 21624 ALOFFD G

WW—016 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 **£70.00.**

Si452 . . . . **£56.00**
Distortion Measuring Unit
15 Hz — 20 KHz — .01%

Si453 . . . . **£70.00**
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—009 FOR FURTHER DETAILS

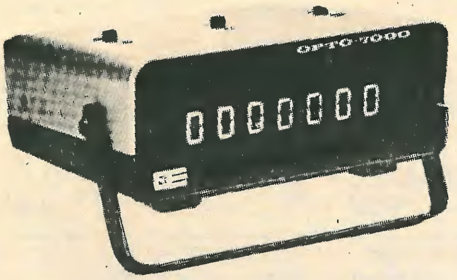
FREQUENCY COUNTING BREAKTHROUGHS

ADVANCING THE-STATE-OF-THE-ART IN FREQUENCY COUNTERS – INTRODUCING NEW LSI TECHNOLOGY COUNTERS AT AFFORDABLE PRICES.

MODEL OPTO 7000 7 Digits AC/DC/Portable MINIATURE 10 Hz to 600 MHz COUNTER ± 1 ppm TCXO ONLY £129.95 + £3 p&p + 8% VAT

The go anywhere portable counter that gives you more range, visibility, accuracy and versatility than any comparable unit at anywhere near its low, low price.

- De-luxe black and gold anodized aluminium case – combination handle/tilt-up bail
- Built-in pre-scaler
- Automatic Decimal placement
- No direct-connect required for RF pick-up
- Built-in amplifiers in both direct and pre-scale input circuits
- Signal inputs diode/overload protected
- DC power plug and chord included
- Built-in Ni-Cad rechargeable battery pack & charger (optional) £19.95 + VAT
- Rear panel switch (S4) for 1 Hz resolution (optional) £4.95 + VAT



Ex Stock Delivery Subject to availability

SPECIFICATIONS

Frequency Range: (Switch Selectable)	10 Hz to 60 MHz (65 MHz Typical) 10 MHz to 600 MHz Guaranteed (10 MHz to 700 MHz Typical)
Input Impedance:	1 megohm shunted by 20 pf (60 MHz input) 50 ohm (600 MHz input)
Input Protection:	1 megohm/60 MHz input - 100V up to 10 MHz 50V up to 60 MHz 50 ohm/600 MHz input - 2V max.
Gate Times: (Switch Selectable)	100 millisecond (1/10 second) 1 second
Resolution:	*1 Hz (10 Hz to 6 MHz) with switch (S4) Option 10 Hz (10 Hz to 60 MHz) 100 Hz (10 MHz to 600 MHz)
Sensitivity:	<10 mV to 60 MHz 25 mV to 150 MHz 50 mV 450 MHz typ. (<75 mV Guaranteed)
Time Base:	Quartz Crystal, 5.24288 MHz, TCXO, first order linear compensation
Counter Accuracy:	±1 count, Temperature stability and aging
Temp. Stability:	.08PPM/C° (± 1 PPM 20° to .40°C, Typ.)
Aging:	<2 PPM/year
Display:	7, .4" Red LED Digits
Decimal Point:	Auto Placement
Connectors:	BNC type.
Power Requirement:	1.5 Watts 7.5 - 15V AC/DC <250 ma
Batteries:	*4 - AA Ni-Cad, Constant Current Charger
Size:	1-3/4"H x 4-1/4"W x 5-1/4"D
Weight:	14 oz. (17 oz. with batteries & charger)

**Optional - not included with basic unit*

COMING SOON: 10 Digits 1.3 GHz Frequency/Ratio/Time/Incidents Counter for less than £500.
4½ digits true RMS multimeter with built-in industrial thermometer for less than £230.

Sole Distributors for the U.K. and Eire. Agents Wanted for U.K. and Eire.

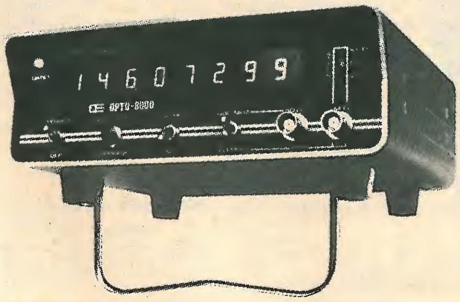
ME

Maclin-Zand Electronics Ltd.,
38 Mount Pleasant, London WC1X 0AP.
Tel: 01-837 1165 or Hemel Hempstead 832 966

MODEL OPTO 8000.1A Mains/DC/Portable 8 Digits 10 Hz to 600 MHz FREQ. COUNTER ±.1 ppm TCXO ONLY £299.95 + £5 p&p + 8% VAT

The OPTO 8000 1A is a no compromise professional quality counter. Thanks to new CMOS LSI technology, size, power and cost have shrunk while performance improved. The OPTO 8000 1A combines this new technology with careful circuit design and unique packaging for a state-of-the-art counter that sets the pace.

- Selectable step attenuation X1, X10, X100
- 50 ohm and 1 Megohm inputs diode protected against overload
- Amplifier circuits for Super Sensitivity
- Front panel features "Lead Zero Blanking Control" and LED gate period indicator.
- Built-in Ni-Cad rechargeable battery pack & charger (optional) £19.95 + VAT
- Detachable AC and DC chords included



SPECIFICATIONS

Frequency Range:	10 Hz to 600 MHz in two over-lapping ranges. 1 Megohm input - 10 Hz to 60 MHz 50 Ohm input - 20 MHz to 600 MHz
Gate Times: (Switch Selectable)	100 milliseconds (1/10 second) 1 second
Resolution:	1 Hz to 60 MHz, 10 Hz to 600 MHz
Display:	8 LED digits with floating decimal point. Flashing LED gate period indicator
TIME BASE	
Frequency:	5.242B80 MHz
Type:	TCXO (Temperature Compensated Crystal Oscillator) less than .1 ppm from 17° to 40° C less than 1.0 ppm from 0° to 60° C
Aging:	less than 1.0 ppm first year. (less than 1.0 ppm first three years typical) less than 0.5 ppm per year thereafter
Initial set accuracy:	less than 0.5 Hz at 25° C
External adjustment range:	± 10 ppm
Impedance:	1 Megohm shunted by 20pF, DC coupled (10 Hz to 60 MHz) 50 Ohm, AC coupled (20 MHz to 600 MHz)
Connectors:	BNC type
Typical Sensitivity:	2 - 10 MV RMS below 150 MHz 10 - 50 MV RMS below 600 MHz
Max Input Signal:	1 Meg input - 100V peak to peak up to 10 MHz 50V peak to peak up to 60 MHz 50 Ohm input - 2V peak to peak max.
Power:	220-250V AC nominal, 50 Hz, 2 Watts 8 to 16 VDC, 300 MA or internal batteries
Dimensions:	3-1/4" H x 7-1/4" W x 6-3/4" D
Weight:	Approximately 2.5 pounds

Delivery ex-stock, subject to availability – Otherwise allow up to 4 weeks

To: **Maclin-Zand Electronics Ltd.**
38 Mount Pleasant, London WC1X 0AP.

Please send me the following:	**Prices inc. p&p + VAT**
☐ OPTO 7000	**£143.59**
☐ OPTO 7000 with built-in Ni-Cads + charger	**£165.14**
☐ OPTO 7000 with rear panel switch S4 for 1Hz resolution	**£148.94**
☐ OPTO 7000 with built-in Ni-Cads + charg. & switch S4 for 1Hz resolution	**£170.49**
☐ OPTO 8000.1A	**£329.35**
☐ OPTO 8000.1A with built-in Ni-Cad battery pack and charger	**£350.90**

I enclose Cheque/P.O. for £ ....

Name: ....

Address: (please print) ....

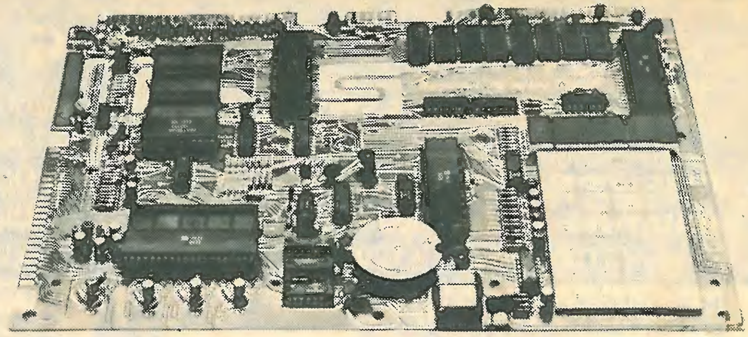
....

....

Overseas orders: VAT not applicable – add 10% for Airfreight & Handling.

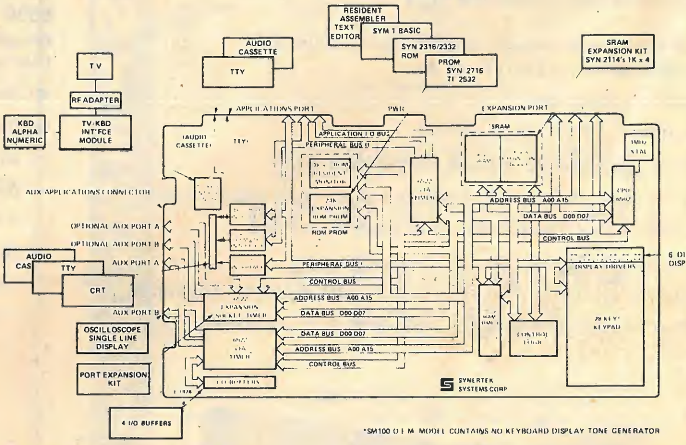
WW—062 FOR FURTHER DETAILS

SYNERTEK* SYM-1 MICROCOMPUTER



Features Include:

- Ready to use because it's fully assembled, tested and completely integrated as soon as you open the shipping container.
- 51 total I/O lines, expandable to 71.
- The powerful SY6502 8-bit microprocessor with advanced architectural features which make it one of the largest selling "micros" on the market today.
- Five on-board programmable interval timers available to the user for timing loops, watchdog functions, and real-time communications protocols.
- 4K-byte ROM SUPER-MON resident monitor and user expandable.
- Single 5-volt power capability is all that is required.
- 1K-bytes of static RAM on-board with sockets provided for immediate expansion to 4K bytes on-board, with total memory addressability to 65,536 bytes.
- User PROM/ROM — the system is equipped with 4 PROM/ROM expansion sockets for SY2316/SY2332 ROMs or 2716/2732 EPROMs, up to 28K bytes.
- Standard interfaces: digital audio cassette recorder interface with remote control; full duplex 20mA teletype interface; system expansion bus interface; TV/KB controller board interface; RS 232 compatible interface; four strappable relay drivers or input buffers; and a 32-character single line oscilloscope display interface.
- Application port — 15 bidirectional TTL lines for user applications with expansion capability for added lines.
- Expansion port for add-on modules (51 I/O lines in basic system).
- Separate power supply connector for easy disconnect of the DC power.
- Uses same hardware interface busses as KIM-1 (MOS Technology).



*SM100 O E M MODEL CONTAINS NO KEYBOARD DISPLAY TONE GENERATOR

Sym-1 Microcomputer Board .... £192 (+8% VAT)
Sym-1 Reference Manual .... £7 (no VAT)

Ex-stock from:—

*Synertek Inc.
is a Honeywell Company

CITADEL PRODUCTS LTD.

50 High Street, Edgware, Middx. HA8 7EP. Tel: 01-951 1848

VALVES

Minimum Order £1.00

VALVES VAT PLEASE ADD 12½%

	£
A1065	1.25
AR8	0.60
ARP3	0.60
ATP4	0.50
B12H	3.00
CY31	0.50
DAF96	0.60
DET22	19.50
DF96	0.60
DK96	0.80
DH76	0.40
DL92	0.50
DY86/87	0.55
DY802	0.55
E55L	7.50
E8B CC/01	1.30
E180CC	1.30
E180E	6.00
E182CC	3.50
EA76	2.00
EABC80	0.50
EB91	0.40
EBC33	1.00
EBF80	0.50
EBF83	0.50
EBF89	0.50
EC52	0.40
ECC81	0.55
ECC82	0.50
ECC83	1.15
ECC84	0.45
ECC85	0.50
ECC86	1.25
ECC88	0.60
ECC189	0.80
ECF80	0.50
ECF82	0.45
ECF801	0.75
ECH34	0.95
ECH35	1.50
ECH42	0.85
ECH81	0.45
ECH84	0.95
ECL80	0.60
ECL82	0.55
ECL83	1.20
ECL85	0.85
ECL86	0.55
EF37A	1.50
EF39	2.90
EF40	0.70
EF41	0.75
EF80	0.40
EF83	1.50
EF85	0.45
EF86	0.55
EF91	0.85
EF92	0.75
EF95	0.55
EF183	0.85
EF184	1.60
EF804	2.00
EFL200	0.75
EH90	0.80
EL32	0.90
EL34	2.20
EL37	3.00
EL41	0.80
EL81	1.05
EL82	0.60
EL84	0.60
EL86	0.95
EL90	1.30
EL91	1.60
EL95	0.70
EL504	0.80
EL802	1.50
EL822	3.00
EM31	0.75
EM80	0.60
EM81	0.60
EM84	0.40
EM87	1.00
EY51	0.45
EY81	0.45
EY86/87	0.55
EY38	0.55
EX80	0.45
EZ81	0.60
GY501	0.90
GZ32	0.65
GZ33	3.50
GZ34	2.00
GZ37	2.50
KT66	4.00
KT88	5.75
MH4	1.00
ML6	1.00
OA2	0.55
OB2	0.60
PABC80	0.40
PC85	0.50
PC86	0.85
PC88	0.75
PC900	1.25
PCC84	0.45
PCC89	0.55
PCC189	0.65
PCF80	0.80
PCF82	0.40
PCF84	0.65
PCF86	0.65
PCF200	0.90
PCF201	0.90
PCF801	0.90
PCF802	0.85
PCF805	1.80
PCF806	0.85
PCF808	1.80
PCG200	0.80
PCL81	0.60
PCL82	0.65
PCL84	0.70
PCL86	0.70
PCL805/85	0.75
PD500	3.25
PFL200	1.35
PL36	0.80
PL81	0.75
PL82	0.50
PL83	0.50
PL84	0.65
PL504	1.40
PL508	1.30
PL509	3.25
PL802	2.80
PLL80	1.80
PY33	0.60
PY80	0.60
PY81/800	0.55
PY82	0.45
PY83	0.50
PY88	0.65
PY500	1.35
PY859	5.75
PY801	0.60
QQV03-10	2.50
QQV03-12	2.50
WQV06-40A	14.00
QV03-12	2.50
SC1/400	4.00
SC1/600	4.00
SP61	0.85
TT21	7.50
U25	1.00
U26	0.85
U27	1.00
U191	0.75
U281	0.50
U301	0.50
U801	0.80
UABC80	0.60
UAF42	0.75
UBF80	0.55
UBF89	0.50
UBL1	1.00
UBL21	0.75
UCC84	0.60
UCC85	0.50
UCF80	0.80
UCH81	0.80
UCL82	0.75
UF41	0.80
UF80	0.45
UF85	0.50
UL41	0.75
UL84	0.75
UM80	0.60
UM84	0.40
UY82	0.55
UY85	0.50
VR105/30	1.80
VR150/30	1.25
Z66	0.90
X61M	1.50
Z800U	3.00
Z801U	3.50
Z900T	1.50
1A3	0.60
1L4	0.30
1R5	0.55
1S4	0.40
1S5	0.40
1T4	0.40
1U4	0.60
1X2B	1.10
2D21	0.55
2K25	11.00
2X2	0.80
3A4	0.60
3D6	0.40
3D21	20.00
3E29	5.50
3S4	0.50
3V4	0.85
5B/254M	6.50
5B/255M	6.50
5B/258M	6.50
5R4GY	1.10
5U4G	0.95
5V4G	0.65
5Y3GT	0.65
5Z3	1.00
5Z4G	0.70
5Z4GT	0.75
6AB7	0.60
6AC7	0.60
6AH6	0.70
6AK5	0.55
6AK8	0.40
6AL5	0.40
6AL5W	0.65
6AM5	1.60
6AM6	0.65
6AN8	0.85
6AQ5	1.30
6AQ5W	0.85
6AS6	0.80
6AT6	0.75
6AU6	0.40
6AV6	0.50
6AX4GT	0.80
6AX5GT	1.00
6B7	0.75
6BA6	0.40
6BE6	0.50
6BG6G	1.00
6BJ6	1.10
6BQ7A	0.60
6BR7	2.30
6BW6	2.80
6BW7	1.00
6C4	0.40
6C6	0.55
6CH6	3.00
6CL6	0.75
6CY5	0.90
6D6	0.50
6EA8	0.80
6F6GB	0.90
6F8G	0.75
6F12	0.65
6F14	0.80
6F15	0.60
6F17	1.00
6F24	0.90
6F33	4.20
6H6	0.95
6J4WA	1.75
6J5	0.75
6J5GT	0.55
6J6	0.50
6J7	0.75
6J7G	0.50
6K7	0.70
6K7G	0.35
6K8GT	0.55
6L6M	1.90
6L6GT	0.90
6L7G	0.65
6L18	0.60
6LD 20	0.50
6Q7G	0.80
6SA7	0.55
6SG7	0.75
6SJ7	0.70
6SJ7GT	0.50
6SK7	0.60
6SL7GT	0.75
6SN7GT	0.75
6SQ7	0.75
6V6GT	0.80
6X4	0.60
6X5GT	0.55
6Y6G	0.95
6Z4	0.65
6-30L2	0.90
7B7	0.80
7V4	0.80
9D2	0.60
9D6	0.75
10C2	0.60
10F18	0.60
10P13	0.60
11E2	11.00
12A6	0.60
12AT6	0.45
12AT7	0.55
12AU7	0.50
12AV6	0.70
12AX7	0.50
12BA6	0.50
12BE6	0.60
12BM7	0.60
12C8	0.55
12E1	4.25
12J5GT	0.40
12K7GT	0.60
12K8GT	0.70
12Q7GT	0.50
12SC7	0.55
12SH7	0.70
12SJ7	0.55
12SQ7	0.55
12Y4	0.40
13D6	0.60
14S7	1.00
19AQ5	0.75
19G3	10.00
19G6	6.00
19H5	17.00
20D1	0.80
20F2	0.60
20L1	1.00
20P1	0.40
20P3	0.60
20P4	1.10
20P5	1.00
25L6GT	0.80
25Z4G	0.70
30C15	1.00
30C17	1.10
30C18	see PCF805
30F5	1.00
30F12	1.20
30FL12	1.20
30FL14	1.80
30L15	1.00
30L17	1.00
30P12	1.00
30PL1	1.00
30PL13	1.10
30PL14	1.10
35L6GT	1.00
35W4	0.60
35Z4GT	0.70
50C5	0.70
50CD6G	1.20
75	1.00
75C1	0.80
76	0.80
78	0.75
80	0.75
85A2	2.20
723A/B	11.00
803	6.00
805	18.00
807	1.00
813	10.50
829B	11.00
832A	4.50
866A	2.80
931A	6.00
954	0.50
955	0.55
956	0.50
957	0.90
1625	1.00
1629	0.70
2051	1.00
5763	2.50
5842	6.50
5933	3.00
6057	0.85
6060	0.85
6064	0.85
6065	1.20
6067	1.00
6080	3.50
6146	3.80
6146B	4.20
6360	2.00
8020	5.50

POSTAGE: £1-£2 20p; £2-£3 30p; £3-£5 40p; £5-£10 60p; over £10 free.

VIDECON TUBE TYPE P863B
English Electric—£20

MARCONI SIGNAL GENERATORS

TF 2400/1 Frequency Converter up to 510MHz.
MODULATION METER 210A. 2.5-300MHz. AM 0-100% FMD+100kHz in 4 rantes. **AIRMEC**
VHF WAVE ANALYSER 248 Freg from 5MHz to 300MHz.
TF 801 D/1/S SIGNAL GENERATOR. Range 10-485MHz in 5 ranges. R.F. output 0.1 V-1V. Source C.M. 50Ω output impedance. Internal modulation at 1KHz at up to 90%.
TF 995 A/1 or A/2 or A/2M or A5 SIGNAL GENERATORS. Very high class AM/FM 1.5MHz to 220MHz. Detailed spec. and price on application.
TF 995/3S with additional amplifier to give extra high output between 1.5 and 5 Mc/s.
HIGH FREQUENCY SPECTRUM ANALYSER. MARCONI TYPE 1094A/S. Basic Freq. range 3 to 30 Mc/s and with LF unit from 100Hz to 3 MHz. Measures relative amplitudes up to 60dB.
TF1041 B VALVE MULTIMETER. DC voltage from 300mV to 1.000V. AC voltage from 300mV to 300V at up to 1,000MHz.

WHITE NOISE TEST SET. The instrument consists of two units: a Marconi Noise Generator Type TF 2091 and Noise Receiver Type TF 2092. Measures noise and intermodulation on wide band multichannel telephone systems. Suitable for 12 channel to 2,700 channel system

MARCONI TF 867 SIGNAL GENERATOR
Range 15KHz to 30MHz. Output 0.4µ V to 4V to 13 or 75 ohms. Impedance with termination (supplied). Built in crystal check facility with handbook. CT 478; CT479; QT480 Signal Generators frequency from 1.3kMS up to 11kHz output up to 1mV CW and imp. mod.

LEVEL OSCILLATOR TYPE REL 3W29. Frequency from 0.3 to 1200Kc/s. Mod. ext. output from +16dB to −60dB. Impedance output 75, 140, 600 ohms.

36' AERIAL MASTS consisting of 6 sections 6' 8'' × 2¼'' dia. Complete with all accessories to erect and instal.

RHODE & SCHWARZ

Z-g DIAGRAPH TYPE 2DU 30-420MHz-50Ω. Model type ZDD, Frequency 300-2400MHz. Directly measures multiterminal networks, phase shift, phase angle with complementary POWER SIGNAL GENERATOR TYPE SMLM high freq. resolution, internal external mod. up to 3v out.

LOW RESISTANCE HEADPHONES TYPE CLB £1.50. 40p postage. VAT 12½%.

A lot of these valves are imported and prices vary for each delivery, so we reserve the right to chance prices for new stock when unavoidable.

VALVES AND TRANSISTORS

Telephone enquiries for valves, transistors, etc.; retail 749 3934; trade and export 743 0899.

OUR ANNUAL SALE OF TEST EQUIPMENT STARTS FEBRUARY 1st

OSCILLOSCOPES (NEW PRODUCTION)
SCOPEX 4S-6, 6MHz. Single Beam, 10mV sensitivity. Display — 6 cm x 8 cm. Weight: 4.5kg.
SCOPEX 4D-10A, 10MHz. Dual Trace, 10mV sensitivity. Display — 6 cm x 8 cm. Weight: 6kg.
DARTON D12, 15MHz. Dual Trace. 1mV sensitivity. Display — 8 cm x 10 cm. Weight: 7.8kg.

SIGNAL GENERATOR H.P. MODEL 680C. High power, stable and high accuracy. Frequency 10 to 480MHz. Modulation level 0 to 95% at carrier levels 0.5V output level continuously from 0.1µV into a 50 ohm. Maximum output 1V.

FOR EXPORT ONLY

Mullard C11, High power installation, 1000W. 'Technical details and prices available on request.

TEKTRONIX OSCILLOSCOPES

545A. Bandwidth DC to 30MHz.
570 CHARACTERISTIC CURVE TRACE
CABLE LAYING APPARATUS No. 11. New production P.O.A.
FURZEHILL SENSITIVE VALVE VOLTMETER TYPE V200A full scale from 10mV to 1000V in 6 steps without amplifier.
EDDYSTONE COMMUNICATIONS RECEIVER MODEL 730/1A 730/4. Frequency from 500kc/s to 28Mc/s.
HIGH VACUUM VARIABLE CAPACITORS — ceramic envelopes — UC 1000A/20/150=VMMHC 1000 60-1000µF, 20kv-150A RF max=27MHz.
TEST SET FT2 for testing Transceivers A40, A41, A42 and CPRC26.
UNIVERSAL WIRELESS TRAINING SET No 1 Mk 2 YA 8316 to train 32 operators simultaneously on key and phone. Complete installation consists of 3 kits packed in 3 special transit cases.
HARNESS "A" & "B" CONTROL UNITS "A" "R" "J1" "J2," Microphones No 5, 6, 7 connectors, frames, carrier sets etc.

VAT FOR TEST EQUIPMENT
PLEASE ADD 8%

COLOMOR
(ELECTRONICS LTD.)

170 Goldhawk Rd., London W.12
Tel. 01-743 0899
Open Monday to Friday
9-12.30, 1.30-5.30 p.m.

STAR DEVICES

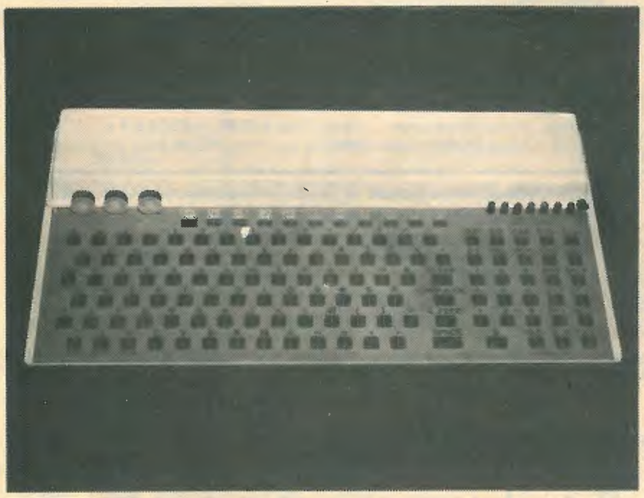
Low Cost

ASCII Encoded Capacative

Touch Keyboard

£37.50

Inclusive



The Standard Unit offers:

★ 7 bit parallel ASCII encoded output.
★ Positive and negative strobe edges.
★ All code outputs will drive 4 TTL loads.
★ LEDs to show code of selected character.
★ Audio feedback with volume/tone control.
★ Adjustable character rate.
★ Touch sensitivity control.
★ Auto repeat.
★ Automatic scan facility.
★ Requires 5 Volts at only 200mA.
★ Gold plated edge connector provided.
★ Low profile case.
★ Assembled, tested and burnt-in.
★ 6-month guarantee.
★ All 128 character ASCII set.
★ Comprehensive Handbook supplied.

Optional Extras:

Include Serial Output — RS232, On -board 5 Volt regulator. Plus 8 others.

For further details please write to:

STAR DEVICES LTD.
P.O. BOX 21, NEWBURY, BERKSHIRE

WW—061 FOR FURTHER DETAILS

ELECTROVALUE

FOR A GOOD DEAL BETTER THAN MOST

WE PAY POSTAGE on C.W.O. orders in U.K. over £5.00 list value (If under add 25p handling charge).

WE GIVE DISCOUNTS on C.W.O ORDERS — 5% where list value is over £10.00; 10% where list value is over £25.00.

WE GUARANTEE all goods are brand new, clean and to specification — no seconds, no surplus.

WE GIVE SERVICE to all orders large or small — with microfilm order storage, computer processing and double check personel supervision.

Specialist Mail Order Suppliers since 1961

This month's ELECTROVALUABLES

'Electrovaluables' are our own overstock items offered from time to time at greatly reduced prices. Orders for these items should quote 'Electrovaluables' and also description and price as advertised. PRICES ARE NET AND V.A.T. MUST BE ADDED @ 8% or 12½% where prices show*. Available only by Mail Order to our Englefield Green Depot.

SOLDERING IRONS
Type 31 240V 60W .. **£3**
Type 31 100V 60W .. **£3**
Type 62 110V 75W .. **£4**

VYNAIR 36" x 25"
Graphite (grey) **90p**
Rhapsody (black & fleck) **90p**
Oyster (beige) **90p**
Freno (black) **90p**

LAMPS
9mm. clear neon ... **15p**

HEAT CLIPS
TO1 crinkle 224F, 10 for **30p**

PITMAN BOOKS
(Zero rated for VAT)
Radiocontrol for Models, No. 2313 (RRP £6) **£4**
Hi Fi for the Enthusiast No, 4972 (RRP £5) .. **£3.50**
Radio Construction for the Amateur. No. 8684 (RRP £2.50) **£1.75**
(All three titles for **£8.50**)

VEROBOARD
5"x3.4"x2" matrix **20p**

TRANSFORMER CORES
0.5W 50 Hz Unisil, Belclere kit ES **20p**

POTENTIOMETERS
Carbon track
P20: 22K log short spindle 8 for **£1**. 2K2 log standard spindle .... 8 for **£1**
P20: +switch 470K 1M log .... 3 for **£1**
JP20 45K 1in, short spindle .... 3 for **£1**
2M2 1in, long spindle .... 3 for **£1**
100K log, 2M2 log 3 for **£1**
1M log, rev log short-spindle .... 3 for **£1**
PG58, slider 1M 1in, 10k log, 47K log, 100K log, 220K log, 1M log any 6 for **£1**

WIRE WOUND
Colvern 905C; 100, 150, 1K5, 5K, 10K, 15K, 25K, 50K; .... any 2 **£1**

WE ARE NATIONAL DISTRIBUTORS FOR

nm

NASCOM COMPUTER KITS

for delivery from stock from **£197.50** net + V.A.T.
Also supporting Nascom items. Enquiries invited.

MOTOROLA D.2 MICROPROCESSOR EVALUATION KIT

(for the M.680 Microcomputer — **£175.87** net + V.A.T.)

CATALOGUE 9

Yours for the asking — and it's FREE

Good projects start with Electrovalue's Catalogue 9

Completely revised, up-dated and more attratively presented, 120 pages — Semi-conductors, I.C.s, Opto-electronics, Rs, Cs, materials, tools, connectors, etc. etc. And you'll be delighted with our three-month stabilised price list system.

TWO DEPOTS TO SERVE YOU NORTH AND SOUTH

ELECTROVALUE LTD

Head Office: **Dept. W2, 28 St. Judes Road, Englefield Green, Egham, Surrey TW20 0HB.** Tel: Egham 3603 Telex: 264475.

Northern Depot: **680 Burnage Lane, Manchester M19 1NA.** Tel: 061-432 4945.

WW—111 FOR FURTHER DETAILS

TRANSISTORISED 3cm RADAR AMPLIFIER SWITCH: with 24v waveguide switch, .9 x .4cm ins. with crystal CV.2355 and spark gap VX.1046. **£16.20** + £1.00 post.

TRANSISTORISED VIDEO INDICATOR (used with above amplifier): 1½" C.R.T. **£10.80** + £1.00 post.

INSULATION TEST SET 0 to 10 KV, negative earth, with Ionisation Amplifier, 100/230 Volts. AC **£45.90,** carr. £3.00.

RACAL RA-17 RECEIVER 500KHz—30mHz, s/hand, good condition, **£365.00** (including VAT 12½%).

AVO TRANSISTOR ANALYSER CT.446: £37.80, carr. £2.20.

MARCONI FREQUENCY METER 1026/4: 2000-4000mHz 'as new' condition. **£32.40** or secondhand condition **£24.30.**

1026/2: 100-160mHz £32.40 'as new' or s/hand **£24.30.** Carriage for all type £2.00.

TELEPRINTER TYPE 7B: Pageprinter 24v. d.c. power supply, speed 50 bauds per min. S/hand cond. (excellent), no parts broken **£21.60,** carriage £3.50.

AUTO TRANSFORMER: 230v. 50c/s, 1000 watts. Mounted in strong steel case 5" x 6½" x 7". Bitumen impregnated. **£12.96,** carr. £2.00.

CRYSTAL TEST SET TYPE 193: Used for checking crystals in freq. range 3,000-10,000kHz. Mains 230v 50hz. Measures crystal current under oscillatory conditions and the equivalent resistance. Crystal freq. can be tested in conjunction with a freq. meter. **£27.00,** carr. £2.00.

TEKTRONIX PLUG-IN UNITS. Sweep delay time base, unit 11B2A £125.00 + £2.00 Post. Dual trace unit DC-MHz. 10AZA £125.00 + £2.00 Post.

ADVANCE PLUG-IN UNIT. Sweep delay time base. TG 10287 £75.00 + £2.00 Post.

TELONIC PLUG-IN UNIT. Type L7. £45.00 + £2.00 Post.

FIELD FLUID SAMPLING SET TYPE TP/SKP/10,000 with thermal control milliporer oil sampling kit. **£125.00.** Carriage £4.00.

RING TOROIDAL DUST CORES: Size 2½" outside, 1¾" inside, 5/16" thick. Box of two **£1.10** + 30p post.

ROTARY INVERTERS TYPE PE-218E: Input 24-28v. d.c. 80 amps, 4,800rpm. Output 115v. a.c. 13 amp 400c/s. 1Ph. P.F.9 **£21.60** + £3.00 carr.

R.F. POWER RADIATION METER CT.477. Covering X, S and L bands, **£125.00.** Carriage £4.00.

RECTIFIER UNIT: 200-250v. a.c. input, 24v. d.c. at 26 amps output continuous rating. **£37.80,** carr. £5.00.

MARCONI SIGNAL GENERATOR 801/DS: 10-480mHz. **£318.60.**

ROTARY CONVERTER: 24 volts d.c. input, 230 volts, 100 watts output. **£27.50,** carriage £4.00.

RADIO TELETYPE TERMINAL SET SG1A 115 volts a.c. **£17.50,** carriage £3.00.

TELEGRAPH DISTORTION TEST SET (TYPES 5CBV and 5BV) 230v. a.c. **£25.00,** carriage £3.00.

RESONATOR PERFORMANCE CT.424 8.5 to 9.0 kmc/s 3 cm. **£75.00,** post £2.00.

INVERTER 24 volts d.c. input 400 cycles 1pH 6600 r.p.m. 200 volts peak. **£7.50,** £1.50 post.

OXYGEN BOTTLE 1800lb. w.p. **£10.00,** carriage £3.00.

NOISE SOURCE UNIT with CV.1881 noise source mount. Produces thermal noise 15.5dB 200/250 a.c. **£75.00.**

LOW SPEED TAPE COMPARATOR (Datronic) ⅝" tape, **£45.00,** £5 carr.

ADDO 1" TAPE REPRODUCER: £65.00, carriage £5.00.

MUIRHEAD D514 T.M.S.: 12v. d.c. or 100-250v. a.c. volts input. Range 100-40,000Hz. **£15.00,** carriage £4.00.

AUTOTUTOR MARK II: (Viewer Training Aid) 230v. a.c. Designed for use in intrinsic programming method, info stored on microfilm and projected through optical system onto viewing screen. **£120.00.**

AVO VALVE TESTER & CHARACTERISTIC METER: £75.00, carr. £5.00.

RANK FLUTTER METER TYPE 1740: £65.00, carr. £4.00.

MICROMETER CONDENSER TYPE C.689: 0-8.5uuF precision variable condenser, **£35.00,** post £2.00.

HS33 HEADSET. Low Imp. £5.00 pair + 75p Post.

MARCONI UNIVERSAL BRIDGE. Type TF868 £85.00. Carr. £4.00.

MUIRHEAD DECADE OSCILLATOR TYPE 890D: £85.00, carr. £5.00.

BARGAIN MAPS

Large stocks of unused U.S.A.F. surplus maps, weather charts, etc. including:—

ONC-E1 — U.K. in full and part N.W. Europe. Scale 1:1,000,000.
JNC-9N — N. Europe, U.K., Scandinavia. Scale 1:2,000,000.
JN-21N — Europe (Mediterranean). Scale 1:2,000,000.
SIZE: 58" x 42", colour. Many others. Please send S.A.E. for list.
Price each 70p (inc. p + p)
25 x Maps (either same type OR assorted) **£10.00** + £1.00 p + p.
10 x Maps (either same type OR assorted) **£6.00** (inc. p + p).

Above prices include VAT at 8% (except where stated)

Carriage quotes given are for 50-mile radius of Herts.

W. MILLS

The Maltings, Station Road
SAWBRIDGEWORTH, Herts.
Tel: Bishop's Stortford (0279) 725872

OVER 200 GAMES

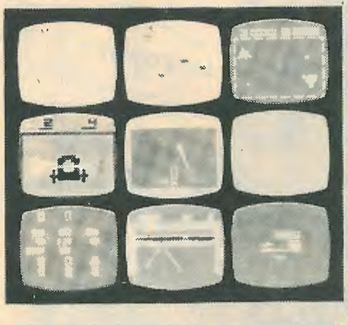
'ATARI' VIDEO COMPUTER

—READY BUILT

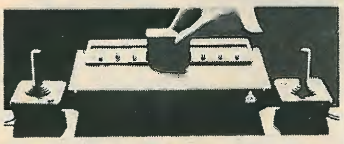
CARTRIDGE SYSTEM(ROM)

Designed and built by Atari (part of Warner Bros.) in the USA this unit is the most advanced games centre available.

Just look at a few of the cartridges (up to 50 games each) available in full glorious multi-colour and very realistic on TV Sounds.



Examples of some of the many new cartridges plus — due, during early '79: Chess, backgammon, INY500 available. Combat, Air Sea Battles, Space War, Outlaw, Video Olympics, Surround, Blackjack, Breakout, Basic Math.



The Video Computer (based on Signetics Micro) comes complete with 27 Game Combat Cartridge (tanks, bi-planes, bombers, jets), 2 joysticks, 2 rotational controllers, mains adaptor and aerial switching unit. Fully guaranteed for 12 months. **VCS £139.95.** (R.R.P. £169.95). **CARTRIDGES £13.45.** (R.R.P. £14.95).

Full Colour Brochure available on request

★ Prices include VAT, packing and delivery charges and money back guarantee. Send cheque or P.O. to:

BARCLAYCARD VISA

VIDEOTIME PRODUCTS

56 Queens Road, Basingstoke, Hants RG21 1REB
Tel: (0256) 56417. Telex 858747

Access Buy it with Access

(Trade & Export Enquiries welcome)

Following the success of Breadboard '78, Trident Exhibitions announce

BREAD BOARD 1979

The second hobby electronics show

Information on exhibiting from:
Trident International Exhibitions Limited,
Abbey Mead House, 23a Plymouth Road,
Tavistock, Devon. PL19 8AU.
Telephone (0822) 4671 Telex 45412 TRITAV

December 4th - 8th Royal Horticultural Hall, Westminster, London SW1

MARCONI TEST EQUIPMENT

TF791D Deviation meter
TF455E Wave analyser. New. **£135**
TF1101 RC oscillators. **£65**
TF1099 20MHz Sweep generators
TF1041 B & C. VT Voltmeters
TF1102 Amplitude modulator. 500MHz
TF1020A Power meter. 100W. 250MHz. **£85**
TF1152A/1 Power meter. 25W. 500MHz. **£75**
TF890A/1 RF test set. **£425**
TF801B/3S Signal generator. **£175**
TF1064B/5 VHF. FM Signal generator
TF1400 Pulse generator
TF675F Pulse generator
TF1370 Wide-range RC oscillator. **£125**
TF2162. MF Attenuator
TF1058 UHF/SHF signal generator
TF995A/4. AM/FM signal generator
TF1066 AM/FM signal generator
TF340 Power meters.

ADVANCE CONSTANT VOLTAGE TRANSFORMERS

Input 190-260V AC. Output constant 220 Volts. 250W. **£25** (£2 carriage)

NICKEL CADMIUM BATTERIES

Size 'D' (HP2) 4 A.H. **£2** (pp. 20p)
Size 'F' 6.00 A.H. **£2.75** (pp. 25p)

POWER SUPPLIES

ADVANCE PMA47. 0-15V @ 3 Amps. **£30**
ADVANCE RMA20. 0-7V @ 20 Amps. **£39**
Both brand new, boxed, with book.
APT10459/11. 10-15V @ 7.5A **£25**
APT10459/13. 24V (var) 5A **£25**
(All items + £1 carr.)

BECKMAN TURNS COUNTER DIALS

Miniature type (22mm diam.). Counting up to 15 turn "Helipots". Brand new with mounting instructions. Only **£2.50 each.**

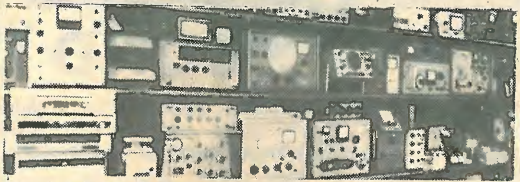
Wandel & Gotterman Equipment
Level Meter 0.2-1600KHz
Level Oscillator 0.2-1600KHz
Level Transmitter 0.3-1350KHz
Carrier Frequency Level Meter

P. F. RALFE ELECTRONICS

10 CHAPEL STREET, LONDON, NW1
TEL: 01-723 8753

TEST EQUIPMENT

LEADER TV FM Sweep and marker generator
AIRMEC 210 Deviation meter
HEWLETT-PACKARD 302A Wave-Analyser
RACAL type 801R. 100MHz digital frequency meter
TEXSCAN X-Y oscilloscope. 9-inch CRT
TELETYPE ASR33 now in stock
SOLARTRON 1420. 2 digital voltmeter. 6 ranges to 1KV
BOONTON 80 Signal generator. 2-400MHz **£105**
BOONTON 230A RF Power Amplifier **£325**
BPL Capacitance decade (5) CD133. 100pF-1uF **£45**
GERTSCH Frequency meter and deviation meter 20-1000MHz
HEWLETT-PACKARD 695A Sweep oscillator
HEWLETT-PACKARD Sweep oscillator **£350**
DERRITRON. Digital Wheatstone Bridge **£110**
MUIRHEAD K-134-A Battery op. wave analyser
WEINSHEL Power Supply Modulator MO3



BRUEL & KJOER Vibration equipment 1018
BRUEL & KJOER Frequency analyser 2105
BRUEL & KJOER Microphone amplifier 2603
BRUEL & KJOER Type 3301 Automatic frequency response recorder 200Hz-20KHz
MUIRHEAD-PAMETRADA D489EM Wave Analyser
TEKTRONIX 555 scope with plug-ins types CA (2 off), 21, 22
TEKTRONIX 515A Oscilloscope
TEKTRONIX 545 main frames. **£210.** Choice of plug-in units extra
TEKTRONIX 585A oscilloscope with '82' P.I. DC-80MHz
TEKTRONIX type 180A Time-mark generator **£110**
TELEQUIPMENT DM53A Storage oscilloscope
TEKTRONIX 556. 50MHz oscilloscope

NOTICE. All the pre-owned equipment shown has been carefully tested in our workshop and reconditioned where necessary. It is sold in first-class operational condition and most items carry our three months' guarantee. Calibration and certificates can be arranged at cost. Overseas enquiries welcome. Prices quoted are subject to an additional 8% VAT.

ROHDE & SCHWARZ EQUIPMENT

HUZ Field Strength Meter. 47-225MHz.
AMF TV. Demodulator 55-90MHz.
Selective UHF v/meter, bands 4&5 USVF.
Selectomat. RF Voltmeter. USWV. BN 15221 .... **£450**
Standard attenuator. 0-100dB, 0-300MHz. DPR.
UHF Sig. gen. type SDR 0.3-1 GHz **£750**
UHF Signal generator type SCH. **£175**
UHF Test receiver type USVD **£325**
POLYSKOP SWOB 1.

PYE-LING VIBRATORS

3 ohm coil. Overall dimensions 9 x 6½ x 6½ cms. Each **£5.25** (25p P&P).

SOLARTRON Type CD1400 OSCILLOSCOPES

Double-beam, DC-15MHz (—3dB). Complete with types CX1441 (2 off) plug-in Y-Amp units, 100mV/cm (10mV to 750KHz) and type CX1444 Sweep delay time-base unit. Sold in first class operational condition with guarantee. **£175** + 8% VAT.

'CENTAUR' INSTRUMENT COOLING FANS

Made by Rotron Holland. These are very high quality, quiet running fans, specially designed for the cooling of all types of electronic equipment. Measures 4.5 x 4.5 x 1.5in. 115V AC. 11 Watts. The list price of these is over £10 each. Also 230V. AC available. Either voltage **£4.50 each** (postage 25p).

TEKTRONIX TYPE 556

OSCILLOSCOPE WITH TYPES 1A1 and 1A2 PLUG-IN UNITS. First class condition throughout.

TELEVISION MONITORS

Philips studio quality precision colour monitors and Pye monochrome 405/525/625 lines.

PACE ELECTRONICS VARIPLOTTER

Type 1100E **£175**

MUIRHEAD DECADE OSCILLATORS Type 890A.

1Hz-110KHz in four decade ranges. Scope monitored output for high accuracy of frequency. Excellent generator.

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	**£27.13**	£2.00
2	24-30-40-48-60v	10	**£24.03**	£2.00
3	24-30-40-48-60v	8	**£20.15**	£1.75
4	24-30-40-48-60v	5	**£13.95**	£1.75
5	24-30-40-48-60v	3	**£10.54**	£1.00
6	24-30-40-48-60v	2	**£7.60**	£1.00

6-8-10-12-16-18-20-24-36-40-48-60v
CAN BE OBTAINED FROM THE ABOVE RANGE

Type	Sec Taps	Amps	Price	Carr
7	19-25-33-40-50v	10	**£21.70**	£2.00
8	19-25-33-40-50v	6	**£15.66**	£1.50
9	19-25-33-40-50v	3	**£8.45**	£1.25
10	19-25-33-40-50v	2	**£7.60**	£1.00

5-7-8-10-13-15-17-20-25-30-40-50v
OR 25-0-25v OR 20-0-20v CAN BE
OBTAINED FROM THE ABOVE RANGE

Type	Sec Taps	Amps	Price	Carr
11	12-15-20-25-30v	10	**£13.33**	£1 75
12	12-15-20-25-30v	5	**£8.37**	£1.25
13	12-15-20-25-30v	2	**£5.27**	£1.00

3-4-5-6-8-9-10-12-15-18-20-24-30v
OR 12-0-12v OR 15-0-15v CAN BE
OBTAINED FROM THE ABOVE RANGE

Type	Sec Taps	Amps	Price	Carr
14	12-24v	12v 60A, 24v 30A	**£26.82**	£3.00
15	12-24v	12v 30A, 24v 15A	**£17.05**	£2 00
16	12-24v	12v 20A, 24v 10A	**£13.18**	£2.00
17	12-24v	12v 10A, 24v 5A	**£7.67**	£1.00
18	12-24v	12v 4A, 24v 2A	**£4.03**	£1.00
19	15-20-24-30v	2	**£4.95**	£1.25
20	50v CT	1	**£3.75**	£1.00
21	60v CT	1	**£3.95**	£1.00
22	50v CT	3	**£5.75**	£1.25
23	60v CT	2½	**£5.75**	£1.25
24	6v twice each	4	**£3.75**	£1.00
25	6v twice each	½	**£2.00**	50p
26	12v twice each	½	**£2.50**	75p
27	28-32v	4	**£5.95**	£1.25

ISOLATION TRANSFORMERS FRACTION OF MAKERS PRICE. EX EQUIP.

Pri. 240v. Sec. 240v. 3,000 watts enclosed in steel case **£60** carr. £5. Pri. 200-220-240v. Sec. 240v. 700 watts. Open type. Cable end connections **£12.50** carr. £2. Pri. 240v. Sec. 220-240v. 500 watts. Open type top panel connections **£8.50** carr. £1.50.

AUTO STEPDOWN TRANSFORMERS FOR AMERICAN EQUIPMENT

240/110v. 80-3000 watts. Fitted with American two or three pin socket outlet and three core 240v mains lead. Send sae for latest price list. American plugs, sockets, extension leads also available.

PARMEKO ISOLATION TRANSFORMERS 240-110V

Ex-equipment, perfect condition. Metal shrouded case. Table top connections. Pri tapped 190-200-210-220-230-240-250-260v. Sec 125v 13A **£35** carr. £4. Pri tapped 200-210-220-230-240-250v. Sec tapped 90-100-110-120v 7.5A **£19.50** carr. £2.

ISOLATION TRANSFORMERS 240-240V. BY FAMOUS MAKERS. FRACTION OF LIST PRICES. EX EQUIPMENT.

Pri. 220-240v. Sec. 240v. Shrouded. Top panel connections. **£50** carr. £5. Pri. 200-220-230-240v. Sec. 240v. Open frame cable lead connections **£10.50** carr. £2. Pri. 240v. Sec. 240v, 500 watts. Open frame. Top panel connections **£8.50** carr. £2. Pri. 220-240v. Sec. 100-110v. Shrouded lead connections **£6** carr. £1.50.

SPECIAL PURCHASE BY FAMOUS MAKERS L.T. TRANSFORMERS IDEAL FOR UP-TO-DATE POWER SUPPLY CIRCUITS

No 1 GRESHAM Pri. 240v Sec. 43v 3amps. Fully tropicalised. Open type wire connections **£3.95** pp 75p. No 2 HINCHLEY Pri 240v Sec. 33v 5amps and 18-0-18v 1A. Tropicalised open frame. Wire connections. Two in series will give 33-0-33v 5A and 18-0-18v 2A **£3.95** each pp 75p. No 3 PARMEKO Pri. 240v Sec. 30v 5A and 12v 2.2amps. Table top connections **£4.95** pp £1.

LOW POWER L.T. TRANSFORMERS BY FAMOUS MAKERS. ALL PRIMARIES 240v. TAG OR LEAD CONNECTIONS

No 1 20v 3A **£3** pp 75p. No 2 27v 1A **£1.50** pp 50p. No 3 12v 1½A and 24v ½A 2 separate windings **£1.50** pp 50p. No 4 12v 1A **£1** pp 50p. No 5 20v 1A **£1.50** pp 50p. No 6 55v ½A and 6.3v ½A **£1.50** pp 50p. No 7 24v 1A shrouded type **£1.50** pp 50p. No 8 13v 3A and 15v 1A 2 separate windings 'C' core type. **£3.50** pp £1. No 9 15v 1.2A 6.3v 4.5A 250v 80M/A. 3 separate windings **£3.50** pp £1. No 10 27v 1.8A 9v 1.8A 3v 1.8A 3 separate windings **£3.50** pp £1. No 11 13-0-13v 1A **£2.50** pp 50p.

PARMEKO H.T. TRANSFORMERS POTTED TYPE

Pri 240v sec 1875v 60M/A and 500v 31M/A. Fraction of maker's price, **£5.75,** carr £1.

L.T. SMOOTHING CHOKES

4.8M/H 10 amps **£4,** pp£1. 150M/H 3 amps **£3.50,** pp £1. 100M/H 2 amps potted type **£4,** pp £1. 13M/H 1 5 amps potted type **£1.50,** pp 50p. 2+2M/H 12 amps **£4,** carr. £1. "C" core types 10M/H 25 amps **£8.50,** carr. £2. 18M/H 10 amps **£4.50,** carr. £1.50. Gardner 50M/H 10 amps open type top panel connections **£8.50,** carr. £2.

STANDARD OPEN TYPE RELAYS SINGLE HOLE FIXING 7 AMP CONTACTS BY FAMOUS MAKERS

COIL VOLTAGE	CONTACT	PRICE
240v AC	3 CO	**85p**
240v AC	2 CO	**75p**
240v AC	1 CO	**65p**
110v AC	2 CO	**65p**
50v AC	3 CO	**65p**
48v DC	3 CO	**50p**
24v DC	2 CO	**75p**
12v DC	2 CO	**75p**

PP 10p per relay. Please add VAT 8% on total.

11 pin plug in type

12v AC	3 CO	**85p**
24v AC	3 CO	**85p**
24v DC	3 CO	**85p**
10v DC	3 CO	**85p**

AC WKG BLOCK CAPACITORS BY FAMOUS MANUFACTURERS

MFD	Volts	Price
Q25	1500vAC	**50p**
Q75	440vAC	**50p**
1	470vAC	**60p**
1.25	360vAC	**65p**
2	400vAC	**75p**
2.4	360vAC	**75p**
2.5	360vAC	**75p**
2.7+0.1	700vAC	**£1.25**
3	440vAC	**£1.00**
3.5	250vAC	**£1.00**
4	250vAC	**£1.00**
5	360vAC	**£1.25**
6	440vAC	**£1.50**
7.2	440vAC	**£1.50**
8.4	250vAC	**£1.00**
15	250vAC	**£1.75**

PP up to 2.5 MFD **25p,** 2.7 to 15MFD **50p** + 8% on total.

BLOCK PAPER CAPACITORS

6 MFD 300v wkg. AC. **£1** pp 25p. 6 MFD 350v DC wkg. **75p** pp 25p. 1 MFD 1,500v DC wkg **60p** pp 25p. 0.1 MFD 3,000v DC wkg. **50g** pp 25p.

BENSONS SOLENOIDS

AC 240v 25% duty. Approx. 2ins. ½in. pull. Size 2 x 1½ x 1 ins. Res. 350Ω. **75p,** pp 10p.

"C" CORE L.T. TRANSFORMERS NEW SURPLUS BY FAMOUS MAKERS. ALL PRIMARIES 220-240v.

No 3 18-0-18v 12.5A **£12.50** carr, £2. No 4 Sec 1 tapped 22-23-24-25-26-27v, 6A Sec 2 20-21-22-23-24-25v 3½A. Sec 3 18-19-20-21-22-23-2A. Sec 4 11-12-13-14-15-16v ½A. Sec 5 11-12-13-14-15-16v ½A Sec 6 100-0-100v 150 M/A **£12.00** carr £3. No 5 Sec 25-28v 5A. Sec 2 26v 2½A. Sec 3 26v 2½A. Sec 4 24v 1A. Sec 5 16v 1A. Sec 6 16v 1A. Sec 7 6.3v 3A **£5.75** carr £2. No 8 12.6v 5.7A 128-0-120v 14M/A, **£4.75** pp £1.25 No 9 11.6v 3.5A **£3.50** pp £1 No 10 17.5v 1A three times **£4.50** pp £1.25. No 11 23-5-0 23.5v; 0-11A **£1.50** pp 75p. No 12 12v 1A 22v 1.4A, 21v 0.7A, **£2** pp 75p. No 13 55v 0.5A, 6.4v; 0.3A, **£2** pp 75p. No 14 10-7-0-7-10v 0.47A, 28-21-0-21-28v 0.37A, **£2** pp 75p

NEW "C" CORE TRANSFORMERS BY FAMOUS MAKERS. FRACTION OF LIST PRICE. UNREPEATABLE OFFER ALL PRIMARIES 220-240V

No 1 Sec, 15v, 40A **£18.75** carr £3. No 2 sec, 12v 40A **£17.50** carr £3. No 3 sec, 15-0-15v 1A four times. 19v 1.8A. 27-0-27v 1.3A. 27 x 1.8A separate windings **£6.95,** carr £2. No 4 Sec 12.6v 5.75A **£4.75** pp £1. No 5 11.6v 3.5A **£3.50** pp £1. No 6 17.5v 1A three times **£4.50** pp £1. No 7 12.3 v 10A, and 30-0-30v ½A **£4.95** pp £1. No 8 12.3v 5A and 30-0-30v 250 m/a **£3.75** pp £1. No 9. Sec 18-22-27v 250 m/a twice **£2.50** pp 75p. No 10 Sec 24v 480 m/a twice, 6.3v 2A 128v 64 m/a **£4.50** pp £1. All above transformers are conservatively rated.

HEAVY DUTY LT TRANSFORMERS OPEN FRAME TYPE TERMINAL TAG CONNECTIONS ALL PRIMARIES 220-240v

No 1 Sec 17v+2v+1½v+1v separate windings all at 20A **£9** pp £2 No 2 Sec 17v+2v+1½v+1v separate windings all at 10A. **£6** pp £1.50. No 3 Sec 36v 6A **£8.50** pp £1.75. No 4 Sec 65v 2.2A and 30-0-30v 100 m/a **£3.95** pp 75p.

L.T. TRANSFORMERS NEW SURPLUS FAMOUS MAKERS. FRACTION OF MAKER'S PRICE

No. 1 Pri 115-220-240v. sec. 10.7v 20A open type tag board connections **£6.95** carr. £1.50. No. 2 Pri. 115-220-240v. sec. 9.3v 7A and 25v 0.8A open type tag board connections **£4.75** carr. £1.50. No. 3 Pri. 115-220-240v. sec. 9v 2A and 9v 1A open type terminal block connections **£2.50** pp £1. No. 4 Pri 230v sec. 80v 1.1A open type tag board connections **£3.00** pp £1. No. 5 Pri. 120-240v sec 13v 3A and 15v 1A open type terminal block connections **£3.00** pp £1. No. 6 Pri 240v sec. 30v 5.5A and 12v 2.2A open type table top connections **£5.75** carr. £1.50. No. 7 Pri 230v sec tapped 24-30-32v 2A potted type **£3.00** pp £1. No. 8 Pri 220-240v, sec. 6v 1A twice shrouded GPO type **£2.00** pp 75p. No. 9 Pri. 110-220-240v, sec. 1 3v 1.8A, sec. 2 9v 1.8A, sec. 3 27v 1.8A. 3-9-12-27-30-36-39v 1.8A can be obtained, open type table top connections, **£3.75** pp 75p. No. 10 Pri. 220-240v sec. 10v 1.5A and 50v 0.6A **£3.50** pp 75p.

H.T. TRANSFORMERS BY FAMOUS MAKERS. ALL PRIMARIES 240v

Type MT33 300-0-300v 150M/A 6.3v ct 4A 5-6.3v 2A **£4.50** pp £1. MT12. Sec 300-0-300v 120M/A 6.3v ct 4A 5-6.3v 2A **£4.00** pp £1. MT11 Sec. 300-0-300v 100M/A 6.3v 3.5A 5v 2A or 6.3v 1A **£3.75** pp £1. MT7 Sec. 350-0-350v 100M/A 6 3v 3.5A 5v 2A or 6.3v 1A. **£4.00** pp £1.

NRDC-AMBISONIC UHJ

SURROUND SOUND DECODER

The **first ever** kit specialy produced by Integrex for this British NRDC backed surround sound system which is the result of 7 years' research by the Ambisonic team. W.W. July, Aug., '77.
The unit is designed to decode not only UHJ but virtually all other 'quadrophonic' systems (Not CD4), including the new BBC HJ 10 input selections
The decoder is linear throughout and does not rely on listener fatiguing logic enhancement techniques. Both 2 or 3 input signals and 4 or 6 output signals are provided in this most versatile unit. Complete with mains power supply, wooden cabinet, panel, knobs, etc.

Complete kit, including licence fee **£49.50** + VAT
or ready built and tested **£67.50** + VAT

NEW S5050A STEREO AMP

50 watts rms-channel. 0.015% THD. S/N 90 dB, Mags/n 80 dB.

Tone cancel switch. 2 tape monitor switches.

Complete kit only **£63.90 + VAT.**

Wireless World Dolby™ noise reducer

Trademark of Dolby Laboratories Inc.

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.

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.

Complete Kit **PRICE: £43.90** + VAT

Also available ready built and tested	**Price £59.40** + VAT
Calibration tapes are available for open-reel use and for cassette (specify which)	**Price £2.40** VAT *
Single channel plug-in Dolby™ PROCESSOR BOARDS (92 x 87mm) with gold plated contacts are available with all components	**Price £9.00** + VAT
Single channel board with selected fet	**Price £2.75** + VAT*
Gold Plated edge connector	**Price £1.75**+VAT*

Selected FETs **65p** each + VAT, **110p** + VAT for two, **£2.10** + VAT for four.

Please add VAT @ 12½% unless marked thus*, when 8% applies (or current rates)

We guarantee full after-sales technical and servicing facilities on all our kits, have you checked that these services are available from other suppliers?

Buy it with Access

EUROCARD

BARCLAYCARD

master charge
THE INTERBANK CARD

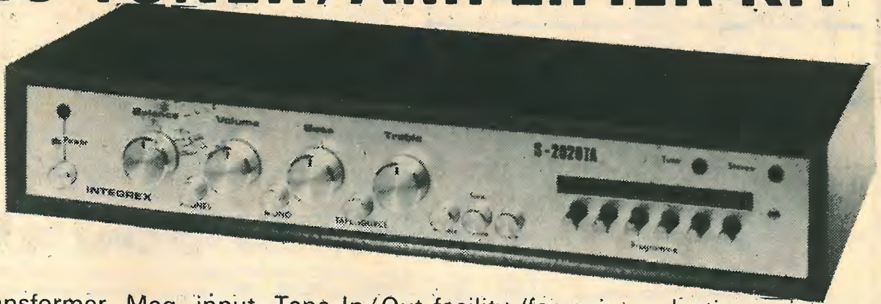
INTEGREX LTD.

Please send SAE for complete lists and specifications
Portwood Industrial Estate, Church Gresley,
Burton-on-Trent, Staffs DE11 9PT
Burton-on-Trent (0283) 215432 Telex 377106

INTEGREX

S-2020TA STEREO TUNER/AMPLIFIER KIT

SOLID MAHOGANY CABINET

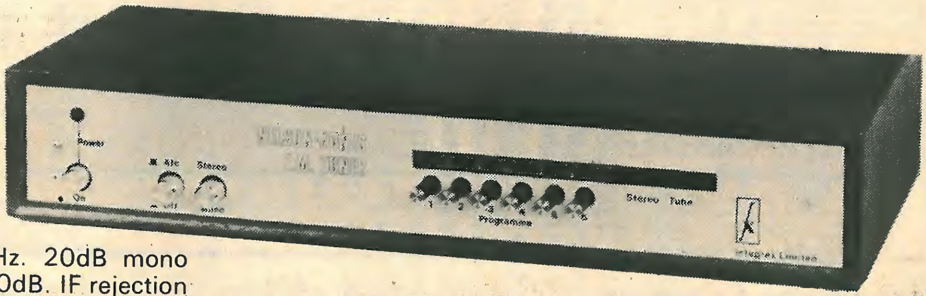


A high-quality push-button FM Varicap Stereo Tuner combined with a 24W r.m.s. per channel Stereo Amplifier.

Brief Spec. Amplifier Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc.), THD less than 0.1% at 20W into 8 ohms. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section uses 3302 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88—104MHz. 30dB mono S/N @ 1.2μV. THD 0.3%. Pre-decoder 'birdy' filter. **PRICE: £59.95** + VAT

Nelson-Jones Mk. 2 Stereo FM Tuner Kit. Price: **£69.95** + VAT.

NELSON-JONES MK. I STEREO FM TUNER KIT



A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter/dual IC IF amp.

Brief Spec. Tuning range 88—104MHz. 20dB mono quieting @ 0.75μV. Image rejection — 70dB. IF rejection — 85dB. THD typically 0.4%.
IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

Compare this spec. with tuners costing twice the price.

Mono £36.40 + VAT
With ICPL Decoder £40.67 + VAT
With Portus-Haywood Decoder £44.20 + VAT

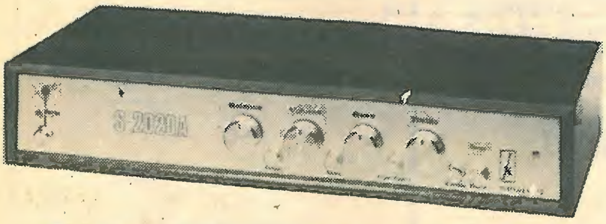
Sens. 30dB S/N mono @ 1.2μV
THD typically 0.3%
Tuning range 88—104MHz
LED sig. strength and stereo indicator

STEREO MODULE TUNER KIT

A low-cost Stereo Tuner based on the 3302 FET RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC. Pre-decoder 'birdy' filter Push-button tuning

PRICE: Stereo £33.95 + VAT

S-2020A AMPLIFIER KIT



Developed in our laboratories from the highly successful "TEXAN" design. PC mounting potentiometers, switches, sockets and fuses are used for ease of assembly and to minimize wiring Power 'on/off' FET transient protection.

Typ Spec. 24+24W 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: £35.95 + VAT

BASIC NELSON-JONES TUNER KIT	**£15.70** + VAT
BASIC MODULE TUNER KIT (stereo)	**£18.50** + VAT
PHASE-LOCKED IC DECODER KIT	**£4.47**+VAT
PUSH-BUTTON UNIT	**£6.00** + VAT
PORTUS-HAYWOOD PHASE-LOCKED STEREO DECODER KIT	**£8.80** + VAT

THE NEWBEAR COMPUTING STORE

The Bear announces its new store at:

2A GATLEY ROAD, CHEADLE, CHESHIRE
Tel. 061-491 0134
Callers welcome, mail order to Newbury

NASCOM-1
Ex Stock £197.50 + 8% VAT, £1 P&P

BOOKS

		P&P
Computer Designs. 77-68 a 6800 Microcomputer	**£7.50**	.50
WB-1 a TTL Microcomputer	**£6.50**	.50
Zilog Z-80 Technical Manual	**£4.00**	.50
Z-80 PIO Manual	**£2.50**	.50
Z-80 Programming Manual	**£4.00**	.75
Accounts Payable and Receivable	**£9.95**	.75
Getting Acquainted with Micros		
TTL Databook	**£2.50**	.50
6800 Assembly Language Programming	**£6.95**	.50
Understanding Microcomputers	**£7.56**	.50
Z-80 Programming for Logic Design	**£9.95**	.50
How to Buy and Use Microcomputers	**£6.95**	.75
Microcomputer Primer	**£5.55**	.75
Adam Osbourne Introduction to Microcomputers		
Vol. 0 Beginners Books	**£5.25**	.50
Vol. 1 Basic Concepts	**£5.95**	.50
Vol. 2 Some Real Products	**£11.95**	1.00
8080 Programming for Logic Design	**£5.95**	.50
6800 Programming for Logic Design	**£5.95**	.50
Some Common Basic Programs	**£8.95**	.50
Payroll with Cost Accounting in Basic	**£9.95**	1.00
Sybex Microprocessors	**£8.00**	.50
Microprocessor Interfacing Techniques. C20	**£8.00**	.50
Scelbi 8080 Software Gourmet Guide Cook Book	**£7.95**	.50
6800 Software Gourmet Guide Cook Book	**£7.95**	.50
The Scelbi Byte Primer	**£9.95**	1.00
What To Do After You Hit Return	**£7.00**	.75
PCC Reference Book on Home Computers	**£4.95**	.50
Instant Basic	**£4.95**	.75
My Computer Likes Me	**£1.65**	.30
Games with a Pocket Calculator	**£1.75**	.30
Games, Tricks & Puzzles for a Hand Calculator	**£2.45**	.30
Best of Creative Computing Vol. 1	**£6.95**	.75
Best of Creative Computing Vol. 2	**£6.95**	.75
Hobby Computers are Here	**£3.99**	.50
Best of Byte	**£8.95**	.75
101 Basic Computer Games	**£5.50**	.75
The Home Computer Revolution	**£3.45**	.50
Computer Lib	**£5.95**	.50
First Book of Kim	**£7.00**	.50

Send for our new CATALOGUE and BOOKLIST

6800P	**£7.15**	4116	**£11.50**
6810AP	**£3.61**	2102L-1	**£1.35**
6820	**£4.63**	2102-1	**£1.25**
6840	**£12.72**	2112	**£2.25**
8602	**£2.88**	2114	**£8.25**
Z80 CPU	**£13.99**	2708	**£8.50**
Z80 P10	**£9.15**	4027	**£4.50**
Z80 CTC	**£9.15**	SWATBUG	**£16.00**
Z80A CPU	**£20.00**	6830L/7	**£13.65**
Z80A P10	**£11.05**	(MIKBUG)	
Z80A CTC	**£11.05**	6402 UART	**£4.50**
6502	**£14.93**	6571	**£6.71**
6522	**£6.58**	2513	**£6.50**
6532	**£12.56**	74S262	**£13.70**
5FF 96364	**£11.75**	8080	**£6.00**

INS 1771 FLOPPY DISC CONTROLLER . . . £54.00

FLOPPY DISC DRIVES

5½" SHUGART SA400 DISC DRIVE	**£225.00**
Carriage by Securicor 'C' rate	£4.50
8" DRI SINGLE SIDED DOUBLE DENSITY	**£325.00**
Carriage by Securicor 'C' Rate	£5.00
8" DRI DOUBLE SIDED DOUBLE DENSITY	**£365.00**
Carriage by Securicor 'C' Rate	£5.00

Dr. Dobbs Journal (Vol. 1)	**£10.00**	.75
Z-80 Microcomputer Handbook	**£7.25**	.50
8080A Bugbook	**£6.95**	.75
TTL Cookbook	**£6.30**	.50
How to Program Microcomputers (Barden)	**£6.30**	.50
Microprocessors Systems	**£5.70**	.50
Take a Chance with Your Calculator	**£4.95**	.50
Home Computers Questions and Answers Vol. 1 Hardware	**£5.95**	.50
Vol. 2 Software	**£5.95**	.50
Data Acquisition Handbook	**£2.50**	.50
SC/MP Applications Manual	**£3.00**	.50
Getting Involved with your own Computer	**£4.75**	.50
Your Home Computer	**£4.95**	.50
Using the 6800 Microprocessor	**£6.25**	.50
Basic Programming in Real Time	**£5.95**	.50
IC Timer Cookbook	**£6.95**	.75
Active Filter Cookbook	**£10.45**	.75
IC OP-AMP Cookbook	**£9.05**	.75
Kim-1 User Manual	**£7.00**	.75
The New Hobby Computers	**£3.95**	.30
Computer programs that work	**£2.40**	.30
Guide to SC/MP Programming	**£3.75**	.50
Guide to Kitbug	**95p**	.20
6800 System Design Data	**£2.00**	.50

SYM-1

(FORMERLY VIM-1)

The new 6502 based Micro from Synertek. Fully assembled and tested. **£199.00** plus 8% VAT. Carriage £1.00. Send for data sheet.

BEAR BAGS

1.	77-68 CPU P.C.B. Components and Edge Connectors	**£45.00**
2.	77-68 LED's and Switches	**£14.95**
3.	77-68 Power Supply*	**£17.95**
4.	77-68 19" 5u Rack and Backplane*	**£27.70**
5.	77-68 4K Ram P.C.B. and Components	**£75.00**
6.	77-68 Mon 1 P.C.B. and Components	**£50.70**
7.	4K Ram Exorcisor P.C.B. and Components	**£71.50**
8.	8K Ram Exorcisor P.C.B. and Components*	**£160.00**
9.	Petitevid V.D.U. Kit	**£85.00**
10.	Kansas City Cassette Interface	**£18.95**
11.	U.H.F. Modulator	**£4.50**
12.	77-68 VDU P.C.B. and Components	**£69.50**
13.	77-68 Mon 2 P.C.B. and Components	**t.b.a.**
14.	Prom Programmer P.C.B. and Components	**£35.00**
15.	Promverter	**£8.50**

Plus VAT 8%
50p Postage & Packing
*£1.00 Postage & Packing

PRINTED CIRCUIT BOARDS

77-68 CPU P.C.B.	**£10.00**
77-68 4K Ram P.C.B.	**£10.00**
77-68 Mon 1 P.C.B.	**£10.00**
77-68 V.D.U. P.C.B.	**£10.00**
S50 bus 4K Ram P.C.B.	**£12.00**
Exorcisor Compatible Motherboards (8 slot)	**£23.50**
4K Ram P.C.B.	**£10.00**
Veroboard Backplance 8" x 17"	**£4.30**
77-68 Extender card	**£4.10**
ASCII Keyboard assembled and tested	**£86.00**
Keyboard Kit	**£55.00**
Keyboard Case	**£20.33**
U.V. Prom Eraser	**£56.00**
S100 bus 9-slot Motherboard	**£19.50**
Double Eurocord Motherboard	**£15.00**

Goods are normally shipped within 24 hours, subject to availability. Barclaycard & Access. VAT at 8% for Hardware Components. 30p Postage and Packing unless otherwise stated. Cheques to be made out to The Newbear Computing Store. Send for an up-to-date catalogue to The Newbear Computing Store, 7 Bone Lane, Newbury. 0635 49223. Callers are welcome Monday to Saturday 9.00 a.m.-5.30 p.m., but please ring to let us know when you are calling.

VIEWDATA . . . TELETEXT . . . VIDEO RECORDERS . . . TV GAMES . . .

If you are interested in the development of Viewdata

The new world of TV using is expanding at the speed of light. To help you get the maximum profits from it. IPC Electrical - Electronic Press has launched a brand-new quarterly: **Viewdata and TV User.**

Issue No. 1 explained in clear, non-technical terms how Viewdata works and how it differs from Teletext. It covered Prestel (the Post Office Viewdata System) in detail. It also reviewed a wide range of news and products. Subsequent issues are covering the developing story of Viewdata, Teletext, home video cassette recording, TV screen games, home computers and every other aspect of TV using, and how it can benefit you. Each issue of Viewdata and TV User will contain the current Prestel directory, and will be available to all Prestel users free of charge. To others, the annual subscription is £2.00. Not much for a journal which could be your passport to a whole new world of interest. Post this coupon, with your cheque, today!

...you could use a new journal!

AND TV USER
Viewdata

Quarterly
Editorial enquiries: Owen Ascroft (editor)
Advertisement enquiries: Stewart Goodwin
at Dorset House, Stamford Street, London SE1 9LU. Tel: 01-261 8000

TO TAKE IT REGULARLY, POST THIS COUPON NOW.

To: Subscriptions Dept.
IPC Business Press (S. & D.) Ltd.
Oakfield House, Perrymount Rd.
Haywards Heath, Sussex

Please send me Viewdata and TV User quarterly for a year. I enclose cheque/P.O. for £2.00 (inc. post and package) made payable to IPC Business Press Limited.

Name . . . .

Address . . . .

. . . .

. . . .

. . . .

. . . .

. . . .

we wondered why....

The B.B.C., British Rail, B.A.C., Decca Acoustics, Institute of Sound and Vibration Research, I.C.L., Post Office Telecommunications, Philips Research, U.K. Atomic Energy Authority, and many Universities were among our customers.

Maybe they liked the competitive prices of our modules, or the fact that all modules have a frequency response from 20Hz to 22kHz – 0.2dB, a slewing rate of 8 volts per microsecond, input sensitivity of 0dB (0.775V), a damping factor greater than 400 to 1kHz and a total harmonic distortion less than 0.055% at 1kHz.

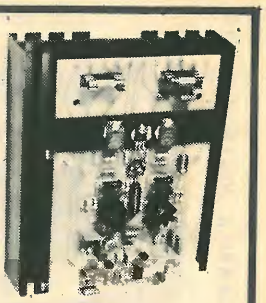
Or could it be that they went for the reliability and the comprehensive protection circuitry. Then there is the full 2 year guarantee which accompanies our range of modules.

OR PERHAPS .... THEY JUST LIKED THE SOUND OF US!

J.P.S. 60 : 60 Watt.
J.P.S. 100 : 100 Watt.
J.P.S. 150 : 150 Watt.

Power supplies available to suit all modules. Send for further information on our range of pre amplifier modules. JPS products are now stocked at the distributors shown below. Further information on all products available direct from JPS Associates or via reader reply service.

All modules are made in the United Kingdom



J.P.S. ASSOCIATES
(ASTONKILN LTD.)
BELMONT HOUSE
STEELE ROAD
PARK ROYAL
LONDON NW10 7AR
Tel: 01-961 1274/5

DENMARK
T.S.RADIO
Bakkegardsvej 36
3300 Frederiksvaerk,
Denmark.
Tel. (03) 12 07 39
Mr. Ole Juul-Moller.

BELGIUM
Studelek Elektronika
Tiensestraat 260
3000 Leuven Belgium
Tel (016) 234554
Contact Mr Leo Swinnen

ENGLAND Midlands
CROXFORD CUSTOM EQUIP.
64 London Road,
Leicester
Tel. 0533 538465
Mr Phil Croxford.

ENGLAND West
SEVERNSIDE AUDIO & LTG
29 The Promenade
Gloucester Road,
Bristol BS7 8TZ.
Tel. 0272 41666
Mr. Peter Hannay.

ENGLAND South
R.E.W. AUDIO VISUAL
126 Charing Cross Road,
London,
W.C.2.
Tel. 01 836 2372
Mr. John Cowan.

SCOTLAND
ATMOSPHERE LTG. & SOUND
57 Nelson Street,
Aberdeen,
Scotland.
Tel. 0224 572905
Mr. Keith Main.

WW — 075 FOR FURTHER DETAILS

ASTRA-PAK

92 GODSTONE ROAD, WHYTELEAFE, SURREY CR3 0EB

GRAND SALE

All prices **include** VAT. Add 25p for P.&P (Extra for overseas). Send SAE for complete Special Offers list. Where more than one price appears, overall quantity prices apply to groups of devices **of the same type** (74 and 74LS cannot be mixed).

	7400 SERIES			74LS00 SERIES		
	1+	25+	100+	1+	25+	100+
7400	.08	.075	.07	.155	.14	.13
7401	.11	.105	.10	.155	.14	.13
7402	.11	.105	.10	.155	.14	.13
7403	.11	.105	.10	.155	.14	.13
7404	.11	.105	.10	.16	.15	.135
7405	.12	.115	.11	.16	.15	.135
7406	.22	.21	.20			
7407	.22	.21	.20			
7408	.13	.125	.12	.155	.14	.13
7409	.13	.125	.12	.16	.15	.135
7410	.11	.105	.10	.155	.14	.13
7411	.17	.16	.15	.16	.15	.135
7412	.14	.135	.13	.16	.15	.135
7413	.23	.21	.20	.28	.26	.24
7414	.46	.43	.40	.65	.57	.50
7415				.16	.15	.135
7416	.22	.20	.18			
7417	.22	.20	.18			
7420	.11	.105	.10	.155	.14	.13
7421	.22	.21	.20	.16	.15	.135
7422	.17	.165	.16	.16	.15	.135
7423	.20	.19	.18			
7425	.20	.19	.18			
7426	.21	.20	.19	.16	.15	.135
7427	.21	.20	.19	.16	.15	.135
7428				.18	.17	.16
7430	.11	.105	.10	.155	.14	.13
7432	.21	.20	.19	.23	.20	.18
7433	.30	.27	.26			
7437	.20	.19	.18	.24	.21	.185
7438	.20	.19	.18	.24	.21	.185
7440	.12	.115	.11	.18	.16	.15
7441	.48	.45	.43			
7442	.40	.36	.34	.50	.44	.40
7443	.65	.60	.57			
7444	.64	.59	.56			
7445	.53	.50	.48			
7446	.55	.52	.50			
7447	.50	.44	.40	.67	.60	.56
7448	.55	.50	.48	.82	.73	.65
7449				.67	.60	.56
7450	.12	.115	.11			
7451	.12	.115	.11	.16	.15	.135
7453	.12	.115	.11			
7454	.12	.115	.11	.155	.14	.13
7455				.16	.15	.135
7460	.12	.115	.11			
7470	.25	.23	.21			
7472	.22	.20	.18			
7473	.23	.21	.20	.26	.23	.21
7474	.23	.21	.20	.26	.23	.21
7475	.30	.28	.26	.40	.35	.32
7476	.26	.24	.23	.26	.23	.21
7478				.28	.25	.23
7480	.40	.36	.34			
7483	.52	.48	.46	.59	.55	.52
7484	.84	.80	.77			
7485	.62	.58	.55	.67	.60	.56
7486	.22	.20	.19	.28	.25	.23
7489	1.35	1.25	1.18			

	7400 SERIES			74LS00 SERIES		
	1+	25+	100+	1+	25+	100+
7490	.30	.28	.26	.42	.38	.36
7491	.60	.55	.52			
7492	.33	.30	.28			
7493	.28	.25	.23	.43	.40	.38
7494	.50	.45	.42			
7495	.50	.45	.42	.64	.58	.55
7496	.48	.42	.38			
7497	1.80	1.70	1.65			
74100	.80	.72	.68			
74104	.40	.36	.34			
74105	.37	.34	.32			
74107	.22	.20	.18	.32	.28	.28
74109	.28	.26	.24	.32	.28	.25
74110	.36	.34	.32			
74111	.55	.52	.50			
74112				.32	.28	.25
74113	.28	.26	.24	.32	.28	.25
74114				.32	.28	.25
74116	1.10	1.00	.95			
74118	.78	.75	.72			
74119	1.10	1.00	.95			
74120	.80	.76	.74			
74121	.24	.22	.20			
74122	.32	.29	.27			
74123	.38	.35	.32	.55	.50	.48
74124	1.60	1.50	1.42	1.15	1.05	.98
74125	.32	.30	.28	.38	.33	.29
74126	.32	.30	.28	.38	.33	.29
74128	.60	.55	.52			
74130	.40	.36	.32			
74132	.47	.44	.42	.62	.56	.48
74134	.32	.30	.28			
74135	.62	.58	.55			
74136	.52	.48	.46	.38	.33	.29
74137	.74	.68	.66			
74138				.52	.45	.41
74139				.52	.45	.41
74141	.52	.48	.46			
74142	1.85	1.75	1.68			
74143	2.30	2.10	2.00			
74144	2.30	2.10	2.00			
74145	.55	.50	.48			
74147	1.00	.92	.88			
74148	.84	.78	.75			
74150	.60	.55	.50			
74151	.46	.41	.38	.50	.44	.40
74153	.46	.41	.38	.48	.42	.36
74154	.78	.68	.60	1.00	.90	.82
74155	.50	.46	.44	.75	.67	.60
74156	.50	.46	.44	.75	.67	.60
74157	.45	.40	.38	.44	.40	.38
74158	.55	.52	.48	.50	.44	.40
74159	1.95	1.80	1.70			
74160	.57	.52	.48	.90	.84	.75
74161	.50	.44	.40	.60	.53	.48
74162	.57	.52	.48	1.10	1.00	.92
74163	.57	.52	.48	.60	.53	.48
74164	.57	.52	.48	.82	.75	.70
74165	.57	.52	.48			
74166	.70	.64	.59			

	7400 SERIES			74LS00 SERIES		
	1+	25+	100+	1+	25+	100+
74167	2.20	2.05	1.95			
74168				1.60	1.40	1.25
74169				1.60	1.40	1.25
74170	1.20	1.10	1.00	1.50	1.28	1.12
74172	3.80	3.55	3.40			
74173	.90	.84	.80	.85	.80	.76
74174	.64	.60	.56	.58	.52	.49
74175	.58	.54	.51	.58	.52	.49
74176	.58	.54	.51			
74177	.56	.52	.49			
74178	.90	.80	.75			
74179	1.08	1.00	.95			
74180	.80	.70	.62			
74181	1.15	.95	.80			
74182	.52	.47	.44			
74184	1.25	1.08	1.00			
74185A	1.00	.90	.88			
74186	7.20	6.90	6.70			
74188	2.60	2.40	2.25			
74189				1.98	1.75	1.60
74190	.68	.60	.55	.72	.65	.58
74191	.68	.60	.55	.70	.63	.56
74192	.62	.55	.48	.68	.62	.58
74193	.60	.50	.46	.68	.62	.58
74194	.58	.50	.46			
74195	.58	.50	.46	1.00	.92	.85
74196	.56	.50	.45	.78	.71	.65
74197	.50	.44	.40	.92	.83	.78
74198	.96	.85	.78			
74199	.98	.90	.85			
74221	1.20	1.00	.88	.94	.85	.80
74247				.90	.82	.75
74248				.90	.82	.75
74249				.90	.82	.75
74251	1.00	.82	.74	.58	.52	.48
74257				.68	.50	.56
74258				.68	.56	.50
74266				.33	.28	.25
74273	1.90	1.70	1.55	2.00	1.85	1.50
74279	1.10	.90	.82	.46	.40	.34
74283	1.50	1.30	1.20	.58	.53	.50
74284	3.50	3.20	3.00			
74289				3.75	3.45	3.28
74290				.52	.48	.45
74293	1.20	1.00	.80	.80	.72	.65
74298	1.80	1.55	1.40	.90	.82	.75
74252				.84	.75	.70
74253				.92	.85	.80
74365				.44	.40	.38
74366				.44	.40	.38
74367	1.10	.85	.70	.44	.40	.38
74368				.44	.40	.38
74386				.34	.30	.28
74390	1.70	1.40	1.25			
74393	1.75	1.45	1.25			
74670			–	1.60	1.40	1.30

Mixed prices apply for quantity discount

CMOS

	1+	25+	100+
4000	.13	.11	.10
4001	.13	.12	.11
4002	.13	.12	.11
4006	.70	.62	.58
4007	.13	.12	.11
4008	.58	.52	.48
4009	.32	.29	.27
4010	.36	.32	.30
4011	.13	.12	.11
4012	.13	.12	.11
4013	.30	.25	.22
4014	.68	.62	.56
4015	.60	.55	.52
4016	.32	.28	.26
4017	.50	.46	.44
4018	.55	.50	.47
4019	.40	.35	.32
4020	.68	.64	.60
4021	.66	.62	.58
4022	.60	.55	.52
4023	.13	.12	.11
4024	.42	.39	.36
4025	.13	.12	.11
4026	.90	.84	.78
4027	.30	.27	.25
4028	.46	.42	.40
4029	.52	.47	.44
4030	.32	.28	.26
4031	1.80	1.60	1.48
4032	.86	.80	.77
4033	1.05	.98	.92
4034	1.60	1.40	1.25
4035	.98	.90	.86
4036	2.50	2.35	2.25
4037	.82	.76	.72
4038	.84	.78	.74
4039	2.30	2.18	2.10
4040	.62	.57	.54
4041	.70	.64	.58
4042	.50	.45	.42
4043	.56	.51	.48
4044	.62	.58	.55
4045	1.05	.95	.88
4046	.90	.85	.80
4047	.84	.79	.75
4048	.42	.38	.36
4049	.28	.26	.24
4050	.28	.26	.24
4051	.54	.49	.46
4052	.54	.49	.46
4053	.58	.52	.48
4054	.92	.87	.84
4055	.92	.87	.84
4060	.92	.87	.84
4066	.36	.32	.30
4067	2.45	2.20	2.05
4068	.18	.16	.14
4069	.14	.13	.12
4070	.14	.13	.12
4071	.14	.13	.12

	1+	25+	100+
4072	.14	.13	.12
4073	.14	.13	.12
4075	.14	.13	.12
4076	.82	.78	.75
4077	.38	.35	.32
4078	.14	.13	.12
4081	.14	.13	.12
4082	.14	.13	.12
4085	.58	.54	.52
4086	.58	.54	.52
4089	1.20	1.08	1.00
4093	.45	.40	.38
4094	1.38	1.25	1.15
4095	.85	.80	.77
4096	.85	.80	.77
4097	3.00	2.80	2.67
4098	.90	.84	.78
4099	1.10	.95	.88
4160	.88	.83	.80
4161	.88	.83	.80
4162	.88	.83	.80
4163	.88	.83	.80
4164	.88	.83	.80
4174	.98	.92	.87
4175	.98	.92	.87
4194	.98	.92	.87
4501	.14	.13	.12
4502	.72	.66	.63
4503	.52	.46	.43
4506	.42	.36	.34
4507	.42	.36	.34
4508	1.90	1.68	1.50
4510	.60	.54	.50
4511	.65	.58	.55
4512	.62	.56	.53
4513	1.42	1.30	1.20
4514	2.35	2.20	2.08
4515	2.35	2.20	2.08
4516	.66	.60	.56
4517	3.40	3.15	3.00
4518	.65	.58	.55
4519	.38	.36	.34
4520	.62	.56	.53
4521	1.40	1.25	1.10
4522	.80	.70	.63
4526	.80	.70	.63
4527	1.15	1.00	.90
4528	.85	.76	.70
4529	.98	.84	.75
4530	.82	.78	.74
4531	.74	.66	.60
4532	.95	.86	.80
4534	4.00	3.50	3.25
4536	2.75	2.35	2.15
4538	1.00	.90	.82
4539	.72	.60	.54
4541	.90	.81	.70
4543	1.10	.97	.88
4549	3.00	2.50	2.25
4553	3.20	2.80	2.40

	1+	25+	100+
4554	.90	.78	.68
4555	.75	.62	.56
4556	.75	.62	.56
4557	3.20	2.80	2.40
4558	.90	.80	.72
4559	3.00	2.50	2.20
4560	1.45	1.20	1.05
4561	.62	.55	.50
4562	4.20	3.60	3.25
4566	.98	.86	.80
4568	1.70	1.50	1.38
4569	1.37	1.15	1.05
4580	4.20	3.65	3.40
4581	1.98	1.67	1.40
4582	.82	.74	.68
4583	.70	.60	.52
4584	.30	.27	.25
4585	.88	.78	.70
4599	1.98	1.70	1.50

LOW PROFILE DIL I.C. SOCKETS

8 pin	.10	.09	.08
14 pin	.115	.11	.205
16 pin	.125	.12	.115
18 pin	.18	.16	.15
20 pin	.20	.18	.17
22 pin	.22	.20	.19
24 pin	.24	.22	.21
28 pin	.28	.25	.23
40 pin	.40	.37	.35

LEDS

		.125"	3mm
RED	.08	.07	.06
YELLOW	.12	115	.11
GREEN	.12	115	.11
		.2"	5mm
RED	.09	.08	.07
YELLOW	.13	.125	.12
GREEN	.13	125	.12

Mix colours and sizes for qty. prices
FND107 Red 7 segment display .25" .90
TIL111 Opto isolator .75

STAR OFFER

*100	741-8	.16
*100	555-8	.19
*100	MC1458P	.24
*100	AD161/162 MP	.50
*100	BC184	.06
*100	BC214	.062
*100	2N3055	.35
1000	.125" Red Led	.05
1000	.2" Red Led	.06
1000	IN4001	.025
1000	IN4002	.028
1000	IN4005	.038
1000	IN4007	.042
1000	IN4148	.013
*1000 LESS 10%		

LINEARS

CA3045-14	.30
CA3046-14	.40
LM380N-14	.68
LM381N-14	.90
LM710N-14	.26
LM711N-14	.26
MC1310P-14	1.30
NE555-8	.23
NE556-14	.50
NE2501B-14	1.25
SN75110N	.40
SN76003N	1.65
SN76013N	1.25
SN76023N	1.25
SN76033N	1.65
TAA550B	.30
TAA661B	1.00
TBA120S	.58
TBA641A	1.60
TBA800	.60
TABA810S	.80
TBA820S	.75
TCA270SQ	1.70
TDA2020	3.00
ZN414	.90

OP-AMPS

CA3130-TD99	.80
LM301A-8	.24
LM348-14	.90
LM702-14	.42
LM709-8	.36
LM709-14	.37
LM709-T009	.38
LM741-8	.18
LM741-14	.15
LM741-T099	.38
LM747-14	.40
LM3900N-14	.40
MC1458P-8	.28

VOLTAGE REGULATORS

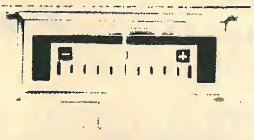
LM300H-T099	.70
LM309K-T03	1.10
uA723-14	.32
7805 T0220	.52
7812 T0220	.52
7815 T0220	.52
7824 T0220	.52
7905 T0220	.72
7912 T0220	.72
7915 T0220	.72

MEMORY

TMS 4030 (2107A) 2.50
4 off less 10%
8 off less 20%

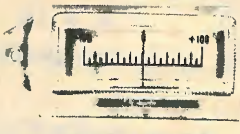
WW—107 FOR FURTHER DETAILS

PANEL INDICATORS

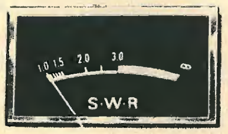


Model SV041

Model SV018



Model SV235



Model SV042

Model SV023

40 DIFFERENT MODELS AVAILABLE

Servo and Electronic Sales

24 HIGH STREET, LYDD, KENT TN29 9AJ
Telephone: Lydd (0679) 20252
Telex: 965265 AB Servoe G

ELECTRONIC KITS OF DISTINCTION FROM POWERTRAN

DE LUXE EASY TO BUILD LINSLEY-HOOD 75W AMPLIFIER

AVAILABLE AS SEPARATE PACKS
PRICES IN OUR FREE CATALOGUE

SPECIAL PRICE FOR COMPLETE KIT £99.30

The standard model of our kit for Mr. Linsley-Hood's 75 watt design has for a long time offered exceptional performance at a very modest cost with high quality high power ready-built units of comparable quality generally being over three times the price.

Features of the amplifier include very low distortion (less than 0.01%), 75W rms per channel power output, rumble filter, variable slope scratch filter, variable transition frequency tone controls, tape monitoring facilities and individually adjustable inputs. This model is based on 5 circuit boards which not having the controls mounted on them can, if desired, be effectively used separately in high performance audio systems not based on our metalwork.

Our new De Luxe model uses 14 boards which interconnect with gold plated contacts and are designed to have the potentiometers and switches mounted upon them. This system almost eliminates internal wiring, making installation, after their assembly, delightfully straightforward, and as each board can be easily removed in seconds from the chassis, checking and maintenance is so simple that even newcomers to electronics will be able to cope competently with the kit. Additional features of our new model are inclusion of the latest circuit improvements, generously sized heat sinks for heavy duty use, even in tropical climates, and metal oxide resistors throughout for long-term stability and reliability.

Pack	Price
1. Fibreglass printed circuit board for power amp	£1.15
2. Set of resistors, capacitors, pre-sets for power amp	£2.50
3. Set of semiconductors for power amp	£6.50
4. Pair of 2 drilled, finned heat sinks	£1.10
5. Fibreglass printed-circuit board for pre-amp	£1.90
6. Set of low noise resistors, capacitors, pre-sets for pre-amp	£4.10
7. Set of low noise, high gain semiconductors for pre-amp	£2.40
8. Set of potentiometers (including mains switch)	£3.50
9. Set of 4 push-button switches, rotary mode switch	£5.40
10. Toroidal transformer complete with magnetic screen/ housing primary: 0 117-234 V: secondaries: 33-0-33 V, 25-0-25 V	£12.95
11. Fibreglass printed-circuit board for power supply	£0.85
12. Set of resistors, capacitors, secondary fuses, semiconductors for power supply	£5.40
13. Set of miscellaneous parts including DIN skts., mains input skt., fuse holder, interconnecting cable, control knobs	£6.20
14. Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.	£8.20
15. Handbook	£0.30
16. High Quality Teak Veneer cabinet 18.3" x 12.7" x 3.1"	£10.70

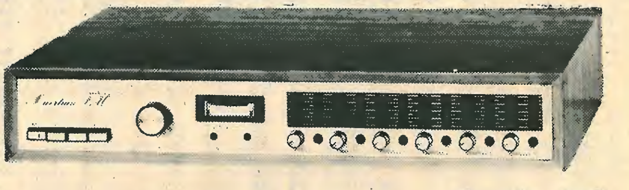
2 each of packs 1-7, 1 each of packs 8-16 inclusive are required for complete stereo amplifier. Total cost of individually purchased packs £92.80

PACK PRICES FOR STANDARD KIT

STANDARD LINSLEY-HOOD 75W AMPLIFIER

SPECIAL PRICE FOR COMPLETE KIT £79.80

WIRELESS WORLD FM TUNER

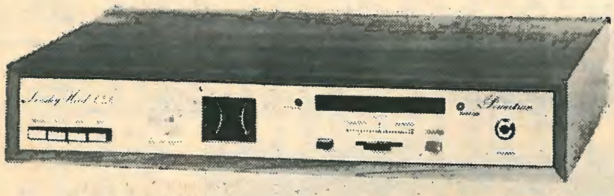


Designed in response to demand for a tuner to complement the world-wide acclaimed Linsley-Hood 75W Amplifier, this kit provides the perfect match. The Wireless World (Skingley and Thompson) published original circuit has been developed further for inclusion into this outstanding slimline unit and features 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.

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

SPECIAL PRICE FOR COMPLETE KIT £70.20

LINSLEY-HOOD CASSETTE DECK



SPECIAL PRICE FOR COMPLETE KIT £79.60

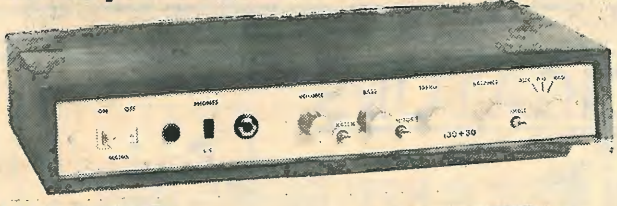
Pack	Price
1. Stereo PCB (accommodates 2 rep. amps, 2 meter, amps, bias/erase osc. relay)	£3.35
2. Steren set of capacitors, M.D. resistnrs, potentiometers for above	£7.95
3. Stereo set of semiconductors for above	£8.50
4. Miniature relay with socket	£2.90
5. PCB, all components for solenoid, speed control circuits	£3.80
6. Goldring-Lenco mechanism as specified	£18.50
7. Function switch, knobs	£1.90
8. Dual VU meter with illuminating lamp	£6.95
9. Toroidal transformer with E.S. screen prim. 0-117V, 234V. Sec. 15V	£4.90
10 Set of capacitors, rectifiers, I.C. voltage regulator P.C.B. for power supply (Powertran design)	£2.80
11. Set of miscellaneous parts, including sockets, fuse holder, fuses, interconnecting wire, etc	£3.40
12. Set of metalwork including silk screened fascia panel, internal screen, fixing parts, etc	£7.10
13. Construction notes	£0.25
14. High Quality Teak Veneer cabinet 18.3" x 12.7" x 3.1"	£10.70

One each of packs 1-14 inclusive are required for complete stereo cassette deck. Tntal cost of individually purchased packs £83.00

Matsushita WY 436 AZ head (optional extra) . £4.50
(free with compete kit)

Published in Wireless World (May, June, August 1976) by Mr. Linsley-Hood, this design, although straightforward and relatively low cost, nevertheless provides a very high standard of performance. To permit circuit optimization separate record and replay amplifiers are used, the latter using a discrete component front-end designed such that the noise level is below that of the tape background. Pushbutton switches are used to provide a choice of equalization time constants, a choice of bias levels and also an option of using an additional pre-amplifier for microphone use. The mechanism used is the Goldring-Lenco CRV, a unit distinguished in its robustness and ease of operation. Speed control and automatic cassette ejection are both implemented by electronic circuitry. This unit which is powered by a toroidal transformer and uses metal oxide resistors throughout offers an excellent match for the Wireless World Tuner and the Linsley-Hood 75 Watt Amplifier. Circuit changes as published in February, 1978, follow-up article are included in the kit AT NO EXTRA COST! A higher performance head (Matsushita WY 436 AZ head as recommended in the follow-up article) is offered as an optional extra but this will be automatically supplied FREE OF CHARGE with all orders for complete kits!

T20+20 AND 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 rms per channel of true Hi-Fi at exceptionally low cost. The **easy to build** 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 headphones 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 model is 30W rms per channel.

SPECIAL PRICES FOR COMPLETE KITS

T20+20 KIT PRICE £33.10

T30+30 KIT PRICE £38.40

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

WWII TUNER

SPECIAL PRICE FOR COMPLETE KIT £47.70

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

Following the success of our **Wireless World FM Tuner Kit** this cost reduced model was designed to complement the **T20+20** and **T30+30** amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either.

POWERTRAN SFMT TUNER

PRICE FOR COMPLETE KIT £35.90

AVAILABLE AS COMPLETE KIT ONLY

This is a simple, low cost design which can be constructed easily without special alignment equipment but which still gives a first-class output suitable for feeding any of our very popular amplifiers or any other high quality audio equipment. A phase-locked-loop is used for stereo decoding and controls include switchable afc, switchable muting and push-button channel selection (adjustable by controls on the front panel). This unit matches well with the **T20+20** and **T30+30** amplifiers.

ASCENSION ISLAND YUGOSLAVIA UNITED STATES OF AMERICA JORDAN GREECE INDIA GUYANA PORTUGAL FALKLAND ISLANDS UNITED ARAB EMIRATES JAMAICA HOLLAND KENYA

EIRE GRENADA SAUDI ARABIA NEW ZEALAND NORWAY SINGAPORE ICELAND SWEDEN MALAYA INDONESIA BRAZIL SWITZERLAND ZAMBIA GIBRALTAR CHILE SPAIN

200 + 200 watt AMPLIFIER

As featured in Electronics Today International

400W rms continuous —— 800W peak!
0.03% THD at FULL power!
PLUS all the following features too!

- ★ Each channel totally independent with its own stabilised power supply driven by custom designed TOROIDAL transformers!
- ★ Inherent reliability — monster heat sinks for cool running at the hottest venues — electronic open and short circuit protection!
- ★ Ultra low feedback (an incredible low 14dB overall!), super high slewing rate (20V/µs), 200W rms continuous to 4 ohm from EACH channel, input sensitivity 0.775V (0dB).
- ★ Professional quality components, sturdy 19" rack mounting chassis complete with sleeve and feet for free standing work too.
- ★ Easy to build — plenty of working space with ready access to all components, minimal wiring, extensive instruction suitable for both experienced constructors and newcomers to electronics.
- ★ Value for money — quality and performance comparable with ready-built amplifiers costing over £600!

PSI 4002 STUDIO MODEL

Cabinet size 17.2" x 6.7"

COMPLETE KIT ONLY £196.90 + VAT

READ THE REVIEW
IN SOUND INTERNATIONAL DEC 78!

TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

As featured in Electronics Today International

The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibre glass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!

COMPLETE KIT ONLY £172.00 + VAT!

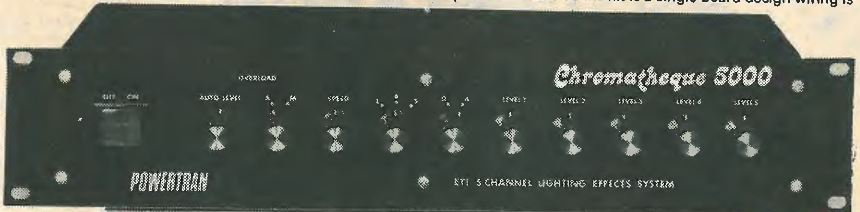
Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more than a multi-meter and a pair of ears!

CHROMATHEQUE 5000 5-CHANNEL LIGHTING EFFECTS SYSTEM

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control setting or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

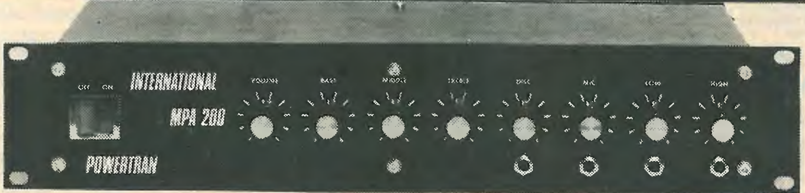
Kit includes fully finished metalwork, fibreglass PCB, controls, wire, etc. — Complete right down to the last nut and bolt!

COMPLETE KIT ONLY £49.50 + VAT



MPA200 100W MIXER/ AMPLIFIER

READ ALL ABOUT IT IN FEB. 1979 ELECTRONICS TODAY INTERNATIONAL!



Wireless World Designs: Full kits are not available for the projects below but PCBs and component sets are stocked. Further details of these and other packs are in our Free Catalogue.

30W Bailey Amplifier

BAIL Pk. 1	F/Glass PCB	£1.00
BAIL Pk. 2	Resistors, Capacitors	£2.35
BAIL Pk. 3	Semiconductors	£4.70

Linsley-Hood Low Distortion Oscillator.

LDO Pk. 1	Fibreglass PCB	£1.65
LDO Pk. 2	MO Resistors, capacitors	£2.60
LDO Pk. 3	Semiconductors	£3.90

E. F. Taylor Pre-Amplifier

EFTP Pk. 1	Fibreglass PCB (stereo)	£1.45
EFTP Pk. 2	MO Res, caps. (stereo)	£3.20
EFTP Pk. 3	Semiconductors (stereo)	£4.20

Details of Stuart Tape Recorder and SQ Quadraphonic Decorders are in FREE CATALOGUE

All kits also available as separate packs (eg PCB component sets, hardware sets, etc). Prices in our FREE CATALOGUE.

EXPORT A SPECIALITY!

Our Export Department can readily despatch orders of any size to any country in the world. Some of the countries to which we sent kits last year are shown in this advertisement. To assist in estimating postal costs our catalogue gives the weights of all packs and kits. This will be sent free on request, by airmail, together with our "Export Postal Guide" which gives current postage prices. There is no minimum order charge. Prices same as for U.K. customers but no Value Added Tax charged. Postage charged at actual cost plus 50p documentaton and handling. Please send payment with order by Bank Draft, Postal Order, International Money Order or cheque drawn on an account in the U.K. Alternatively for orders over £500 we will accept Irrevocable Letter of Credit payable at sight in London.

Value Added Tax not included in prices
UK Carriage FREE

PRICE STABILITY: Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until February 28th, 1979, if this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.

U.K. ORDERS: Subject to 12½% * surcharge for VAT (i.e. add ⅛ to the price). No charge is made for carriage. *or current rate if charged.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

SALES COUNTER: If you prefer to collect your kit from the factory, call at Sales Counter (at rear of factory). Open 9 a.m.-4.30 p.m. Monday-Thursday.

QUALITY: All components are brand new first grade full specification guaranteed devices. All resistors (except where stated as metal oxide) are low noise carbon film types. All printed circuit boards are fibreglass, drilled roller tinned and supplied with circuit diagrams and construction layouts.

FOR FURTHER INFORMATION PLEASE WRITE OR TELEPHONE FOR OUR FREE CATALOGUE

POWERTRAN ELECTRONICS

PORTWAY INDUSTRIAL ESTATE
ANDOVER HANTS SP10 3NN

ANDOVER
(0264) 64455

AUSTRIA CZECHOSLOVAKIA SOUTH AFRICA FINLAND NIGERIA LUXEMBOURG TUNISIA GERMANY NAURU HONG KONG AUSTRALIA GAMBIA DENMARK FRANCE MUSCAT & OMAN

NEW GUINEA ISRAEL GUERNSEY CYPRUS BELGIUM UGANDA BRUNEI TRINIDAD SOUTH WEST AFRICA ITALY JAVA SIERRA LEONE WINDW

AUTOMATIC STANDBY INVERTERS

These units incorporate a transistorised inverter circuit, internal control relay that switches on a trickle 12v battery charger while the public power supply is maintained and automatically switches on the inverter restoring a 240v AC mains supply in the event of public power failure.
All units are assembled in strong durable instrument cases with ventilation slots, grade one new components are used throughout.
Features include: Five second charge to invert switchover period. Trickle charge rated 12v dc 500ma. SILICON POWER TRANSISTORS. DC Line Fused/AC supply fused. Neon-panel charge indicator. Inverter operating neon indicator, 13-amp type inverter outlet socket. Regulated 50Hz, smoothed and filtered inverter output waveform.
Installation is made simply by plugging in the AC lead to a normal domestic power socket, connect the two dc leads to a 12v car type battery and finally connect any electrical item you want to operate if there is a power cut into the unit's front panel inverter outlet socket.

ACE/1 — Cased assembly 6½" x 4½" x 4½". 240v AC 50Hz 150 watts out.	**£38.50**
ACE/2 — Cased assembly 6½" x 4½" x 4½". 240v AC 50Hz 200 watts out.	**£46.73**
ACE/3 — Cased assembly 8½" x 5½" x 5½". 240v AC 50Hz 250 watts out.	**£55.90**
ACE/4 — Cased assembly 10½" x 6½" x 6½". 240v AC 50Hz 300 watts out	**£70.87**
ACE/5 — Cased assembly 10½" x 6½" x 6½". 240v AC 50Hz 400 watts out	**£91.00**
ACE/6 — Cased assembly 12½" x 7½" x 7½". 240v AC 50Hz 450 watts out	**£108.75**
ACE/7 — Cased assembly 16½" x 9½" x 12½". 240v AC 50Hz 700 watts out	**£158.90**

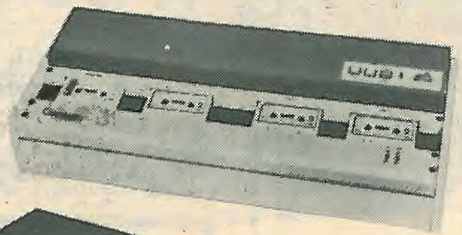
Please add £5 per unit carriage U.K., overseas at cost
Callers strictly by appointment. Telephone enquiries 01-736 0685

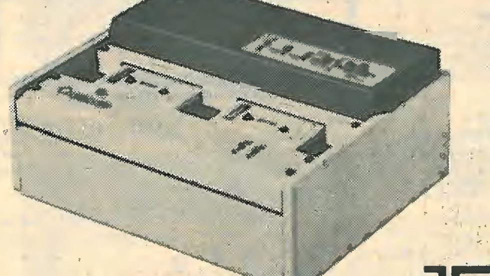
ELECTROVANCE
P.O. BOX 191, LONDON SW6 2LS

NEW! Cassette copiers from PENTAGON

Simple operation - fully automatic 16 times speed.
Choice of one or three copies. C32/34— outproduces all other makes — 75 C60 per hour.
Budget Price from £587 + VAT

Model C32S— Mono C34S— Stereo





Model C-1— Mono C-4— Stereo

PENTAGON from ITA

**1-7 Harewood Avenue, Marylebone Road
London NW1. Tel. 01-724 2497. Telex: 21879**

WW — 074 FOR FURTHER DETAILS

PRECISION DIAL GAUAGES John Bull No. 6 series 1. 01mm. £6 P.P. 50p
COAXIAL CRYSTAL DETECTORS. (Marconi-Saunders), 200 MHZ-12 GHZ. £7.50 (Diode S9B £1.50).
FIBREGLASS COPPER-CLAD BOARD
9x4½x1/16in. 40p P&P 10p
9x6x1/16in. 50p P&P 15p
9x4½x1/16in. (double sided) 50p P&P 10p
9x6x1/16in. (double sided) 65p P&P 10p
15x15x1/16in. (double sided) £2.50 P&P 50p

OFF-CUT PACKS. 150 sq. ins. £1 P.P. 25p.

P.A.R. BI-STABLE RELAYS. 24v d.c. 4 c/o £1 P.P. 15p.

PLUG-IN RELAYS 240v a.c. 10 amp contacts
3 pole c/o (11 pin) £1 P.P. 15p
2 pole c/o.(8 pin) 85p P.P. 15p

U.H.F. COAXIAL CABLE (white) Double screened.
Lab. quality 100m. drum £10 p.p. £1.50.

MULTICORE CABLES

4 CORE RIBBON (RAINBOW) CABLE 4 — 10/.2m.m.
Forming ¼in. wide strip. 10m—75p' 50m—£3; 100m—£6. P&P 1p per metre.
10 CORE CABLE 10 x 7/76 (10 colours) P.V.C.
O.D. 7m.m. 10m—£2. 50m—£8.50. 100m—£16. P&P 2p per metre
12 CORE SCREENED CABLE 12 x 14/76 with outer screen—P.V.C. covered. O.D. 9m.m.
10m—£4. 50m—£18.50. 100m—£35. P&P 2p per metre

16 PAIR RIBBON CABLE 16x2 core P.V.C.
Double sheathed forming 2in wide strip
10m—£3; 50m—£13.50; 100m—£25. P&P 2p per metre.

200 way TELEPHONE CABLE o.d. 12m.m. £1 per metre. P.P. 40p.

E.H.T. MODULES (resin encapsulated, in metal box)
i/p 240x.50hz. o/p 13.7 kv. @ 7 watts (150x95x72m.m.) £10 P.P. £1.

STABILISED POWER SUPPLIES input 120/240v. 50hz.
5-14 volts @ 6amp (pre-set) with manual £20 P.P. £2.
12-17 volts @ 6amp. variable £20 P.P. £2.

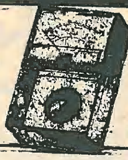
P.C. EDGE CONNECTORS
32 way (.1 pitch) finished end 49p P&P 10p
56 way (.1 pitch) cuttable 65p P&P 15p
64 way (.1 pitch) cuttable 75p P&P 15p
64 way gold plated pins 90p P&P 15p
Mounting pillars for 56/64 way 15p per pair.

'DRYFIT' RE-CHARGEABLE BATTERIES (Lead/Acid)
Ex. Equip. Good condition, tested.
6v @ .9 A.H. £1.25 P&P 35p
6v @ 2.6 A.H. £2.50 P&P 50p
6v @ 6 A.H. £3.50 P&P 75p
6v @ 7.5 A.H. £5.00 P&P 75p

J. B. PATTRICK

**191/193 London Road
Romford, Essex RM7 9DJ
Romford 44473**

SERVICE TRADING CO



WHY PAY MORE?!

MULTI RANGE METERS **Type MF15A.** A.C./D.C. volts 10. 50. 250. 500. 1000. Ma. 0-5. 0-10. 0-100. Sensitivity 2000V. 24 ranges, Dimensions 133 × 93 × 46mm. Price **£7.00** plus 50p P&P (**£8.10** inc. VAT & P).

TRIAC.

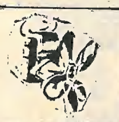
Raytheon tag symmetrical Triac. Type Tag 250/500v. 10 amp 500 piv. Glass passivated plastic triac. Swiss precision product for long term reliability **£1.25** P&P 10p (**£1.46** inc. VAT & P) (inclusive of date and application sheet). Suitable Diac **22p.**

0 to 60 MINUTES CLOCKWORK TIMER.

Double pole 15 amp 230AC. Contacts (no dial). **£1,50.** P&P 30p (**£1.94** inc. VAT & P). N.M.S.

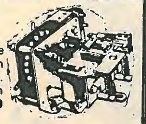
MERCURY SWITCH

Size 27m x 5mm. 10 for **£5.00,** P&P 30p. total including VAT **£5.72.** Min. quantity 10. N M S



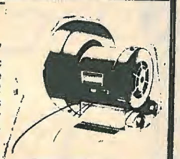
230 VOLT AC FAN ASSEMBLY

Powerful continuously rated AC motor complete with 5 blade 6½″ aluminium fan. New reduced price **£3.00** P&P 65p (**£3.94** inc. VAT & P). N.M.S.



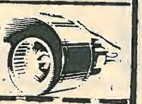
21-WAY SELECTOR SWITCH with reset coil

The ingenious electro mechanical device can be switched up to 21 positions and can be reset from any position by energising the reset coil. 230/240v. A.C. operation. Unit is mounted on strong chassis. Complete with cover. Price **£5.50** P&P 75p (**£6.75** inc. VAT & P). N.M.S.



VORTEX BLOWER AND VACUUM UNIT

Dynamically balanced totally enclosed 9″ rotor with max. air delivery of 1.5 cubic metres per min. Max. static pressure 600mm W.G. Suction or blow from 2 side-by-side 37mm I.D. circular apertures fitted to base of unit. Powerful continuously rated 115v a.c. motor mounted on alloy base with fixing facilities. Dimensions: Length 22cm x width 25cm x height 25cm. These units are ex-equipment but have had minimum use. Fully tested prior to despatch. Price **£12** + £1.50 P&P (**£14.58** inc. VAT & P). Suitable transformer for 230/240v a.c. **£6** + £1 P&P (**£7.56** inc. VAT & P).



CENTRIFUGAL BLOWER

Smith type FFB 1606 022 220/240v A.C. Aperture 10x4½cm overall size 16x14cm. Price **£3.75** P&P 75p (incl VAT **£4.85**). Other types available. S.A.E. for details N.M.S.

24V DC BLOWER UNIT

USA made. 24v D.C. 8 amp blower that operates well on 12v. 4 amp D.C. producing 30 cu. ft. min. at normal air pressure. Maximum housing dia. 110mm. Depth inc. motor 75mm. Nozzle length 19mm. dia. 22mm. Ideal for cooling mobile equipment, car, caravan, etc. **£4.50** P&P 75p. (£5.67 inc. VAT & P).

MINIATURE UNISELECTOR

12v. 11 way 4 bank (3 non-bridging, 1 homing) **£2.50** P&P 35p (**£3.08** inc. VAT & P).

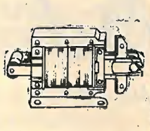
MICRO SWITCHES

Sub min lever m/switch type MML46, 10 for **£2.50.**

Type 3 115M 906T 10 for **£2.50** post paid (**£2.70** inc. VAT & P).

BF lever operated 20a. c/o. mf. Unimax USA. 10 for **£4.00** plus 50p P&P (min. order 10) (**£4.86** inc. VAT & P).

D.P. C/O lever m/switch, mfg. by Cherry Co., USA. Precious metal, low resistance contacts. 10 for **£2.50.** P&P 30p. Total inc. VAT **£3.02** (min 10). N.M.S.



NEW HEAVY DUTY SOLENOID

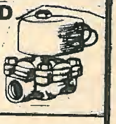
Mfg. by Magnetic Devices. 240v A.C. Operation approx. 10lb. pull at ⅝th in. Rating intermitant. Price **£4.00** P&P 60p (**£4.96** inc. VAT).

PYE EYTHER

240v A.C. Solenoid. Approx. 1 lb pull, ¼in travel, intermitant rating. Price **£1.00** P&P 20p (**£1.30** inc. VAT & P). N.M.S.

WESTOOL TYPE MM8 MODEL 2

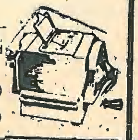
240V AC. Approx. 1¾ lb pull at ½ inch. Rating 1. Price **£1.50** P&P 20p (**£1.84** inc. VAT & P).



240 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 ½ in. b.s.p. inlet outlet. Precision made. British mfg.

PRICE **£3.50** Post 50p (**£4.32** inc. VAT & P). N.M.S.



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
£49.00 Post 80p (**£53.78** inc. VAT & P)
1000 VOLTS 1000 megohms
£55.00 Post 80p (**£60.26** inc. VAT & P)
SAE for leaflet.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230 v. A.C. 50/60

OUTPUT VARIABLE 0/260v. A.C.

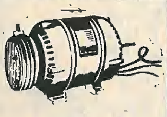
Carriage extra

BRAND NEW. All types.

200W (1 Amp) fitted A/C volt meter	**£14.50**
0.5 KVA (Max. 2½ Amp)	**£17.00**
1 KVA (Max. 5 Amp)	**£22.50**
2 KVA (Max. 10 Amp)	**£37.00**
3 KVA (Max. 15 Amp)	**£45.50**
5 KVA (Max. 25 Amp)	**£74.00**
10 KVA (Max. 50 Amp)	**£168.00**
17 KVA (Max. 75 Amp)	**£260.00**

LT TRANSFORMERS

0-10v-15v at 3 amp. (ex new equip) **£2.50** P&P 50p (**£3.24** inc. VAT)
13-0-13v at 1 amp **£2.50** P&P 50p (**£3.24** inc VAT)
25-0-25v at 2½ amp. **£4.50** P&P 75p (**£5.67** inc. VAT & P)
0-4v/6v/24v/32v at 12 amp. **£18.50** P&P £1.90 (**£22.03** inc. VAT & P)
0.6v/12v at 20 amp **£14.70** P&P £1.50 (inc. VAT **£17.50**)
0.-12v at 20 amp. or 0-24v at 10 amp. **£12.00** P&P £1.50 (**£14.58** inc. VAT & P)
0-6v/12v at 10 amp. **£8.25** P&P £1.25 (inc. VAT **£10.26**)
0-6v/12v/17v/18v/20v at 20 amp. **£18.00** P&P £1.50 (**£22.10** inc. VAT & P)
0.10v/17v/18v at 10 amp. **£10.50** p&p £1.50 (inc. VAT **£12.95**)
Other types in stock; phone for enquiries or send sae for leaflet.



ROTARY VACUUM AIR COMPRESSOR & PUMP

Carbon vane oil free vacuum pump and compressor. Approx. 20 inch vacuum, 10 PSI at 79 CFM. Powered by 110V a.c. 1.8 amp Parvalux motor fitted with additional shaft at rear, suitable light loads. Inc. capacitor **£14.00** P&P £1.50 (**£16.74** inc. VAT + P&P).

Suitable transformer for 230/240V a.c. operation **£5.00** P&P £1.00 (**£6.48** inc. VAT + P&P). N.M.S.

BLOWER/VACUUM PUMP

3 phase A.C. motor 220/250v or 380/440v, 1,425 rpm ⅛ hp cont. Direct coupled to William Allday Alcosa carbon vane blower/vacuum pump. 0.9 cfm 8 hg. Price **£22.00** P&P £2.00. (**£25.92** inc. vat +p). N.M.S.

STROBE! STROBE! STROBE!

HY-LIGHT STROBE KIT 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 **£19.00** post £1 (**£21.60** inc. VAT & P). Specially designed case and reflector for Hy-Light **£8.80** Post £1.00 (**£10.58** inc. VAT & P).

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft. 40 watt £8.70 (callers only). **2ft. 20 watt £6.20.** Post 75p. (£7.51 inc. VAT & P). (For use in stan bi-pin fittings). Mini **12in. 8 watt £2.80.** Post 35p (£3.40 inc. VAT & P). **9in. 6 watt £2.25** Post 35p (£2.81 inc. VAT & P). **6in. 4 watt £2.25** Post 35p (£2.81 inc. VAT & P).

Complete ballast unit. Either 6″, 9″ or 12″ tube 230V. A.C. op. **£3.50** plus P&P 45p (£4.27 inc. VAT & P). Also available for 12V. D.C. op. **£3.50** plus P&P 45p (£4.27 inc. VAT & P).

400w UV lamp and ballast complete **£31.50.** Post £3. (£37.26 inc. VAT & P.) 400w UV lamp only **£11.25** Post £1.20 (£13.45 inc. VAT & P.)

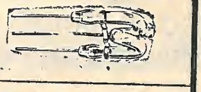
SQUAD LIGHT

A new conception in light control. Four channels each capable of handling 750 watts of spotlights 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 **£60.00** (£65.61 inc. vat +p)

S.A.E. (Foolscap) for further details. Post 75p

WIDE RANGE OF DISCO LIGHTING EQUIPMENT

S.A.E. (Foolscap) for details



XENON FLASH GUN TUBES

Range of Xenon tubes available from stock. S.A.E. for full details.

RELAYS

Wide range of AC and DC relays available from stock. Phone or write in your enquiries.

230/240V A.C. Relays: Arrow, 2 c/o. 15 amp **£1.50 (£1.84** inc. VAT & P).

T.E.C. open type 3 c/o. 10 amp **£1.10 (£1.40** inc. VAT & P). Omoron or Keyswitch 1 c/o, 7 amp **£1.00 (£1.30** inc. VAT & P).

D.C. Relays: Open type 9/12V 3 c/o 7 amp **£1.00** (**£1.30** inc. VAT & P). Sealed 12V 1 c/o 7 amp octal base, **£1.00** (**£1.30** inc. VAT & P). Sealed 12V 2 c/o 7 amp octal base, **£1.25 (£1.56** inc. VAT & P). Sealed 12V 3 c/o 7 amp 11-pin, **£1.35 (£1.67** inc. VAT & P). 24V. Sealed 3 c/o 7 amp 11-pin **£1.35 (£1.67** inc. VAT & P) (amps = contact rating). P&P on any Relay 20p.

Other types available — phone for details. N.M.S

Diamond H heavy duty A.C. relay 230/240V a.c., two c/o contacts 25 amps res at 250V a.c. **£2.50** P&P 50p. (**£3.24** inc. VAT + P&P). Special base **50p.**

VAT AT CURRENT RATE MUST BE ADDED TO ALL ORDERS FOR THE TOTAL VALUE OF GOODS INCLUDING POSTAGE UNLESS OTHERWISE STATED

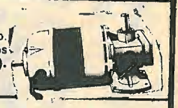
GEARED MOTORS

100 R.P.M. 115 lbs. ins.!!

115 lb. 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 115mm, ex-equipment tested **£12.00** Post £1.50 (**£14.58** inc. VAT & P). Suitable transformer 230/240 volt **£8.00** Post 75p (**£9.45** inc. VAT & P). R&T

GEARED MOTORS

28 r.p.m., 20lb. inch 115v a.c. Reversible motor.
71 r.p.m. 10 lb. inch. 115v a.c. Reversible motor.
Both types similar to above drawing. Price either type **£4.75** + 75p P&P. (**£5.94** inc. VAT + P&P)
Supplied with transformer for 240v a.c. operation **£7.25** + P&P £1. (**£8.91** inc. VAT + P&P).
N.M.S.



FRACMO MOTOR

56rpm 50lbs inch 240vAC reversible, 0.7 amp. sharplength 35mm, dia. 16mm, weight 6 kilos 600 grams. Price **£15.00** P&P £1.50 **(£17.82).** N.M.S.

PARVALUX MOTOR TYPE S.D.2

12v D.C. shunt 1/30th ph motor. Continuously rated 4000 rpm. Price **£10.00** P&P 75p (**£11.61** inc. VAT & P). N.M.S.

PARVALUX 230/250V a.c. MOTOR

Type SD18 240V AC reversible **30 rpm 50lbs** inch. Price **£15.00** P&P £1.50 (**£17.82** inc. VAT). N.M.S.

CITENCO

FHP motor type C 7333/15 220/240v A.C. 19 rpm reversible motor, torque 14.5 kg. Gear ratio 144:1. Brand new incl. capacitor, our price **£14.25** + £1.25 P&P (**£16.74** inc. VAT & P). N.M.S.

REVERSIBLE MOTOR 230V A.C.

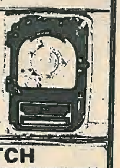
General Electric 230v A.C., 1,600 r.p.m. 0.25 amp. Complete with anti-vibration mounting bracket and capacitor. O/A size 110mm × 90mm. Spindle 5/16 dia. reversing. Ex-equipment tested **£3.00.** Post 50p (**£3.78** inc. VAT & P).

RODENE UNISET TYPE 71 TIMER

0-60 sec. 230V a.c. operation. Incorporating a lapsed time indicator and repeat facilities. A precision motorised timer ideal for process timing, photography, welding, mixing, etc. Price **£6** P.&P. 60p. (£7.13 inc. VAT & P). N.M.S.

METERS (New) — 90mm DIAMETER

A.C. Amp., Type 62T2. 0-1A., 0-5A., 0-20A. **A.C. Volt.** 0.150V., 0-300V. **D.C. Amp.,** Type 65C5. 0-2A., 0-10A, 0-20A. **D.C. Volt.** 0-15V, 0-30V. All types **£3.50** ea. + P&P 50p (**£4.32** incl. VAT). 0-50A D.C., 0-100A D.C. Price **£5.00** + 50p P&P (**£5.94** incl. VAT)

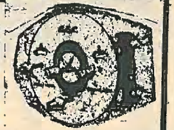


'VENNER TYPE' ERD TIME SWITCH

200/250V A.C. 30 amp. 2 on/2 off every 24 hrs. at any manually pre-set time, 36-hour spring reserve and day omitting device. Built to highest Electricity Board specification. Price **£7.75** P&P 75p. **(£9.18).** R & T.

SANGAMO WESTON TIME SWITCH

Type S251 200/250 V a.c. 2 on 2 off every 24 hours. 20 amps contacts with override switch, diameter 4″x 3″, price **£6.00** P&P 50p (**£7.02** inc. VAT & P). Also available with Solar dial. R & T.



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**). N.M.S.

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 **£2.40** Post 20p (**£2.81** inc. VAT & P). **50 WATT** 100, 250 ohm **£2.90** Post 25p (**£3.40** inc. VAT & P). **100 WATT** 1 / 5 / 10 / 25 / 50 / 100 / 250 / 500 / 1k / 1.5k / 2.5k / 5k ohm. **£5.90** Post 35p (**£6.75** inc. VAT & P).

Black Silver Skirted Knob calibrated in Nos. 1-9, 1½ in. dia brass bush. Ideal for above Rhosats, **24p ea.**

YET ANOTHER OUTSTANDING OFFER

New IMFD 600V Dubilier wire ended capacitors, 10 for **£1.50** P&P 50p. (**£2.16** inc. VAT + P&P). (Min 10). N.M.S.

N.M.S. — New Manufacturers' Surplus.
R & T — Reconditioned and Tested

ACCOUNT CUSTOMERS MIN. ORDER £10.00

ALL MAIL ORDERS, ALSO CALLERS AT:

57 BRIDGMAN ROAD, CHISWICK,
LONDON, W4 5BB. Phone: 01-995 1560
Closed Saturdays

SERVICE TRADING CO.

SHOWROOMS NOW OPEN
AMPLE PARKING

PERSONAL CALLERS ONLY

9 LITTLE NEWPORT STREET,
LONDON, WC2H 7JJ
Tel 01 437 0576

THE BRIDGE BETWEEN MANUFACTURERS & USERS OF MICROELECTRONICS

MICROSYSTEMS '79

West Centre Hotel,
Lillie Road, Fulham,
London, SW6
January 31 to
February 2
09.30-18.00 hrs each day

Now in its second great year, Microsystems is a combined conference and exhibition aimed at alerting industrialists and businessmen to the meaning of the microelectronic revolution.

Learn how to develop and use successfully the new microprocessor-based technologies. Hear a score of experts describe their design experiences and the latest products and development aids.
Find out what new skills are needed, what costs are incurred and how to maintain and test microprocessor-based systems.
Join the expanding group of small business and personal computing enthusiasts, and listen to their experience and advice.
Talk to over 60 leading firms who will show, in the exhibition, new products and ideas for the solution of business and technical problems.
The Exhibition is free. The Conference costs £55 + VAT for each of the first two, professional days (£95 + VAT for a two-day ticket), and £7 + VAT for the final, personal computing, day.

Microsystems is sponsored by 'Computer Weekly', 'Microprocessors', 'Data Processing', 'Electronics Weekly', 'Systems International', 'Electron', 'Electrical Times', 'Electrical Review' and 'Wireless World' and is organised for them by Iliffe Promotions Ltd, Dorset House, Stamford Street, London, SE1 9LU.

WW

USE THIS COUPON TO BOOK FOR MICROSYSTEMS

To: Microsystems, Room 821, Dorset House, Stamford Street, London, SE1 9LU.

Please send me: ☐ Conference details and registration forms ☐ A free exhibition ticket (Tick as required)

Name ....

Address ....

Marshall's Electronics

A. Marshall (London) Ltd., Dept: WW. Head Office mail order: Kingsgate House, Kingsgate Place, NW6 4TA. Tel: 01-624 0805
Retail Sales London: 40-42 Cricklewood Broadway, NW2 3ET. Tel: 01-452 0161/2. Telex: 21492. London: 325 Edgware Road, W2. Tel: 01-723 4242.
Glasgow: 85 West Regent Street, G2 2QD. Tel: 041-332 4133. Bristol: 1 Straits Parade, Fishponds Road, B516 2LX. Tel: 0272 654201.

POPULAR INTEGRATED CIRCUITS. (A very small selection from our vast stocks, please enquire about devices not listed.)

CA3018	**0.75**
CA3018A	**1.10**
CA3020	**2.20**
CA3020A	**2.50**
CA3028A	**0.90**
CA3028B	**1.25**
CA3030	**1.50**
CA3030A	**2.20**
CA3038	**2.90**
CA3038A	**4.10**
CA3045	**1.55**
CA3046	**0.77**
CA3048	**2.45**
CA3052	**1.78**
CA3080	**0.85**
CA3080A	**2.10**
CA3086	**0.50**
CA3088B	**1.87**
CA3089B	**2.90**
CA30900	**4.40**
CA3130	**1.06**
CA3140	**1.04**
LM301	**0.30**
LM307N	**0.50**
LM308N	**0.95**
LM309KC	**1.95**
LM317K	**3.35**
LM318N	**2.45**
LM320TS	**2.15**
LM320T12	**2.15**
LM320T15	**2.15**
LM320T24	**2.15**
LM320P5	**1.15**
LM320P12	**1.15**
LM320P15	**1.15**
LM320P24	**1.15**
LM323K	**6.95**
LM339N	**0.60**
LM340T5	**0.88**
LM340T15	**0.88**
LM340T24	**0.88**
LM341P5	**0.80**
LM341P12	**0.80**
LM341P15	**0.80**
LM341P24	**0.80**
LM348N	**0.95**
LM358N	**0.60**
LM360N	**3.00**
LM370N	**3.30**
LM371H	**2.35**
LM350K	**6.45**
LM373N	**3.35**
LM374N	**3.36**
LM377N	**1.80**
LM378N	**2.40**
LM379S	**4.25**
LM380N8	**0.96**
LM380N14	**1.08**
LM381AN	**2.70**
LM381N	**1.69**
LM382N	**1.32**
LM384N	**1.55**
LM386N	**0.88**
LM387N	**1.10**
LM388N	**1.00**
LM389N	**1.00**
LM702C	**0.81**
LM709	**0.70**
LM7098	**0.50**
LM70914	**0.49**
LM710	**0.67**
LM71014	**0.64**
LM711CN	**0.72**
LM723C	**0.75**
LM723C14	**0.45**
LM741C	**0.70**
LM741C8	**0.30**
LM741C14	**0.30**
LM747CN	**0.99**
LM7488	**0.50**
LM7814	**0.90**
LM1303N	**1.15**
LM1304N	**1.52**
LM1305N	**1.52**
LM1307N	**1.22**
LM1310N	**2.10**
LM1351N	**1.30**
LM1458N	**0.45**
LM1496N	**0.97**
LM1808N	**2.10**
LM1812N	**6.20**
LM1820N	**1.16**
LM1828N	**1.90**
LM1830N	**1.90**
LM1841N	**1.90**
LM1845N	**1.50**
LM1848N	**1.98**
LM1850N	**1.90**
LM1889N	**4.90**
LM3301N	**0.60**
LM3302N	**0.55**
LM3401N	**0.55**
LM3900N	**0.58**
LM3905N	**1.15**
LM3909N	**0.78**
LM3911N	**1.10**
LM7805K	**1.75**
LM7812K	**1.75**
LM7824K	**1.75**
LM78L05CZ	**0.30**
LM78L12CZ	**0.30**
LM78L15CZ	**0.30**
MM5314	**4.60**
MM5316	**4.60**
NE555	**0.33**
NE556	**0.85**
NE558N	**1.98**
NE560	**4.50**
NE561	**4.50**
NE562	**4.50**
NE565	**1.39**
NE566	**1.75**
NE567	**1.90**
NE571N	**4.95**
SAS560	**2.70**
SAS570	**2.70**
SAJ110	**2.10**
SO41P	**1.35**
SO42P	**1.35**
SN76001N	**1.30**
SN76003N	**2.38**
SN76013N	**1.50**
SN76023N	**1.50**
SN76033N	**2.35**
TAA263	**1.35**
TAA300	**3.70**
TAA320A	**1.15**
TAA350A	**3.00**
TAA521	**1.10**
TAA522	**2.10**
TAA550	**0.48**
TAA560	**2.10**
TAA570	**2.20**
TAA370A	**5.45**
TAA630	**2.40**
TAA960	**3.90**
TAA970	**4.20**
TAA611B	**2.50**
TAA621	**2.50**
TAA661A	**1.65**
TAA661B	**1.45**
TAA700	**4.50**
TAA930A	**1.45**
TAA930B	**1.45**
TAD100	**2.00**
TBA120	**0.80**
TBA500	**2.24**
TBA500Q	**2.34**
TBA510	**2.35**
TBA510Q	**2.48**
TBA520	**2.60**
TBA520Q	**2.70**
TBA530	**2.35**
TBA530Q	**2.45**
TBA540	**2.60**
TBA540Q	**2.70**
TBA550	**3.60**
TBA550Q	**3.80**
TBA5600Q	**3.00**
TBA570	**2.10**
TBA570Q	**2.20**
TBA700Q	**2.20**
TBA720AQ	**2.06**
TBA750	**2.36**
TBA750Q	**2.45**
TBA800	**1.30**
TBA810S	**1.30**
TBA820	**0.80**
TBA920	**2.99**
TCA160C	**2.36**
TCA160B	**2.55**
TCA270	**2.99**
TCA730	**4.50**
TCA740	**4.50**
TCA750	**3.00**
TCA760	**2.00**
TCA105	**1.49**
TCA440	**1.65**
TDA1022	**7.50**
TDA1024	**1.24**
TDA1034	**4.75**
TDA2020AD	**4.50**
UAA170	**2.15**
UAA180	**2.15**
TL080CP	**1.25**
TL081CP	**0.90**
TL082CP	**1.10**
TL083CN	**1.40**
TL084CN	**1.45**
LF355N	**0.80**
LF356N	**0.80**
LF357N	**0.80**
LF13201N	**3.00**
LF13331N	**3.00**
LF13741H	**0.80**
LF13741N	**0.55**
7400N	**0.17**
7401N	**0.17**
7402N	**0.17**
7403N	**0.17**
7404N	**0.17**
7405N	**0.22**
7406N	**0.56**
7407N	**0.55**
7408N	**0.22**
7409N	**0.22**
7410N	**0.20**
7411N	**0.26**
7412N	**0.20**
7413N	**0.36**
7414N	**0.80**
7416N	**0.36**
7417N	**0.36**
7420N	**0.22**
7423N	**0.32**
7425N	**0.32**
7427N	**0.32**
7430N	**0.22**
7432N	**0.30**
7437N	**0.35**
7438N	**0.32**
7440N	**0.20**
7441AN	**0.84**
7442N	**0.76**
7445N	**1.40**
7446AN	**0.90**
7447AN	**0.80**
7448N	**0.80**
7450N	**0.22**
7451N	**0.22**
7453N	**0.22**
7454N	**0.22**
7460N	**0.22**
7470N	**0.46**
7472N	**0.30**
7473N	**0.44**
7474N	**0.32**
7475N	**0.80**
7476N	**0.45**
7480N	**0.60**
7481N	**1.00**
7482N	**0.90**
7483N	**1.05**
7484N	**1.20**
7485N	**1.36**
7486N	**0.36**
7489N	**2.45**
7490AN	**0.45**
7491AN	**0.85**

ALL PRICES NOW INCLUDE VAT CORRECT AT 12.11.78

Our range covers over 8,000 items. The largest selection in Britain. Top 200 ICs, TTL, CMOS & LINEARS

MICROPROCESSOR SUPPORT CHIPS

RAM

2101-2	**£3.63**
2102-2	**£1.94**
2111-2	**£3.63**
2112-2	**£3.63**
2107	**£8.47**
2116	**£36.55**

ROM

1702AQ	**£8.10**
5204Q	**£11.00**
2708Q	**£13.00**
2716	**£40.00**

TRISTATE BUFFER

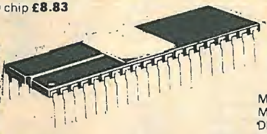
DM81L595	**£1.36**
DM81L596	**£1.36**
DM81L597	**£1.36**
DM81L598	**£1.36**

8080 SUPPORT

8224	**£4.58**
8228	**£5.85**
8212	**£3.10**
8216	**£2.60**
8226	**£2.60**
8253	**£11.38**
8254	**£4.50**
8255	**£6.27**
8250	**£8.99**
8251	**£8.18**

VAT INCLUSIVE PRICES

8154 RAM I/O chip **£8.83**



MICRO CHIPS

SC/MP1	**£12.96**
SC/MP11	**£10.80**
6800P	**£16.99**
8080A	**£7.42**
57109	**£12.75**
57180	**£10.25**
57161	**£10.25**

EXTRAS

MM5303	**£6.85**
MM5307	**£13.69**
DM8678	**£15.40**
AY32513	**£8.75**
AY3-1013 (TMS601 1NC)	**£5.35**

CONVERT TV SET TO VDU

The new CRT control chip from Thomson CSF SFF96364. Convert your TV set into an electronic VDU — 16 lines x 64 characters — requires RAM, character generator and little else for a basic VDU. Available as chip or full display card. Full cursor control, 5 volts TTL compatible, line erase, full card includes UART. Modem, Char, gen, etc. Comp video out from encoded keybd. in.

NEW
CHIP £17.20
FULL CARD £151

★ MAIL ORDER ★

Quick service on all orders — please add 40p for p&p to all orders. Telephone orders on credit cards £10.00 minimum.

DIL SKTS

Low profile IC skts

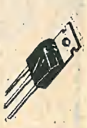
8 pin	**15p**	22 pin	**30p**
14 pin	**16p**	24 pin	**35p**
16 pin	**18p**	28 pin	**45p**
18 pin	**27p**	40 pin	**55p**

FULL RANGE OF

Capacitors
Resistors
Plugs/skts
Meters
Clocks
Diodes
Cables
Cases
In our new catalogue

TRIACS plastic pack 400v TO220
Texas

4 amp	**72p**	16 amp	**93p**
6 amp	**77p**	20 amp	**£1.87**
8 amp	**82p**	25 amp	**£2.20**
12 amp	**93p**		



THYRISTORS plastic power

4 amps	8 amps	12 amps
100v o 38	100v o 47	100v o 63
200v o 44	200v o 54	200v o 70
400v o 54	400v o 68	400v o 90

Branded Texas quality product

LEDS + OPTO

Displays 7 seg
Com anode or cath
Red

8mm HT	**£1.50**
10mm HT	**£1.55**
14mm HT	**£1.57**
18mm HT	**£1.85**

LEDS	Red	Gr	Yell
Small 3mm	**.18**	**.19**	**.19**
Large 5mm	**.20**	**.20**	**.20**
Extra Bright	**.40**	**.40**	**.40**
I/red LD271			**£0.55**
IR receiver			**£1.45**
Opto coupler			**£1.55**

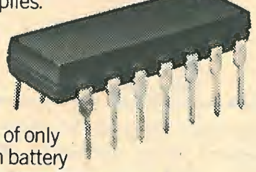
Full range + data in our '79 catalogue

NEW 1979 CATALOGUE

40 page catalogue — new enlarged micro section — largest range of quality components from franchised suppliers available in UK. All VAT inclusive prices. Over 8,000 line items plus lots more 50p post paid or 40p to callers at any of our four branches.

ZN1034 timer. Out on its own.

ZN1034 is a precision timer that can stand alone. It needs no special circuitry or special power supplies.



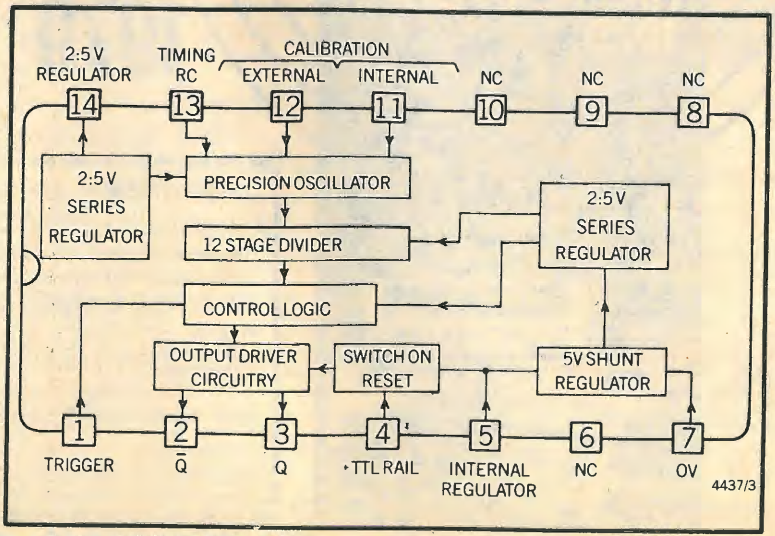
You can set any time—from milliseconds to months.

And with a current consumption of only 5mA it can be used in battery powered equipment, where it gives an output drive capability of 25mA.

ZN1034 is a true timer, not just a simple oscillator with an adjustable period.

Contact IC Marketing,
Ferranti Electronics Limited, Fields New Road,
Chadderton, Oldham OL9 8NP.
Tel: 061-624 0515.

FERRANTI Semiconductors



WW—119 FOR FURTHER DETAILS

OPTOELECTRONICS

RED	£0.10
GREEN	£0.19
YELLOW	£0.18

3mm

RED	£0.14
GREEN	£0.19
YELLOW	£0.18

5mm

DISPLAYS

HP5082-7730	£1.15
DL704	£1.15
FND507	£1.05
DL704 Economy	£0.75
DL707 Economy	£0.75

VOLTAGE REGULATORS

Plastic TO 220

Positive	
7805	£0.85
7612	£0.95
7815	£0.85
7824	£0.85
Negative	
7905	£1.19
7912	£1.19
7915	£1.19
7924	£1.19

Plastic TO 92

Positive	
78L05	£0.40
78L12	£0.40
78L15	£0.40
78L24	£0.40
Negative	
79L05	£0.50
79L12	£0.50
79L15	£0.50
79L24	£0.50

Linear

301	8 Pin DIL	£0.30
308	8 Pin DIL	£0.90
377	14 Pin DIL	£1.40
378	14 Pin DIL	£1.90
379	14 Pin DIL	£2.20
380	14 Pin DIL	£1.05
381	14 Pin DIL	£0.00
387	8 Pin DIL	£0.75
555	8 Pin DIL	£0.30
565	14 Pin DIL	£1.10
567	8 Pin DIL	£1.40
741	8 Pin DIL	£0.20
741	TO5	£0.25
748	8 Pin DIL	£0.35
3046	14 Pin DIL	£0.75
3130	8 Pin DIL	£0.95
3140	8 Pin DIL	£0.65
3140	TO5	£0.80
3900	14 Pin DIL	£0.60

RAM

2102 450 nSec. £1.40

74 Series TTL

7400	0.12	7473	0.27	74153	0.65
7401	0.12	7474	0.27	74154	1.05
7402	0.15	7475	0.33	74155	0.70
7403	0.12	7476	0.25	74156	0.70
7404	0.15	7480	0.50	74157	0.65
7406	0.25	7482	0.73	74160	0.70
7407	0.25	7483	0.60	74161	0.75
7408	0.14	7485	1.05	74162	0.75
7409	0.18	7486	0.30	74163	0.75
7410	0.12	7489	2.45	74164	0.85
7411	0.18	7490	0.34	74165	0.85
7412	0.20	7491	0.75	74166	1.25
7413	0.36	7492	0.45	74167	2.95
7420	0.12	7493	0.45	74173	1.45
7425	0.25	7494	0.90	74174	1.05
7427	0.25	7495	0.55	74175	0.90
7430	0.12	7496	0.55	74176	1.05
7432	0.27	74100	1.35	74177	0.95
7437	0.27	74104	0.45	74180	1.10
7438	0.27	74105	0.45	74181	2.10
7440	0.12	74107	0.35	74182	1.20
7441	0.49	74121	0.30	74185	2.10
7442	0.50	74122	0.40	74190	1.05
7445	0.60	74123	0.52	74191	1.05
7446	0.60	74125	0.45	74192	0.95
7447	0.55	74126	0.55	74193	0.95
7448	0.50	74132	0.65	74194	0.95
7450	0.12	74136	0.75	74195	0.95
7451	0.15	74141	0.60	74196	0.95
7453	0.15	74145	0.70	74197	0.95
7460	0.15	74150	0.90	74198	1.95
7472	0.27	74151	0.55	74199	1.95

C-MOS

4000	0.16	4016	0.40	4046	1.35
4001	0.16	4017	0.90	4047	0.95
4002	0.16	4018	0.90	4049	0.50
4007	0.16	4022	0.90	4050	0.50
4010	0.45	4023	0.20	4060	1.15
4011	0.15	4024	0.80	4066	0.70
4012	0.15	4025	0.20	4069	0.25
4013	0.36	4027	0.55	4070	0.25
4014	0.90	4928	0.75	4076	0.20
4015	0.90	4029	1.00	4502	0.95
		4033	1.25	4507	0.60
		4040	1.00	4508	2.00
		4042	1.75		

C7205EN MULTITESTER 20,000 OPV

£9.75
P&P 75p

AC volts:	0 to 10, 50, 250, 1000
DC volts:	0 to 5, 25, 125, 500, 1000
DC current:	0 to 50 ua, 250 ma
Resistance:	0 to 300 ohms, 6K, 30K 6 meg ohms
Decibels:	— 20 to + 22 db
Size:	115 × 78 × 33mm

IT 1/2 20,000 OPV

£11.95
P&P 75p

AC volts:	0 to 10, 50, 100, 500, 1000
DC volts:	0 to 5, 25, 50, 250, 500, 2500
CD current:	0 to 50 ua, 2.5 ma, 250 ma
Resistance:	0 to 6K ohms, 6 meg ohms
Decibels	—20 to + 22 db
Capacitance:	10 pf, 0.01 uf, 0.1 uf
Size:	4½ × 3¼ × 1 inch

TMK500 MULTITESTER 30,000 OPV

£20.95
P&P 75p

A sturdy and reliable instrument. Has internal buzzer.

AC volts:	0 to 2.5, 10, 25, 100, 250, 500, 1000
DC volts:	0 to 0.25, 1, 2.5, 10, 25, 100, 250, 1000
DC current:	0 to 50 ua, 5 ma, 50 ma, 12 amp.
Resistance:	0 to 6K, 60K, 6 meg, 60 meg.
Decibels:	— 20 to + 56 db
Short test:	Internal buzzer
Size:	160 × 110 × 55mm

LB1 TRANSISTOR/DIODE TESTER

£19.95
P&P 75p

Tests 1CO, Alpha and Beta. Measures parameters of transistors so that readings can be checked against manufacturers specification. Quick Test socket mounted on front panel. Full view meter for accuracy and easy reading.

Dims.: 178 × 108 × 83mm

TE20D R.F. SIGNAL GENERATOR

£57.00
P&P £1.25

Accurately covers 120 KCS. To 500 MCS in 6 bands.
Directly calibrated. Variable R.F. Attenuator. 240v AC.
Dimens: 140 × 215 × 170mm

LT101, 1,000 OPV

£6.95
P&P 75p

AC volts:	0 to 10, 50, 250, 1000
DC volts:	0 to 10, 50, 250, 1000
DC current:	0 to 1 ma, 100 ma
Resistance:	0 to 3K ohms 0 to 150K ohms
Size:	2 x 3½ x 1 inch

20p P&P unless otherwise shown
All prices include V.A.T.

ELECTRO-TECH COMPONENTS LTD.

364 EDGWARE ROAD, LONDON, W.2. TEL: 01-723 5667
CALLERS WELCOME

YOUR GUIDE TO GOOD LISTENING

Hi-Fi Year Book is firmly established as the annual reference to just about everything the quality hi-fi market has to offer. The 1979 edition is better than ever: over 450 pages of products and photographs—separated into the major categories of equipment—giving you descriptions, prices, specifications, who makes it, where to buy it . . . everything you need to know. And this information is backed by authoritative articles on the latest hi-fi developments and their application. So if you want a reliable guide to the latest and best hi-fi products available, order your copy today because it sells out pretty quickly.

HI-FI YEAR BOOK 1979

Available direct from the publishers @ £3.50 inclusive or from leading booksellers and newsagents price £3.00.

ORDER FORM To: General Sales Manager, Room CP34, IPC Business Press Ltd., Dorset House, Stamford Street, London SE1 9LU.

Please send me........copy/copies of Hi-Fi Year Book 1979 @ £3.50 a copy inclusive, remittance enclosed. Cheque/p.o. should be made payable to IPC Business Press Ltd.

NAME...
(please print)
ADDRESS...
....
....

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

U.K. RETURN OF POST MAIL ORDER SERVICE, ALSO WORLDWIDE EXPORT SERVICE

BSR DE LUXE AUTOCHANGER

£17.50 Post £1

Plays 12", 10" or 7" records, Auto or Manual. A high quality unit backed by BSR reliability. Stereo Ceramic Cartridge. AC 200/250V. Size 13½-11¼in. 3 speeds. Above motor board 3¾in. Below motor board 2½in. with Ceramic Stereo/Mono cartridge.

BSR Budget Autochanger with stereo cartridge, plays all size records **£14.95**

HEAVY METAL PLINTHS ONLY

Cut out for most BSR or Garrard decks. Silver grey finish. Post £1.00

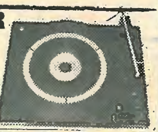
Model "A" Size 14½ x 12½ x 3in. **£3.50**

Model "B" Size 16 x 13¾ x 3in. **£4.50**

TINTED PLASTIC COVERS ONLY

Sizes: 14½ × 12½ × 4¼in. **£3.** 17½ × 14 × 4in. **£4.50.** 15¼ × 13½ × 4in. **£3.75.** 15 × 13½ × 3in. **£3.50.** 17¼ × 9½ × 3½in. **£3.** Post £1. 14½ × 14¾ × 2½in. Rosewood sides **£4.** Ideal for record decks, tape decks, etc.

BSR SINGLE PLAYER

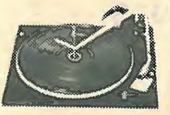


Ideal replacement or disco deck with cueing device and stereo ceramic cartridge. 3 speeds. Large turntable, modern design

£19.50 Post £1

BSR P182 3 speeds flared aluminium turntable "S" shape arm, cueing device, ceramic cartridge **£22.50.** BSR MP60/P128 Stereo Ceramic, balanced arm, cueing device. Bias compensator **£24.50.** Magnetic **£5** extra.

GARRARD HI-FI AUTO CHANGER Model 5-300



3-speed stereo cartridge. **£14.95**

Cueing devices Post £1

SMITH'S CLOCKWORK 15A TIME SWITCH

0-6 HOURS £3.30 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.

ELAC HI-FI SPEAKER 8in. TWIN CONE

Large ceramic magnet. 50-16,000 c/s. Bass resonance 40 c/s. 8 ohm impedance. 10 watts. RMS. **£5.95** Post 35p

20 watt model **£8.95** Post 45p

LOW VOLTAGE POWER PACK for MODELS

Ready made. Famous make. Will supply 10 volts D.C. at 400mA. With terminals and mains lead. **£2.50** Post 50p

VOLUME CONTROLS

5kΩ to 2MΩ LOG or LIN L/S **35p.** D.P. **60p.** Stereo L/S **85p** D.P. **£1.** Edge 5K. S.P. Transistor **45p.**

80 Ohm Coax

FRINGE LOW LOSS **15p** yd.

PLUGS **10p.** SOCKETS **10p.**

LINE SOCKETS **25p**

OUTLET BOXES **80p**

300 ohm FEEDER **5p** yd.

EMI 13½ x 8in. LOUDSPEAKERS

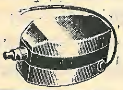
With tweeter and crossover. 10 watt. 3 or 8 ohm. **£8.95** Post 45p

With tweeter and crossover. 15 watts, 8 ohm. **£10.50** Post 65p

With tweeter and crossover. 20 watt. **£11.50** 8 or 15 ohm. 20 to 20,000 c.p.s. Post 75p

Suitable Bookshelf Cabinet Teak finish. For EMI 13 x 8 speakers. Size 16 x 11 x 8 inches approximately. **£8.50** Post £1.00

THE "INSTANT" BULK TAPE ERASER



Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/250V. Leaflet S.A.E. Will also demagnetise small tools **Head Demagnetiser only £4.75.** **£5.50** Post 50p

RELAYS. 12V D.C. **95p.** 6V D.C. **85p.** 240V A.C. **95p.**

BLANK ALUMINIUM CHASSIS. 6 x 4—**95p;** 8 x 6—**£1.40;** 10 x 7—**£1.55;** 12 x 8—**£1.70;** 14 x 9—**£1.90;** 16 x 6—**£1.85;** 16 x 10—**£2.20.** **ANGLE ALI.** 6 x ¾ x ¾in—**15p.**

ALUMINIUM PANELS. 6 x 4—**24p;** 8 x 6—**38p;** 14 x 3—**40p;** 10 x 7—**54p;** 12 x 8—**70p;** 12 x 5—**44p;** 16 x 6—**70p;** 14 x 9—**94p;** 12 x 12—**£1;** 16 x 10—**£1.16.**

PLASTIC AND ALI BOXES IN STOCK. MANY SIZES

VARICAP FM TUNER HEAD with circuit & connections. Some technical knowledge required **£4.95.**

TAG STRIP 28-way **12p.**

TAPE OSCILLATOR COIL. Valve type, **35p.**

BRIDGE RECTIFIER 200V PIV ½ amp **50p.** 8 amp **£2.50.**

TOGGLE SWITCHES S.P. **30p.** D.P.S.T. **40p.** D.P.D.T. **50p.**

MANY OTHER TOGGLES IN STOCK. Please enquire.

PICK-UP CARTRIDGES ACOS, GP91 **£1.50.** GP94 **£2.50.**

SONOTONE stereo **£2.00.** **ADASTRA** magnetic **£6.**

WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt **15p.**

CASSETTE MOTOR. 6 volt **£1.00**

RCS SOUND TO LIGHT KIT Mk. 2

£17 Post 35p

Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel. Suitable for home use. Easy to build. Full instructions supplied. Cabinet **£4** extra. Will operate from 200MV to 100 watt signal.

R.C.S. 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 2½ x 1½in. Please state voltage required. **£2.95** Post 45p

R.C.S. POWER PACK KIT

12 VOLT, 750mA. Complete with printed circuit board and assembly instructions. 12 VOLT 300mA KIT, **£3.15.** **£3.35** 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 9½ x 3 x 2in. approx. S.A.E. details. Full instructions supplied. A.C. mains powered.

R.C.S. DRILL SPEED CONTROLLER/LIGHT DIMMER KIT.

Easy to build kit. Printed circuit Will control up to 480 watts AC mains **£3.25** Post 35p

R.C.S. STEREO PRE-AMP KIT. All parts to build this pre-amp. Inputs for high, medium or low imp per channel, with volume control and P.C. Board **£2.95**

Can be ganged to make multi-way stereo mixers Post 35p

MAINS TRANSFORMERS	ALL POST 75p.
250-0-250V 70mA, 6.5V, 2A	**£3.45**
250-0-250V 80mA, 6.3V 3.5A, 6.3V 1A	**£4.60**
350-0-350V 80mA, 6.3V 3.5A, 6.3V 1A	**£5.80**
300-0-300V 120mA, 2×6.3V 2A C.T.; 5V 2A	**£8.50**
220V 45mA, 6.3V 2A	**£1.75**
HEATER TRANSFORMER. 6.3V ½ amp **£1.50** 3 amp	**£1.75**
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs	
2 amp. 3,,4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V	**£5.30**
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	**£5.30**
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	**£8.50**
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	**£11.00**
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	**£14.50**

12V, 100mA	**£1.00**	20V, 40V, 60V, 1 amp	**£3.50**
12V, 750mA	**£1.30**	12V, 3 amp	**£2.95**
10-0-10V 2amp	**£2.45**	10V, 30V, 40V, 2 amp	**£2.75**
30V, 5 amp and 17V-0-17V, 2 amp	**£3.45**	40V, 2 amp	**£2.95**
0, 5, 8, 10, 16V, ½ amp	**£1.95**	20V, 1 amp	**£2.20**
9V, 3 amp	**£2.75**	20V-0-20V, 1 amp	**£2.95**
25-0-25V 2 amp	**£3.50**	30V-0-30V, 2 amp	**£7.00**
30V, 2 amp	**£3.00**	2 of 18V, 6 amp, each	**£9.00**
30V, 1½ amp	**£2.75**	12-0-12V, 2 amp	**£2.95**
		9V, ¼ amp	**£1.30**

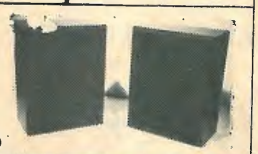
AUTO TRANSFORMERS, 115V to 230V or 230V to 115V 150W **£5.00**
250W......**£6.00.** 400W......**£7.00** 500W......**£8.00**

FULL WAVE BRIDGE CHARGER RECTIFIERS.
6 or 12V outputs, 2 amp.....**75p.** 4 amp.....**£1.25**

CHARGER TRANSFORMERS: 1½ amp.....**£3.50.** 4 amp.....**£6.50.**

12V, 1½ amp Half Wave Selenium Rectifier **25p**

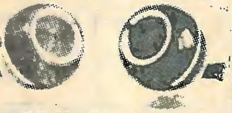
COMPACT SPEAKERS



Teak or White 13 × 10 × 6in. approx. 50 to 14,000 cps. 10 watts. 4 or 8 ohms.

£16 pair Post £1.30

EXTENSION SPEAKERS £3.95 ea.



Globe shaped cases in high gloss mouldings of red or green, are finished with chrome frontal trim and provided with screw-on rubber inset protective bases. In addition, 2½ metres of strong lead already fitted with phono plug is supplied. Full Range Quality Frequency Response Impedance: 8 ohms Power Peak: 5 watts

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;** 420mF/500V **£1.30.**
2500mF 50V **62p;** 3000mF 25V **47p;** 50V **65p.**
3900mF 100V **£1.60.** 4700mF 63V **£1.20.** 2700mF/76V **£1.**
5000mF 6V **25p;** 12V **42p;** 35V **85p.** 5600mF/76V **£1.75**

HIGH VOLTAGE ELECTROLYTICS

8/350V	**22p**	8+8/450V	**50p**	50+50/300V	**50p**
16/350V	**30p**	8+16/450V	**50p**	32+32/450V	**75p**
32/500V	**75p**	16+16/450V	**50p**	100+100/275V	**65p**
50/350V	**50p**	32+32/350V	**50p**	150+200/275V	**70p**

MANY OTHER ELECTROLYTICS IN STOCK

SHORT WAVE 100pF air spaced gangable tuner, **95p.**

TRIMMERS 10pF, 30pF, 50pF, **5p.** 100pF, 150pF, **15p.**

CERAMIC, 1pF to 0.01mF, **5p.** Silver Mica 2 to 5000pF, **5p.**

PAPER 350V-0.1 **7p;** 0.5 **13p;** 1mF 150V **20p;** 2mF 150V **20p;** 500V-0.001 to 0.05 **12p;** 0.1 **15p;** 0.25 **25p;** 0.47 **35p.**

MICRO SWITCH SINGLE POLE CHANGEOVER 20p.

SUB-MIN MICRO SWITCH, 25p. Single pole change over.

TWIN GANG, 385 + 385pF **50p;** 500pF standard **75p.** 365 + 365 + 25 + 25pF, Slow motion drive **65p.** 120pF **TWIN GANG, 50p;** 365pF **TWIN GANG, 50p.**

NEON PANEL INDICATORS 250V. Amber or red **30p.**

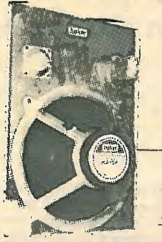
RESISTORS. 10Ω to 10M. ¼W, ½W, 1W, 20% **2p;** 2W, **10p.**

HIGH STABILITY. ½W 2% 10 ohms to 1 meg., **12p.** Ditto 5%. Preferred values 10 ohms to 10 meg., **5p.**

ELECTRO MAGNETIC PENDULUM MECHANISM 95p

Post 30p. 1.5V DC operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or metronome, strobe, etc.

BAKER MAJOR 12" £15



Post £1.00

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 4 or 8 or 16 ohms must be stated.

Module kit, 30-17,000 c/s with tweeter, crossover, baffle and instructions. **£20** Post £1.60 each

Please state 4 or 8 or 16 ohms.

"SALE" BAKER "BIG-SOUND" SPEAKERS. Post £1

'Group 25'	'Group 35'	'Group 50/15'
12in 30W **£12** 4 or 8 or 16 ohm	12in. 40W **£14** 4 or 8 or 16 ohm	15in. 75W **£33** 8 or 16 ohm

BAKER LOUDSPEAKER, 12 INCH. 60 WATT.
GROUP 50/12, 4 OR 8 OR 16 OHM HIGH POWER.
FULL RANGE PROFESSIONAL QUALITY.
RESPONSE 30-16,000 CPS
MASSIVE CERAMIC MAGNET
WITH ALUMINIUM PRESENCE CENTRE DOME.
£21 Post £1.60

TEAK VENEERED HI-FI SPEAKERS AND CABINETS

For 13x8in. or 8in. speaker **£8.50** Post £1
For 6½in. speaker and tweeter 12x8x6in. **£5.95** Post 75p
Many other cabinets in stock. Phone your requirements.

SPEAKER COVERING MATERIALS. Samples Large S.A.E.

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 socket. Produced by demand for a quality valve amplifier. 100V line output to order £10 extra. Send for leaflet. Suitable carrying cab **£16.50** Price **£99** carr. £6.00

Horn tweeters 2-16kc/s. 10W 8 ohm or 16 ohm **£3.60.** Audax Tweeters 3-18kc/s. 50W 8 ohm **£7.50.**

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 OHM 7x4in. **£1.50;** 6½in., **£1.95;** 8x5in., **£1.90;** 8in., **£2.50.**

SPECIAL OFFER: 80 ohm. 2¼in., 2¾in., 35 ohm, 3in., 25 ohm, 2½in., 3in., 5x3in., 7x4in., 8 ohm, 2½in., 3in., 3½in., 5in., 15 ohm, 3½in. dia, 6x4in., 7x4in., 5x3in., 3 ohm., 2½in., 2⅝in., 3½in., 5in. dia. **£1.50 each.**

PHILIPS LOUDSPEAKER, 8in., 4 ohms, 4 watts, **£1.95**

RICHARD ALLAN TWIN CONE LOUDSPEAKERS 8in. diameter 4W **£2.50.** 10in. diameter 5W **£2.95;** 12in. diameter 6W **£3.50.** 3/8/15 ohms, please state.

MOTOROLA PIEZO ELECTRIC HORN TWEETER. £7.95 Handles up to 100 watts. No crossover required

BLACK PLASTIC CONSTRUCTION BOX with brushed aluminium facia. Sturdy job. Size 6¼ x 4¾ x 2in. **£1.50**

BAKER 150 WATT PROFESSIONAL MIXER AMPLIFIER

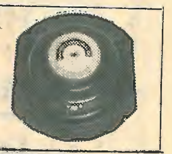
All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 4 8/16 ohms. A.C. Mains. Separate treble and bass controls. Master volume control. 100 volt line model **£99** **£79** £1.50 carr.

BAKER 50 WATT AMPLIFIER £59

Post £1

Superior quality ideal for Halls, PA systems, Discos and Groups. Two inputs with Mixer Volume Controls, Master Bass, Treble and Gain Controls. 50 watts RMS. Three loudspeaker outlets 4, 8, 16 ohm. AC 240V (120V available). Blue wording on black cabinet

GOODMANS COMPACT 12-INCH BASS WOOFER



Standard 12in. diameter fixing with cut sides 12" x 10". 14.000 Gauss magnet. 20 watts R.M.S. 4 ohm imp. Bass resonance = 30 c.p.s. Frequency response 30-8000 c.p.s. **£9.95 each** Post £1

ALUMINIUM HEAT SINKS. FINNED TYPE. Sizes 5" × 4" × 1" **95p.** 6½" × 2" × 2¼" **65p.**

JACK PLUGS. Plastic 25p; Metal 30p.

JACK PLUGS Stereo Plastic 30p; Metal 35p.

JACK SOCKETS. Open 20p; Closed 25p.

JACK SOCKETS Stereo Open 25p; Closed 30p.

FREE SOCKETS — Cable end 30p.

2.5mm and 3.5mm JACK SOCKETS 15p.

2.5mm and 3.5mm JACK PLUGS 15p.

DIN TYPE CONNECTORS

Sockets 3-pin, 5-pin 10p. Free Sockets 3-pin, 5-pin 25p.

Plugs 3-pin 20p; 5-pin 25p.

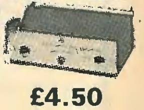
PHONO PLUGS and SOCKETS ea. 10p.

Free Socket for cable end ea. 15p.

Screened Phono Plugs ea. 15p.

TV CONVERGENCE POTS **15p each**
Values = 5, 7, 10, 20, 50, 100, 200, 250, 470, 2000 ohms.

MONO PRE-AMPLIFIER. Mains operated solid state pre-amplifier unit designed to complement amplifiers without low level phono and tape input stages. This free-standing cabinet incorporates circuitry for automatic R.I.A.A. equalisation on magnetic phono input and N.A.B. equalisation for tape heads.



£4.50 Post 50p

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON

Open 9-6. Closed all day Wed. Open Sat. 9-5.

Radio Books and Components Lists 20p. (Minimum posting charge 30p.) Cash prices include VAT. (We accept Access or Barclaycard. Phone your Order) **Tel. 01-684 1665**

COMPUTER APPRECIATION

86 High Street, Bletchingley, Redhill, Surrey RH1 4PA. Tel: Godstone (0883) 843221

GENERAL AUTOMATION Model SPC 12 Minicomputer with 8K x 16 memory & expander box. **£1250.00**
PDP 8/M PROCESSOR with 4K core, M18E Bootstrap ROM, KL8E teletype interface & KP8E powerfail detect. **£625.00.**
PDP 8/F SYSTEM with 16K core KE8E extended arithmetic option, KP8E, KL8E, MR8E Bootstrap & twin TU56 Dectape. Immaculate condition with very low hours. **£2900.00.**
PDP 8 SYSTEM with Model 580 tape drive & software, & type 533 Graphics Display Unit. **£625.00.**
INTERSIL 'INTERCEPT' IM6100 Prototyping System, PDP 8E compatible microprocessor system with 4K & full programmers panel. **£850.00.**
DATA DYNAMICS Model ASR 33 Teletype with RS 232 interface. NEW. **£575.00.**
TELETYPE ASR 33, 20 mA interface & reader control. **£425.00.**
TELETYPE Model KSR 33 ex ICL 1900. Needs 500 mA drive current. **£150.00.**
TELETYPE Model KSR 33 with case & time-unit by MOORE REED. **£225.00.**
OLIVETTI Model 328 Terminal with correspondence-quality upper/lower case character set & tape reader/punch. Interface is not 20mA as supplied, but can be made TTY compatible by circuit using 2N3055 & 2 resistors. (Details available). **£175.00.**
ITEL Model 1021 Terminal. Based on IBM Model 72 Selectric ("Golfball") typewriter. With RS 232 interface & correspondence-quality print out. **£250.00.**
ICL Model 250 high speed (250 cps) optical paper tape reader. With photocell amplifiers & facility to stop on a character. **£68.00.**
ICL/ELLIOTT 250 cps tape reader. As above, but earlier version. **£45.00.**
DIGITRONICS High Speed optical tape reader with TTL output. **£225.00.**
TELETYPE (WESTREX) Model BRPE 1133 paper tape punch. 110 cps. BRAND NEW. **£150.00.**
DATA DYNAMICS high speed paper tape copier comprising TELETYPE BRPE 110 punch & TELETYPE reader. Copies tapes at 110 cps. Voltage levels are converted to TTL in both directions. **£275.00.**
REPCO Model 120 matrix printer, 120 cps. Parallel TTL unit, electrosensitive paper. Compact desk-top unit. **£150.00.**
DATA PRODUCTS Model 2310 LINE PRINTER. 300 lines per minute drum printer with £ sign. In immaculate condition with very low hours. **£850.00.**
LOGABAX Model LX180 high speed matrix printer with upper/lower case characters. 180 cps. As new. **£675.00.**
PERTEC TAPE DRIVES. Most models available. **£250-£495.**
PERTEC Model 6840.7.25 Tape Drive & Control for NOVA 1200. BRAND NEW. **£750.00.**
WEIR Model DTM 1000 digital test set. Measures Volts A.C. & D.C., resistance, frequency & interval coincidence between paired inputs. NEW. **£125.00.**
MUIRHEAD PICTURE TRANSMISSION EQUIPMENT. Various models in stock, F.M. & A.M., full and half duplex. **£75-£100.**

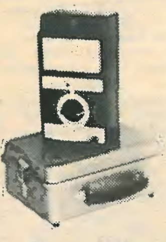
★ Equipment is normally offered working ex these premises. Any other guarantee by written arrangement only.
★ VAT & Carriage extra on all items.
★ We are keen to bid competitively for all good used equipment.

Z & I AERO SERVICES LTD.

Head Office: 44a WESTBOURNE GROVE, LONDON W2 5SF
Tel. 727 5641 Telex 261306

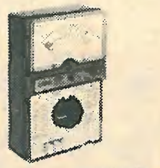
RETAIL SHOP
85 TOTTENHAM COURT ROAD, W.1
Tel. 580-8403

SPECIAL OFFER OF BRAND NEW USSR MADE MULTIMETERS VALID UNTIL 31st DECEMBER, 1978



TYPE	**U4313**	**U4315**
Sensitivity D.C.	20,000 o.p.v.	20,000 o.p.v.
Sensitivity A.C.	2,000 o.p.v.	2,000 o.p.v.
D.C. Current	60µA-1.5A	50µA-2.5A
A.C. Current	0.6mA-1.5A	0.5mA-2.5A
D.C. Volts	75m V-600V	75mV-1000V
A.C. Volts	15V-600V	1V-1000V
Resistance	1K-1M	300Ω-500kΩ
Capacity	0.5µF	0.5µF
Accuracy	1.5% D.C. 2.5% A.C.	2.5% D.C. 4% A.C.
Price complete with pressed steel carrying case and test leads	**£10.50**	**£10.50**
Packing and postage	**£1.50**	**£1.50**

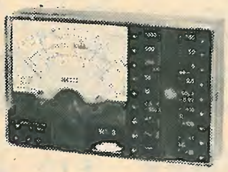
TYPE U4324



D.C. Current	0.06-0.6-60-600mA-3A
A.C. Current	0.3-3-30-300mA-3A
D.C. Voltage	0.6-1.2-3-12-30-60-120-600-1200V
A.C. Voltage	3-6-15-60-150-300-600-900V
Resistance	500Ω-5-50-500kΩ
Accuracy	D.C. 2.5% A.C. 4% (of F.S.D.)

PRICE complete with test leads and fibreboard storage case **£9.50** Packing and postage £1.20

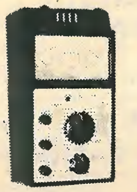
TYPE U4323
COMBINED WITH SPOT FREQUENCY OSCILLATOR



Sensitivity	20,000Ω/V
Voltage ranges	2.5-1000V A.C./D.C.
Current ranges	0.05-500mA D.C. only
Resistance	5Ω-1MΩ
Accuracy	5% F.S.D.
Oscillator output	1kHz 50/50 squarewave 465KHz sinewave modulated by 1KHz squarewave

PRICE, in carrying case, complete with leads and manual **£8.00**
Packing and postage £1.00

TYPE U4341
COMBINED MULTIMETER AND TRANSISTOR TESTER



Sensitivity:	16,700Ω/V D.C., 3,300Ω/V A.C.
Current.	0.06-0.6-6-60-600mA D.C., 0.3-3.0-30-300mA A.C.
Voltage.	0.3-1.5-6-30-60-150-300-900V D.C. 1.5-7.5-30-150-300-750V A.C.
Resistance.	2-20-200kΩ-2MΩ
Transistors.	Collector cut-off current 60µA max D.C. current gain 10.350 in two ranges

PRICE, complete with steel carrying case, test lead, battery and instruction manual **£9.50**
Packing and Postage £1.50

THIS OFFER IS VALID ONLY FOR ORDERS ACCOMPANIED BY REMITTANCE WHICH SHOULD INCLUDE DELIVERY CHARGES AS INDICATED AND 8% V.A.T. ON THE TOTAL.

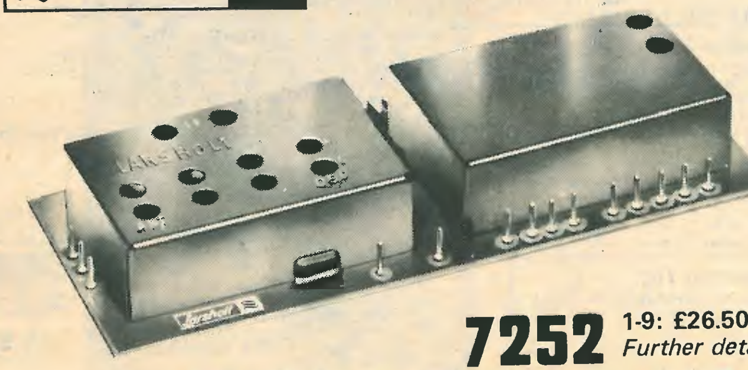
OUR 1978 CATALOGUE/PRICE LIST OF VALVES, SEMICONDUCTORS, PASSIVE COMPONENTS AND TEST EQUIPMENT IS AVAILABLE. PLEASE SEND P.O. for £0.30 FOR YOUR COPY

WW—057 FOR FURTHER DETAILS

Larsholt

88-108MHz in : AF out

VHF FM TUNERSET



The long experience of Larsholt Electronics is reflected in this superbly engineered VHF Band II varicap FM tunermodule. (As used in the Signalmaster Mk8).

The four stage frontend employs dual gate MOSFET transistors for both RF and Mixer stages, providing the 7252 with a 1uV sensitivity for 30dB S/N (m). The IF uses a dual ceramic IF filter, and provides all usual HiFi functions, of tuning meter drives, muting, AFC and AGC. THD is only 0.1%

Special frequency options are available for OEM use, where the high standard of Larsholt construction is frequently employed in sound distribution systems

7252 1-9: £26.50 + 12.5% VAT (£29.81) PP 25p
Further details of this and other Larsholt products in Catalogue (40p)

ex-stock, from: Ambit international, 2 Gresham Road, Brentwood, Essex. tel(0277) 216029

WW—055 FOR FURTHER DETAILS

TTLs by TEXAS	
7400	13p
7401	14p
7402	14p
7403	14p
7404	17p
74S04	90p
7405	18p
7406	32p
7407	32p
7408	19p
7409	19p
7410	15p
7411	24p
7412	20p
7413	30p
7414	60p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
7425	30p
7426	40p
7427	34p
7428	36p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	60p
7448	80p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	34p
7474	30p
7475	36p
7476	35p
7480	50p
7481	100p
7482	84p
7483A	90p
7484	100p
74B5	110p
7486	34p
7489	210p
7490A	33p
7491	80p
7492A	46p
7493A	33p
7494	84p
7495A	70p
7496	65p
7497	180p
74100	130p
74104	65p
74105	65p
74107	34p
74109	55p
74110	55p
74111	70p
74116	200p
74118	130p
74119	210p
74120	110p
74121	28p
74122	48p
74123	55p
74125	55p
74126	60p
74128	75p
74132	75p
74136	75p
74141	70p
74142	200p
74145	90p
74147	190p
74148	150p
74150	100p
74151A	70p
74153	70p
74154	100p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	140p
74167	200p
74170	240p
74172	720p
74173	120p
74174	93p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	200p
74182	90p
74184A	150p
74185	150p
74186	700p
74190	100p
74191	100p
74192	100p
74193	100p
74194	100p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74200	£10
74221	160p
74251	140p
74259	250p
74265	90p
74278	290p
74279	140p
74283	190p
74284	400p
74285	400p
74290	150p
74293	150p
74294	200p
74298	200p
74365	150p
74366	150p
74367	120p
74368	150p
74390	200p
74393	200p
74490	225p

74LS SERIES	
74LS00	18p
74LS02	18p
74LS04	20p
74LS08	22p
74LS10	20p
74LS11	40p
74LS13	45p
74LS14	72p
74LS20	22p
74LS22	28p
74LS27	38p
74LS30	22p
74LS32	40p
74LS47	90p
74LS55	30p
74LS73	50p
74LS74	40p
74LS75	50p
74LS83	110p
74LS85	100p
74LS86	40p
74LS90	60p
74LS93	60p
74LS107	45p
74LS112	100p
74LS123	75p
74LS124	180p
74LS132	120p
74LS133	60p
74LS138	60p
74LS139	60p
74LS151	100p
74LS153	60p
74LS157	60p
74LS158	120p
74LS160	130p
74LS161	100p
74LS162	140p
74LS163	110p
74LS164	120p
74LS165	180p
74LS166	180p
74LS173	110p
74LS174	110p
74LS175	110p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	140p
74LS193	140p
74LS195	140p
74LS196	120p
74LS221	140p
74LS240	175p
74LS241	175p
74LS242	175p
74LS243	175p
74LS244	170p
74LS245	170p
74LS251	200p
74LS253	140p
74LS257	120p
74LS258	160p
74LS259	175p
74LS273	130p
74LS279	160p
74LS298	249p
74LS324	200p
74LS373	200p
74LS374	195p

4000 SERIES	
4000	15p
4001	17p
4002	17p
4006	95p
4007	18p
4008	80p
4009	40p
4010	50p
4011	17p
4012	18p
4013	50p
4014	84p
4015	84p
4016	45p
4017	80p
4018	89p
4019	45p
4020	100p
4021	110p
4022	100p
4023	22p
4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	32p
4050	49p
4051	80p
4052	80p
4053	80p
4055	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	55p
4067	450p
4068	22p
4069	20p
4070	30p
4071	22p
4072	22p
4073	22p
4075	22p
4076	107p
4081	22p
4082	22p
4093	80p
4094	120p
4098	107p
4411	£11
4502	120p
4503	70p
4507	55p
4510	99p
4511	150p
4514	250p
4516	110p
4518	100p
4520	100p
4528	100p
4543	180p
4553	450p
4560	250p
4583	90p
4584	90p
40014	90p
40085	200p
40097	90p
14411	£11
14412	£11
14433	£11

INTERFACE ICs	
MC1488	100p
MC1489	100p
75107	160p
75150N	200p
75182	230p
75324	375p
75325	375p
75451	72p
75491/2	96p
8T26	200p
8T28	300p
8T95	150p
8T97	150p
81LS95	140p
81LS96	140p
81LS97	120p
81LS98	140p
9601	100p
9602	220p
9603	60p

93 SERIES	
9301	160p
9302	175p
9308	316p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	225p
9368	200p
9370	200p
9374	200p

RESISTORS

Carbon film 5% High Stab. Min., ¼w 10Ω—1MΩ E12 **1p**
½w 10Ω—10MΩ E12 **1.5p**
Quantity prices available on request.

LINEAR I.Cs	
*AY1-0212	600p
*AY1-1313	668p
*AY1-1320	320p
*AY1-5050	211p
*AY5-1315	600p
*AY5-1317	636p
*CA3019	80p
*CA3046	70p
*CA3048	225p
CA3080E	72p
*CA3089E	175p
*CA3090AQ	375p
CA3130S	100p
CA3140E	70p
CA3160E	100p
FX209	750p
ICL7106	750p
ICL8038	340p
LM301An	30p
LM311	120p
LM318	200p
LM324	70p
LM339	75p
LM348	95p
*LM377	175p
*LM380	75p
*LM381AN	160p
*LM389N	140p
LM709	36p
LM710	50p
LM725	350p
LM733	100p
LM741	22p
LM747	70p
LM748	35p
LM3900	70p
LM3911	130p
LM4136	120p
*MC1310P	150p
MC1458	55p
MC1495L	400p
*MC1496	100p
*MC3340P	180p
*MC3360P	120p
*MFC4000B	120p
MK50398	750p
NE531	130p
*NE540L	200p
NE543K	225p
NE555	25p
NE556	70p
NE561B	425p
NE562B	425p
NE565	130p
NE566	155p
NE567	175p
NE571	425p
RC4151	400p
SFF96364	1150p
*SN76003N	175p
*SN76013N	140p
*SN76013ND	120p
*SN76023N	140p
*SN76023ND	120p
*SN76033N	175p
SN76477	250p
*SP8515	750p
*TAA621	275p
*TBA641B11	225p
*TBA651	200p
*TBA800	90p
*T8A810	100p
*TBA820	90p
*TCA940	175p
*TDA1004	300p
*TDA1022	600p
*TDA2020	320p
TL084	130p
XR2206	400p
XR2207	400p
XR2211	600p
*XR2216	675p
XR2240	400p
*ZN414	90p
ZN424E	135p
ZN425E	400p
ZN1034E	200p
95H90	800p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		−ve	
5V	7805	90p	7905	100p
12V	7812	90p	7912	100p
15V	7815	90p	7915	100p
18V	7818	90p	7918	100p
24V	7824	90p	7924	100p
100mA	TO-92			
5V	78L05	35p	79L05	80p
12V	78L12	35p	79L12	80p
15V	78L15	35p	79L15	80p

OTHER REGULATORS			
LM309K	135p	TBA625B	120p
LM317T	200p	TL430	65p
LM323K	625p	78HO5KC	675p
LM723	37p	78MGT2C	135p

OPTO-ELECTRONICS			
2N5777	45p	OCP71	130p
ORP12	90p	ORP60	90p
ORP61	90p	TIL78	70p
LEDS			
0.125"		0.2"	
TIL32 I.R.	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	MV5491 TS	120p
TIL216 Red	18p	Clips	3p
DISPLAYS			
3015F	200p	FND500	120p
DL704	140p	FND507	120p
DL707 Red	140p	TIL311	600p
707 Gr	140p	TIL312/3	110p
DL747 Red	225p	TIL321/2	130p
747 Gr	225p	TIL330	140p
FND357	120p		

TRANSISTORS	
AC126	25p
AC127/8	20p
AC176	25p
AC187/8	25p
AF116/7	30p
AD149	70p
AD161/2	45p
BC107/8	11p
BC109	11p
*BC117	20p
*BC147/8	9p
*BC149	10p
*BC157/8	10p
*BC159	11p
*BC169C	12p
*BC172	12p
BC177/8	17p
BC179	18p
*BC182/3	10p
*BC184	11p
BC187	30p
*BC212/3	11p
*BC214	12p
BC461	36p
BC477/8	30p
*BC516/7	50p
BC54/B	16p
*BC548C	16p
*8C549C	18p
*BC557B	16p
*BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	54p
BD139	56p
BD140	60p
8D242	70p
BDY56	200p
BF200	32p
*BF244B	35p
*BF256B	70p
8F257/8	32p
BF259	36p
*BFR39	30p
*8FR40	30p
*BFR41	30p
*BFR79	30p
*BFR80	30p
*BFR81	30p
BFX29	30p
BFX30	34p
BFXB4/5	30p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	22p
BFY51/2	22p
BFY56	33p
BFY90	90p
BLY83	700p
BRY39	45p
BSX19/20	
BU104	225p
*BU105	190p
*BU108	250p
BU109	225p
*8U205	200p
*BU208	200p
*BU406	145p
MJ481	175p
MJ491	200p
MJ2501	225p
MJ2955	100p
MJ3001	225p
*MJE340	65p
MJE2955	100p
MJE3055	70p
*MPF102	45p
*MPF103/4	40p
*MPF105/6	40p
MPSA06	30p
*MPSA12	50p
*MPSA56	32p
*MPSU06	63p
*MPSU56	78p
OC28	130p
OC35	130p
*R2008B	200p
*R2010B	200p
*TIP29A	40p
*TIP29C	55p
*TIP30A	48p
*TIP30C	60p
*TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP2955	78p
TIP3055	70p
*TIS43	34p
*TIS93	30p
*ZTX108	12p
*ZTX300	13p
*ZTX500	15p
*ZTX502	18p
*ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	20p
2N708A	20p
2N918	45p
2N930	18p
2N1131/2	20p
2N1613	25p
2N1711	25p
2N2102	60p
2N2160	120p
2N2219A	20p
2N2222A	20p
2N2369A	16p
2N2484	30p
2N2646	50p
2N2904/5	25p
2N2906A	24p
2N2907A	30p
*2N2926	9p
2N3053	20p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
*2N3565	30p
*2N3643/4	48p
*2N3702/3	12p
*2N3704/5	12p
*2N3706/7	14p
*2N3708/9	12p
*2N3773	300p
*2N3819	25p
*2N3820	50p
2N3823	70p
2N3866	90p
*2N3903/4	18p
*2N3905/6	20p
*2N4036	65p
2N4058/9	12p
*2N4060	12p
*2N4061/2	18p
*2N4123/4	22p
*2N4125/6	22p
*2N4289	20p
*2N4401/3	27p
2N4427	90p
*2N4871	60p
*2N5087	27p
*2N5089	27p
*2N5172	27p
2N5179	27p
2N5191	83p
2N5194	90p
*2N5245	40p
*2N5296	55p
*2N5401	50p
*2N5457/8	40p
*2N5459	40p
*2N5460	40p
2N5485	44p
*2N6027	48p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
3N128	120p
3N140	100p
3N141	110p
3N201	110p
3N204	100p
40290	250p
40360	40p
40361/2	45p
40364	120p
40408	70p
40409	65p
40410	65p
40411	300p
40594	97p
40595	105p
40603	58p
40673	75p
40841	90p
40871/2	90p

DIODES	
*BY127	12p
*OA47	9p
*OA81	15p
*OA85	15p
*OA90	9p
*OA91	9p
*OA95	9p
*OA200	9p
*OA202	10p
*1N914	4p
*1N916	7p
*1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
*15920	10p

*ZENERS	
2.7V-33V	
400mW	9p
1W	15p

HEAT SINKS
For TO220 Voltage Regs. and Transistors **22p**
For TO5 **12p**

BRIDGE RECTIFIERS		
*1A	50V	21p
*1A	100V	22p
*1A	400V	30p
*1A	600V	34p
*2A	50V	30p
*2A	100V	35p
*2A	400V	45p
*3A	200V	60p
*3A	600V	72p
4A	100V	95p
4A	400V	100p
6A	50V	90p
6A	100V	100p
6A	400V	120p
10A	400V	200p
25A	400V	400p

TRIACS PLASTIC	
3A 400V	60p
3A 500V	65p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	120p

THYRISTORS	
1A 50V	60p
1A 400V	75p
1A 600V	85p
3A 400V	90p
8A 600V	140p
*12A 400V	160p
16A 100V	160p
16A 400V	180p
16A 600V	220p
BT106	110p
C106D	45p
*MCR101	36p
2N3525	120p
2N4444	140p
*2N5060	34p
*2N5064	40p

PLEASE SEND SAE FOR FULL LIST

VAT RATES.
All items at 8% except marked * which are at 12½%.

MEMORIES	
2102	100p
2102-2	120p
2102L-4	140p
2107B	600p
2111-1	225p
2112-2	300p
2114	£10
5101	510p
6810	350p
ROM/PROMs	
74S188	225p
74S287	400p
74S387	400p
74S474	£10
74S571	£6
93427	400p
93436	650p
93446	650p
CPUs	
4040a	670p
6502	1200p
6800	900p
6801	TBA
8080A	650p
EPROMS	
1702A	600p
2708	900p
2716	2500p
4702	900p

UART	
AY-3-1015P	550p
AY-5-1013P	400p
TMS6011NC	400p
CHARACTER GENERATOR	
3257ADC	£11
MCM6576	750p
RO-3-2513 U.C.	600p
RO-3-2513 L.C.	550p
SN74S262AN	1360p
OTHER	
3245	400p
4201	390p
4289	970p
4801	500p
6820	600p
6850	700p
8205	320p
8212	225p
8216	225p
8224	400p
8228	525p
8251	700p
8253	1200p
8255	550p
8257	1100p
ꝺ259	1400p
MC14411	1100p

SUBMINIATURE SWITCHES	
Toggle	
SPST	51p
SPDT	53p
DPDT	55p
DPDT (centre off)	75p
Push to make (Red, Green, Yel., Black)	15p
Push to break (Black only)	25p

CRYSTALS	
100KHz	300p
1MHz	370p
3.2768MHz	350p
10.7MHz	350p
18MHz	300p
27.135MHz	300p

EDGEBOARD CONNECTORS 0.156" Solder Tail	
2 x 10 way	85p
2 x 15 way	100p
2 x 18 way	120p
2 x 22 way	135p
2 x 25 way	160p

KEYBOARD ENCODER	
AY-5-2376	£10
AY-5-3600	£12

LOW PROFILE DIL SOCKETS BY TEXAS					
8 pin	11p	18 pin	25p	24 pin	33p
14 pin	12p	20 pin	28p	28 pin	42p
16 pin	13p	22 pin	30p	40 pin	51p

WIRE WRAP SOCKETS			
8 pin	30p	24 pin	80p
14 pin	40p	28 pin	100p
16 pin	55p	40 pin	120p

"PE" VDU SYSTEM: A low cost ASCII memory mapped output peripheral to display all your program development on a TV screen. Connects to address and data bus. Easy to build, an excellent expansion for all MPU systems. 16 lines × 64 characters. UHF MODULATOR ON BOARD. Excellent hardware cursor capabilities. Reprints of all "Practical Electronics" articles describing VDU at 75p + SAE.
Demonstration at shop any time and at BREADBOARD Exhibition (PE Stand) in November.
KIT PRICE £49 — Ready built & tested module **£69** (all prices VAT inc.)

Please add 25p p&p & VAT at appropriate rates.

Government, Colleges, etc. Orders accepted.

CALLERS WELCOME Mon.-Fri. 9.30-5.30 Saturday 10.30-4.30

TECHNOMATIC LTD.

17 Burnley Road, London NW10
(2 minutes Dollis Hill tube station) (ample street parking)
Tel: 01-452 1500 **Telex: 922800**

SINCLAIR PRODUCTS*

Microvision TV, UK model **£89.95.** PDM35 **£27.25,** mains adaptor **£3.24,** case **£3.25.** DM350 **£67.80,** DM450 **£96.50,** DM235 **£49.45**. Rechargeable batteries **£7.50.** Mains adaptor **£3.70.** Enterprise prog calculator **£21.95.** Cambridge prog calculator **£13.13,** prog. library **£3.45,** mains adaptor **£3.45.**

COMPONENTS

Send sae for full list. 1lb FeC1 **£1.05.** Dalo pen **73p.** 60 sq in PCB **55p.** Laminate cutter **75p.** Small drill **20p.** ZN414 **£1.05.** PCB and extra parts for radio **£3.85.** Case **£1.** 1N4148 **1.4p.** 1N4002 **2.9p.** 723 **29p.** 741 **15p.** NE555 **23p.** BC182B. BC183B, 8C184B, BC212B, BC213B, 8C214C **4.5p.** Plastic equivs BC107, BC109, **4.8p.** ¼W 5% E12 resistors 10R to 10M **1p. 0.8p** for 50+ of one value. electrolytics 16v. 5/1/2/5/10/22mf **5p,** 100mf **6p,** 1000mf **10p,** 1500mf (PC) **3.4p,** 10v 2mf (PC) **1.7p** 1000mf **5.1p,** 2200mf **6p.** Polyesters 250v .015, .068, .1mf **1½p.** Ceramics 50v E6 22pf to 47n **2p.** Polystyrenes 63v E12 10pf to 10n **3p.** Zeners 400mW E24 2v7 to 33v **7p.**

TV GAMES

Send s.a.e. for data. AY-3-8500 + kit **£8.95.** AY-3-8600 + kit **£12.50.** Tank battles: — chip + kit **£13.95.** Stunt cycle chip **£6.90.** Kit **£4.** Rifle kit **£4.95.**

TRANSFORMERS

6-0-6V 10C.ma **74p.** 1½a **£2.35.** 6.3V 1½a **£1.89.** 9-0-9V 75ma **74p.** 1a **£2.** 2a **£2.60.** 12-0-12V 100ma **90p.** 1a **£2.49.**

IC AUDIO AMPS

With pcb JC12 6W **£1.60.** JC20 10W **£2.95.** JC40 20W **£2.95.**

BATTERY ELIMINATORS

3-way type 6/7½/9V 300ma **£2.95.** 100ma radio type with press studs, 9V **£3.35,** 9+9V **£4.50.** Stabilized type 3/6/7½/9V 400ma **£6.40.** 12V car convertors 3/4½/6/7½/9V 800m **£2.50.**

BATTERY ELIMINATOR KITS

Send sae for data. 100ma radio types with press-studs, 4½V **£1.40,** 6V **£1.40,** 9V **£1.40,** 4½+4½V **£1.80,** 6+6V **£1.80,** 9+9V **£1.80.** Stabilized 8-way types 3/4½/6/7½/9/12/15/18V 100ma **£2.80,** 1 Amp **£6.40.** Stabilised power kits 2-18V 100ma **£3.60,** 2-30V 1A **£6.95,** 2-30V 2A **£10.95.** 12v car converter 6/7½/9V 1A **£1.35.**

T-DEC AND CSC BREADBOARDS

S-Dec **£3.17.** T-Dec **£4.02.** U-Deca **£4.40.** U-Decb **£6.73.** 16 dil Adaptor **£2.14.** Exp. 300 **£6.21,** Exp. 350 **£3.40,** Exp. 650 **£3.89,** Exp. 4B **£2.48.**

BI-PAK AUDIO MODULES

S450 **£23.51.** AL60 **£4.86.** PA100 **£15.58.** SPM80 **£4.47.** BMT80 **£5.95.** Stereo 30 **£20.12.**

SWANLEY ELECTRONICS

DEPT. WW, 32 Goldsel Road, Swanley, Kent.
Post 30p extra. Prices include VAT

NEW! AMERICAN STYLE CRADLE

TELEPHONE AMPLIFIER

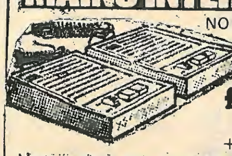
ONLY **£16.95** + VAT £1.36

Latest transistorised Telephone Amplifier is completely automatic with detachable plug-in speaker. Placing the receiver on to the cradle activates a switch for immediate two-way conversation without holding the hand-set. Many people can listen at a time. Increase efficiency in office, shop, workshop. Perfect for "conference" calls: leaves the user's hands free to make notes, consult files. No long waiting. On/Off switch, volume control. Model with tape-recording facility £19.95 + VAT £1.60. P. & P. 89p, C.W.O. 10-day price refund guarantee.

NEW IMPROVED

MAINS INTERCOM

NO BATTERIES NO WIRES

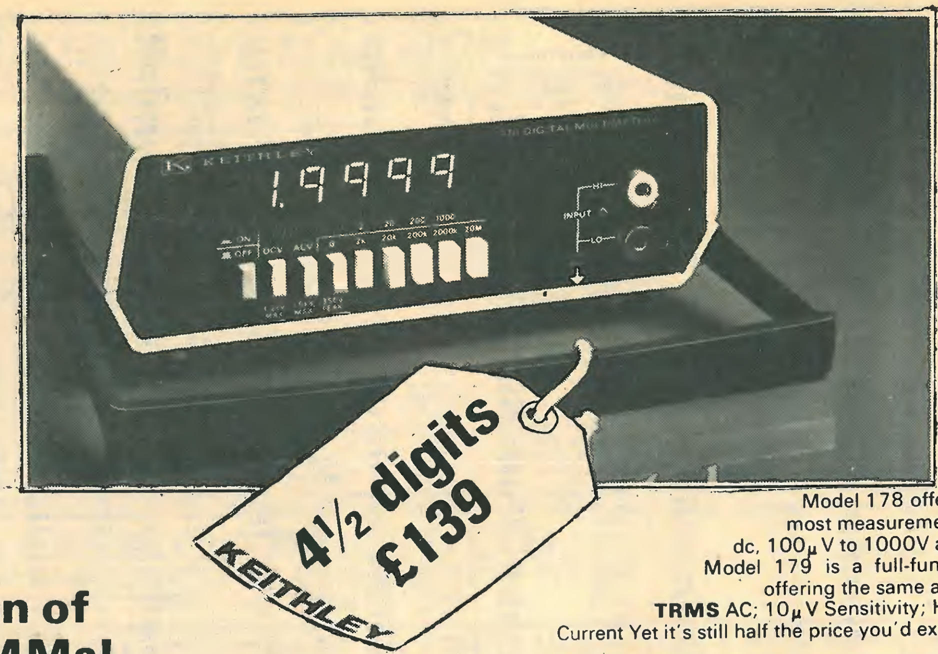


ONLY **£34.99** per pair + VAT £4.37

Made to High Safety and Telecommunications Standards. The modern way of instant 2-way communications. Supplied with 3-core wire. Just plug into power socket. Ready for use. Crystal clear communications from office to office. Operates over ½-mile range on the same mains phase. On/off switch. Volume control. Useful as office intercom, surgery and homes, between office and warehouse. Full price refund if returned in 10 days. **Six months' service guarantee.** P. & P. 99p.

WEST LONDON DIRECT SUPPLIES (W/W)

169 Kensington High Street, London W.8



Model 178

Now . . . the next generation of bench DMMs!

Two New Keithley Models offer uncompromising performance and outstanding value!

- Accuracy 3½'s can't match 0.04% + 1 digit on dc volts and ohms
- Large, bright, 20,000-count LED display that's quick and easy to read.
- Convenient bench size that won't get "lost" yet doesn't crowd.
- Exceptional reliability.

Model 178 offers functions and ranges for most measurement needs 100μV to 1200V dc, 100μV to 1000V ac, 0·1Ω to 20MΩ.
Model 179 is a full-function, multi-feature model offering the same advantages as the 178. Plus **TRMS** AC; 10μV Sensitivity; Hi and Lo Ohms; AC and DC Current Yet it's still half the price you'd expect. Only £199.

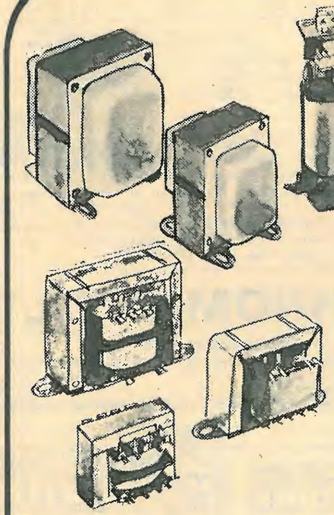
Both models feature designed-in reliability

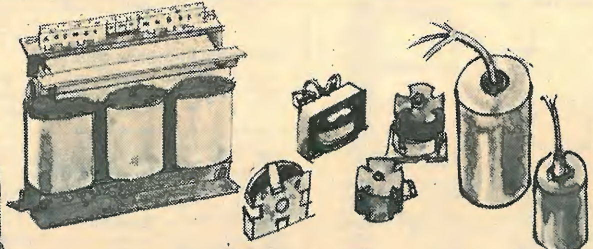
Rugged circuits use a minimum of parts — high quality, off-the-shelf parts — carefully assembled and tested by Keithley.
Outstanding overload protection and rugged mechanical design keep both units going even after severe abuse. One-year accuracy specifications minimise recalibration costs.
A battery option, user installable, gets you off "line" for critical measurements or for field use.

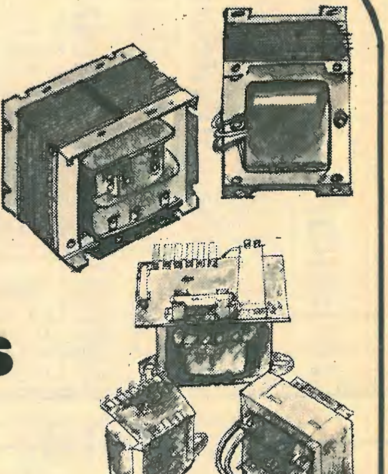
For complete specifications on the 178 and 179, call Keithley Instruments, 1 Boulton Road, Reading. Phone 0734 861287

KEITHLEY
The measurement engineers.

WW—029 FOR FURTHER DETAILS







there are Transformers and . . .

We have been established for over twenty years and are proud of the reputation earned for the design and manufacture of high quality transformers, and other wound components.

Our design team is available to give their personal attention to customers' technical requirements.

Development and pre-production samples can be supplied by our prompt prototype service.

Drake Transformers

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

WW—030 FOR FURTHER DETAILS

The Celestion sound... hand-made to perfection.

Rola Celestion Limited,
Ditton Works, Foxhall Road, Ipswich, Suffolk, England.
Tel: 0473-73131.

Send this coupon for literature or ask your dealer for a demonstration.

Name ______________________________

Address ______________________________

______________________________ 07.20.02

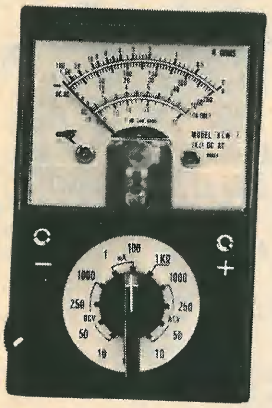
Rola Celestion Ltd., Ditton Works, Foxhall Road, Ipswich, Suffolk IP3 8JP.
Telephone: Ipswich (0473) 73131. Cables: Voicecoil, Ipswich. Telex: 98365.
07.20.08.

NOT EVERY CABLE HAS A LABEL

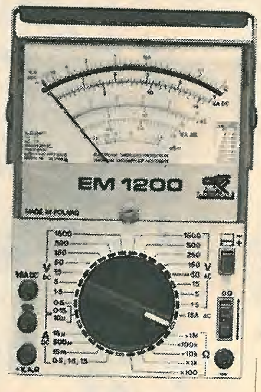
Everyone who works with electricity needs to know at some time or other what's going on inside the cable he's handling. What voltage. What current. What resistance. Not knowing the answers, or worse still having inaccurate answers, can make life difficult, even terminal.

Eagle Test Equipment gives the right answers

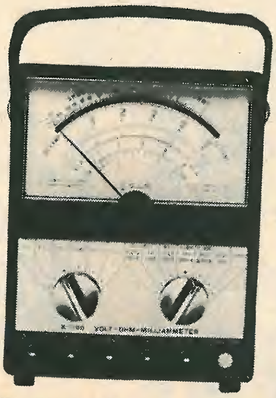
The range covers general multimeters, high voltage probes, clamp meters, insulation testers.
Here are just four. Send the coupon for details of all the rest.



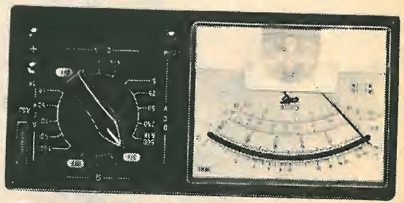
KEW 7 Multimeter
1000 OPV. DC volts up to 1000, DC amps up to 100 mA. AC volts up to 1000. Resistance up to 150 Kohms. Pocket size. "Off" damping. Complete with leads & battery. R.R.P. £6.95 ex. VAT.



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

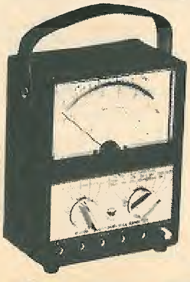


K1400 Multimeter
20,000 OPV. DC and AC volts up to 5000. DC and AC amps up to 10. Resistance up to 20 megohms. "Off" damping. Overload protection. R.R.P. £68.00 ex. VAT.



EM10, 20 & 30 Multimeters
10, 20 & 30,000 OPV. All with antiparallax mirror scale. DC volts to 1000 (1200 for EM30). DC amps to 250 mA (600 for EM30). AC volts to 1000 (1200 for EM30). Resistance up to 6,5 and 60 megohms respectively. R.R.P.'s EM10 £12.40 EM20 £16.40 EM30 £18.95 ex. VAT.

Test Equipment: EAGLE



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

Name ______________________ Company ______________________

Address ______________________

____

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

WW3

WW — 106 FOR FURTHER DETAILS

SOUTHEAST ENGLAND'S ELECTRONICS CENTRE

BARCLAYCARD VISA

OPEN MONDAY-SATURDAY 9am-5.30pm

In stock now test equipment, microprocessors, teletypes, transformers, power supplies, scopes, sig. gen's, motors, peripheral equipment, I.C.'s, tools, components, variacs, keyboards, transistors, microswitches, V.D.U's sub-assemblies + thousands of other stock lines. Just a mere fraction of our vast range, is displayed below: 100's of bargains for callers.

PHILIPS GM 6001 20 HZ — 1000 MHZ VVM

We are now able to offer this superb compact VVM at even lower prices.

Original specifications
1v-300v AC
300mv-1000v DC
1Ω-1000MΩ resistance
Input Z
0.3v range 10MΩ
1v range 30MΩ
All others 100MΩ
Features include:
Large readable meter, switchable centre zero, lightweight, supplied complete with manual and mains plug, believed in good condition but untested.

NEW LOW PRICES
*Grade 1 damaged A.C. probe £25.00 + p.p.
*Grade 2 less A.C. probe £20.00 + p.p.
*Probe circuit shown in manual.
Post and Packing £1.75.

OPTO SMASH!

TIL 302/MAN 7 7 segment LED readout common anode direct drive (via resistors) from 7447 £1-10 each

TIL 119/OC72 Darlington opto isolator 3 for £1-00.

SAVE THAT SPACE! THICK FILM RESISTOR NETWORK 7x100Ω resistor in DIL pack. Ideal for use with 7 seg. displays etc. 4 for £1-00.

TIL305 0.3" 7 x 5 matrix LED alphanumeric readouts £4.75 each.

PHOTO TRANSISTOR Fairchild FPT-100 NPH silicon 30v, 25ma. 4 for £1-00.

SUPER VALUE PCB Special

This superb P.C.B. consists of 59 digital I.C.'s including 7442, 7475, 7404 etc. etc. All I.C.'s are plugged in on 14 and 16 pin D.I.L. top quality gold plated sockets. The board also includes 77 long lead 2N3704 NPN transistors, 1 TIP 33, 77 IN4148 silicon diodes, res. caps. connectors etc. All components easily removable. Original cost well over £100.00.

59 digital I.C.'s
78 silicon transistors
59 D.I.L. I.C. sockets

Unbeatable value at **£4.75** + p.p. 75p.

HOW TO GET HERE

Victoria or London Bridge to East or West Croydon. 1 minute from West Croydon Bus and Rail Stations. 25 minutes Gatwick Airport.

THIS MONTHS SNIP

HARTLEY CT436 DC-6 MHZ DOUBLE BEAM OSCILLOSCOPES

A new Ministry release enables us to offer this much coveted mains portable scope, featuring a real double beam C.R.T. with independent brightness controls, and sensitivity of 10mv/cm. Dimensions of only 10" x 10" x 15" make this ideal for portable work, T.V. servicing etc. etc.

Supplied in good external condition complete with mains lead, but untested Full service manual **£5.00** purchased with scope, **£10.00** purchased separately.

£75.00 + p.p. £4.50.

DISPLAY I.C. AND TRANSISTOR BARGAINS NEVER CHEAPER

All I.C.'s and Transistors by well known manufacturers and fully guaranteed. No fall outs. Comprehensive data on I.C.'s 12p per type.

2N4351 N channel MOS FET,
2N4352 P channel MOS FET,
95p each £1.50 per pair.

HIGH VOLTAGE POWER SWITCHING transistors BVcbo 600v BVceo 500v BVebo 5v 1c 5 amps Pc 125 watts HFE 60 typ ft 2.5 mhz ideal invertors, etc. TO3 £1-50 each 4 for £5-00.

BF258 NPN 250v @ 200 ma 40p each 3 for £1-00.

A.E.I. power TRIACS 10 amp 400v ready mounted on 2½" x 2½" heatsink 95p each 4 for £3-50.

I.R. BSB01 2.5 amp 100v bridge rec. P.C. mount long leads. 30p each 4 for £1-00.

IN4998 4 amp 100v P.C. mount diodes Long leads 12p each 10 for £1-00.

I.R. 25G60 60 amp 600v silicon stud diodes £1-80 each 8 for £10-00.

E.C.C. 1.6 amp 400v triacs 35p each 4 for £1-00.

2N1671B unijunction 450mw 30v 45p each 3 for £1-00.

IN4004-SD4 1 amp 400v diodes 6p each 20 for £1-00.

I.R. 10 AMP BRIDGE RECS. 200 volt working. £1-00 each.

2N3001 30 volt 350 ma S.C.R. TO18 20p each 6 for £1-00.

LM380N-SL6051 14 D.I.L. 2 watt A.F. amp. 75p each 8 for £5-00.

CA3028B DC-120 MHZ differential/cascode amp £1-00 each 3 for £2-50.

TMS3114 DUAL MOS 128 bit static shift reg. DC-2.5mhz £1-75 each 4 for £5-00.

TMS 4050 4096 x 1 dynamic ram £4-75 each 8 for £30-00.

NE555 10 for £2-40

GE424 zero voltage switch, triac SCR, relay driver TO5 can £1-00 each 7 for £5-00.

CA3011 20MHZ wideband amp T099 case 60p each 2 for £1-00.

FSA 2719 8 diodes1N4148-1N914 type in 16 D.I.L. pack all independently connected 35p each 4 for £1-00.

FPQ3725 4 NPN 50v 500ma silicon transistors in 14 D.I.L. pack 65p each 2 for £1-00.

TEXAS LOW PROFILE I.C. SOCKETS
14 DIL 14p each 9 for £1-00
22 DIL 25p each 5 for £1-00
24 DIL 30p each 4 for £1-00

2N5109 R.F. power output 400ma 2.5 watts up to 1200 mhz TO5 70p each 2 for £1-00.

AF279 low noise P.N.P. germanium up to 780 mhz 30p each 4 for £1-00.

2N4304-WN720 F.E.T. transistor. 35p each 4 for £1-00.

M.P.U. CORNER

SAVE £120 TANDY TRS 80 MEMORY UPDATE

Update your new or existing TRS 80 from 4K to 16K of RAM. Install your own chips and save £120.00. Kit includes full iinstructions and 8 x 16K full spec. devices. Simple plug-in and jumper change no soldering. **£108**

TRS 80 software now in stock. Programs include: Micro Chess,Space Fighter, Startrek 3, etc. Phone for details.

RACAL SUPERGRADE C10 CASSETTES

screw fixing, complete with library cases, 2 for £1.00, 10 for £4.50, p + p 70p.

Self-adhesive die cut Cassette labels 20 for £1.00.

POWER SUPPLY UNITS

5 VOLT 2.5 AMP T.T.L. P.S.U.

Made for T.T.L. this compact ex computer systems unit features a 10 amp transformer with D.C. outputs of 5 volts @ 2.5 amps and 7.5 volts @ 5 amps. The 5 volt output is fully regulated and smoothed and has electronic current limiting. May be easily moded for 5 volts @ 7.8 amps, believed working but untested. Complete with circuit **£7.25** p.p. £1-50

EQUIPMENTCASES

Superb professional fully enclosed, made for the G.P.O. to the highest standard, offered at a fraction of their original cost they feature aluminium sides, hinged removable front panel, which can be secured by 2 screws to prevent prying fingers. All are finished in two tone G.P.O. grey and although believed brand new may have minor scuff marks/scratches due to bad storage. Dimensions:

SMALL 16" D x 6½" H x 8¾" W **£5.25** + P+P £1.00
MEDIUM 16" D x 6½" H x 14¾" W **£7.25** + P+P £1.15
LARGE 16" D x 12½" H x 17½" W **£10.75** + carr £1.75

MUFFIN FANS

Ideal equipment cooling etc.
tested, ex-equipment.
240v 50-60 HZ **£5.75** + p.p. 40p
110v 50-60 HZ **£4.75** + p.p. 40p

MOS ROM CHARACTER GENERATORS

Purchased from a major V.D.U. manufacturer, this end of line Motorola 3 chip R.O.M. set is pre-programmed to give a full 96 upper and lower case character font on a 10x7 mattrix for the upper case and a 14x5 mattrix for the lower descenders "g j p q y" thus resulting in a superb and extremely legible display. Full ASCII input, TTL compatible in and out. Supplied with 9 page data and instruction pack, This item cannot be repeated. Hurry while stocks last.

brand new at only **£7.25** P+P 30p.

ULTRA 39 WAY 0.1" DOUBLE SIDED EDGE CONNECTORS. Open ended, ideal veroboard, easily cut 75p each.

PLESSEY EDGE STACKABLE DECADE SWITCHES Gold plated contacts, dimensions 2 x 2 x 3/8 80p each 8 for £5.00.

LM309K +5v 1.2 amp regulator £1.00 each 6 for £5.00
MC7812CK + 12v 1.2 amp £1.00 each 6 for £5.00

C90 Audio Cassettes screw type construction 40p each 3 for £1-00.

Scotch 215 Long Play Tape Brand new ¼" low noise on 1200' 5¾" spools £1-50 each 4 for £5-00 + P.P. 45p.

1000 Watt fully shrouded **auto transformers** term. block connections £13-75 + P.P. £2-25 *.

Bulbs 24v 14 watt white frosted S B.C. 8 for £1-00.

S,B.C. Bulb Holders All steel cad. plated panel mount easily fixed via nut and round hole. Ideal disco displays, scoreboards etc. 4 for £1-00.

Xtal filters S.E.1. QC1121t/B miniature low insertion loss P C. mount C.F.10.7 mhz with B.W of 7.5 khz. 2000 Ω imp. in-out Brand new at £7-50.

Heavy Duty Flat Insulated Earth Braid 80-100 amp braided tinned copper in heavy clear P.V.C. sheath 40p per metre £5-00 for 15 metres P.P. 8p per metre.

BULGIN miniature 6 way male chassis mount socket and matching shrouded free plug. 60p each 2 for £1-00.

Red L.E.D.'s full spec. 0.2" 12p each 10 for £1 00.

Dynamic Stick Mics 600 Ω with built in on/off switch complete with lead and min. jack plug £1-00 each

TO5 HEATSINKS "Thermaloy" black anodised press on aluminium finned type. 15p each 10 for £1-00.

HARDWARE PACK Don't be stuck for the right nut and bolt for the job. Pack contains B.A. Metric, Unified, Self Tap. etc. nuts, bolts, screws, washers, etc. in brass bronze and steel. All steel items plated. Average contents 400-600 pieces, sold by weight, 2-lb bag **£2.50**

MANY HUNDREDS OF TRANSFORMERS IN STOCK – SEND SAE FOR LIST

KEYBOARD

A special bulk purchase enables us to offer the above Keyboard at a lowest ever price. 49 coded keys encoded into a direct TTL compatible 7 bit output. Features such as delayed strobe, 5 volt D.C. single rail operation and rollover protection make this an absolute must for the MPU constructor! Supplied complete with connection diagram and edge connector, at a secondhand "no time to test" price of only **£18.50** P.P. £1-50

SEMICONDUCTOR 'GRAB BAGS'

Amazing value mixed semiconductors, include transistors, digital, linear I.C.'s, triacs, diodes, bridge recs. etc. etc. All devices guaranteed brand new, full spec. with manufacturers markings, fully guaranteed.

50 + BAG **£2.75** 100 + BAG **£4.95**

ELECTRONIC COMPONENTS & EQUIPMENT 66% DISCOUNT

Due to our massive bulk purchasing programme which enables us to bring you the best possible bargains, we have thousands of I.C.'s Transistors, Relays, Cap's., P.C.B.'s, Sub-assemblies, Switches, etc. etc. surplus to our requirements. Because we don't have sufficient stocks of any one item to include in our ads., we are packing all these items into the **"BARGAIN PARCEL OF A LIFETIME"** Thousands of components at giveaway prices! Guaranteed to be worth at least *3 times* what you pay plus we always include something from our ads. for unbeatable value!! Sold by weight

7lb £ 4-75	**14lb £ 7-50**
28lb £12-75	**56lb £21-00**
112lb £34-00	**P.P. £1-00**

DIODES·DIODES

1N4148-1N914-types etc. mixed and untested 1000+ bag £1-50 P P 40p. Buy some for a friend!

CRYSTALS

FREQUENCY	CASE	
100 KHZ	B7G	£2.25
250 KHZ	B7G	£2.25
2.50 MHZ	B7G	£2.25
5.00 MHZ	HC18/U	£2.00
8.00 MHZ	HC18/U	£2.00
10.25 MHZ	HC18/U	£2.00

Standard U.A.R.T. Xtal 38.40 KHZ for 2400, 1200 band etc. **£2.75***
Send S.A.E. for Xtal list.

Where cost of post and packing not indicated please add 25p per order Collection saves cost of postage but if collecting please telephone to check availability.

We are always interested in buying P.C.B.'s surplus components, test equipment, valves, etc. Phone for details

Top Grade MULLARD+PLESSY CAPS

Ultra low ripple 10 amp. smoothing
1500 mf 100v Screw Term. ________ 50p*
3300 mf 63v Screw Term. ________ 60p*
*ex equipment but tested

HIGH EFFICIENCY SMITHS RADIAL BLOWERS

Are your hot parts sweltering? Then keep them cool with our high efficiency radial-snail type blowers. Made by Smiths, designed for continuous use in expensive electronic equipment very powerful and quiet, gives massive air flow to prolong component life and reliability. Easily mounted, air aperture 2½" x 3" supplied complete with fixing bolts. Ideal linears etc. Please state 240v or 110v operation. 50hz only.

BRAND NEW **£4.25** P.P. £1-10

MINIATURE SNAIL BLOWER

This superb "little" blower, imagined as a cube measures only 3¼" x 3¼" x 3¼" with a 1½" x 1½" air output aperture. Almost silent running, ideal for miniature projectors, computers, P.S.U.'s etc. Brand new at only Please state 110v or 240v operation. **£3.99** + p.p. 55p.

ONE INCH NUMERIC DISPLAYS

This fine example of modern miniature optical engineering consists of a 12 lamp and lens system constructed to project numerals between "0" and "9" and a "+" and "–" sign onto an opaque screen to give extremely legible, rounded characters of up to 1" in height. Features easily replaceable 6 volt bulbs, changeable negative for different character fonts. Dimensions 1½" x 1" x 3¼" supplied complete with bulbs and plug in carrier. Ex- equipment **£1.75** p.p. 30p.

DISPLAY ELECTRONICS

103 Tamworth Road Croydon CR9 1SG 01688 1833

MAIL ORDER INFORMATION:
All prices inclusive of VAT. Cash with order. Minimum order value £1-00. Postage quoted for UK only. Bona Fide account orders minimum £10-00. Export and trade enquiries welcome. Orders despatched same day where possible. Access and Barclaycard welcome.

WW—112 FOR FURTHER DETAILS

Nevenco mixing consoles — sophisticated performance from the pioneers

The Corinthian

The new Nevenco range of mixing consoles is low on cost and high on quality and performance. It is designed exclusively for non-profit organisations; the Christian communicator, broadcaster, music or programme producer; and for universities, colleges and training studios with specialised needs and the ever-growing demand for sophisticated production.

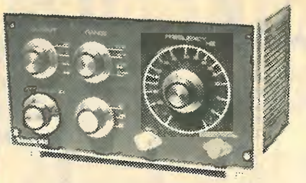
The Philippian Portable: 8 mono or stereo inputs, 2 programme and 2 auxiliary outputs.
The Philippian Studio: Desk-mounted version with studio interface.
The Ephesian Console: 16 input, 4 bus full production console for the programme and small music studio.
The Corinthian Console: 16 or 24 input, 8 bus for stereo and simulataneous mono multi-purpose recording and TV sound.

All feature wide band low distortion, low noise and high reliability together with detailed attention to facilities and layout to your needs — the sort of equipment you would expect from Rupert and Evelyn Neve, Geoff Watts and Alan Foster, pioneers of the world's most advanced audio consoles.

Nevenco Ltd

2 Hills Road
Cambridge CB2 1JP England
Tel. Cambridge 62392
(STD 0223)

WW—078 FOR FURTHER DETAILS



Model 146
VERY LOW DISTORTION
(.0015%)
AUDIO SIG: GENERATOR
Based on
J. Linsley Hood Design (W.W.)
£36
(Kit. £31) + tax 8%

Low cost version, A0113 (02% dist), **£27.50 (Kit £23**). Other instruments include: Millivoltmeter, Tachometer, Noise level meter, Distortion Analyser, F.M. Sig. Gen. Crystal Frequency Standard. KEF Speaker Units. Send S.A.E. for lists. VAT extra 8%. Post/Pkg. £1.50.

TELERADIO ELECTRONICS
325 Fore Street, Edmonton, N.9. 01-807 3719
Closed all day Thursday

WW — 072 FOR FURTHER DETAILS

FOTOLAK

POSITIVE LIGHT SENSITIVE AEROSOL LACQUER

Enables YOU to produce perfect printed circuits in minutes!
Method Spray cleaned board with lacquer. When dry, place positive master of required circuit on now sensitized surface. Expose to daylight, develop and etch. Any number of exact copies can of course be made from one master. Widely used in industry for prototype work.

FOTOLAK	£1.50
Developer	30p
Ferric Chloride	40p

Pre-coated 1/16 Fibre-glass board	
204mm x 114mm	£1.50
204mm x 228mm	£3.00
408mm x 228mm	£600
467mm x 305mm	£9.00

Plain Copper-clad Fibre-glass.	Single-sided	Double-sided
Approx. 3.18mm thick sq. ft.	£1.25	£1.50
Approx. 2.00mm thick sq. ft.	£2.00	£2.25
Approx. 1.00mm thick sq. ft.	£1.50	£1.75

Single sided Copper-clad Paxolin, 10 sheets 245mm x 150mm	£2.50
Clear Acetate Sheet for making master, 260mm x 260mm	12p

Postage and packing 60p per order. VAT 8% on total
G. F. MILWARD ELECTRONIC COMPONENTS LIMITED
369 Alum Rock Road, Birmingham B8 3DR. Telephone: 021-327 2339

Ferranti Semiconductor Distributors Nationwide.

Semicomps Northern Ltd.,
Keighley Tel: 0535 65191
Kelso Tel: 05732 2366

Woolley Components Ltd.,
Altrincham
Tel: 061-941 1911

Intel Electronics Ltd.,
Henlow
Tel: 0462 812505

Comway Electronics,
Bracknell
Tel: 0344 24765

Semicomps Ltd.,
St. Albans
Tel: 0727 24522

Semicomps Ltd.,
Kenilworth
Tel: 0926 59411

S.D.S. Components Ltd.,
Portsmouth
Tel: 0705 65311

ITT Electronic Services,
Harlow
Tel: 0279 26777

Swift Hardman,
Rochdale
Tel: 0706 47411

FERRANTI
Semiconductors

WW—108 FOR FURTHER DETAILS

STABILIZER : FEEDBACK UNDER CONTROL

+5Hz Fixed Shift Circuit Boards as WW July 1973 article, but improved noise level.

Small enough to be built inside the cabinets of many amplifiers.

Complete kit and board £30
Board built and aligned £38
including PSU & mains transformer
DESIGNER APPROVED

CASH WITH ORDER less 5%
UK POST FREE ADD VAT at 8%

The Stabilizer is a versatile frequency shifter for howl reduction on both speech and music. It offers variable shifts either up or down between 1 and 10 Hertz so allowing choice of the optimum shift for the particular acoustics and sound sources involved in each installation.

A shifter not only allows more usable gain (4-8dB) but also gives a greater stability margin between the onset of ringing and actual howling. With a shifter this is something between 3 and 5 dB, whereas a conventional system will go from 'ringing' to howling with a gain increase of 1 or 2 dB.

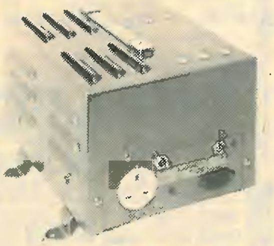
Available is a boxed unit with either balanced or unbalanced signal lines or rack mounting version offering studio quality 'SHIFT' control, duplicated jack and XLR connectors and a smart anodised finish with engraved front panel. Stabilizers include a signal overload LED, a 24 Hz high pass filter to remove VLF signals before connection to power amplifiers and a mumetal shrouded mains transformer to achieve low noise levels.

Stereo Disc Amplifier 2 ★ 10 Outlet Distribution Amplifier 2★ Peak Programme Meter movements, single and twin, and PPM2 IEC268-10A Drive Circuits ★ Peak Deviation Meter ★ Programme and Deviation Chart Recorders.

SURREY ELECTRONICS
The Forge, Lucks Green, Cranleigh, Surrey GU6 7BG. Tel. 04866 5997

SINE WAVE INVERTERS

120-300 VA. 50/60 Hz



HIGH QUALITY A.C. POWER SUPPLIES FOR MOBILE, INDUSTRIAL, COMMUNICATIONS, MARINE AND MANY OTHER USES

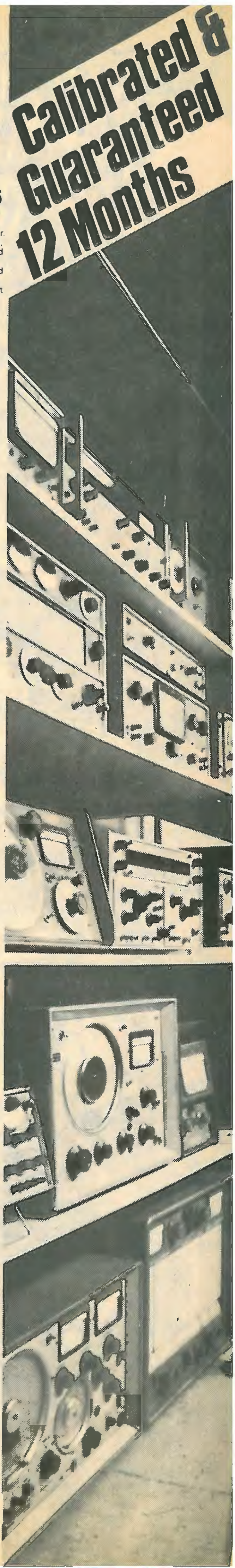
- ★ Ruggedly built in welded steel cases
- ★ Stabilised low distortion output
- ★ Closely controlled frequency
- ★ Full overload and short-circuit protection
- ★ Battery protection by low voltage warning and automatic cut-out
- ★ Automatic standby and remote options

SERIES A: 12/24 V DC.IP.
240, 220 or 115V. AC. O.P.

CARACAL ENGINEERING
42-44 SHORTMEAD ST., BIGGLESWADE, BEDS. Tel: 0767-81361

Electronic Brokers Ltd

The Test Equipment People



SEND FOR NEW 86 PAGE CATALOGUE
Containing latest information on our stocks of test equipment, minicomputers, computer peripherals, stroboscopes and tachometers.
Apply now on official company headed paper for your free copy.
Private address applications please remit £1.00.
Airmail to overseas addresses. £2.00

Sound Level Meters

GENERAL RADIO

1933 Sound Level Meter with 1935 Cassette Data Recorder. 10dB-130dB. A, B & C weighting. Supplied with ½ microphone. Fast and slow response. Built in Octave band analyser with 10 centre frequencies from 31.5Hz to 16kHz, uses normal high quality C60 cassettes. Both Units are battery operated . . **£2,600.00**

1565B Portable Sound Level Meter 40-140dB, A, B & C weighting, Fast and slow response **£225.00**

1981 Portable Sound Level Meter 70-120dB. A weighting. Digital and analogue reading. Maximum hold facility on digital readout **£575.00**

1983 Portable Sound Level Meter 70-120dB. A weighting **£190.00**

AC Voltmeters & Electronic Multimeters

ADVANCE

VM77E Transistorised Voltmeter 10Hz-6Mz. 1mV-300V I/P Z 10M Ohms **£130.00**

BOONTON

91H RF Valve Voltmeter 20KHz-1200MHz. 100µV-300V . . . **£415.00**

BRADLEY

112RF Millivoltmeter 3mV-300mV. 1-300MHz. Battery operated . . **£375.00**

BRUEL & KJAER

2409 Electronic Voltmeter 2Hz-200KHz. 10mV-1000V True RMS **£245.00**

HEWLETT PACKARD

400F AC Voltmeter 20Hz-4MHz 100µV-300V **£235.00**

411A RF Millivoltmeter 500KHz-1GHz. 10mV-10V **£395.00**

PHILIPS

PM.2503 Electronic Multimeter AC/DC Voltage and Current **£90.00**

ROHDE & SCHWARZ

U.R.V. RF Voltmeter 1KHz-2400MHz with 50 Ohms insertion unit 20mV-10V **£235.00**

SIGN

AM324 AC Voltmeter 15Hz-500Khz 1mV-300V **£60.00**

Analogue Multimeters

AVO

Model 7 . . . . **£40.00**
Model 8 . . . . **£55.00**
Test Set No. 1 . . . . **£65.00**
Precision Avo **£45.00**
Leads, Prods, clips for Avo's **£4.95**

PHILIPS

PM 2412 AC/DC Volts & amps 40K Ohms/V **£60.00**

Analysers

GENERAL RADIO

1911A Recording Sound Vibration Analyser 2.5Hz-25kHz. 1/3 and 1/10 octave bandwidth. Recorder spec: 7Hz-200kHz, 1mVac sensitivity 20-40 or 80dB range. **£2,100.00**

HEWLETT PACKARD

310A Wave Analyser
1kHz-2.5MHz. 10µV-100V voltage range. >76dB dynamic range. B.F.O. and recorder O/P. Has built in AM, LSB and USB detector. **A SUPERB UNIT OF THE HIGHEST QUALITY** **£1200.00**

332A Distortion Analyser 5Hz-600kHz. 0.1%-100% also AM detector **£495.00**

333A Distortion Analyser 5Hz-600kHz 0.1%-100% also Auto Null . . **£515.00**

RACAL

409 Modulation Meter 3-1500MHz. AM & FM **£345.00**

ROGERS/SIGN

DM.344 Distortion Meter 20Hz-20KHz **£230.00**

TEKTRONIX

1L10 Spectrum Analyser Plug In 1-36MHz **£750.00**

1L30 Spectrum Analyser Plug In 925MHz-10.5GHz **£1200.00**

1L40 Spectrum Analyser Plug In 1.5-12.4GHz **£1275.00**

T.E.S.

D.566B Distortion Meter 10Hz-1MHz. 0.03 to 100% **£305.00**

MARCONI INSTRUMENTS

T.F. 791D Deviation Meter 4-1024MHz. Dev 10Hz 125KHz **£195.00**

UREI

Sonipulse 100A Acoustical Analyser 40-16KHz. 27 x 1/3 octabe bandpass filters. Microphone not included **£675.00**

Attenuators

MARCONI INSTRUMENTS

TF.1073A Series Step Attenuator DC-100MHz 0-100dB 50 or 75 Ohms **£75.00**

TF.2162 Step Attenuator DC-1MHz. 0-111dB 600 Ohms. **£120.00**

ROHDE & SCHWARZ

RBD Attenuator BN 33662/60 DC-600MHz. 20dB. 60 Ohms **£40.00**

DPR Step Attenuator BN 18042/60 DC-300MHz 0-100dB 60 Ohms **£90.00**

ROHDE & SCHWARZ

RBD UHF Attenuator BN33661/50 DC-2. 4GHz, 10dB, 50 Ohms **£55.00**

Bridges

MARCONI INSTRUMENTS

TF.2701 In Situ Universal Bridge **£395.00**

TF.1245 'Q' Meter Supplied with TF.1246 Oscillator 40KHz-50MHz **£625.00**

WAYNE KERR

B.221 (CT.530) Univ. Bridge 0.1% accuracy **£275.00**

Q.221 Low Impedance Adaptor for use with B.221 . . . . **£75.00**

B.521 (CT.375) Univ. Bridge 1% accuracy **£120.00**

Calibration Equipment

HEWLETT PACKARD

740B DC Voltage Source & Differential Voltmeter **£850.00**

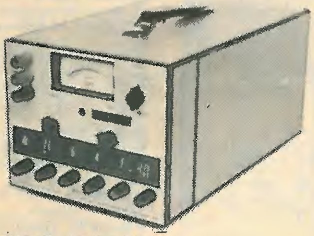
741B DC Voltage Source & AC/DC Differential Voltmeter **£975.00**

FLUKE

332A DC Voltage Calibrator
0-1111.1110V in 3 ranges. 1ppm resolution. 0.003% calibration accuracy. O/P current 0-50mA **£1350.00**

931B True RMS Differential Voltmeter 10Hz-1MHz. 0.01V-1100V . **£1,050.00**

883AB. AC/DC Differential Voltmeter 1mV-1100V **£975.00**



TEKTRONIX

184 Time Mark Generator . **£275.00**
2901 Time Mark Generator **£400.00**
2101 5nS Pulse Generator . **£525.00**

109 Pulse Generator. Repetition rate 550-720Hz 250 ps risetime. Output 0-55V into 50 ohms **£320.00**

Digital Counters

ADVANCE

TC.14 Frequency Counter DC-250MHz. 9 digit **£295.00**

TC.15 + TC.15P1 Counter & Plug In DC-500MHz. 9 digit. 10mV sensitivity **£495.00**

TC.17 or TC.1/A Time Counter Freq. period. Period Average, Pulse width count DC-80MHz **£195.00**

TC.21 Time Counter Freq. Time, Period, Count Pulse width 2Hz-10MHz **£195.00**

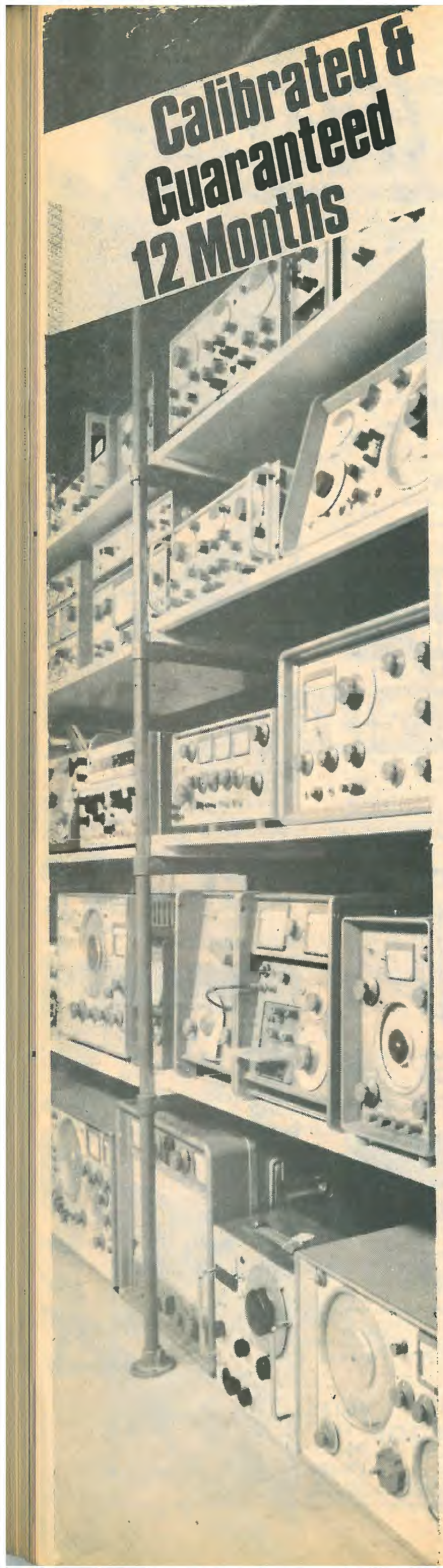
A copy of our trading conditions is available on request

ELECTRONIC BROKERS LIMITED
49-53 Pancras Road, London NW1 2QB
Tel. 01-837 7781. Telex: 298694
Hours of Business: 9 a.m.-5 p.m.
Mon.-Fri.: closed lunch 1-2 p.m.

ADD 8% VAT TO ALL PRICES

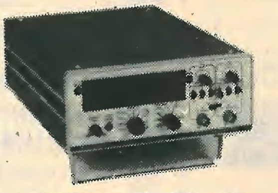
Carriage and Packing charge extra on all items unless otherwise stated.

WW — 101 FOR FURTHER DETAILS



Electronic

49-53 Pancras Road, London NW12Q
Tel: 01-837 7781



TC.22 Time Counter DC-100M+12 . . . . **£275.00**

FLUKE

1900A opt. 01 5Hz-80MHz. 25mV Sensitivity with battery option . . . **£215.00**

1941A Industrial Counter/Totaliser 5Hz-40MHz **£120.00**

1900A Multifunction Counter. 6 digit LED display. Autoranging. 5Hz-80MHz. 25mV sensitivity **£175.00**

1910A-01 Multifunction Counter. 7 digit LED display, autoranging, 5Hz-125MHz. 15mV sensitivity. Battery/Mains operated **£285.00**

1910A as 01 model but no battery opt **£199.00**

1911A-01 Multifunction Counter. 7 Digit LED Display. Auto ranging. 5Hz-250MHz. 15-30mV sensitivity. Battery/mains operated **£380.00**

1912A Multifunction Counter. 7 Digit LED display. Auto ranging 5Hz-520MHz. 15-25mV sensitivity **£390.00**

1920A-06 Communications Counter 9 digit LED display. 5Hz-520MHz 15-25mV Sensitivity. Burst facility. A.F. resolution multiplier **£490.00**

1920A-13 Communications Counter As 1920A-06 but 5Hz-1GHz, and no A.F. resolution multiplier **£525.00**

1925A Multifunction Counter 9 digit LED display. 5Hz-125MHz. 15-25mV sensitivity. Adjustable trigger level. EMI Proof case **£405.00**

1953A-07 Universal Timer Counter 9 digit LED display DC-520MHz. 30mV sensitivity variable trigger level . . . **£675.00**

1953A-15-16 Universal Timer Counter 9 digit LED display. DC-125MHz. 30mV sensitivity. Variable trigger level IEEE interface, rear inputs **£850.00**

1953A-15 as with opt. 16 but no rear input **£825.00**

PHILIPS

PM.6612 Timer Counter 10Hz-80MHz 9 digit display **£405.00**

PM.6615 Timer Counter 10Hz-1GHz. 10mV sensitivity **£795.00**

PM.6620 Timer Counter DC-45MHz. 50mV sensitivity **£395.00**

PM.6661 Frequency Counter 10Hz-80MHz. 20mV sensitivity. 8 digit **£185.00**

PM.6630A Timer Counter DC-160MHz. 8 digit Display **£600.00**

PM.6645 Frequency Counter 30Hz-512MHz. 5mV sensitivity . . . **£710.00**

Digital Voltmeters & Multimeters

ADVANCE

DRM6 True R.M.S. DVM 4½ digit, scale 1999. 10mV-1KV 10μV resolution. Frequency range DC-1MHz . . . **£295.00**

FLUKE

8020A DMM. 3½ digit LED Display. DC volts and current. Resistance and diode test. Battery operated **£99.00**

8030A-01 DMM. 3½ digit LED Display. DC Voltage and current. True rms AC Voltage and current. Resistance and diode test. Rechargable battery supply . . . **£135.00**

8040A-01 DMM 4½ digit LED display. DC voltage and current. True rms AC Voltage and current. Resistance Rechargable battery supply **£220.00**

8600A-01 DMM 4½ digit LED display DC-AC voltage and current. Resistance. Mains or battery operated **£335.00**

8600A as 01 model but no battery opt. **£290.00**

HEWLETT PACKARD

3490A DM 5½ digit, scale length 120000. AC Volts 1V-1kV 10μV resolution. DC Volts 100mV-1kV, 1μV resolution. Resistance 100 Ohms-10M Ohms, 1M Ohms resolution. Full auto-ranging and variable sample rate. Self check facility **£595.00**

34702A DMM C/W 34740A Display 4½ digit. AC/DC & Ohms . . . **£295.00**

PHILIPS

PM2424 DMM 4 digit **£300.00**

PM.2443 DC DVM 4½ digit, scale length 19999 . . . . **£430.00**

PM2513 D.M.M. 3½ digit . . **£90.00**

PM.2513A DMM 3½ digit, scale length 1999 . . . . **£95.00**

S.E. LABORATORIES

SM210 DC DVM 4 digit, scale length 9999. 100mV-1kV, 10μV resolution **£250.00**

SM214 AC-DC DVM 5½ digit, scale length 10999. SC-DC Volts 1.1V-1.1kV, 10μV resolution **£300.00**

SCHLUMBERGER

A243 Digital Voltmeter 5½ digit. 1μV. resolution Autoranging DC & AC (mean) & Ohms **£675.00**

WESTON

4449 3½ digit D.M.M. AC-DC volts and current. resistance **£79.50**

Miscellaneous

E.N.I.

500L R.F. Amplifier 2-500MHZ. 20Db gain. 300mW o/p **£315.00**

FLUKE

412B H.V. Power Supply 0-2100V. Resolution 5mV o/p current 5-40mA **£365.00**

BRUEL & KJAER

2607 Measuring Amplifier 2Hz-200kHz. 10μV-300V range. Average times 0.1S-300S. A, B, C and D weighting. Output signal 10V rms for F.S.D. on meter **£1,200.00**

Oscilloscopes

COSSOR

CDU 150 Dual Trace Oscilloscope DC-35MHz. 5mV20V/div. Full delayed sweep. Long persistence CRT **£450.00**

4000 Dual Trace Oscilloscope DC-50 MHz. 5mV-10V/div. Full delayed sweep. Unused **£495.00**

DYNAMCO

7100 Dual Trace Portable Oscilloscope with 1Y2 and 1X2 modules DC-30 MHz. 10mV-20V/div. Full delayed sweep **£350.00**

7500 Dual Trace Portable Oscilloscope DC-40MHz. 10mV-20V/div. Full delayed sweep Unused **£495.00**

HEWLETT PACKARD

184B Storage Scope Rack style, variable persistance, c/w 1808A Dual Channel Vertical Amp, DC75MHz. 1825 Time base and Delay Generator, UNUSED CONDITION — BARGAIN **£1,600.00**

1707B Dual Trace Portable Oscilloscope DC-75MHz. 10mV-5V/div. Full delayed sweep **£895.00**

PHILIPS

PM.3240 Dual Trace Portab
Oscilloscope DC-50MHz. 5mV-2V/d
Full delayed sweep. From . . . . **£950.**
PM3010 Miniature Scope DC5MHz D
Trace. Battery/Mains operation. Ligh
weight 1.8 Kg . . . . **£325.**
PM3230 Dual Beam Scope DC-10MH
20mV/div, TV frame and Sync separator
. . . . **£155.**

SOLARTRON

CD 1400 Dual Trace Oscilloscope with
off CX 1441 and 1 off CX 144
modules. DC-15MHz . . . . . . **£155.**

TEKTRONIX

531A Bench Oscilloscope with Dial tr
vertical Plug-In unit CA. DC-13.5M
Sensitivity 50mV-20V/div. . . **£290.**
647A Bench Oscilloscope with Dual tr
vertical Plug-in unit 10A2A and delay
time base plug-in unit 11B2A DC-100M
Sensitivity 10mV-20V/div. . **£1,200.**
585A Bench Oscilloscope with Dual tr
vertical Plug-in unit 82 DC-80MHz. S
sitivity 10mV-50V/div. . . . . **£775.**
547 Bench Oscilloscope with dial tr
vertical Plug-in unit 1A1 DC-50MHz. S
sitivity 5mV-20V/div. . . . . **£775.**
545B Bench Oscilloscope with Dual tr
vertical Plug-in unit CA DC-24MHz. S
sitivity 50mV to 20V/div. . . . **£425.**
432 Portable Scope Dual Tra
DC125MHz. 1mV/Div. SUPERB CON
TION. QUANTITIES AVAILABLE **£495.**

661 Sampling Scope c/w 5T3 and 4S
Dual Trace and accs. . . . . **£585.**
CA Plug In for 530, 540 and 580 series
. . . . **£60.**

T932 Dual Trace Portable oscillosco
DC-35MHz. 2mV-10V/div. Sweep spe
0.5S-10nS/div. With trigger hold off .
. . . . **£550.**

7313 Split Screen Bistable Storage sco
c/w 7A18 and 7B53A modules. D
25MHz. 5mV-5V/div. Full delayed swe
C.R.T. readout. 4.9cm/μS writing spe
Auto erase can be converted to 4 trace u
with addition of another 7A18 modu
EXCELLENTLY PRICED AT ONLY . . . .
. . . . **£2450.**

7A22 Differential Plug In Unit. D.C-1M
10μV-10V/div. Selectable upper and lov
— 3dB joints DC offset. 100,000:1 cm
SUPERB VALUE . . . . **£450.**
7A26 Dual Trace Plug In Unit. DC-200M
5mV-5V/div . . . . **£610.**
7D11 Digital Delay Plug In Unit. Delay
time or events. Digital delay readout to
digits. 100nS-1S delay time. 1nS reso
tion. Delay internal CRT display **£850.**

543B Bench Oscilloscopes with Dual tr
vertical Plug-in unit CA . . . . . **£350.**
575 Transistor Curve Tracer **£400.**

556 Dual Beam Scope (Mainframe)
50MHz dependent on choice of Plug-ins
. . . . **£325.**

555 Dual Beam Scope (Mainframe)
33MHz wide choice of Plug-ins **£300.**

422 Dual Trace Battery Portab
Oscilloscope DC-15MHz. 10mV-20V/d
. . . . **£750.**

A copy of our trading conditions
is available upon request

Carriage and packing charge extra on all items unless otherwise stated

Please note: All instruments offer are secondhand and tested and guaranteed 12 months unless otherwise stated

Hours of business: 9a.m.-5p.m. Mon.-Fri. Closed lunch 1-2p.m.

Brokers Ltd
The Test Equipment People

TELEQUIPMENT

67A Dual Trace Portable Oscilloscope. C-25MHz. 10mV-50V/div. Full delayed weep **£450.00**

Oscilloscope Probes

ROBES

890 X1 Probe Kit DC-20MHz. 1.5 mtr ble 40pF I/P cap. 500V DC max. working. BRAND NEW **£9.00**

891 X10 Probe Kit. DC-80MHz. 1.2 mtr. able I/P Z 10M Ohms paralleled by 0.8pF. Compensation 15-50pF. BRAND EW **£11.00**

895 X1 and X10 Switched Probe Kit. C-15MHz in X1. DC-80MHz in X10. I/P Z 0M Ohms paralleled by 10.8pF in X10. 2 mtr. cable. BRAND NEW .. **£15.00**

REENPAR

E81500/2 X1, X10 Probe Kit. DC-0MHz. 10M Ohms I/P resistance. Compensation 15-50pF. UNUSED .. **£27.00**

Power Meters

EWLETT PACKARD

0C RF Power Meter with 477B Thermistor Mount 10MHz-10GHz. 100mW **£225.00**

ARCONI NSTRUMENTS

F893A AF Power Meter 20Hz-35KHz. W-10W I P Z 2.5 Ohms-20K Ohms **£185.00**

F.1020A Series RF Power Meter DC-0MHz. 50-100W FS or 150-300W FS. P Z 75 Ohms on 50-100W model, 50 ms on 150-300W model. From **£105.00**

E.S.

U964 AF Power Meter 20Hz-50KHz. W-10W I/P Z 2.5 Ohms-20K Ohms **£175.00**

Pulse Generators

DVANCE

.52B Modular Pulse Generator 0.1Hz-MHz c/w 2 x P3, 3 x P2, P4, P5, P1 **£700.00**

59 Dual Output Pulse Generator 600) 1Hz-10MHz **£595.00**

HILIPS

M5704 TTL Pulse Generator with .U. 0.1Hz-10MHz. TTL O/P will drive 30 gates **£250.00**

M5715 Pulse Generator Similar spec. to 5712 but with variable rise and fall times **£575.00**

M5775 Pulse Generator 1Hz-100MHz able delay, width, rise and fall time. gle or double pulse, base line offset **£800.00**

M5776 Pulse Generator Same spec as 5775 but dual O/P **£900.00**

Recorders

DVANCE

niscribe 5000 Strip Chart Recorder 1 2 pen models available. Please contact for full details on modules and main mes. From **£200.00**

HOUSTON INSTRUMENTS

6520 YT Recorder **£450.00**

PHILIPS

PM8110 Mini Single Channel Chart Recorder Sensitivity 10mV-10V full span. Chart width 12cm. Chartspeed 5 and 20mm/min **£250.00**

RECORD

3" Paper Width Recorder with 500 µA sensitivity FS. Left-hand zero. 1 and 6 per hour chart speed **£75.00**

Radio Receivers

EDDYSTONE

730/1A Communication Receiver 480KHz-30MHz in 5 ranges, BFO, noise limiting, AF filter, AVC, RF/gain, S Meter **£175.00**

730/4 Communications Receiver 480KH-30MHz, 5 Bands, BFO, noise limiting, AVC, RF gain, AF filter. UNUSED CONDITION **£275.00**

880 Communications Receiver 500kHz-30.5MHz in 1MHz wavebands. BFO, AGC, RF-IF gain, noise limiting, AF filter, S Meter **£325.00**

RACAL

RA117E Communications Receiver 1-30MHz MHz and KHz tuned separately. Selectivity 100Hz-13kHz in 6 ranges. BFO, AVC, Noise limiter, RF/IF gain, S meter **£375.00**

Signal Sources

ADVANCE

H1E LF Sine/Square Oscillator 15Hz-50kHz. Sine Square **£75.00**

J2E L.F. Oscillator 15Hz-50kHz **£90.00**

J3 L.F. Oscillator 10Hz-100kHz **£150.00**

J4 L.F. Oscillator 10Hz-100kHz **£135.00**

SG67A Wide Range Oscillator 1Hz-1MHz sine or square wave **£95.00**

SG68A Low Distortion Oscillator 1.5Hz-150kHz. Battery operated. Distortion less than 0.01%. **£150.00**

FLUKE

6160A/DX Synthesised Signal Generator 4-30MHz. 1Hz resolution ... **£675.00**

HEWLETT PACKARD

202H AM/FM Signal Generator 54-216MHz. From **£495.00**

608D VHF Signal Generator 10-420MHz. From **£495.00**

612A U.H.F. Signal Generator 540-1230MHz. From **£950.00**

616A U.H.F. Signal Generator 1.8-4.2GHz **£550.00**

626A S.H.F. Signal Generator 10-15.5GHz **£500.00**

MARCONI INSTRUMENTS

TF.801D/1 AM Signal Generator 10kHz-470Mhz **£400.00**

TF.995A/5 AM/FM Signal Generator 1.5MHz-220MHz **£380.00**

TF995B/2 AM/FM Signal Generator 200KHz-220MHz **£675.00**

TF1060 AM Signal Generator 450-1250Mhz. From **£400.00**

TF1101 R-C Oscillator 20Hz-200kHz. 1mV-20V into 600 Ohms. Metered O/P **£125.00**

TF2000 AF Oscillator 20Hz-20kHz **£325.00**

TF2002 AM Signal Generator 10kHz-72MHz **£675.00**

TF.2005R Two Tone AF Signal Source **£350.00**

TF2100 AF Oscillator 20Hz-20kHz **£150.00**

MUIRHEAD

D890A L.F. Decade Oscillator 1Hz-111.1kHz **£260.00**

PHILIPS

PM5125 Sine/Square Oscillator 10Hz-1MHz **£145.00**

PM5167 Function Generator 1MHz-10MHz. Sine, square, + pulse, ramp, triangle, single shot with variable phase **£875**

PM5105 LF Oscillator 10Hz-100kHz **£156.00**

PM5324 AM/FM Signal Generator 100KHz-110MHz **£450.00**

PM5326 AM/FM Signal Generator 100KHz-125MHz Digital Readout **£695.00**

TELECOMMUNICATIONS

SG5U Battery Operated F.M. Signal Generator 400-480MHz **£390.00**

SIGN ELECTRONICS

S324 Low Distortion Oscillator 6Hz-60kHz Battery operated **£90.00**

Sweep Generators

KAY

154C Sweeper Main Frame with PM7650B Plug-in Unit 50KHz-110MHz **£450.00**

MARCONI INSTRUMENTS

TF1099 MF Sweep Generator 100KHz-20MHz **£175.00**

ROHDE & SCHWARZ

Polyscop SWOB 1 Price to read **£700.000**

Polyscop SWOB I Wideband Sweeper and Display 0.5-400MHz .. **£1,000.00**

SWH LF Sweep Generator 50MHz **£250.00**

Test Sets

MARCONI INSTRUMENTS

TF.2332 AF Transmission Test Set 20Hz-20kHz **£425.00**

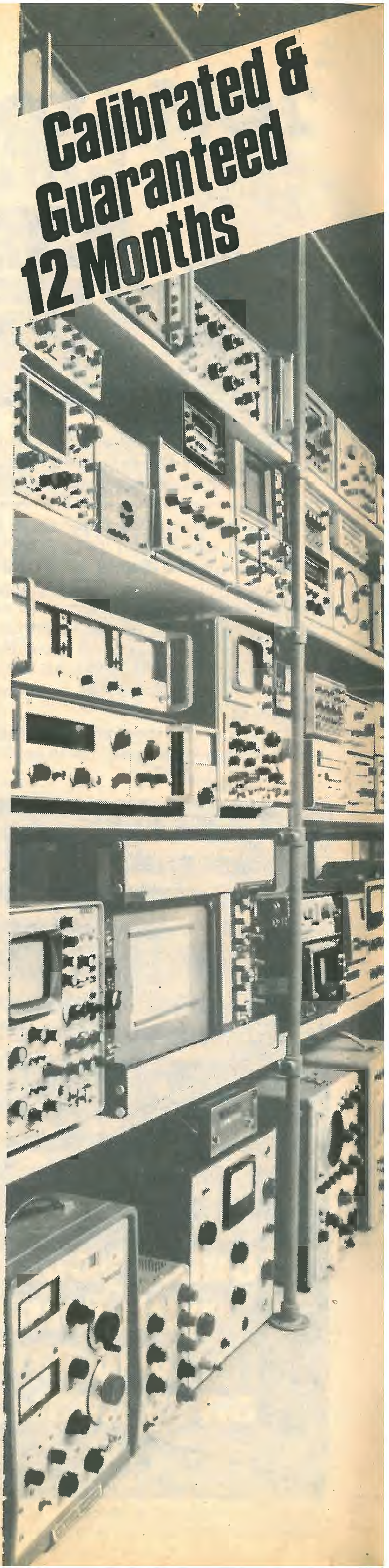
TF.2333 MF Transmission Test Set 30Hz-560kHz **£600.00**

TF.2343 Quantization Distortion Tester **£400.00**

A copy of our trading conditions is available upon request

49-53 Pancras Road
London NW1 2QB
Tel: 01-837 7781. Telex: 298694

ADD 8% VAT
TO ALL PRICES



WW—101 FOR FURTHER DETAILS

20Hz to 100MHz ~ £85.37

(U.K. only including VAT + P & P.) Export + 10%

Actual size.

It's an incredible price for a very credible frequency counter . . . Continental's MAX-100.

It comes to you from a major American corporation and has one operating range, and one only: 20Hz to 100MHz, minimum. (Guaranteed.)

So we've pensioned off the range selector, and fitted the sharpest of LED displays. (Sheer brilliance.)

We've also designed the MAX-100 around the latest in LSI technology; and built-in high sensitivity, with a 30mV trigger level; protection against high transients; and an outstanding accuracy of 3ppm. (What performance!)

But, most importantly, the MAX-100 is totally automatic – and available now. In fact, you could have one tomorrow.

Hesitating? Just take a look at the spec. Then, if you're ready to order immediately, call us on (0799) 21682. And your MAX-100 could be on its way, today! (Continental are great performers, too.)

For data, please use our enquiry number.

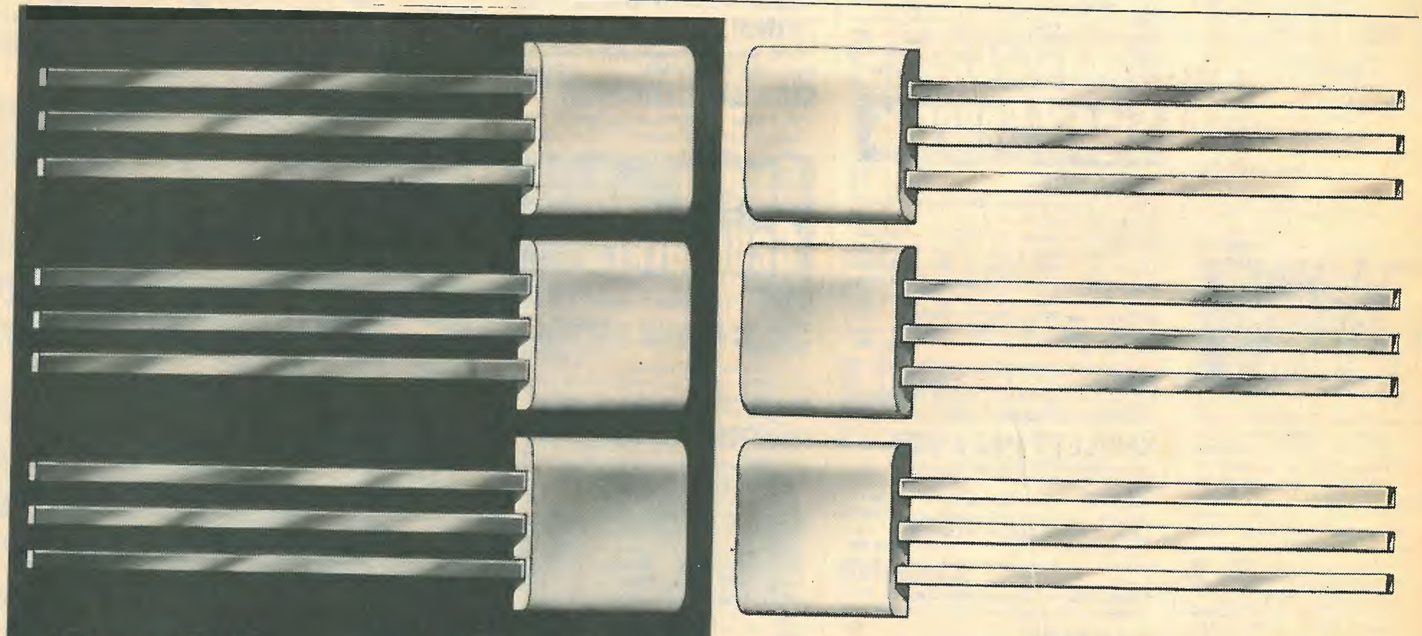
Specification * Frequency range 20Hz to 100MHz * Input impedance 1 megohm shunted by 56pF * Sensitivity 30mV to 300mV r.m.s., from 20Hz to 100MHz * Timebase accuracy 3ppm *Temperature stability 0.2ppm per °C * Max. ageing rate 10ppm per year * Overfrequency indication * Low battery power alarm * Operates from a.c. mains, dry or rechargeable cells, or 12Vd.c. auto battery * Dimensions 45 x 187 x 143 mm. * **Options:** 12V auto. cigar lighter adaptor; battery eliminator/charger; r.f. antenna; low-loss r.f. tap; and carrying case.

Quality. At a low, low, price.

CSC

Continental Specialities
Corporation (U.K.) Ltd.
Shire Hill Industrial Estate
Units 1 and 2, Dept. I/D
Saffron Walden,
Essex CB11 3AQ.

WW—104 FOR FURTHER DETAILS



Double your diodes with Ferranti and save on system costs.

If you're using glass diodes, here's a gentle warning. Pre-forming and insertion costs can make them more expensive than you think on the assembly line.

Ferranti ZDX double diodes save you all that. Each package contains two connected diodes so you save both on insertion cost and component counts.

The ZDX range includes both switching and general purpose diodes.

Common anode, common cathode or series pair.

Ready to plug into your PCB—another saving.

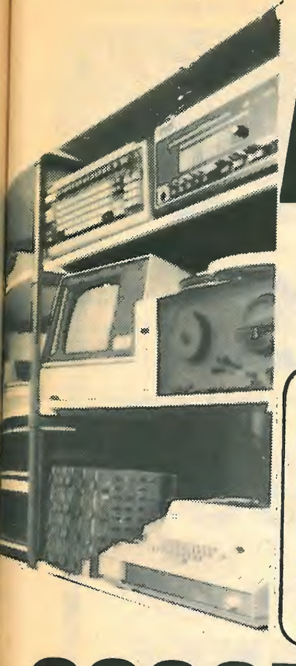
And they're competitively priced. Saving again.

Data and samples? Contact:

Discrete Components Marketing, Ferranti Electronics Limited,
Fields New Road, Chadderton, Oldham OL9 8NP. Call—061-624 0515.

FERRANTI
Semiconductors

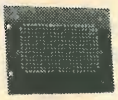
WW—109 FOR FURTHER DETAILS



Electronic Brokers
The Computer People

STOP PRESS — LATEST SPECIAL PURCHASES

SEALECTRO PATCH BOARDS



Programme boards for switching and interconnecting input/output circuits. 11 x 20 XY matrix. Interconnection is by means of shorting, skip and component holding pins (not supplied). Dimensions: 7½'' x 5¾'' x 1''

PRICE: £12.50
(mail order total £14.58)

NEW KEYTOP/KEYSWITCH KITS

BRAND NEW SURPLUS
Pack of 56 Keyswitches plus 56 keytops comprising standard ASCII character set. Ideal as basis for self-build keyboard projects

PRICE: £15.00
(mail order total £17.28)

SURPLUS ASCII KEYBOARDS BY CLARE-PENDAR

KB3 ROM-encoded ASCII keyboard with 63-push-button key stations. Selectable mode — either full ASCII or TTY. Selectable parity. TTL-compatible. Power requirements, +5V-12V. Constructed on rugged PCB with metal mounting plate. Supplied with full technical data.
Manufacturers surplus.

ONLY £35.00 + p.&p.
VAT (mail order total £39.42)

SCOOP! MASSIVE BULK PURCHASE BRINGS YOU HAZELTINE VDUs AT LOWEST EVER PRICES

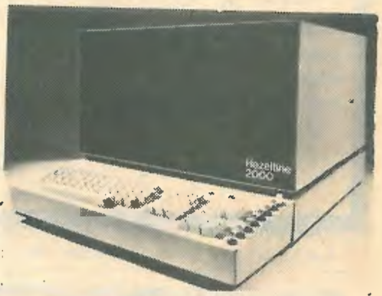
H1000 ONLY £350

HAZELTINE H1000 SPECIFICATION

SCREEN SIZE — 12'' diagonal.
SCREEN CAPACITY — 960 characters 80 per line x 12 lines.
CURSOR — underline.
CHARACTER GENERATION — 5 x 7 dot matrix 625 line raster.
CHARACTER SET — 64 ASCII alphanumerics and symbols.
CHARACTER SIZE — 1/8 inch (.32cm) nominal height. 3/32 inch (.24cm) nominal width.
TUBE PHOSPHOR — P4 (white on black)
REFRESH RATE — 50 fields per second.
KEYBOARDS — TTY format attached.
INDICATORS — Power On. Parity Error. Dataset ready.
PARITY — Parity error indicated by Parity light and question mark (?) displayed in character position.
TRANSMISSION — Asynchronous. Switch-selectable for any two standard rates up to 9600 baud.
OPERATING MODES — Full/half Duplex.
MEMORY — High speed MOS refresh.
STANDARD INTERFACE — CC ITT V-24. (EIA RS-232 B/C),
REMOTE COMMANDS — Home Cursor, Clear Screen, Carriage Return, Line Feed.

HAZELTINE H2000 SPECIFICATION

SCREEN SIZE — 12'' diagonal. 1998 characters; 74 per line x 27 lines.
CHARACTER GENERATION — 5 x 7 dot matrix 625 line raster.
CHARACTER SET — 64 alphanumerics and symbols. 32 ASCII control codes.
KEYBOARD — Detachable, solid state, teletypewriter design. 10-key numeric cluster plus editing and cursor control keys.
TRANSMISSION — Asynchronous. Switch-selectable for combinations of 5 standard rates, 75 to 9600 baud.
OPERATING MODES — Switch-selectable, full duplex, half duplex or batch (buffered).
MEMORY TYPE — 2048 x 8 RAM.
EDITING FEATURES — Full Cursor controls plus Insert/Delete Character, Insert/Delete Line, Clear Screen, Clear Foreground Data Only, Tab.
STANDARD INTERFACE — CC ITT V-24 (EIA RS-232 B/C) or 202C Compatible.
REMOTE COMMANDS — Insert/Delete Line, Clear Screen, Clear Foreground Data Only, Home Cursor, Address Cursor, Set Background Intensity, Set Foreground Intensity, Carriage Return, Backspace, Ring Bell, Transmit, Print.



H-2000A ONLY £495
Also available:
H-2000B £595

AUXILIARY OUTPUT — Standard printer interfaces; standard cassette interface; remote monitor interface.
TUBE PHOSPHOR — P39 (green on black).

Mini-Computer Exchange

DEC BIG SAVINGS ON OUR LARGE STOCK OF PROCESSORS, PERIPHERALS AND ADD-ON MEMORY

PDP11/04 PROCESSORS. Configured to suit your requirements — 8K and 16K MOS memory increment or 16K core memory increments. Asynchronous interface/line clock — either DL11WA (20mA) or DL11WB (EIA). All in perfect as-new condition. Prices from **£2,500.**

PDP11 ADD-ON MEMORY
11/04-11/34 series - MS11FP 8K MOS, £550' MS11JP 16K MOS **£1,200;** MM11DP 16K core **£1,500;** M7850 parity control. **£250.**
11/35-11/40-11/45 series - MF11UP 16K parity core complete with backplane — **ONLY £1,500;** MM11-UP 16K expander core (prerequisite MF11-UP). NOW ONLY **£1,250.**

DD11A	4 SPC-slot backplane	**£195.00**
DR11B	DMA Interface complete with backplane	**£750.00**
VT8E	Alphanumeric & graphic Display terminal complete with PDP8E interface	**£875**
KW11P	Programmable Clock	**£345.00**
PR11	High-speed paper tape reader and control	**£1,450.00**
RTO1AB	Numeric single-line data entry terminal	**£150.00**
TC11	TU56 DECtape drive and control	**£1,395.00**
VTO1	Tektronix 611 XY Storage Monitor As new condition. ONLY	**£950.00**
	Also available AA11-D controller	**£195.00**

Printers and Terminals

LARGE STOCKS OF ASR33 AND KSR33 TELETYPE TERMINALS

- ★ ASCII Keyboard
- ★ Hard-copy unit (friction or sprocket paperfeed)
- ★ Paper tape punch and reader (ASR33 only)
- ★ Line unit (20mA/6V/80V)

Prices from **£425** (KSR) and **£650** (ASR).

CENTRONICS MATRIX PRINTERS

132 column printer with 64 ASCII character set, 165 cps operation.
Model 101-5x7 dot matrix.
Model 101A-7x9 dot matrix.
£750.00

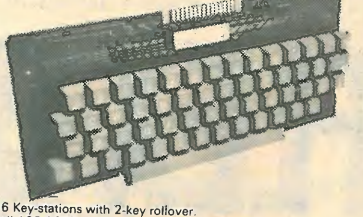
ANOTHER SCOOP PURCHASE — SCOPE DATA 240 CPS MATRIX PRINTER

- ★ 80 Column Receive-Only Printer with full upper & lower case ASCII character set.
- ★ Standard RS232 Interface.
- ★ Electro-Sensitive printing ensuring quiet operation.
- ★ BRAND NEW SURPLUS.

Dimensions: 17½'' x 13½'' x 5½'', weight: 30lbs.
PRICE: **ONLY £695.**

Keyboards

NEW ASCII KEYBOARD MODEL KB756



- ★ 56 Key-stations with 2-key rollover.
- ★ Full 128 ASCII character set with ROM encoder.
- ★ Standard TTL logic — power requirements +5V-12V.
- ★ Supplied with full technical data and circuitry.

Now available in two versions at GREATLY REDUCED PRICES as a result of our bulk buying policy.

		Mail Order Total
KB756 mounted on PCB	**£49.50**	**£55.08**
KB756MF inc. metal mounting frame for extra rigidity	**£55.00**	**£61.02**
OPTIONAL EXTRAS:		
KB15P Edge connector	**£3.25**	**£4.05**
KB701 Plastic Enclosure	**£12.50**	**£14.31**
KB702 Steel Enclosure	**£25.00**	**£28.62**
KB710 Numeric Pad	**£8.00**	**£9.18**
KB2376 Spare ROM Encoder	**£12.50**	**£14.00**

All items quoted are refurbished second-user equipment unless otherwise stated.

ELECTRONIC BROKERS LIMITED (COMPUTER DIVISION)
49-53 Pancras Road, London NW1 2QB. Tel. 01-837 7781. Telex: 298694

A copy of our trading conditions can be supplied on request.

Hours of business:
9 a.m.-5 p.m. Mon.-Fri. Closed lunch 1-2 p.m.

ADD 8% VAT TO ALL PRICES

Carriage & Packing charge extra on all items unless otherwise stated

WW — 102 FOR FURTHER DETAILS

RADIO SUPPLY COMPONENTS LTD

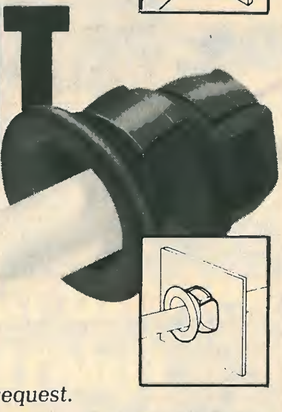
39 WHITBY STREET
HARTLEPOOL
DURHAM

WW — 114 FOR FURTHER DETAILS

GRIP IT

Heyco Nylon Strain Relief Bushings securely anchor and insulate cables passing through a chassis in one low cost operation. They completely absorb 'push', 'pull' and 'twist'. 39 sizes.

FLEX IT



Heyco Nylon Bell-Mouth Strain Relief Bushings do the same job but also provide a widely flared exit hole to help meet cable flexing requirements. Other types of strain relief bushings are available.

FREE SAMPLES and catalogue on request.

Heyco have got it made for cables

HEYCO ®

Heyco Manufacturing Co. Ltd.,
Uddens Trading Estate,
Nr Wimborne, Dorset BH21 7NL.
Tel: Ferndown (STD: 0202) 871411/2/3/4.
Telegrams: HEYCOMAN Wimborne.
Telex: 41408.

WW—105 FOR FURTHER DETAILS

K9 COMPONENTS

GRAPHIC HOUSE
PANGBOURNE
BERKSHIRE

PROFESSIONAL SUPPLIES TO THE AMATEUR

LINEAR SELECTION

CA3130T	1.06	uA709	0.65
LM301-8	0.30	uA710	0.66
LM308-8	0.95	uA723-14	0.45
LM309K	1.95	uA741-8	0.27
LM3900N	0.68	Ua747-14	0.97
NE555-8	0.32	uA748-8	0.47
NE556-14	0.82	7805-UC	0.81
TBA810	1.30	7812-UC	0.81
TBA820	0.80	7905-UC	1.30
ZN414	1.40	7912-YC	1.30
72702	0.79		
	0.65		

DIODE/TRANSISTOR SELECTION

BAX13	0.05	BC209C	0.15	OA91	0.17
BAX16	0.05	BC212	0.11	ZTX107B	0.09
BC107	0.10	BC214B	0.15	1N4001	0.05
BC108	0.10	BCY70	0.15	1N4004	0.06
BC109	0.10	BCY71	0.20	1N4148	0.04
BC207	0.10	BCY72	0.15	1N5401	0.11
BC207B	0.11	BFX85	0.30	2N3053	0.16
BC208	0.10	BFY50	0.20	2N3055	0.49
BC208A	0.10	OA47	0.11	2N3702	0.10
BC209	0.10	OA90	0.14	2N3703	0.09

BZY88 ZENER DIODES 2V7-33V 0.06

CMOS SELECTION

4000	0.14	4023	0.15	4093	0.64
4001	0.15	4026	1.28	4507	0.49
4002	0.16	4027	0.48	4508	2.21
4008	0.90	4030	0.46	4510	1.02
4010	0.46	4051	0.83	4511	0.98
4011	0.15	4053	0.83	4518	0.98
4012	0.16	4060	0.98	4520	1.05
4013	0.41	4066	0.48	4528	0.90
4016	0.39	4069	0.17	4556	0.85
4017	0.76	4075	0.17		
4020	0.89	4081	0.17		
4022	0.81	4082	0.17		

TTL SELECTION

7400	0.12	7496	0.57	74186	7.15
7401	D.12	74110	0.45	74190	0.99
7402	0.12	74120	0.80	74193	0.97
7404	0.13	74121	0.25	7446A	0.67
7405	0.13	74122	0.38	7447A	0.64
7407	0.26	74123	0.53	7448	0.59
7410	0.12	74126	0.44	7470	0.28
7411	0.18	74132	0.67	7473	0.25
7413	0.25	74136	0.72	7474	0.25
7420	0.12	74141	0.58	7480	0.45
7421	0.27	74142	1.96	7484	0.88
7422	0.17	74160	0.78	74147	1.25
7427	0.24	74161	0.78	74148	1.15
7428	0.32	74162	0.78	74150	0.96
7430	0.13	74163	0.78	74151A	0.60
7440	0.13	74164	0.87	74153	0.60
7422A	0.52	74165	0.87	74154	1.03
7485	0.83	74173	1.16	74157	0.63
7490	0.33	74174	0.87	74159	1.65
7493	0.37	74175	0.68	74197	0.87
7494	0.75	74180	0.87	74198	1.45
7495	0.51	74184A	1.18	74393	1.94

TANTALUM CAPS

0.1mfd 35v	0.087	6.8mfd 35v	0.122
0.15mfd 35v	0.087	15mfd 35v	0.208
0.22mfd 35v	0.087	22mfd 35v	0.211
0.33mfd 35v	0.087	33mfd 25v	0.211
0.47mfd 35v	0.087	10mfd 25v	0.122
0.68mfd 35v	0.087	6.8mfd. 25v	0.109
1mfd 35v	0.087	47mfd. 16v	0.211
1.5mfd 35v	0.087	33mfd 16v	0.208
2.2mfd 35v	0.087	22mfd 16v	0.122
3.3mfd 35v	0.093	10mfd 16v	0.109
4.7mfd 35v	0.109	100mfd 6.3v	0.208

OPTOELECTRONICS

Red 3mm	0.12	10mm Comm Anode	1.55
Red 5mm	0.12	14mm Comm Anode	1.57
Green 3mm	0.16	18mm Comm Anode	1.85
Green 5mm	0.16	Height:	
Yellow 3mm	0.19	8mm Comm Cathode	1.50
Yellow 5mm	0.19	10mm Comm Cathode	1.55
FN0500	1.41	14mm Comm Cathode	1.57
FN0501	1.41	18mm Comm Cathode	1.85
FN0507	1.41		

7 Segment Displays:

Height: 8mm Comm Anode 1.50

ORDERS:
CWO: P.O., Cheque
All price include VAT

DISCOUNT:
Orders over £10 less 5%
Over £20 less 10%.
Over £50 less 15%
Over £100 less 20%
Add 30p for P&P (Export Extra)
Send SAE for our complete stock list

WW—076 FOR FURTHER DETAILS

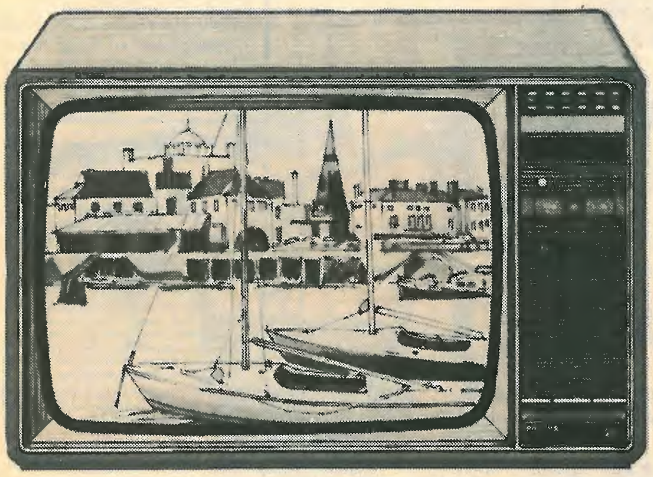
Appointments

Advertisements accepted up to 12 noon Monday, January 22 for March issue, subject to space being available.

DISPLAYED APPOINTMENTS VACANT: £8.50 per single col. centimetre (min. 3cm).
LINE advertisements (run on): £1.20 per line, minimum three lines.
BOX NUMBERS: 60p extra. (Replies should be addressed to the Box Number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London SE1 9LU.)
PHONE: Barry Leary on 01-261 8508
Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.

Test Systems Engineers

Your prospects will take on a new outlook at Lowestoft



Lowestoft: a pleasant seaside town of some character, with a busy fishing quarter and narrow lanes running down to the beach. Close to the extensive leisure and recreational facilities offered by Oulton Broad, and the Suffolk Wild Life and Country Park, with housing offering really excellent value for money.

So might run the guide book entry, but for skilled test engineers, Lowestoft offers even more than that — it is also the location of the Manufacturing Division of Pye Ltd., a member of the international Philips Video Group.

We're currently looking for additional men and women with a sound knowledge of television systems and measurement techniques to join a team involved in the design and construction of specialist test equipment for use within the production facility. The work is extremely varied, covering monochrome and colour receivers, teletext and viewdata systems, and remote control units for the UK and European markets.

As well as the splendid location, these positions offer attractive salaries and a first-class range of benefits including removal expenses where appropriate.

If you're qualified to degree level or equivalent and are looking for a new way of life, contact Richard McMullan, Staff Personnel Officer, Pye Ltd., Manufacturing Division, Oulton Broad, Lowestoft. (0502) 62222.

8923

Pye Limited
Manufacturing Division

PHILIPS

BRIGHTON POLYTECHNIC
LEARNING RESOURCES

MAINTENANCE ENGINEER

FOR VIDEO AND AV FACILITIES
£3933-£4761 p.a. plus £312 p.a. salary supplement

Experienced engineer of proven management ability required to take direct responsibility for the running of a large central maintenance service repairing and developing colour video systems to near broadcast standards and maintaining other first quality AV equipment. Facilities include an excellently equipped electronic and mechanical workshop.

MAINTENANCE TECHNICIAN

£2967-£3834 p.a. plus £312 p.a. salary supplement

Opportunity for a CCTV maintenance technician to work in a new unit developing novel techniques in studio and field colour tv production and using lightweight plumbicon cameras, telecine, 1" broadcast vtr's, advanced signal processing and multi-track audio. The post will also involve working on some studio and outside productions.

Further details and application forms from Personnel Officer, Brighton Polytechnic, Moulsecoomb, Brighton BN2 4GJ. Tel: Brighton 693655 Ext. 2536. Closing date: 2nd February, 1979.

(8846)

TECHNICAL WRITER

ELECTRONIC COMPONENT APPLICATIONS

C. £14,000 P.A.

HOLLAND

This is a unique opportunity for a person with a keen and intensive interest in state-of-art solid state physics and electronic component technology to join a team, within one of the largest companies in this field, engaged in communicating the latest developments to users.

The successful applicant will be sufficiently self-motivated to liaise directly with Product Managers and Application Engineers and will be given the opportunity to contribute at all levels. Comprehensive support and advice will be given to obtain maximum benefit from this unique opportunity.

Apply in first instance to:

G. W. King, Overseas Recruitment Consultant
Howard Organisation International Ltd.
Employment Business Section
8 Elstree Way, Borehamwood, Herts.
01-953 4066

(8879)

Opportunities exist for Engineers (male or female) to contribute to the planning and maintenance of the Independent Television and Local Radio Networks.

Transmitter Engineer

Ref: WW/247CC

To join our specialist team responsible for the planning, installation and commissioning of television and radio transmitting stations. The work involves liaison with equipment manufacturers, installing equipment on site and preparation of technical specifications.

Applicants should be qualified to degree level (or equivalent) and have several years' experience either related to the manufacture of transmitter equipment or in the operations and maintenance of broadcasting equipment.

Transmitter Engineer

Ref: WW/249CC

An experienced Broadcast Engineer familiar with radio and television transmission equipment to assist in the provision of a back-up service to our Station Engineers. The work involves the investigation of problem areas in the transmission equipment associated with our VHF and UHF television relay stations and VHF and MF radio stations, the maintenance of adequate documentation and spares; liaising with component suppliers; and assisting with the processing of modifications.

Applicants should be qualified to HNC/HND level in electrical/electronic engineering, or equivalent, and have had several years' experience in the maintenance, testing or commissioning of television transposing equipment and radio broadcast transmitters.

Telemetry Engineer

Ref: WW/251CC

The Engineer will assist with the provision of a maintenance support service for computer based remote control and supervisory equipment used to monitor and control the IBA's network of transmitters. The work involves maintenance of operational software and the provision of test equipment, diagnostic procedures and spares for field maintenance staff.

Applicants should be qualified to HNC/HND level in electrical/electronic engineering, or equivalent, and have had several years' experience in the maintenance or installation of digital equipment.

All three posts will be based at the Authority's Engineering Headquarters in Hampshire, and since travelling throughout the U.K. is involved, a current driving licence is essential.

Starting salaries will be on a range which rises to £6,066 per annum (inclusive of a productivity supplement). Generous travel and subsistence allowances are payable and relocation expenses will be paid, where appropriate.

IBA
INDEPENDENT
BROADCASTING
AUTHORITY

Please write with full details of experience, quoting the appropriate reference nos., or telephone for an application form to: Glynis Powell, IBA, Crawley Court, Winchester, Hampshire, SO21 2QA. Telephone: Winchester 822270.

University of Leicester
Department of
Engineering

ELECTRONICS TECHNICIAN

Applications are invited for a post of Electronics Technician (Grade 5) in the Electrical and Electronics Laboratories. The successful applicant will work as a member of a small group of technicians who provide a service to the Department that includes construction, installation, maintenance and repair of electrical and electronic equipment used for teaching and research. Applicants should have a sound knowledge of electronic circuits and experience in digital techniques. Work will include manufacture and calibration of specialised equipment for teaching and research, including microprocessor systems.

The post is pensionable. Salary scale (under review) from £3186 to £3720 (Grade 5).

Apply in writing to the **Head of Department of Engineering, The University, Leicester, LE1 7AH, quoting reference 56/T.**

(8878)

CANCER RESEARCH CAMPAIGN
4 MV Van de Graaff

ELECTRICAL ENGINEER/PHYSICIST
(Lecturer or S.R.O.)
PHYSICS OR ELECTRONICS TECHNICIAN

for operation, application and development of this unique multi-purpose machine for non-clinical research into biological and biochemical effects of radiation to improve cancer therapy. Neutron and pulsed and continuous beams of electrons produced.

LECTURER or S.R.O. to manage accelerator and its technical staff, should have degree (or equivalent) or high degree and experience of particle accelerators, ionizing radiations, electronics, vacuum technology, mechanical design. Salary to £6,530 according to experience, qualifications and age.

TECHNICIAN Candidates, preferably with HNC or degree and some experience as above. Salary to £4,050 according to experience, qualifications and age.

Apply: Deputy Director, CRC Gray Laboratory, Mount Vernon Hospital, Northwood, Middx. HA6 2RN.

(8869)

Engineers

- DESIGN / DEV
- TEST
- FIELD SERVICE

High Salaries – Most Areas

Phone 01 - 731 4353

(8515)

Apex Personnel

THE UNIVERSITY OF CAMBRIDGE
requires a

TECHNICAL OFFICER

as CHIEF ELECTRONICS ENGINEER

in its Audio Visual Aids Unit

Duties:

Supervising the work of the electronic technicians in the Unit including maintenance and studio services. Advising on specifications and plans for audio visual systems for lecture theatres, laboratories, TV installations, etc., in the University.

Requirements:

1. A very good technical knowledge of all types of audio and video equipment.
2. Wide experience of maintaining and developing all types of CCTV and video recording equipment including colour equipment.
3. Experience in technical supervision of professional television/sound studio.

The following qualifications are essential:

a) Experience — At least 7 years in a position of responsibility looking after technical staff.

b) Education — A degree in Electronics or Electrical Engineering or HNC or HND (Electrical Engineering or Applied Physics).

Reward:

Salary in the range £4,631 by 6 increments to £6,080.

Further details:

If you would like to apply for this appointment please write to the Director, Cambridge University AVA Unit, Old Exam Hall, Free School Lane, Cambridge CB2 3RH.

Closing date for applications is 15th February, 1979.

(8848)

LONDON COLLEGE OF PRINTING

ELEPHANT AND CASTLE
LONDON SE1 6SB

DEPARTMENT OF PHOTOGRAPHY, FILM AND TELEVISION

LECTURER GRADE I

Applications are invited for the post of lecturer in the School of Film and Television.

The post offers scope to a person with television engineering and some production experience to teach students on a three-year honours degree course in Visual Communications while being responsible for the television facilities in the department. Experience of installation and maintenance in the Broadcast or CCTV industries is an essential qualification.

The successful applicant would be expected to work closely with the Head of School on future planning and development of the technical facilities within an area where there are limitations both in resources and finance.

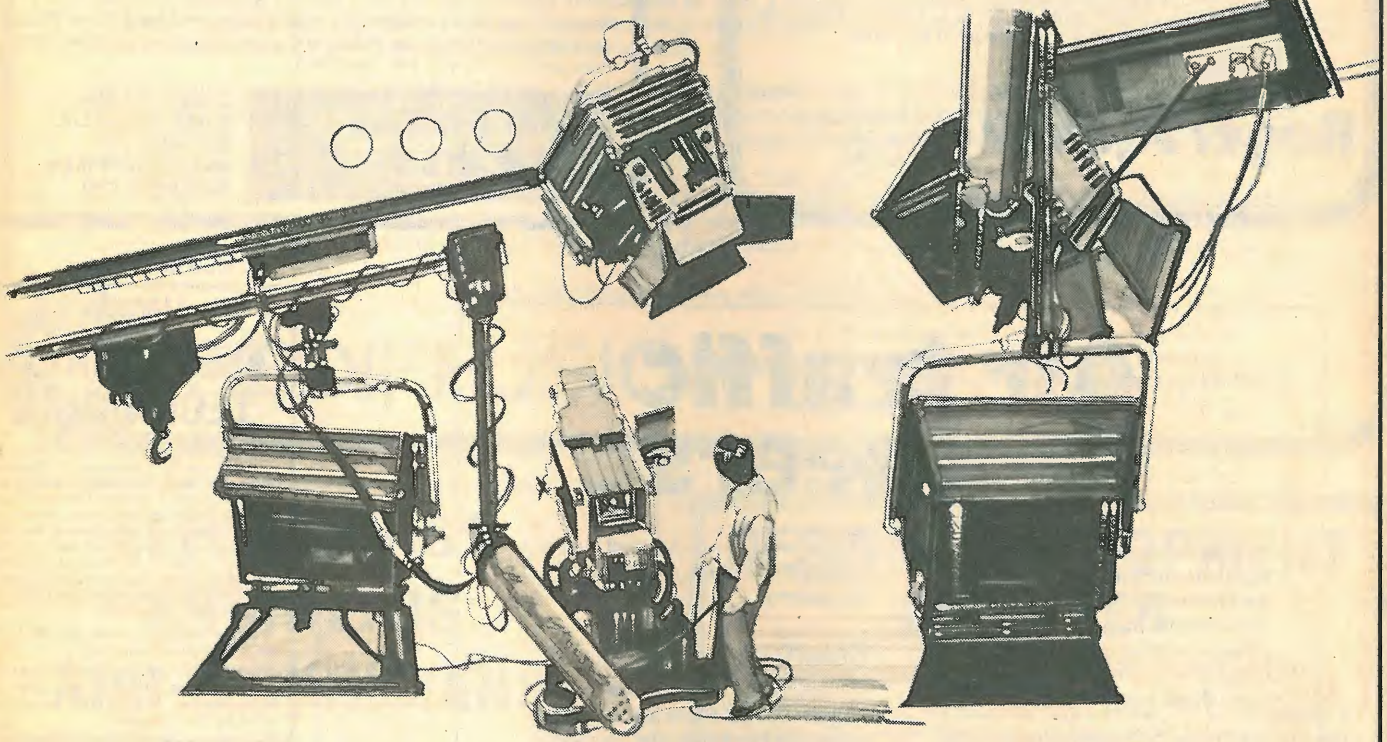
Salary scale in accordance with the Burnham (FE) Report: on an incremental scale within the range £3192-£5334 (plus £474 London Allowance, subject to formal approval) starting point depending upon qualifications, training and experience.

Application forms, returnable by 31 January, 1979 and further details, may be obtained from the Acting Senior Administrative Officer at the college. Telephone 735 8484, Ext. 227.

(8853)

INSTALLATION TECHNICIANS

Behind the scenes, behind the screens.



Behind the people who are behind the scenes at all the BBC's film, radio or television studios you will find the expertise, professional competence and innovative skill of the Studio Capital Projects Department. This department is responsible for the planning, installation and commissioning of entire sound and vision systems for all the BBC's film, radio and television studios and so is responsible for the outstanding technical reputation which we enjoy worldwide.

To help us maintain this excellent tradition, we are looking for Installation Technicians to assist our engineers in the preparation and requisitioning of schedules of equipment, on-site liaison, supervision, testing and commissioning of installations. The work is exciting and varied.

To succeed in this project work, you should be trained to ONC or equivalent level, with experience in testing electronic equipment and workshop or office drawing. Further experience in the manufacture, operation or maintenance of broadcasting equipment in a relevant field would be an advantage.

Although you will be based in London, you must be prepared to work throughout the U.K. Salaries, ranging from £3775 to £4590 rising to £5130 (under review) will reflect your experience and qualifications and relocation expenses will be considered.

If you could fit in behind the screens, we would like to hear from you. Just call **George Boston** on **01-580 4468 ext 2426** or write to: **Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA** quoting reference no 78.E.4093/WW.

BBC

(8850)

ELECTRONIC SERVICE ENGINEERS

LONDON - BRISTOL - MANCHESTER - GLASGOW

Our Company specialises in both sales and servicing of Discotheque Sound and Lighting Equipment.

We are the UKs leading Company in this specialised field and due to continued expansion, we have vacancies in London, Bristol, Manchester and Glasgow.

Applications are invited from Electronic Service Engineers who have had at least 5 years' experience working with either Hi-Fi, Studio, PA or similar equipment.

We offer excellent salaries (depending on age and experience) generous staff discount scheme, a bonus paid 4 times per year, plus the opportunity to progress with a young, go-ahead company.

In the first instance, ring or write to: Mrs. L. Cooper, Personnel Officer for further details. (Reverse charges if you wish).

(8890)

Roger Squire's

Barnet Trading Estate,
Park Road, Barnet,
Herts. EN5 5SA
Telephone: 01-441 1919

ADVANCED TECHNOLOGY

Against a background of long-term Government Contracts we are expanding our teams working on advanced underwater systems engineering; research and target rockets, and welding process control. Currently we have the following vacancies:

ELECTRONICS DESIGN ENGINEERS
ELECTRONICS DEVELOPMENT ENGINEERS
ELECTRONICS TECHNICIANS (SNR & JNR)
ELECTRONICS WIREMEN

For the senior posts, applicants should be qualified to degree or HNC standard. Experience in working with aerodynamicists or hydrodynamicists or on process control equipment, as appropriate, is desirable.

For the technicians and wiremen vacancies, applicants should have ONC or practical experience.

The Company is pleasantly situated on the Avon/Somerset border just a few minutes from the sea, the Mendip Hills and Junction 21 of M5.

Salary is negotiable according to qualifications and experience. Please write giving brief personal details and home telephone number, stating position in which you are interested.

BRISTOL AEROJET

Contact Ron Moir,
Bristol Aerojet Ltd.,
Banwell,
Weston-Super-Mare,
Avon BS24 8PD

8872

Air traffic Engineers

The Civil Aviation Authority has vacancies for men and women as Air Traffic Engineers Grade 2 in its Telecommunications Division offering a variety of work on a wide range of electronic systems and specialised equipments.

Air Traffic Engineers Grade 2 are involved in the installation and maintenance of radio, radar, air navigational and landing aids, and data processing systems. Staff are employed at some Civil Airports, Air Traffic Control Centres and Radar Stations and other locations throughout the U.K. but at present most of the vacancies are likely to be in the South of England with a few vacancies at locations in Scotland and Shetlands.

Qualifications and Experience

You should be at least 20 years of age and have obtained either the ONC(ENG) with an electronic bias or C & G Telecommunications Technician T3 Certificates or other similar technical qualifications. You should also have had skilled working experience in radio, radar or data processing.

Salary

Salaries are on an incremental scale £3890–£5763. Posts in the London area attract an additional allowance (Inner London £495–Outer London £293). Grade 1 posts (maximum salary £6957) are normally filled by promotion from Grade 2.

For full details and an application form complete and send the coupon to:—CAA Tels Staff.
Management (ATE2),
Room K206,
CAA House,
45/59 Kingsway,
London WC2B 6TE.

Name ....

Address ....

....

.... (WW)

CAA
Civil Aviation Authority

UMIST

ELECTRONICS TECHNICIAN

Applications are invited from candidates of either sex for a vacancy of Electronics Technician Grade 5 in the Department of Pure and Applied Physics. The technician is required for the development, construction and maintenance of specialised electronic equipment for research and teaching using the full range of electronics workshop procedure. Applicants should be at least 24 years of age and preferably hold ONC, OND or equivalent qualification.

Salary within the scale: £3186-£3720 per annum (review pending).

Application forms may be obtained from the **Registrar, UMIST, P.O. Box 88, Manchester, M60 1QD,** by quoting reference PH/119/AU. (8844)

UNIVERSITY OF SURREY

LINGUISTIC & INTERNATIONAL STUDIES

TECHNICIAN

Grade 5

£3186-£3720 (under review)

A vacancy exists in this rapidly expanding Department. The successful candidate would take a prominent part in the day-to-day running of the Department's language laboratories.

Technical experience with audio and video tape recording apparatus and associated equipment, experience of film, slide or filmstrip overhead projection, and reprographic equipment are essential skills.

Educational requirement C. & G. Radio and T.V. Technicians Cert.

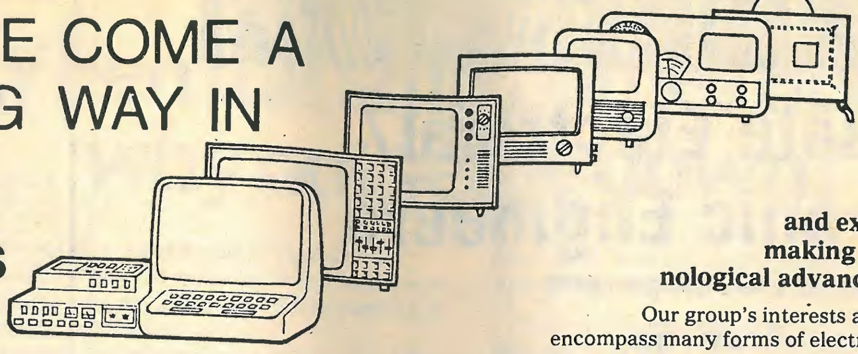
Application forms and further details may be obtained from the Staff Officer, at the University of Surrey, telephone 71281, Ext. 452. (8877)

MONEY, KNOCKERS GOTCHA!

Wanna earn a few bucks moonlighting? We need a part-time design/layout personage.

Phone Paul 579 2535 day
567 9705 evenings (8893)

WE'VE COME A LONG WAY IN 50 YEARS



and expect to continue making significant technological advances in the next 50

Our group's interests are wide ranging, and encompass many forms of electronics and communications, including computers, flight simulators, marine radio, satellite navigation and all aspects of television from receiver design and manufacture to cable systems and the supply of complete TV studios and outside broadcast vehicles.

Our Post Design Service on TV receivers offers technical assistance to our factories and rental companies throughout the UK, aimed at securing the best return on the huge investment in over 1 million operational television receivers. We require additional engineers for this important section, who are able to tackle a wide variety of re-design projects working very much autonomously and seeing their projects through to completion.

Formal qualifications in electronic engineering would be an asset, but most importantly we are looking for men and women with sound technical experience in some of the following areas: — colour and monochrome receiver re-design, detailed circuit fault investigation, safety investigations and approvals to BS415, component evaluations and receiver quality assurance and evaluation.

Career opportunities within this large and successful group are excellent, offering you the possibility of eventually designing a new generation of colour TVs or entering an allied field. You can expect an attractive salary, in line with your experience, together with generous benefits and relocation assistance to the Chessington area of Surrey, ideally situated for both London and the South Coast.

For further information please write or telephone:—

REDIFFUSION

Mr J. Sinclair,
Rediffusion Consumer Electronics Limited,
Fullers Way Sth., Chessington, Surrey KT9 1HJ
Telephone No. 01-397 5411

8891

ELECTRONICS ENGINEERS AND TECHNICIANS

THE COMPANY:
We are a young company experiencing vigorous growth, full of good ideas and successful in putting these ideas into practical uses.

We are now the dominant force in our original market area and have expanded into others.

THE PRODUCTS:
Our products are state of the art, well conceived and built with care. To back this up we pride ourselves on the service our customers receive. Our products include Traffic Monitoring Equipment, Data Loggers, through to OEM Single Board Microcomputers.

THE JOB:
We are looking for both Engineers and Technicians. Successful candidates would be involved in the design, development and debugging of microprocessors based products. The ability to work in an inventive and practical manner is essential. Knowledge of programming would also be an advantage.

THE APPLICANTS:
These persons will be qualified and hold relevant degrees, HNC or HND, although the emphasis is on ability rather than qualifications.

THE PAY:
For the Technician, circa £5,500 and for the Engineer circa £6,500. In addition a yearly bonus is paid depending on merit and company performance, up to 20% of yearly salary.

IT'S YOU? Then for an interview write or phone Roy Tuthill (Technical Director).

Golden River Company Limited
Telford Road
Bicester (086-92) 44551
Oxfordshire

(8858)

DESIGN/DEVELOPMENT ENGINEER

To work on the next generation of VHF/UHF ground to air communication equipment.

We are building up our design team to undertake all aspects of design and development from product conception through to production, including product definition, initial design, prototype development and the generation of full manufacturing information. This includes subsequent liaison with the Production Department.

The successful applicant will be a self-motivated engineer capable of working alone or as part of a team. A relevant Degree/HNC is desirable but this should not deter less qualified engineers with VHF/UHF experience.

The Company is located in a rural environment and offers an attractive salary package which includes a Contributory Pension Scheme, subsidised Canteen and concessional fare rebates on holiday air fares.

Applicants who are keen to join a small stable Company with excellent growth prospects should apply in the first instance for an Application Form to:

Mrs M. R. Jennings, Park Air Electronics Limited, Northfields, Market Deeping, Peterborough PE6 8LG. Telephone: Market Deeping (0778) 345434.

PAE

PARK AIR ELECTRONICS LIMITED
(A Member of the IAL Group)

(8880)

Graduate Electrical/ Electronic Engineers

Research and Development in telecommunications

The Directorate of Telecommunications, London, is responsible for the extensive and sophisticated facilities used by the police, fire, prison and associated services. The role of the Research and Development Section is to ensure that maximum benefit is derived from the use of modern techniques.

The training and experience given to Graduate Engineers covers the training requirements of the IEE — ranging from the initial interpretation of a non-technical statement of requirement through to the management of design, development and contract — and is carefully planned by a senior engineer.

You should preferably be aged under 26 and must have (or obtain in 1979) a good honours degree in electronics or electrical engineering or an allied subject.

Your starting salary will be at least £4150. Completion of training (usually one or two years) leads to a salary rising to £6200. Further promotion prospects to £9190 and above. Non-contributory pension scheme.

For further details and an application form (to be returned by 15 February 1979) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). Please quote ref. T/9998/2.

HOME OFFICE

(8847)

The University of Liverpool
Department of Electrical Engineering and Electronics

SENIOR EXPERIMENTAL OFFICER

A vacancy exists in the Department of Electrical Engineering and Electronics for a Senior Experimental Officer to join a small group giving technical support across a wide range of research activities. These include power electronics, mass spectrometry, high current arc investigations, microprocessors and other digital systems as well as general electronic instrumentation.

Applicants should be of graduate or equivalent status with a minimum of five years' experience of electronic engineering and will be expected to have the ability to translate basic ideas into practical working systems with the minimum of supervision.

Salary within a range from £3883 to £6555 per annum according to qualifications and experience.

Application forms may be obtained from The Registrar, The University, P.O. Box 147, Liverpool L69 3BX.

Quote Ref: RV/412/WW. (8870)

UNIVERSITY OF BATH
SCHOOL OF MATHEMATICS

TRAINEE TECHNICIAN

A vacancy exists for a trainee technician, aged about 18, to assist mainly in servicing and developing computing devices, including working with mini- and microcomputers. Candidates should have at least four relevant 'O' Levels and provide evidence of a keen interest in electronics.

Salary at 18 £1824 per annum (under review).

Application forms from the Personnel Officer, University of Bath, Bath, BA2 7AY, quoting reference number 78/268/WW. Closing date will be 31.1.79. (8889)

TELEVISION SOUND TECHNICIANS

Thames Television Limited has several vacancies for experienced Television Sound Technicians. These vacancies are based at our Riverside Studios in Teddington, Middlesex.

The posts involve the operation and maintenance of all television studio or outside broadcast equipment and entails both work on the studio floor or on location and in post production sound dubbing. Salary will be up to £5596 per annum (for a 38-hour week) depending on experience.

We also offer 21 days holiday, Company Pension Scheme, Subsidised Canteen and Restaurant and a Social Club and Bar.

For application form please write or telephone: Mike Allen, Staff Relations Officer, Thames Television Limited, Broom Road, Teddington Lock, Teddington, Middlesex. 01-977 3252 ext. 325.

THAMES

(8849)

Television Engineer

We are based in Buckinghamshire and operate a broadcast quality colour mobile unit and studio equipped with Link hand-held and studio cameras, Cintel Mark III telecine, VPR I recorders and a wide range of other facilities.

An experienced television engineer is now required for operational and maintenance work with our small team producing training programmes for the Services at base and on location.

You should have worked on professional colour equipment and some training could be provided, where necessary.

Good starting salary. Assisted travel allowance when applicable. Free canteen. Four weeks' annual leave.

Pleasant rural environment. Pension and Life Assurance Scheme.

For further information telephone or write to:

Personnel Officer
The Services Kinema Corporation
Chalfont Grove, Narcot Lane
Gerrards Cross, Bucks SL9 8TN
Chalfont St. Giles (02407) 4461

(8851)

SKC

Radio Officers

When the ship comes home, why not settle down?

We're the Post Office Maritime Service and we have everything in a job that you'd want: the kind of work you're trained to do, good pay, job security and all the comforts of home where they really count – at home!

Vacancies exist at several coast stations for qualified Radio Officers to carry out a variety of duties that range from Morse and teleprinter operating to traffic circulation and radio telephone operating. And for those with ambition, the prospects of promotion to senior management are excellent.

You must have a United Kingdom Maritime Radio Communication Operator's General Certificate or First Class Certificate of proficiency in Radio-telegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic. And, ideally, you should have some sea-going experience.

At 25 or over, salary starts around £4093, rising after three years to about £5093. (Starting salary for those between 19-24 varies between £3222-£3732.) Overtime is additional, and there is a good pension scheme, sick-pay benefits and at least 4 weeks' holiday a year.

For further information, please telephone Andree Trionfi on Freefone 2281 or write to her at the following address:
ETE Maritime Radio Services Division (WW/C/8)
ETE17.1.1.2, Room 643, Union House,
St. Martins-le-Grand, London EC1A 1AR.

Post Office Telecommunications

(7141)

ROYAL COLLEGE OF ART

AUDIO TECHNICIAN

required in the Department of Environmental Media, to assist and advise students in the creative use of equipment, in the design and construction of ''one off'' pieces of equipment; to interface or modulate the standard departmental facilities; to maintain equipment. Applicants must have a thorough working knowledge of:—Sony video recording and editing facilities (½'' open reel and U-Matic); sound recording and synthesizing equipment; multi-screen encoder/decoder and cross-fade unit; film and slide cameras and projectors.

The starting salary will be in the scale £3651-£4185 according to qualifications and experience.

Please write giving full details of age, qualification and previous experience to: **Assistant Registrar (Staff), Royal College of Art, Kensington Gore, SW7 2EU.** (8856)

THE POLYTECHNIC OF CENTRAL LONDON

Educational Development Unit
Audio Visual Services

TECHNICIAN

Grade 4/Language Laboratories

Salary £3441-£3891

Duties will involve responsibility for day-to-day servicing and maintenance of language Laboratories in PCL, and will also include some work with basic Audio Visual equipment. Good working knowledge of tape recorders and preferably experience of language laboratory work is required.

Qualifications: C & G or equivalent and 7-9 years' experience.

Application form and job description from the Establishment Officer, PCL, 309 Regent Street, London, W1R 8AL (01-580 2020, ext. 212). (8871)

We've variety and interest to offer you as a service and test engineer in Stanmore

It's the variety that comes with working on a wide range of equipment. And the interest of knowing that your skills and experience are playing a vital role in maintaining the critical standards demanded by major airlines and Air Forces for their highly sophisticated avionics equipment.

Working either in aircraft or in our well equipped and pleasantly situated workshops in Stanmore, Middlesex, you will be involved in the repair, maintenance and overhaul of a variety of advanced airborne electronics equipment, both British and American.

It's work for which you'll need to have sound practical experience of radio and electronics theory, ranging from audio to microwave. You should also have experience of using advanced test equipment for fault diagnosis, although training can be given where necessary.

We can offer you an excellent salary and benefits together with really first-class working conditions and subsidised staff restaurant, so if it's variety and interest you're looking for write now with details of your experience to: Mrs. E. Wagg,
Marconi Avionics Limited,
22–26 Dalston Gardens, Stanmore,
Middlesex HA7 1BZ.
Telephone: 01-204 3322.

MARCONI AVIONICS

A GEC-Marconi Electronics Company

(8763)

Opportunities in Test Engineering Digital and HF/VHF

Our range of equipment has an international reputation for its reliability under the most demanding operational conditions and it is the responsibility of our Test Departments to ensure this standard is maintained by fault finding and aligning the equipment, from sub units to complete systems, using sophisticated test equipment.

At our Chelmsford establishment we are now looking for additional men and women to test a wide range of HF/VHF systems and digital equipment.

Applicants should be qualified to Final C & G or H.N.C. in electronics and ideally have experience of radio or digital communications. A few vacancies also exist for those with intermediate C & G or with good practical experience of digital systems.

These positions carry attractive salaries, benefits and conditions of service and, in approved cases, relocation expenses will be met.

Write giving details of your experience to Mr. R. Humphries, Marconi Communication Systems Limited, New Street, Chelmsford, Essex CM1 1PL or telephone Chelmsford 53221 ext. 474.

A GEC-Marconi Electronics Company

MARCONI
COMMUNICATION
SYSTEMS

(8883)

KING'S COLLEGE HOSPITAL

MEDICAL PHYSICS TECHNICIAN III

FOR ELECTRONIC EQUIPMENT SERVICING

Minimum qualifications an appropriate HNC or equivalent plus three years' relevant experience. The successful candidate would be responsible primarily for the maintenance under supervision of nuclear medicine imaging and counting equipment. Experience of similar work with sophisticated electronic systems essential though training on particular equipment will be given.

Salary in range: £4098-£5142 according to qualifications and experience.

Job description and further details from the Sector Administrator's Office, King's College Hospital, Denmark Hill, London SE5 9RS. Tel. 01-274 6222 ext. 2408.

(8910)

BRISTOL POLYTECHNIC
Faculty of Technology:
Department of Engineering

RESEARCH ASSISTANT IN MICROPROCESSOR APPLICATIONS

Ref: R52/130

Salary: £3192 per annum.

The project is concerned with the development of microprocessor controlled data acquisition and processing systems.

Candidates should have a degree or equivalent in a scientific subject and some experience either with minicomputers or microprocessors.

Further details and application forms, to be returned by the 30 January 1979, from the Personnel Office, Bristol Polytechnic, Coldharbour Lane, Frenchay, Bristol BS16 1QY.

Please quote Post Reference Number R52/130 in all communications. 8914

ELECTRONIC FIELD ENGINEERS GET INTO COMPUTERS IN GERMANY & U.K.

SMS is a successful Computer Maintenance Company, well-established in Europe with offices in London and Frankfurt and engineers in most EEC Countries.

Business is growing fast and SMS needs additional Electronic Engineers to train for Computer Maintenance in Germany and the U.K.

An HNC/ONC/FTC or equivalent in Computers, Electronics, Telecommunications, Radio or Radar together with 2-3 years' practical experience could be your chance to get into Computers now!

Let SMS train you as a **Computer Field Engineer.** If you are less qualified but still eager to work in Computers you could train as an **Associate Field Engineer.**

The right applicants will be between 20 and 30 years of age with the ability to work with the minimum of supervision.

Salaries and benefits package will reflect the important role played by the engineer within S.M.S.

Please send particulars of your career to date to:

ROY BARLING
Training Manager
SYSTEMS MAINTENANCE AND SERVICES LTD.
P.O.Box 13, Unitair Centre
Great South West Road
Feltham, Middlesex TW14 8NT
England

(8866)

MAINTENANCE SUPERVISOR

Rediffusion Reditune Limited, the World's leading music service, requires a MAINTENANCE SUPERVISOR to take charge of a small team responsible for the maintenance of professional recording and high speed duplicating equipment in a busy Dubbing Studio Complex at Orpington.

A formal qualification to H.N.C. Standard is preferred but not essential, but applicants must have a thorough knowledge of studio equipment and techniques.

Previous experience of control of staff will be an advantage.

The salary is negotiable around £4,200 per annum.

If you are fed up with shift work and irregular hours this could be the job for you!

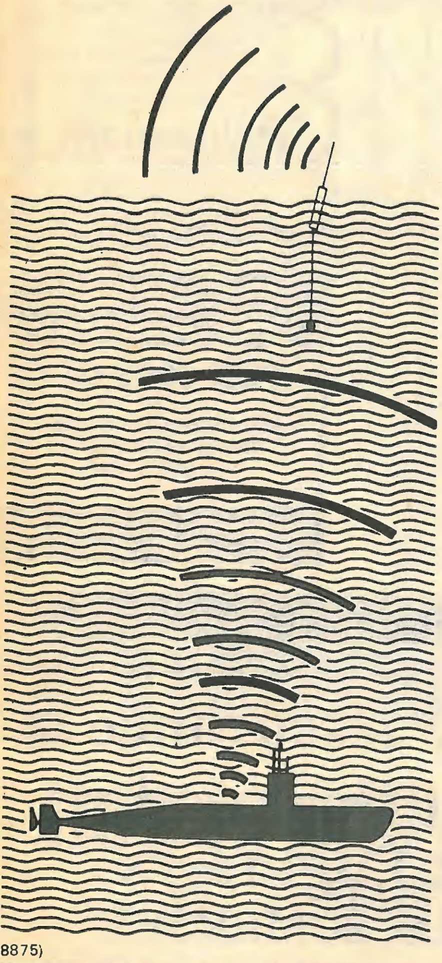
Please write giving details of age and experience to:

Chief Engineer
Rediffusion Reditune Limited
Cray Avenue, Orpington, Kent

REDIFFUSION REDITUNE
THE WORLD'S LEADING COMMERCIAL MUSIC SERVICE.

(8867)

Listening-in at 75 fathoms needs your kind of engineering experience



Modern anti-submarine warfare relies heavily on detection devices such as the sono-buoys manufactured by UEL Electronic Communications Ltd that, after drop from an aircraft flying at up to 10,000 ft, deploy themselves automatically, lowering hydrophones to a pre-selected depth and raising a radio aerial so as to listen for tell-tale engine noises, amplify them and transmit the information back to submarine hunting aircraft.

The company, part of the international Dowty Group, also manufactures and develops communication control systems and intercom units for civil and military aircraft, airborne emergency radios, and beacons for homing and rescue applications. Our latest project is in the area of VHF radio where we are providing British Rail with a communication system between signal boxes and trains. Many of these systems need a high degree of ingenuity and the kind of engineering experience that maybe you can offer. In particular we are looking for the following men or women:

Electronic Development Engineers

We are looking for men or women to join a small team of Engineers and Technicians working on the design of analogue systems and circuits. Visits to trials may be necessary and opportunities might arise for visits to clients and suppliers.

Applicants should be qualified to HND or preferably degree level with several years design experience.

Senior Development Technicians

We require men or women to join project teams working on the design and development of analogue systems and circuits for prototype equipment. Will be responsible for building, testing and evaluating experimental equipment and for assisting with the development of analogue circuitry.

Applicants, aged between 25 and 45, should hold City & Guilds Electronics, Radio & TV, or Telecommunications Certificates up to Part 1 or Intermediate level and have at least 5 years' development experience, preferably involving government contracts.

Test Technicians

Our production department require additional male or female Testers with experience of radio or analogue circuits and test equipment. Candidates should have several years practical experience in this area with or without qualifications.

We are offering attractive salaries, negotiable according to qualifications and experience plus a wide range of attractive large company benefits. There are good promotion prospects and generous relocation package is available where necessary covering all legal and estate agency fees, Building Society survey fees, viewing expenses, and a disturbance allowance.

For further information and an application form phone or write to:–

Mr Gavin Rendall, Personnel Manager,
Ultra Electronic Communications
Limited, 419 Bridport Road,
Greenford,
Middlesex UB6 8AU.
Tel: 01-578 0081.

UEL
Electronic Communications Limited

(8875)

AIRWORK SERVICES LIMITED

now require

FIELD SERVICE ENGINEERS

for

Installation and Commissioning

of

Ground Radar, Comms and Navigational Aids at various overseas tax-free locations

also required

DIESEL GENERATOR ENGINEERS and GENERAL FITTER/WIREMAN experienced with Stand-by and No-Break Diesel Generators and associated A.C. Power Distribution systems as used with Airfield Navigational Aids.

Applicants should have ONC or similar qualifications and have at least 5 years' experience. Ex-Service Personnel would be particularly suitable.

You are invited to write in the first instance to the Senior Personnel Manager (Ref.).

AIRWORK SERVICES LIMITED
Bournemouth (Hurn) Airport
Christchurch, Dorset BH23 6EB

(8868)

LONDON COLLEGE OF PRINTING

ELEPHANT & CASTLE, LONDON SE1

Department of Photography, Film and Television

Television Technician/ Engineer (ST1/2)

Applications are invited for the above post in the School of Film and Television, Department of Photography, Film and Television.

Candidates should be conversant with ½", ¾" and 1" black and white and colour equipment and be capable of electronic maintenance. Experience in professional broadcasting would be an advantage, as well as an interest in experimental video work. The successful applicant will be expected to assist in running studio productions, and video tape editing.

Salary scale within: £3,640-£5,353 inclusive.

Application forms returnable within 14 days, obtainable from the Senior Administrative Officer at the College. Tel. No. 735 8484 Ext. 227.

ilea INNER LONDON EDUCATION AUTHORITY

Broadcast Transmission Engineers

Train for a future in Broadcasting

We require Engineers qualified, or about to qualify, at least to HNC, HTC or equivalent level and possibly with a few years' experience, who will be trained to operate and maintain the advanced electronic equipment at our Transmitting Stations throughout the country bringing Independent Television and Radio into millions of homes.

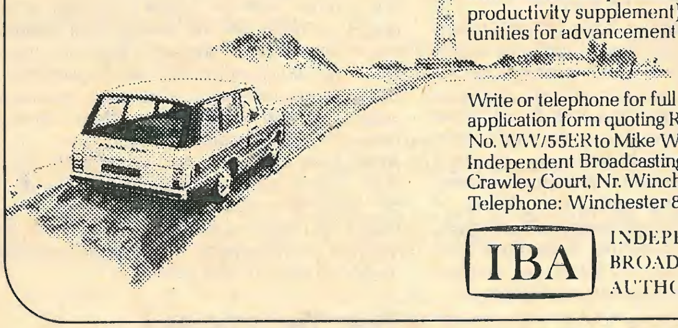
Our Engineers fulfil a mobile role, being required to maintain equipment anywhere within a specified area. You will, therefore, need a driving licence.

Paid while you train

You must be prepared to undergo our demanding eighteen months training course, which combines theoretical study with practical familiarisation training on stations, which will give you a comprehensive knowledge of broadcasting operations and maintenance techniques. You will be paid a training salary on a scale up to £3,792 per annum (inclusive of a productivity supplement), depending upon experience.

The Future

On completion of your training, you will be a full-time engineer on a salary range of £4,715 to £5,688 per annum, (inclusive of a productivity supplement). There are opportunities for advancement to higher grades.



Write or telephone for full details and an application form quoting Reference No. WW/55ER to Mike Wright, Independent Broadcasting Authority, Crawley Court, Nr. Winchester, Hants. Telephone: Winchester 822574.

IBA INDEPENDENT BROADCASTING AUTHORITY

8860

APPOINTMENTS IN ELECTRONICS
£5 – £10,000

Take your pick of the permanent posts in:

MISSILES — MEDICAL
COMPUTERS
RADAR — COMMS
MICROPROCESSOR
HARDWARE — SOFTWARE

For free expert advice and immediate action on salary and career improvement, 'phone or write to, Mike Gernat BSc.

Technomark
[illegible]

11 Westbourne Grove
London W2. 01-229 9239

CAPITAL APPOINTMENTS LTD.

FREE JOBS LIST
for
FIELD SERVICE ENGINEERS
BASIC SALARIES TO
£7,000 + CAR

(8781)

30 Windmill Street, London, W1
01-637 5551

Experienced in television engineering?
Join Middlesex Polytechnic as our

Technical Operations Manager

Centre for Television and Film

Salary scale rising to c. £7000 pa inc.

To be responsible for the operation, management and development of the Polytechnic's new television and film centre at Cockfosters, North London.

As the most senior technical member of staff, you will play a major role in the overall development of the centre, its personnel, and the services offered to students and staff.

Considerable experience in professional television engineering and film operations, a lively interest in research and development work, and appropriate qualifications are expected. An enthusiastic and outgoing attitude, together with a willing 'hands on' approach whenever needed, are also looked for.

Write quoting ref. 136.6F for further details and an application form, posting first-class to: Appointments Officer, Middlesex Polytechnic, Bounds Green Road, London N11 2NQ. Closing date 25 January.

(8863)

Middlesex Polytechnic

AUDIO + VIDEO LTD.

We require top grade Engineers capable of servicing and maintaining to a high standard, all types of video tape recorders. Experience of all U-matic, VCR, VHS, Betamax of 2" Quad machines is essential. Highest rates paid.

Other equipment in-house includes Vidicon and Flying Spot Mk III Telecine, DICE Standards Converter, TBCs etc.

Please phone Cliff Carroll on 01-580 7161

8711

Quality Assurance

Test Gear and Test Engineers

WELLS, SOMERSET

EMI Electronics Limited, a Company within the EMI Group, is involved in the research, design, development and manufacture of advanced electronic equipment. The Company invites applications for the following posts.

PROJECT QUALITY ENGINEERS

To work with development teams, with responsibility to ensure compliance with customers requirements, on a wide range of technologically advanced projects.

TEST GEAR ENGINEERS

To maintain and calibrate a wide range of modern test equipment to Def. Std. 05-26.

TEST ENGINEERS

To test and diagnose faults on: Analogue, digital and R.F. Circuits, or - pulse and R.F. Transformers.

We are looking for men and women of at least ONC (or equivalent standard) and with proven quality assurance experience.

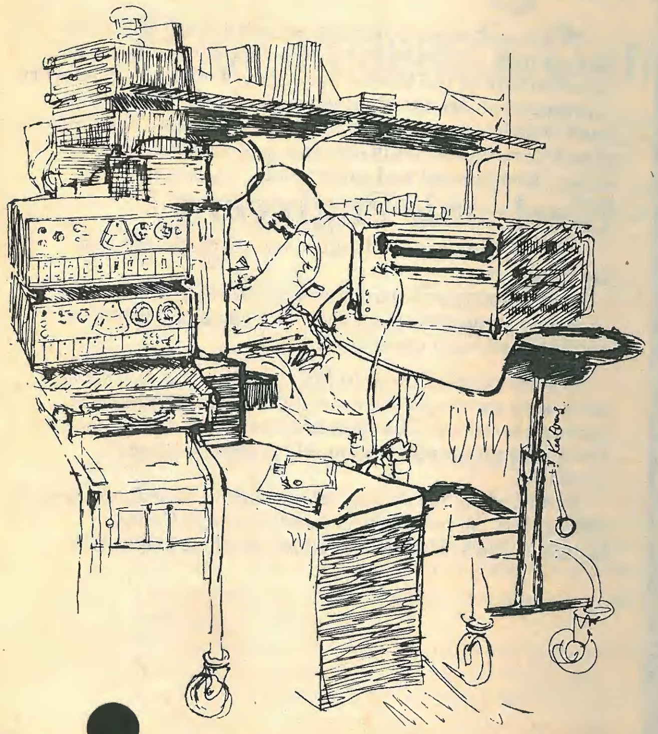
Competitive salaries are offered together with (where appropriate) assistance with relocation expenses.

Please write or phone for an application form (quoting Ref. WW 104) to: D. K. Shires, Personnel Manager, EMI Electronics Limited, Wells, Somerset. (0749) 72081.

(8885)

EMI **EMI Electronics Limited**
Wells, Somerset BA5 1AA. Tel: (0749) 72081
A member of the EMI group. International leaders in music, electronics and leisure.

Marconi Instruments



ELECTRONIC TECHNICIANS

Opportunities for the experienced and sometimes inexperienced in St. Albans and Luton.
Work situations range from fault finding on PCB's and components, to batch product testing of equipment that utilise very advanced techniques including microprocessors and the repair/calibration of all manner and types of test instruments.
Attractive salaries and, where appropriate, relocation are offered for the right candidates.
Further information may be obtained in confidence from John Prodger
Marconi Instruments Limited,
Longacres, St. Albans, Herts. tel: St. Albans, 59292

A GEC-MARCONI ELECTRONICS COMPANY

(8638)

mi

How to find a better job without leaving your armchair.

Don't for a single moment question your motives. Striving for a higher income is a philosophy practised by people in all walks of life.

Perhaps though, you cannot get a fair picture of the opportunities available from the standard, limited sources of job information.

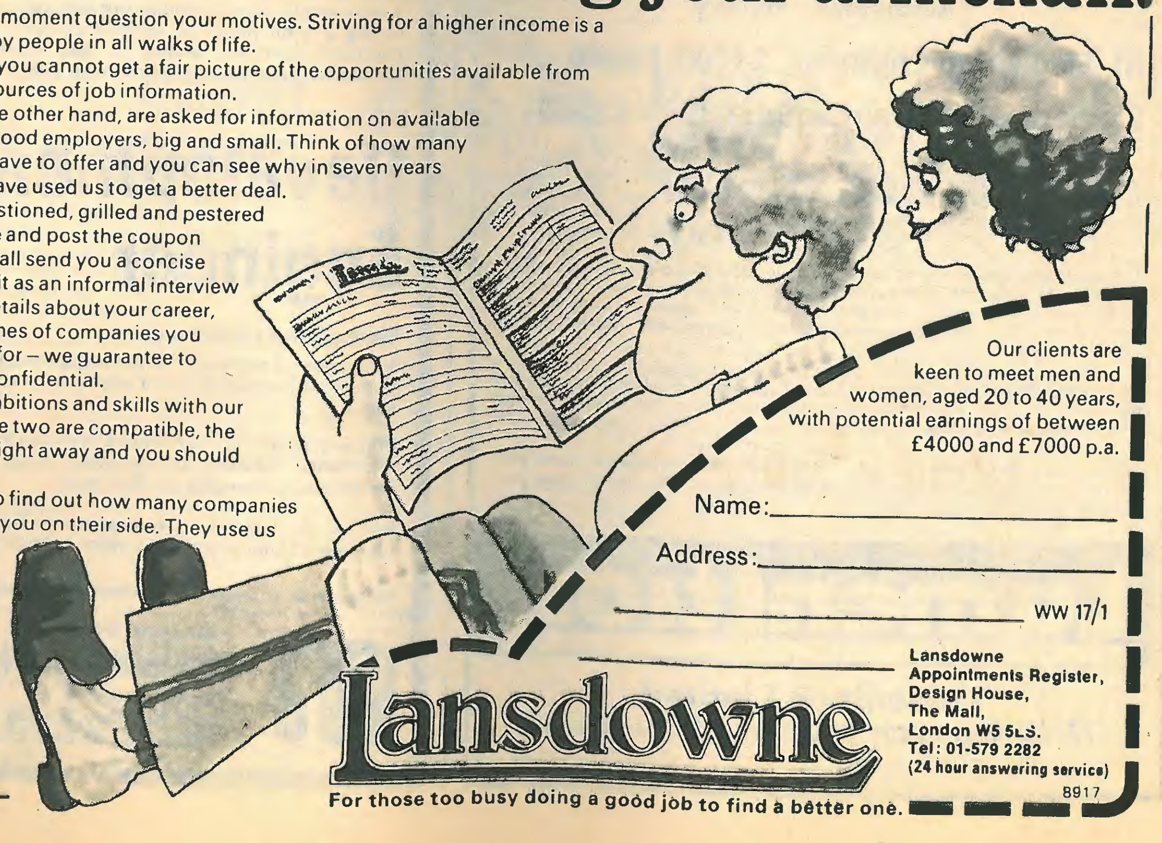
Lansdowne on the other hand, are asked for information on available people by over 3,000 good employers, big and small. Think of how many different careers they have to offer and you can see why in seven years thousands of people have used us to get a better deal.

You won't be questioned, grilled and pestered by us. Simply complete and post the coupon below. By return we shall send you a concise application form–treat it as an informal interview giving us all relevant details about your career, aspirations and the names of companies you would not like to work for – we guarantee to keep this information confidential.

We match your ambitions and skills with our clients' needs. When the two are compatible, the clients hear about you right away and you should get an invitation to talk.

Take this chance to find out how many companies are interested in having you on their side. They use us because our method is simple, quick, efficient.

Lansdowne Appointments Register, Design House, The Mall, London W5 5LS.
Tel: 01-579 2282
(24 hour answering service).



Our clients are keen to meet men and women, aged 20 to 40 years, with potential earnings of between £4000 and £7000 p.a.

Name:____________________

Address:____________________

____________________ WW 17/1

Lansdowne

Lansdowne Appointments Register,
Design House,
The Mall,
London W5 5LS.
Tel: 01-579 2282
(24 hour answering service)

8917

For those too busy doing a good job to find a better one.

Electronic Engineers

Make Hanslope Park your next stop

The Government Communications Centre at Milton Keynes now requires several of the above qualified staff to contribute to the Centre's growing reputation. Our work is often novel, always challenging and requiring a high level of dedication and application to the task. The fields of work are increasingly offering new opportunities for career development and experience.

Electronic Engineers

VHF, HF general and digital circuitry, design and development.

Minimum qualification needed is HNC.

Salaries ranging up to £5448 per annum, depending on qualifications and experience.

We are situated close to Milton Keynes, a fast growing town with many modern entertainment, shopping and sporting facilities. The area is crossed by several main travelling routes and reasonably priced housing is available.

Please apply for an application form to the Recruitment Officer, HM Government Communications Centre, Hanslope Park, Hanslope, Milton Keynes, MK19 7BH.

Hanslope Park – is vital to your career.

8911

ELECTRONIC ENGINEERING

Automotive Industry

A) Electronic Engineer, £4000-£5000

B) Electronic Technician, £3000-£3500

Lumenition, an expanding company engaged in the automotive electronic ignition and fuel injection field wish to appoint additional staff to their research and development team. The company forms part of the successful Autocar Equipment Limited group. Lumenition automotive ignition systems are sold to customers throughout the United Kingdom and in countries overseas.

The appointees will be part of an engineering team which is dedicated to the development of new, advanced systems. They will need to have an engineering background and for position (A) a degree or HNC level qualification ideally with two or three years' experience in analog or digital systems and opto-electronics will be required.

For position (B) an ONC in electronics would be useful but not essential as the duties will be biased towards practice rather than theory and will involve the interpretation of diagrams.

Please write to the General Manager, stating age, experience, current salary and stating for which position you are making application. Indicate also how you consider you meet the requirements.

Lumenition®

Lumenition Limited
77/85 Newington Causeway, London S.E.1

(8882)

Electronics Engineering

Sound experience as important as qualifications.

A well established, growing organisation, manufacturing and marketing a wide range of synchro-conversion products and microcomputer systems, wishes to hear from experienced personnel particularly concerning the following appointment.

Development Engineer

Starting circa £5,500 p.a.

A minimum of two years' sound practical experience in Analog/Digital techniques is essential and if you have an HNC or Degree so much the better.

Starting salary for the above appointment depends largely on experience. Salaries are reviewed twice yearly and our working conditions and benefits are first class.

We are an expanding operation in Surrey and provide ample opportunities for progress for men and women of ability.

Kindly write or telephone in the first instance:

Margaret Holland
MEMORY DEVICES LTD.,
Central Avenue
East Molesey, Surrey
Telephone 01-941 1066

8913

Electronics Engineers and Technicians

Electromagnetic Compatibility

The Underwater Weapons Division of Marconi Space and Defence Systems at Portsmouth needs Professional ELECTRONIC DESIGN ENGINEERS AND TEST TECHNICIANS, men and women, with experience in at least one of the following fields to join the Division for work on an important new weapon.

RADHAZ
Radio Interference Suppression
Electronic System Compatibility
EMC Testing
Filter Design
Shielding Design
EMC Analysis and Prediction

The specialist group in which you would work forms part of a large team. As a member of that team you would have the opportunity of making a significant contribution to the successful attainment of required weapon performance.

Engineers can expect to be involved in some of the following activities:

Critical Analysis of Weapon and Test Equipment Design.
Preparation of EMC Test Plans and Procedures.
Support of RADHAZ, EMP and MAGNETIC tests.
Investigation of EMC problems.
Specification of EMC designs and preformance requirements.
Analysis of Test Results.

and **Technicians** will be involved in:

Operation of EMC Test Equipment.
Analysis of Test Results.
Design and construction of test aids.
Support of engineers.

We can offer you a salary that reflects the true value of your qualifications and experience and an extensive and worthwhile benefits package. If you are not familiar with the attractions of living and working on the South Coast, you are in for a pleasant surprise.

All you have to do now is to decide which of these jobs suits your experience and your ambitions.

Please telephone or write to Ken Hoxey, Marconi Space and Defence Systems Limited, Browns Lane, The Airport, Portsmouth, PO3 5PH. Tel: Portsmouth 64966 Ext. 305 quoting reference CDA.

Marconi
Space & Defence
Systems (Portsmouth)
A GEC-Marconi Electronics Company

8862

RADIO TECHNICIANS

WORK IN COMMUNICATIONS R&D AND ADD TO YOUR SKILLS

At the Government Communications Headquarters we carry out research and development in radio communications and their security, including related computer applications. Practically every type of system is under investigation, including long-range radio, satellite, microwave and telephony.

Your job as a Radio Technician will concern you in developing, constructing, installing, commissioning, testing, and maintaining our equipment. In performing these tasks you will become familiar with a wide range of processing equipment in the audio to microwave range, involving modern logic techniques, microprocessors, and computer systems. Such work will take you to the frontiers of technology on a broad front and widen your area of expertise — positive career assets whatever the future brings.

Training is comprehensive special courses, both in-house and with manufacturers, will develop particular aspects of your knowledge and you will be encouraged to take advantage of appropriate day release facilities.

You could travel — we are based in Cheltenham but we have other centres in the UK, most of which, like Cheltenham are situated in environmentally attractive locations. All our centres require resident Radio Technicians and can call for others to make working visits. There will also be some opportunities for short trips abroad, or for longer periods of service overseas.

You should be at least 19 years of age, hold, or expect to obtain shortly, the City and Guilds Telecommunications Technician Certificate Part 1 (Intermediate), or its equivalent, and have a sound knowledge of the principles of telecommunications and radio, together with experience of maintenance and the use of test equipment. If you are or have been in HM Forces your Service trade may allow us to dispense with the need for formal qualifications.

You start on £2927 at 19, up to £3700 if you are 25 or over, rising to £4252, and promotion will put you on the road to posts carrying substantially more. There are also opportunities for overtime and on-call work paying good rates.

Get full details from our **Recruitment Officer, Robby Robinson, on Cheltenham (0242) 21491, Ext. 2269, or write to him at GCHQ, Oakley, Priors Road, Cheltenham, Glos. GL52 5AJ.** If you seem suitable, we'll invite you to interview in Cheltenham — at our expense, of course.

(8508)

PERSONNEL REQUIRED FOR SAUDI ARABIAN TELEVISION NETWORK

Three Chief Engineers

with considerable experience in Television transmission maintenance. 8200/00 SR month.

Four of Class A Engineers

with experience in maintaining telecine , studio cameras and associated studio video and audio mixers and processors preferably with transmission experience also. 7400/SR/month.

Two of Microwave and Transmitter Engineers

with experience in maintenance of microwave and TV transmitters. 7400/00 SR/month.

Two of Class A Engineers

with experience in maintenance of VTR and studio video and sound equipment. 7400/00 SR/month.

Six Utility and Powerhouse Supervisors

with maintenance experience Diesel Generators up to 250 KVA and Cubical Switchboards up to 750 KVA 400 Volt systems, with control circuitry and switching for mains/diesel systems, three phase wiring and distribution systems, single and three phase motors and pumps, wiring of breaker boards, lighting and heating distribution, maintenance of self-contained and central air-conditioning systems up to 80 tons of both radiator cooling and chilled water types, including associated handling units, cooling tower maintenance, switch gear, relays and controls. 6000/00 SR/month.

Furnished accommodation and other benefits for all positions as per the Contract of Employment which includes return air tickets, 30 days annual vacation, medical treatment, etc.

All applicants should have B.Sc. in Electrical or Electronic Engineering with a minimum of five to seven years' experience, or a two years' High Technical Certificate from a recognised institution or its equivalent with nine to twelve years' maintenance.

All salaries mentioned above are negotiable and dependent upon qualifications and experience.

Applicants should be ready for interview in two or three weeks from now and should be prepared to move to Saudi Arabia immediately after their interview.

Applications tb:

RICHARD JOB LIMITED
41 Whitehall, London SW1

Approx. 6.5 Riyals =)1 Sterling.

(8908)

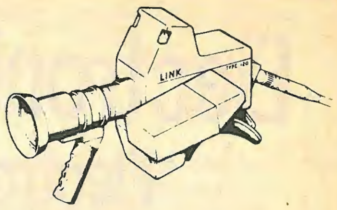
SOUTHAMPTON AND SOUTH WEST HAMPSHIRE HEALTH DISTRICT

Senior Electronics Technician

To be responsible for servicing, maintenance, repair and testing of electro-medical and electronic equipment, including some communication equipment, in an established and expanding team based on Southampton General Hospital site. Candidates should possess Ordinary National Certificate or preferably Higher National Certificate or equivalent in Electronic Engineering. Salary £3,744-£4,788. This post offers wide experience and practical training in medical electronics. Application form and job description from Personnel Department, Tremona Court, Tremona Road, Southampton, telephone Southampton 777222, Ext. 3556. Closing date 9th February, 1979.

(8857)

LINK



TELEVISION

WE ARE	Link Electronics Ltd., a successful expanding company with room for individual ability to make itself felt.
WE MAKE	A full range of TV studio broadcast equipment, including colour cameras.
WE NEED	DEVELOPMENT ENGINEERS at senior and junior levels, to put good theoretical knowledge into practice in circuit design of all types of broadcast equipment, employing the latest techniques. You must have 2-3 years' relevant experience in industry, preferably obtained in a TV or similar environment.
	SENIOR TEST ENGINEER to undertake test and commission of advanced and complex TV cameras and associated equipment. This appointment is at a senior level and so direct experience of similar equipment is a must.
WE OFFER:	
SALARY	Above average, according to ability and not a rigid grade structure.
BENEFITS	Generous holidays, free life and health insurance, pension scheme, staff restaurant, relocation expenses.
LOCATION	A modern factory in a very pleasant part of Hampshire with no traffic problems and easy access to London, the South Coast and many major towns.
HOUSING	A wide choice. Prices from about £15K upwards if you want to buy.
TO APPLY:	Either phone Jean Smith at Andover (0264) 61345 and ask for an application form or write with enough information to make form unnecessary.

LINK
ELECTRONICS

North Way, Andover
Hampshire. England

Telephone. Andover (0264) 61345

(8701)

COVENTRY AREA
HEALTH AUTHORITY
WALSGRAVE HOSPITAL

MEDICAL PHYSICS TECHNICIANS

GRADE II AND III

are required by the Clinical Physics and Bio-engineering Department to join a team involved in the maintenance and development of a wide range of physiological measurement equipment, nucleonic equipment and laboratory equipment. A knowledge of diagnostic maintenance of instrumentation and/or mini computers would be desirable.

Candidates for the posts should hold an ONC, HNC or equivalent qualification. Salary scales: Medical Physics Technician, Grade III, within the range £3744 to £4788 per annum. Medical Physics Technician, Grade II, within the range £4470 to £5610 per annum. Further details can be obtained from Chief Physicist, Walsgrave Hospital. Tel. Coventry 613232, ext. 482. Application forms (quoting ref: WW) obtained from the Sector Administrator, Walsgrave Hospital, Clifford Bridge Road, Walsgrave, Coventry, CV2 2DX. (8886)

HATFIELD POLYTECHNIC
SCHOOL OF HUMANITIES
LANGUAGE LABORATORIES
REF 146

TECHNICIAN

(degree level)

for the servicing and repair of electronic equipment within Laboratories and Departments. This will also involve the repair of Tape and Cassette Recorders, Radio Tuners, Amplifiers, etc.

Work includes the use of the Recording Studio, and the editing and copying of tapes and cassettes.

Candidates, male or female, must be ambitious and able to work on their own initiative.

Salary Scale:
T1: rises to a maximum of £3399 inclusive.
T2: £3399-£3771 inclusive, according to age and qualifications.

Informal enquiries to Mr. A. Wellington, Extension 337.

Application forms for the above post are available from the Staffing Office, The Hatfield Polytechnic, P.O. Box 109, Hatfield, Herts, AL10 9AB, Telephone Hatfield 68100, extension 309. Please quote reference number. (8887)

BORDER TELEVISION LIMITED

have vacancies at their Carlisle Studios for

TELEVISION BROADCAST ENGINEERS

Applicants should be experienced in telecine, VTR and/or CAR operations and maintenance. An academic qualification would be an advantage. Commencing salary up to £6024 per annum (including supplement) depending on qualifications and experience. Applications, in writing, to:

Chief Engineer
BORDER TELEVISION LIMITED
Carlisle, CA1 3NT

(8884)

TOP JOBS IN ELECTRONICS

Posts in Computers, Medical, Comms, etc. ONC to Ph.D. Free service.

Phone or write: **BUREAUTECH AGY, 46 SELVAGE LANE, LONDON, NW7. 01-959 3517.**

(8912)

Can we bring your interest in technical publications to light?

For a company which designs and builds complex electrical and electronic equipment, the technical handbooks on which service engineers and customer operators rely are of vital importance.

At Rank Strand Electric, we need a man or woman with an ONC or sound general electronics knowledge to look after our technical publications section.

We develop and install professional sound and lighting systems, some computer-controlled, and it will be your responsibility to originate or edit technical copy, prepare layouts and indexes for all handbooks, arrange economical printing and then ensure that the information can be accessed when required.

Your experience to date may have been gained as an electronics technician, service engineer or technical information officer. The only real requirements are familiarity with the technology organisational ability and a flair for communicating technical data verbally as well as in writing.

Please contact Valerie Hutchings, Personnel and Training Officer, Rank Audio Visual, P.O. Box 70, Great West Road, Brentford, Middlesex. Telephone: (01) 568 9222.

RANK AUDIOVISUAL

8920

Marine Transmitter Development Engineer

In Marine Division we are responsible for the design and development of advanced HF Communication systems for the Merchant Navy at both low and high powers using solid state techniques as well as valves.

The two engineers we are seeking will have a professional qualification and some years experience of one of the following: Transmitter RF design, solid state drives and frequency generation equipment in general. You should also have the ability to progress your design through the production phase.

Write or phone for an application form to Mr. G. Short, Marconi Communication Systems Ltd., New Street, Chelmsford, Essex. Telephone Chelmsford 53221.

A GEC-Marconi Electronics Company

MARCONI
COMMUNICATION
SYSTEMS

(8859)

WESSEX EDUCATIONAL TELEVISION CONSORTIUM

CCTV ENGINEER

An engineer is required for the Consortium's mobile CCTV production unit which makes video programmes for use in initial and in-service teacher education in this area.

Applicants should have a graduate or full professional qualification.

Inclusive salary ranges from £4773 to £6060, depending on age, qualifications and experience.

Further details from The Director, Wessex Consortium, King Alfred's College, Winchester, SO22 4NR. Phone (0962) 66359.

Closing date for applications is February 2.

(8873)

CAPITAL APPTS.

FREE LISTS

101 Design/Development and Test Jobs

Permanent and Contract

To £6,000

(8782)

29, Windmill St.

London, W.1.

637 5551 day: 636 9659 eve.

Broadcasting Engineer

enjoy the benefits of working at the fore of broadcasting technology

We require an Engineer, male or female, qualified to HNC or equivalent level, with at least three years' experience in a broadcasting discipline to maintain the advanced electronic equipment at our main transmitting stations and relay stations bringing Independent Television and Independent Local Radio into millions of homes.

The successful applicant will become a member of a team based at our Black Mountain Transmitting Station, Hannahstown, Dunmurry, Northern Ireland and will be required to travel throughout Northern Ireland. A current driving licence is required. The post will involve some week-end working. Equipment familiarisation training will be provided.

The salary will be on a scale up to £5,688 per annum, with provision for movement on to a higher scale rising to £6,399 per annum. These rates are inclusive of a productivity supplement.

Relocation expenses will be paid where applicable.

IBA INDEPENDENT BROADCASTING AUTHORITY

Act now! Write or telephone for an application form quoting Ref. No. WW/35ER to:– Mr. M. Wright, Personnel Officer – Engineering Regions, Independent Broadcasting Authority, Crawley Court, WINCHESTER, Hants. SO21 2QA. Telephone No: Winchester 822574.

8861

Oxfordshire AREA HEALTH AUTHORITY (TEACHING)

ELECTRONICS TECHNICIANS

M.P.T. III £3,744-£4,788

M.P.T. IV £3,069-£4,143

For the Nuffield Department of Anaesthetics, a busy University Teaching Hospital Department. These new posts are due to the imminent opening of the John Radcliffe Hospital. Duties will include the maintenance and repair of electronic patient monitoring and laboratory apparatus, as well as modification and development of clinical equipment. The Department offers an electronics service to many other departments and possesses a strong technical structure.

Applicants for the Grade IV post will have 2 years' experience and 5 years' experience for the Grade III post and will be qualified to ONC/HNC (Electronics).

Application forms and further particulars from Nr. J. B. Thompson, Principal Chief Technician, Nuffield Department of Anaesthetics, Radcliffe Infirmary, Oxford.

(8855)

Design / Development Engineer

Labgear Limited, a member of the Pye of Cambridge Group of Companies involved in the development and manufacture of Television RF distribution, Service Test and Teletext equipment, requires an Engineer, male or female, of at least HNC or equivalent standard with a minimum of two years' experience in electronics, preferably with the television industry.

The post could, alternatively, offer an excellent opportunity to a university graduate to enter an industry which is continually expanding in both analogue and digital techniques.

This pensionable post carries an attractive salary, 20 days' holiday and where appropriate assistance with relocation expenses.

Please write giving details of your experience to:
Mr. C. Houghton, Personnel Manager

Labgear Ltd
Abbey Walk, Cambridge CB1 2RQ
Tel: Cambridge 66521

(8912)

SALES ENGINEER

Zettler require an enthusiastic Sales Engineer for their rapidly expanding relay sales programme.

The person appointed, aged 20/40, should have an electrical engineering background and preferably some sales experience. Applicants without previous sales experience will also be considered.

A good salary, commensurate with experience and ability, will be paid, plus company car. Assistance given with re-location to Harrow area.

Applications in writing please, giving brief career details, to **The Divisional Director, Zettler UK Division, Brember Road, Harrow, Middlesex HA2 8AS. Tel. No: 01-422 0061.**

(8888)

THE UNIVERSITY OF LEEDS

DEPARTMENT OF CARDIOVASCULAR STUDIES

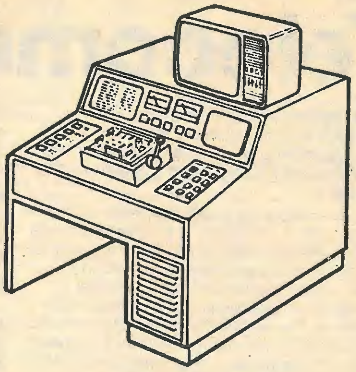
Applications are invited for the post of ENGINEER OFFICER (Electronics) in the above Department which operates in the New Medical School and two hospitals. Responsibilities will include the design and development of electronic equipment for use in biological and physiological instrumentation and the successful candidate wil be expected to collaborate in research into new applications for physiological investigations. He/she will also be expected to provide effective liaison with the electronics technicians in the University department and the hospitals. Applicants should have an honours degree in Electronic Engineering together with proven experience in the application and development of electronic instrumentation equipment preferably in the medical field. A knowledge of digital techniques including the use of microprocessors would be an advantage.

Salary at an appropriate point on either the grade IA or II scale for Other Related Staff (£3883-£6555 or £6317-£7754) according to age, qualifications and experience.

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT, quoting reference number 105/9/CI. Closing date for applications: 5th February, 1979.

(8854)

TEST EQUIPMENT ENGINEERS



Come and join Rediffusion and help us design a brand new range of test equipment for production testing our future colour receivers. Our present equipment is a combination of sophisticated manual and automatic test consoles employing both analogue and digital circuitry. We are currently looking at the application of microprocessors to the testing of television modules and are confident that our future equipment will take advantage of these latest techniques.

Applications are invited from well qualified and experienced test equipment engineers to join our energetic young team at Chessington, Surrey, working in a congenial and stimulating environment. We have vacancies at both senior and intermediate levels, offering excellent salaries and opportunities for career advancement in this exciting field.

Since engineers are expected to see their projects through to completion, some travelling to our factories in the North East is expected to assist on installation and commissioning and to give back-up service where necessary.

Additionally, an intermediate engineer is required to be based at Bishop Auckland in our Engineering Department on the main factory site. This position involves some design and development work interspaced with the planned maintenance of complex production test equipment.

If you are interested in these challenging positions and would like more details or wish to discuss the matter in depth, please write to or telephone:

REDIFFUSION

Mr H. Brearley,
Rediffusion Consumer Electronics Limited.
Fullers Way Sth., Chessington, Surrey KT9 1HJ
Telephone: 01-397 5411

8892

ELECTRONIC BLOKES!

YOU ARE NEEDED AND APPRECIATED!

Electronic Blokes have evolved from the dedicated electronic engineers of the 1960s. Past masters at doing their job with the minimum of effort, their unequivocable zeal is directed into — designing their own hi-fi, reading scientific journals (particularly Sits Vac), stocking the bit box and creating an amicable working environment — their hole.

Our client, a manufacturer of computer peripheral equipment needs electronic blokes who will desist from these activities for a few hours and help their employer try to:

1. Improve track location and reduce access times on head positioners.
2. Devise methods to identify and eliminate data errors on disc files and floppys.
3. Get rid of bugs and beetles in heads, discs and data channels.
4. Design test equipment to measure nano-second wide pulses.
5. Evaluate methods for testing — guess what? — the microprocessor itself.

CASH REWARD — Excellent for the bloke who wants to get off his backside, display some enthusiasm, and develop his financial acumen.

Location 20 miles due west of London.

For further details, contact:

Charles Airey Associates

"PROBABLY THE BEST KNOWN SUPPLIER OF ELECTRONICS ENGINEERS IN THE COUNTRY" — FINANCIAL TIMES

155 KNIGHTSBRIDGE, LONDON, SW1. TEL: 01-581 0286

(8864)

Electronic Engineers

£4815 – £6643

There are vacancies for electronic engineers with experience in the design and specification of audio frequency, CCTV, CATV and mobile radio systems. These vacancies are in a number of grades with differing responsibilities and requirements.

Qualifications required for the higher positions are degree or chartered engineer status (IEE or IERE).

HNC, ONC, City & Guilds or equivalent are required for the junior posts.

Appointments will be made depending upon qualifications and experience. We offer excellent conditions of employment including 4 to 5 weeks leave and a pension scheme.

Write or telephone for an application form, returnable by 2 February to the Establishment Officer (ME/Estab/931/AC/021) Room 510, 1 Queen Anne's Gate Buildings, Dartmouth Street, London SW1H 9BS. Tel: 01-633 5700.

GLC Mechanical & Electrical Engineering

(8865)

SITUATIONS VACANT

Telecommunications

We require staff, male or female, to prepare and maintain the latest in communications equipment used by the Police and Fire Brigade in England and Wales.

You will need to be qualified at least to City and Guilds Intermediate Telecommunications standard and be able to demonstrate practical skills in locating and diagnosing faults in a wide range of equipment from computer based data transmission to FM and AM radio systems. You would live near to and work from one of our service centres located throughout England and Wales or our Headquarters in the London area. Specialised courses of training are run to assist staff to keep up to date with developments and new equipment, and there are opportunities for day release to gain higher qualifications. Applications from registered disabled persons will be considered.

Promotion prospects are good and the work represents a secure future with generous leave allowances and a non-contributory pension scheme.

Possession of a driving licence is essential since some travelling will normally be involved.

The salary is £2627 (at 17), £3176 (at 21) and £3700 (at 25), rising to a maximum of £4252.

If you are interested in working with us, then write for further details and an application form stating where you are interested in working, to:

Mr C B Constable Directorate of Telecommunications Horseferry House Dean Ryle Street LONDON SW1P 2AW Telephone: 01-211 6420

HOME OFFICE

8894

A TELEVISION STUDIO ENGINEER

is required to assist in the operation and maintenance of the University's television unit and other audio-visual production.

Applicants should have a wide experience of television studio techniques including lighting, camera operation and vision control, and a good knowledge of sound recording.

Experience of helical scan video recording systems would be an advantage.

Salary scale (under review) £4107-£4749 according to age and experience.

Write giving details of age, qualifications and experience to: The Director, University of London Audio Visual Centre, 11 Bedford Square, London WC1B 3RA.

(8918)

ELECTRONICS TECHNICIAN (Grade 5) required in Department of Psychology, University of Reading. Candidates should have, or be completing, Final C & G in electronic servicing or equivalent. Salary in scale £3186-3720 p.a. Apply with full details and names of 2 referees, quoting Ref. T.W.W. 66A, to Assistant Bursar (Personnal), University of Reading, Whiteknights, Reading RG6 2AH. (8901

Dublin Corporation
Bárdas Átha Cliath

ASSISTANT SUPERINTENDENT (Waterworks)

Dublin Corporation has a vacancy for an Assistant Superintendent in its Waterworks Section. The successful candidate will be based at Ballymore Eustace Reservoir.

QUALIFICATIONS: Applicants must:

(a) hold a National Diploma in Engineering (Electronics, Industrial Electronics or Telecommunications Electronics) or an equivalent qualification in Electronics or Instrumentation AND

(b) have had at least three years' satisfactory experience in Sanitary Services Works (water supply and/or sewerage or in Industrial engineering).

AGE LIMIT: Not less than 23 years and not more than 45 years on 1st February, 1979.

SALARY SCALE: £5,597 x £121 - £5,839 x £120 - £6,559 per annum.

For application forms apply to:
Personnel Department, 55 Aungier Street, Dublin 2.

Latest date for receipt of completed application forms: Friday, 16th February, 1979.

(8876)

UNIVERSTY OF LEEDS. Electronics Technician — Grade 5 required in the Department of Physiology. The person appointed will be responsible to the Supervisor of the Electronics Workshop for the development, construction and maintenance of electronics equipment associated with research and teaching of biological studies. Candidates should hold ONC or equivalent qualification in relevant subjects and have at least, 5 years appropriate experience. Salary on the scale £3,186 to £3,720 (under review) according to qualifications and experience. Applications stating age, qualifications and full experience, together with the names and addresses of two referees, should be addressed to Mr E. French, Departmental Superintendent, Department of Physiology, Medical and Dental Building, Leeds LS2 9NQ. (8783

RADIO TELEPHONE SERVICE ENGINEER required in Croydon. Proven ability to repair equipment more important than formal qualifications. Salary commiserate with ability. Contact LONDON CAR TELEPHONES on 01-680 1010. (8822

ARTICLES FOR SALE

LOW COST LOGIC ANALYSER Paratronics Model 100A plus Model 10 Trigger Expander and full instructions. Use with scope for memory mapping etc. Also an A.T.E. Systems Ferret Model E56200 circuit tester plus frequency to voltage plug in unit, plus add-on p.c.b. so that programms can be stored in 2716 PROMS. Both in first-clas as new condition. Offers phone Bicester (086 92) 44551, ask for R. Tuthill. (8894

AMPEX

the world's leading manufacturers of magnetic recording equipment have the following vacancies:

BROADCAST ENGINEERS
resident in Africa and the Middle East

We are looking for Broadcast Engineers with VTR experience to take up resident engineering positions throughout Africa and the Middle East.

We offer:

★ Attractive salaries
★ Home leave every three to four months
★ Free accommodation
★ Free transport
★ Free medical insurance

If you have had several years' experience in broadcasting and are looking for something different, interesting and demanding, why not give us the opportunity of discussing the above contracts with you.

BROADCAST ENGINEERS
based in Athens

How would you like to join a team of professional engineers based in Athens, to travel the Middle East and Africa and to receive product training on the world's leading video tape machines? Attractive salaries and conditions are offered for these positions.

Please send your curriculum vitae to **Mr. Don Cameron, Engineering Manager, Ampex World Operations S.A., P.O. Box 45, Halandri (1), Athens, Greece.**

(8874)

ARTICLES FOR SALE

LAB CLEARANCE: Signal Generators; Bridges; Waveform, transistor analysers; calibrators; standards; millivoltmeters; dynamometers; KW meters; oscilloscopes; recorders; Thermal, sweep low distortion true RMS, audio FR, deviation. Tel. 040-376236. (8250

G.W.M. RADIO LTD., 40/42 Portland Road, Worthing, Sussex. Tel. 34897. Pneumatic masts 40ft. By Scam Clark. 300 watt radar calorimeters, noise generators, type CT410, Eddystone communication receivers 730/4, v.g.c. £185.00 inc. Many bargains for callers, surplus always wanted. (8832

PATCH BOARD V.G.C. 60 x 60 single XY bussing on 6mm matrix. Also pins and plugs, suit big synth, rom programmer, mixing desk, etc., £370. Mike Boyd, 0234 750111, ext 273 or 751104 evenings. (8902

TEKTRONIX OSCILLOSCOPES type 545A DC/24MHZ with type CA D/trace plug-ins, handbooks, in good clean condition, £250 each inclusive. 14 Braidley Road, Bournemouth 0202 29148. (8906

WIDE selection unused discrete and logic (TTL/ECL) components; pre-aged 5MHz 3rd. overtone crystals; 7 segment 0.63'' LED displays; muffin fans; transformers, etc. Full stock list sent on request. Send S.A.E. to Coope Durrant Ltd., 66/67 High Street, Lymington, Hampshire, England S04 9YZ. Tel. Lymington (0590) 77971. (8835

MARCONI SINE SQUARE PULSE/bar generator TF 2905/8, £400 mint; TF 791D deviation meters £100; 1 Henry standard inductance tinsley 4109C £100; AV08, £65; AVO 7D £50. Please add 8% VAT. Q Services Electronic Camberly Ltd, 0252 871048. (8900

ARTICLES FOR SALE

HP 8551 Spectrum Analyser (.0V 42 GHz). R&S Polyskop I (0.5-400 MHz). Tek 531, 532, 545, 585, 575, 581 Scopes (inc. 453). Solartron LM 1420 D.V.M. Telegraph Distortion Measuring Equipt. Nagard, E-H Pulse Generators. Telonic LH-2M Sweep Oscillator. A.F. & R.F. Signal Generators. Marconi TF 1041 V.T.V.M. Advance VM 77D A.C. Millivoltmeter. R&S Sweep Oscillator. Sandos SG313 Sig. Gen. (4-7GHz). Marconi TF1313 ¼% Universal Bridge. Marconi T.V. Test Equipt. Siemens Level Meter (10KHz-17MHz). Wandel & Goltermann Noise Receiver. MP 250B RX Meter (0.5-250 MHz). Marconi TF801B Sig. Gen. (12-425 MHz). Advance Timer Counters TC6, TC4. Farnell Stats P.S.V. 30T/2/EC. MP185B Sampling Scope (>10ns/cm). Airmec 365A Sig. Gen. (1-320 MHz). Standards Equipt.: Potentiometers, Bridges, S/S Meters, Capacitors. COHU Thermal Transfer Standard Model 666 & Galvo. Marconi TF 867/2 Standard Sig. Gen. (15 KHz-30 MHz). Marconi TF 1066 FM & AM Sig. Gen. (10-420 MHz). Advance V.H.F. Millivoltmeter VM79. BPL 10KV Insulation Tester. Racal 835 Universal Counter. Paper Tape Readers ★ IBM Printers with Keyboards ★

Compare our prices.

P&R TEST EQUIPMENT

Salcott Mill, Goldhanger Road, Heybridge
Near Maldon, Essex (8748)
Open Saturday: Tel. Maldon (0621) 57440

SOWTER TRANSFORMERS

WITH 37 YEARS' EXPERIENCE we have the expertise to design and manufacture ANY TYPE OF AUDIO TRANSFORMER AT THE RIGHT PRICE.

Whilst we specialise in every kind of transformer for audio control desks and mixers demands are increasing for **LOUDSPEAKER TRANSFORMERS** and **100 VOLT LINE AUDIO OUTPUT TRANSFORMERS** FOR MOST KINDS OF AMPLIFIERS FROM 30 WATTS TO 500 WATTS OR MORE. We can also supply multi-output transformers for **COLUMN LOUDSPEAKERS.** A recent tendency is the demand for **OUTPUT TRANSFORMERS FOR ULTRA LINEAR AMPLIFIERS** using **KT 88** and **KT 66 BEAM TETRODES** and for these we have standard designs with exceptional performance.

We call your attention to our very successful **MICROPHONE SPLITTER TRANSFORMER** type 4079 with a high impedance 200 ohm primary and two 200 ohm secondaries. It will handle up to 2.3 volts rms at 30 Hz and has a frequency response of plus/minus ½dB from 20 Hz to 20 kHz. It is contained in a Mumetal Can 33 mm diam x 37 mm high and WORKING DETAILS OF THE CONSTRUCTION OF A SPLITTER ARE AVAILABLE ON REQUEST.

We will supply single transformers, or any quantity, with short delivery times and, without obligation on your part, will quote price and exact dispatch on receipt of your requirements.

E. A. SOWTER LTD., Manufacturers and Designers, P.O. Box 36 IPSWICH IP1 2EG, ENGLAND. Tel. IPSWICH (0473) 52794 and 219390.

(8289)

THE FABULOUS D2
MICROPROCESSOR EVALUATION
KIT FROM MOTOROLA

Featuring *24 key keyboard *Seven segment display *Cassette interface *Erom & Ram Expandable *Interface Capability. *Full Documentation *5 Volt power supply required *One year's FREE membership of The Amateur Computer Club with every purchase* **£176** + £1.50 P&P + 8% VAT.

ENAMELLED COPPER WIRE

SWG	i lb	8 oz	4 oz	2 oz
14-19	2.60	1.40	.66	.55
20-29	2.80	1.60	.85	.65
30-34	3.00	1.70	.95	.70
35-40	3.35	1.90	1.10	.79
40-43	4.50	2.50	1.90	1.25
44-46	5.00	3.00	2.10	1.65
47	8.00	5.00	3.00	1.76
48	15.00	9.00	6.00	3.30

Tinned Copper, Even Gauges 14-30 £3 per lb. Multicore 60/40 Solder 18SWG £3.24 per lb. Prices include P&P and VAT.
SAE brings list of copper and resistance Wires.

THE SCIENTIFIC WIRE COMPANY
PO Box 30 London E.4 (7771)

TEST EQUIPMENT

Waveform Monitor MN6/503/131 **£50**; Marconi TF 801 Signal Generator (10 to 310 MHz) **£90**; Marconi TF 1060/2 UHF Signal Generator (450 to 1200MHz — Marconi tested and calibrated 1977) **£300**; Advance OS 2100 Oscilloscope (tested and calibrated 1977) **£400**; Telequipment D66 Oscilloscope **£250**; Unused Levell R601S Resistance Box **£30**; Telectro Signal Generator (0-200KHz) **£60**.

COOPE DURRANT LTD.
66/67 High Street, Lymington
Hampshire, England, SO4 9YZ
Tel. Lymington (0590) 77971
(8834)

NE 2528 NE 2528 NE 2528 NE 2528 NE 2528 NE 2528. Four add on oscilloscope. Storage unit. £5 each. Quantity discount. Send S.a.e. for full list. C. P. Developments, 16 Hughenden Road, High Wycombe, Bucks. (8916

ENAMELLED COPPER WIRE

s.w.g.	*1lb reel*	*½lb reel*
10 to 19	**£2.95**	**£1.60**
20 to 29,	**£3.15**	**£1.80**
30 to 34	**£3.45**	**£1.90**
35 to 40	**£3.65**	**£2.10**

All the above prices are inclusive of postage and packing in UK

COPPER SUPPLIES
102 Parrswood Road, Withington,
Manchester 20
Telephone 061-445 8753 (100)

WAYNE KERRBRIDGE. Type CT375 (B521) price £5.40. Marconi sweep signal generator type TF 1099/35 £86.40. Voltimeter TF 1041B £37.80. Foster Mains isolation transformer 240v. single phase, 5KVA power rating, 200 kv test primary and secondary. 150 kv d.c. working Pri. 21.3 Amps, Sec. 20.8 Amps, 440 kg (weight), £599. TF1101 R.C. Oscillator £70.20. Cambridge Decade Bridge (Portable) X1, X10, X100, X1000. Ratio: X.001, X.01, X0.1, X1, X10, X100, X1000. Price £54. Insulator Tester CT318 (500v-15KV) £54. TF801D/8/S A.M. Signal generator Freq. 10MHZ £485. MHZ £297. Digital Voltmeter, LM1480.3 £54. Oscilloscope 645 with CA plug-in unit £162. Plug-in units: L32.40, M£135, N£81. Signal generator set CT 378A Freq. 2MHz-250 MHz Portable £64.80. Racal Probe Electronic Test for Racal Timer-counter type CT488 or SA550 £21.60. Signal generator frequency swept type CT202 (as new) £27. ALL PRICES INCLUDE V.A.T. AT 8%. Buyer collects. Tel. 404 5011 (London) or telex 24224. Quote Ref. 3165. F. R. G. General Supplies. (8919

GWYNEDD HEALTH AUTHORITY. One x 120ft. heavy duty Skymast, single pole (in sections) complete with guy wire ropes. In good condition. Buyer to arrange transport. View by arrangement with Mr Gwynfor Williams, Ambulance Headquarters, Eryri Hospital, Caernarfon, Gwynedd. Tel: Caernarfon 4811. Offers to the Area Supplies Officer, Bodfan, Eryri Hospital, Caernarfon, by noon on 9th February, 1979. (8925

DYNAMCO D.V.M.S. fully calibrated £100 each. Buyer collects. Tel. 0234-44685. (8924

GOLFBALL PRINTERS

IBM 1053 Printer (10-pitch), similar to 735, but separate BCD keyboard, will accept any IBM Golfball Head. Motor is 220v 50Hz. Print solenoids are 50v. Character selection is by Parallel BCD 50v drive to tilt and rotate solenoids — a more useful type (correspondence) in any language can be supplied for **£10 extra.**

Other functions have separate solenoids. Space, backstage, line-feed, tab, carriage return, upper/lower case, red/black ribbon shift. Writing line 13 inches. Max. speed 15 char./sec.

GE optical tape reader PTR661A. Asynchronous stepping 150 char./sec. 8-hole-12V outputs **£25** +8% P&P £1.50 NCR 8-hole punch. 15-char./sec. 115V. **£25**+8% carriage £3.

Supplied in good condition with workshop manual and circuit. Also copy of "byte" article on interfacing. A golfball printer to "Kim" 1.

Price £130 + 8% VAT (in UK)
Carriage/packing to Germany and Holland £35.

HIGH PERFORMANCE POWER SUPPLY KIT

ZERO→30v 5mA→1.5A current limit
O/P resistance 1mΩ (at board O/P)
Noise/ripple<. Very sharp
current limit
Ideal lab standard PSU
Generally idiot proof
Kit of parts/F/G pcb tinned, transformer
controls, wire all components
£11+8%
Schools and Colleges **£10+8%**
P&P 70p

40kHz Ultrasonic Transducers **£2/pair** (15p)
Audio Amp i.c. μA706=TBA641B 5w, 12v 4Ω **£1** (15p)
Vernitron 10.7m Ceranic Filters **65p** (15p)
455 kHz Ceramic Filters **50p** (15p)

Mono Cassette Amp/osc board with circuit **£1.30** (15p)
Stereo Cassette Deck top loading **£9** (60p)
Double V.U. Meter (WW Dolby type) .... **£3 (20p)**
LM107 Op Amp Sim. 307/741 (compensated 301 but no offset null pins) **20p**(10p)
Sprague 30A Mains RF1 Filter . **£4** (60p)
Papst Fan, 4½" x 4½" x 2" 100 c.f.m. **£3.50** (80p)
Humidity Switch Adjustable **£0.50** (15p)
Air Operated Switch ½ p.s.i. ... **£1** (25p)
Mains Latching Relay **80p** (20p)
8-Pin Octal Relays
12v, 24v, 110v DC Coil
11-Pin Octal Relays ...... **£1 ea.** (25p)
24v, 48v DC Coil
115v, 240v, AC Coil

Bead Thermistors N.T.C. Res @ 20" C 250R 1k2 20k 220k 1m4 . **60p** (10p)
Transformers 12v 10A **£5** (90p), 24v 10A **£6** (£1), 9v, 3A **£1.60** (60p), 20v, 1A Toroid 3" dia. x 1". **£2.25** (30p), 6-0-6v 250mA **£1.10** (20p), 6v 500mA **£1.10** (20p), 18v 2.5A **£2.25** (35p), 12 + 12v 36VA **£2.25** (60p), 12v 4A **£2.30** (65p). 15-0-15v 36VA **£2.25** (60p).

† ELECTROLYTICS
4700μ 40v .... **50p**(15p)
15,000μ 50v **£1.25** (60p)
1000μ 63v .... **25p**)12p)
4700μ 63v **80p** (12p)
1μ 600v Paper Cap **65p** (15p)
Ideal for Electronic Ignition

CONVERGENCE POTS . **£5**/100 (40p)
5Ω 10Ω 50Ω 200Ω
2N3773 .... **£2.25** (15p)
2N3442 .... **£1.10** (15p)

W.W. RESISTORS
0.1Ω 1% 10w **20p**
0.3Ω 1% h/sink resistor 25w ... **25p**

P&P shown in brackets. Min. order **£2.**

Add 12½ % VAT to terms marked†. Other 8%.
£2 min. order

KEYTRONICS

332 LEY STREET, ILFORD, ESSEX
Shop open Mon.-Sat. 9.30 a.m.-2 p.m.
Telephone: 553 1863 (8909)

THREE SINEWAVE INVERTERS for sale, 24 volts DC input, 240 volts AC output at 500 VA. Price £220 ono each. 1 Sinewave inverter 100 volts DC input 240 volts AC output at 300 VA. Price £80. Thyristors 10 amp 600 volts, up to 500 amps 1200 volts. Prices on request. Bridge rectifiers 25 amps 800 volts, £3.50 each. Thyristor and Triac regulators of all ratings variable frequency inverters 240 volts single phase input 20-220 volts at 5 to 50 Hertz 3 phase output suitable for standard squirrel cage three phase motors power ranges 2 to 7½ HP. A. T. Wortley, Tel. Leicester (0533) 773577. (8926

ANTENNA BOOSTERS improve weak radio and television reception, price £5 including UK and overseas postage. BII-standard VHF/FM radio, BIIA-30MCS & 135CS bands. B12-VHF television. B45-UHF television. Send for free leaflets. Electronic Mailorder Ltd. Ramsbottom, Bury, Lancs, BLO 9AG. (8898

PAPER TAPE READERS & PUNCHES — GTN 34 punches, 40 CPS, reconditioned by manufacturer £100, Clary 601 readers, 120 CPS, new (boxed) £150, electrographic reader, 300 CPS £90. Friden 2115 punch, 20 CPS £40. Phone 01-540 6224. Mr. Wedgwood. (8907

MARCONI TF 801D/1 GENERATOR £260, TF893 audio power meter £65. AVO 49A £28, Racal RA17 (new) £280, GEC RC660 R/T £55, all ono. Tel. West Drayton 43694 evenings. (8897

SOLATRON CD 1400 DB SCOPE DC to 15 megs, good condition, manual £110 ono. — Phone Woodscaves (Staffs) 388. (8903

60KHz MSF Rugby Receiver, BCD TIME OF DAY OUTPUT. High performance, phase locked loop radio receiver, 5V operation with 1 second LED indication. Kit complete with tuned ferrite rod aerial £14.08 (including postage and VAT). Assembled circuit and cased-up version also available. Send for details, Toolex, Sherborne (4359), Dorset. (8252

TIME?

MSF RECEIVER, built-in 60 KHz antenna, £13.70, or with sequential YEAR, MONTH, DATE, DAY, HOURS, MINUTES, SECONDS display parts (no case or pcb) £24.40.
STILL NO RADIO 4? 200 KHz to Medium Wave Converter £9.70.
V.L.F.? 10-150 KHz Receiver £10.70.
Each easy-assembly kit includes all parts, printed dircuit, case, postage, etc., money back assurance so SEND off NOW.

CAMBRIDGE KITS
45 (WP) Old School Lane, Milton
Cambridge
(8910)

SOLAR CELLS: bits, books and bargains. Send stamp for list or 95p for Solar Cell booklet and Data sheets. Edencombe Ltd 34 Nathans Road, North Wembley, Middlesex HA0 3RX. (8061

BRUEL & KJAER LEVEL RECORDER TYPE 2305, pristine condition, see working, £750. Proaudio Ltd. Walton-on-Thames 21078. (8798

T.V. TUBE REBUILDING. Complete plant, equipment, supplies and training. If you can afford the best contact Western-Whybrow Engineering. Tel. 073 676 2265. (8048

LINSLEY-HOOD 75 WATT AMPLIFIERS constructed and repaired. comprehensive range of spares in stock. I. G. Bowman (Dept WW), 59 Fowley Avenue, Torquay, S. Devon. (8899

HI-FIDELITY DESIGNS No. 1 (a Wireless World publication). We had announced that this publication was out of print but we now discover that we have 350 copies in stock. Due to our announcement, many readers were disappointed, but we are now pleased to inform them that copies are available from The General Sales Manager, Room CP34, Dorset House, Stamford Street, London SE1 9LU. Please forward your order together with your remittance of £1.50 (including P&P) made payable to IPC Business Press Ltd. (8652

Classified

ARTICLES FOR SALE

COLOUR, UHF AND TV SPARES. CEEFAX, ORACLE IN COLOUR. MANOR SUPPLIES "EASY TO ASSEMBLE" TELETEXT KIT. Including TEXAS Decoder. Aerial Input, completely external unit, no further connections to set. Full facilities, mixed TV programme and Teletext, Newsflash. Update, and many special features not found in other units. Demonstration model in operation at 172 West End Lane, NW6. Phone or write for further information.
TEXAS TIFAX XM11 Decoder module, new, £130, p/p £1.00.
NEW COMBINED COLOUR BAR GENERATOR PLUS CROSS HATCH KIT (Mk4) UHF Aerial input type. Eight vertical colour bars plus R-Y, B-Y, Luminance combinations, Grey scale etc. Pushbutton controls. Battery operated £35*, De Luxe case £4.80*, aluminium case £2.40*, battery holders £1.50*, mains supply kit £5.78*, p/p £1.00. Built and tested (battery) £58*, p/p £1.20.
CROSS HATCH KIT, UHF Aerial input type, also gives peak white and black levels. Battery operated, £11* p/p 45p. Add-on Grey Scale kit £2.90* p/p 35p. Aluminium case £2*, p/p 85p. Cross Hatch Unit, complete and tested in De Luxe case £20.80*, p/p £1.
"WIRELESS WORLD" TV Tuner and FM Tuner Projects by D. C. Read. Kits of parts available, CRT test and reactivator kit for colour and mono £19.80 p/p £1.20. UHF Signal Strength Meter kit £18* p/p 90p. 625 TV IF Unit for Hi-fi amps or tape recording £6.80 p/p 70p. Decca Colour TV Thyristor Power Supply Unit, incl. H.T., L.T., etc. Incl. circuits £3.80 p/p £120 Bush A823 (A807) decoder panel £7.50 p/p £1. Bush 161 T-B panel A634 £3.80, IF panel A583 £3.80 p/p 90p. Bush Portable TV 11V stab power supply unit £4.80 p/p £1. Bush CTV 25 Convergence Panel plus yoke, blue lateral £3.60 p/p 90p. Philips Single Standard Convergence Units complete, incl. 16 controls £3.75 p/p 85p. Colour Scan Coils, Mullard or Plessey, £6 p/p 90p. Mullard AT 1023/05 Converg. Yoke £2.50 p/p 75p. Mullard or Plessey Blue Laterals 75p p/p 35p. BRC 3000 type Scan Coils £2 p/p 90p. Delay Lines: DL20 £3.50. DL50 £3.50. DLIE, DLI 85p p/p 45p. Lum delay lines 50p p/p 40p. G8 Tripler £6. BRC 300 Tripler £6.60 p/p 75p. Others available. Philips G8 Decoder part-complete £2.50 p/p 75p. GEC 2040 Ex-Rental Panels. Decoder £5.00. Time Base £5.00, p/p 90p. VARICAP TUNERS UHF: Gen. instr. £3.50. ELC 1043 £4.50, ELC 1043/05 £5.50. VHF: ELC 1042 £4.80, Philips VHF £3.80. Salvaged UHF & VHF Varicaps £1.50 p/p 35p. VARICAP CONTROL UNITS, 3 position, £1.20. 4 PSN £1.50, 5 PSN £1.80, 7 PSN £2.80. Special offer 6 position £1, p/p 35p. UHF Transd. Tuners incl. slow motion drive £2.80, 4 position push button £2.50. 6 psn. £4.20, p/p 90p. Helical Pots 100K, 4 for £1.20 p/p 30p. Thorn 850 Dual Std. Time Base panels 50p. Philips 625 IF panel incl. oct. 50p p/p 70p. Mullard Mono Scan Coils for Philips Stella, Pye, Ekco, Ferranti, Invicta £2.00 p/p 85p. Large selection LOPTs, FOPTs available for most popular makes. MANOR SUPPLIES 172 WEST END LANE, LONDON, N.W.6. Shop Premises. Callers welcome. Thousands of additional items available not normally advertised. (Nos. 28, 159 buses or West Hampstead-Bakerloo Line and British Rail). Mail Order: 64 Golders Manor Drive. London, N.W.11. Tel: 01-794 8751. V.A.T. Please ADD 12½% TO ALL PRICES (EXCEPT WHERE MARKED*. V.A.T. 8%). (60

ARTICLES WANTED

SPOT CASH

paid for all forms of electronics equipment and components.

F.R.G. General Supplies
550 Kingston Road, London
Tel: 01-404 5011
Telex: 24224 Quote Ref 3165
(8742)

BUILD YOUR OWN 9-DIGIT 500MHz HIGH QUALITY COUNTER

Case, Hardware and Circuit Drawings provided
£170 + VAT complete plus £3 P&P
Coope Durrant Ltd.
66/67 High Street, Lymington
Hampshire, England SO4 9YZ
Tel. Lymington (0590) 77971
(8833)

TRANSFORMER PROBLEMS?

1VA-1KVA Prototypes in 7-10 days. Phone Vince Sellar on 06076-66716.

TRENT TRANSFORMERS LTD
Chapel Street
Long Eaton, Nottm.
(8363)

ARTICLES WANTED

MINICOMPUTERS PERIPHERALS INSTRUMENTATION

For fastest, better CASH offer Phone:

CHILTMEAD LTD.
Reading (0734) 586419

WE PURCHASE ALL FORMS OF ELECTRONIC EQUIPMENT AND COMPONENTS, ETC.

SPOT CASH

CHILTMEAD LTD.
7, 9, 11 Arthur Road
Reading, Berks.
Tel. (0734) 582 605

TURN YOUR SURPLUS Capacitors, transistors, etc., into cash. Contact COLES-HARDING & Co., 103 South Brink, Wisbech, Cambs. 0945-4188. Immediate settlement. We also welcome the opportunity to quote for complete factory clearance. (7439

ELECTRONIC SCRAP. Components, etc., Receivers, Transmitters Test Equipment wanted. Ferrographs from £15 in stock. Contact M & B Radio, 86 Bishopgate Street, Leeds 1. Tel. Leeds 35649. (8011

STORAGE SPACE is expensive, why store redundant and obsolete equipment? For fast and efficient clearance of all test gear, power supplies, PC boards, components, etc., regardless of condition or quantities. Call 01-771 9413. (8209

SPOT CASH for all types test equipment, receivers, transmitters, valves, components, cable and surplus electronic scrap. M. & B. Radio, 86 Bishopgate Street, Leeds LS1 4BB. 0532 35649. (8789

WANTED: Semiconductors and clean new components. Quotations by return. Hewitts, 52 Barkby Road, Syston, Leics. LE7 8AF. (8797

CAPACITY AVAILABLE

BATCH Production Wiring and Assembly to sample or drawings. McDeane Electricals 19B Station Parade, Ealing Common, London, W.5. Tel: 01-992 8976. (7531

PCB ARTWORK DESIGN SERVICE with component notation masters and assembly drawings. PADS Electrical Ltd, 01-850 6516, 45 Southwood Road, New Eltham SE9. (7905

CAPACITY AVAILABLE

Wind your own coils

Short runs, Long runs, One type, Many types, Simple, Complex.

You name it

AVO

will help you wind it

AVO LIMITED Archcliffe Road, Dover, Kent, CT17 9EN.
Tel: 0304 202620 Telex: 96283

8915

THORN Thorn Measurement & Components Division

I.H.S. SYSTEMS

Due to expansion of our manufacturing facilities we are able to undertake assembly and testing of circuit boards or complete units in addition to contract development.

We can produce, test and calibrate to a high standard digital analogue and RF equipment in batches of tens to thousands.

Telephone to arrange for one of our engineers to call and discuss your requirements, or send full details for a prompt quotation.

TEL. 01-253 4562
or reply to Box No. WW 8237
(8237)

Specialised PCB Service

Layouts - Photography - Drilling
Roller Tinning - Gold Plating
Legend Printing - Profiling
Special quick prototype service

Crofton Electronics Limited
35 Grosvenor Road, Twickenham
Middlesex - Tel. 01-891 1923

8210

TECHNOVA DEVELOPMENTS offer a comprehensive and fast service in: quality P.T.H., single and double sided PCBs; precision artwork and draughting services. Send drawing etc. for quotation. Samples available. Technova Developments, 136 Whitehall Road, Norwich, Norfolk. Tel. 0603 28015. (8355

HIGHWAY ELECTRONICS. Logic design, PCB artwork, assembly, testing, custom built electronics. Unit 112, Springvale Ind. Estate, Cwmbran, Gwent NP44 5BG. Telephone Cwmbran (06333) 68042. (8347

SKILLED HAND ASSEMBLY, one-offs and small batch runs. I. G. Bowman, 59 Fowey Avenue, Torquay,, S. Devon. (8904

DIGITAL CIRCUIT DESIGN AND DEVELOPMENT printed circuits built to customers specifications from sub units to completed items. Electronic Developments, Louis Road Lake, Isle of Wight, Sandown 3727. (8895

SMALL QUANTITY PCB ASSEMBLY to sample or drawings. Small kits built, first-class workmanship. Write 82 Northern Parade, Portsmouth, Hants. PO2 9LN. (8896

COURSES

THE UNIVERSITY OF ASTON IN BIRMINGHAM

M.SC COURSE IN ELECTRICAL AND ELECTRONIC ENGINEERING

with specialisation in any one of the following:

Electrical Machines
Electrical Machines and Power Electronics
Communication Systems
Electronic Instrumentation Systems
Control Engineering and Digital Electronic Systems
Design of Pulse & Digital Circuits and Systems
Microprocessors.

The Course which commences in October 1979 may be taken on a Full Time Sandwich or Block Release basis, and is open to applicants who will have graduated in Science or Engineering, or who will hold equivalent qualifications, by that date. The Science Research Council has accepted the Course as suitable for the tenure of its Advanced Course Studentships.

A Diploma Course in some of the above topics or in Power Systems, is also open to applicants with the above or slightly lower qualifications.

RESEARCH IN ELECTRICAL AND ELECTRONIC ENGINEERING
Applicants are also invited from similarly qualified person who wish to pursue a course of research leading to the Degree of M.Phil or Ph.D. in any of the above topics or in Electroheat.

Application forms and further particulars from the Head of the Department of Electrical and Electronic Engineering (Ref. M.Sc 5) The University of Aston in Birmingham, Birmingham B4 7ET.

8905

The University of Aston in Birmingham
Gosta Green
Birmingham B4 7ET

UWIST

DEPARTMENT OF PHYSICS
ELECTRONICS AND
ELECTRICAL ENGINEERING

M.Sc./DIPLOMA COURSE IN ELECTRONICS

Applications are invited for places in the full-time one-year MSc/Diploma course in Electronics, commencing 26 September, 1979.
Further details and application forms (returnable as soon as possible) may be obtained from the Academic Registrar, UWIST, Cardiff CF1 3NU.
(8922)

EQUIPMENT WANTED

TO ALL MANUFACTURERS AND WHOLESALERS IN THE ELECTRONIC RADIO AND TV FIELD

BROADFIELDS & MAYCO DISPOSALS

will pay you top prices for any large stocks of surplus or redundant components which you may wish to clear. We will call anywhere in the United Kingdom.

21 LODGE LANE
NORTH FINCHLEY, LONDON N12 8JG
Telephone Nos. 01-445 0749/445 2713
After office hours 958 7624

SERVICES

W.K.F. ELECTRONICS

(R.P.C.B.S. Ltd.)

THE CIRCUIT BOARD SPECIALISTS — UNIVERSAL SUPPLIERS

Contractors for: P.C.B. Production, Contract Drilling, Electroplating, Laminate Cutting.
Services for: Master Artwork Preparation, Process Photography, Circuit Diagrams, Layouts & Legends.
Consultants for: Instrument Engineering, Automatic Control & Applications.

Do-It-Yourself Won't Do: Today's assemblies demand close tolerances.
Goodbye to the Long Wait: 3 to 7 Day Prototype P.C.B. Production Service.
Quotations: By Return. **Guaranteed Quality** on every process.
Short or Long Term Production now acceptable from **1 to 10,000 units.**

We Universally Distribute: Laminate, Carbide Drill Bits & Routers, Process Chemicals (any), Presensitised Laminate, Drilling Machines (Manual, Multi-spindle, N.C./C.N.C. Control), Graphic Art Draughting materials & aids.

We Manufacture to Specification: Quality Circuit Boards (Single or Double Sided with any finish). Due to expansion we now have space available for prototype or long term production.

For Quotations: Submit Copy Masters, Roughs, Circuit or Sample units for costing.

To:

W.K.F. ELECTRONICS
FLEET HOUSE, WELBECK STREET
WHITWELL, WORKSOP, NOTTS.
TEL. WORKSOP (0909) 720695
TELEX: 547616
Telephone Quotations: Ask for pricing.

NOTICE TO OTHER MANUFACTURERS

IS YOUR DRILLING/ROUTING DEPARTMENT A BOTTLENECK?
IF SO TRY OUR SERVICE FOR DRILLING AND ROUTING

THE RATES ARE VERY RESONABLE AND THE FAST SERVICE WILL ENSURE THAT YOUR CUSTOMERS DELIVERIES ARE MET

PRECISION SHEET METAL work, chassis, panels, etc., steel, stainless or aluminium, long/short runs, good deliveries. EES Ltd., Clifford Rd. Monks Road, Exeter 56280 36489. (8060

TEST EQUIPMENT

We are disposing of a considerable amount of good quality test gear including Tektronic scopes at silly prices.

✳ Ring Derek Pattinson now and discuss your requirements.

Crofton Electronics Ltd.
35 Grosvenor Road,
Twickenham, Middlesex.
Tel. 01-891 1923 (8211)

ELECTRONIC CIRCUIT DESIGN AND PROTOTYPE CONSTRUCTION. PCB manufacture and production test services available. We have many years' experience in high power audio, digital relay, counters, MPUs, etc, Microsystems Electronics. Tel. 01-950 5146. (8793

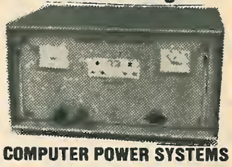
DESIGN SERVICE. Electronic Design Service. We offer a Design Development and Production Service with many years' experience working for Civil and Government Departments throughout the world in Digital and Analogue Instruments, RF Transmitters, Receivers, Telemetery, Video Equipment, including U.H.F. TV Transmitters and Monitors, Cameras, Motoriszed Pan and Tilt Heads, general electronics, including Micro Processors using the latest techniques and hardware. Phone or write Mr. Falkner, R.C.S. Electronics, 6 Wolsey Road, Ashford Middlesex. Phone Ashford 53661. (8341

RADIO AMATEURS EXAMINATION CITY & GUILDS. Pass the important Examination and obtain your G8 licence with an RRC Home-study course. For details of this and other courses (GCE, professional examinations etc), write or phone: The Rapid Results College, Dept: JW1, Tuition House, London SW19 4DS. Careers Advisory Service, 01-947 7272 or ring 01-946 1102 for prospectus only (24hr answering service). (8575

DESIGN AND DEVELOPMENT, competent engineering effort available for all aspects of electronic design. Single circuits or complete systems, prototype to production run. E.I.A., 80 Wheatland Lane, Wallasey, Merseyside, 051-639 9122. (8615

INVERTERS

High quality DC-AC. Also "no break" (2ms) static switch, 19" rack. Auto Charger.



COMPUTER POWER SYSTEMS
Interport Mains-Store Ltd.
POB 51, London W11 3BZ
Tel: 01-727 7042 or 0225 310916
(8783)

FOR
CLASSIFIED ADVERTISING
RING
BARRY LEARY
ON
01-261 8508

CLASSIFIED ADVERTISEMENTS

Use this Form for your Sales and Wants

To "Wireless World" Classified Advertisement Dept., Dorset House, Stamford Street, London, SE1 9LU

PLEASE INSERT THE ADVERTISEMENT INDICATED ON FORM BELOW

- Rate £1. 20 PER LINE. Average six words per line. Minimum THREE lines.
- Name and address to be included in charge if used in advertisement.
- Box No. Allow two words plus 60p.
- Cheques, etc., payable to "Wireless World" and crossed "& Co."

NAME..

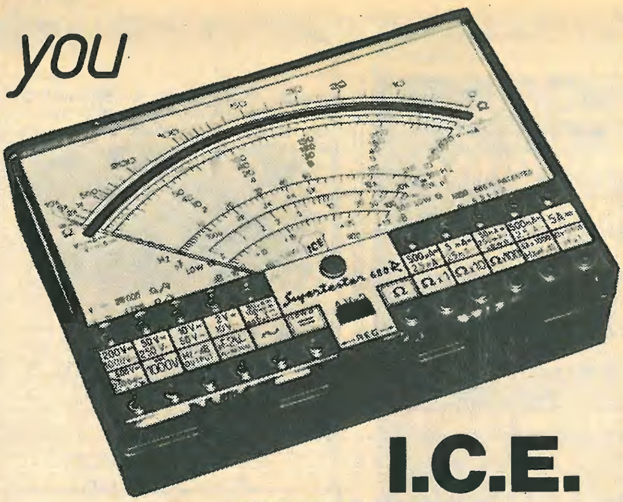
ADDRESS ....

....

....

REMITTANCE VALUE................................**ENCLOSED**

PLEASE WRITE IN BLOCK LETTERS. CLASSIFICATION.................................. **NUMBER OF INSERTIONS**..................



INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 127-147

OVERSEAS ADVERTISEMENT AGENTS:

France: M. D. Soubeyran, Compagnie Francaise D'Editions, Division Internationale, 40 Rue du Colisee, Paris 8e Telephone 225-77-50 — Telex. 280274.

Hungary: Mrs. Edit Bajusz, Hungexpo Advertising Agency, Budapest XIV. Varosliget Telephone: 225 008 — Telex: Budapest 22-4525. INTFOIRE.

Italy: Sig. C. Epis, Etas-Kompass, S.p.a. — Servizio Estero, Via Mantegna 6, 20154 Milan. Telephone: 347051 — Telex: 37342 Kompass.

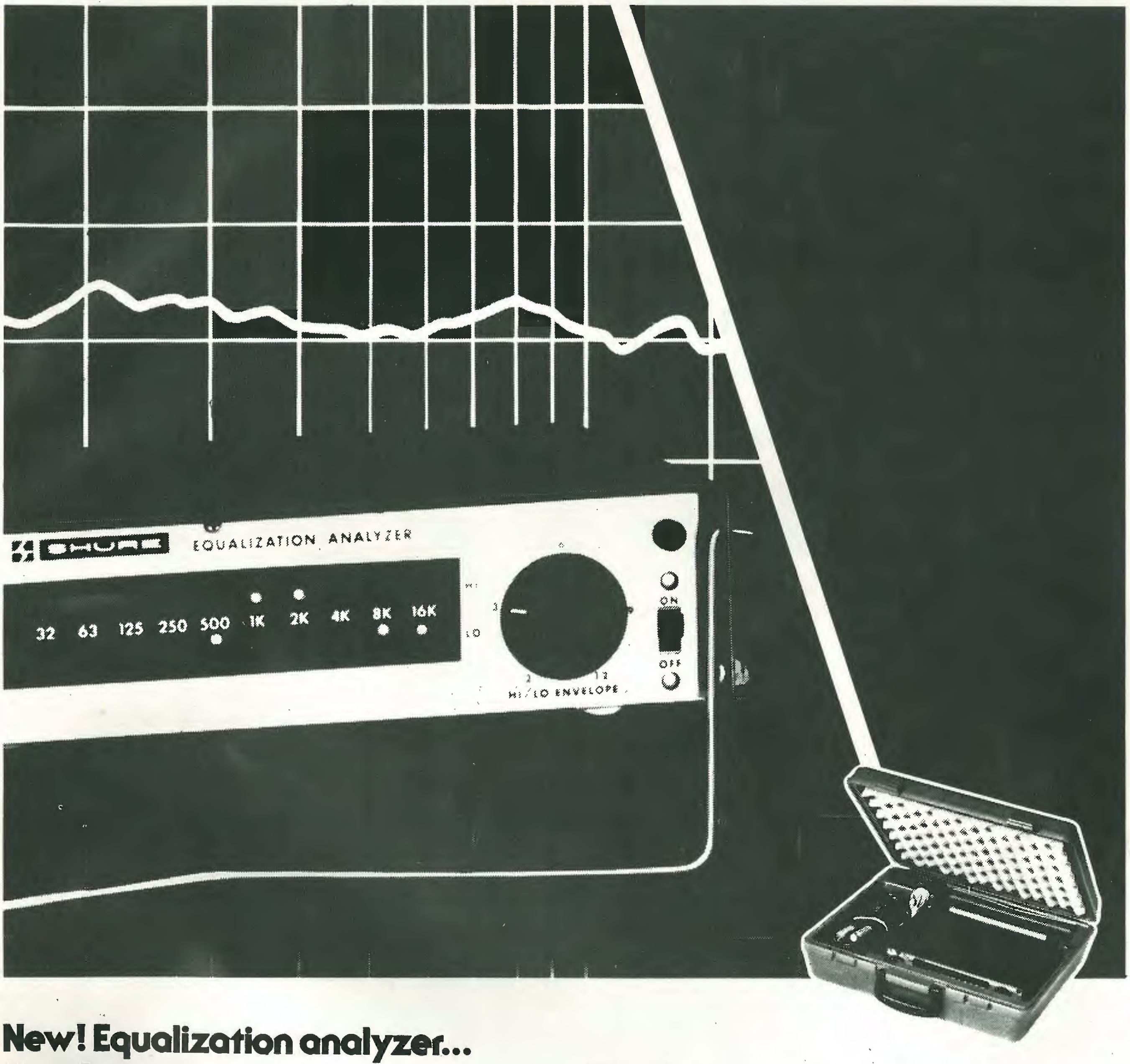
Japan: Mr. Inatsuki, Trade Media — IBPA (Japan), B.212, Azabu Heights, 1-5-10 Roppongi, Minato-ku, Tokyo 106. Telephone: (03) 585-0581.

United States of America: Ray Barnes, *IPC Business Press, 205 East 42nd Street, *New York,* NY 10017 — Telephone: (212) 689 5961 — Telex: 421710.
Mr. Jack Farley Jnr., The Farley Co. Suite 1584, 35 East Wacker Drive, *Chicago,* Illinois 60601 — Telephone: (312) 6 3074.
Mr. Victor A. Jauch, Elmatex International, P.O. Box 34607, Los Angeles, Calif. 90034, USA — Telephone (213) 821-8581 — Telex 18-1059.
Mr. Jack Mentel, The Farley Co., Suite 650, Ranna Building, Cleveland, Ohio 4415 — Telephone: (216) 621 1919.
Mr. Ray Rickles, Ray Rickles & Co., P.O. Box 2008, *Miami Beach, Florida* 33140 — Telephone: (305) 532 7301.
Mr. Jim Parks, Ray Rickles & Co., 3116 Maple Drive N.E., Atlanta, Georgia 30305. Telephone: (404) 237 7432.
Mike Loughlin, IPC Business Press, 15055 Memorial, Ste 119, Houston, Texas 77079 — Telephone (713) 783 8673.

Canada: Mr. Colin H. MacCulloch, International Advertising Consultants Ltd., 915 Carlton Tower, 2 Carlton Street, Toronto 2 – Telephone: (416) 364 2269.

*Also subscription agents.

Printed in Great Britain by QB Ltd, Sheepen Place, Colchester and Published by the Proprietors IPC ELECTRICAL-ELECTRONIC PRESS LTD., Dorset House, Stamford St. London, SE1 9LU, telephone 01-261 8000. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd, Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd: William Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Distributors Inc., 14th Floor, 111 Eighth Avenue, New York, N.Y. 10011.



New! Equalization analyzer...

Balance a system...Balance a budget.

Quick and accurate adjustment of sound system frequency response is finally within the reach of most budgets. The Shure M615AS Equalization Analyzer System is a revolutionary breakthrough that lets you "see" room response trouble spots in sound reinforcement and hi-fi systems—without bulky equipment, and at a fraction of the cost of conventional analyzers.

The portable, 11-pound system (which includes the analyzer, special microphone, accessories, and carrying case) puts an equal-energy-per-octave "pink noise" test signal into your sound system. You place the microphone in the listening area and simply adjust the filters of an octave equalizer (such as the Shure SR107 or M610) until the M615 display indicates that each of 10 octaves are properly balanced. You can achieve accuracy within ± 1 dB, without having to "play it by ear."

Send for complete descriptive brochure.

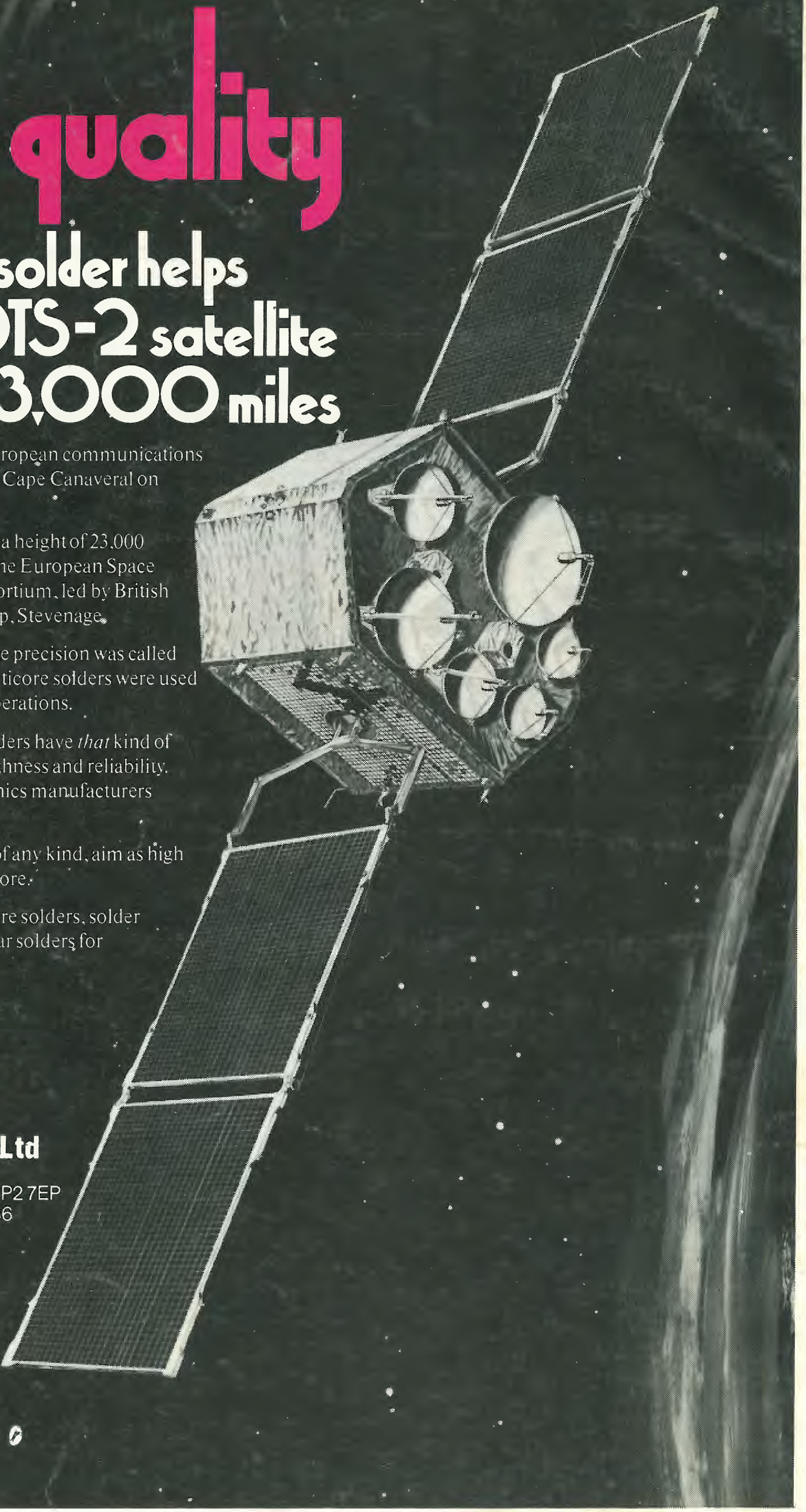
Shure Electronics Limited
Eccleston Road
Maidstone ME15 6AU
Telephone: Maidstone (0622) 59881

TECHNICORNER
The M615 Analyzer's display contains 20 LEDs that indicate frequency response level in each of 10 octave bands from 32 Hz to 16,000 Hz.
A rotary hi/lo envelope control adjusts the HI LED threshold relative to the LO LED threshold. At minimum setting, the resulting frequency response is correct within ± 1 dB. Includes input and microphone preamplifier overload LEDs.
A front panel switch selects either flat or "house curve" equalization.
The ES615 Omnidirectional Analyzer Microphone (also available separately) is designed specifically for equalization analyzer systems.

SHURE®

high quality

Multicore solder helps Europe's OTS-2 satellite orbit at 23,000 miles



OTS-2, a forerunner of a European communications satellite, was launched from Cape Canaveral on May 11th 1978.

Now orbiting the equator at a height of 23,000 miles, OTS-2 was built for the European Space Agency by the MESH consortium, led by British Aerospace Dynamics Group, Stevenage.

In building OTS-2, complete precision was called for. Which is why Ersin Multicore solders were used for many of the soldering operations.

Quite simply, Multicore solders have *that* kind of reputation. For quality, toughness and reliability. That's why so many electronics manufacturers won't use anything else.

Next time you need solder of any kind, aim as high as OTS-2 . . . and use Multicore.

Full details of Ersin Multicore solders, solder chemicals and high purity bar solders for automatic soldering from

ERSIN
Multicore
5 CORE SOLDER

Multicore Solders Ltd
Maylands Avenue
Hemel Hempstead Herts HP2 7EP
Tel: Hemel Hempstead 3636
Telex: 82363

WW—004 FOR FURTHER DETAILS