wireless world

Australia A$ 2.00
Canada $ 3.15
Denmark Kr. 17.00
Germany Dm. 5.00
Greece Dr. 87.00
Holland Dfl. 5.75
Italy L. 1900
Norway Kr. 17.25
Singapore M$ 4 50
Spain Ptas. 140.00
U.S.A. $ 2.50

JANUARY 1980 50p

Radio and electronics into the 'eighties

2100

Front cover design by Geoff Harrold symbolizes man's increasing involvement with his technology and introduces the special feature "Radio and electronics into the 'eighties".

IN OUR NEXT ISSUE

***Microwave intruder alarm,* based on a Gunn diode r.f. generator, uses a cycle counting scheme to prevent detector from being triggered by short movements and has good interference rejection.**

***The Townsman aerial* is a design for two-band operation, for example 2m and 70cm, which uses no switching and needs no ground plane.**

More on the *Scientific Computer.* In response to many requests from readers John Adams gives further details of the machine code monitor and the BURP monitor.

Current issue price 50p, back issue (if available) £1.00, at Retail and Trade Counter, Paris Garden, London SE1. Available on microfilm: please contact editor.
By post, current issue 79p, back issues (if available) £1.00, 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 £9.00 UK and $31 outside UK.
Student rates: 1 year, £4.00 UK and $15.50 outside UK.
Distribution: 40 Bowling Green Lane, London EC1R 0NE. 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

wireless world

ELECTRONICS/TELEVISION/RADIO/AUDIO

JANUARY 1980 Vol 86 No 1529

37 **Into the 'eighties**

38 **RADIO AND ELECTRONICS INTO THE 'EIGHTIES**
Land mobile radio by W. M. Pannell
Broadcasting by D. P. Leggatt
Consumer electronics by St John C. Jackson
Radio navigation and radar by D. W. G. Byatt
Audio by Adrian Hope
H.f. radio communication by R. F. E. Winn
Electronic measuring instruments by John L. Minck

61 **News of the month**
More v.h.f. broadcasting — Engineers want registration
Japanese make Prestel terminals

64 **World of amateur radio**

67 **Practical parallel-tracking pickup arm — 2**
by R. Cooper

73 **Circuit ideas**
Simple waveform generator — Amplitude modulator
Long duration timer

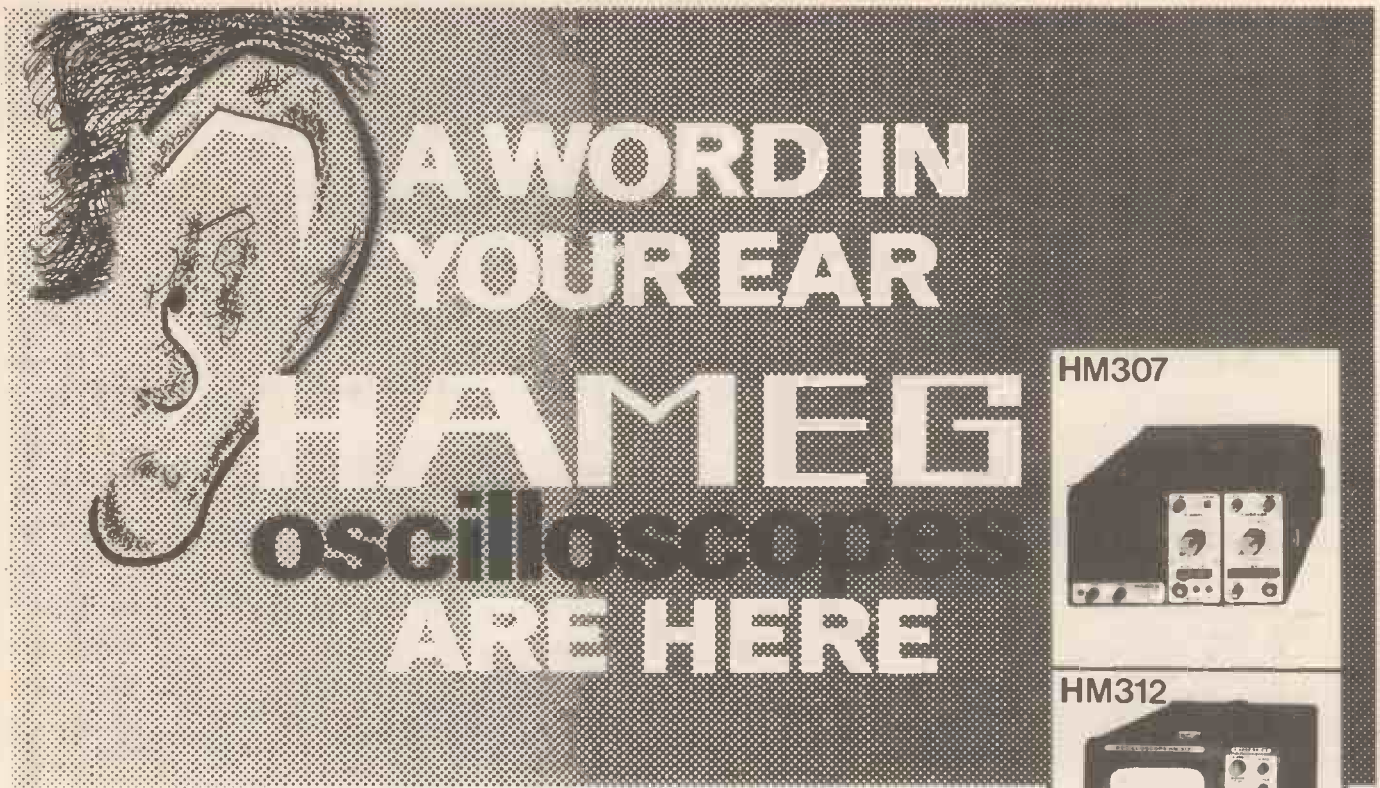
77 **Letters to the editor**
Sidebands as phasors — Digital filters
The Poynting vector

81 **More on the scientific computer**
by J. H. Adams

87 **S.s.b. and f.m. tranceiver — 4**
by G. R. B. Thornley

92 **Novatexts: astables — logic gate circuits**
by P. Williams

95 **New products**



Hameg the name for quality, performance and value in OSCILLOSCOPES. Advanced design optimising the use of both integrated circuits and discrete components ensures reliability.

Just a glance at the specification chart will make you want to know more.

HM 307	Single Trace **DC-10 MHz,** 5 mV/cm Plus built in **Component Tester**	£149
HM 312	Dual Trace **DC-20 MHz, 5 mV/cm** Sweep Speeds 40 ns - 0.2s/cm **8 x 10** cm **Display**	£250
HM 412	Dual Trace **DC-20 MHz**, 2mV/cm Sweep Speeds 40 ns - 2 s/cm and **Sweep Delay**	£350
HM 512	Dual Trace **DC-50 MHz**, 5 mV/cm Sweep Speeds 20 ns - 5 s/cm plus **Sweep Delay**	£580
HM 812	Dual Trace **DC - 50 MHz**, 5 mV/cm 20 ns - 5 s/cm, Sweep Delay and **Storage**	£1325

We may be a new name to you, but each instrument is backed by over 21 years experience in oscilloscopes.

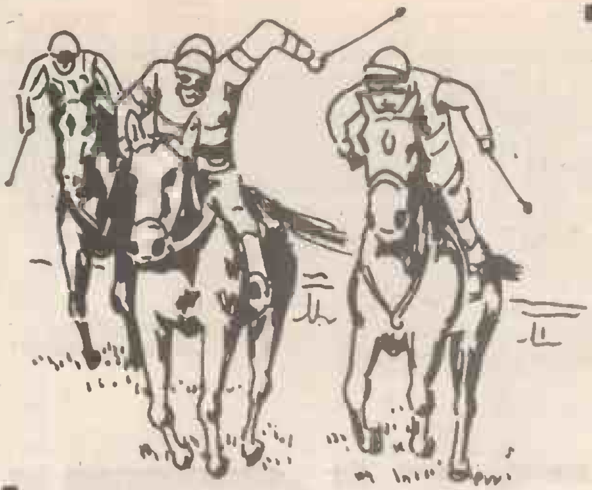
For FULL Details please contact

HAMEG Limited
74 - 78 Collingdon St.,
Luton, Beds. LU1 1RX.
Tel: (0582) 413174

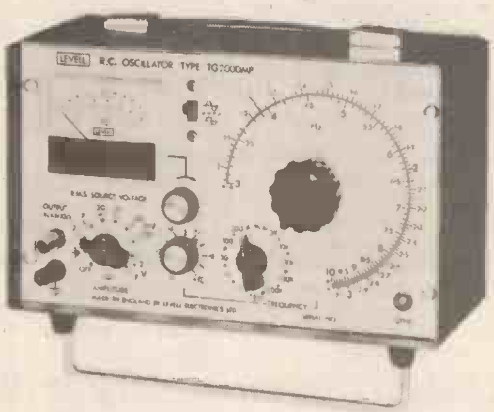
UK Subsidary of Hameg K Hartmann KG

All prices UK list exc. VAT.

WW—033 FOR FURTHER DETAILS

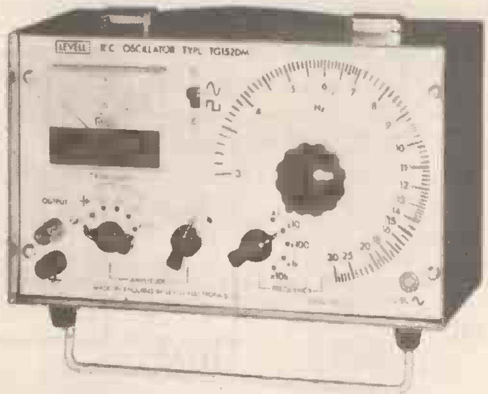


DON'T GAMBLE WITH PERFORMANCE BUY LEVELL OSCILLATORS



FREQUENCY	1Hz to 1MHz in 12 ranges. 0 to 1% fine control on TG200DMP.
ACCURACY	±1.5% ±0.01Hz up to 100kHz. ±2% up to 1MHz.
SINE OUTPUT	7V r.m.s. down to <200μV with Rs = 600Ω.
DISTORTION	<0.05% from 50Hz to 15kHz, <0.1% from 10Hz to 50kHz, <0.2% from 5Hz to 150kHz, <1% at 1Hz and 1MHz.
SQUARE OUTPUT	TG200D, DM & DMP only, 7V peak down to <200μV. Rise time <150nS.
SYNC OUTPUT	<IV r.m.s. sine in phase with output
SYNC INPUT	±1% freq. lock range per volt r.m.s.
METER SCALES	TG200M, DM & DMP only. 0/2V' 0/7V & −14/+6dBm.
SIZE & WEIGHT	260 × 130 × 180mm. 4.3kg with batteries.

TG200	TG200D	TG200M	TG200DM	TG200DMP
£92	£99	£115	£120	£125



FREQUENCY	3Hz to 300kHz in 5 decade ranges.
ACCURACY	±2% ±0.1Hz to 100kHz. Increasing to ±3% at 300kHz.
SINE OUTPUT	2.5V r.m.s. down to <200μV
DISTORTION	<0.2% from 50Hz to 50kHz. <1% from 10Hz to 200kHz.
SQUARE OUTPUT	2.5V peak down to <200μV.
SYNC. OUTPUT	2.5V r.m.s. sine.
METER SCALES	0/2.5V & −10/+10dB on TG152DM.
SIZE & WEIGHT	260 × 130 × 180mm. 3.4kg with batteries.

TG152D Without meter **£74**

TG152DM With meter **£92**

FREQUENCY	0.2Hz to 1.22MHz on four decade controls.
ACCURACY	±0.02Hz below 6Hz. ±0.3% from 6Hz to 100kHz. ±1% from 100kHz to 300kHz. ±3% above. 300kHz.
SINE OUTPUT	5V r.m.s. down to 30μV with Rs = 600Ω.
DISTORTION	<0.15% from 15Hz to 15kHz. <0.5% at 1.5Hz and 150kHz.
METER SCALES	2 Expanded voltage and −2/+4dBm
SIZE & WEIGHT	260 × 180 × 180mm. 5.4kg.

TG66B Battery model **£245**

TG66A Mains & battery model **£260**

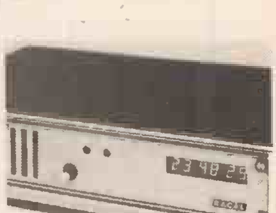
Prices are ex works with batteries. Carriage, packing and VAT extra.
Optional extras are leather cases and mains power units.
Send for data covering our range of portable instruments.

LEVELL ELECTRONICS LTD.

MOXON STREET, BARNET, HERTS., EN5 5SD.
TEL: 01-449 5028/440 8686

WW—028 FOR FURTHER DETAILS


RACAL



Eddystone EC958/7 for arduous environments

This ruggedized version of the famous Eddystone 958 Series of high-grade professional receivers is fitted with anti-vibration mounts and drip-proof cowl. It covers 10kHz to 30MHz, with 1Hz digital readout and 4Hz stability under rigorous conditions of service. This receiver is ideal for general communication use, network monitoring, surveillance, military, mobile and shipborne installations. It is also available in standard form for bench or rack mounting.

Eddystone Radio Limited

Member of Marconi Communication Systems Limited

Alvechurch Road, Birmingham B31 3PP, England

Telephone : 021-475 2231 Telex : 337081

A GEC-Marconi Electronics Company

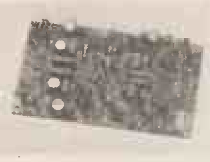
Eddystone

WW — 006 FOR FURTHER DETAILS

TOTAL AMPLIFICATION FROM **CRIMSON ELEKTRIK**

WE NOW OFFER THE WIDEST RANGE OF SOUND PRODUCTS —

STEREO PRE-AMPLIFIER



POWER AMPLIFIER MODULE

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.

XO2:XO3 — ACTIVE CROSSOVERS. XO2 — two way, XO3 — three way. Slope 24dB/octave. Crossover points set to order within 10%.

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 120 x 80-25mm.

POWER SUPPLIES. We produce suitable power supplies 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 enable a novice to build it with confidence in a few hours.

PRE-AMP KIT

This includes all metalwork, pots, knobs, etc., to make a complete pre-amp with the CPR1(S) module and the MC1(S) module if required.

POWER AMPLIFIER MODULES

CE 608 60W/8 ohms 35-0-35v	£19.52
CE 1004 100W/4 ohms 35-0-35v	£23.02
CE 1008 100W/8 ohms 45-0-45v	£25.96
CE-1704 170W/4 ohms 45-0-45v	£31.00
CE 1708 170W/8 ohms 60-0-60v	£33.97

TOROIDAL POWER SUPPLIES

CPS1 for 2xCE 608 or TxCE 1004	£16.56
CPS2 for 2xCE 1004 or 2/4xCE 608	£18.80
CPS3 for 2xCE 1008 or 1xCE 1704	£19.75
CPS4 for 1xCE 1008	£17.12
CPS5 1 for 1xCE 1708	£24.15
CPS6 for 2xCE 1704 or 2xCE 1708	£25.53

HEATSINKS

Light duty, 50mm, 2 C/W	£1.44
Medium power, 100mm, 1-4 C/W	£2.35
Disco/group, 150mm, 1-1 C/W	£3.04
Fan, 80mm, state 120 or 240v	£19.70
Fan mounted on two drilled 100mm heatsinks 2x4 C/W, 65 max, with two 170W modules	£31.05

THERMAL CUT-OFF, 70°C £1.54

POWER AMP KIT £35.03

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.

CPR 1	£31.65
MC 1	£21.28
CPR 1S	£40.87
MC 1S	£33.17

ACTIVE CROSSOVERS

XO2	£15.16
XO3	£23.58

POWER SUPPLY

REGI £6.90 TR6 £1.97

PRE-AMP KIT £38.07

BRIDGE DRIVER, BD1

Obtain up to 340W using 2x170W amps and this module.

BD1 £5.75

CRIMSON ELEKTRIK

1A STAMFORD STREET, LEICESTER LE1 6NL. Tel. (0533) 553508

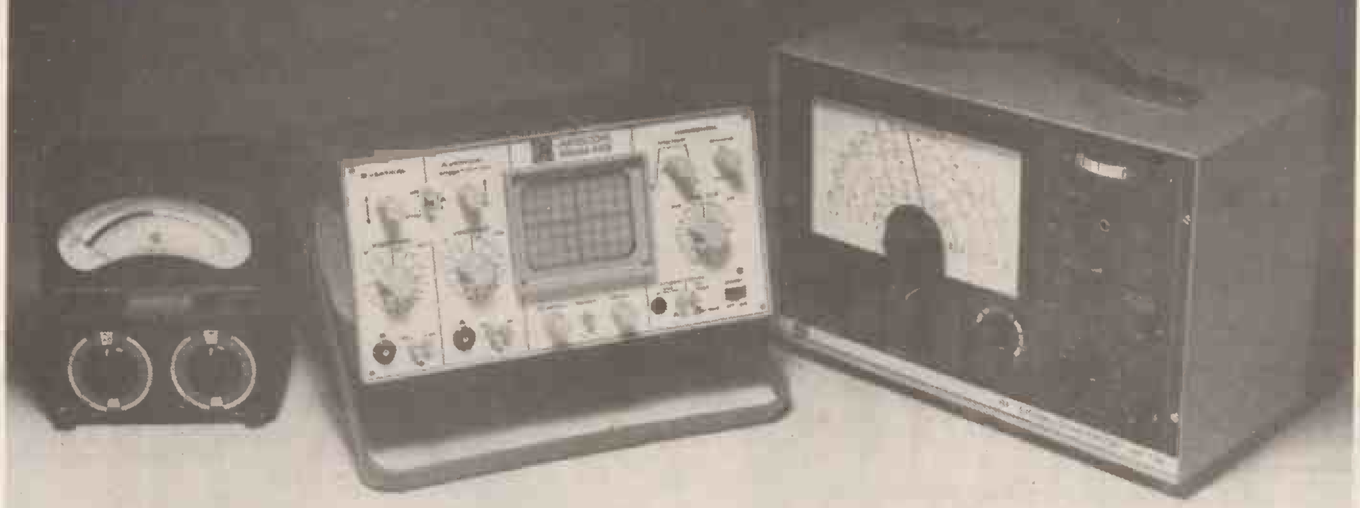
U.K. — Please allow up to 21 days for delivery

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.

Distributors: Down Hi-Fi & Video Centre, 66 Abbey Street, Bangor, N. Ireland. Badger Sound Services Ltd., 46 Wood Street, Lytham St. Annes, Lancashire FY8 1QG.

WW—035 FOR FURTHER DETAILS

1...2...3... testing...testing testing



Avo produce an impressive range of servicing instruments for on-site and work-bench use.

1. There is the tried and tested **Avometer 8**, with overload protection and a robust centre-pole movement resisting all the knocks of on-site work. It is just one of a complete range of portable multimeters.

2. Then there is the **Avoscope A101**, a portable, mains operated dual channel 10 MHz oscilloscope – a low cost instrument offering an accuracy of ±5% that is simple to use.

3. Also, Avo offer a choice of AM or AM/FM **Signal Generators** with variable outputs, providing accurate repeatable attenuation.

Avo quality is built on many years of experience. If you'd like more detailed information about the range, contact your nearest Avo Appointed Distributor, or ask Avo.

AVO

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

Thorn Measurement & Components Division

You'll never meet a better meter

SCIENCE FACT

The invention of the silicon chip by Texas Instruments, turned science fiction into science fact overnight. That was in 1965, but only now is the full potential of the 'chip' being realised.

Texas Instruments offer you 14 years of extensive research and development in the form of data and reference books that will enable you to get the very best from their micro-miracle.

Whether it's your business or hobby, anyone interested in micro-technology will find these books invaluable.

Get the real facts from the inventors of the 'chip'.

TEXAS INSTRUMENTS

Texas Instruments Ltd, Supply Division,
MS21, Manton Lane, Bedford Tel: 0234 67466

Slough: 186 High Street, Slough, Berks. Tel: 0753 70531

Manchester: Knightsbridge Mall, Arndale Centre,
Market Street, Manchester. Tel: 061-832 6238

Please send me the books ticked. I enclose £_____ plus £1.15 P&P

DATA BOOKS
- ☐ T.T.L. Data £5.00
- ☐ Linear Control Data £2.50
- ☐ Interface Circuits Data £3.50
- ☐ Optoelectronics Data £3.50
- ☐ Power Semiconductor Data £3.20
- ☐ Transistor and Diode Vol. I £3.50

OTHER T.I. BOOKS
- ☐ Optoelectronics Theory and Practice £7.50
- ☐ Semiconductor Circuit Design Vols. I to IV £6.50 each
- ☐ Volume V £7.95
- ☐ Understanding Solid State Electronics £1.20
- ☐ Understanding Digital Electronics £3.50
- ☐ Software Design for Microprocessors £12.00
- ☐ 9900 Assembly Language Guide £4.00
- ☐ 9900 Family Systems Design £8.00
- ☐ Calculating Better Decisions (SR51-II) £5.00
- ☐ Calculator Decision Making Source Book (TI-51 III) £5.00
- ☐ Calculator Analysis for Business and Finance (TI-42 MBA) £7.00
- ☐ Sourcebook for Programmable Calculators (TI-58/58C/59) £11.45

TI-59 PAKETTES

Each pakette contains complete listings of programmes suitable for use with the TI Programmable 59 calculator £5.95 each
- ☐ Electronic Engineering
- ☐ Oil/Gas/Energy
- ☐ Black Body Radiation
- ☐ Printer Utility
- ☐ Astrology
- ☐ Programming Aids
- ☐ Marketing/Sales
- ☐ Fluid Dynamics
- ☐ Mathematics
- ☐ 3D Graphics
- ☐ Production Planning
- ☐ Lab Chemistry
- ☐ TI-59 Fun (Games Pakette)

NAME ____________

ADDRESS ____________

WW — 010 FOR FURTHER DETAILS

PORTABLE PRECISION

A range of 3½ digit LCD multimeters offering high precision and extended battery life. All feature 0.5" LCD read-out with 'battery low' warning, inputs protected against overloads and transients, Auto-polarity, Auto-zero, rugged ABS cases and a full 1-year warranty.

The LMM-200 is a compact handheld multimeter with 0.5% basic accuracy and 15 different ranges. It measures voltage from 0.1mV to 500V, current from 0.1uA to 2 Amps, and resistance from 0.1Ω to 2MΩ.

The LMM-2001 is an identical instrument but with 0.1% basic accuracy.

The LMM-100 has an adjustable handle, a 2,000 hour battery life and is ideally suited to field or bench use. It measures voltage from 0.1mV to 1KV, current from 0.1uA to 2 Amps, and resistance from 0.1Ω to 20MΩ. 0.1% basic accuracy.

Lascar Electronics Ltd., Unit 1, Thomasin Road, Basildon, Essex.
Telephone No: Basildon (0268) 727383.

	£	P&P	VAT	TOTAL
LMM-200	34.95	1.00	5.39	**41.34**
LMM-2001	44.95	1.00	6.89	**52.84**
LMM-100	69.95	1.50	10.72	**82.17**
TEST LEADS	1.95	0.25	0.33	**2.53**

To: Lascar Electronics, Unit 1, Thomasin Road, Basildon, Essex.

Please send me Data ☐

LMM-100 £82.17 ☐ LMM-200 £41.34 ☐ LMM-2001 £52.84 ☐ TEST LEADS £2.53 ☐

Name ____________

Address ____________

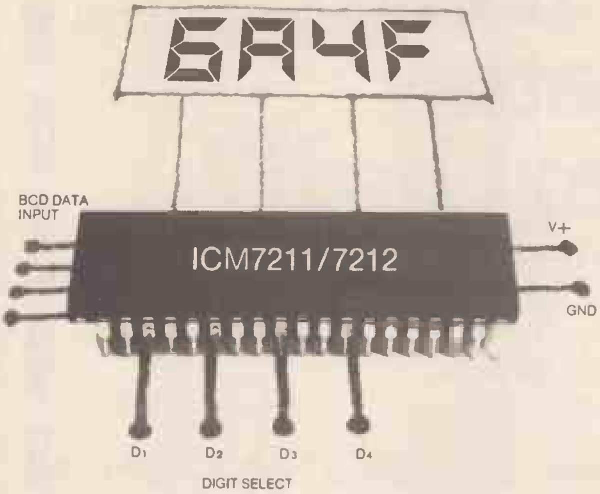
Tel. No. ____________

I enclose cheque/P.O. value ____________

A

WW — 051 FOR FURTHER DETAILS

4-DIGIT DDD'S FOR LCD'S. SMARTER. CHEAPER. MONOLITHIC. FROM INTERSIL. NATURALLY.



4-DIGIT LCD/LED HEXADECIMAL/CODE B DISPLAY DECODER DRIVER

DOWN GOES THE COMPONENT COUNT.

As a leader in monolithic Display Decoder Drivers (DDD), Intersil pioneered the "Driver on a Chip." But, we're not resting on our laurels. We're making more and better DDD's. Less expensively. The ICM7211 (LCD) and ICM7212 (LED) Display Decoder/Drivers are two good examples.

ONE CHIP FROM LOGIC TO DISPLAY.

The ICM7211 is simply the best 4-digit LCD driver available today. μP-controlled or multiplexed BCD input. Hexadecimal (0-9, A, B, C, D, E, F) or Code B (0-9, –, E, H, L, P, BLANK). It requires no external logic to drive four digits. The segment outputs of ganged chips can be directly slaved to the backplane. And, a complete on-board backplane oscillator eliminates the need for any external components. LED Displays? Specify the ICM7212 for non-multiplexed LED display and get a brightness control with a single potentiometer, no RF interference, and typically 8mA DC per segment at full brightness.

LOW POWER CMOS DDD'S.

Today, Intersil offers a complete family of counters, timers and display drivers in low-power MAXCMOS™. Monolithic circuits that reduce your component count, power requirements and design time. At a cost that helps you think CMOS.

COMPARE PRICE AND PERFORMANCE.

ORDER	PART NUMBER	OUTPUT CODE	INPUT CONFIGURATIONS	PRICE*
LCD DISPLAY	ICM7211IPL ICM7211AIPL	HEXADECIMAL CODE B	MULTIPLEXED 4-BIT	£3.55
	ICM7211MIPL ICM7211AMIPL	HEXADECIMAL CODE B	MICROPROCESSOR INTERFACE	
LED DISPLAY	ICM7212IPL ICM7212AIPL	HEXADECIMAL CODE B	MULTIPLEXED 4-BIT	£2.57
	ICM7212MIPL ICM7212AMIPL	HEXADECIMAL CODE B	MICROPROCESSOR INTERFACE	

*100 + price

COUNT ON US.

Whatever your display or counting problem, there's probably a better, simpler solution available from Intersil. For complete information on the ICM7211/7212, call your Intersil Sales Office, Franchised Distributor, or, return the coupon below.

U.K. SALES OFFICE

Intersil, Snamprogetti House, Basing View
Basingstoke RG21 2EE, Hants.

U.K. DISTRIBUTORS

Macro Marketing Ltd. 396 Bath Road, Slough, Berks.
Tel: Burnham 63011
Tranchant Electronics (U.K.) Ltd. 61-63 London Road,
Redhill, Surrey. Telephone: Redhill 69217 Telex: 8953230 TRELEC G
Rapid Recall Ltd. 46-50 Beam Street, Nantwich, Cheshire CW5 5LJ.
Tel: Crewe 626061 Telex: 36329
Rapid Recall Ltd. Soho Mills Industrial Park, Wooburn Green, Bucks.
Tel: Bourne End 24961 Telex: 849439
Andis Components Ltd. Etwall Street, Derby. Tel: Derby 363296

WW 1/79

INTERSIL

Intersil, Snamprogetti House, Basing View
Basingstoke RG21 2EE, Hants.
Send me everything I'll need to know about the ICM7211/7212 DDD's.
____ Send me literature on your family of display driver/counter/timer circuits.

Name ____________________
Company ____________________
Address ____________________
____________________ Tel.: ________

REGULATED POWER SUPPLIES

Protection:

All models internal foldback, overload, thermal and short circuit protected. Fully fused.

2-YEAR GUARANTEE

Type AD12 - AD24 (Illustrated)

TYPES AVAILABLE

MODEL NO.	AD12	AD24	AD2412	ADV030
OUTPUT CURRENT	8 amp	8 amp	16 amp	5 amp
NOMINAL OUTPUT VOLTS	12	24	12	0 to 30 Fully variable and metered
INPUT VOLTS	15-230-250 50 cycles a/c	115-230-250 50 cycles a/c	24 DC	115-230-250 50 cycles a/c
TOLERATED MAINS VARIATION	15%	15%		15%

PRICES

1 off — AD 12-AD24 .... £68.50
1 off — AD 2412 £54.00
All subject to VAT @ 15%

1 off — ADV030 £118.00

SOUTHERN ELECTRONICS

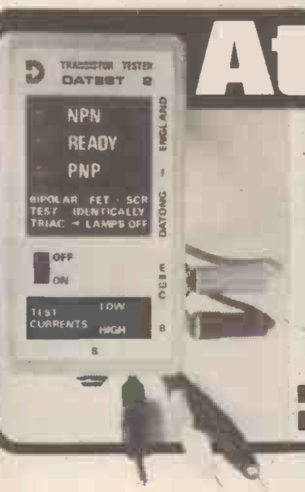
6 WESTCLIFF ARCADE, RAMSGATE, KENT
TEL. THANET (0843) 57888

WW — 042 FOR FURTHER DETAILS

ORGAN and PIANO KEYBOARDS

	Price inc. VAT	P & P
4-Octave C-C	**£32.20**	£2.75
5-Octave C-C	**£34.50**	£2.75
5-Octave F-F	**£34.50**	£2.75
6-Octave C-C	**£36.80**	£3.00

DALSTON ELECTRONICS
40a Dalston Lane, Dalston Junction
London, E8 2AZ Tel: 01-249 5624



At last...

A REALLY RELIABLE IN CIRCUIT TRANSISTOR TESTER THAT WORKS!

Previous Testers have been too easily fooled by low shunt impedances resulting in false alarms on perfectly sound transistors. Designed for fast IN-CIRCUIT testing the new DATONG DATEST 2 tests transistors, FETs SCRs and Triacs even when shunted by resistors as low as 20 ohms!

Automatic NPN/PNP indication, foolproof three-LED display, and unique test probes allow a very high rate of testing even by unskilled users. Very competitive price includes probes and the DATEST 2 is available from stock. Full data sheet free on request. ONLY £45 COMPLETE + 15% VAT.
Total Price £51.75 inc. VAT & P&P.

DATONG ELECTRONICS LIMITED
Spence Mills, Mill Lane, Bramley
Leeds LS13 3HE
Telephone: Pudsey (0532) 552461

WW — 043 FOR FURTHER DETAILS

ELECTROVALUE

CATALOGUE 10

Ready early December

Our computer has already selected thousands of our customers to whom our new catalogue has automatically been sent. If you would like a copy too, simply send us your name and address. It's

FREE

(You don't even have to pay postage)

IT'S A GOOD DEAL BETTER FROM ELECTROVALUE

- **We give discounts**
  on C.W.O. orders, except for a few items market Net or N in our price lists.
  5% on orders, list value £10 or more
  10% on orders list value £25 or more.
  Not applicable on Access or Barclaycard purchase orders.
- **We pay postage in U.K.**
  on C.W.O. orders list value £5 or over. If under, add 30p handling charge.
- **We stabilise prices.**
  by keeping to our printed price lists which appear but three or four times a year.
- **We guarantee**
  all products brand new, clean and maker's spec. No seconds, no surplus.
- Appointed distributors for SIEMENS, VERO, ISKRA, NASCOM and many others.

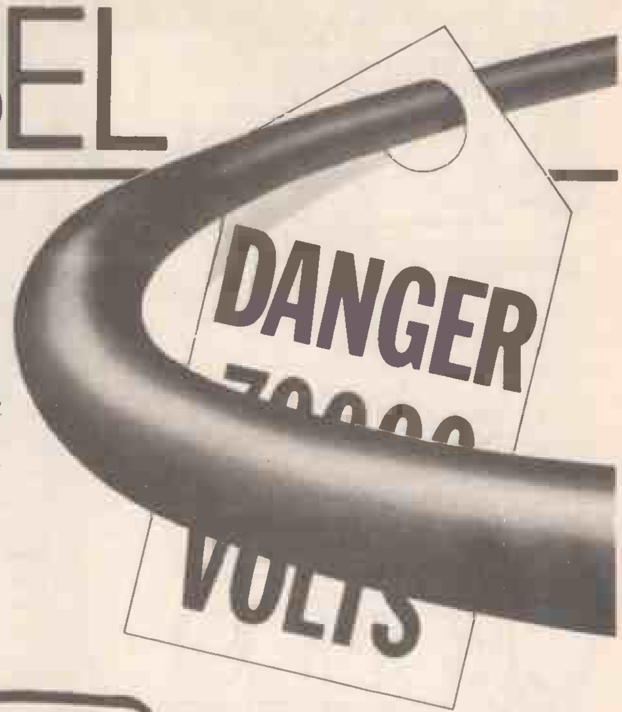
OUR NEW CATALOGUE No 10
Over 120 pages. Thousands of items. Improved classification for easier selection. Valuable working information. Illustrations. Separate quick-ref price list.

ELECTROVALUE LTD

HEAD OFFICE (Mail Orders)
28(G) St. Judes Road, Englehard Green, Egham, Surrey
TW20 0HB. Phone: 33603 (London prefix 87. STD 0784)
Telex 264475.
NORTHERN BRANCH (Personal Shoppers Only)
680 Burnage Lane, Burnage, Manchester M19 1NA
Phone: (061) 432 4945.

WW — 013 FOR FURTHER DETAILS

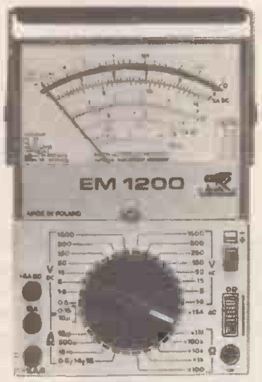
NOT EVERY CABLE HAS A LABEL

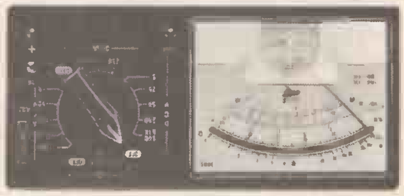


Everyone who works with electricity needs to know at some time or other what's going on inside the cable he's handling. What voltage. What current. What resistance. Not knowing the answers, or worse still having inaccurate answers, can make life difficult, even terminal.

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.





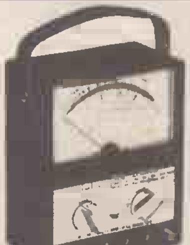
KEW 7 Multimeter
1000 OPV. DC volts up to 1000, DC amps up to 100 mA. AC volts up to 1000. Resistance up to 150 Kohms. Pocket size. "Off" damping. Complete with leads & battery. R.R.P. £6.95 ex. VAT.

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. £79.35 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 £13.50 EM20 £17.25, EM30 £20.75 ex. VAT.

Test Equipment: EAGLE



Please send me details of your complete range of Test Equipment.

Name ______________________ Company ______________________

Address ____

____

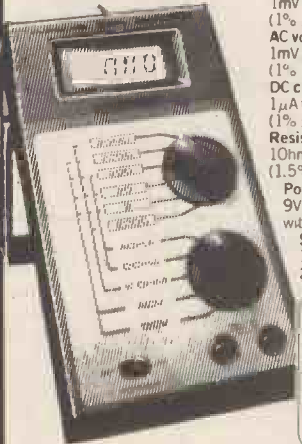
EAGLE INTERNATIONAL Precision Centre, Heather Park Drive, Wembley, Middlesex HA0 1SU.

WW1

Top value test equipment from TANDY

LCD DIGITAL MULTIMETER.

Low-cost hand held digital multimeter with a full 3½ digit LCD display. 0.5% basic accuracy, auto polarity operation. 10 Mohm DC input impedance.
Reading to ± 1999.



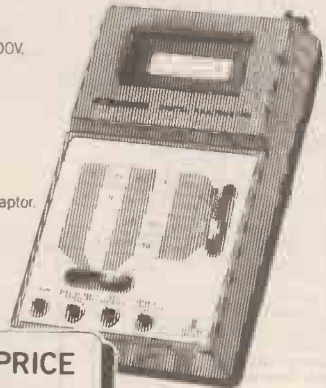
Scales:
DC volts: 1mV to 1000V (1% ± 1 digit accuracte).
AC volts: 1mV to 500V (1% ± 2 digits accurate).
DC current: 1μA to 200mA (1% ± 1 digit accurate).
Resistance: 1Ohm to 20 MOhms (1.5% ± 1 digit accurate).
Power source: 9V battery or AC with optional adaptor.
Size: 155 x 75 x 30 mm.
22–198

PRICE 53.19

LOW—COST LCD MULTIMETER

A portable, compact sized multimeter with a full 3½ digit LCD display. Auto polarity operation, low battery indicator. 10 MOhm Input impedance.

Scales:
DC volts: 2 20 200 1000V.
AC volts: 200 500V.
DC current: 2 20 200MA.
Resistance: 2 20 200 2000 KOHM.
Power source: 9V battery or AC adaptor.
Size: 37 x 85 x 130 mm.
22–197



PRICE 39.93

COMPONENTS AND PARTS

CAT No	DESCRIPTION	PRICE
276–032	LED	4 for 69p
276–033	LED	2 for 48p
276–034	LED	2 for 59p
276–142	Infra-Red Emitter Detector Pair	£1.37
277–1003	12V DC Automotive Digital Clock Module	£17.52
276–9110	6 pin edge connector for 277 1003	40p
276–1373	Power Transistor Mounting Hardware	50p
276–1363	TO 220 Heat Sink	60p
276–1364	TO 3 Heat Sink	81p

AC/DC 8 MHz OSCILLOSCOPE

A new approved 8MHz version of last years' winner! The advance design features of this oscilloscope make it an absolute essential for industrial uses on production lines, in laboratories and schools. Ideal for radio and TV servicing, audio testing, etc.

Specifications:
Horizontal axis: Deflection sensitivity better than 250mV DIV. **Vertical axis:** Deflection sensitivity better than 10mV DIV (1DIV 6mm). Bandwidth: 0.8MHz. **Input impedance:** 1MOhm parallel capacitance 35pF. **Time base: Sweep range:** 10Hz 100kHz (4 ranges). Synchronization: Internal ( ) Size: 200 x 155 x 300 mm. Supply 220 240 50Hz. 22–9501.

PRICE 137.36

You save because we design, manufacture, sell and service.
Tandy have over 7,000 stores and dealerships worldwide. Over 2,500 products are made specifically for or by Tandy at 16 factories around the world. The quality of our products has been achieved by over 60 years of continuous technological advancement.

KNOWN AS RADIO SHACK IN THE U.S.A. MAKERS OF THE WORLD'S BIGGEST SELLING MICROCOMPUTER TRS80

TANDY

TANDY DEALER

Most items also available at Tandy Dealers. Look for this sign in your area.

The largest electronics retailer in the world.
Offers subject to availability. Instant credit available in most cases.
OVER 170 STORES AND DEALERSHIPS NATIONWIDE.

Access, Barclaycard and Trustcard welcome

WW — 060 FOR FURTHER DETAILS

Carston Electronics

specialists in second user test and measuring instruments

AS NEW

EX STOCK DELIVERY

Oscilloscopes

TEKTRONIX 465

DC-100MHz Dual Trace 5mV-5V/Div
0.05μs-0.5s/Div Delayed T/B XY DC 4MHz

£1200

TEKTRONIX 475A

DC-250MHz Dual Trace 5mV-5V/Div
0.01μs-0.5s/Div Delayed T/B XY DC 3MHz

£1950

THESE INSTRUMENTS SOLD WITH ONE YEAR FULL GUARANTEE

Other New Additions to our Stock —

Amplifiers	
MICRO MOVEMENTS	
M1229 AC Amplifier and Strain Gauge Conditioning Unit	60
M1270 DC Amplifier 15mV-150V	50
2 and 10 channel rack systems available	
Counter Timers	
HEWLETT PACKARD	
5300A/5303B DC-520MHz 6 Digit	210
RACAL	
835 DC-15MHz 6 Digit Time interval/Period/Ratio	100
Distortion Systems	
RADFORD	
DMS2 10Hz-100KHz meter	160
LDO2 10Hz-100KHz Oscillator	160
Modulation Meters	
MARCONI	
TF2300A AM/FM 1000MHz	495
Oscilloscopes	
DYNAMCO	
7210 DC-15MHz Dual Trace	230
PHILIPS	
PM3210 DC-25MHz Dual Trace	325
TEKTRONIX	
547 1A1 DC-50MHz Dual Trace DTB	525
547 1A4 DC-50MHz Four Trace DTB	625
Plug-ins for 500 Series	
1A1 Dual Trace Plug-In DC 50MHz	225
1A2 Dual Trace Plug-In DC 50MHz	180
1A4 Four Trace Plug-In DC 50MHz	375
1A5 Differential Plug-In	175
Z Differential Plug-In	140
81 Adaptor Plug-In 1A Series to 580 Series	75
TELEQUIPMENT	
D34 DC 15MHz Dual Trace Batt Mains Portable	450
Power Meters	
MARCONI SAUNDERS	
6460 10MHz 40GHz (Depending on Head)	300
6420 10MHz 12.4GHz 10mw	75
6421 10MHz 12.4GHz 100mw	75
6422 10MHz 12.4GHz 1mw	50
6428 26.5 40GHz 10mw	50
Pulse Generators	
EH	
120D 100Hz-10MHz 20V 50Ω RT 1ns	100
122 1KHz-200MHz 5V 50Ω RT 12ns	220
123 1KHz-20MHz 20V 50Ω RT 7ns	130
139(L) 10Hz-50MHz 10V 50Ω RT 6ns	175
1221 Timing Unit 6 Channel 0-10MHz 5V 50Ω RT 8ns	50
Recorders	
HEWLETT PACKARD	
680M 5 Inch Stripchart Single Pen 5mV 120V I P 20cm min 2.5cm Hr	295
SOUTHERN INSTRUMENTS	
10-100 6 Channel U.V. 5 1,000mm sec	250
M1330 10 Channel U.V. 5-2500mm sec	325
Selection of Galvonometers available @ £15.00 each	
YOKOGAWA	
3046 10 inch Chart Single Pen 0.5mV-100V I P 2.60cm min and Hr	350
3047 2 Pen Version of 3046	425
Voltmeters Digital	
FARNELL	
DM131B 1999 FSD AC/DC OHMS Current Temp.	110
SOLARTRON	
LM1420.2 2300 FSD DC Only 0.05%	99
LM1420.2BA 2300 FSD AC True RMS DC	110

seed seed seed seed seed seed

STRUMECH ENGINEERING ELECTRONICS DEVELOPMENTS

★★★ BUSINESS ★★★ EDUCATION ★★★
★★★RESEARCH ★★★

32K-56K RAM - DUAL MINI DISKS

seed system one
prices from £1500-£2500
NEW-FORTRAN £80

56K RAM-DUAL 8" DISKS-10MgDISK

seed system 12
prices from £4500-£12000

Suppliers of equipment to: Leading Universities, H.M. Government, Hospitals, Schools, Colleges and Small Business

SEED - STRUMECH - PORTLAND HSE. - COPPICE SIDE - BROWNHILLS - WALSALL

WW — 076 FOR FURTHER DETAILS

---

the indispensable
BIRD 43

THRULINE® WATTMETER
0.45-2300 MHz / 0.1-10,000 watts
The Standard of the Industry
What more need we say...

Exclusive UK representative

aspen *electronics limited*

2 KILDARE CLOSE, EASTCOTE, MIDDX. HA4 9UR
TELEPHONE: 01-868 1188 — TELEX 8812727

The King of Valves

Genuine Gold Lion™ valves – hand built, utilising advanced pumping techniques and individually tested to a tight specification – are your answer to the high quality sound demands made by musicians and listeners alike.

Gold Lion KT77's and KT88's covering 30-200 watts, are now available from M-OV along with data and distribution details. Find out all about the King of Quality – from M-OV.

(TM) Trade Mark of M-OV Audio Valves.

M-OV
A MEMBER OF THE GEC GROUP

GEC

S711

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

WW — 067 FOR FURTHER DETAILS

The new Toolrange catalogue

still the only catalogue of its kind

The New Toolrange Catalogue is still the only comprehensive single source of electronic tools and production aids.

The product range has almost doubled since last year and now over 2,000 tools, toolkits and service aids are illustrated in full colour.

Products from over 100 top manufacturers are available from stock.

Over 60,000 catalogues are now in circulation. If you don't have one simply write, telephone or telex Toolrange for your free copy.

toolrange

Upton Road, Reading, Berks. RG3 4JA
Telephone: Reading (0734) 22245 Telex: 847917

WW — 063 FOR FURTHER DETAILS

---

15 Hz-100 KHz Generator
0.008% THD
100 μV-IV Sin/Square
RIAA Output

6 Digit Frequency Display from input or output

100 μV-100V FSD Millivoltmeter
1% Accuracy
1 Hz-200 KHz Bandwidth

Ultra low-power operation from single PP9 battery or optional mains adaptor

DIN or BNC connectors

FLUTTER

0.01%-10% FSD
1 Hz-300 Hz or DIN Weighted
Mean or DIN Quasi Peak

NOISE

CCIR/ARM
DIN Audio Band
DIN Rumble A and B
Other Weightings Available

YOUR MEASUREMENT PROBLEMS SOLVED IN ONE COMPACT PRECISION INSTRUMENT — THE LINDOS LA1 AUDIO ANALYSER

DISTORTION

0.01-100% FSO
@ 45 Hz 1 KHz 10 KHz

£425 + V.A.T.

Lindos

LINDOS ELECTRONICS
Sandy Lane, Bromeswell
WOODBRIDGE, Suffolk
IP12 2PR 03947 432

WW — 007 FOR FURTHER DETAILS

The 935

from Data Precision

HANDY · VERSATILE · TOUGH · PRECISE

HANDY—easy to hold, to carry, to use, to read. Always at hand to make difficult measurements easy.

VERSATILE—all the functions and ranges you need . . . 29 in all: volts and amps, s.c. and d.c. switchable Hi and Lo ohms.

TOUGH—built to take the rough and tumble of field service and survive normally disastrous overloads the 935 will stay in cal.

PRECISE—basic 0.1% d.c. accuracy — better than many bench models!

VISIBLE—big, clear, high contrast 3½ digit LCD display, readable anywhere. ½" characters.

EXPANDABLE—accessories extend measurements to 1000A 40kV r.f. at 700MHz or temperature from 60 to 150 C.

INEXPENSIVE—the 935 has the lowest price tag of any high performance hand-held DMM at £94, UK. mainland delivered exc VAT. It uses a low cost PP9 battery which can give up to 200 hours use.

Get the leaflet now and see why your next multimeter should be a Data Precision 935!

Contact: **Farnell International**

WETHERBY · WEST YORKSHIRE LS22 4DH · TEL: 0937 63541 · TELEX 557294 FARIST G OR LONDON OFFICE – TEL: 01 864 7433

WW — 058 FOR FURTHER DETAILS

- the Mark III ASCII encoded touch keyboard

This professional quality touch sensitive keyboard has the full ASCII code set of characters available from the main keyboard, plus a separate 12 key pad to allow fast numeric entry. The MK III has a 'bleep' facility with volume control and power 'on' light plus a polyester sealed wipe clean surface making the unit particularly suitable for use in hostile environments. The MK III is supplied complete with mating gold plated edge connecter in a low profile matt grey plastic case with non-slip feet.

Additional features

- 7 bit parallel ASCII encoded output with positive and negative strobes
- Odd and even parity check bits (bit 8)
- Two user definable pads - switch closures (24V 50mA max)
- Repeat pad
- Illuminating, electronically latched shift lock pad
- Electronic hysteresis
- Industry standard key spacing (¾ in)
- Operating life greater than 5,000,000 operations per pad
- Available ex stock (manufactured in U.K.)

Custom keyboard design and manufacturing capability

Optional extras (all options are incorporated in the unit)

A	Serial output compatible to RS232/V24	£6.00
A1	Internal baud rate generator. For use with Option A or C. Please state Baud rate required	£5.00
A2	Internal generation of $\pm$ 12 Volts for use with Option A	£8.00
C	20 mA Current loop output. Passive.	£6.00
D	On board — 5 Volt regulator. Requiring unregulated D.C. input of 7-12 V	£4.00
E	Earphone socket and plug in personal earphone	£2.00
F	Switch selectable TTY compatability	£10.00

With Option 'A' or 'C' the Baud rate may be supplied externally by the user
With Option 'A' the — 12 Volt may be externally supplied

Please send me details of your range of keypads.

Price £48.50 plus VAT

Postage and packing
U.K. £1.00 *Europe £2.00 *Outside Europe £3.00
*(This includes Air Mail delivery)

Payment should be made in sterling drawn on a U.K. bank or I.M.O.
Cheques made payable to Star Devices Ltd.
P O Box 21, Unit 1, Mill Lane, Newbury, Berkshire.
Telephone 0635 40405

Access/Eurocard/Mastercharge
Name ....
Address ....
....
Card Number ....
BLOCK CAPITALS

NOW IN ITS FIFTH YEAR

A major exhibition of computers, peripherals, terminals and services, held each spring in the most highly industrialised area of Western Europe.

COMPEC EUROPE'80

Centre International Rogier, Brussels, May 6, 7 & 8, 1980

The ever-growing international attendance gives Compec Europe exceptional status as a sales platform for providers of hardware, software and services from every country. Ensure participation in its benefits by posting the coupon below.

COMPEC EUROPE'80 STAND RESERVATION FORM

To: The Exhibition Manager, Compec Europe, Room 821, Dorset House, Stamford Street, London, SE1 9LU, England.

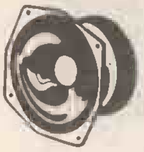
Please provisionally reserve for us stand space at Compec Europe 80 and send the undersigned more information.

Name ______________________ Company ______________________

____

____

WILMSLOW AUDIO
The firm for Speakers



HI-FI DRIVE UNITS

Audax HD12 9D25	£7.65
Audax HD13D34H	£12.75
Audax HP11P25EBC	£6.65
Audax HP20B25H4	£13.25
Audax HD24S45C	£20.50
Baker Superb	£25.00
Castle Super 8RS/DD	£12.65
Chartwell CEA205 8" bass, matched pairs only 8 ohm (pair)	£61.25
Coles 4001	£7.65
Coles 3000	£7.65
Celestion HF 1300 II	£8.45
Celestion HF 2000	£10.25
Dalesford D10 tweeter	£8.45
Dalesford D30/110 5in	£11.25
Dalesford D50/153 6½in	£12.25
Dalesford D50/200 8in	£12.25
Dalesford D70/250 10in	£22.25
Dalesford ABR 10in	£10.25
Dalesford D100/310 12in	£35.75
Decca London horn	£57.25
Decca DK30 horn	£43.75
Decca CO/1000/8	£10.25
EMI 14A/770 14in x 9in 8 ohm	£19.50
EMI 8in x 5in d/c, 10 watt, 4 ohm	£4.05
EMI Type 350 4 ohm	£9.45
Isophon KK8/8	£8.15
Isophone KK10/8	£8.45
Jordan Watts Module	£20.40
Jordan Watts HF kit	£9.15
Jordan 50mm unit	£23.00
Jordan CB crossover (pair)	£23.00
Jordan Mono crossover (pair)	£23.00
Kef T27	£9.45
Kef B110	£12.00
Kef B200	£13.25
Kef B139	£27.00
Kef DN13	£5.40
Kef DN 12	£8.65
Kef DN 22 (pair)	£40.85
Lowther PM6	£51.00
Lowther PM7	£88.45
Peerless KO10DT	£10.50
Peerless DT10HFC	£10.50
Peerless KO40MRF	£12.25
Radford BD25 II	T.B.A.
Radford MD9	T.B.A.
Radford MD6	T.B.A.
Radford FN8/FN831	T.B.A.
Richard Allan DT20	£8.95
Richard Allan DT30	£9.45
Richard Allan CG8T	£11.25
Richard Allan CG12T Super	£25.30
Richard Allan LP8B	£11.75
Richard Allan HP8B	£17.60
Richard Allan HP128	£28.40
Seas H107	£8.95
Shackman Electrostatic, c/w polar network and crossover (pair)	£130
Tannoy DC386 15in	£178.90
Tannoy DC296 10in	£107.35

PA GROUP & DISCO UNITS

Baker Group 35	£15.45
Baker Group 50/12	£23.45
Baker Group 50/15	£35.15
Celestion Powercell 12/150	£56.50
Celestion Powercell 15/250	£69.25
Celestion G12/50 Twin cone	£15.95
Celestion G12/80 Cambric edge	£20.25
Celestion G12/80 Twin cone	£19.75
Celestion G12/125 Cambric edge	£35.10
Celestion G15/100 Cambric edge	£31.95
Celestion G15/100 Twin cone	£32.25
Celestion G18/200	£53.25
Celestion MH1000	£15.95
Fane Pop 40	£12.50
Fane Pop 50H	£13.80
Fane Pop 75	£19.70
Fane Pop 65	£21.25
Fane Pop 80	£25.50
Fane Pop 100	£41.80
Fane Guitar 80L	£26.10
Fane Guitar 80B	£27.15
Fane Disco 80	£27.15
Fane PA80	£26.10
Fane Bass 85	£34.00
Fane Crescendo 12E	£57.50
Fane Crescendo 15E	£74.50
Fane Crescendo 18E	£94.75
Fane J44	£6.90
Fane J104	£13.75
Fane J73	£9.75
Fane HPX1/HPX/2	£3.45
Fane HPX3A	£5.60
Fane HPX3B	£4.55
Goodmans 8PA	£5.05
Goodmans 12P	£21.00
Goodmans 12PD	£23.95
Goodmans 12PG	£23.65
Goodmans 18P	£48.45
Goodmans Hifax 50HX	£21.85
Motorola Piezo horn 3½in	£8.50
Motorola Piezo horn 2inx6in	£12.25
Richard Allan HD8T	£17.00
Richard Allan HD10T	£18.50
Richard HD12T	£24.45
Richard Allan HD15	£43.40
Richard Allan Atlas 15in	£85.15
Richard Allan Atlas 18in	£110.75

WILMSLOW AUDIO
KITS FOR MAGAZINE DESIGNS etc.

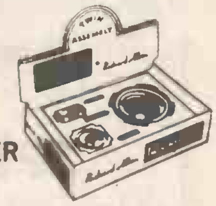
KITS FOR MAGAZINE DESIGNS
Kits include drive units, crossovers, BAF/long fibre wool, etc. for a pair of speakers. Carriage £3.75

Practical Hi-Fi and Audio PRO9-TI (Rogers) Felt panels for PRO9-TL £6.72 plus £1.60 carriage	£138
Hi-Fi Answers Monitor (Rogers)	£146
Hi Fi News State of the Art (Atkinson)	£182
Hi Fi News Miniline (Atkinson) (carriage £2.66)	£48
Hi Fi for Pleasure Compact Monitor (Colloms) (carriage £5.25)	£115
Popular Hi-Fi Mini-Monitor (Colloms)	£74
Popular Hi Fi Round Sound (Stephens) including complete cabinet kit	£71
Popular Hi-Fi (Jordan) plus (carriage £2.66)	£93
Practical Hi-Fi & Audio BSC3 (Rogers)	£65
Practical Hi-Fi & Audio Monitor (Giles)	£155
Practical Hi-Fi & Audio Triangle (Giles)	£99
Practical Hi-Fi & Audio Mini Triangle (Giles)	£108
Wireless World Transmission Line (Bailey) KEF	£122
Wireless World Transmission Line (Bailey) RADFORD	£184
Hi-Fi News Tabor (Jones) with J4 bass units	£60
Hi-Fi News Tabor (Jones) with H4 bass units	£66

Smart badges free with all above kits (to give that professional touch to your DIY speakers!). Send 50p for up to 6 reprints/construction details of above designs.

CARRIAGE & INSURANCE

Tweeters & Crossovers	50p each
Speakers 4"-6½"	80p each
Speakers 10"-12"	£1.00 each
Speakers 12", 13"×8", 14"×9"	£1.75 each
Speakers 15"	£2.75 each
Speakers 18"	£4.00 each
Speaker kits £1.75 each	£3.00 pair
Mag. design kits	£3.75 pair



SPEAKER KITS

PRICES PER PAIR—
CARRIAGE £2.66

Dalesford System 1	£54
Dalesford System 2	£57
Dalesford System 3	£104
Dalesford System 4	£110
Dalesford System 5	£142
Dalesford System 6	£95
Eagle SK210	£17.60
Eagle SK215	£32.60
Eagle SK320	£40.80
Eagle SK325	£68.50
Eagle SK335	£93.00
Goodmans DIN 20 4 ohm (special offer)	£27.60
LS3/5A equivalent kit	£71
Lowther PM6 kit	£105.30
Lowther PM6 Mk 1kit	£110.40
Lowther PM7 kit	£176.85
Peerless 1070	£124.70
Peerless 1120	£142.10
Peerless 2050	£51.10
Peerless 2060	£67.40
Radford Studio 90 kit	£184
Radford Monitor 180 kit	£218
Radford Studio 270 kit	£350
Radford Studio 360 kit	£440
Ram Kit 50 (makes RAM 100)	£71.50
Richard Allan Tango Twin kit	£49.00
Richard Allan Maramba kit	£69.00
Richard Allan Charisma kit	£101.20
Richard Super Triple kit	£81.70
Richard Allan RA8 kit	£52.65
Richard Allan RAB2 kit	£83.30
Richard Allan RA82L kit	£89.90
Seas 223	£40.85
Seas 253	£63.10
Seas 403	£76.60
Seas 603	£122.60
Wharfedale Denton XP2 kit	£31.45
Wharfedale Shelton XP2 kit	£40.40
Wharfedale Linton XP2 kit	£56.20
Wharfedale Glendale XP2 kit	£69.00

Everything in stock for the speaker constructor!
BAF, Long Fibre Wool, Foam, Crossovers, Felt Panels, Components, etc.
Large selection of grille fabrics. (Send 18p in stamps for grille fabric samples).

PRICES CORRECT AT 18.6.79

ALL PRICES INCLUDE VAT @ 15%

Send 30p stamp for free 38 page catalogue 'Choosing a Speaker'

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

Telephone Speakers, Mail Order and Export 0625 529599
Hi-Fi: (Swift of Wilmslow) 0625 526213.

Lightning service on telephoned credit card orders!

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

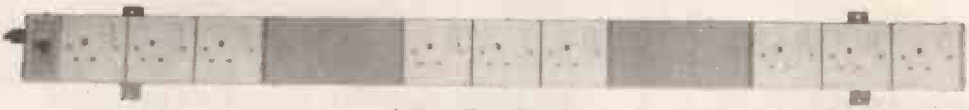
OLSON

PORTABLE MAINS DISTRIBUTION

New! Slim Jim

Dim. 1¾" x 2½" x 18¾"
£12.15. PP **85p + VAT**

19" Rack Mounting Type 13A/4SW/R **£16.80**. P&P **£1 + VAT.**



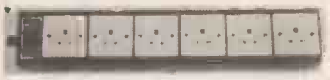
Instant Trunking System for Wall or Bench Mounting

TR6 — 6 sockets switched **£21.50**

TR9 — 9 sockets switched **£25.50**
Plus P&P **£2 + VAT**

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	£12.75
6 sockets 13A	£15.00
4 sockets 13A switched	£14.45
6 sockets 13A switched	£16.75

+ Post £1 + VAT

EPROM ERASER

Low cost ultra violet eprom erasing lamp will erase up to 12 chips at one time.

PRICE £95.00 + VAT

MAINS ISOLATING UNIT

The Olson mains isolating unit is an essential bench item for safety when testing and repairing mains-operated equipment. The isolating transformer has an earthed screen and is rated 250VA.

£38 + P&P £2 + VAT

ALL DISTRIBUTION PANELS ARE FITTED WITH MK SOCKETS & PLUG
Send for details of complete range

OLSON ELECTRONICS LTD., FACTORY NO. 8, 5-7 LONG ST., LONDON E2 8HJ
TEL. 01-739 2343

WW — 093 FOR FURTHER DETAILS

AEL

Suppliers of

Electronic Tubes Semiconductors

For use in Professional Equipment

Exceptionally wide range of spares for most equipment in use

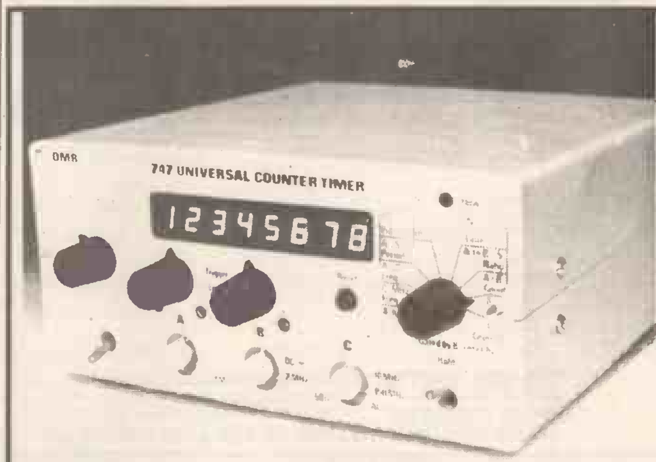
Write for catalogues or just state your requirement to

AEL

AERO ELECTRONICS (AEL) LIMITED
GATWICK HOUSE, HORLEY, SURREY,
ENGLAND RH6 9SU

Telephone: Horley (02934) 5353
Telex: 87116 (Aero G Horley)
Cables: Aero G Telex Horley

WW — 082 FOR FURTHER DETAILS



747 UNIVERSAL COUNTER TIMER
£175 + £3.50 p&p

DC-150MHz
8 DIGITS
8 FUNCTIONS
3 CHANNELS

Measures — A KHz, C MHz, Period A, Pulse Width A±, Time A± to B±, Count A, Count A (gated by B, reset by C)
Max. resolution 0.1Hz, 100pS.
Averages 1 to 1000 events.

Also available — Counter Timers, Frequency Meters, Filter Oscillators, Function Generators, Off-air Standards, Lab/Bench Power Supplies, Panel Meters & Bar Indicators.

OMB ELECTRONICS

Riverside, Eynsford, Kent DA4 0AE
Tel: Farningham (0322) 863567

Prices, which are CWO & ex-VAT, are correct at time of going to press and are subject to change without notice.

WW — 073 FOR FURTHER DETAILS

REGUN TV TUBES

with EDICRON ELECTRON ASSEMBLIES

- Monochrome or colour
- Standard, quick heat, delta or inline
- Wide range of neck sizes and heater ratings
- Predictable in use and performance
- High tolerance on insert procedure
- High conversion rate on ageing
- Long service life
- Neck glass, tube bases, equipment and accessories also supplied

For full details contact:

EDICRON LTD.
Redan House, 1 Redan Place, London W2 4SA.
Tel: 01-221 4717 Telex: 265531 Edicrn G

WW — 066 FOR FURTHER DETAILS

LOWE ELECTRONICS LTD.

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

NEW MODEL CS1577
30 MHz/2mV

CS1577

130mm DUAL TRACE TRIGGERED SWEEP OSCILLOSCOPE

£480 + VAT

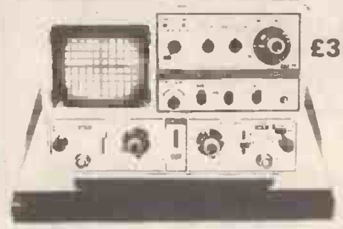
PRICE INCLUDES TWO X10 FULL BANDWIDTH PROBES

- ★ 130 mm mesh PDA
- ★ DC - 30 MHz
- ★ 2 mV sensitivity
- ★ Signal delay
- ★ Auto level triggering
- ★ Display modes CH1, CH2, DUAL, ADD, X-Y
- ★ Single shot with variable hold off

SPECIFICATION

Bandwidth:	DC - 30 MHz (3 dB) 40 MHz (6 dB)
Sensitivity:	2 mV/cm - 10V/cm
Input R.C.:	1 M ohm 22 pF
Risetime:	11.7 nS
Overshoot:	less than 3%
Sweep time:	100 nS/cm - 0.5S/cm
Linearity:	better than 3%
Calibrator:	1 KHz 100 mV square wave
Trigger bandwidth:	DC - 40 MHz
Trace rotation:	Electrical
Phosphor:	P31
Power:	AC 100/120// 220/240V 50/60 Hz 40W
Dimensions:	260mm x 190mm x 375mm
Weight:	10 Kg

CS1352 DUAL TRACE 15 MHz/2mV PORTABLE



£350 + VAT

The CS1352 oscilloscope offers you not only dual trace, 15MHz bandwidth operation at sensitivities down to 2mV/cm but also use from 100-240 Vac mains and portable operation using the optional rechargeable battery pack. Automatic charging is carried out when the CS1352 is plugged into a mains supply. Now you can have top performance both on the bench and out in the field — and at an affordable price.

CS1575 DUAL TRACE 4 FUNCTION

The CS1575 is a unique tool for the audio engineer. It features the normal facility of dual trace display with sensitivity to 1 mV/cm but not only can it display the input signals on two channels, it can **simultaneously** display the phase angle between them and measure the phase angle referenced to a zero phase calibration display. In addition to these unique features, you also have independent triggering from each channel to give stable displays even with widely differing input frequencies.

Absolutely indispensable to the professional audio engineer, the CS1575 is now in use all over the world. See it in action or send for complete details.

£278 + VAT

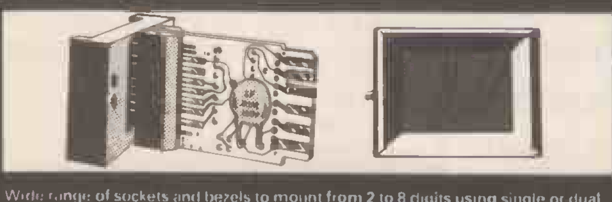
TRIO OSCILLOSCOPES

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.

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

WW — 052 FOR FURTHER DETAILS

MOUNTING HARDWARE – THE NO.1 SOURCE



Wide range of sockets and bezels to mount from 2 to 8 digits using single or dual digit LED or incandescent displays. Also electronic modules with decoder driver, latch and counter options to mate with hardware

- 5 ranges accomodate most available displays
- Attractive one piece bezel with choice of filter
- Ex stock

WW — 016 FOR FURTHER DETAILS

LCD DIGITAL PANEL METERS ULTRA LOW COST

DPMs 1 and 2 are extremely compact, significantly saving panel space while full scale values of 0-1.999V or 0-199.9mV are variable by means of a multi-turn potentiometer. Plastic bezel & screen, user selection of decimal point, auto polarity & zero, accuracy of ±0.1% and character heights of 0.7" & 0.5" combine to offer probably the most attractive DPM on the market.

WW — 017 FOR FURTHER DETAILS

PCL Perdix Components Ltd
98 Crofton Park Road, London S.E.4. Tel: 01-690 1914 Telex: 897883

wireless world

Into the 'eighties

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

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

Communications Editor:
TED PARRATT, B.A.
Phone 01-261 8620

Drawing Office Manager:
ROGER GOODMAN

Technical Illustrator:
BETTY PALMER

Production & Design:
ALAN KERR

Advertisement Controller:
G. BENTON ROWELL

Advertisement Manager:
BOB NIBBS, A.C.I.I.
Phone 01-261 8622

DAVID DISLEY
Phone 01-261 8037

BARRY LEARY
Phone 01-261 8515

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

NEIL McDONNELL
(Classified Advertisements)
Phone 01-261 8508

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

Publishing Director:
GORDON HENDERSON

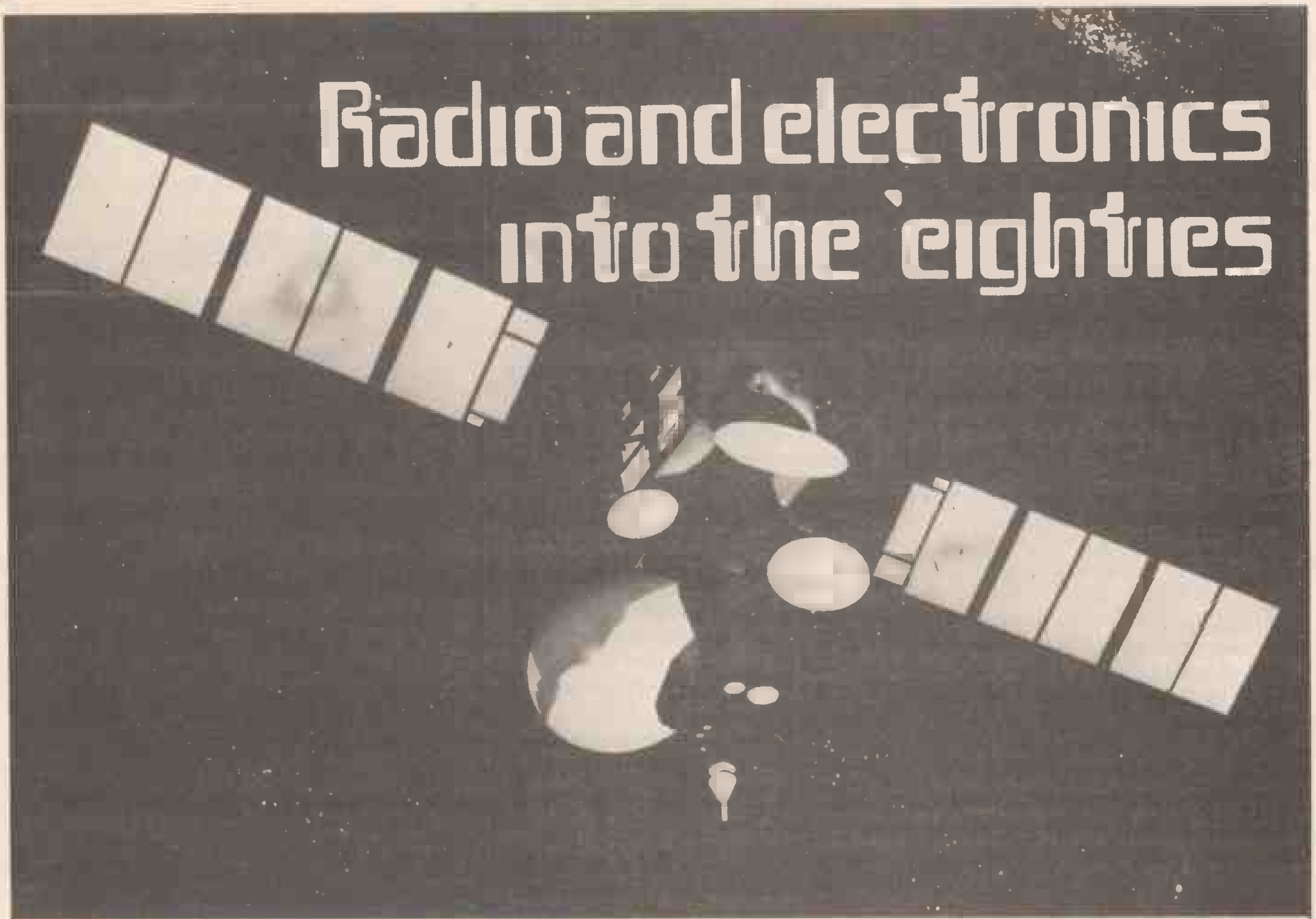
Our front cover this month, introducing the articles "Radio and electronics into the 'eighties", symbolizes man's increasing involvement with his technology. This is a two-way process. The more devices and systems he produces the more he changes his environment and this reflects back on him by modifying his customs, institutions and general way of life. And it may go deeper than this. According to the early sociologist Durkheim, a person's knowledge of himself — his self-image — is created by the society in which he lives. Not only does he exist in society but society exists in him. So in modifying the material basis of society and hence social relations by technology, he continually changes his concept of himself as an individual and all the imagined needs or wants that arise out of this concept. No wonder that modern man in industrialized society seems such a restless, anxious and dissatisfied creature.

This two-way process is very intense when the technology is electronics, for here we are concerned with transmitting and transforming information, and ultimately, if not directly, this information causes human beings to think, feel and act. What seems to emerge from the developments described in the following articles is that the 1980s will see a further intensification of the links between the human being and his electronic systems. The systems will become even more closely matched to the input and output capabilities of the biological organism and will make even greater demands on it. It's not simply a case of more communication channels conveying more information in a given time, but a continuing increase in the refinement and variety of the information put in by and presented to the human beings.

Higher quality sound and visual images, and higher performance in radar systems and laboratory instruments, for example, all demand greater attention and discrimination. In broadcasting the addition of colour and text to television and stereophony to sound have already given us more to perceive and cognize, and electronic tricks in sound and vision synthesis are stretching these abilities to the edge of confusion. In radiocommunication, voice messages are being supplemented by digital data transmission, often on the same circuits, to make possible greater detail and accuracy. And now the general public can retrieve useful facts from data banks over the ordinary telephone lines. Telecommunications are, of course, essential to organizations — especially large, far-flung organizations like multinational companies, airlines and political/military alliances — to enable them to respond quickly and appropriately to events in any part of their structure. Any message demands a decision, if only to ignore it, but with messages arriving quicker, and in ever greater quantity and detail, the mounting pressure on responsible people to be continually making decisions and deciding priorities is reaching inhuman proportions. Some individuals have found it too much and have left for a quieter life.

On the 50th anniversary of Bell Laboratories, the president, W. O. Baker, said of communications: "I see it also as a mission of importance involving great responsibility. Improving communications, more efficient and satisfying handling of information — these I deeply feel are essential to help solve economic and social problems and aid efforts to civilise the future". These are noble sentiments but it is already evident that we cannot solve such problems by technology alone. As humans we are limited in our powers to assimilate information and in our good will to act on it properly. Perhaps what we really need is less information and more wisdom.

Radio and electronics into the 'eighties



Intelsat V (above) the latest communications satellite, which will be launched at the turn of the year, marks dramatically the entry of radio and electronic technology into the 1980s, for it has double the communications capacity of its predecessor, Intelsat IVA. Equally important advances are being made in terrestrial radio and its related fields, and in the following pages we present articles by seven specialists who first look back at what has happened over the past decade and then project their thoughts and expectations into the 'eighties.

Land mobile radio

by W. M. Pannell, M.I.E.R.E. Pye Telecommunications Ltd

Technical progress in the electronics industry over the past decade has taken vast strides, with the land mobile radio sector certainly not lagging behind. The inevitable questions arise: What effect have all the changes in technique had on the mobile radio industry and its users? Which changes have made the biggest impact? And, what can we expect over the next decade?

Although the changes to the mobile and portable units, the fixed equipments and the peripherals have shown considerable innovation over the past ten years, many of the changes in technique have been brought about by the increasing complexity of overall system requirements.

One change that made a major impact on mobile radio in the UK, over a decade ago, was the decision to split the channel bandwidth at v.h.f. from 25 to 12½ kHz. This resulted in some immediate relief in the search for extra spectrum and a marked reduction in co-channel interference. The change improved the utilization of channels for many types of user.

During the 1970s we also saw the increasing use of personal portables in all types of system. This is, of course, a logical progression in view of communication being needed between people rather than vehicles in most cases — the main exceptions being where interrogation of vehicle status is desired or where vehicles are the essential tool, for example fire engines.

It was at this point that the move towards miniaturization became an essential requirement in all types of equipment, not so much because of the need for smaller equipments, although in portable design this was naturally a fundamental requirement, but more to enable equipments of increased complexity and versatility to be designed for the more sophisticated systems without increasing the total volume of individual units. So an upsurge in the use of integrated circuits took place: the ubiquitous light bulb was replaced by light emitting diodes: l.e.d. followed by l.c.d. displays became a recognised means of presenting information; while conventional components became steadily smaller to keep up with the new techniques. At the same time, higher stability frequency sources and better i.f. filters became necessary in fixed, mobile and portable equipments as the need for higher performance developed.

Meanwhile, in the systems control field, processors began to take over many of the functions which had previously involved complicated manual operations. More facilities and information became available to the system controller, while, in the mobile, actions could, for example, be initiated from control or other designated points without the need for intervention by the mobile user.

Signalling. Signalling over radio gained considerable ground during the 1970s. Previously such requirements as selective calling were often considered to be refinements and were avoided where possible, usually on the grounds of cost and size. Solid-state techniques changed this view and selective calling units employing relays and often mechanical selectors gave way to units of but a fraction of the size and power consumption.

Unfortunately during this period the variations in signalling techniques increased in an alarming way, each manufacturer tending to develop his own form of coding with the result that compatibility became almost impossible. At present there is however a trend to standardise on a few of the better systems, mainly of the sequential tone variety. Even with the reduced number of variants, compatibility is still a problem and further standardisation would be advantageous.

A lot of work has been undertaken in recent years in digital signalling, generally of the order of 1200 bit/s. Various error detecting and correcting codes have and are being investigated to obtain higher coding efficiency and provide a good throughput of data. Such techniques may help in providing data communication at signal levels which in the past have been considered too low for error free data transmission. Digital signalling will undoubtedly be the answer to providing channel assignment switching, sophisticated selective calling, alarms, identity, printer drive, data display and many other uses. However, the low signal threshold achieved with tone signalling has yet to be equalled by any but very low speed digital signalling.

Microprocessors have enabled "intelligence" to be added to systems. The era of manual press-to-talk and the occasional channel change accompanied, where needed, by a selective call operating an electronic 'door bell' is now often superseded in the larger systems by intelligent switching functions where channel and routing procedures are performed automatically; hand shaking/identity routines are undertaken with complex control functions being processed, as well as many other technically complex operations. At the moment, microprocessors, although cheap, tend to be greedy in power consumption (n.m.o.s.). This may be improved in the near future by the use of c.m.o.s. and ultimately silicon on sapphire (s.o.s. m.o.s.). Microprocessors in portables where low consumption is critical may thus become practical.

Trunking. Trunking in land mobile systems is a technique which has grown during the past few years with the help of the microprocessor. While the full advantages of such systems in frequency spectrum economy have yet to be seen, undoubtedly first indications are favourable. The use of trunking, however, can raise an operational problem concerning the ownership of the base complex, and this may limit its use to definite types of system where single ownership or the radio common carrier type of operation prevails.

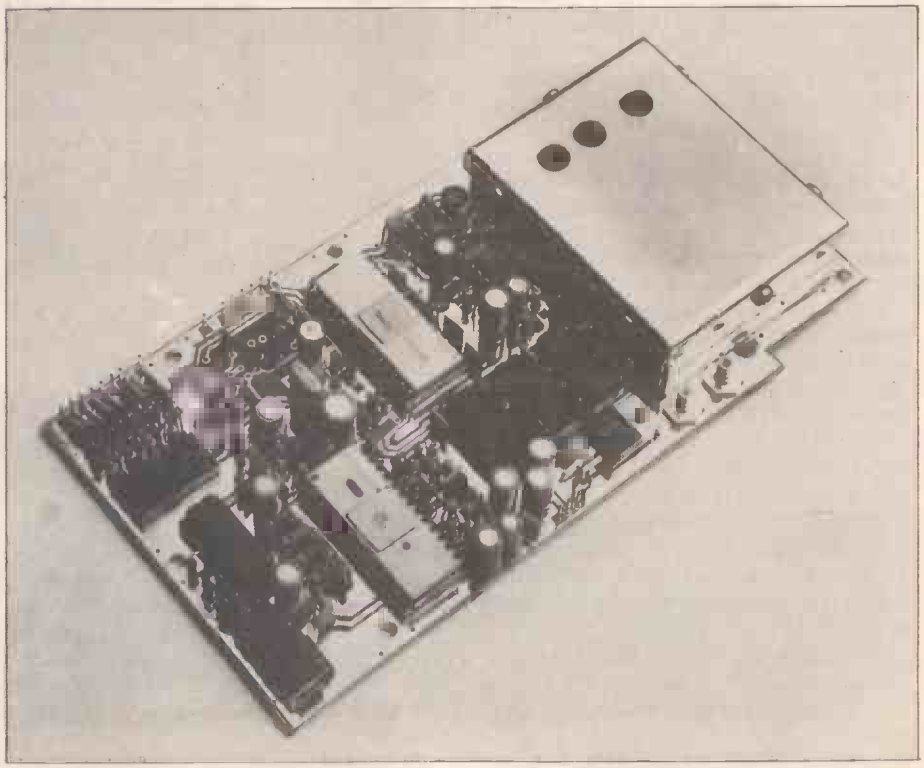
Quasi-synchronization. System techniques evolved during the 1970s included the use of a quasi-sync — a method whereby a number of transmitters carrying the same intelligent radiate simultaneously without interference in a number of overlapping areas. Although as early as 1946 J. R. Brinkley proposed the use of staggere carrier techniques, this method ultimately became unworkable as the channel habdwidth was reduced down to 12½kHz. At these narrow bandwidths much closer staggering, of the order of a few hertz, is required, so that a need arose for high stability, low noise oscillator sources. The technique of quasi-sync is generally applicable to a.m. and f.m. at frequencies up to 500MHz although at v.h.f. the use of f.m. quasi-sync is subject to some reservations.

Frequency sources. The development of frequency synthesisers for mobile radio also shows signs of increasing in tempo as the need for greater frequency agility grows. Several designs have been announced using various custom built chips. It is just a matter of time before the cost of such devices is comparable with conventional crystals, even for one channel. Meanwhile frequency control has improved considerably by the use of a phase lock loop system and this is often standard on present day fixed receivers in the land mobile bands.

Modulation methods. Overshadowing many of the developments during the past few years has been the obvious rapidly diminishing spectrum space available for each new land mobile radio system. Much has been written on the

This microprocessor controlled equipment generates and decodes selective calling tones. Providing alert, identification, status, alarm and other operating functions, it is compatible with all known selective calling systems.

Synthesizer board in the Pye M206X two-way radio can be supplied for anything from 16 to 128 channels.



subject and at the recent World Administrative Radio Conference in Geneva much was undoubtedly discussed.

Even if, as a result of all the decisions made, extra spectrum is handed to mobile radio, the rate of growth is such that economies must be made. To this end techniques are already being investigated to achieve spectrum savings and further bandwidth splitting by the use of s.s.b. is but one method currently under review. Others include spread spectrum methods, stored speech and the virtual elimination of speech by the total use of data in those applications where standard forms of message predominate. The latter methods are still in the early stages of investigation, but the development of s.s.b. is quite advanced and shows considerable promise.

Cellular systems. Much has also been written on the use of small cell techniques in urban area radio systems. In the United States, where a lot of work has originated, several systems are being put into operation at 900MHz using this principle. Although the cells involved initially in these systems cannot really be described as 'small cell', the possibility of sub-division exists and will undoubtedly be the subject of further investigation. Small cell systems are necessarily oriented towards processor control if all the functions proposed are to be implemented. Cellular systems and trunking have a great deal in common in many design aspects.

Energy sources. In spite of the huge variety of systems which have been devised over the past decade, one common denominator remains — that of the energy source required to drive the equipments. Vehicle units are generally no problem, there being a ready source of d.c. in the vehicle. Portables are a different matter insofar as, although a battery of a suitable type is included in the assembly, this must be either replaced or recharged after a period of work. There has been no outstanding design change during the past ten years which has increased the portable battery capacity appreciably or reduced its size, so this is one aspect where changes are required.

In fixed equipment the tendency has been to use secondary batteries charged from sources of energy ranging from the public power supply through diesel generating sets, wind and water driven generators, thermal generators to solar cells. All methods have their place in providing power to radio equipment. With the present energy crisis, further work is indicated, not only to find means of providing power in relatively inaccessible places but to do so using the minimum resources at present in great demand.

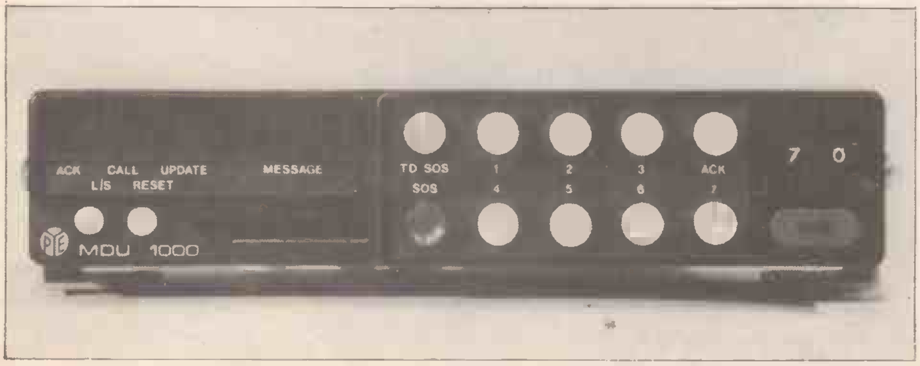
The next ten years

In view of the vast changes which have taken place over the past decade one is tempted to forecast the future almost in terms of science fiction. It is not my intention to examine such possibilities but rather to consider the more down-to-earth developments of existing techniques.

Data will undoubtedly appear as one of the main contenders for optimising usage of the frequency spectrum. While speech will be with us for some considerable time, particularly in the simpler systems, the efforts being made in the data field must be recognised. For example although there is a lack of economically viable vocoders suitable for digital speech at the moment, they will undoubtedly appear. Alternatively, stored speech controlled by a digital bit stream could well be a relatively inexpensive method of spectrum conservation. Speech synthesisers driven directly by computers are also likely. Good speech quality at real time digital speeds of 2 or 3 kbit/s now appears probable in the next decade. Bubble memory techniques permitting occupancy time reduction are, even now, a possibility, with available bubble memories capable of 10^6 bits/chip, one square centimetre in size, already available.

At present the rate of growth of data by digital methods is in excess of 20% per annum and is expected to maintain or even exceed this during the next ten years.

Obviously the use of digital techniques, spread spectrum for example, provides a high degree of privacy and at the same time enables a high degree of large scale integration to be employed — all leading to smaller equipments and, one hopes, greater power economy.



Two-way mobile data unit for use in a vehicle availability system.

The use of data processing methods to impart "intelligence" to a system is of course one of the most important aspects. Already microprocessors play a major role in the more sophisticated systems, as indeed they are beginning to do in many other areas of present day activity. The future holds an almost unlimited range of possibilities. Dynamic channel allocation, automatic transmitter power level adjustment to suit the propagation conditions and local interference level, automatic call routing, and many others are already in the pipeline, and every day sees a new requirement.

In spite of the digital revolution we must not forget the more conventional forms of mobile communications — forms which will undoubtedly remain in use for a long time, particularly in the simple system and in many of the overseas areas where sophistication is not necessarily needed at present. Here single sideband at frequencies up to at least 500 MHz could well provide all the channels needed until the end of the present century even in areas of international congestion — where, for economic reasons, several countries merge into a single overall area. It should also be emphasised that s.s.b. can also carry the simpler forms of data on equal terms with the more conventional a.m. and f.m. systems.

Portables will tend to become the more normal form of unit, although generally adaptable also for mobile use. Here again the use of data may modify the portable as we see it. For example, display methods may be incorporated to minimize standard speech messages. Key pads to send alpha-numeric messages will be of greater convenience than speech, in many cases, for example, in crowded environments where privacy is required. Similarly key pads will be used for routing the call.

The low efficiency of the portable antenna is another area for further development. However, it could well be that, rather than improving the ranges possible with portables, cell type systems will predominate and most fixed networks will consist of many low power stations closely spaced. Typically, if operation into the telephone is envisaged, the existing telephone call box could be used to locate individual fixed stations, the present physical spacing being close enough to permit very low power to be used. available power and eacy connection into the telephone system favours such an approach.

All these innovations will inevitably increase the complexity of the portable, requiring more compact packaging if only to maintain the same size. Work must be undertaken on battery design if sizes are to remain as at present or preferably reduced in volume, while the extra consumption of the ancillary equipments means that increased battery efficiency is a 'must'.

With the ever increasing use of integrated circuits it is not impossible that the design of much of the radio circuitry will move from largely discrete components to both hybrid and monolithic i.cs. With this approach the basic radio equipment will tend to become stereotyped in design and specification, with only the overall packaging being different. The ancillaries, which will be determined by the system, will then be the part of the package which will highlight the individual units.

It is for these reasons that, although there is a desire to harmonize specifications in as many aspects as possible future advances may be inhibited by too great a degree of commonality as integration becomes more involved. The use of common designs, however, show up some advantages. Already we are at the point where 'throw-away' modules are often more economical if and when a fault develops. This practice could even extend to the complete unit, especially where the simpler type is in use. Even now for example, it is cheaper to buy another medium wave pocket broadcast radio than to repair it. It is only a short step to the more complicated mobile/portable transmitter/receiver unit.

In the realm of power supplies, one hopes that there will soon be some breakthrough in the overall efficiency of batteries relative to size. Ultimately the size of portable units — in spite of increasing electronic complexity — must be reduced to a point where they can be 'worn' in an inconspicuous manner by the average person. Nevertheless, *very* small units are not really practicable at this moment for a number of technical and functional reasons.

Possibly a packet of 'king' size cigarettes is about optimum, although the present day 'credit card' calculator seems to be popular, and this format could well be considered in future personal radio designs. The 'king' size package has already been achieved in many types of pager, but of course the battery requirement here is quite different as there is no heavy transmitter drain.

Methods of charging batteries, whether the batteries are small in size and number, or are the larger types feeding a fixed station, are important aspects requiring further attention. In many parts of the world solar energy is the obvious immediate answer for powers up to a maximum of 500 watts. If efficiency could be improved, many other types of station could benefit, quite often saving expendable fuel.

In suitable areas the wind is already utilized as a source of electrical power and work on optimizing the energy conversion has produced good results. The energy in water movement, whether wave motion, tidal changes or just flow, also offer large scope for investigation.

Without any doubt, the future of mobile radio looks exciting. We must however, keep a firm grip on future developments to ensure that they do not fall into 'nice to have' category, but perform a real service to the world. Improved communication, saving of energy and all the other advantages likely to accompany the microchip era will undoubtedly gain momentum as we move through the years towards the next century. It is up to the engineer to ensure that the steps taken follow an ordered path. □

Broadcasting

by D. P. Leggatt B.Sc., F.I.E.E.
Engineering Information Department, BBC

One of the most striking features of the last decade has been the public appetite for high-quality audio. The 'hi-fi' was becoming a must in any modern household in the early 'seventies and by the end of the decade this had developed into the 'stereo.' While this movement has been led by the gramophone record, it represents a gratifying conversion to the gospel preached by the broadcasters since the introduction of v.h.f./f.m. broadcasting in the 'fifties, with the addition of stereo in the 'sixties. Public acceptance was slow to develop but at last there is wide appreciation of high-quality reproduction. Much recent development in radio broadcasting has been spurred by this public expectation: in the studios, stereo origination is becoming standard; on the distribution networks, high-quality digital p.c.m. systems are spreading stereo broadcasting throughout the country; the v.h.f. transmitter network is being extended; and experimental transmissions of quadraphony or surround-sound systems have been mounted. Although the majority of the radio audience still uses medium and long waves, the congestion and limited quality of reception on these bands has added further impetus to the swing towards v.h.f.

Another reflection of the healthy activity of radio in the last ten years has been the development of local and regional radio services. BBC Local Radio started in the late 'sixties, followed by Independent Local Radio in the early 'seventies. These did not bring new technical problems, but they did increase pressure on available frequency channels: indeed, we have now reached the point where the v.h.f. Band II is badly congested and frequencies have to be shared by programme services which really require channels to themselves.

Turning to television, the main areas of development in the past decade can be categorised as improvements in transmitted quality; extension of programme services; and improved facilities for programme makers. Improvement of picture quality is, of course, a continuing process as each generation of equipment succeeds the last, but one very obvious advance has been the spread of colour into the majority of all programmes with steady development in clarity, fidelity and consistency of colour picture generation and reproduction. Two other examples of technical quality improvement are worthy of mention: the introduction of almost distortion-free digital standard converters has brought significant quality improvements in the international exchange field; and the video noise reducer, a recent digital development, offers considerable benefits for programme material in general.

Programme services have been actively extended in the 'seventies. Notable developments have been the extension of u.h.f. transmitter coverage; the introduction of the teletext information services, Ceefax and Oracle; increasing use of satellites for international exchange; computer-based subtitling services for the deaf and for foreign films; the simultaneous transmission (on radio) of stereo sound with selected television music programmes; and, in the home, the availability of video cassette recorders for catching programmes which would otherwise be missed.

Improved facilities for programme makers should, and do, result in a wider range of better programmes for the viewer. The decade has seen much progress, including improved videotape recorders with sophisticated editing systems; instant replay and slow motion facilities; really portable cameras and video recorders for electronic news gathering; full-facilities outside broadcast cameras requiring only a single coaxial cable; zoom lenses of increased range and aperture; digital timing correctors and synchronisers for automatic signal timing; and digital picture stores for special effects and graphics work.

What, then, is the *zeitgeist* which has characterised the 'seventies? I suggest it is the realisation that with

Experimental BBC radio receiver allows programmes to be selected digitally by a sensing pen drawn across bar codes printed in the Radio Times.

transistors, large-scale integration and computer techniques, technical solutions can be devised for most problems. Increasingly, as time goes on, it will be economic, political and social factors which determine the course and pace of development. The questions for the future will more often be "how much do we want and what can we afford?" rather than "is it technically feasible?"

The next ten years

You want '100 Best Tunes' in the kitchen, so you pull out the telescopic aerial in your v.h.f. portable. For good results you need the aerial horizontal and angled for best reception; and in doing so you sweep three cups onto the floor! Then you find Radio 1 is taking its turn on the v.h.f. channel so you switch to medium wave. You find three or four stations transmitting serious music, so which is Radio 2? Eventually you hear Alan Keith's voice, but with an excitable Frenchman in the background plus crackles from your neighbour's electric drill. So there's nothing for it but down to the pub again!

This points the way to some main tasks for the 'eighties. We need more radio channels, signals which can be more easily received, and something to help us find the programme we want.

It is to be expected, following the World Administrative Radio Conference in Geneva, that more broadcasting channels will become available in the v.h.f. Band II. This will enable us to re-engineer the existing v.h.f. transmitting networks to avoid the necessity for sharing between BBC Radio 1 and Radio 2; to reduce the need for displacement of some Radio 3 and Radio 4 programmes by educational material; to cater for significat extensions of local radio services, ILR and BBC; and to increase the number and power of transmitters so that adequate signal strengths for reception on portables and in cars become available throughout most parts of the country. Further extension of the p.c.m. signal distributuion system will be a necessary ancillary to this transmitter development.

IBA's transportable 14GHz up-link to OTS satellite used for ITN broadcast from Wembley conference centre.

Towards the end of the 'eighties we may see the start of some direct transmission and reception of sound programmes in digital form. Although this may become the norm in the long-term future, current investment in conventional analogue systems is such that change to digital methods is not likely to be rapid.

Choosing a programme from the published schedules, selecting the right channel at the right time and tuning the receiver for optimum reception are becoming increasingly difficult for the average listener. Ideas are now developing for radio transmissions to carry coded identification signals inaudible to the listener but detectable by a suitable receiver. Given such codes, a receiver could be pre-programmed at the listener's choice to search for any desired programme — or type of programmes such as news, light music — and switch on at the appropriate time without the need for any manipulation or control by the listener. Such coded signals could also be used for automatic control of cassette recorders and to carry time information for electronic clocks.

New radio services we can expect in the 'eighties may include whatever form of surround-sound is finally agreed; and a dedicated channel of motoring information such as the BBC's Carfax development.

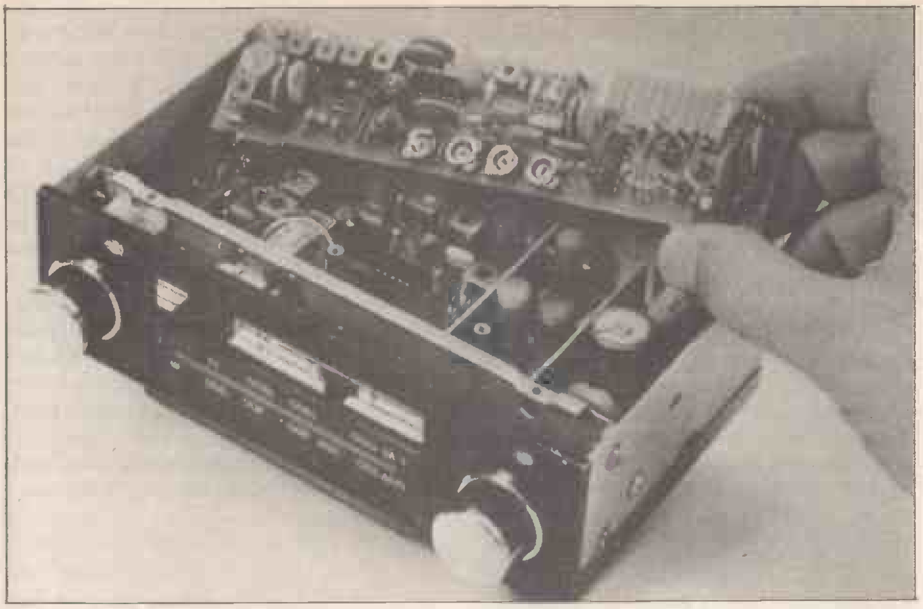
At the programme origination end, digital sound recorders will fairly soon be with us and will offer quality good enough for multi-generation work with little need for the careful alignment and maintenance which analogue recorders demand. Digital sound mixing desks will also appear, together with computer control of complex mixdowns from multitrack recordings which is already a facility in some recording studios and television sound dubbing areas.

Television. Although the solution to many technical problems can be foreseen, there are in television one or two areas where we need to tell our inventors "go away and make a breakthrough!"

The limited sensitivity of colour cameras is a case in point. Existing sensors are already approaching the region where photon noise — arising from the quantum nature of light — becomes the limiting factor. No new sensor, however revolutionary, can cross this fundamental barrier nor can we foresee optical devices of manageable size which would gather in many more of the limited number photons emitted by an ill-lit scene. The apparently much greater sensitivity of the human eye/brain combination is achieved by physical and subjective integration processes and it is down this road that useful investigation may proceed: the current development of integrating noise reduction equipment perhaps points the way.

In another area, colour camera sensors and receiver display devices employ rather cumbersome three-colour superimposition techniques with attendant disadvantages in terms of size, complexity and cost. A single colour pick-up device is wanted with outputs directly related to hue and luminance and no need for optical colour separation filtering; correspondingly a large area, flat display device is needed, responding to hue and luminance signals rather than relying on superimposition of three separate colour images. We must hope that the 'eighties will see a breakthrough in this area also.

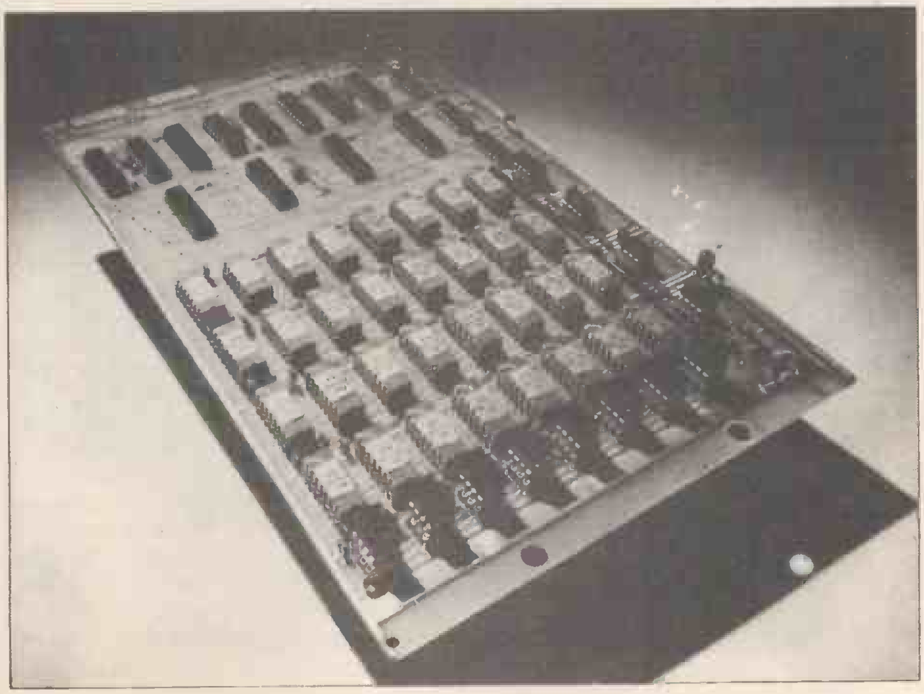
Turning to more foreseeable developments, work will continue through

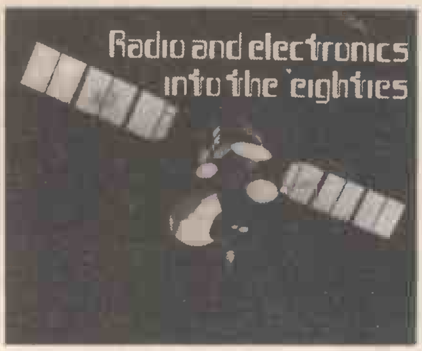


Prototype Carfax receiver module. ▲

Teletext hard copy printer. ▲

2Mbit television field store based on c.c.d. devices, as used in digital standards converter and digital noise reducer. ▼





the decade to extend relay station coverage to yet smaller population groups in the UK, with community aerials and local wired distribution systems playing an important part. The fourth television channel will be with us and there may be increasing pressure for local television services. More channels will be needed and the u.h.f. bands may be extended to accommodate this; 405-line services on v.h.f. Bands I and III will be closed down and Band III at least is likely to be re-developed for extended, or new, television networks. Band I is not ideal for television and could be used for mobile services displaced from Band II and perhaps for the start of direct digital radio broadcasts. Television broadcasting via satellites — for direct reception at home or with local distribution from a number of ground stations — is being actively planned for some European countries, but seems less needed in the UK where conventional transmitter coverage is fairly comprehensive.

An alternative source of television programmes is the video cassette recorder. Already well launched in the 'seventies, its use for replay of pre-recorded material will become a significant factor in programme distribution in the 'eighties.

In the studios, programme makers will be looking for increased flexibility and reliability. These qualities are offered by digital techniques, by which signals may be stored, manipulated and passed between areas with little degradation or need for manual intervention. Already we have digital systems for special effects and graphics, standards conversion, noise reduction, source synchronisation, sound distribution, teletext services and numerous routing control functions. We can soon expect to see digital video recorders and editing systems, digital vision mixers and digital camera processing chains. Digital PAL coding will reduce very significantly the cross-colour effect which is perhaps the most obvious shortcoming of present-day colour television. For outside broadcasts we can look forward to compact cameras using highly integrated digital circuitry (and a single colour sensor?) with digital transmission via transportable satellite links into the network control centre.

The islands of digital operation now appearing in the chain will steadily be merged during the 'eighties. Once a signal has been converted to digital form there are many good reasons for keeping it that way until final conversion at the transmitter to the PAL coded analogue signal required by the domestic receiver.

For international exchange we shall find signals distributed in digital form, very possibly as luminance plus colour difference components; final coding into PAL, SECAM, etc. will be left to the individual customer countries. Accompanying sound will be digitally multiplexed with the vision signal, several sound channels being available for multilingual requirements. All this will require comprehensive national and international standardisation of digital coding methods, and much work in the 'eighties will be devoted to negotiation and argument on this front.

Teletext and similar services can clearly be expected to advance rapidly in the next ten years. The scope of the information provided can increase almost indefinitely, reasonably short access times being maintained by allocating an entire television channel to this purpose and by provision of further storage and processing in receivers. High-resolution graphics, still and animated pictures of full television quality, and increasing sophisticated subtitling services will become available. Telesfotware, the transmission via teletext of computer programmes, will greatly extend the variety of tv games and will provide the non-specialised computer services which increasingly we shall make use of in our domestic lives. Hard-copy printers will become available to give us permanent records of any desired teletext information and (though not perhaps in the 'eighties) this may become the medium by which we receive our copy of *Wireless World*.

As we move towards the 'nineties, we may see the first optical fibre data circuits run into private homes. In the longer term all radio, television, information and communication services will come to us 'on the fibre,' radiated transmissions being reserved for mobile applications where wireless communication is essential. Once we have our domestic wide-band circuits and high-quality large screen displays, the way will be clear for 'hi-fi' television on new standards. But it will not be in the 'eighties that we shall be closing down the 625-line services. □

Consumer electronics

by St John C. Jackson, Thorn Consumer Electronics Ltd.

The last decade has been one of rapid development in the different design areas of consumer electronics products making use of advances in electrical component availability and electrical engineering to entertain or make life easier for the majority of people, whose interest lies mainly in what such products will do rather than how they work.

There is perhaps one feature which, on looking back, makes consumer electronic products unique when compared with any other manufactured product. It is the fact that, despite the very real improvements and the ravages of inflation at the end of the 'seventies, on a like-for-like basis, products were cheaper at the end of the decade than they were at the start — in many cases in cash terms but without doubt in real money terms. A comparison of consumer electronics products shows that a 12in mains/battery monochrome portable tv cost around £55 (or 2 weeks average earnings) in 1970 and nowadays even with v.a.t. at 15%, the same two weeks' average earnings will almost buy a 14in portable colour tv. Similarly, the first electronic calculators retailed at over £200 — now for less than £10, a pocket calculator is commonplace and includes all or more of the functions of the earlier £200 machine. But the 'seventies also had their casualties — remember the 8-track cartridge, remember quadraphonic sound, remember Elcaset? Just to dwell on quadraphonic sound for a moment, possibly for the first time, technological advance overtook the ability of the market place to accept it. Whilst the electrical engineer could point to the benefits of quad, the same engineer forgot that the user didn't have four ears or, perhaps more to the point, his girl friend, mistress or wife was not prepared to accept four separate loudspeakers in the living room.

There was also a more fundamental point; the competing quadraphonic systems each required their own prerecorded software and because more time and effort was spent on selling the advantages of one system against the others, confusion reigned. For the future, it is important that product development is based on agreed international and common standards, but let's look at specific pocket areas and how they developed in the 'seventies.

* * *

With tv receivers now in 97% of UK homes (70% colour) it's right and proper to consider television first. In the early 'seventies, the transition was being made from hybrid chassis with a mixture of valves and transistors to all solid-state. With moves in this direction, styling improvements were made possible to reduce the overall size of the average television cabinet and chassis engineering moved towards modular construction.

Ultrasonic remote controls made their appearance, and were quickly accepted only to be gradually replaced by quicker-acting infra-red control systems. Whilst ultrasonic controls were more than adequate for the typical viewer of the late 'seventies who wanted to send simple commands to his receiver, the introduction of infra-red microprocessor-controlled systems is particularly relevant to the customer requirements of the 'eighties when

Music centre with digital frequency tuning (Ferguson 3951)

Teletext and Prestel are likely to be in widespread use.

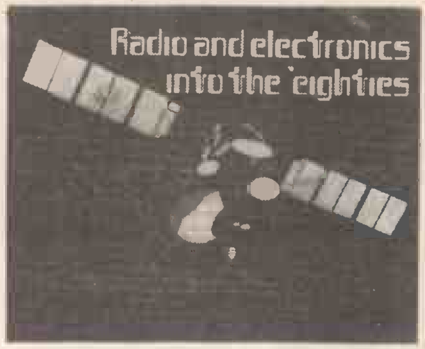
However, both of these great British developments with their data display capabilities are still in their infancy and the lack of average consumer awareness about their existence and what the services offer is an indication that it is not enough for the engineers to apply their minds and develop such powerful means of communication. Marketing people must do more to promote their benefits.

Probably the product area of the 'seventies which will have the greatest impact in the 'eighties is domestic video, both cassette recorder and disc. The late 'seventies saw the introduction of domestic video cassette recorders not much larger than conventional audio cassette recorders and almost as easy to install and use. The early recorders (of any format) relied heavily on mechanical control functions but already we are beginning to see mechanical operations replaced by electronics and especially microprocessor controls, but more of this later. The audio scene saw one overriding development — the growth in importance of the conventional audio cassette, aided by the world-wide acceptance of a common standard. Ten years ago, the available cassette hardware and software was still regarded as something of a novelty and not a serious contender to the established position of the quality record player and audio disc or open reel recorder. Developments such as noise reduction systems, improved drive systems and record/replay heads, software developments improving overall performance standards (with first of all CrO_2 tape and more recently the introduction of metallic tapes) have elevated the performance of cassette equipment and cassettes of ten years ago to a replay medium generally accepted even in serious hi-fi circles. Certainly the public have also accepted the cassette. At the close of the 'seventies, UK homes owned more cassette playing equipment than disc playing.

The development of low price, good quality cassette mechanisms made the music centre a practical proposition and without doubt this particular item was the audio home entertainment product of the 'seventies. The audio cassette is also the common denominator amongst those other products that during the period had greatest appeal for the public. Cassette and radio cassette recorders now sell at an annual rate of more than 2-million units per annum in the UK. The biggest growth area in the late 'seventies was quality stereo radio cassettes with automatic programming facilities and even Dolby Noise Reduction.

Cassette-based products have been so successful because they have two overwhelming advantages over their disc counterparts; the cassette can be re-recorded and the machine is easily portable, satisfying today's demand for music on the move. In-car entertainment products have also adapted to the higher ownership levels of home based cassette equipment so that today it is possible to have better quality audio sound in a car than was possible in most *homes* ten years ago.

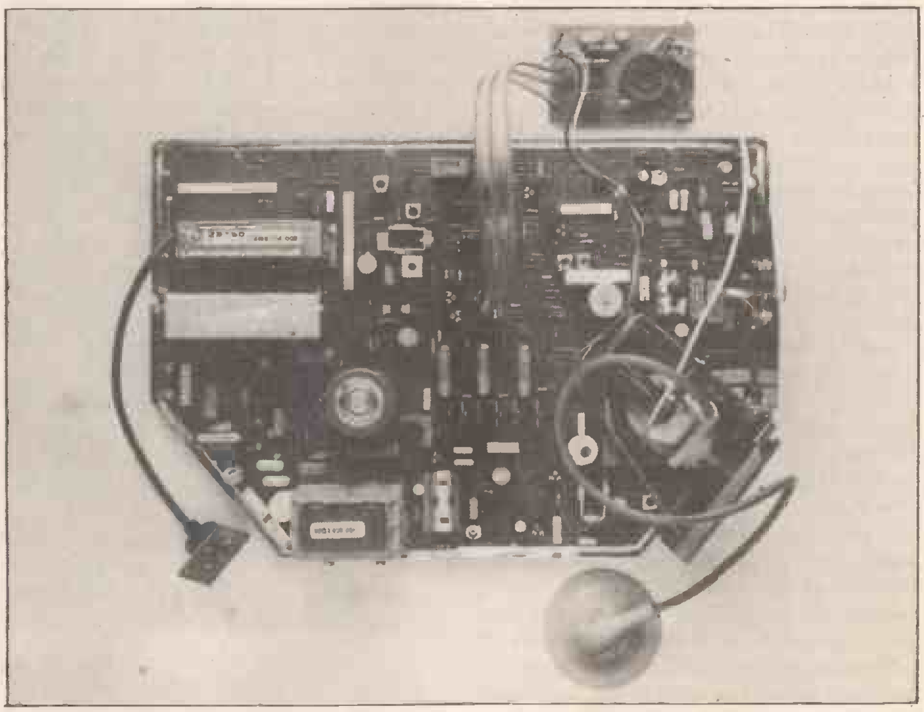
But enough of the past; it seems that the 'eighties will see most of the colour televisions acquired during the 'seventies replaced by receivers which, on the outside, may look similar (apart from the reduced number of function controls) but on the inside will bear very little likeness. The modular chassis of the 'seventies will increasingly be replaced by single board chassis de-



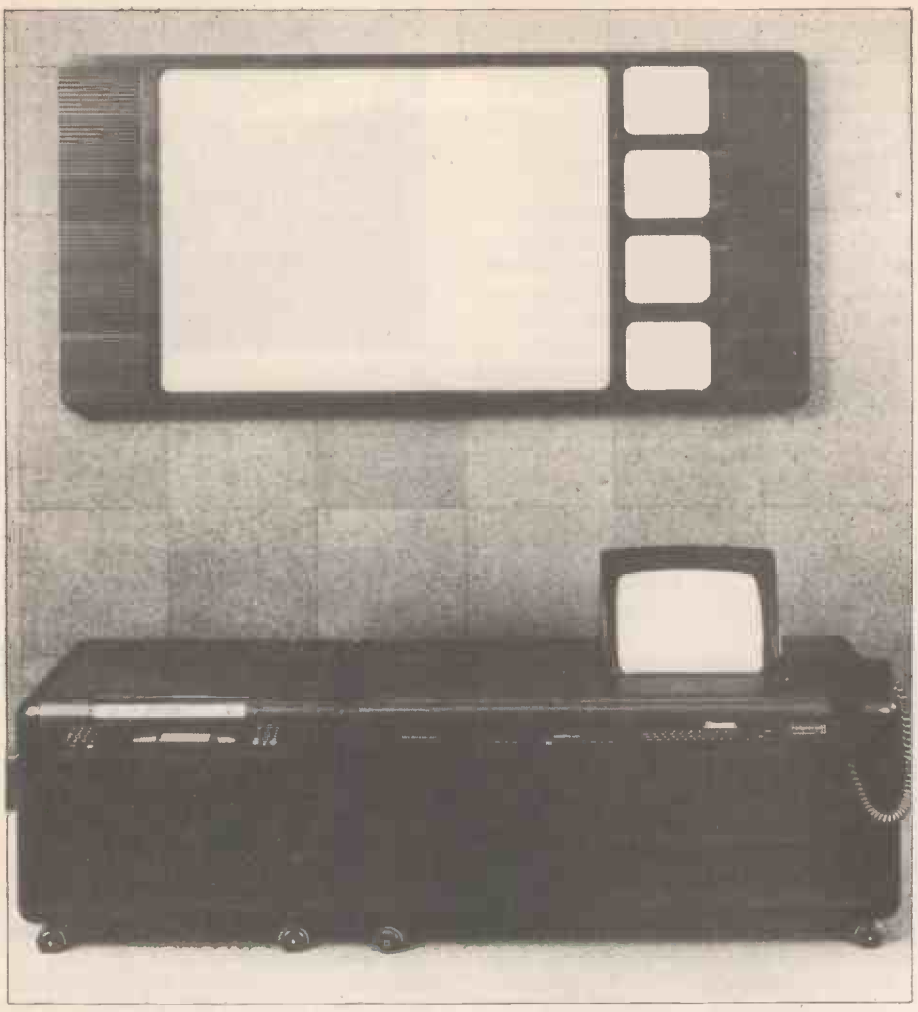
signed to optimize the availability of large scale integrated circuits (l.s.i.) and the application of microprocessors, remote control teletext and viewdata displays. The introduction of single board chassis will revolutionise not only product reliability but also the approach to servicing so that the service department of the 'eighties will look vastly different to that of the 'seventies. Today's cathode ray tube tehnology means that the television viewers of tomorrow will see demonstrably better pictures and data displays than have been seen to date.

Increasingly, tv receiver design will have to accommodate the requirements of home computers, video games etc. which are rapidly changing the nature of television from a passive piece of equipment capable of only showing programme material being broadcast by the BBC or IBA to a two-way, interactive display medium at the centre of a communications network. By the mid 'eighties, satellite broadcasting could become a reality, allowing the viewer a much wider choice of programme material. It is also reasonable to predict that voice-activated controls will begin to make their appearance, freeing the

Ferguson TX9 single circuit board colour tv chassis ▶



Personal computer by ITT is contained in the keyboard unit with floppy disc drive on left. Memory is up to 48K bytes of r.a.m. and 8K bytes of r.o.m. holding BASIC and a system monitor. ▼



◀ *Ferguson's forward-looking flat screen (with other station monitors) receiver, called "Total Television." Although this is just a dummy, most of its component parts are available as production items or on the development horizon.*

ITT TXV 16 viewdata terminal. The lower section contains an isolated power supply and the viewdata equipment while the upper section can function as either the viewdata display or as a "straight" 16in black and white tv receiver. ▼

viewer from the arduous task of having to press the control buttons of a hand-held remote unit!

But, as previously mentioned, the 'eighties will more than anything else be the decade of the widespread introduction of domestic video products. The VHS (Video Home System) format has quickly established itself as the best-selling video system in the world in all the major developed markets – the UK, Europe, USA and Japan – but despite this, other video formats are likely to be around for many years to come. The conventional format of the early video recorders is likely to change with the accent being on the portability of a recorder unit linked to a separate programmable tv tuner/timer which could be indispensable when satellite broadcasting is a reality. Indeed the situation could well arise that despite the increased leisure time available, video owners will be so busy recording programmes they will never have the time to replay them!

Already the introduction of the vidicon tube has made low-cost, good quality colour video cameras a reality. No one can doubt that the already high performance standards of today's products will be improved, real money prices will fall and the cameras themselves will weigh less and diminish in size. No wonder that with the arrival of electronic photography manufacturers around the world are getting out of the conventional cine 8 camera business as quickly as possible – they have seen the writing on the wall.

It is forecast that the ownership of domestic video cassette recorders will parallel the early growth of colour tv in the UK. By 1984 at least 7% of UK homes are expected to have acquired one. They will be used mainly for time-shift recording and the replay of home-made video movies at around £5 per hour, compared with £100 per hour plus for cine, the difference adding greatly to consumer appeal. The additional appeal of pre-recorded video cassette software will pale into insignificance when video disc players with their lost cost software become a reality. One thing is certain; the incompatibility of the various video disc standards that are likely to appear will be a much more serious factor than with the present ones surrounding video cassette recorders. The availability of disc software will be a critical factor on three counts:

a. without the appropriate software the disc player itself is useless.
b. questions related to the low cost production of video discs still have to be resolved.
c. material for reproduction on video disc is likely to be surrounded by a minefield of copyright issues which have still to be resolved.

However, the video disc player is likely to lead to the further demise of the conventional audio record player because despite the name "video disc," all video disc players give the capability of very much improved audio-only replay, making possible a signal-to-noise ratio in excess of 90dB through the use of p.c.m. recording techniques. So looking ahead, any audio disc system that does not include a video replay mode is likely to find the going a bit tough.

So far no reference has been made to monochrome television receivers which, as the years pass, are likely to become increasingly less attractive as potential purchasers accept colour tv viewing as the norm. On the other hand it is not unreasonable to suggest that the youth of tomorrow will look at television in the same way that today they look at radio and the cassette. That is, they will want to take it with them wherever they go. Therefore (and with continuing miniaturization) today's combination tv products either with radio, or radio and cassette, are likely to become more and more popular. Audio products either mains-only, portable or "in-car" will become increasingly cassette-based as the youngsters of today become the purchasers of tomorrow. This is a generation to whom the cassette is not something new and the majority look upon their parents collection of 78, 33⅓ and 45 r.p.m. discs with the same degree of interest that Arthur Negus looks at 17th century antiques. Further improvements in cassette hardware and software, because of the introduction of p.c.m. recording techniques, will be readily accommodated on the conventional audio cassette format.

In looking at the 'seventies, little was mentioned about radio, not deliberately, but because with the expansion of f.m. stereo broadcasting that has already taken place, no great changes are anticipated. Certainly, in looking ahead it is, expected that pre-set tuning facilities will appear in all but the most basic of radio products. Synthesized tuning systems will undoubtedly make their way down the market into more basic products and digital tuning frequency displays will become standard.

To many people, the radio is still a very important vehicle for keeping in touch with the outside world and with broadcasting putting the emphasis on news and general current affairs, the radio will increasingly take the place of more conventional sources of information, for example, newspapers. News is of great value in the car, and travel information systems, such as the BBC's pilot testing of Carfax, will be a practical expression of advances in electronics applied to real consumer applications, particularly as such systems can lead to real time and energy savings. Citizens' band radio has received enough recent publicity and (regardless of its merits or drawbacks) at the end of the day the outcome will be decided by politicians and civil servants rather than engineers, marketers or even public demand.

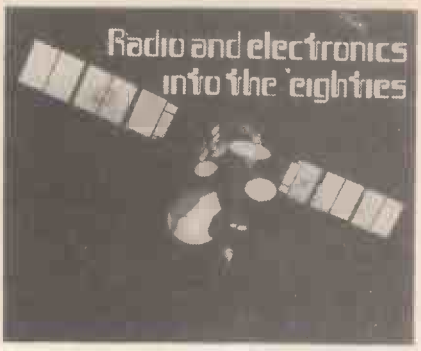
Home video computers and programmable video games will be areas of dramatic growth in the 'eighties but initially confusion about base technologies could prove a deterrent factor. Certainly one of the best money-making opportunities in the 'eighties will be in providing the software programming facilities in support of the expanding range of hardware in these two product areas.

So where does this quick review lead us? Very simply, to many new and exciting product areas capable of providing new business opportunities and the ability to keep a continuous flow of new products available to customers to help and entertain them. Not all of these new products will be instantly accepted and one major problem will be in the retail store where the salesman will have to assimilate a lot of new technology if his or her traditional role is to continue.

The degree of product knowledge needed to demonstrate and sell a home computer calls for a different person to the one currently selling a mains/battery cassette recorder. Service engineers too, are going to come across a lot of advanced new technology in the products they will be looking at on a day-to-day basis.

Beyond the 'eighties?

Quite recently Ferguson had an experimental look at the home entertainment centre of the early 1990s. The result was a concept called "Total Television" which included in a domestic console unit, a VHS electronic cassette recorder, floppy disc machine, electronic audio cassette, Prestel/home computer keyboard and videophone with remote control of all viewing functions. The conventional c.r.t. was replaced by a wall-mounted flat screen including four monitor screens to take account of the multiple screen viewing that might be a requirement of the future. A dream? Well apart from the sorting out of problems related to the flat screen the other features of the unit are either with us today or at least a large scale manufacturing possibility.



Only time will tell how close to reality the ideas of the late 'seventies will be at the end of the 'eighties. □

Radio navigation and radar

by D. W. G. Byatt, B.Sc., F.Inst.P., F.I.E.E., GEC Marconi Electronics

The fields of radio navigation and radar cover a broad range of constantly changing techniques, and are influenced by advances in computers and military systems.

With both these topics, we are interested either in where we are, or where someone else is. The system may rely on transmitting or receiving signals at a known location or vehicle in question (ship or aircraft). Almost every permutation and combination of these alternatives has been investigated over the past fifty years or so.

In moving a vessel from A to B some basic form of dead reckoning and position plotting should be maintained and in ships in particular, traditional methods using the sextant, chronometer and compass are fundamental to good navigation. In the air, long-haul aircraft frequently rely on inertial navigation, again based upon the gyro, and indeed ships also use this type of navigational aid. However, we are here primarily concerned with radio aids and radar, and in very many ships, in aircraft and at airfields, the ubiquitous direction finder (d.f.) is used, and is sometimes the only form of aid. In fact, both radar and radio navigation can trace their ancestry back to the simple d.f.

The adoption of new equipment in civil aircraft and ships is inevitably limited by financial constraints; every piece of new hardware proposed for a ship or aircraft must be justified in terms of cost effectiveness. This means that adequate, well-proven techniques and systems tend to have a very long operational life. Nevertheless, if rapid, accurate position-fixing can shorten journeys and minimize delays, then in a period of increasing fuel costs, new equipment capable of providing this must become more readily acceptable.

Safety at sea and in the air is, of course, vitally important. At sea, minimum safety requirements are recommended by the International Maritime Consultative Organization (IMCO) primarily for vessels above 300 tons, although the country in which the ship is registered legislates for this – in the UK, it is the responsibility of the Department of Trade. In the air, the equivalent authority is the International Civil Aviation Organization (ICAO).

Direction finding

Before dealing with some of the more recent developments in navigation aids, the current state of d.f. is worth examining. There are three major areas of common commercial usage, air-to-ground, ship-to-shore and ground-to-air. There are other military applications, but for general navigation the major advances have been in improving the equipment. A typical marine automatic direction finder, in common use, covers the m.f. beacons in the band 250-550 kHz and also operates on the international distress frequency of 2182 kHz. This equipment is as simple to use as a domestic receiver, gives automatic ambiguity resolution, the bearing of the station being read directly from a compass-type scale, typically to within ±1°. Because of the relatively short range of reliable bearings, ship navigation by d.f. is mainly confined to coastal waters; in the consumer field, many thousands of simple direction finders are in use in modest sailing boats and motor cruisers. The situation with airborne d.f. is similar to that for ships: most aircraft carry one and the accent is on automatic operation. The frequency band is typically 190 to 1800 kHz. The size of the antenna loops have been reduced and contained in stream-lined bumps to reduce air drag. In many parts of the world a.d.f. is still the primary source of navigation information, which in areas with good reception can provide a bearing of ±1°.

Ground-based direction finders require only the minimum of a communication set in the aircraft to provide a position line, so that if all else fails, navigation assistance can still be provided. These direction finders mostly operate on v.h.f./u.h.f. and in order to minimize the bearing errors from all causes, antenna arrays are multi-element, frequently wide aperture and automatic in operation, with direct-reading bearing presentation. Most locations can provide ±1° accuracy on signals of reasonable strength.

A short-range navigational aid closely allied to d.f. is the v.h.f. omni-range (VOR) which, when associated with a distance-measuring equipment (DME), gives aircraft a precise location. The range limitations caused by operating at v.h.f./u.h.f. (108-118 MHz for VOR and 960-1215 MHz for DME) make this system unattractive for ships.

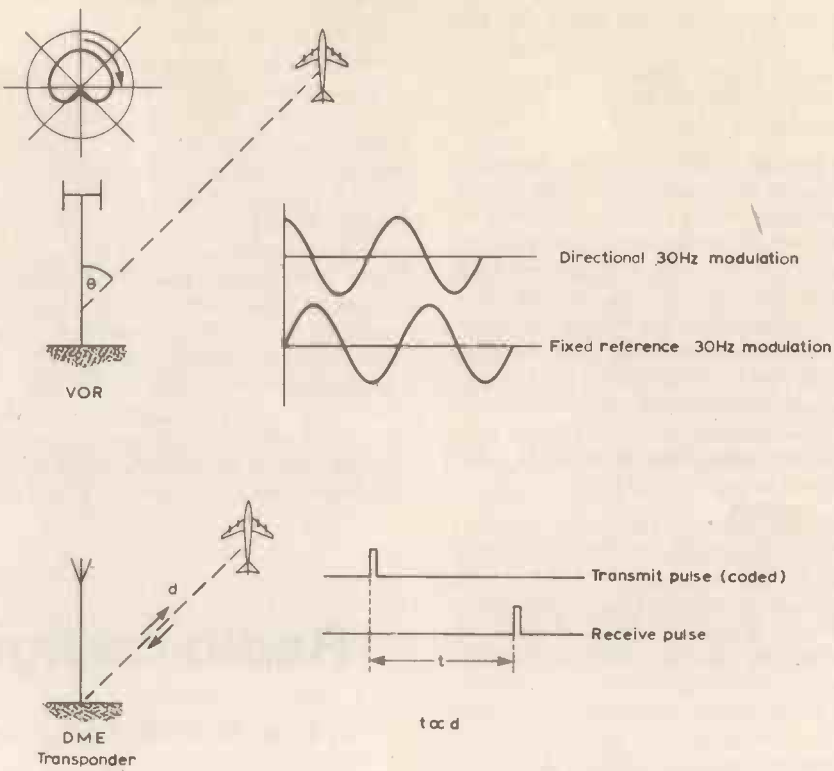
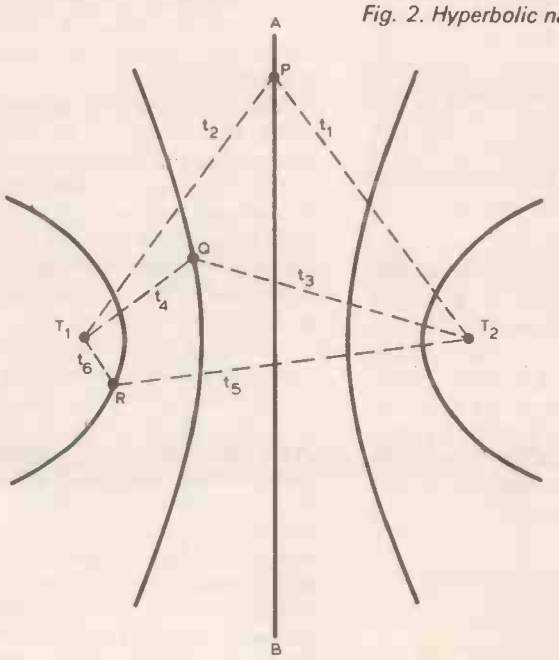


Fig. 1. V.o.r./d.m.e.

Fig. 2. Hyperbolic navigation



Hyperbolic systems

Measuring distances from known ground radio stations is a well established navigational aid. Hyperbolic systems are so called because the position lines they provide from such measurements are hyperbolic curves. Referring to Fig. 2, if T_1, a transmitting station, emits a short pulse, and transmitter T_2 simultaneously emits a second pulse, then any receiver on line A-B will receive these pulses together. Positions at which one pulse is delayed by a given time with respect to the other lie on one of the hyperbolae. The association of a third transmitter would provide two position lines and therefore a fix.

One of the best known pulse systems is Loran 'C' which operates on a frequency of about 2 MHz and covers large areas of the Pacific, Atlantic and Europe. During the last war, a similar British system known as GEE operated at v.h.f. With a good ground-wave pulse, position accuracies of better than one mile in 100 miles are possible but, as with many long-range navigational aids, ionospheric sky-wave propagation can produce errors an order of magnitude larger, and considerable skill is needed to interpret results in adverse conditions. The Decca system, operating at around 100 kHz, also became established during the second world war. This uses c.w. signals and phase measurement to provide position lines and fixes. Very many ships and aircraft carry Decca, which has been considerably refined over the years to overcome propagation and ambiguity problems, so that automatic plotting on route maps is now generally in use, giving accuracies of fractions of a mile.

A system of increasing importance, which is designed to minimize range and propagation problems, is Omega. This operates on very low frequencies (v.l.f.)—typically 10-14 kHz—with inter-station baselines of around 5,000 miles. The very low frequency provides long range, stable and predictable propagation characteristics and the large separation between stations means that position lines are almost parallel over very large areas. Omega is a c.w. phase-comparison system and is virtually the only radio navigation system that can be used by completely submerged submarines.

A typical marine Omega receiver incorporates four channels for continuous monitoring of four transmitters, each channel measuring the phase of the signal relative to an internal high stability reference oscillator. Phase difference can be measured to one-hundredth of a cycle, defined as centilanes. In use, the receiver is run continuously from leaving port, automatically logging the lanes. It takes about half an hour to cross one lane, and modern equipment provides direct

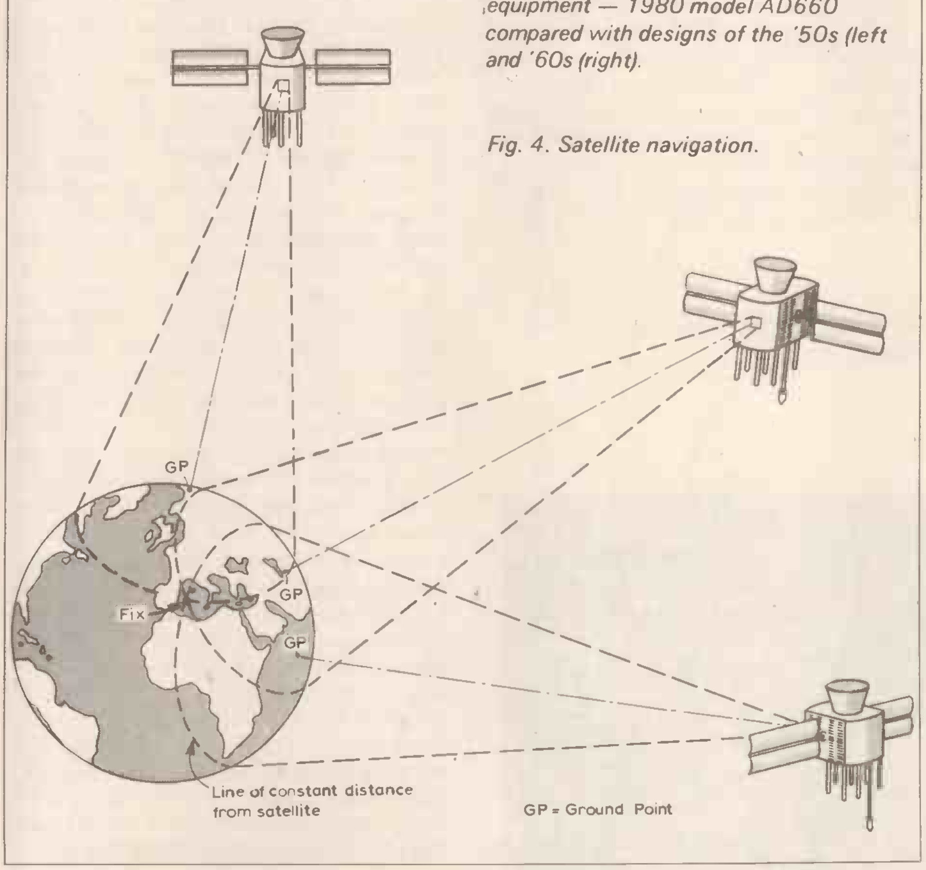


Fig. 3. Doppler navigation — airborne equipment — 1980 model AD660 compared with designs of the '50s (left and '60s (right).

Fig. 4. Satellite navigation.

read-out of position. World cover is achieved with eight Omega stations.

For aircraft use, initial problems arose with antenna design for such low frequencies: a further difficulty was the high speed of lane crossing. However, advances over the last few years have led to an increase in the use of Omega for aircraft, current equipments providing automatic operation with 95 per cent errors less than 3 nautical miles.

Terrain-reference navigation

The Doppler navigator provides an aircraft with means for measuring the frequency shift of a radio signal reflected from the ground. With no drift and for a radio beam transmitted at a forward angle θ to the aircraft horizontal axis, the Doppler frequency shift $= (2V/\lambda) \cos \theta$ Hz. Thus, the Doppler shift can provide an accurate measure of the aircraft ground speed, V.

If two beams are radiated downwards at an angle to the forward direction then it is possible to measure the sideways motion or drift of the aircraft. Note that the Doppler shift is also proportional to the cosine of the vertical angle of the beam, hence antenna systems must be horizontally stabilized or a further pair of beams arranged to point aft to provide a differential signal, independent of attitude.

The Doppler itself gives ground speed and drift angle: to determine location, accurate heading information must be provided to the navigation computer. Most Doppler systems operate at microwave frequencies around X-Band (3 cm) and are sufficiently refined to drive an automatic map reader, or feed an integrated navigation system. Overall accuracies of one or two per cent of distance flown can be expected.

Sonar Doppler operating on similar principles is increasingly used by larger ships, and mariners also use depth sounding to augment their position fixing, particularly near harbour.

Airborne radar systems giving very high azimuth resolution and known as synthetic aperture radar (s.a.r.) can be used for navigation by map reading the high quality returns. The high resolution is obtained by simulating the radiation as from a wide aperture antenna by storing and recombining the individual signal elements from a small antenna as the aircraft carrying this small antenna moves along its track.

Similarly, by storing the height of the terrain along or adjacent to your own desired flight path, and comparing actual height from a radio altimeter, positional information may be obtained using correlation techniques.

Satellite navigation

NAVSTAR or Global Positioning System (G.P.S.) is designed to give very accurate position and velocity information anywhere in the world. The full system is intended to include 24 satellites in three orbits, giving visibility of 6 to 11 satellites at 5° or more above the horizon from any location on the earth's surface.

The basic method of position fixing by means of satellites is similar to celestial navigation except that distance, rather than angle provides the basic data. Fig. 4 shows the essential components of NAVSTAR. The height of the satellite is accurately determined, the earth's radius is known and the range is measured by timing radio signals from the satellite. In three dimensions, the range line traces a circle upon the earth's surface giving an observer position line. Two such lines give a location fix, and three are needed for an aircraft to include its height.

Signals are transmitted on two L-band frequencies, 1227 MHz and 1575 MHz, containing identification and the navigation data for the user to compute his position. This includes information on the status of the satellite, orbit details to enable the user to calculate the position of each satellite at the time of transmission, time corrections and propagation delay corrections.

High accuracy can only be achieved by precise synchronization of the satellite clocks with each other and the user clock error must be known or corrected; each space vehicle carries an atomic frequency standard which is corrected at least daily with a caesium clock at the master control ground station. In terms of accuracy one nanosecond of time error is equivalent to 0.3m range error.

The concept of navigation by satellite is simple. In practice however, for a worldwide system, a number of space vehicles must be maintained in accurate orbit, constantly updated for time and position. The user equipment includes a microwave antenna and receiver, together with a comprehensive navigation computer. Nevertheless, advances in microwave and microprocessor devices have made possible a range of receivers for ships, aircraft and missiles, and even a 10kg manpack, which will locate position to within about 10m. At present, GPS is in the validation phase I – about six satellites are in operation. Phase II is the period of development for military use, primarily in the USA, and this phase will end in 1982. True production of an operational system will take place between 1984 and 1987. Thus, one can expect that it will be the latter part of the '80s before NAVSTAR can be considered a truly universal worldwide navigational aid.

Radar systems

There is an enormous variety of radar equipments and techniques, ranging from small boat sets, to large ground military complexes.

Radar is frequently used for navigation, especially by ships, but here I would like to discuss a few recent innovations affecting the big system design philosophies.

A simple, basic, airfield-based surveillance radar locates an aircraft by rotating a continuous train of pulses in a transmitted radio beam, narrow in azimuth, and measuring the time of flight of the pulses reflected from the aircraft. The aircraft position is usually displayed on a cathode ray tube or plan position indicator (p.p.i.) in the form of range and bearing from the radar antenna.

There have been considerable developments in radar techniques since the last war to help controllers cope with increased air traffic. Early improvements integrated computers and alpha/numeric labelling systems to automatically track and identify target returns. Extensive signal processing and moving target indication circuitry (m.t.i.) have overcome many problems of false returns and clutter obscuration.

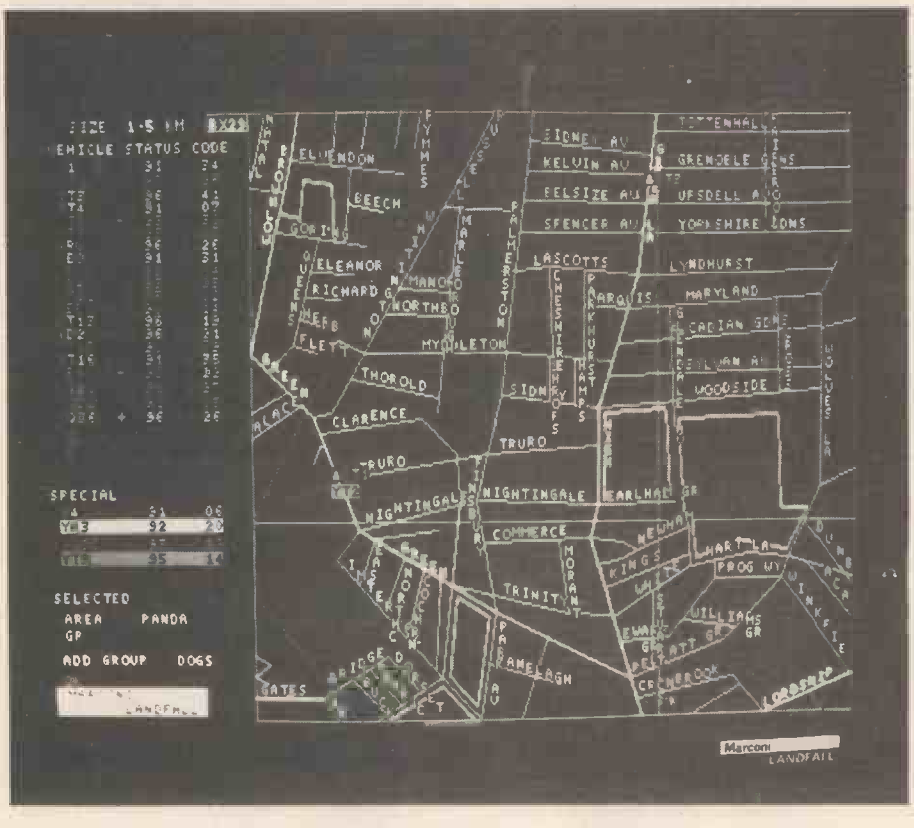


Fig. 5. Automatic vehicle location, base station v.d.u.

Perhaps two of the more recent major improvements in ground radar have been the growth of secondary radar for air traffic control and the evolution of the 3-D radar for military use.

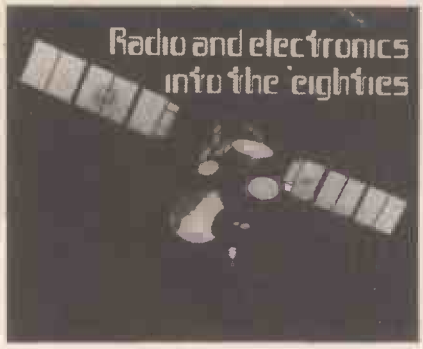
In hostile conditions the ability to observe enemy aircraft without their co-operation is obviously useful, but for aircraft which are both co-operating and controlled, the addition of a transponder confers useful advantages.

Secondary surveillance radar (s.s.r.) is similar to the military Identification Friend or Foe (i.f.f.) developed during the war to protect friendly aircraft. S.s.r. works by sending a radar pulse from an interrogating transmitter. This pulse is received aboard the aircraft by a transponder and retransmitted on a different frequency as a group of coded pulses, which include aircraft identity and a height reading from the aircraft's altimeter. The equipment is normally mounted on the primary radar and the signals from s.s.r. are either displayed directly on the radar p.p.i. for identification purposes or separately processed in the computer system.

The classic radar with the rotating beam will not provide height information; in fact, the beam shape is designed to cover as much vertical air space as possible. For height information, a separate vertically-scanning radar antenna was employed, usually controlled on demand. Continuing improvements in the design of microwave antennas and component design have enabled a new 3-D radar to be designed. Modern techniques enable such a system to be fully transportable and highly reliable; for example, the transmitter valve operates at 3.3MW to provide a 10,000h expected life. The operating wavelength of this particular system is 23cm, the range accuracy 0.05 nautical miles, azimuth accuracy 0.5 nautical miles in 100 and height accuracy 1,000ft at 100 nautical miles. It has many advanced facilities such as automatic plot extraction and tracking in three dimensions, and for military operation provides a range of electronic counter-countermeasure (e.c.c.m.) facilities including unrestricted frequency agility, random pulse stagger, pulse compression, chaff and clutter suppression and digital Doppler moving-target indication.

The future

The ideal radar gives all-weather, clutter-free operation and as much information as possible about aircraft in the air space of interest. This is true for both ground-based and aircraft systems, and similar criteria apply to ships' radars. The ideal navigation aid gives exact location under all operational conditions, is lightweight and simple to use. For both activities, of course, equipment needs to be highly reliable and cost-effective. The systems described so far represent the current



state of development and undergo continuing refinement towards these objectives.

One must, however, differentiate between military and civil use. Co-operation-dependent systems, such as those based upon satellites or global transmitters, could well be vulnerable in times of national conflict. Probably the self-contained navaid is least open to this sort of criticism if high accuracy at reasonable cost can be sustained.

One can fairly safely predict that semiconductor microcircuit advances will continue to affect radar and radio navigation developments in a very significant manner. Digital processing and storage are already leading to new concepts in system organization and complex error corrections not previously feasible.

Miniaturization of the newer solid-state, microwave power sources and other components leads to new applications. One example is for location and control of road vehicles, increasingly important for large, commercial fleets or public utilities in these times of energy problems and rising fuel costs. The display shown in Fig. 5 us of part of the area of a map of London, where the characteristics of each road junction are stored in a computer in the boot of a car for automatic position fixing.

A further example is in radar developments which are making feasible static antenna arrays where each element of the array is effectively a miniature transmitter/receiver and the beam is electronically rotated or selected. One such system, known as bi-static, can use a separate transmitter as an illuminator, with several spaced receiving systems using multi-beam static arrays. Such a system could provide enhanced protection against noise, interference and signal fluctuation.

The US Air Force hopes to deploy a 600ft diameter radar in earth orbit by 1985, using the space shuttle. This could be used for tracking ships, aircraft, cruise missiles, inter-continental ballistic missiles and even armoured vehicles on the ground.

The author thanks the technical director, GEC-Marconi, for permission to publish this article.

Further Reading

"Navigation Systems" G. E. Beck. Van Nostrand Reinhold 1971. *Journal of Inst. of Navigation* Vol. 25 No. 2 1978. "Radar Handbook" M.I. Skornik, McGraw-Hill. □

Audio

by Adrian Hope

BACK IN the early winter of 1969 the Olympia Exhibition Hall played host to the International Audio and Photo-Cine fairs. Ten years ago, although burgeoning trade and public interest in sound reproduction had made it impractical to continue the post-war tradition of exhibiting equipment in the Russell, Washington and Waldorf hotels in London, there was still insufficient support to justify an audio-only show at Olympia. It soon changed of course as hi-fi became an essential domestic luxury. Now, ten years later, we have seen the rise to dizzy heights and fall into disfavour of Olympia as a hi-fi exhibition site. Indeed in many respects Olympia has been a barometer of hi-fi trade. After 1969 the Audio and Photo-Cine Fair became the Audio Festival and Fair and then the Home Entertainment Show. It was cancelled at the eleventh hour in 1976 and in 1977 drew only very disappointing crowds. Since then there hasn't been an Olympia audio exhibition.

The face of audio retailing has changed at least as much as the Olympia Exhibition. At the beginning of the 1970s most of the electronic shops in London's Tottenham Court and Charing Cross roads sold electronic components, along with construction kits and a smattering of ready-built audio equipment. Almost all had one characteristic in common: undisguised impatience with the average customer. It was, I suppose, understandable. There is little profit to be had from testing a valve or advising an amateur constructor on why a resistor has burned out. Soon the names of the shops started to change, for a while almost exclusively to Lasky. Profits increase because the shops started to concentrate on selling hi-fi equipment, to the exclusion of components. By the mid-seventies anyone asking for a fuse, a resistor or a spare part could expect to be treated like a mad leper in all but a very few shops. Gradually the public became reconciled to the idea of buying equipment in a cardboard box from a shop assistant who might just as well have been selling washing powder or potatoes. The main culprit, some observers argued, was the end of resale price maintenance and the consequent declaration of a competitive price war. Shops selling at cut-to-the-bone prices could not hope to offer anything in the way of before and after sales service or advice. Some dealers stuck to higher prices but offered service into the bargain. Inevitably some customers took free advice from the high price dealer and then bought the recommended product at cut price in a cardboard box from a warehouse dealer. Between these extremes some dealers, both in London's golden mile and elsewhere in the UK where the golden mile image had spread, offered intelligent advice and reasonable service at a low price. Others offered neither service nor advice but at high price.

It was inevitable that the bubble would eventually burst. There comes a time, especially when money is short, when a householder with an adequate sound system will no longer go out once a year and buy a replacement. There comes a time too when the public, working hard for their money, start to resent the need to junk relatively new equipment for the want of a single spare part that proves unobtainable, or at least an expensive nightmare to procure. It is no secret that now, at the end of the decade, the audio trade is in bad trouble. Spare cash now, and there is clearly less of it around, goes toward a video recorder or a second colour tv, not a new stereo amplifier, record turntable or cassette recorder to replace a perfectly adequate system which is still giving faithful service.

The Olympia barometer of hi-fi is not however to be taken as gospel. Although Olympia is no longer the site of an annual audio exhibition in London, other shows flourish. The sad truth is that Olympia now has a bad name in the audio world. Exhibitor firms have suffered once too often from what they euphemistically refer to as "union problems," but which in less euphemistic terms means spending many tens of thousands of pounds to exhibit and finding the stand unfinished on opening day. It's also a barn of a place, in many respects the unideal venue for audio demonstrations. But smaller shows in hotels in and around London have always left some exhibitors or visitors dissatisfied. One year in the mid-seventies there were two rival shows at two Heathrow hotels running in parallel. An autumn 1979 show in London was cancelled at the last minute through lack of trade support. Currently, perhaps rather curiously, the major UK show is the annual exhibition held at Harrogate in Yorkshire. The fact that so many of the trade, press and public are prepared to venture so far north into the provinces as to make Harrogate an annual success, while declining to give sufficient support to make a London show viable, is surely the audio phenomenon of the decade.

Another phenomenon of the decade has been the rise, and occasional fall, of so many audio and hi-fi publications. At the beginning of the decade there were just two specialist hi-fi magazines. Both had a fairly staid outlook. Then the first of the breakaway "glossies" appeared followed by a string of several more. After various changes of ownership, a few bankruptcies, and several changes of title and direction the market now appears stable.

One theory is that the current misfortunes of the trade are partly due to the boom in hi-fi journalism. The argument is that enthusiasts, with limited money, are now content to read about new developments and leave buying them to someone else. Whereas magazines like *Playboy* and *Penthouse* work on the assumption that readers are interested mainly in vicarious thrills, the hi-fi industry has so far assumed that a stimulating article on audio will stimulate sales of the product described. As a result they have continued to keep the magazines in business by using them as an advertising vehicle. (It is easy for the lay reader to forget that although reputable magazines try hard to ensure that editorial content is not influenced by advertisers, every magazine relies on advertisements for commercial viability). Although the hi-fi magazine market now seems to have stabilized, with all those publications currently on sale likely to remain so, it is highly unlikely that any new hi-fi magazines will now appear.

Perhaps the most notable overall trend of the last decade has been the massive influx of Japanese electronics equipment, moving towards almost a total market domination in some areas. At the 1969 Audio and Photo-Cine Fair there was just a handful of USA exhibitors, notably ADC, Shure and Koss. From Europe (excluding Britain) there were 15 exhibitors, including Agfa, Arena, B & O, BASF, Dual, Grundig, Luxor, MB, Mikrofonbau, Ortofon and Peerless. From the UK (excluding the BBC, and several magazine and book publishers) there were over 40 companies of which only a very few were importers. Among the British names showing were Brenell, Bush, Colton, Decca, EMI, Ferguson, Ferrograph, Ferranti, Garrard, Hacker, HMV, Leak (then still of Brunel Road, London, W3), Lowther, Lustraphone, Mullard, Dansette, Philips and Sinclair. These were in addition to currently famous names such as Armstrong, B & W, Celestion, Connoisseur, Goldring, Goodmans, KEF and Quad who were all already well established. From Japan, and often with very low profile, came just 14 exhibitors. Of the Japanese firms, Yamaha was showing just loudspeakers and cabinets but Trio offered a full range of amplifiers and tuners and Toshiba, Sony and Sanyo offered tuners, amplifiers and turntables. Teac offered just tape recorders. It is sobering to compare this list with the catalogue for the 1979 Harrogate Audio Exhibition. For the European electronics industry ten years has been a very long time.

The last decade has seen any number of new developments and offered, often foisted on the buying public. But a few have stood out head and shoulders from the rest either as a result of value which has been subsequently proven or because the passage of time has underlined their lack of consequence. But some ideas of consequence have failed, at least first time round. And some ideas of no consequence have succeeded, at least temporarily.

From a considered and selective recap on the technology seen in the 'seventies, likely trends for the 'eighties become clear.

The 1970s must surely go down in history as the decade in which surround sound didn't happen. In the late 'sixties engineers in the USA started to show interest in improving the reproduction of music in a relatively small domestic room by adding reverberation to simulate the sound of concert hall or large room. Early workers soon recognised that it was not sufficient merely to remove all sound absorbent furnishing and furniture from a small room, with short reverberation paths. An artificial long path reverberation signal had to be generated and reproduced from loudspeakers behind or around the listener. The 'sixties experiments sought to record and reproduce natural hall ambience, rather than simulate it at the reproduction stage.

The then-new breed of multitrack studio recorders provided the ideal tool to record ambience along with the main, front, sound stage. An eight-track tape cartridge or four-track tape-recorder provided the ideal medium for selling the resultant multichannel surround sound to the public. The record companies, forseeing a drastic drop in two-channel stereo disc sales, panicked. At the turn of the decade numerous engineers around the world beavered away to produce a multichannel surround sound disc that would also offer good stereo and mono.

Not to be outdone, the broadcasters addressed themselves to the same problem. At first there was excitement that the apparently impossible had been achieved; a quartet of loudspeakers around the room could be fed with four sets of signals derived from a two-channel stereo source. But as the inevitable trade-offs and compromises became better understood, thinking engineers became disillusioned. So did the public not so much because of the various system deficiencies, but because of the lack of standardisation between so many competitive systems.

With the benefit of hindsight we now know that lack of standardisation on any one system was probably the best thing that ever happened to domestic audio. If any one early 'seventies system had become a world standard we would now be stuck with it — and all its inherent inadequacies. But early in the 1970s surround sound reproduction (or quadraphonics as it became known when four loudspeakers in the four corners of a room became tradition), looked to the marketing men like potential big business. The 1972 Consumer Electronics Show in Chicago saw private discontent flare into public squabbles. While the manufacturers tried to produce reproduction equipment capable of playing any or all of the competitive systems then available or announced, the record companies hedged over which system to adopt. "They ought to be locked in a room and kept on bread and water until they come out with an agreement" said one frustrated manufacturer.

When broadcasters finally agree a surround format we might get multi-channel surround sound records from the industry again.

At around this time a compromise offered by American engineer David Hafler started to find favour. This was the now familiar "Hafler circuit" which feeds a rear pair of loudspeakers with the difference information available across the outputs of a conventional stereo amplifier.

This simple connection provides signals for the rear, from almost any programme material. Readers of hi-fi magazines, puzzled over which quadraphonic system to buy, were repeatedly advised to compromise with a Hafler set up, at least temporarily until a standard was agreed. Even now, long after the quadraphonic bubble has burst, many enthusiasts retain a Hafler connection to feed rear loudspeakers because, especially with programme material recorded with a simple crossed pair of microphones, the results can be highly acceptable. There is now little doubt that every quadraphonic system marketed during the last decade is dead in its present form.

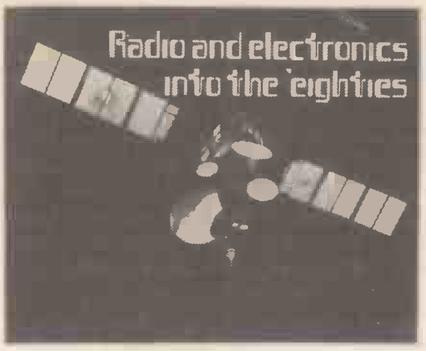
But the last years of the decade has seen the progressive acceptance of Ambisonics surround sound technology. This of course stems from the work of Michael Gerzon and Professor Peter Fellgett.

It is also embraced, albeit to a fluctuating extent, by the BBC and IBA. The recent patent pool agreement between Ambisonics-NRDC, Nippon Columbia and Duane Cooper (joint holders of most of the crucial patents covering a hierarchical approach to Ambisonics surround-sound technology) will almost certainly prove a significant influence in the next decade. In the USA the Federal Communications Commission is currently debating, yet again, the future of surround-sound broadcasting. The signs are that the final FCC choice will be between Ambisonics and the CBS SQ system, or modern variants thereof. Until recently there has been a fairly unified approach from the Ambisonics faction. But now the IBA has raised a question mark over the validity of the hierarchical approach. Essentially the IBA argues that the best compromise is a three channel system, which offers good surround sound to listeners with a three-channel decoder, and good stereo and mono with existing equipment. This conflicts with the Ambisonics-NRDC approach which seeks to offer the surround-sound listener the choice of using either two or three channel (the third with or without limited bandwidth) reproduction equipment in hierarchical fashion. The IBA now describes the two approaches as "irreconcilable" so it is clear that if surround sound is to progress in the 'eighties past the laboratory stage the IBA, BBC and Ambisonics-NRDC engineers must reconcile their differences. This will require the cooperation of all parties in extensive on-air transmission tests. Unfortunately the BBC and IBA have not been noted for their mutual cooperation and have instead appeared more inclined to generate competition even where none naturally exists. Although independency of technical research at the development stage is admirable and in the public interest, rivalry at the early stages of commercial development can only hamper the spread of a new technology. Witness the public ignorance over teletext. In fact cooperation of the two British broadcasting authorities is essential if ever the public are to be educated into what teletext and surround sound are all about. Is it too much to hope that the 'eighties may see British broadcasters thinking and speaking of new technologies as a common vehicle for competitive programming, not as a source of competition in their own right?

The 1970s saw not only the emergence of the Philips compact audio cassette as a serious recording medium, but also the parallel emergence of Dolby noise reduction as a standard. Indeed the parallel progress of the cassette and Dolby system is no coincidence. Without one the other would not be where it is now.

It took three years into the decade before Philips finally agreed on a licence to incorporate Dolby circuitry. Until then Philips had tried vainly to interest the cassette recording world in the Dynamic Noise Limiting playback-only system. The pity of it was that DNL was a useful noise limiting tool, but certainly not an alternative to the Dolby encode-decode system. Now, at the end of the decade, DNL is reappearing as an addition to Dolby noise reduction on some cassette decks. Despite the emergence and marketing of rival noise reduction systems, Dolby B has become an integral part of cassette recording. Another Dolby proposal, the use of Dolby encoding on f.m. broadcasts with modified pre-emphasis to suit the frequency content of modern music and aid compatibility, has not however taken off in Europe. Another slow starter, Dolby's work in film sound encoding, is however starting to boom. The words "Dolby stereo" now often feature as large on the publicity posters outside the cinema, as the names of the stars or director of the film.

Throughout the last ten years tape manufacturers around the world have offered every imaginable modification of the basic iron oxide magnetic coating, plus a few more besides. Following work by Dupont in the USA magnetic oxides of chromium have also become popular with some tape manufacturers. Others mainly in Japan have eschewed the use of chromium and concentrated instead on a range of cobalt-modified iron oxide particles. The newest innovation, of which a few samples may reach the retail shops before the end of the year, is tape coated with pure iron particles. Although the original pre-war pioneering work in magnetic recording relied on iron-coated tape, this material is a brute to handle at the manufacturing stage. It is



only now that a few tape makers feel the time is ripe for a full circle return to this original technology. Philips and 3M were the first to make public noise over their new metal tape formulations. But their announcements have backfired. Philips has at least temporarily pulled out of commercial production of the tape and 3M, after proudly announcing the product in June 1978, is still unable to supply more than a few cassettes to a few selected dealers for retail sale. It is likely however that the first years of the 1980s will see pure metal tape come into plentiful supply. Certainly within a year or so virtually every respectable cassette recorder will be equipped with recording heads and circuitry capable of coping with the new high coercivity material. But all the manufacturers involved in tape production are agreed that the cost of pure metal tape will always be higher than oxide tape (currently around four or five times as expensive) and it remains to be seen whether the public will actually pay the extra for the new wonder medium when it is on open sale and readily available.

Pure metal tape is counted as the short-term answer to digital recording. But in the long term, and at today's current accelerating pace of development, this may mean only a year or so. There is no doubt that the days of analogue recording are numbered. The idea of digital encoding is not new; it was Alec Reeves of course, at STC, who proposed and patented a workable system shortly before the last war. But without solid-state switching equipment Reeves could only theorize. By 1972 the BBC, after experimenting with digital sound links between London and Scotland, was regularly distributing p.c.m. sound for television and stereo radio around Britain using microwave links. The BBC has continued through the last ten years to develop digital sound encoding techniques both for the transmission of sound signals around the country and for digital audio tape recording. The IBA has meanwhile devoted considerable effort to the development of digital recording techniques applicable to colour video.

In the domestic area interest in digital sound has been stimulated by snowballing developments in video recording. Indeed only a closed minded fool would not attempt to delineate between audio and video. The two technologies are now so closely and inextricably linked that the future of one is dependent on the other. It was in 1972 that Philips first announced a video cassette recorder capable of recording colour tv pictures and sound on a cassette of half-inch tape. Although the original N1500 machine was intended for the industrial and educational market, by 1974 it was launched for — albeit limited — open sale to the general public. This started not only the domestic video revolution but also the inexorable move toward digital sound. Any recording system capable of handling the four or 5MHz necessary for colour video is more than capable of handling the bit stream necessary for stereo or multichannel sound in digital form. Moreover a decade of work into video reproduction from discs, which culminated in the USA test marketing launch of a practical video disc system by Philips-Magnavox in 1979, brings the digital audio disc a step closer. Philips has of course already shown the compact disc, or digital audio version of the Philips VLP video disc, and toward the end of 1979 announced a patents liaison with Sony. Sony had independently developed a laser-optical disc system similar to that proposed by Philips. With the union of Philips and Sony standardization of a laser-read optical video disc comes a step closer. Almost certainly the Philips-Sony union will bring agreement on a digital Compact Audio Disc smaller than the 30cm proposal made by Sony and larger than the 11.5cm diameter chosen by Philips for the compact disc. Very probably a digital "compact audio disc" of around 15cm will emerge from the union. But this will almost certainly *not* herald world standardization. JVC still sticks hard with its different, and quite incompatible, capacitance-read grooveless disc and RCA argues in favour of a grooved capacitance disc. Matsushita has proposed a grooved disc which is read by a mechanical pressure-sensitive stylus similar to that developed by Telefunken and Decca early in the decade and briefly marketed at the Teldec TeD video disc. It is now known that Teldec has a miniature digital audio disc version of TeD. This Teldec Mini Disc is ready to launch in Europe if and when the time is adjudged commercially right. Without doubt there are many bitter battles ahead before there can be world standardization on the digital audio disc. These battles will delay standardization and give impetus to the short term stop gaps such as metal tape. There is also a move toward 45rev/min long-playing analogue discs. It is argued that their higher rotational speed, coupled with the long playing time per side offered by computer-assisted cutting techniques, offer the analogue album a shot in the arm.

Casual observers talk vaguely of some wholly new, as yet undreamed of, storage medium to replace the tape or disc. Without doubt it would be possible to encode programme material in holographic form. But the idea of a chip or memory, storing an hour of programme in solid state, must surely remain a dream for at least the next decade. Although high density memories with fast access time are available, a few moments calculation is sufficient to show that solid-state memories have a long way to go before they can offer the equivalent of an LP record in real time. Prophesies, especially in such fast-moving times, are always dangerous, but it seems a safe bet that for the next ten years sound and vision in the home will be stored on, and reproduced from, a moving strip of magnetic, capacitive or optical material or a rotating disc of similar characteristic.

Cassette recorders for the 'eighties will have bias and equalization for metal-particle tape but will the public pay the extra price?

The speed with which a new storage medium becomes a commercial success and gains acceptance as a household norm, will depend entirely on the behaviour of the companies involved in the development and promotion of such a new medium. Rapid agreement on digital encoding standards and storage techniques could bring a new record medium into the home within a couple of years. But behind the scenes squabbling, similar to that which killed off the quadraphonic systems could delay even the start of a transition from analogue reproduction until at least the mid-eighties. But as we learned from the quadraphonics fiasco this may not necessarily be a bad thing. Currently the signs are that the strong US and Japanese influences may impose on us world coding and sampling standards for digital sound reproduction which are tied to local tv standards. These could well prohibit or make expensively difficult, the exchange of recorded audio material between continents. Certainly it would be an appallingly retrogressive step. Moreover in their enthusiasm for a new generation of recording and reproduction techniques, engineers at laboratory level appear to have overlooked, or at least brushed to one side, the very real problems of mass producing high-density storage programme material in reliable quality as well as quantity. After one hundred years of analogue disc recording, there are still all too few record pressing plants capable of producing a respectable audio disc pressing. With track spacing between 50 and 100 times tighter in digital or video programme storage the importance of producing blemish-free pressings becomes paramount. The video and digital audio systems that succeed in the long run may well be the system for which it proves easiest to mass produce programme material. □

H.f. radio communication

by R. F. E. Winn B.Sc.(Eng.), F.I.E.E. Racal Communications Ltd

Advances in component technology and new design concepts during the past decade, together with projected future developments, ensure that h.f. radio communications will retain importance well into the twenty-first century. In particular this is true of the maritime mobile service where satellite communication is still in its embryonic stage, in developing countries where the economics of h.f. point-to-point working with low traffic density are attractive, in defence (as a back-up if not always primary system), and in emergency use where air-transportable containerised stations can be rapidly deployed. As well as advances in technology in recent years there has been a better understanding of the vagaries of propagation. This has resulted in greater precision in predicting maximum usable frequencies over various paths during the 24-hour day at different seasons and during sun-spot cycles.

For medium and long-haul communication h.f. radio today is still an economic, efficient and reliable solution.

Receivers of the 1970s. The most significant technical changes have been in receiver design in which a number of ideas, coupled with newly available components, converged to provide by the early 1970s a completely new order of excellence in terms of overall performance and ease of operation. Before discussing the "breakthrough" of the 1970s it is helpful to look briefly at two previous generations of receivers.

In the immediate post-war years the most exciting development was the drift-cancelling technique known as the Wadley Loop. Although a tricky concept, demanding skilled mechanical as well as electrical design, it was successfully implemented in the now classic RA 17 receiver, made by my company, of which some thousands are still in daily use throughout the world. For the first time it had become possible to tune to a given frequency and leave the receiver unattended with reasonable confidence in its frequency stability over extended periods.

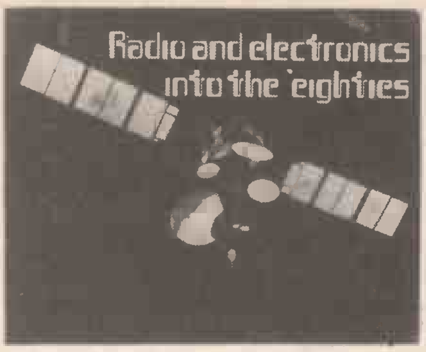
The next big challenge came in the 1960s with the change from thermionic valves to solid state devices. Early examples were heavily influenced by the previous valved designs, and although greater ingenuity was sometimes achieved they were little more than an exercise in re-engineering using transistors in place of valves. The advantages were reductions in weight, size and power consumption and an increase, at least in theory, in reliability. Overall performance, however, was disappointing and, in general, the best of the first generation of solid state receivers were inferior to the best of the valved sets. There was not even an advantage in price.

A parallel development in the 1960s was the frequency synthesizer, which generated a wide range of frequencies each with a stability equal to that of a single master crystal oscillator. This was seen as an elegant substitute for the often troublesome free-running local oscillator in superhet receivers and as a simpler solution to drift than the Wadley Loop. Unhappily the early synthesizers brought their own problems in the shape of unwanted intermodulation products generated by the internal mixers, adders and dividers. The advent of the digital synthesizer provided a cleaner output and today's units are capable of excellent spectral purity. The early synthesizers also suffered from the operational disadvantage in that frequency was selected through decade switches. Excellent if the exact frequency of a wanted signal was known, but hopeless for "searching". This problem was overcome later.

With so much new technology becoming available, engineers in this field came to the conclusion that a radical re-think on receiver design was overdue. Not only on how newly available technology and components could be implemented to advantage but also all aspects of performance and operation in modern conditions. The starting point was a statistical analysis of their occupancy of the h.f. frequency spectrum in terms of density and types of signals, their distribution and relative strengths, which would give a clearer indication of how a receiver needed to perform in order to use efficiently the 9,000 or so 3kHz channels available. An analysis was made by a computer in my company and, independently, a similar exercise was carried out by B. M. Sosin of Marconi Communications Systems.

It had been realised that the most significant limiting factor in receiver performance was linearity. Selectivity was as important as ever but the emphasis on front end sensitivity which had been a paramount feature of design for the past 50 years had come to the end of its usefulness and no further gains were necessary or indeed possible in this area.

It was found from the analysis and measurement that high powered broadcast and commercial stations



were generating tens, in some cases hundreds, of millivolts at the antenna terminals when received on large collecting systems. The strong signals were generating a large number of intermodulation products strong enough to give the appearance of liveliness in the receiver yet masking weak wanted signals. What was required was a big increase in dynamic range together with extreme linearity, and the key to the problem of intermodulation products was to work out the linearity of previous receivers and to discover where the products were formed and at what level.

The first range of solid state receivers to incorporate the new principles in the 1970s was the RA 1770 series, of which the RA 1772 general purpose receiver will be discussed. The block diagram of this receiver (Fig. 1) shows it to be a straightforward double conversion superhet but with a number of novel features which provided a performance with respect to dynamic range, intermodulation products, reciprocal mixing, cross modulation, blocking and spurious response far superior to any other receiver then in production. This

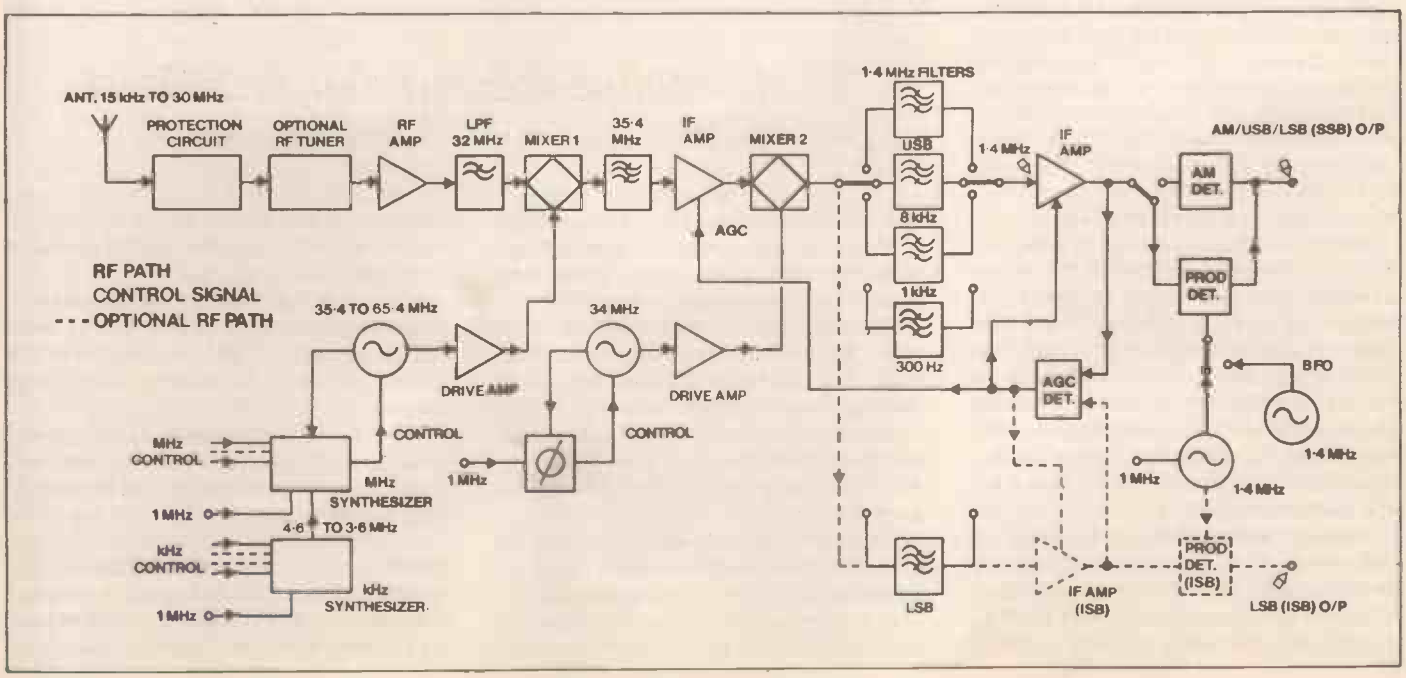


Fig. 1. *Block diagram of the RA 1772 general purpose receiver.*

was achieved through using a single linear broadband r.f. amplifier, a double-balanced hard-driven fast-switching m.o.s.f.e.t. first mixer, only moderate gain at the first i.f. of 35.4MHz with the main gain in the second i.f. amplifier operating at 1.4MHz.

The new order of performance at first caused some confusion. First comments on the development models, later echoed by the first customer, were apparent lack of sensitivity because there were far fewer signals. Repeated tests with a signal generator were necessary to convince ourselves that the design sensitivity had indeed been achieved and that the "emptiness" of the h.f. band was due to the elimination of spurious signals and not lack of band activity or insensitivity.

Apart from the redistribution of gain throughout the receiver the most notable advance in achieving the new performance was the use of a high first i.f. of 35.4MHz. This became possible through using a high stability digital synthesizer which also provided additional advantages. It was now no longer necessary to employ the traditional tuned r.f. preselector amplifier ahead of the first mixer to eliminate image signals. There were no tracking problems associated with a linear broadband amplifier so the front end was greatly simplified and this, in turn, helped open the way to remote control.

As a general purpose receiver, the set needed a free-tune facility and this was achieved by using an optical shaft encoder on the tuning knob which provided electrical pulses and directional information to step the synthesizer in 100 Hz (fast) or 10 Hz (slow) intervals up or down giving the operator all the "feel" of the familiar v.f.o. but with synthesizer stability. The tuning knob could be disengaged electrically to hold the receiver on any particular frequency. The digital frequency readout, derived from the local oscillator, although at first disliked by operators accustomed to dial and pointer indicators, was necessary if the accuracy of the synthesizer was to be exploited operationally. No traditional mechanical analogue dial could achieve a resolution of 10Hz at 30MHz and even the most conservative of the old-time operators now see its advantages.

Another innovation was to provide a complete receiving terminal in a single case instead of extending facilities with add-on adaptor units, which, in the past, had frequently resulted in a 6ft high rack of equipment. Provision was made for six internal filters which could be fitted at the customers' choice. The filters were selected through transistor switching controlled by d.c. only from the front panel. This not only eliminated the potentially troublesome mechanical switching of r.f. circuits from the front panel but also simplified remote control.

Although an earlier receiver had been developed using plug-in modules

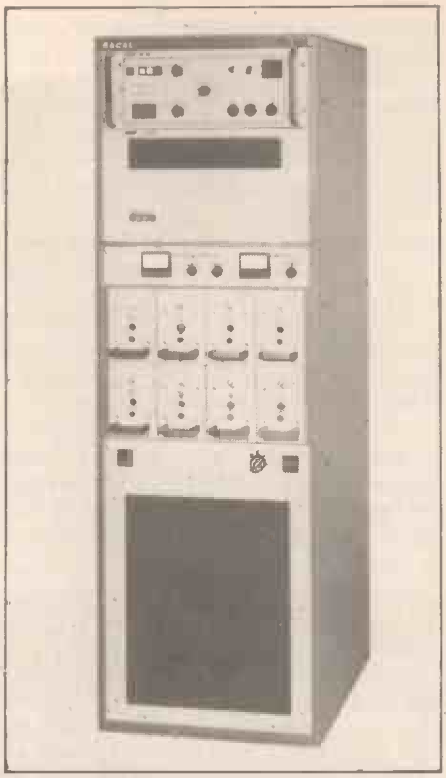


Fig. 2. *Solid state 1kW transmitter comprising eight 125W modules.*

it was decided in the interests of economy to use conventional construction in the RA 1770 series but the physical configuration allows all circuits and components to be accessed by test gear for fault diagnosis while the receivers are in an operating condition.

By the mid-1970s the series had been extended to include programmable and remote control receivers. The programmable set, in addition to continuous tuning at three selectable rates (10 Hz, 20 Hz or 1 kHz), had twelve programmable channels selected from a front panel switch.

The receiver for extended or full remote control is in two units, the receiver itself with blanked-off front panel except for local test facility, and an associated remote control unit with all the front panel controls. The receiver is triple conversion with the third i.f. at 100 kHz. Apart from a spin-wheel tuner and rotary controls for b.f.o. setting and i.f. and a.f. gain, all other functions on the remote control unit are selected by push-buttons. Control is exercised by a time-sharing data-multiplexing system which converts parallel control information into serial form for transmission over single wire lines. For extended control of all receiver functions three cable pairs are required. For full remote control over virtually any distance standard data modems are used on an ordinary unconditioned four-wire telephone circuit.

The system enables complete receiving systems to be built in which a single operator with one remote control unit commands several remote receivers.

The advent of such remote control systems resolved a social as well as a technical problem. It now became possible to establish the receivers at the best or alternative sites without having to move the operators. Assuming three shifts for round-the-clock surveillance, considerable savings are effected in re-housing, quite apart from the natural reluctance of operators to move to an unfamiliar and very often isolated environment.

This, then, was the measure of progress in receiver technology in the 1970s. The order of excellence was henceforth to be expressed not in sensitivity, selectivity or long-term stability, although all of these are still important, but in terms of third order intermodulation performance with a figure better than —90dB for two 30mV signals as the new industry standard.

Transmitters of the 1970s. Transmitter development in the past decade has not been as spectacular as in receivers. The digital synthesizer came into more general use for frequency control in drive units and remote control systems provided flexible extended and fully remote control. The most dramatic development was a solid-state power amplifier delivering up to 1kW of power (Fig. 2). This presented a great technical challenge, the problem as with solid state receivers being the inherent non-linearity of bipolar devices which demanded careful balance at every stage. No single device could produce significant output and my company's approach was to employ eight modules, each of 125W output with combiners summing through hybrid units to 250W, 500W and finally 1kW. The system had to survive a module failure which necessitated some complexity in design to provide protection over a large frequency range.

The advantages of the solid state design were mainly in reliability and ease of servicing. The 30V supply rail was non-lethal (although it is of course still possible to receive a serious r.f. burn from the antenna terminal). In terms of reliability there was adequate redundancy, failure of a module merely reducing total power output and any of the eight modules could be replaced or worked on without interruption of service. A 500W version on the same principle but with only four 125W modules was also produced.

For higher powers the valve remains supreme in terms of economy and efficiency. One 10 kW transmitter of the 1970s period, still in production, was solid state in the drive stages with air-cooled ceramic electrodes in the power stages. Automatic tuning, servo-driven, gave a typical tuning time of 8 seconds with a maximum over the band of frequencies of 20 seconds. Automatic level control was provided and the power supply had automatic overload protection with automatic re-set which would not finally lock out the supply in the case of a transient fault until four unsuccessful attempts at reconnection had been made.

The next ten years

Both technical and economic gains are anticipated in the decade ahead and in fact are already being realised. The market is highly competitive and it is clear that design trends will be towards better specification and more facilities per unit cost.

A positive example is an m.f./h.f. receiver which made its public debut in London in October 1979. It is a joint Anglo-American development and substantial orders have already been received from the US Air Force. The receiver (Fig. 3) has the overall performance of its predecessors at a far lower price, achieved largely by more functions per integrated circuit and therefore a smaller number of components. It is a double conversion superhet with the first i.f. at 40.455 MHz and the second i.f. at 455kHz. Frequency and receiver status displays are liquid crystal and all functions are push-button selected, control being through a microprocessor.

The important innovative advance is the synthesizer. In the RA 1772, described earlier, there were five circuit loops constructed on four printed circuit boards. In the new receiver a single loop synthesizer occupies only one board and as well as generating the local oscillator frequencies at intervals of 1Hz (previously 10Hz resolution) it also generates the b.f.o. output in 10Hz steps. Because of the single loop design the new synthesizer has even greater spectral purity because all mixing has been eliminated and thus fewer frequencies are being generated. The unit is based on an l.s.i. m.o.s. chip developed by Racal Microelectronics Ltd which achieved 1Hz resolution by synthesizing phase as well as frequency. The UK version has a 100-channel frequency store and an interface for a remote control system. The US version has IEEE 488 input/output interfaces as standard, but both versions can be adapted for other interfaces by software changes.

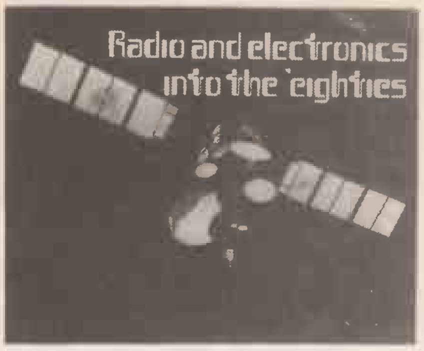
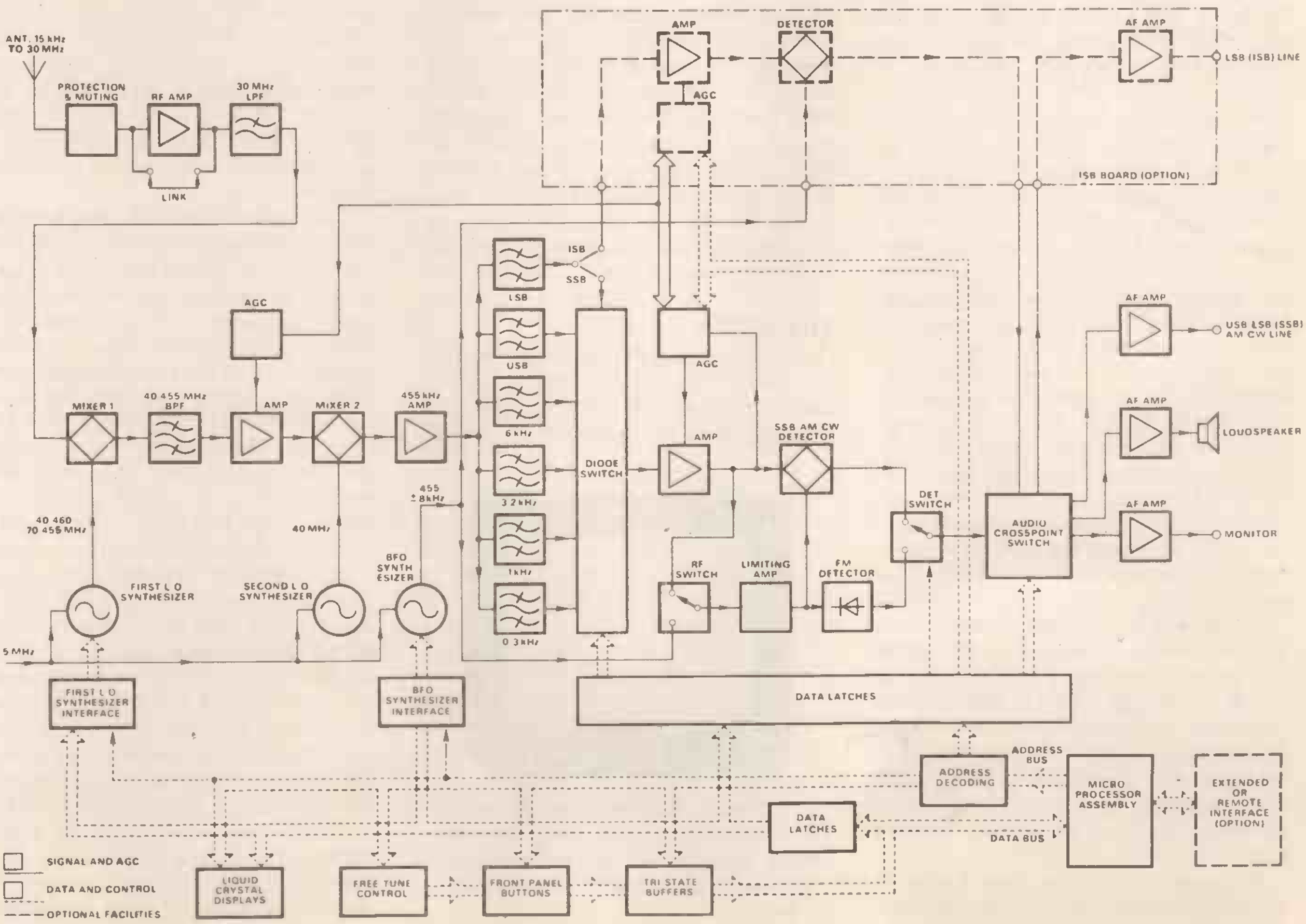


Fig. 3. *Anglo-American m.f./h.f. receiver. This recently introduced model uses a microprocessor for control and a new synthesizer.*



The synthesizer mentioned above is also employed in a military wide-band receiver where it is used to cover the h.f./v.h.f. spectrum continuously from 2MHz to 512MHz.

On the transmitter front the advances that one will see in the 1980s are less spectacular but none-the-less worthwhile. A second-generation 1kW solid state amplifier uses four 300 W modules which, allowing for losses in the combiners, delivers a full 1kW to the radiating system. Linearity has been further improved so that for the first time the CCIR recommendations for intermodulation products have been met over the whole of the h.f. range.

Looking further ahead there are two great hopes. One is v-m.o.s. devices which could provide much greater linearity than current bipolar devices, and of greater efficiency. The second is the feed-forward or polar loop concept on which research is being conducted at Bath University. If successful, there is a promise of solid-state transmitters comparable in efficiency and linearity with current class AB vacuum tube amplifiers.

On a more immediate note the world demand for low-cost channelised transmitters continues unabated, and it is now becoming apparent that the conventional channelised drive unit may well be displaced by a programmable synthesizer on economic grounds. With modern technology a synthesizer is already comparable in cost with a 10-channel crystal drive unit.

Receiver performance has now reached a new plateau but the application of the microprocessor will provide considerable refinement, resulting in more "intelligent" units in both systems management through remote control and in the receiver itself. For example, there is the self-adaptive receiver already realisable which senses the type of signal it is receiving and automatically adjusts itself by minor frequency shift and selection of appropriate filters and demodulators to the transmission mode it is receiving without operator intervention. If on c.w. it would probably select the narrowest filter and adjust the b.f.o. frequency for a pleasant tone, and audio gain to a convenient level, for recording or operator convenience. If s.s.b. is detected then the appropriate upper or lower sideband filter, and so on. The microprocessor will also be used for routine self-checking of sensitivity and other parameters.

The newer techniques pioneered on h.f. are already producing a spin-off at higher frequencies, particularly the concept of a high first i.f. which opens the door to broad band pre-mixer amplification. High stability v.h.f. synthesizers will also allow s.s.b. on v.h.f. and u.h.f., thus enabling more efficient use of the spectrum as has happened on h.f.

We may also expect new forms of modulation which will help overcome the inherent limitations of ionospheric propagation. There could be re-births such as the Piccolo system, where the advent of solid state circuitry has made the system economic enough to attract much wider application.

Work is currently being conducted on topics such as time encoded digital speech at 2.4 kilobit/s and, though presenting considerable technical difficulties, few professionals doubt that such developments will eventually prove successful and further enhance communications at h.f.

Although for purposes of illustration the practical examples quoted are all from the author's own company, he gladly acknowledges parallel work in other countries which, through professional cross-fertilisation, will continue to advance the art and science of h.f. radio. □

Electronic measuring instruments

by John L. Minck Hewlett-Packard Company

Progress in instrumentation is a result of at least three driving forces: the on-rush of new system requirements such as fibre-optic communications and satellite technology; 'breakthroughs' in component technology, such as microprocessors or microwave, hybrid microcircuits; extensions and combinations of present instrumentation, such as the remarkably successful IEEE-488 interface bus for programmable systems.

Very often, progress is really an intricate combination of all of the above. In so many cases successful instruments don't involve technology 'breakthroughs', but merely embody the right combination of customer requirements. With few exceptions, most of the component technologies were already in place at the beginning of the decade. Digital, analogue, and microwave integrated circuit techniques advanced substantially, but the primary technology was already there.

The 1970s

Dramatic progress did take place during the 'seventies. Probably the most important new developments were of logic analysers and logic design instruments. The earliest of these, typified by the HP 1601L introduced in 1973, was nothing more than a standard oscilloscope display with columns of 0s and 1s. An early serial data analyser, the HP 5000A, permitted diagnostics on long streams of data captured and displayed on rows of l.e.ds.

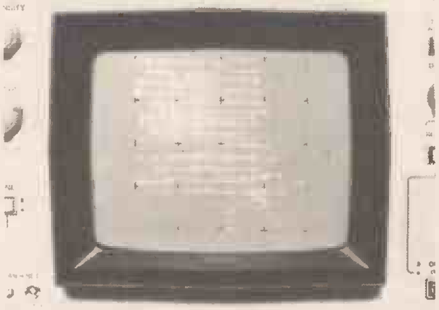


Fig. 1. Modern logic analysers can show timing waveforms, logic states, and some provide logic "maps" which help engineers diagnose malfunctioning processors.

In the six years since, the progress in logic analysers and microprocessor design instruments has been nothing less than breathtaking. And none too soon either, because relentless marketing pressure is pushing microprocessors well beyond the obvious applications in calculators and communications into appliances, toys, electric organs and motor cars. Design, qualification, production test, maintenance and service all need these measurement tools to work with microprocessors and digital circuitry.

One common theme of the 'seventies for most classes of instrument was that requirements moved two ways at once. Thus, the market called for smaller, more portable and less expensive models at the same time that other models went as far as technology would allow, with highly complex and powerful instruments and remarkably high price tags. An example of the former is the low-priced, digital voltmeter, while the high-priced example is the HP 3455A, a high-precision, system d.v.m.

Oscilloscopes handled higher frequencies and became both smaller and more portable, while others became much more powerful and complex, using microprocessors to measure digital time delay or rise times. Waveform, pulse and function generators tended to go in only one direction — towards smaller and cheaper designs, but with remarkably strong specifications. It's amazing how much waveform performance can be packed in a small package these days. The more complex pulse-generator products usually were the word and coded-pulse instruments required by new digital communications technology and fibre-optics.

R.f. and microwave. R.f. and microwave instruments entered the 'seventies with great promise. In 1970, hybrid microcircuit technology and the design processes using scattering parameters were in place, ready to supply the building blocks; G.a.s.f.e.t. devices were coming. The results were truly astounding. The microprocessor has made the difference — about half the circuits in many microwave instruments are now digital and it comes as no surprise that about half of our microwave design teams are digital and software designers.

A typical result is a newly-introduced synthesized signal generator. The 10kHz-1280MHz signal spectral purity of this generator rivals the best cavity-type generator of previous years, but it is also fully programmable and frequency agile (500µs switching time). The real contribution of this very expensive generator is in the design of the front panel controls. The mostly digital keyboard communicates only to the microprocessor, which does all the circuit and signal control, making things extremely easy for the operator. For example, he can set up ten completely different front-panel signal conditions, store each, and recall them at the push of a button.

Another example of this "smart" type of microwave instrument is a recent 1500MHz spectrum analyser. Starting from power switch-on, the machine runs through 30 self-tests and draws its own graticules and titles, and provides powerful measurement routines which are far beyond usual manual testing. Self-tuning routines bring identified signals to the centre of the screen and read out frequency and amplitude digitally. Sweep speed, bandwidth and resolution are automatically selected in program to prevent errors and ease the job. Peak detecting and hold and store functions capture information digitally to show historical peaks. Six sets of user-defined front panel set-up conditions can be stored and recalled. Powerful diagnostic routines and displays aid maintenance people. This new measurement capability can't be appreciated by reading about it. One must sit down in front of such a machine for about an hour to grasp its significance. For example, if the spectrum analyser is connected to a receiving antenna, all background spectrum accumulated for a given period can be used to cancel a given signal environment and the display will then show only new signals which show up later.

R.f. network analysis finishes the 'seventies with a typical instrument, covering 500 kHz to 1.3 GHz, which measures, calculates and displays complex impedance transfer functions, group delay, deviations from linear phase, etc. It's about all the design power an r.f. design engineer needs.

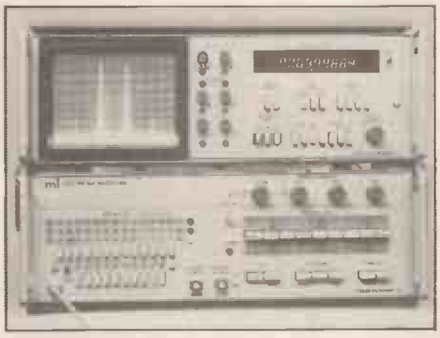


Fig. 3. 110MHz spectrum analyser employs digital storage, a television type display and automatic operation to give accurate spectral information quickly and easily.

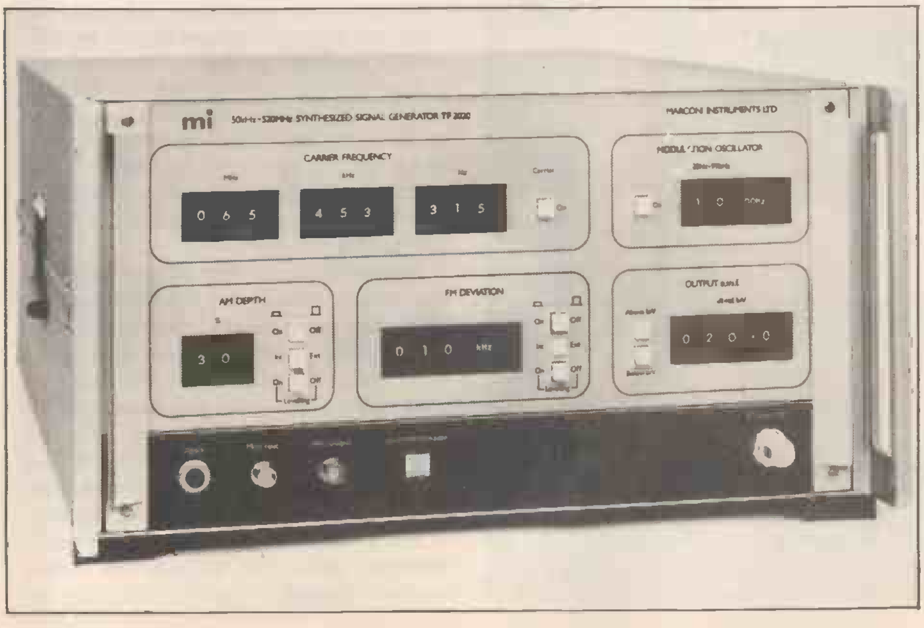
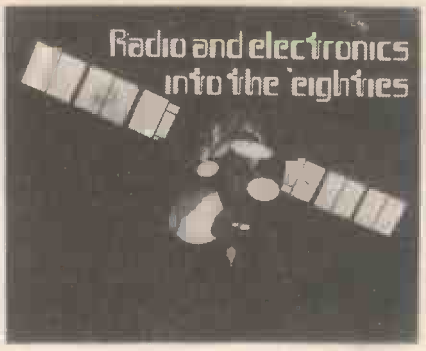


Fig. 2. Synthesized signal generator provides precision r.f. signals and, being bus-controllable, may be incorporated into a fully automatic test set up.



In instrumentation, the 'seventies brought one development which probably overshadows all other advances in instrument techniques — the IEEE-488 bus. Interestingly, the IEEE bus was not a technological breakthrough; it was really more of an organisational and political advance. A simple data party line allowing automatic control of instruments and resulting data computations has revolutionised measurements already: over 700 instruments and controllers from over 160 manufacturers throughout the world now operate on the bus. Engineers now *think* in terms of automatic measurements for labs and production and maintenance uses.

Servicing. Finally, in the late 1970s, a more coherent strategy for dealing with service and repair of digital circuits was emerging. Early attempts at field diagnosis and repair of 'digital' boards placed the emphasis on changing the board. When the total number of instruments in service was small and widely scattered, the organisation to make this feasible was difficult.

One solution gaining rapid acceptance now is a design strategy based on signature analysis of digital circuitry. Instruments with a high content of digital components are designed with a certain portion of the microprocessor set aside to be used in fault diagnosis. In that test mode, the instrument circuitry is forced through a switching procedure which causes each digital circuit node or pin on a digital logic pack to produce a sequential stream of 0s and 1s. That repetitive pattern is unique to that pin of a good instrument. Thus a signature analyser like the HP 5004 takes a bit stream as long as 2^{16} bits and compresses it into a 4-digit alphanumeric display. Instruction manuals and test procedures are written to measure and assign a unique 4-digit signature number to every digital circuit pin. Technicians can quickly troubleshoot right down to a component level, picking out faulty i.c. packs with little trouble and alleviating the serious problem of stocking complete p.c. boards.

The future

Forecasting the future is always risky, but the clues to the next five years of instrumentation are already apparent from the most recent offerings.

Alternative digital methods will continue to invade analogue and r.f. techniques. For example, instead of a super-accurate, flat-frequency-response r.f. attenuator for use in signal generators, a signal generator will use a moderately-accurate but highly stable one: a highly-precise calibration table stored in memory then corrects the output signal. This is effective and inexpensive so long as there is already a microprocessor available.

It seems quite clear that analogue and radio-frequency circuit techniques will be further eroded by digital methods. As faster analogue-to-digital converter components come along, instruments will sample and convert signals to digital form further forward in the measurement process. Output signals may be more commonly generated by digital waveform synthesizers. For example, oscilloscope sweeps would be much more accurate if generated digitally by a clock whose frequency was referred to a crystal standard.

Systems. Systems engineering will call for new initiatives in measurement which will create new instrument concepts. Communications systems are moving rapidly to digital modulations. Signal simulators will be needed for generating phase-shift-keyed modulations for satellite work as well as frequency agile signals for the new military communications and the cellular mobile telephone technology.

Fibre optics technology's on-rush into communications, in spite of its highly optimistic projections, has been underestimated: few people really see its impact clearly. The bandwidths of communication power to be unleashed by fibre optics will revolutionise not only the system business but will change instrumentation. Fibre optic data links can already link IEEE-488 bus

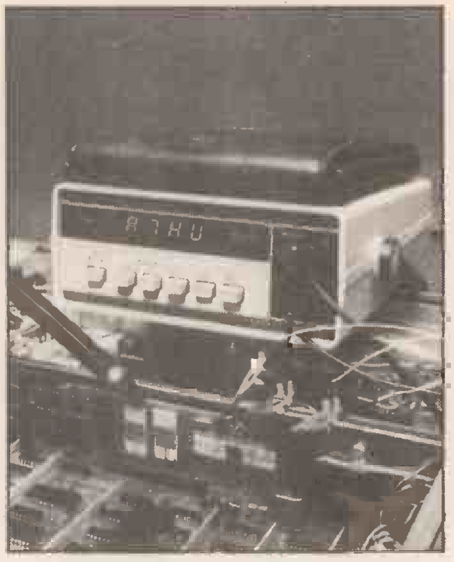
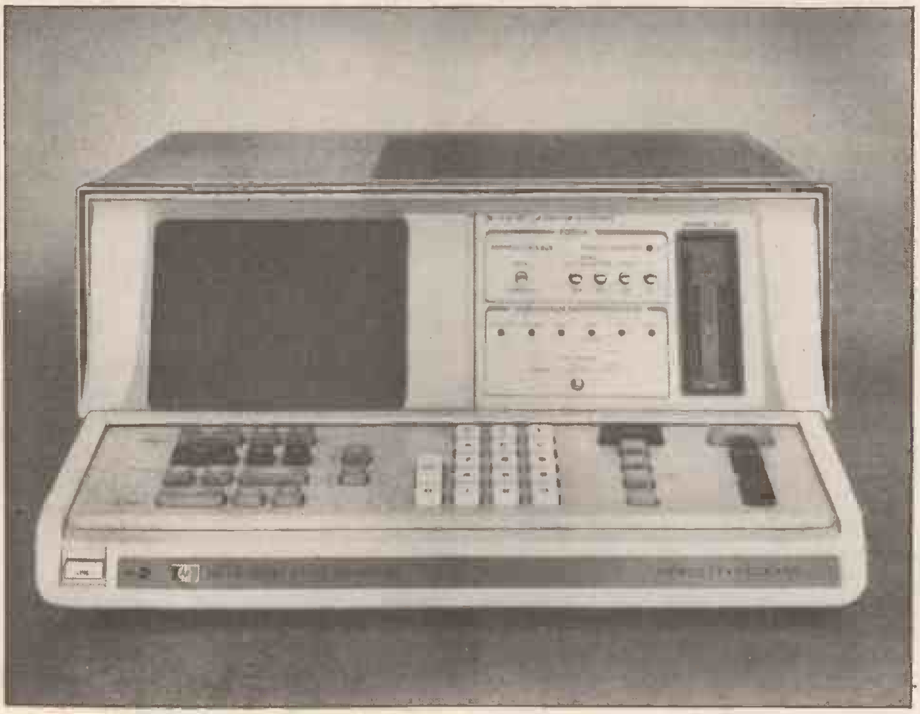


Fig. 4. Each pin of a digital i.c. pack has a unique 4-digit signature displayed and referenced in the repair manual, allowing diagnostics down to a component level.

instruments. Computer and terminal links as well as medical data transmission with no ground loops are just the beginning. These technologies will call for design and test equipment not yet envisaged. More importantly, they will call for new concepts in measurement.

The computer system technology will have memory and processors in every corner. Instrumentation will more than adapt: there is very heavy interaction between logic design instrumentation and the semiconductor revolution itself.

Fig. 5. Logic analysers for design of microprocessor-based everything will proliferate into many companies and industries outside electronics.



Certainly, computer-aided design for assistance in lab. projects becomes crucial. Engineering productivity is the key: in the 'seventies, automatic test equipment found willing ears for production test and for lowering costs — it was easier to justify.

The 1980s must attack the design side of things. Technology moves so fast that any lab. project which lasts longer than three years is going to produce a product with old or obsolete technology. As a result, there will be a steady proliferation of IEEE-488 bus mini-systems in laboratories. New instruments will appear with more operator-interactive controls and displays which interact, compute, correct and translate into your terms.

Complicated measurement procedures will be captured in software so the same tests can be re-run two weeks later. Suppose you run a particular test as you complete your circuit bread-board. Two weeks later, after modifications, you would like to recall the same procedure, set up all front panel settings as they were, run the test and compare the data to the previous test. This may sound a little like the HAL computer from the movie 2001, but it isn't; the technology to do that is here now in IEEE-488 bus systems. Now just contemplate individual instruments doing much of the same.

How will we maintain all this equipment? One computer maker recently proposed throwaway p.c. boards as a repair strategy; that might happen. Super-integration and high-reliability test programs could well give a substantial advance in reliability. But the usual reaction to that is to pack even more complexity into the instrument functions, putting instrument reliability back where it started. Smaller, lower cost, highly digital instruments will get more reliable. Larger, more complex, high priced instruments will hold their own on reliability. The most likely course will be a combination. With maintenance labour rates bound to increase, there may be some trends towards the throw-away-type repair on very low-priced instruments. In higher-priced equipment the instrument will contain more self-test and diagnostic capability, under control of its own microprocessor: that trend is already apparent. Then when the self-test has isolated problems to a given module or p.c. board, the digital signal analysers will take over.

Instruments in ten years will still consist of printed-circuit mother boards and plug-in modules. But p.c. board testing which has focused mostly on production functions may gravitate to maintenance depots where repair quantities can justify the cost. The new super-flexible automatic board-test systems are becoming attractive because of their remarkably low prices.

So, get ready for some technically exciting times. The surface has barely been scratched. □

NEWS OF THE MONTH

"Make way for engineers"— IERE president

The normal fabric of British life will have to be substantially changed, claims Professor William Gosling of the University of Bath, if we are to create an engineering profession adequate to the needs of our society. Giving his inaugural address as new president of the IERE, he said that we urgently need "an elite corps of engineers, particularly electronic engineers, who will be as able, perhaps abler, than any others in the world. To induce the most talented people to seek such a life, society will need to use the only inducements which have ever been known to work, namely honour, prestige and wealth. They will also need a good 'second division' of supporting engineers, of technician engineers and technicians. At each level of employment the appropriate rewards – tangible and intangible – to secure the quality and numbers to meet our social needs must be forthcoming. Such things are not achieved cheaply, but only by the diversion of resources in the appropriate direction. Since the wealth of society cannot immediately increase, even with the most favourable industrial policies, we are faced with a stark logic. If we need better engineers, more able to facilitate the creation of wealth by industry, we must make that career more attractive to the ablest of our children. To do that the rewards must be markedly improved. But if the very best engineers grow richer, everybody else, including all the other engineers, the trade union members and the arts graduates, must for a time see their prosperity grow less rapidly than would otherwise have been the case. This is a high hurdle for us all to get over, particularly in a society largely run by a collusion of arts graduates and trade unions, which has developed a marked predilection for living on its seed corn."

In a reference to the Finniston inquiry into the engineering profession, Professor Gosling said that nothing that could conceivably come out of this will change overnight the whole status and remuneration of engineers. "Maybe if engineers could be organised into a tight and monolithic union, and if they exploited their power ruthlessly and without regard for others, a change of that magnitude could be achieved. So far, engineers have for the most part not shown that willingness to unionize themselves, nor yet to their credit the extreme degree of ruthlessness and militancy. We may be sure that what they have not been prepared to organize themselves for and force from society, they will not be given unasked, from some kind of altruistic recognition of merit. We do not live in that kind of world."

"Engineers want statutory registration"—survey

A survey has revealed that professional electrical and civil engineers are overwhelmingly in favour of a statutory registering authority for the profession. The survey, carried out by NOP Market Research Ltd for the Institution of Electrical Engineers, questioned IEE and ICE members on their attitudes towards their professions, standards, and the way qualified engineers were perceived by society. It found that 92 per cent of IEE members favoured registration while the figure for the Civils was 87 per cent. The registering authority should be responsible for the registration of professionally qualified engineers (said 92 per cent IEE, 93 per cent ICE) as well as exercising control over the standards of education, training and qualification (80 per cent IEE, 72 per cent ICE) and professional conduct and discipline (78 per cent IEE, 79 per cent ICE). Virtually all members questioned believed that the registering authority should have the right of sanction against an individual if professional standards were not maintained.

It should be compulsory for all professional engineers to become registered (said 58 per cent IEE and 65 per cent ICE). A further fifth thought registration should be compulsory above a certain level of responsibility. However, if registration wasn't made compulsory then 79 per cent (IEE), 71 per cent (ICE) said they would apply anyway.

Not only did the majority favour registration but 67 per cent of both institutions believed that work requiring a high degree of responsibility should only be undertaken by registered engineers. When it came to the way the profession was perceived by the public, 97 per cent (IEE), 98 per cent (ICE) stated that "the public have little knowledge of the engineering profession." On the question of pay, 91 per cent (IEE), 88 per cent (ICE) said that they believed they were paid less than others in similar professional occupations. An overwhelming majority stated that engineers had achieved a higher professional status abroad than in the UK.

The questions were posted to a random sample comprising 4,400 corporate members of the IEE and 600 of the ICE, and the overall response rate was 52 per cent.

Japanese see opportunity in Prestel

Only a month after Prestel, the Post Office's viewdata system, started as a full public service (December 1979 issue, p55), the Japanese firm Sony displayed in London some equipment it has specially developed and manufactured for this information retrieval service. Shown by Sony (UK) Ltd at the Professional Viewdata Exhibition in November, it consists of two 14-inch colour television terminals using the famous Trinitron tube (December 1971 issue, p.587), one with a simple keypad and the other with a full alpha-numeric keyboard. Editing will be possible on these terminals. The equipment was developed at Tokyo and at the Sony (UK) manufacturing plant at Bridgend, Wales, and is assembled at Bridgend.

Speaking of his company's involvement in Prestel, Mr Kazuo Imac, of the Commercial and Industrial Division, said: "As well as being the first Japanese company to develop Prestel equipment, we have considerable investment in viewdata technology and this Prestel equipment is only the first of many developments to come." It will be remarked that this Japanese company seems to show considerably more enthusiasm for the system than the television set manufacturers in the country where Prestel was born. The British set makers have been well behind schedule in supplying viewdata receivers ordered for the test service started in September 1978.

● Four companies, Mullard Ltd, General Instruments, Texas Instruments and VG Electronics, demonstrated the British teletext/viewdata system in Tokyo on December 10 and 11. The object of the presentations was to show the advantages of the system's components and sub-assemblies to Japanese setmakers who undertake, or plan to undertake, the manufacture of suitably-adapted tv receivers in the UK or Europe. The presentations were organised by the British Overseas Trade Board. The Sony terminals mentioned above in fact use Mullard viewdata integrated circuits.

Arts competition

The Royal Society of Arts is including an audio-visual presentation in its 1979/80 Design Bursaries Competition, which this time will offer awards to the value of £50,000. In the audio-visual presentation section, students and young designers are given the opportunity to develop their technical skills and to apply their visual imagination to animating a sequence of ideas by means of lasers, holograms or any other audio-visual method.

Further information may be obtained from the Royal Society of Arts, John Adam Street, Adelphi, London WC2N 6EZ.

Hospital paging using synthesized speech

A new microprocessor-controlled radio paging system, recently installed by Multitone Electric Company Ltd at Frenchay Hospital near Bristol, includes synthesized speech. Multitone's ACESS 1800 paging terminal has enabled the hospital to organise several group alert sections of staff and considerably speed up the connection of one member of staff to another by telephone without using the switchboard staff.

ACCESS 1800 enables simultaneous calls to be made to as many as 12 team members in up to ten teams including the cardiac arrest team, a mobile resuscitation unit, and major accidents and fire teams. A member of staff can locate any receiver holder by simply dialling an access digit on any telephone, followed by the receiver number and the caller's extension number. He may then hang up the phone. A "bleep" will be heard by the receiver holder who, upon pressing a button, will then hear a synthesized speech message giving the caller's extension number. The switchboard is not involved in this at all. The cardiac arrest team can be alerted and mustered within seconds to a particular ward by a verbal message over their receivers. Similarly, the mobile resuscitation unit can usually be mobile in about 30 seconds from the origination of a call from the switchboard.

Thirty calls may be stacked in the computer's memory and automatically processed in sequence, even when interrupted by a priority call. Any temporary change of receiver number, for staff on call, can be programmed into the memory, which will automatically call the alternative number when the original, unobtainable number is dialled. If one doctor is unobtainable, a second on-call doctor can be summoned automatically in his place. This call transfer system eliminates the need to inform all staff of the change of number when any receiver is exchanged.

An operator on Frenchay Hospital's busy switchboard using the control panel for Multitone's ACCESS 1800 microprocessor-controlled speech-synthesized paging system.

Pseudo-direct satellite speculation

Mr Pat Hawker of the IBA, speaking as a 'devil's advocate' – his own words – at a meeting of the Society of Cable Television Engineers on October 16, posed the question "What would happen if say a commercial company in Luxembourg were to use a lower-power satellite positioned at 19°W (the orbital position allocated to Luxembourg, France, West Germany etc.) on the appropriate 12GHz channels and carrying a stream of bought-in programmes in the English language?" Speculating, he said, "Such transmissions would be picked up in the UK."

A small number of enthusiasts, according to Mr Hawker, would undoubtedly be capable of making their own equipment to receive these transmissions, either directly or for community distribution. For good quality reception, he said, they would need efficient satellite receive-only terminals with – for 12GHz – possibly 1.5, 2 or at most 3 metre dish aerials and these, while requiring greater profile accuracy, would not necessarily be any more expensive than the 4.5 metre dishes used in the USA. According to a recent press report, he said, enthusiasts in North America had managed to receive tv from Westar and Satcom Systems, mainly to mining and timber camps. The report said that Canadian government officials had estimated that 50 unlicensed stations were involved, but their operators were not shut down because the government had difficulty in locating them and there was a genuine danger, according to an official, that the lumberjacks and miners would resist with force.

Reminding his audience that Radio Luxembourg had been carried on cable, Mr Hawker posed a second question, "Would British cable networks be permitted to distribute programmes from France, West Germany or Luxembourg?"

"It would need Home Office approval," he said, "but as Erik Jurgens, chairman of the Netherlands Broadcasting Corporation has pointed out, there is Article 10 of the European Convention. This states: Everyone has the right to freedom of expression. This right shall include freedom to hold opinions and to receive and impart information and ideas without interference by public authority and regardless of frontiers. This Article shall not prevent States from requiring the licensing of broadcasting, television or cinema enterprises." Mr Hawker suggested that such an Article posed legal questions which only experts could answer, and that it was possible that no two experts would agree on how this might be held to effect the distribution of programmes from other members of the EEC and where no copyright protection was sought. If cable operators could distribute programmes in such a manner, it would open the way for programmes and advertisements which did not conform to BBC or IBA conventions, guidelines and regulations – de-regulation of broadcasting.

Pat Hawker made it clear that the views expressed were entirely his own and not those of the IBA.

CA for CB

The Consumers' Association have come out in favour of introducing a citizens' band radio service in the UK. In a one-page summary of the arguments for and against in the November issue of their magazine *Which?* they conclude: "Citizens Band radio in this country may not save many lives, nor may it be the best way of relaying traffic information. But it could provide an easy-to-use, relatively cheap method of communication that many people would find useful to have on occasions. We'd like to see it available here, if the problems of interference can be overcome."

The Association maintains in fact that the possibility of interference with other electronic equipment is the only serious argument against the introduction of c.b.: "The system of transmission used in most other countries would certainly cause interference, and shouldn't be used in the UK. There are other systems (e.g. v.h.f./f.m.) that would be much less troublesome – but the problem of interference is undoubtedly important, and more research is needed to ensure that any chosen system would be satisfactory."

SERT move

The Society of Electronic and Radio Technicians moved to larger offices on November 10, 1979. Its new offices are at 57-61 Newington Causeway, London SE1 6BCL. The Society occupied its previous offices, in Faraday House, since 1968.

German press considers higher frequencies for c.b.

Conditions on the 27MHz citizen's band are giving users cause for concern and every day there are new calls for better operating conditions. The German electronics journal, *Funkschau*, therefore carried out tests and compared some alternative bands to get acquainted with the advantages and disadvantages of each one as far as c.b. was concerned. Their findings showed that shifting c.b. into the v.h.f. or u.h.f. region could produce considerable advantages. It would cause much less interference to home-entertainment equipment, and the substantial increase in the channels which could be used would put an end to the present overcrowding.

Because special permission is required in West Germany to use frequencies around 900MHz, this band could not be included in the tests. Instead the 23cm amateur band (1295MHz), which has similar propagation characteristics, was considered, together with the 70cm (435MHz) band and the current 11m (27MHz) band. On the 11m band they found that there was always heavy interference from stations in countries further south and from industrial generators, while on v.h.f. and u.h.f. only noise could be heard. The tests were carried out using omnidirectional antennas with no gain and powers of less than 1W.

For propagation comparisons the different types of terrain were considered. Munich was chosen as a heavily built-up municipality, the Upper-Bavarian lakes were used for propagation over areas of water, and the hilly country in the north of Munich enabled trials to be done over undulating terrain. As expected, the poorest ranges were observed in the 23cm band, and usable ranges could not be achieved until a station arrived at an exposed location. Penetration was good on this band and radio contact was not even lost when one station moved into a garage. In the city, however, the "phase wipeouts" from passing vehicles proves a great nuisance, and it was concluded that diversity reception could help in this case. It was the journal's experience that the 23cm band could only be of value for c.b. radio if repeater stations were set up on high buildings or mountains, and it would also be necessary to obtain approval for high-gain antennas.

US noise jammer simulator to be made by UK company

A contract, valued at more than $4 million, to build the US Navy a noise jammer simulator, has been awarded to Watkins-Johnson the Windsor-based electronics company. The order, which comes from the Naval Weapons Centre at Dahlgren, Virginia, gives the company the responsibility of designing, manufacturing, installing and activating a computer-controlled system capable of emulating hostile jamming environments. When completed in 1981, the simulator will be used at the Atlantic Fleet Weapons Training Facility to provide electronic counter-countermeasures training for Navy radar operators.

More v.h.f. broadcasting likely

The v.h.f. sound broadcasting band in Region 1, at present 87.5 MHz to 100 MHz, will almost certainly be extended upward to 104 MHz as a result of a decision at WARC 79, we understand. In Britain, for example, this will allow an extension of BBC and IBA local radio services, will avoid the necessity for sharing between BBC Radio 1 and Radio 2, and will reduce the need for some Radio 3 and Radio 4 programmes to be displaced by educational broadcasts (see article by D. P. Leggatt in this issue). To permit this extension of broadcasting, the police radio communications at present occupying 100-104 MHz will have to be moved elsewhere but it is not yet known what frequencies are likely to be used.

Apart from this loss, mobile radio in Region 1 has benefited overall from the decisions at WARC 79. At the time of going to press we understand from unofficial sources that this service will be allocated sections of the spectrum which it has not had the use of before. In Britain one of these sections could well be part of Band 1 (47-68 MHz) which is at present used for 405-line television broadcasting by both the BBC and IBA, but what happens here will in fact be an internal UK decision made by the Home Office. The BBC hint that the remainder of Band 1 could perhaps be used for the new direct digital radio broadcasts.

It seems there has been something of a conflict at WARC 79 between the USA and Canada over the allocations for services in the u.h.f. bands in Region 2. Because the heavily populated areas of Canada are close to the US border it is obviously necessary that the two countries use these bands in the same manner in an integrated way to avoid interference. Canada wants to use the u.h.f. bands exclusively for television broadcasting (the present exclusive allocation for this service being 470-890 MHz), partly because it has a large number of language groups to cater for both native peoples and immigrants, while the USA wants a more flexible arrangement in which they are shared with mobile radio. For example, the land mobile radio community in the USA recommended a co-equal mobile and broadcasting allocation between 470 and 806 MHz to provide flexibility in the international table of allocations and leave the domestic u.h.f. television allocations intact to the degree that is necessary. At the time of going to press we understand that the Canadian case is getting strong support from other delegations, but the issue is not yet settled.

Impulse buying by hi-fi customers

A consulting firm, Venture Development Corporation, from Massachusetts, claims that there is a link between the time spent by a customer selecting a hi-fi product and the amount of money spent by the manufacturer. The Corporation says that hi-fi buyers sometimes have a lot in common with new car buyers in that they need a lot of information, they often price shop, and they frequently require substantial psychological support. At other times, it says, the hi-fi buyers behave like chewing-gum buyers, needing very little time to make a brand selection and being completely pre-sold on a particular product. Price did not seem to be a critical factor as long as the merchandise was available.

The consulting firm compared the owners of systems costing $1400 or more with owners of systems costing less than $800, and found that 72.7% of the owners of high-priced systems spent at least a month selecting component brands, but only 37.2% of low-priced systems owners spent that long. Two factors accounted for this, according to the firm. Firstly, the larger the purchase, the more time the people were willing to invest to guarantee an optional selection, and secondly, the more expensive systems had more features requiring consideration, making the final choice more complicated. 20.7% of the owners of systems worth less the $800 decided on their components within one day or less, and only 4.2% of the owners of high-priced systems were able to make a purchase in the same time.

The Corporation claims that the implication for retailers is clear. They should not rush the sales of high-priced merchandise. Product literature, specification sheets and reprints of reviews should be readily available for customers to consider at their leisure, and the higher the price, the more information should be offered.

V.o.r. computer

Walter Freter, who is a member of the Munich gliding club and the Siemens (Munich) amateur electronics group, has developed an automatic v.h.f. omnirange (v.o.r.) receiver, using a microprocessor to calculate and display the required compass bearing. Normally, the pilot of an aircraft is required to look up the frequency of the selected v.o.r. beacon, tune his navigation receiver and set the omni-bearing selector, observing the left/right indications of the display and adjusting the heading to keep the needle centred.

Freter's design avoids all this by virtue of its programmed table of all European frequencies, and the power of its microprocessor to tune the navigation receiver to the beacon transmission. The processor will calculate the required compass course to fly, using the left/right information which would normally be displayed, and will show the continuously up-dated compass course on a numerical display on the control panel.

Siemens say that several manufacturers (not Siemens?) have shown interest in the equipment.

WORLD OF AMATEUR RADIO

Past the peak?

By the time these words are published it seems likely that the peak of Solar Cycle 21 may have passed — although this will not be known for certainty until mid-1980. Long-distance paths on frequencies up to and above 50MHz reappeared in mid-October with many cross-band (50MHz/28MHz) amateur contacts between Europe and North America. The season appears to have opened on October 18 when American 50MHz signals were received in West Germany. The amateur station, G3SSO, operated by personnel at GCHQ, Cheltenham is thought to have been the first British station to make such a contact this autumn, working Canadian VE1AVX on October 19. RSGB advises that 28.875 — 28.895MHz has become established as the frequencies for cross-band s.s.b. operation with 50MHz North American stations.

The sunspot peak has been reached sooner than expected, although if the cycle follows the usual pattern, the decline will be considerably slower and several more seasons of 28MHz (and possibly 50MHz) long-distance "openings" appear likely. The past decade has shown once again the great difficulties experienced by radio physicists in accurately predicting, except in the short-term, the dates of maxima and minima and the level of maximum sunspot activity. Perhaps the most interesting new theories to emerge recently are those of Professor R. H. Dicke of Princeton University who believes that the cycles are accurately timed deep inside the sun by a form of magneto-fluid oscillator but take varying times for the magnetic fields to reach trhe surface; he also espouses the theory that the true solar cycle last 22 years with a reversal of magnetic field polarity at 11-year intervals.

Foxhunting

One of the aspects of amateur radio that continue to attract a small but faithful and enthusiastic following is the art of locating hidden stations by the use of direction-finding receivers. For many years the RSGB has organized a series of "qualifying events" leading to a "national final" based on transmissions in the 1.8MHz amateur band. For the qualifying events, competitors are expected to locate two different hidden transmitters within about a ten-mile radius of the starting point, but for the national final it is a question of finding three stations in a matter of a few hours. The 1979 winner, Eric Mollart of the Mid-Thames Club, took only just over two hours to do this, in spite of the many ingenious difficulties that tend to get built into the course as a result of past experience. For example, a technique which has been used at several events is to have an extremely long aerial which even when located may apparently lead nowhere. At Wolverhampton, in one of the 1979 qualifying events, for instance, one transmitter had several hundred yards of fine wire suspended in the trees as aerial, but with a final length tacked under the horizontal rails of a fence, eventually leading to gorse bushes in which the operator and his transmitter were concealed. The d/f bearings thus led the competitors only to a wooden fence with no sign of the concealed station.

A rather different form of 'foxhunting' using the 144MHz band, is also organized, for example, by the UK FM Group (London), though one gains the impression that care is taken to ensure that it can be combined with the objectives of the Campaign for Real Ale!

The first G/YL

Miss Barbara Dunn, G6YL, who died recently, is generally believed to have been the first licensed 'YL' (young lady) amateur operator in the UK and held her licence for over 50 years. Throughout the 1930s she was one of the small group of British 'YL' operators who were tremendously active on the long-distance bands and in pioneering both 28MHz and the old 56MHz bands. Even in 1937, ten years after she took out her licence, there were only five 'YL' amateurs in the UK: Nell Corry, G2YL; Constance Hall, G8LY (still licensed); A. J. Burns, GM2IA; G6SF; and Barbara Dunn — though these were joined soon afterwards by Catherine Myler, G3GH, who later was one of the very few amateurs to receive official recognition for their work as Voluntary Interceptors in the Radio Security Service.

Barbara Dunn became interested in radio communication as early as 1923 when she heard spark signals from ships breaking through on top of the old London 2LO broadcasts. She taught herself 20w.p.m. Morse by listening on a crystal set to the FL (Eiffel Tower) time signals on 2600 metres and ships on 600 metres before becoming interested in short waves at the end of 1925, acquiring her licence in 1927 and using initially an LS5 power oscillator with a rotary converter powered from 6V accumulators. Next year, moving from Stock, Essex to Northumberland, she was still limited (like many other amateurs of the time) to using 100V d.c. mains but worked all over the world with a maximum input of 8 watts to t.p.t.g. oscillators and, using a bent 60-ft 'AOG' (Act of God) aerial; with her rotary converter mounted on a block of sorbo rubber under the table. Her interest in ships continued and she made contact with many of those equipped with h.f. radio, although at that time British ships were not permitted to operate in this way.

The amateur radio market

Throughout the 1970s, the amateur radio equipment market has been increasingly dominated by Japanese firms whose products are now used by the majority of amateurs in most parts of the world (including many of the Eastern European countries although not in the USSR where much of the equipment continues to be described as "home made"). Although during the decade the total amateur market for equipment has risen sharply, few of the old-established British or American firms have come through unscathed from the torrent of equipment from Yaesu, Trio (Kenwood), Icom (Inoue), FDK etc. Some firms have adopted the policy of continuing to manufacture established designs but without introducing new equipments involving heavy development costs; others have attempted to keep ahead of the Japanese designs, although this is proving an increasingly difficult and hazardous policy and there are unconfirmed rumours that one of the more innovative American firms may soon be a further casuality of the trade war.

In brief

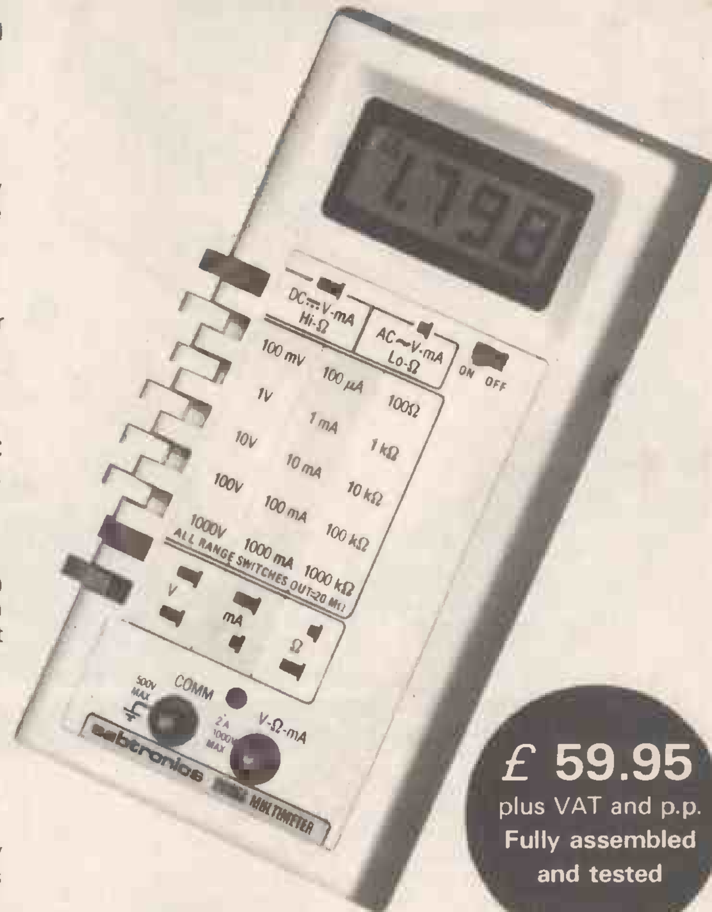
The USSR is planning to launch an RS3 amateur radio satellite during spring or summer 1980 .... King Hussein of Jordan (JY1 and G5ATM) recently met 45 members of the Radio Society of Harrow at a reception given by the Mayor .... Richard Thurlow, G3WW has become the third amateur in the world to obtain a CQDX award for working 100 different countries on slow-scan television (No. 1 was W8YEH, No. 2 G3IAD) .... Japan is now issuing amateuir callsigns in the JM prefix series .... The VHF Committee of the RSGB has recommended 145.650MHz as a "calling frequency" for amplitude-modulated transmissions.

PAT HAWKER G3VA

NOBODY CAN DO IT LIKE SABTRONICS CAN. NOBODY!

We pioneered the first benchtop professional quality Digital Multimeter at lowest price anywhere. We sold tens of thousands of units around the world and are still selling. Nobody has been able to beat our price/performance ratio.

Now we are making the impossible again. A 3½ Digit LCD handheld professional quality multimeter at an absolute low price of only £ 59.95*. But don't get sold yet, wait till you have read further.



£ 59.95
plus VAT and p.p.
Fully assembled and tested

QUALITY, PERFORMANCE AND ACCURACY

The model 2035A offers you long term accuracy with a laser trimmed resistor network, a stable bandgap reference element, and single chip LSI circuitry. Expert circuit design and board layout have reduced component count to the optimum minimum. With 32 ranges** and 6 functions, you can measure AC or DC volts from 100 µV to 1000 V; AC and DC current from 0.1 µA to 2A; resistance from 0.1 Ω to 20 MΩ. Typical DCV accuracy of 0.1% ± 1 digit.

OVERLOAD PROTECTION FOR GREATER SAFETY

Input overload is protected to 1000 V (DC + AC peak). Ohm and current ranges are fuse protected. These features, plus a high immunity to voltage transients, protect the 2035A against uncertain input conditions. Input and battery eliminator jacks are recessed to ad to operational safety.

Wait don't order it untill you have read further.

OTHER FEATURES FOR GREATER CONVENIENCE AND FLEXIBILITY

Automatic zero; Automatic polarity (+ implied, – shown); Large ½" LCD readout with automatic decimal and low battery indicator; uses inexpensive 9 V transistor battery; 200 hours battery life; push button switches for easy operation; light weight (only 11 oz); fits easily into a jacket pocket; specially designed injection moulded rugged plastic case in beautiful grey beach colour with matching switch buttons; only 2 caliberation controls. Whether you are professional or amateur, you should check out the Model 2035A for yourself.

ORDER YOURS NOW!

* Model 2035A as shown.
Model 2037A with temperature measuring circuitry £ 69.95.

** Model 2037A has 34 ranges and 7 functions.

BRIEF SPECIFICATIONS MODEL 2035A & 2037A

DC Volts	5 ranges	100 µV	to	1000 V	0.1%	±1 digit–0.25% ±1 digit
AC Volts	5 ranges	100 µV	to	1000 V rms	0.5%	±1 digit–1.0% ±1 digit
DC Current	5 ranges	0.1 µA	to	2.000A	0.25%	±1 digit–0.25% ±1 digit
AC Current	5 ranges	0.1 µA	to	2.000A rms	0.5%	±1 digit–1.0% ±1 digit
High Ohms	6 ranges	0.1 Ω	to	20 MΩ	0.2%	±1 digit–0.5% ±1 digit
Low Ohms	6 ranges	0.1 Ω	to	20 MΩ	0.2%	±1 digit–0.5%, ±1 digit
Temperature**	2 ranges	–50°C	to	+150°C	1°C	– 2.5°C.

Input impedance	10 MΩ – DCV and 10 MΩ/10pF – ACV
Burden voltage	100 mV at 1000 display
Over voltage protection	1000 (DC + AC peak)
Over current protection	2a/250 V fuse
Ohm overload protection	250V DC or AC peak
AC Frequency response	40 Hz to 5 kHz
Battery life (9V)	200 Hours typical with alkaline battery
Weight	11 Oz. (310 gms) without battery.
Accessories supplied	Test leads
Temperature Co-eff.	0.1 x /°C
Display	½" (13 mm) Character, 3½ Digit Liquid crystal display with low battery indicator and «–» sign.
Case colour	Light grey with matching buttons.
Case Material	ABS Rugged plastic with texture.
Optional	Touch and hold probes for hard to reach measuring areas.

Making Performance Affordable

sabtronics
INTERNATIONAL INC.

Send your orders with payment to:

TIMWOOD LTD.
14 Albert Street, Cowes Isle of Wight, England:
Telex 86892

Please send me by parcel post:

__ Model 2035A
assembled and tested at £ 59.95 £ ________

__ Model 2037A
assembled and tested at £ 69.95 £ ________

__ Model THP 20
Touch and Hold probe at £ 9.95 £ ________

Plus VAT at 15% and p.p. £ 3.50 each £ ________

Total enclosed herewith: £ ________

Name: ________________

Address: ________________

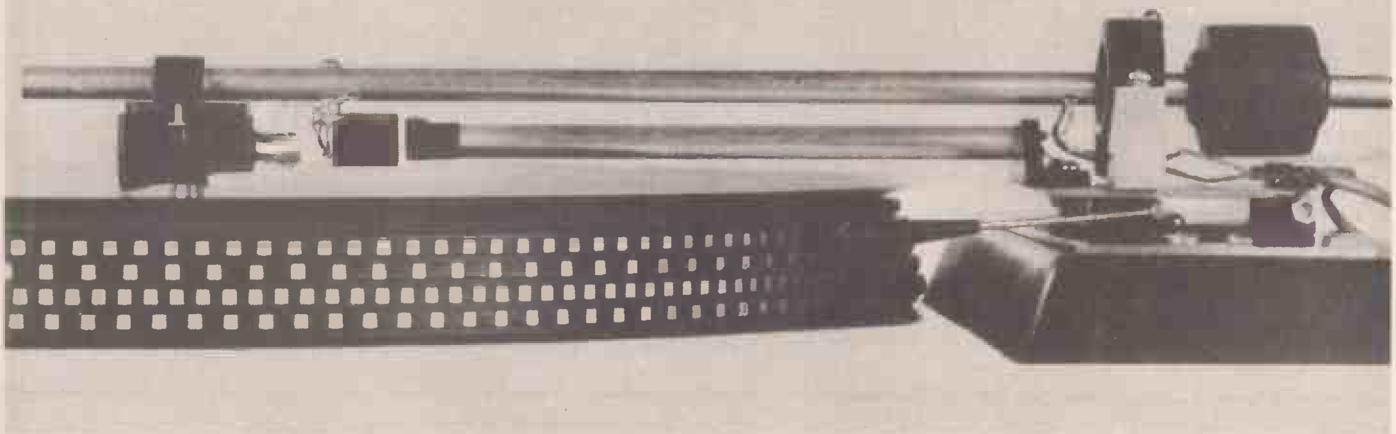
City: ____________ Postal Code: ________

WW — 018 FOR FURTHER DETAILS

Practical parallel-tracking pickup arm — 2

Optoelectronic servo control gives low-inertia, fail-safe operation

by Rod Cooper



Despite the many advantages of the parallel-tracking record deck, the high cost of owning one deters all but the well-heeled few. This prompted the design and construction of a pick-up arm and control system with simplicity of construction specifically in mind. By avoiding complex engineering it is possible to construct the design with non-specialized tools in about 40 hours and for a fraction of the cost of a commercial item.

WHILST ACCESS to a lathe makes construction quicker and easier, it is quite feasible to make all the parts with tools normally found in a small workshop. An electric drill and stand, some BA taps and dies and a selection of metal cutting files and saws are however essential.

Both the tracking arm and reference arms are made of thin-wall Duralumin tube, readily available from aeromodel shops. One end of the tracking arm is plugged with a tight fitting brass rod and glued into place with Araldite. This serves to strengthen the fragile tube where the vertical pivot goes through, and provides some degree of counterbalance.

Constructors will notice that the positions of horizontal and vertical pivots have been transposed, compared with the conventional arrangement. Having the vertical pivot on the tracking arm is not good practice on a conventional arm of course, but is permissible here because the tracking arm on a parallel-tracking machine does not swing on the pivot more than half a degree, whereas the conventional must swing through a wide angle. The change enables an unusual design of horizontal pivot to be used — one that allows the tracking arm assembly to be easily taken off for transport or adjustment without having to dismantle anything, and allows replacement without having to re-align it with the reference arm. There are other advantages to this design, namely: it is much easier to make than the usual spindle type, it is virtually friction-free, needs no lubrication, has no play due to bearing clearances and does not introduce play due to wear.

Avoiding play is important because the control system cannot distinguish between play and tracking error. It is for this reason too that the sliding platform is spring loaded, so that any running clearance in the track is taken up. Diagram 3 shows the horizontal pivot design. Two adjustable screwed pivot points rest on top of two support pillars, one in a slot and the other in a conical cup on the opposite side of the gimbal ring. The arrangement is quite stable, provided the two pivots are far enough apart.

The vertical pivot is straightforward. Adjustment for inclination is by means of the brass plate which forms the upper bearing, and which can be moved around on the flat top of the gimbal ring to the correct position.

The track in Fig. 4 can be cut with a small hacksaw and then filed to the exact dimensions. It is worth spending some time ensuring the track is straight, as the whole concept depends on the reference arm maintaining a constant angle to the tracked radius of the record. Also, it is essential that the carriage slides without any hard spots. It is not necessary to produce a perfect fit, as a small amount of slack will be taken up by the spring-loading.

To reduce wear, a few drops of clock-oil (which has good non-gumming properties) can be applied to the vertical pivot, the lead screw and the running surfaces parallel track. Don't use mineral oil sold as general-purpose or light machine oil because it thickens to a gum after a while.

The hinge pivot holder part 14 is soldered in position to the lower plate, part 11. The best way of doing this is to pre-solder both plate and holder; with a length of 6BA rod through both holders, position them the correct distance apart and place them on the plate, and gently heat the plate from below. It is then quite easy to move the two holders into the exact position while the solder is molten; excess solder will cause holders to float out of place, so use the bare minimum.

For the sake of simplicity, the counterweight on the prototype was made from a piece of 1in diameter brass bar drilled through the centre and decoupled with a foam rubber insert. However, the comments by Randhawa on counterweights (*WW* April 1978 pages 63-8) should be noted by constructors as a better design is probably possible. The main requirement for the counterweight is that it should give neutral equilibrium with the chosen cartridge when the tracking arm is positioned about half way up the vertical pivot.

The photocell holder was filed from a piece of solid engineering-grade p.v.c. which is particularly easy to use, but other reinforced or filled plastics such as Tufnol would probably be suitable. The two photodiodes were cemented to the holder with Araldite. An aluminium shim separated the diodes, this being necessary to prevent light from one diode reaching the other by reflections via the transparent sides of the BPW34. The size of the shim is not critical but for good light cut-off between the diodes it should project ⅛in or so all round.

A shroud was made from the same shim material to clip onto the holder. It is best if this is eventually fixed in place with Araldite when the system has been proved to work satisfactorily. Beer and soft drink cans are a good source of strong, thin aluminium. It is important that the weight of the holder and shroud is kept as low as possible to preserve the low inertia of the tracking arm.

Regarding the finish and appearance of the self-made metal parts, both polished brass and aluminium can be protected from tarnish by Letraset aerosol spray No. 101. This provides quite a tough, abrasion-resistant transparent film which is almost undetectable.

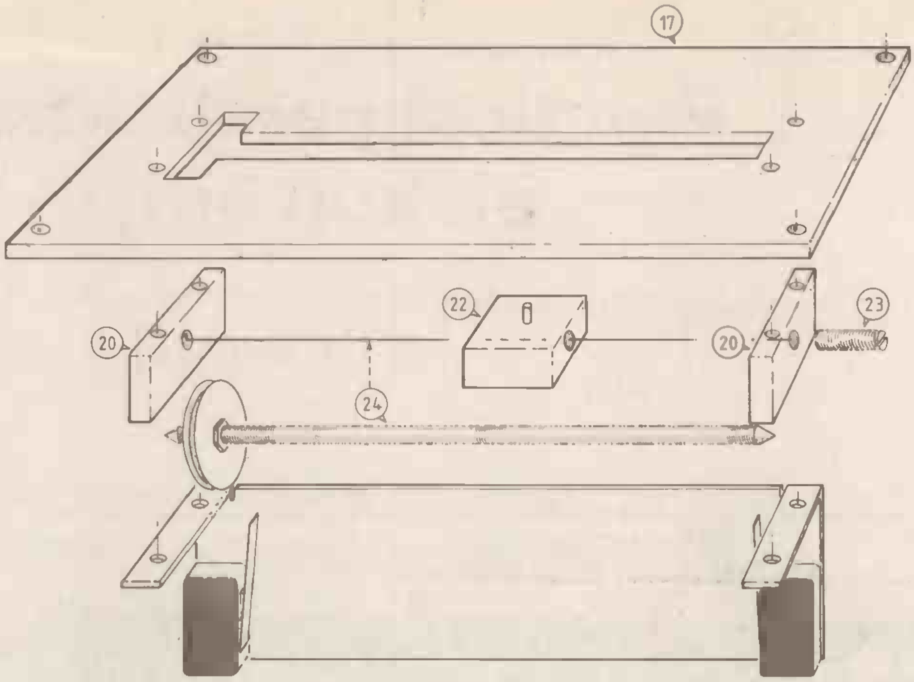
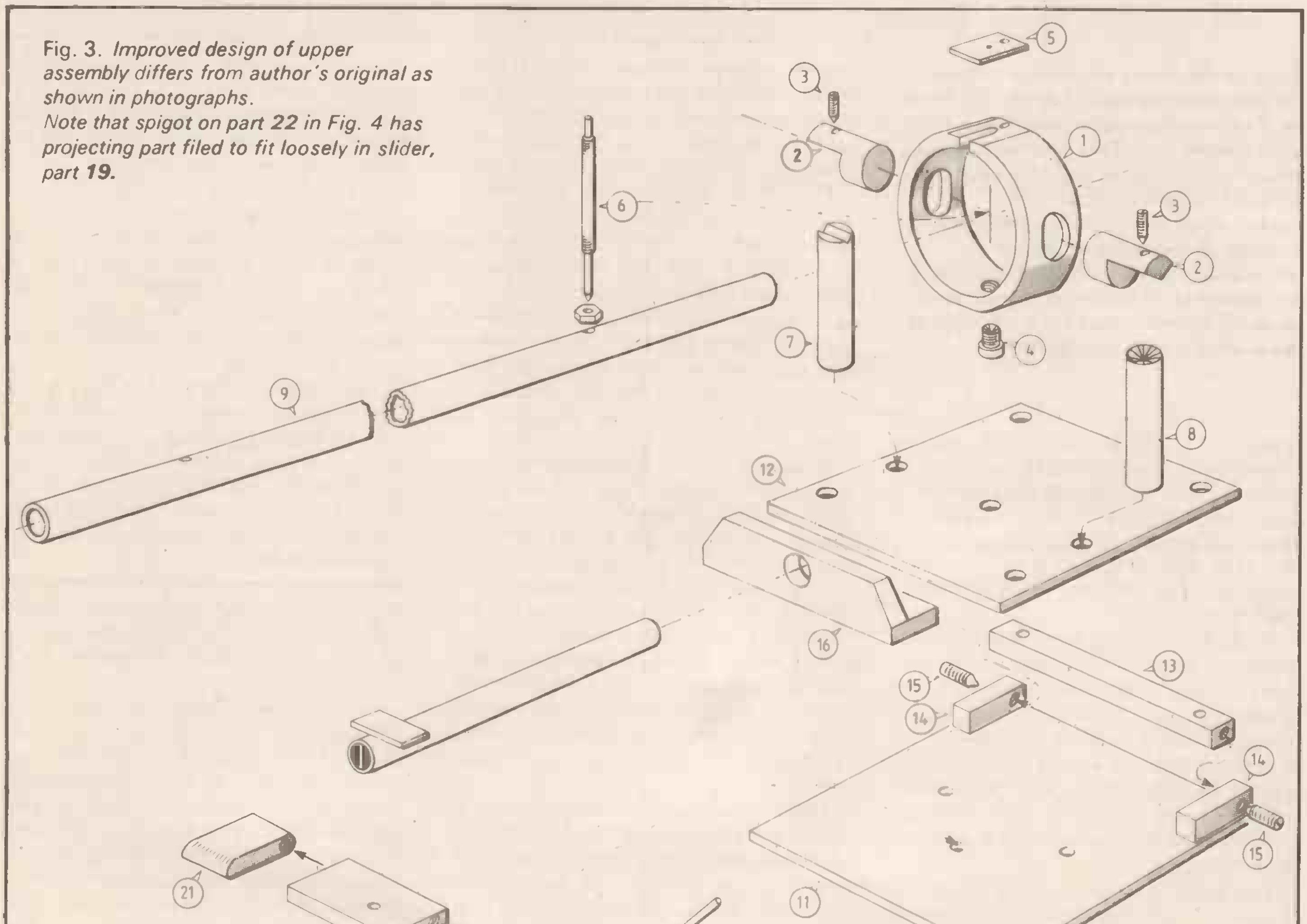
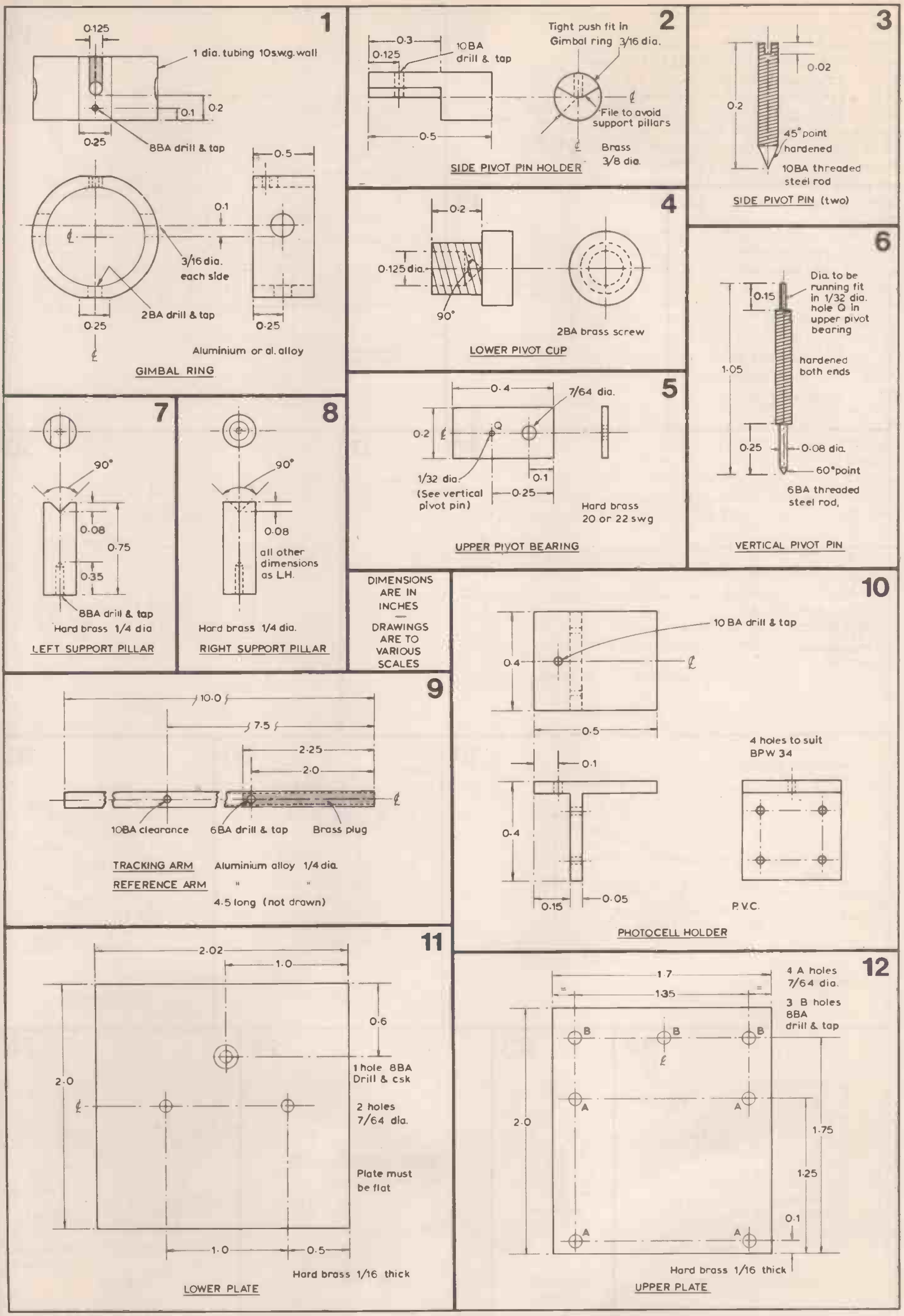


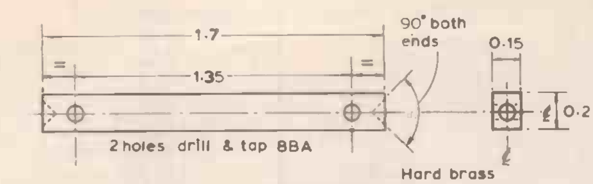
Fig. 4. *Lower assembly comprised lead screw arrangements as shown, together with drive mechanism pictured in December issue.*

Fig. 3. *Improved design of upper assembly differs from author's original as shown in photographs.*
*Note that spigot on part 22 in Fig. 4 has projecting part filed to fit loosely in slider, part **19**.*



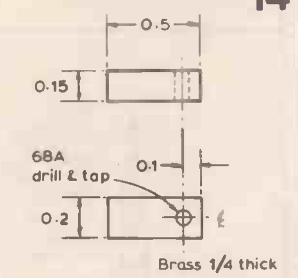

1
0.125
1 dia. tubing 10s.w.g. wall
0.1
0.2
0.25
8BA drill & tap
0.5
0.1
3/16 dia.
each side
2BA drill & tap
0.25
0.25
Aluminium or al. alloy
GIMBAL RING
2
0.3
0.125
10BA
drill & tap
Tight push fit in
Gimbal ring 3/16 dia.
File to avoid
support pillars
0.5
Brass
3/8 dia.
SIDE PIVOT PIN HOLDER
3
0.02
0.2
45° point
hardened
10BA threaded
steel rod
SIDE PIVOT PIN (two)
4
0.2
0.125 dia.
90°
2BA brass screw
LOWER PIVOT CUP
5
0.4
7/64 dia.
0.2
Q
0.1
1/32 dia.
(See vertical
pivot pin)
0.25
Hard brass
20 or 22 swg
UPPER PIVOT BEARING
6
Dia. to be
running fit
in 1/32 dia.
hole Q in
upper pivot
bearing
0.15
1.05
hardened
both ends
0.25
0.08 dia.
60°point
6BA threaded
steel rod,
VERTICAL PIVOT PIN
7
90°
0.08
0.75
0.35
8BA drill & tap
Hard brass 1/4 dia
LEFT SUPPORT PILLAR
8
90°
0.08
all other
dimensions
as LH.
Hard brass 1/4 dia.
RIGHT SUPPORT PILLAR
DIMENSIONS
ARE IN
INCHES
DRAWINGS
ARE TO
VARIOUS
SCALES
9
10.0
7.5
2.25
2.0
10BA clearance
6BA drill & tap
Brass plug
TRACKING ARM Aluminium alloy 1/4 dia.
REFERENCE ARM " "
4.5 long (not drawn)
10
10 BA drill & tap
0.4
0.5
0.1
4 holes to suit
BPW 34
0.4
0.15
0.05
P.V.C.
PHOTOCELL HOLDER
11
2.02
1.0
0.6
1 hole 8BA
Drill & csk
2.0
2 holes
7/64 dia.
Plate must
be flat
1.0
0.5
Hard brass 1/16 thick
LOWER PLATE
12
1.7
1.35
4 A holes
7/64 dia.
3 B holes
8BA
drill & tap
B
B
B
A
A
2.0
1.75
1.25
0.1
A
A
Hard brass 1/16 thick
UPPER PLATE

13



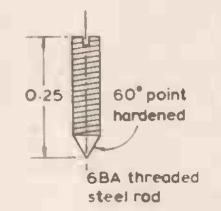
HINGE BAR

14



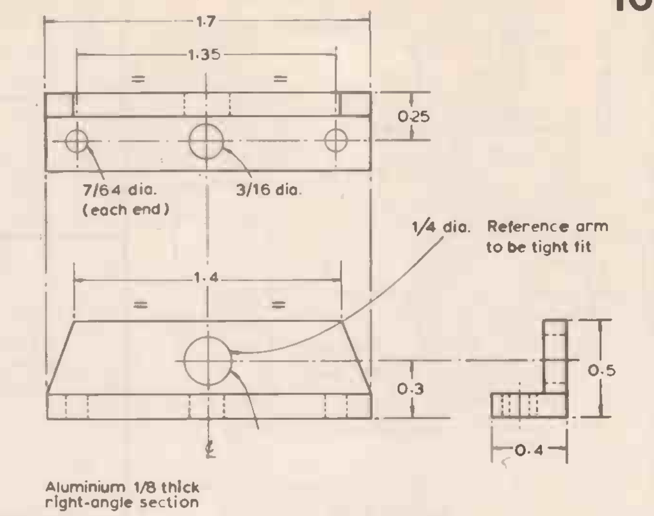
HINGE PIVOT HOLDER

15



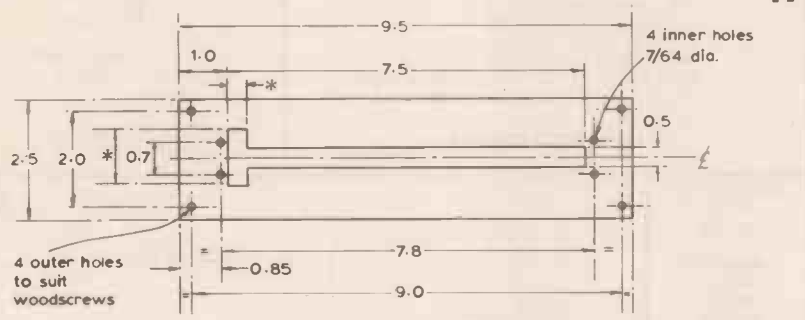
HINGE PIVOT

16



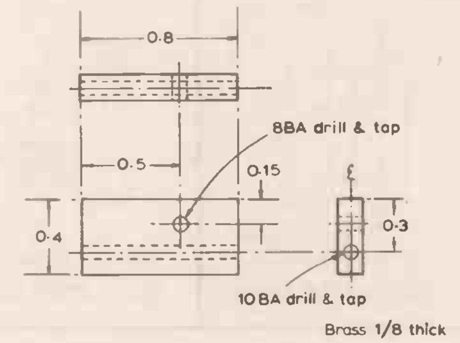
REFERENCE ARM HOLDER

17



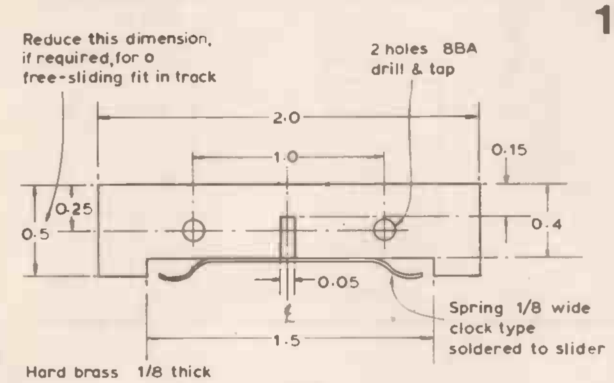
TRACK

18



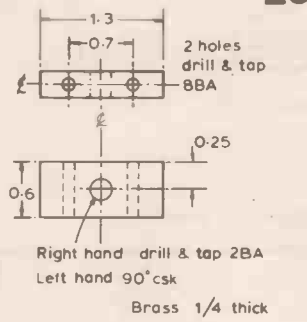
CUE LEVER BASE

19



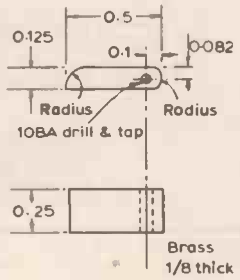
SLIDER

20



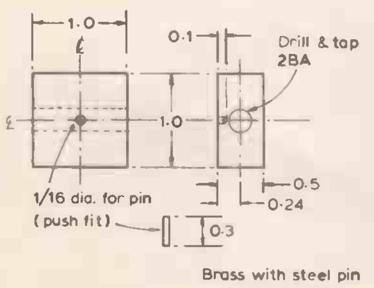
END PLATE (two)

21



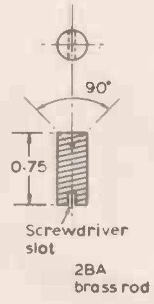
CUE LEVER CAM

22



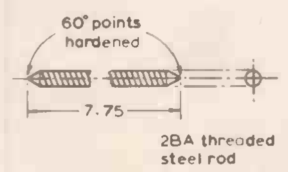
LEAD SCREW COUPLING

23



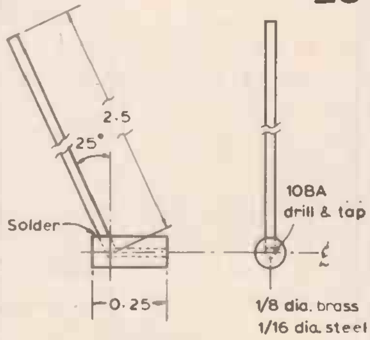
LEAD SCREW BEARING

24



LEAD SCREW

25



CUE ARM

Wiring to the cartridge, opto-switch and filament bulb is made with 3x45swg Litz wire. There seems to be no readily available alternative to Litz wire which is flexible enough for the job. The cartridge and opto-switch wiring is carried inside the tubular tracking arm, exits near the vertical pivot and is firmly clipped to the back of the upper platform. From here the cartridge wiring is kept apart and carried in p.v.c. sleeving to a 16 pin dual in-line plug and socket on the plinth. The opto-switch wiring is combined with the wiring from the bulb and carried in separate p.v.c. sleeving to the socket. This arrangement gives a neat and symmetrical layout and helps prevent the lead-out wires from fouling the gimbals.

The T1¼ filament bulb is rated at 24V 35mA and is run directly from the 20V supply. When under-run like this it has a very long life but does not emit much white light. This hardly matters, as the response of the BPW34 diode lies mainly in the infra-red and matches the bulb's output quite well. An infrared-emitting diode could propably be used instead. The efficiency of the reference arm tube can be improved by polishing the inside surface — bright aluminium has a high reflectivity in the infra-red register.

The T1¼ bulb is the only commonly available bulb which will insert into the standard ¼in diameter tube. It should not be free to move when in place, and wrapping a small piece of adhesive tape round the plastic body of the bulb will make it a firm push fit. Insert so that the filament is vertical.

The cassette motor used in the prototype drew 60 mA on normal play, rising only a few milliamps when running on full rated voltage, but drawing 500 mA when stalled. The output transistors need to be mounted on heat dissipators to avoid overheating when the motor is stalled; though stalling should never take place in theory, it is not unlikley during testing and setting up. Similarly, the short-circuit protection resistor in the BD135 collector circuit should be generously rated.

The relay used was a sensitive reed-switch type with a coil wound specifically for this circuit, but a standard 12V relay could be used in conjunction with a series ballast resistor. The 47kΩ adjustment potentionmeter should be set so that in normal ambient light conditions and with the light slit off the face of the photodiodes, the relay will close. High ambient light conditions may swamp the diodes despite the shroud, and prevent the relay from closing. However this is never likely to occur if the unit is used sensibly, for example away from bright sunlight. A heavily-tinted or even light-tight cover on the record player is recommended.

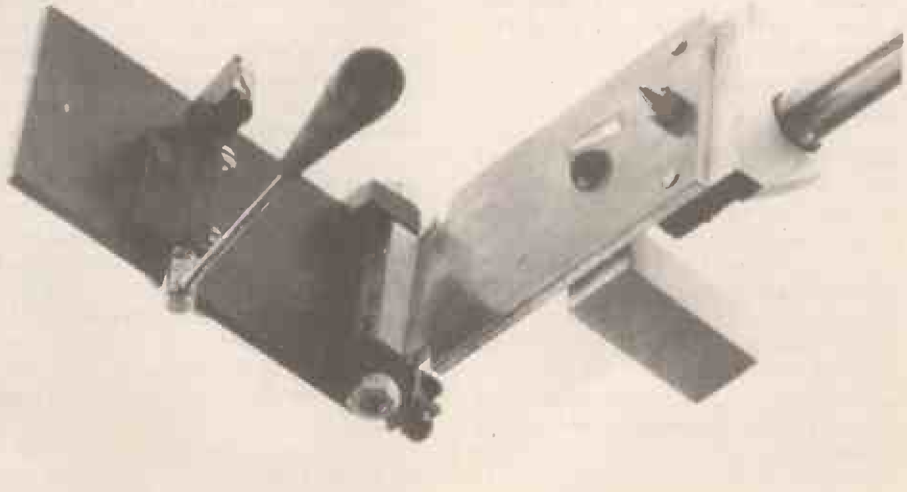
The power supply for the turntable, servo motor and electronics is a 20V stabilized unit capable of giving 1A (my turntable required 350mA peak). As the design of the power supply is by no

PARTS LIST

Raw materials No allowance has been made for wastage during machining.	**Identification**
½in 2BA brass screws	lead screw bearing **23**
8in 2BA screwed steel rod	lead screw **24**
1in plain round brass rod 3/16in dia.	side pivot holder **2**
2BA brass screw	lower pivot **4**
2½in 6BA screwed rod	hinge pivot **15** and vertical pivot pin **5**
½ x ¼in brass shim (say 20 or 22 gauge)	upper pivot bearing **6**
2in plain brass rod ¼in dia.	support pillars **7 & 8**
9½ x 2½in brass plate 3/16in thick	parallel track **17**
4 x 2in brass plate 1/16in thick	upper & lower plates **11 & 12**
2 x 2 x ¼in brass bar	end plate **20**, hinge pivot holder **14**, hinge bar **13**
2 x 1in brass plate ⅛in thick	slider **19**, cue lever base **18**, cam **21**
2in of ⅛in clock spring	slider **19**
1 x 1 x ½in brass block	lead screw coupling **22**
½ x ½ in aluminium angle 2in length	reference arm holder **16**
10in alloy tube, thin wall, ¼in o.d.	tracking arm **9**
5in alloy tube, thin wall ¼in o.d.	reference arm
2½in plain brass rod, dia, to suit i.d.	plug for tracking arm **9**
¼in 10BA steel grub screws	side pivot pins **3**
1¼in 10BA steel screw (or 1/16in dia. rod)	cue lever shaft
¼in plain brass rod ⅛in dia.	cue lever **25**
Short length steel rod (1/16 dia.)	cue lever **25**
10BA screw to suit photocell holder	
8BA ¼in brass screws	
1in brass bar	counterweight
½in length 10 gauge extruded aluminium tube 1in o.d.	gimbal ring **1**
Aluminium sheet, as appropriate	template, Fig. 6, & microswitch plate, Fig. 4.
Aluminium shim, as appropriate	slit & photocell holder

Other essentials
1mA meter movement
6V d.c. reversible electric motor, cassette deck type
Relay — see text
Two small lever-type microswitches
T1¼ 24V 35mA light bulb*
Chassis-mounting 16 dual in-line socket
Wire-terminating type 16 dual in-line plug for above
4 metres Litz wire*
Four pulley wheels to suit motor, lead screw, gears
Matched worm gears and shafts*
Matched pair BPW34 diodes*
Watch oil*

Raw materials and parts marked with asterisk are available from J. Biles. Send s.a.e. for list to 120 Castle Lane, Solihull, West Midlands B92 8RN. Suitable turntable and motor are available from Symot Ltd, 22a Reading Road, Henley-on-Thames, Oxon RG9 1AG



Suggested simplifications for reference arm hinge include avoiding cuts in top plate by making lower plate larger. Gimbal pivot pillars, shown rectangular on page 67, are more simply made from ¼in rod.

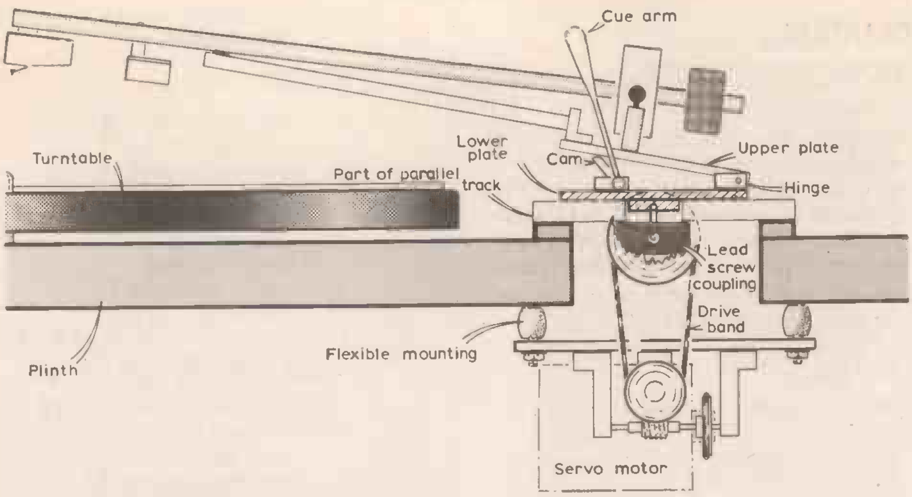


Fig. 5. Assembly details of motor and 100 to one speed reduction (lower portion) are left to individual constructors. Upper assembly is detailed in drawings and Figs. 3 & 4.

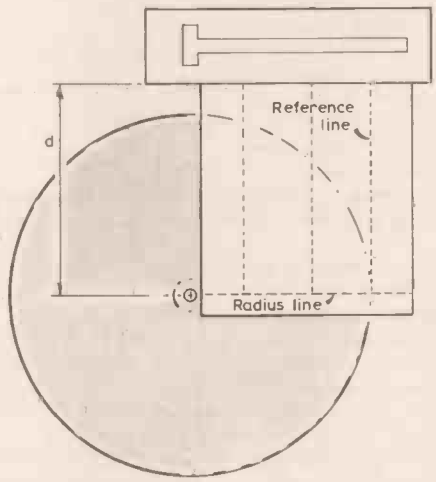


Fig. 6. When properly adjusted a tracking error of 0.2° is corrected in half a second. A set square is needed for scribing reference lines on an aluminium template at right angles to radius line.

means critical it is left to the discretion of the constructor. On the prototype, which had the mains transformer botled to the plinth, it was found that mechanical vibration was finding its way to the tracking arm to give 50Hz hum. Mounting the transformer on rubber grommets cured the problem, but it is perhaps a better solution to have a power supply unit which is separate from the plinth. At least one commercial unit has adopted this approach.

Setting up

With the tracking arm fully assembled with cartridge and counterweight, raise or lower the vertical pivot to produce neutral equilibrium. The horizontal pivots can also be adjusted to help produce equilibrium, and then set in place with Loctite thread-locking compound. With the cartridge resting on a discarded record, the level of the opto-switch is now adjusted to be in line with the light beam, by means of the spacing washer (Fig. 1, part 1), which may have to be filed down or added to in order to achieve this.

A template to check the accuracy of tracking is essential. A sheet of thin aluminium is cut to suit Fig. 6, the corners being checked against an engineer's set-square. Find distance d, which will depend on cartridge position, with the template resting firmly against the front edge of the parallel track. Scribe a radius line at distance d parallel to the front edge of the template, left to right, and then using the set-square scribe several lines for reference purposes at right angles to this radius. Adjust the reference arm by means of the screws securing it to the upper platform so that it is parallel to one of the reference lines on the template. Track the arm fast forward and check that the reference arm remains parallel to the various other reference lines. If there is a discrepancy, the parallel track is not straight, and should be re-filed; fortunately the eye has very good perception of parallelism. When this is satisfactory, and with the opto-switch disconnected, play a record, setting the voltage to the servo motor so that the tracking arm keeps pace with the record, very approximately. Note this voltage.

Now connect the opto-switch and with the record stationary and the sliding platform disconnected from the lead screw, bring the tracking arm parallel to the reference arm. The meter reading should now correspond to that obtained with the opto-switch disconnected. If it is not then either the reference arm must be moved sideways to correct this (and then re-aligned of course) or the opto-switch must be moved in relation to the tracking arm.

As a final check, observe the tracking arm from above as it plays a record properly, and note the changes in meter reading as the servo-system corrects tracking errors. Now is the time to adjust the sensitivity by means of R_f and the maximum voltage to the motor (if necessary), by changing the 13V limiting Zener diode for a higher or lower value as required. The prototype was set to correct an error of 0.2 degrees in about 0.5 seconds, which I found to be adequate. The time taken depends not only on the sensitivity but on how hard one is prepared to drive the servo motor. The amount of noise and vibration generated is naturally small in motors designed for cassette decks, but in the prototype, which used a 6V motor, 5.5V was the optimum voltage, before noise from this motor overtook noise from the turntable motor. □

S. G. Brown, F.R.S.

At the time of his death shortly after the end of the second world war Sidney George Brown F.R.S. had more than 1000 patents for inventions. These included the gyrocompass used by the Admiralty during the first world war, when they wanted to avoid adopting the American Sperry equipment; the tuned-reed headphones, which were so sensitive to weak signals that they were a standard issue for wireless operators; and a loudspeaker. Brown was the son of a family which had already won fame in the USA for proposing methods of preventing a repetition of the fire which destroyed much of Chicago in the eighteenth century.

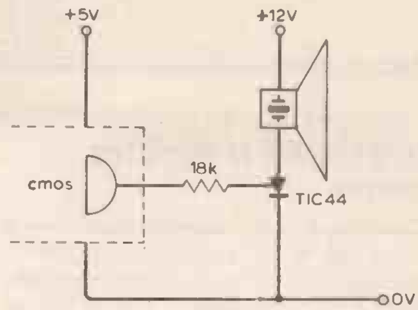
Mr F. P. Thomson, biographer of A. D. Blumlein, is now preparing a biography of Brown. He would like to hear from people who knew the Brown family in the USA or worked for S. G. Brown or his company in Britain and who could give or lend papers, notes, photographs, etc. Mr Thomson's address is 39 Church Road, Watford, Herts WD1 3PY.

C.m.o.s. compatible piezo sounder

Piezo electric sounders are efficient and reliable devices which contain a ceramic transducer and a switching transistor. Although the average current drain is 50mA, the sounder functions as a class C blocking oscillator where the current is pulsed with a peak of 800mA.

It is difficult to switch such a current directly with c.m.o.s. or t.t.l. and a switching transistor would need a wasteful 50mA or so of base current to ensure saturation. Although v.m.o.s. transistors need no drive current they are relatively expensive and have a significant saturation voltage. The simplest solution is a small thyristor which requires a maximum gate current of only 0.2mA. Because the anode current falls to zero between each pulse, the thyristor will turn off unless gate current is present. No gate to cathode resistor is required because a logic low output clamps the gate off.

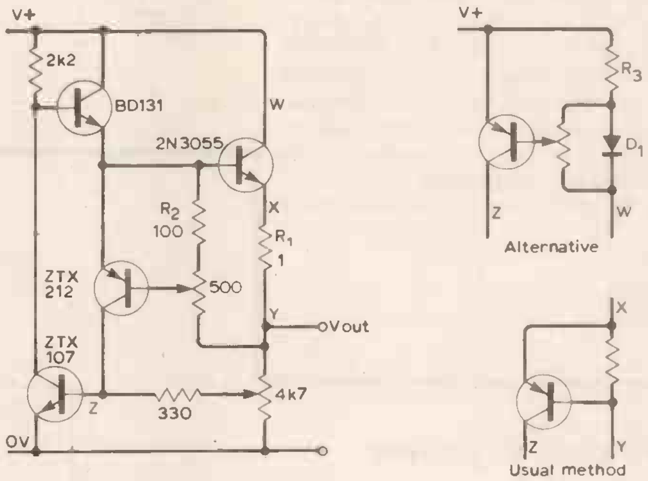
C. Stephens
Woodbridge
Suffolk

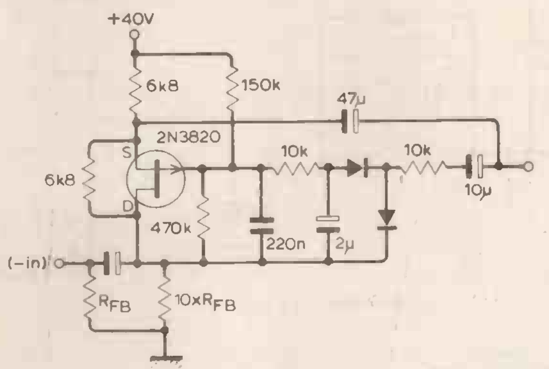


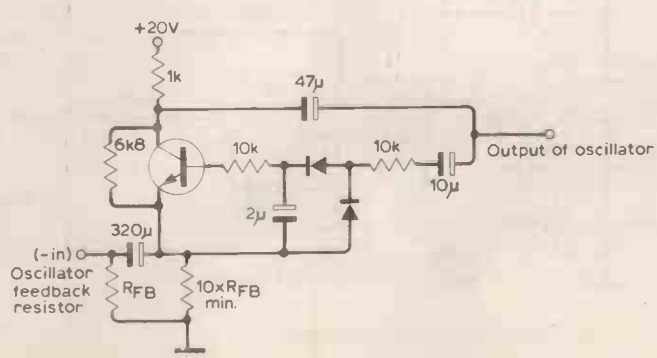
Variable current-limiting supply

This simple power supply offers variable current limiting from 10mA to 3A by using the pass transistor to offset the V_{be} of the protection transistor. Resistor R_1 can have any reasonable value and omitting R_2 allows unlimited maximum current. In the alternative circuit, R_3 and D_1 must be chosen for the maximum current required.

D. Rawson-Harris
Stockport
Cheshire







Thermistor replacement for oscillators

The R53 thermistor is often used in oscillator circuits to stabilize the output and reduce distortion. Unfortunately the device is reasonably expensive and intolerant of accidental power surges. This circuit provides a more stable output than the bridge driven rectifier previously published in *Wireless World.*

In the bipolar version the transistor and diodes can be any general purpose silicon types. The output level can be raised by connecting a Zener diode in series with the emitter. As the output of the oscillator is stabilized to 2.5V ± 5% it should be at least 3.5V r.m.s. before limiting.

If low distortion is important, a similar circuit with a f.e.t. can be used as shown. This does, however, require an oscillator output which at least equals V_{gsc}, i.e. 8V r.m.s. for a 2N3820.

R. Dynan
London

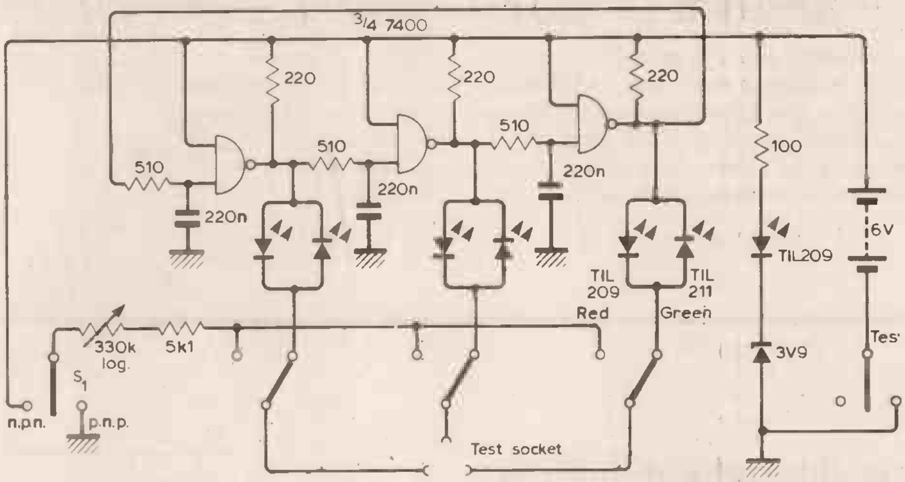
Continued on page 94

CIRCUIT IDEAS

Improved transistor tester

This transistor tester is based on a circuit by N E Thomas in the March 1977 issue of *Wireless World*. Any unknown bipolar transistor can be placed in the test socket and the transistor leads can be in any order. The ring of three oscillator produces a three-phase waveform which switches either two green and one red l.e.d. on for a n-p-n device or two red and one green for a p-n-p type. Other displays indicate a faulty device. By switching S_1 to the appropriate position, the base can be biased via the correct test socket switch. When this has been identified, increasing the base current by reducing the variable resistance turns the collector l.e.d. on first so all three leads are identified. Noting the position of the wiper and the brightness of the l.e.d. gives an indication of the transistors' gain.

M. Odyniec
Podlaska
Poland



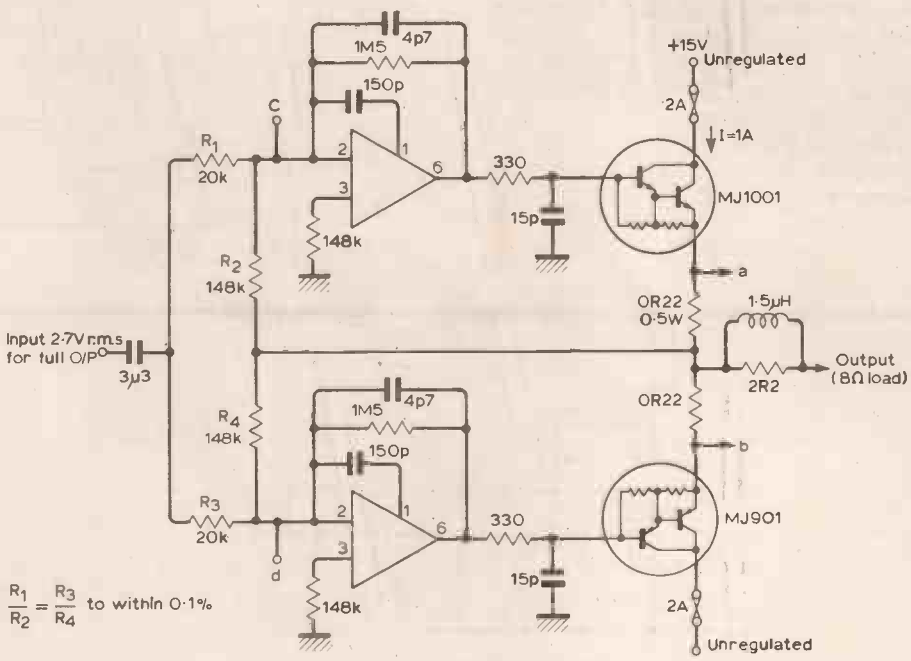
12W class A power amplifier

Almost all of the published audio power amplifier designs have had outputs in excess of 30W. However, there are still many applications where a high quality amplifier with less output is needed.

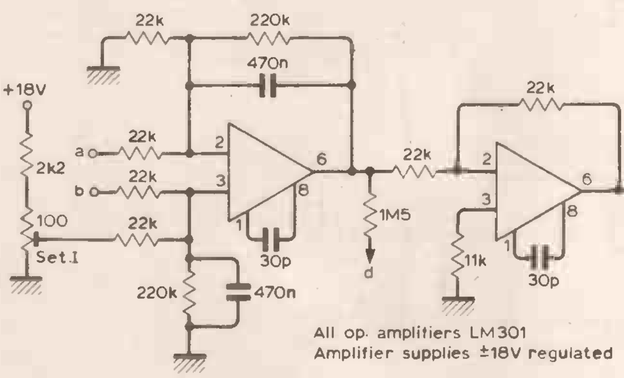
This circuit uses a class A output stage with feedback control of the quiescent current. Two independent amplifiers throughout simplify the circuit and provide a 3 dB improvement in the signal to noise ratio. The necessary trimming of resistors R_1 to R_4 can be achieved by temporarily connecting them in a bridge arrangement. Specification of the prototype is shown below.

Power output into 8Ω	12.5W
Frequency response (−3dB)	5Hz to 225kHz
Output slew rate	10V/μs
Distortion (5Hz to 20kHz, 0 to 10W)	<0.02%
Hum (rel. full power)	−85dB
Noise excluding hum component	−103dB
Stabililty	Unconditional
Output offset without nulling network	15mV

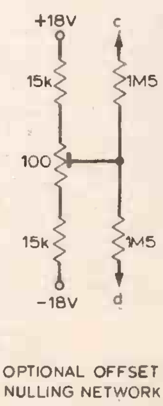
N. Pollock
Victoria
Australia



MAIN AMPLIFIER



QUIESCENT CURRENT CONTROL



OPTIONAL OFFSET NULLING NETWORK

LETTERS TO THE EDITOR

HURRAH FOR TELETEXT

May I, as a television dealer, air my views concerning teletext, which seems to have dominated Letters to the Editor in recent issues?

I feel the first point I must make concerns the letter from Mr Williams in the October 1979 issue. He complains on the one hand that there are not enough pages, and then goes on to add that if there were, he would not have time to read them all. Spelling and punctuation errors, he says, occur frequently but in my opinion they do not occur as often as in some newspapers.

Regarding access time, it takes on average 12 seconds for a page to appear, a little longer on Oracle – not bad for a system that has to ride piggyback on a few borrowed lines.

Teletext is not fading away as some people would have you believe. We dealers must take a lot of the blame for its slow start. My teletext customers are extremely pleased with their sets, which could be due to the fact that we spend over an hour demonstrating the full teletext facilities to them.

I keep wondering why some people wish to change the format of teletext. As far as I am concerned, it offers a very good and comprehensive service the way it is. Teletext sales are on the increase and I feel there is a healthy market developing for the future. So hands off our teletext service, it is the best thing in television for years!

R. J. Timms
Swadlincote
Burton-on-Trent

SIDEBANDS AS PHASORS

The opening remarks of J. M. Osborne's excellent article "Sidebands as Phasors" (September 1979) suggest that Bessel functions are necessary to show that the sidebands of a frequency modulated wave extend to infinity. This is not strictly true for their use is merely a mathematical convenience. The same result can be achieved using mainly traditional trigonometrical methods.

A general expression for a frequency modulated wave (see Terman's "Electronic and Radio Engineering", page 588) is:

$$e = A\sin(\omega_c t + m_f \sin\omega_m t)$$

where ω_c and ω_m are $2\pi\times$ the carrier and $2\pi\times$ the modulation frequency respectively and m_f is the modulation index. This expression can be expanded using the well known "sine–sum" formula to

$$e = A[\sin\omega_c t\cos(m_f\sin\omega_m t) + \cos\omega_c t\sin(m_f\sin\omega_m t)]$$

Thus the problem now turns on finding a simplification for the terms $\cos(m_f\sin\omega_m t)$ and $\sin(m_f\sin\omega_m t)$ and here we must depart into the realms of simple differentiation. Sine x and cosine x can each be expanded in series form (see, for example, Saxelby "A course in Practical Mathematics", page 221) so that:

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} \ldots\ldots$$

$$\text{and } \cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} \ldots\ldots$$

Substituting $m_f\sin\omega_m t$ for x in these two series we arrive at two other series, one with odd powers of $\sin\omega_m t$, and the other with a zero frequency component and even powers of $\sin\omega_m t$. Each has related coefficients in powers of m_f.

The individual terms of each series can be further expanded into fundamental and harmonic components of ω_m. The even indices will produce cosine terms of even harmonics and the odd indices harmonic sine terms, the highest harmonic in a particular term being equal to the order of the index.

For example:

$$\sin^3\omega_m t = \tfrac{1}{4}(3\sin\omega_m t - \sin 3\omega_m t)$$

$$\text{and } \sin^4\omega_m t = \tfrac{1}{8}(3 - 4\cos 2\omega_m t + \cos 4\omega_m t)$$

It is now necessary to collect together terms of similar frequencies and to consolidate their coefficients. We have to substitute these terms back into the original expansion where the cosine terms will be multiplied by $\sin\omega_c t$ and the sine terms by $\cos\omega_c t$. We are now on familiar ground where each term will resemble that of an a.m. wave. The terms will have the form:

$$(\cos\omega_c t)\,.\,\sin p\omega_m t \text{ and } (\sin\omega_c t)\,.\,\cos n\omega_m t$$

where p is an odd integer and n is an even one. The expansion of these two expressions results in:

$$\tfrac{1}{2}[\sin(\omega_c + p\omega_m)t - \sin(\omega_c - p\omega_m t]$$

$$\text{and } \tfrac{1}{2}[\sin(\omega_c + n\omega_m)t + \sin(\omega_c - n\omega_m)t]$$

respectively.

These are, of course, the infinite sidebands of the frequency modulated wave. The carrier term will result from the zero frequency component arising from the expansion of the even powers of $\sin\omega_m t$ and it should be noted that it will have an amplitude depending on a complex function of m_f.

The method is laborious and it does not have the elegance of the more accepted method. However, it may appeal to students who have not progressed far with their mathematics – if they have the time and patience to pursue the complicated calculations. There may also be advantages when the modulating wave is not a simple sine or cosine function as, for instance, in frequency shift telegraphy, although the mind boggles at the intricacy of the ensuing manipulations.

A similar expansion can also be used for showing the infinite extent of the sidebands when phase modulation is employed.

S. F. Brown
Post Office Telecommunications
Rugby Radio Station
Warwickshire

CORRECTIONS

In the second part of J. M. Osborne's article "Sidebands as phasors" in the October issue, several errors occurred on page 68 in Appendices 1 and 2, for which we apologize to readers. In Appendix 1 the expression in the second line (for p.m. of carrier) should read:

$$a\sin(\Omega t + \theta\sin\omega t)$$

The second expression (seventh line) should read:

$$a\sin(2\pi F_0 t + \theta\sin 2\pi ft)$$

In Appendix 2 the first expression (for f.m. of carrier) should read:

$$a\sin(\Omega t + \frac{\Delta F}{f}\sin\omega t)$$

and the second expression (seventh line) should read:

$$a\sin(2\pi F_0 t + \frac{\Delta F}{f}\sin 2\pi ft)$$

Also in Appendix 2 the expression in the middle column of p. 68 for the maximum rate of swing in terms of frequency (11 lines from top of column) should read:

$$2\pi\Delta F = \theta 2\pi f$$

– Editor.

WHAT IS AN ELECTRON?

Neither Dr Theocharis nor Professor Jennison appears to understand the aim of modern physics (Letters, October). This is to discover and systematise useful descriptions of the natural universe as we observe it in experiment. Those descriptions are invariably mathematical and some of them are carefully bounded. Professor Jennison has proposed a model and time alone will show whether or not it is useful. Particle-wave duality must be one of the classic paradoxes and it remains unresolved. Dr Theocharis thinks that most physicists actually believe in a real Jekyll and Hyde electron. Professor Jennison actually appears to do so—and that is his prerogative.

Most modern scientists will be happy to leave these two to fight it out. Paradoxes arise through the inadequacy or incompleteness of mathematical descriptions but that does not itself invalidate those descriptions. One must simply tread carefully in making use of them.

D. A. Ross
Poynton
Cheshire

CITIZENS' BAND AND THE LAW

In November a correspondent criticised you for "supporting" the illegal use of c.b. radio, and his criticism was based on the belief that law-breaking is automatically wrong in any circumstances. Is lawbreaking automatically wrong? Let us hear some eminent views.

> J. J. Rousseau, 1762: "The inflexibility of the laws, which prevents them from bending to circumstances, may in certain cases make them injurious, and bring about in a time of crisis the ruin of the state."
>
> Edmund Burke MP: "It is not what a lawyer tells me I may do, but what humanity, reason, and justice tell me I ought to do."
>
> J. S. Mill, 1861: "There is no ethical creed which does not temper the rigidity of its laws by giving a certain latitude .... for accommodation to peculiarities of circumstances .... it seems to be universally admitted that there may be unjust laws, and that law.

consequently, is not the ultimate criterion of justice."

"There are different degrees of obedience and it is not every degree that is commendable. Only an unmitigated despotism demands that an individual citizen shall obey unconditionally every mandate of persons in authority.

Bertrand Russell: "Individuals who opposed received opinions have been the source of all progress. .... Without rebellion mankind would stagnate and injustice would be irremediable."

C.B. is not illegal because it's wrong but only because the constitution has virtually ground to a halt under the strain of modern life. Within government it is mainly the unelected bureaucrats who are against c.b. and neither the Home Secretary nor the Commons has had time to examine the issue closely because of more pressing matters.

So the bureaucrats rule by default. In respect of this and most other matters we are ruled by what J. S. Mill called "the obstructive spirit of trained mediocrity." This is not democracy; it is not even elective dictatorship; it is pure tea-cup tyranny; and in a tyranny it is morally right to break the law because of the absence of democratic procedures for changing the law.

Mr Pearson says that he is opposed to modification of law by blatant disregard for it, but he fails to understand that the only reason the law is being modified in *this* way is because there is, in practice, no *other* way.

C.B. is only one of many issues which are clamouring for the attention of an overburdened parliament. (For an example of another issue see the remarks of Dr Budworth, News, August 1979, p. 41.) The threat to the rule of law does not come from *Wireless World* but from the lack of parliamentary time to deal with these matters. This problem does not exist in federal countries like Australia and Switzerland;it need not exist here.

The more support that respected journals give to the fight against the tyranny of centralism the sooner that tyranny will be ended and the sooner respect for the law will be restored.

Carry on *Wireless World!*

S. Frost
Dunsyre Lanarkshire

COMMENT IS POLITICAL

I have read *Wireless World* for more than 25 years and paid for it out of my own pocket as, unlike many readers, I do not have the subscription paid by my company. During this period it has served me well and I shall be forever grateful for the technical help and guidance it has provided me with. There have also been delightful moments of humour which have helped to demonstrate that technical people can be human.

However, recently I have noticed a tendency to knock the establishment – whatever flavour it might be. I consider the inclusion of political rhetoric out of place in a journal of the calibre of *Wireless World*: your November editorial was particularly distasteful to me. I take *Wireless World* for many reasons but they do not include being subjected to the political bias of the editorial staff, both in editorials and general content.

Please, Mr Editor, can we return to an apolitical journal – crusades I can accept but political bias no.

J. Greenwood
Chelmsford
Essex

DIGITAL FILTERS

It is with great interest that I have been following the *Wireless World* articles on digital filters ever since the original article by Rees[1]. Having programmed the RC low-pass filter on my H-P calculator, I would like to draw attention to a problem that seems to have been overlooked concerning the testing of these algorithms.

As the algorithm is basically derived from the impulse response via the Laplace transform method, the user is tempted to test it by applying a unit step, and feel satisfied when the desired exponential response is obtained. However, the filter cannot operate meaningfully on any frequency above the Nyquist frequency, while any impulsive type of test signal contains a large proportion of its energy in its high frequencies. Thus the only acceptable test signal must be one containing no harmonics beyond a certain frequency.

When a sine wave was used to test the RC filter it was found to be phase advanced by an amount corresponding to half of one time increment. The amplitude error was 0.16% when there were 10 samples per cycle and the period was equal to RC. To correct the time error a sliding mean was applied. Each sample was meaned with the previous sample before being used (see Fig. 1). The sliding mean can be considered as another filter with a rectangular impulse response whose first frequency null falls upon the sampling frequency (see Fig. 2). The equivalent geometrical procedure is to interpolate the samples as shown in Fig 1. Even so the procedure is not entirely satisfactory as odd multiples of the Nyquist frequency are only attenuated, not removed. The interpolated sine wave had negligible phase error but the amplitude error had increased to 3.5%.

The process is equivalent to using an almost ideal filter on the interpolated waveform and then sampling the output at the original sample rate. Presumably a more sophisticated pre-processor such as for example a filter with a Gaussian impulse response would reduce errors due to residual harmonics.

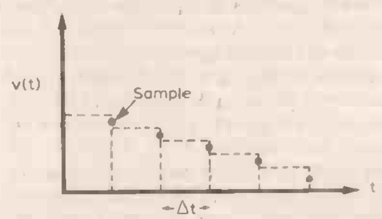


Fig. 1. Replacement of v(t) with ½(v(t) + v(t + Δt)).

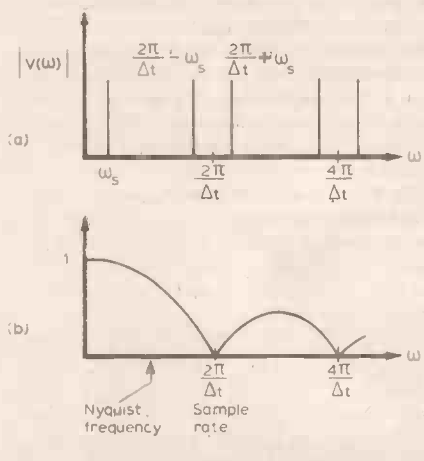


Fig. 2. (a) Spectrum of sampled sine-wave frequency ω_s. (b) Frequency response of sliding-mean pre-processor.

In conclusion, and as Ham[2] points out, aliasing of the input signal is to be avoided if at all possible. Thus, at least for instrumental data there is no entirely satisfactory substitute for an analogue anti-aliasing filter to be applied before any digital processing. For synthetic test data, some digital preprocessing is needed to reduce unwanted harmonics. It seems that digital filters are not necessarily as simple as has been implied in your articles.

W. Gray
Farnborough
Hants

References

1. V. J. Rees, "Digital filter design", *W.W.* Oct 1976 and subsequent correspondence.
2. P. A. L. Ham, "Simple digital filters," *W.W.* July 1979.

PROGRAMMABLE NOTES FOR MUSICAL INSTRUMENTS

Your correspondent M. Robins (November letters) does not seem to be aware that the scale of tuning proposed in his letter was in fact discarded some 250 years ago. Until this time 'just' temperament tuning was the standard, but, as M. Robins says, the problem is that a piece of music sounds very different when played in different keys, some keys being unusable. Bach was a great promoter of 'equal' temperament tuning and composed his 48 Preludes and Fugues as proof that all keys could be used with this tuning method. He even called these pieces "The Well-tempered Clavier". Incidentally, even in 'equal' temperament tuning certain keys sound 'brighter' than others. This is a well known fact amongst musicians who would also consider going back to 'just' temperament very much a retrograde step.

Richard Waters
Leighton Buzzard
Beds

POYNTING VECTOR

Apparently many people find the concept of displacement current useful and some find it distasteful. Not being a member of either group I would normally be prepared to continue as a passive spectator of the fascinating correspondence which has been stimulated by the recent articles on the subject; after all, no-one is suggesting that $\partial D/\partial t$ should be struck out from Maxwell's equations, and presumably no-one is insisting that everyone must believe that there is any physical reality in a current which is said to flow in empty space where there is nothing to carry it (and nothing to be displaced). I would even leave it to others to point out that in Fig. 4 of "The history of displacement current" in your March issue the current *i* will vary continuously between B and B', as is the way with transmission lines, so if you want a continuous "current" you do need a displacement current, not localised at B, but distributed along the length of the transmission line.

However, the excellent iconoclasts Catt, Davidson and Walton have spurred me to action by their uncharacteristically unquestioning use of a concept/mathematical construct which is far less harmless than displacement current, namely the Poynting vector or "energy current" **E×H.** A single example will show what I mean. Suppose I take a battery and connect it to a lamp by a pair of good thick metal wires. Since the electric field is negligible inside the wires the Poynting vector is too. In fact the Poynting vector is mainly localised in the space surrounding and particularly between the wires. By examining the Poynting vector one can validly draw the conclusion that energy flows from the battery to the lamp. One could even, in principle, integrate the Poynting vector over a surface containing the battery or the lamp, but not both, and calculate correctly the rate at which energy flows from the battery to the lamp, but one would be allowing oneself to be blinded by one's own mathematics to deduce from the fact that the Poynting vector is partically zero in the wires and is at a maximum between the wires that the energy flows mainly between the wires and not to any appreciable extent through them.

In case anyone does believe that even in this case the Poynting vector represents a physical energy flow I propose the following experiment. First, interpose a metal screen between the battery and the lamp, insulated from the wires themselves, but fitting as closely as possible, so as not to leave more than the tiniest space for the Poynting vector to squeeze through. Note the effect (if any) on the amount of energy which gets to the lamp. Now take away the screen and make a break (just a little one, mind) in one of the wires. Again, note the effect on the amount of energy (if any) which gets through. A similar experiment could be carried out on telegraph lines, at some inconvenience to the public. If the Poynting vector really represents a flow of energy, the screen should have more effect than the break. After all, what do we mean when we say (if we do) that the energy flows between the wires rather than through them, other than that if we wish to obstruct the flow of energy we would do better, to a first approximation at least, to insert a barrier where the energy flows than where it does not flow.

Perhaps it is time someone did a hatchet job on the Poynting vector along similar lines to that of Catt, Davidson and Walton on displacement current, with the hoped-for result being that it is cut back to its proper size, not that it is necessarily cut out completely. It may be less entertaining (surely not if the same team could be persuaded to take on the job) but the usefulness in actual practice would arguably be greater.

C. M. K. Watts
Western Electric Company Ltd
Woodford Green
Essex

The authors reply:

The last sentence of Mr Watts's first paragraph shows that he does not understand the mechanism for a TEM signal travelling undistorted between two perfect uniform conductors.

We should however applaud, not condemn, those who come out in the open and discuss electromagnetic theory even though their grasp of the fundamentals is weak. CAM Consultants have found that those professors and text book writers who are hiding from the present dialogue, although their professional duty would direct them otherwise, are more ignorant than Mr Watts and the other brave men who are rushing in to the vacuum. CAM Consultants challenge professors of physics and electronics to come out of the undergrowth and start *earning* their salaries by discussing the fundamentals of electromagnetic theory.

Returning to para. 2, if Mr Watts bares his chest to the sun, does he believe that the electromagnetic energy (light) burning his skin is travelling from the sun to him down conducting wires, or through a dielectric?

Paragraph 3 is very instructive. (Why must he leave the "tiniest space"? Why leave a space at all if the conductor is what it is all about?) Our book Electromagnetic Theory Vol. 2 discusses such situations thoroughly, on pages 245 and 319 and elsewhere. Referring again to his second sentence, conventional transmission line theory lets us calculate the mechanism by which energy current rapidly builds up to a high flow rate through a small gap as a result of repeated reflections. The argument somewhat resembles that in the appendix to our article in the December 1978 issue. If in his second sentence, the screen hugs the conductors for a long length (say one mile), creating a long section with very low characteristic impedance, transmission line reflection theory correctly tells us that energy flow from battery to lamp is delayed. More conventionally, this delay would be thought of as an *RC* time constant, the *C* being the narrow gap between conductor and screen for the very long distance. Referring to his sentence 3; once the tiny break in the conductor (which Heaviside called an obstructor) is made, energy current flows through the break and out into the vast space beyond. This space presents a rapidly increasing (characteristic) impedance, causing all the outgoing energy current to be reflected back through the break into the narrow channel through which energy was previously gliding calmly (at the speed of light) from the battery to the lamp. After the initial disturbance of the steady state caused by the breaking of the conductor (obstructor), the lines of energy current gradually, through the mechanism of reflections, settle down to a new pattern where energy (of the same amplitude as before the conductor was broken) flows out of the battery to the gap in the wire, there to be fully reflected back into the battery, in a "continual dance of energy" which Carter dismissed as absurd but CAM Consultants do not. (The Electromagnetic Field in its Engineering Aspects, by G. W. Carter, Longmans 1954, page 321.) If however the break made in the conductor is extremely narrow (and long), it will take time for its existence to become apparent. Very traditionally, this very narrow, long gap in the conductor would be regarded as a capacitor. We should regard it as a transmission line of very low characteristic impedance.

Dealing with his third para. in a lighter vein, one is urged to suggest that it is the "phlogiston" in a balloon material which keeps it doing its job. The absurd theory that it is the air pressure in the space inside which maintains a balloon's femininity can easily be disproved by making a tiny hole in the balloon; too small to let the air out but large enough to collapse any imagined air pressure inside. Alternatively, we can show that the goods travelling in a railway system travel *inside* the rails, or an obstruction across between the rails, *nearly* touching the rails; close enough to leave too little space for the train wheels to get through. This will prove that goods are really piped along *inside* the railway lines and it is absurd to think that the lines merely guide the flow of merchandise.

When all is said and done, however, the acid test is the question of whether the *velocity* of propagation of the energy (/electric) current is a function of the characteristics μ, ϵ of the dielectric or of the conductor. When a seagull (or merely the reflection of a seagull) glides along above (/below) the surface of the water, does its speed depend on the nature of the air or of the water?

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

"TRIVIAL" AMPLIFIER DESIGNS

I find it quite incredible that *Wireless World* should see fit to publish yet another article describing amplification equipment for domestic sound reproduction, in which purely academic distortion levels are pursued virtually for their own sake. The author states that he designed the amplifier with a view to its being "competitive with current commercial designs." Can this really be an altruistic aim? In my experience the second and third harmonic distortion audibility threshold (even where skilled sound engineers and producers are concerned) is in the region of 0.1%. Given that this is so, then an amplifier with second and third harmonic distortion not in excess of 0.1% over its entire bandwidth should sound as good as one with 0.0002% second harmonic distortion, all other factors being equal — entrance slew rate limitations, overload effects, audibility threshold of high harmonics, et al.

A multitude of exotic schools of thought currently abound to extol the 'sound' of polypropylene capacitors, special loudspeaker cables, discrete circuitry, valves, f.e.ts, 'real time' amplification, 180V/μs slew rates, passive equalisation, minimal overall feedback, etc. I challenge *Wireless World* to seek out the truth of this mysticism, rather than to present conventional designs ad-nauseam. I wish to state that I in no way whatsoever wish to depreciate *per se* the designs presented by Douglas Self and B. J. Codd, but rather to suggest that whilst their engineering approaches are interesting, they are really grossly trivial in a world where the allowable second harmonic distortion on a studio tape machine is of the order of 3%, where 70% of record pressings are defective and electromechanical transducers from the cutting head to the loudspeaker are as yet imperfect.

To exemplify: I have recently built Douglas Self's Mk 1 advanced preamplifier design using TDA 1034N op-amps. Using horn-loaded loudspeakers and Crimson Electrik amplifiers in a tri-amplified configuration, I perceive no difference. I am still waiting for my friends to say "Your equipment sounds different." The chances are high that your recently acquired records were mixed in the studio on desks stuffed with 'nasty' op-amps and transformers. Need I say more?

Ben J. Duncan
Tattershall
Lincoln

THERMIONIC DEVICES

I know of nothing more likely to start an argument between historians than that of throwing into the ring a seemingly innocuous statement such as '. . . no doubt that Fleming's diode ushered in the thermionic valve era . . .' (November 1979, p.94).

Dare I suggest that Edison's patent of 1884 (nothing to do with wireless of course) covered a most practical application of thermionics to the control of a generator? For all I know this may also have been the first thermionic closed-loop servo-mechanism to be described. But Edison was very busy inventing hundreds of other things, and can perhaps be excused for not applying his "so-called" effect to wireless, the phonograph, moving pictures etc. as well.

What is most puzzling is that Fleming was apparently so slow off the mark – a whole 20 years before the penny dropped! Of course he had been fairly busy around 1900 combining the more recent ideas of Tesla, Thomson and Marconi into the Poldhu transmitter, a very substantial engineering task; and this may have diverted his mind from developments in Germany, such as Wehnelt's lime-coated thermionic filament also published in 1904 which was incorporated into the Braun-Wehnelt cathode ray tube of 1905. (The same Braun, of course, who later shared a Nobel prize with Marconi.)

In the event it must have been a little humiliating for Fleming that there was not more interest in his thermionic diode (though it may have stimulated the invention of the the crystal detector). The reasons were that the carbourundum detector was simpler and more rugged and the Marconi magnetic detector needed no battery. Thermionics really took off in a more obvious fashion about a decade later, with the advent of better vacua and other technical improvements. In fact, it became important enough for litigation over rights; and though neither side seemed to emerge with much of value, the ruling did confirm Fleming's legal title to his (rather gassy) diode valve.

Desmond Thackeray
University of Surrey
Guildford

MICROPROCESSOR PERIPHERAL ICs

A problem exists in the design of circuits using the latest microprocessor peripheral i.cs. I would like to suggest a solution which, although using one more pin of the package, would require little complication of the i.c.

The problem is evident when several such peripherals interface to the same data bus, and this bus includes one or more sets of bi-directional bus buffers. In order to ensure that these buffers are always driving in the correct direction, the logic designer finds himself duplicating circuitry that must already exist inside the i.c. Some peripheral chips put data on the bus for up to one of three different reasons. To determine the direction of the relevant bus buffer, all these states must be decoded, and ORed together, along with similar lines from other peripheral chips on that section of the bus.

My suggestion is that a 'drivers active' function be brought out to a pin of each bus-interfacing device. Relevant bus buffers could be turned around by a simple OR of these few signals. Even greater simplicity could be achieved if the 'drivers active' lines were open-collector types, a wired-OR then being possible.

I feel sure that this line would also be useful in the debugging phase of microprocessor support circuitry where problems of bus conflicts and floating buses may have to be resolved.

E. J. Board
St Albans
Herts

PRE-AMPLIFIER WITH NO T.I.D.

Potential builders of the Miloslavskij passive de-emphasis preamplifier (August issue) might like to note that its RIAA network is *grossly* in error. Correct design formulae for passive de-emphasis can be found in the literature[1,2]

Stanley P. Lipshitz
University of Waterloo
Ontario, Canada

References

1. Livy, W. H., Disc replay equalizers. Letters to the editor, *Wireless World*, vol. 63, January 1957, p.29.
2. Lipshitz, S.P., On RIAA equalization networks, *J. Audio Eng. Soc.*, vol 27, June 1979, pp458-481.

ELEMENT OR DIAMOND?

While experimenting in television during the "mechanical" period, I realised that the accepted theory of the "picture element", based on the chessboard idea, is a fallacy. I found that a continuously moving spot cannot resolve a picture detail as small as itself; it smudges along the traced line, generating a maximum frequency only two-thirds that calculated by the element-based line-standard formula. This was proved by the failure of the "low definition" broadcast to reach the frequency of 13kHz, the theoretical maximum for a picture with 2,100 elements (30 lines with aspect ratio 3:7) at 12½ pictures a second. Only about 9kHz was achieved, yet the same erroneous formula was employed for the 405-line transmission, and is still the basis of the 625-line standard. "Line" still means "line of elements", with line-pitch "elemental".

My letter in *Wireless World* for July 1961 explained how practical engineers, with a calculated "high frequency" definition to achieve, focus spot-size to half-elemental (4/9) by reducing spot diameter to two-thirds of line-pitch. This is easily proved on any monochrome screen by reducing picture height until the traced lines touch; the closed up lines leave about one-third of the screen dark.

I eventually found a spot shape which forms no visible structure, however large the spot: the "playing card" diamond. Cutting experimental discs (thin black card was adequate) I turned the original square "elemental" aperture on end, then extended it transverse to the scan direction, reducing it along the scan. Each field traced double-spaced lines (which just touched), and alternate lines "interlinked" their lines by half-overlap both ways. Diamond scan exposure tapers uniformly about line-centre, so two interlinking lines conceal structure. The line-free complementary scanning allows diamond size to be chosen for desired definition only, with resolution enhanced by the reduced scanning depth of the diamond.

The ideal "diamond" focus may be impossible electronically, and would be wasted on a 625-line picture. A close approximation is possible by extending the existing half-element spot vertically to points, while compressing it horizontally. The resulting pointed oval, resembling the contracted pupil of a cat's eye, would raise resolution to the standard's limit.

Astigmatic focus has been tried but the "elemental line" taboo seems to have prevented any attempt at elongating the spot sufficiently to achieve complementary overlap. This inexpensive focus correction at camera and receiver would improve definition and remove all trace of visible structure from our screens.

A. O. Hopkins
Worthing
West Sussex

JOHN SCOTT-TAGGART

Your brief, but nostalgic, obituary on John Scott-Taggart (p.55 October 1979) recorded his prowess as an engineer. In his earlier days he was also a formidable showman. From the mid-twenties to the early thirties, thousands of experimenters were persuaded that the 'ST' series of circuits had supernormal powers.

The celebrated 'ST100' offered plenty of scope for compulsive twiddlers, with two tuning capacitors, plug-in coils with variable coupling, filament rheostats and a cats whisker. Although it was an essentially simple reflex arrangement, Scott-Taggart showed real originality in circuit-diagram presentation. Scorning ordinary logic in layout, he produced bafflingly devious links.

One of the figures I have sent you is copied from an 'ST100' diagram, which involved 15 crossed wires. The other one is the same circuit, but as it would more commonly have been drawn 50 years ago – with only three crossovers [Diagrams supplied.—Ed.] The contrast speaks for itself.

C. Leslie Thomson
Kingston
Edinburgh, 16

RADIO AMATEUR INVALID AND BLIND CLUB

May I bring to your attention the change in the title, secretary and address of the Radio Amateur Invalid and Blind Club.

Now celebrating its silver jubilee, the Club is formed of invalid and blind members interested in the hobby of amateur radio; their local representatives who undertake to help by visits, repairs and advice; and supporter members whose financial contributions enable help to be given. The sole condition of membership in any of the above categories is an annual subscription of £1 minimum for *Radial* the Club newsletter which is issued every six weeks.

F. E. Woolley (Mrs)
Hon. Secretary
9 Rannoch Court
Adelaide Road
Surbiton
Surrey KT6 4TE

More on the scientific computer

Further details of the monitors

By J. H. Adams, M.Sc.

After publication of the scientific computer series (April to September 1979) there have been many requests for more information on the firmware. This article describes in more detail the machine code and BURP monitors in terms of hexadecimal machine code. Readers will need a hex print-out of the three p.r.o.m.s and the mnemonic to hex conversion tables published in the July 1979 issue of *Wireless World*.

Several readers have expressed incredulity at the thought of working directly in machine code rather than using assembly language mnemonics. However, the hex codes for 50 to 60 of the most regularly used operations can soon be learnt and, thanks to the logical distribution of codes to operations, many more follow from these. The once-in-a-megabyte ones such as IN D (C), ED 50 in hex, can be obtained from the conversion table. This does not rule out working in assembly language and using an assembler, or translating yourself, but in my experience the latter soon becomes tiresome and it is easier to write in hexadecimal.

When writing software it is useful to have a supply of the forms shown in Fig. 1. The instruction 18, a relative jump, should be pronounced one eight and not eighteen. Similarly, the second byte is one seven and definitely not seventeen. If you want to jump forward with a relative jump, simply make the jump byte the number of bytes (up to 7F) over which execution must move, in this case 17 — 1 row and 7 bytes, to reach the target byte FF. For a jump back to the same target from the second 18, calculate the jump forward code to the next byte immediately under the target, 02 in this case, and then jump up row by row, decrementing the higher order hex character, i.e. from 02, F2, E2. When using a jump back the byte must be in the range 80 to FD (FE and FF serve no useful purpose).

Fig. 1. Typical software form.

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
					18	17									
														FF	
										18	E2				

Work . . . . No . . . . . .

Machine code monitor

Both monitors follow the same basic sequence as illustrated in Fig. 2. With the machine code monitor the base address of the Z80 stack is set, the address for the top corner of the screen is loaded into the DE register pair which is then used throughout the monitor as the destination pointer or vector for v.d.u. operations, and the message READY is printed by the subroutine at 03CE. This is one of several routines in the computer which draws data from the locations directly following the call of the routine. The program counter, which will have been pushed onto the stack, is exchanged with the contents of the HL register pair and then used as a pointer to that data before being exchanged back onto the stack, at the end of the routine, to cause a return to, in this case, 0010. The start procedure then clears the rest of the top line, resets the teleprinter output flip-flop and, using the subroutine at 0355, reads in and encodes a command from the keyboard. As explained in table 1, only the first and last letters are important to the subroutine. Whilst this limits the number of possible combinations which will produce different codes, a byte by byte comparison with a look-up table comprising all of the commands would use far too much p.r.o.m. space. After this has been achieved (001A), a comparison is made and if the code is not FC (the entry code for RUN) executions jump over 0D bytes for a further comparison and so on until a match is found, whereupon a block of instructions is executed before operation reverts to 0000 again.

Table 1. Low level monitor subroutines.

Address	
0254	Sets tape interface tone to 2400Hz and then calls 255 long time delays — about 4 seconds.
0260	Transmits the byte in register A to the tape interface, preceded by a start bit and followed by two stop bits.
027F	Calls a new line and then prints the contents of HL on the teleprinter.
028E	Formats the hex byte in register A for printing as two characters on the teleprinter.
02EC	Prints a space on the teleprinter.
02F0	Calls a new line on the teleprinter.
0301	Prints the contents of the A register on the teleprinter.
0317	List subroutine. Entered at 0317, the starting address must be loaded in from the keyboard. Entry at 031D assumes the address to be at 1FF0 to 1. Entry at 0320 assumes that the address is already in HL.
0336	A programmable time delay. The computer loops through six E3s, a long exchange instruction which, if used in pairs, does nothing but use up time. The number of loops is set by the byte immediately following the CALL in the original program. Each loop lasts 64μs.
0345	Clears the top line and sets DE at 8000.
034E	Used to format results, as in FIND and COR, this rounds DE up to the next multiple of 8.
0355	The algorithm for encoding input commands. Returns with last letter of the command minus the first letter in register A.
0372	The formatter used in LOAD and LIST in machine code language.
0393	Clears the v.d.u., leaving DE unaffected.
039F	Displays HL and a space. Used in LIST, LOAD, FIND, COR and in BURP lists.
03AA	Displays the contents of A as a two character hex byte.
03C4	Calls a new line on the v.d.u. and clears the remainder of the current one.
03CE	Displays the string of characters following the call in the program block up to byte 1D.
03DE	Loads HL from the keyboard.
03E7	Loads A with a hex byte from the keyboard.
03F6	Reads in a single keyboard character and, if a letter adds 6, then truncates to four bit binary (used as part of 03E7).

An exception to this is for the code FC, the routine for which 001E jumps immediately to 0042. This avoids one of the subroutines which have to be located at particular points in the memory map. Several subroutines can be called by single byte instructions which are known in mnemonic form as RSTs. These were originally intended for use with the 8080 and the Z80's "8080 mode" interrupt response which, after receiving the interrupt, calls for the interrupting device to place one or more instruction bytes onto the data bus for execution. Although this mode is not used, the single byte calls are a useful space-saver where a subroutine may be short and often needed. The subroutine which is avoided in this case at 0020 is called by byte E7 and produces a space on the v.d.u. At address 0028 is a jump to a subroutine which would require more than eight bytes. It is intended for use during the testing of machine code programs and when its RST byte EF is inserted into the program by using an ALT, it will suspend the execution of the program and display the contents of the HL, DE and AF registers, the point at which the EF was found, and the last entry onto the stack. Note that whilst there is not a specific subroutine at 0000 the one byte call CF for this address is used as an end command to a program. Although it does not do the same as C3 0000, because the stack is immediately re-defined at 0000, it has the same effect and saves two bytes.

The two interrupts also use fixed service routines. At 0038 is the maskable interrupt routine which reads in and stores number cruncher data using HL as a pointer. At 0066 the non-maskable interrupt's routine services the keyboard, first checking if the computer is at a HALT byte (76) and reading in the keyboard if it is or reseting the computer if it is not (006B is an example of a long relative jump). This particular software does not make use of the control characters available in ASCII except for the RETURN byte 0D, which it translates to 1F. Instead, it blanks off the top three bits of any codes above 3F (mainly the letters) at 007C and moves lower and upper case codes into the area 00 to 1F. This compression of the ASCII code into six bits produces bytes which are compatible with the v.d.u. character generator and this makes writing to the v.d.u., which occurs at many places in the monitors, a simple operation.

Beyond the service routines, the routines for the various operations in table 2 fit end to end up to 0253, with the exception of some unprogrammed space at 0130-9. This space may be used by overprogramming the jump byte 011F-10 and the ten bytes as required. Note that the LIST (01A4) routine is just a call to a subroutine at 0317 because an identical block of instructions are required as part of the ALT routine. As this is the last command code to be checked, the call is conditional on a match so that if the code is undefined, execution passes to 01A9 and a software reset.

Table 2. Machine code routine starting addresses.

002F	FILL	0042	RUN	004D	MOV
0099	LOAD	00F7	PROM	0120	ALT
0113E	ALPH	014D	PRINT	016F	COR
01CD	FIND	0203	TAPE	0226	READ
01A6	LIST				

Table 3. BURP subroutines.

0400	Used in graph plotting. Converts a number stored in 1E00-F to the nearest integral value. Negative values are put to zero.
042E	Executes MM57109 instruction present in register A. The sequence checks that the 57109 is ready, outputs the instruction with the hold off, waits for the ready to go off and then puts the hold on again.
0446	Repeats 042E for the string of 57109 instructions following the call in the main program. The list is terminated by FF.
0452	Jumps over the next word in the program line. Used in FOR statements to miss STEP and UNTIL.
045A	04E6 with BC protected.
0460	Outputs the contents of the 57109 X register to locations 1FF4 - 1FFF and then reformats it into the location specified by the contents of register A at the call, i.e. 1E10 for 01 in A, 1E20 for 02 etc.
04BA	Converts denary digits in the text to binary in register C. HL must be pointing to the first digit which must be in register A.
04D4	Graph plotting routine which scales the variables to be plotted to the screen matrix of 63 × 126. It divides the variable specified by the contents of A, by the declared maximum for that axis, and then multiplies by 126 before outputting to 1E00.
04E6	Jumps any spaces in the text and then analyses the following for (a) operators (04FB) which are converted by algorithm to 57109 code and executed (b) numbers (050F) which are rearranged and then input to the 57109 (c) instructions (054E) which are encoded by algorithm and the result used as part of the address for the location in a look-up table (positioned at the end of the r.o.m.) where the 57109 instruction code can be found, drawn and executed (d) variables (057B) which are foundas in 0460 and entered as a series of 57109 instructions. When encoding words the standard algorithm two times first plus last is used but to compress the range of codes produced, those under 20 have 20 added and those above 50 are reduced by 10. This compressed byte is then added to 07B4 which is used as a pointer to the instruction required. Some instructions need two bytes for their execution, the first being 20, e.g. 24 is SIN but 20 then 24 is SIN^{-1}. These are encoded in the table and detected at 0566 by bit 7 of the instruction being set.
058A	Handles the 57109 $\overline{BR}$ (branch) output which pulses low whenever one of the 57109 test instructions proves to be true. The subroutine starts the execution of the instruction in register A and then reads in the 6-bit data word from the 57109. The four digit out lines are blanked off so that only the READY and BR lines, both initially high, get through (0591). By continually re-reading and jumping back on even parity, the Z80 is effectively waiting for one of these two lines to become active. If it is the BR line the Z80 outputs a NOP to the 57109 because, when tests prove true, the 57109 immediately looks for a new instruction and waits for its completion. If READY became active to indicate a failed test, the last procedure is jumped. Finally, the read in and masked byte which caused the exit from the parity checking loop, stored in register B as part of that loop, is read into A and masked for bit 6 so that the state of this line and hence the zero flag in the F register is set on a successful test.
05A9	With the HL register pointing to a variable in the text, and with that variable in register A, this subroutine computes the variable's address, formats it into 6 bit ASCII in the area 1 E00-F and converts results in the range 0.000 1-99 999 999 to floating point. The byte in the text is checked and, if a digit, is used as the new mantissa digit count to be stored at 1FE0 (063A). Whether or not the contents of 1FE0 are then drawn out, the block from 0641 to 0681 rounds off the figures after the decimal point to the extent indicated by this digit. Blanked figures are replaced by ASCII spaces. The mantissa is then sent to the v.d.u. and the text interrogated again, this time for a comma, which has the effect of suppressing the printing of any spaces and close packs the digits in the number (0693-7). Finally, at 06A3 an E for the exponent is looked for and if found the exponent is displayed. The alternative is three spaces or nothing, depending upon the comma, for floating point numbers.
06BB	Prepares the store area specified by the contents of A using 0714 and then reads in a number from the keyboard, converting standard and non-standard scientific and floating point arrangements to the machines standard format.
0714	Prepares a number store by dumping 9 00s, 6OFs and a 3F. This means that 06BB dump the input data into the store without having to worry about leading or trailing zeroes or the non-existance of an exponent (0Fs being NOPs as well). The 3F terminates number entry to the 57109 as well as being a NOP therefore two consecutive variable inputs to the 57109 do not have to be separated by an ENTER as with reverse polish calculators.
0729	Algorithm for entering words from keyboard (two times first letter plus last).
0736	Inputs denary keyboard digits to binary in C.
074A	Converts A to three digit denary and displays on v.d.u.
076D	Converts A to three digit denary and displays on teleprinter.
07A2	Data for MOD command.
07AC	Forms the address for the start of a variable store area in HL from the variable code in A.
07B7	Displays a number formatted by 05A9 in 1E00-F displaying E for 0B,. for 0A, a space for 0F, - for 0C and ASCII digits for 00 to 09.
07D6	The look-up table for the 57109 instructions.

Table 4. Format for storing and printing three variables.

```
005 LET A=23.45
006 LET B=-0.00733
007 LET C=3.456E33
008 PRINT A
009 END '
0C45
```

1E00	A0	32	33	2E	34	35	30	30	20	20	A0	A0	A0	A0	A0	6F
1E10	02	0A	03	04	05	00	00	00	00	0F	0B	0F	00	01	0F	3F
1E20	07	0A	03	03	00	00	00	00	00	0C	0B	0C	00	03	0F	3F
1E30	03	0A	04	05	06	00	00	00	00	0F	0B	0F	03	03	0F	3F

Table 5. BURP routine starting addresses.

083F	DEL	08C7	MOD	08F7	ADD
0929	LOAD	092F	LIST	0939	DUMP
0977	RUN				
099A	INPUT	09B2	PRINT	09D8	END
09DF	GOTO	09EB	LET	0A04	IF
0A43	WRITE	0A83	ERASE	0A8F	TOP
0A9E	GOSUB	0AAA	RETURN	0AB2	FOR
0AE2	NEXT	0B13	HALT		

From 0254 to 03FF are the subroutines listed in table 1. When necessary, the subroutines PUSH registers to be used solely within the subroutine and then POP them back before the return so that no interference is caused to data within the main program. Most subroutines are self-contained but some, e.g. 02EC, jump on to others for their completion. As subroutines are sometimes called within subroutines, within subroutines etc., the stack storage area, which extends into the r/w.m. from 1FDF, should be left free to at least 1FC0 for the computer's use. Like C7, other space savers will be found in the subroutines, e.g. AF to clear the register A instead of 3E 00, A7 to set the flags according to the contents of A. To save byte space some apparently unnecessary bytes appear, e.g. E3 at the start of the routine at 03C4 is included so that it and 03CE can share the same ending. Care is needed when writing subroutines because with a lot of PUSHing, POPping and EXchanging taking place it is important to ensure that the bytes called back off the stack by the return command at the end of a subroutine are definitely the correct ones. I have found this to be the Z80's most adept way of erasing painstakingly developed programs. This type of error is common when a conditional return is used as in 034E which prints spaces until the lower three bits of DE are zero. Ideally this should have pushed AF initially as it uses A and F, but to also arrange for them to be restored on return would extend the routine to at least nine bytes. The EF described earlier is a very powerful tool for sorting out these problems.

BURP monitor

For the BURP monitor the first p.r.o.m. is solely for subroutines whilst the second contains the operating system which makes use of them. Details of the subroutines are given in table 3. In BURP, program material is loaded from 0C00 on, the area 1E00 to 1E0F is used for the formatting of results to be printed and 1E10-F stores variable A and so on up to 1FB0-F which holds the FOR loop step. Table 4 shows the formatting used for the storage and printing of three different variables. Note that all results are stored scientifically to maintain eight digit accuracy. Although the MM57109 can operate in either mode, it is quicker to stay in the scientific mode and let the Z80 convert the results within the range 0.0001-99999999 to floating point for display.

At 0800 the stack pointer is set and DE is assigned as the screen pointer again. BURP is then displayed and the rest of the top line cleared. The mantissa digit count is set at 04 (0817) and the screen position reset to 8008 ready for the input of a command. 081E to 0823 is harmless nonsense and 0824 to 0837 resets the number cruncher by sending the operation 3F (NO OP) with the hold to the 57109 off, pausing for 8ms and then reapplying the hold. During this sequence the interrupt mode is set but as it is the masked one that is driven by the number cruncher, the somewhat capricious behaviour of the i.c. before it has been reset has no effect upon the rest of the system. The i.c. is then given a master clear (2F) and switched to the scientific mode (22) by a multiple executive subroutine at 0446 (0832).

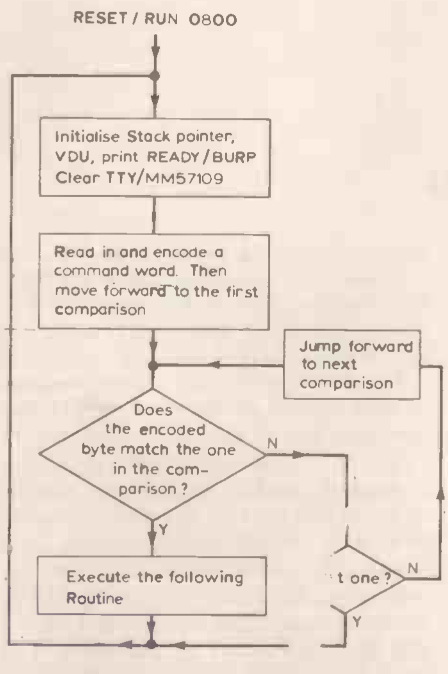


Fig. 2. Basic operating sequence for both monitors.

At 0838 another command encoder is called to read in a command from the keyboard. The algorithm used here is two times first plus last, so once again only two letters are required. However, this algorithm is capable of producing a far greater list of codes and therefore reduces the chance of two words deriving an identical one. As with the low level monitor, routines entered by recognition of this code ensue, see table 5. The start of the last of these, for the RUN command, reads in and encodes the line number input in the command and stores it in register C. The v.d.u. pointer is then set to 8040, the start of the second line, and C is decremented, pushed, popped, incremented and then pushed again. Four of these operations might seem to do nothing to C and on this occasion they do not. The total effect is to store the current line number on the stack. When the execution of a line is completed however, the next line number can be computed and saved by returning to 097F. After GOTOs, when A will hold the next line number, a pop to remove the old number followed by a jump to 0981 will load this as the next line to be executed. As all lines will terminate by jumping back to one of these locations (except for END which returns to 0800), to avoid absolute jumps (i.e. jumps to specific addresses), relative jumps to these two critical points are string out through the third p.r.o.m.

A line of BURP is stored as the hex byte ED, the line number in hex, the actual data in modified ASCII and then the byte 1F to signify its end. The end of the memory block in use is signalled by the byte C0. With the commands ADD, DEL, DUMP, LIST and RUN involving line numbers, the interpreter scans the program block up to C0 and looks for ED followed by the line number in question. During a RUN the next word in the line is encoded using the two times first plus last algorithm (0993) and again, the routines for all of the commands are strung end to end and each is preceded by an immediate compare and a jump-on-not-zero (20 hex). The last command, HALT, compares at 0B0F and if a match is not made the computer jumps over the single byte 76 of the HALT routine and goes on to the next line by executing several relative jumps back to 097F. This explains why there is no routine for REM as it and any unrecognised first word on a line is just

Table 6. New features of the improved firmware.

General
V.d.u. cursor on all modes.
DEL delete last character on all modes.
RETURN available in graphics mode.
Interface for ASR or KSR teleprinter (as printer and/or punch).

BURP
Extended IF statements. Any statement may be conditioned by IF.
Mathematical capability available in IF, FOR PRINT, WRITE, GRAPH and AXIS statements.
Printed strings in INPUT as well as PRINT statements.
Multiple statements — virtually unlimited numbers of statements may be written against a single line number. This speeds execution and expands the effective statement capacity well beyond the 254 lines.

Extra maths functions;	ABS	makes current result positive
	INT	blanks digits following decimal point
	FRAC	blanks digits preceding decimal point
	RND	places pseudo-random number into the MM57109

No need for LET at the start of LET-type lines.
' in a line, causes the computer to ignore the data following, up to the end of that line (alternative to REM).

Hardware changes required
The wiring of several spare keys.
The teleprinter interface shifted from D_7, to D_0, and 55V reduced to 5V.

P.r.o.m. required
Complete with the graph plotting firmware, this will still fit into three 2708 e.p.r.o.m.s.

ignored (the very requirement for REM). Throughout the monitor the register pair HL address the program block contained from 0C00 onwards, whilst B and C are available for general use within the execution routines.

Subroutine p.r.o.m.

As far as possible, subroutines have been written which can be called in many different places within the interpreter. This particularly applies to 04E6 which can be thought of as a basic text handler which recognises and deals with words, variables, numbers and operators.

In the next part a new monitor will be described, the features of which are given in table 6. I would like to thank all of the readers who have contacted me with suggestions for extra facilities and I hope that the new system will meet their requirements. Lists of the new firmware will be available from *Wireless World* (editorial department) upon receipt of a large s.a.e. and these will be a useful accompaniment to the details in part two.

The author is offering a set of three p.r.o.ms programmed with the new monitor hardware for £30. Alternatively, existing p.r.o.ms can be reprogrammed for £6.50 (both plus 35p post and packing).

Micro show is bigger

Personal computers are prominent among the systems to be displayed and discussed at the Microsystems '80 conference and exhibition, January 30 to February 1. Sponsored by *Wireless World* and associated electronics and computer journals, this annual event has grown in size to such an extent that it has had to be moved from its hotel venue to the Wembley Conference Centre (opening hours, 0930 to 1800 hours each day).

The 1980 conference has a four-part programme ranging from an introduction to microprocessors to an overview of the latest developments in microelectronics. Topics include: technology update, micro processor software, controlling microprocessor projects, microprocessor applications, bridging the hardware/software gap, and microprocessors in process control. The conference will concentrate on personal computers on its third day.

There will be buyers' forum sessions to help people in selecting goods and services, and a one-day appreciation course to introduce managers to the use of microprocessors in business and industry. Delegates' fee for the conference is £145.50, including v.a.t. and booking forms are obtainable from the organizers, Iliffe Promotions, Room 821, Dorset House, Stamford Street, London SE1 9LU (telephone 01-261 8113). The exhibition, with some 110 stands, is open to all at no charge, whether or not the visitor is a conference delegate.

Literature Received

Reference sheets on the world's **electronics industry** produced by Mullard, showing exports, consumption, production of a variety of products. Sheets can be obtained from Mullard, Ltd, Mullard House, Torrington Place, London WC1E 7HD. WW401

Leaflet on the ZIP KDP **computer terminal**, comprising 30ch/s dot-matrix printer, keyboard and v.d.u., can be had from Data Dynamics, Data House, Springfield Road, Hayes, Middx. WW402

Fourteenth edition of **Intel News** contains descriptions of an 8086 single-board computer, 1Mbit bubble memory and other items of interest in the computing field. Intel Corp (UK) Ltd, 4 Between Towns Road, Cowley, Oxford OX4 3NB. WW403

Solid-state relay applications manual on specification, preotection circuits, loading and failure modes, with typical circuits, is available from Hamlin Electronics Europe Ltd, Diss, Norfolk IP22 3AY. WW404

Full ordering information on the component parts of the Elma **collet knob** range is available in broadsheet or wall-chart form from Radiatron Components Ltd, 76 Crown Road, Twickenham, Middx. WW405

Signal-conditioning amplifiers in the SE 990 series are described in a leaflet now available from Spur Road, Feltham, Middx, TW14 0TD. WW406

Data for meteorologists, oceanographers, and ecologists can be collected by sensors on ships, without attention from the crew, collated by a **data collection platform** and transmitted to a satellite for retrieval. The McMichael platform is briefly described in a new leaflet from McMichael Ltd, Wexham Road, Slough, Berks SL2 5EL. WW407

Leaflet from Astralux gives full details of 8000 series of opto-coupled, **solid-state relays** in 10, 20, 30 and 40A versions. Sales department, Astralux Dynamics Ltd, Brightlingsea, Colchester, Essex CO7 0SW. WW408

Selection of test equipment for **logic-testing** is presented by Electroplan in a four-page leaflet, obtainable from Electroplan Ltd, PO Box 19, Orchard Road, Royston, Herts. SG8 5HH. WW409

Various types of **panel meter**, counters, printers, etc., are described in a 48-page catalogue, produced by Techmation, Ltd, 58 Edgware Way, Edgware, Middx. HA8 8JP. WW410

Brochures on the American Crown (Amcron) range of **audio equipment** can be had from the sole UK distributors, HHB PA Hire and Sales, Unit F, New Crescent Works, Nicoll Road, London NW10 9AX. WW411

A collection of tools for **bending and cutting** component leads and for handling i.c. packages is detailed in a Wybar catalogue from Eraser International Ltd, Unit M, Portway Industrial Estate, Andover SP10 3LU. WW412

Top marks in one clear sweep.

You'd expect a Sweep Function Generator from Feedback to contain a lot more features for your money. And you'd be right – the SFG606 with its crisp frequency marker does just that.

It sweeps up to 4 decades of frequency – bi-directionally. So you can avoid problems of transient effects. It maintains low signal distortion with absolute precision over the entire sweep range. It features a choice of decade or octave sweep – so it's ideal for narrow band analysis. It provides sine, square or triangle outputs over the frequency range 0.01Hz to 1MHz.

And with that beautifully sharp, fine line frequency marker that gives you accurate determination of spot frequency on the display, the SFG606 really does score top marks. Read all about the SFG606 and all its companion test instruments in the Feedback 600 range. Send to Feedback for literature today.

Feedback Instruments Limited

Or contact our distributors

electroplan

P.O. Box 19, Orchard Road, Royston, Herts. SG8 5HH. Telephone: Royston 45145.

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

The new SFG606 passes even the testiest tester's test.

WW — 014 FOR FURTHER DETAILS

there are transformers and...

Drake Transformers

OEM — let Drake Transformers advise you on a component specification and design to solve that special problem. Pre-production prototypes and development undertaken as necessary.

Well known over a quarter century for personal service and high-quality products, Drake specialise in the design and manufacture of transformers and other wound components for large and small quantity production.

Expertise and service put DRAKE TRANSFORMERS in a class of their own.

DRAKE TRANSFORMERS LIMITED
South Green Works Kennel Lane
Billericay Essex CM11 2SP
Telephone: Billericay (02774) 51155
Telex: 99426 (prefix Drake)

WW — 062 FOR FURTHER DETAILS

Two-metre s.s.b. and f.m. transceiver—4

Alignment procedure and operating notes

by **G. R. B. Thornley**, G2DAF

For satisfactory alignment the following test instruments will be required: a c.w. signal generator; an absorption wavemeter; an AVO Model 8 or equivalent; a diode probe valve-voltmeter; a digital frequency meter; and an audio oscillator.

It is advantageous to test and align as many units as possible before final assembly in the chassis, so the following instructions will be based on this method. Initially, each unit should be connected to a stabilized power supply, set to 12.7V, with a milliameter in series to monitor the current drain and to ensure that there is no short circuit or fault condition on the circuit.

S.s.b. generator unit

Connect the power supply, still set to 12.7V, to the +12V TX terminal post on the s.s.b. generator board and wire an external 1-pole, 2-way switch in place of S_{1a}, with the pole connected to the power supply. Check that there is 9.1V feeding Tr_4. Set the slider of R_{11} to mid position and connect the diode probe of the valve-voltmeter to the test point TP. Adjust the core of L_5 for maximum carrier output – this will be in the range 0.3 to 0.5V r.m.s. Operate the temporary switch S_{1a} to select crystals XL_1 and XL_2 in turn, and ensure that they are both oscillating at approximately equal amplitude.

Remove the valve-voltmeter probe and connect the digital frequency meter via a 5pF series capacitor to the test point TP. Switch to the l.s.b. crystal and adjust C_{30} until the crystal is on exactly 10,701.5kHz. Next, switch to the h.s.b. crystal and adjust C_{32} until the crystal is on exactly 10,698.5kHz. (The author found that additional 20pF capacitors, C_{29} and C_{31}, were necessary for the crystals used in the prototype, and these were soldered across C_{30} and C_{32} on the etched side of the p.c.b.) The i.f. gain is determined by the gate 2 potential of Tr_1 and Tr_2. Initially, set the R_2 slider to mid position. Unbalance R_{11} by turning the slider to one end of the track, and adjust the cores of L_4, L_3 and L_2 for maximum r.f. output, monitoring by connecting the diode probe of the valve-voltmeter to the input connection of the s.s.b. filter (junction of C_{44} and R_{30}). Disable the carrier oscillator by removing the 12V connection to the temporary switch and ensure that the valve-voltmeter indicates a zero reading. If this is not the case, the i.f. stages Tr_2 and Tr_1 are unstable, and R_2 requires adjusting to reduce the gate 2 potential of the transistors until stability is ensured.

Reconnect the 12V supply to the temporary switch and balance the diode modulator by adjusting R_{11} and C_{18} in turn to the point at which the valve-voltmeter indicates zero reading. Note that C_{18} is not connected by the p.c.b. and must be connected by a wire link to one side of R_{11}. If adjusting C_{18} does not improve the modulator balance, transfer the link to the other side of R_{11}.

With a short length of screened cable running along the top of the p.c.b., connect the "A out" terminal post to the "A in" terminal post. Transfer the valve-voltmeter probe to the "I.F. out" terminal post (output side of C_{91}). Connect a microphone to the "Mic" terminal post and adjust R_{25} for maximum gain. If all is well, a whistle into the microphone will produce an s.s.b. signal and will deflect the pointer of the valve-voltmeter to approximately 0.25V r.m.s.

Connect an 8-ohm loudspeaker to the circuit, transfer the 12.7V supply to the +12V amplifier terminal post and adjust R_{57} for exactly 6.35V at the junction of R_{60} and R_{61}. Open circuit the wire link between the test point TP and the ground plane, and connect the AVO, on the 1,000mA range, in lieu. Adjust R_{75} for a quiescent Tr_{13}, Tr_{14} collector current of 20mA. Set the audio signal generator to 1.5kHz and zero output, and connect it to the "A in" terminal post (connection to C_{69}). Advance the audio generator output to 100mV r.m.s. while watching the AVO reading, which should increase to 250-300mA. A clean undistorted note, at full volume, should be heard from the loudspeaker. Reduce the audio drive to about 100mA collector current and swing the audio generator output frequency from 300 to 3,000Hz. The sound amplitude should remain approximately constant and without distortion at any frequency. Remove the AVO and reconnect the link.(Note that R_{75} is soldered across D_{13} on the etched side of the p.c.b.)

Temporarily bridge the "A out" terminal post of the demodulator (junction of R_{44} and C_{64}) to the "A in" terminal post of the audio amplifier using screened cable. Connect the 12.7V power supply to the +12V RX terminal post, check that the source rail is at 3.3V and set the a.g.c. rail to 5.5V by adjusting R_{65}. Set the wiper arm of the balancing potentiometer R_{45} to mid position, connect the signal generator, set to exactly 10,700kHz to the "IF. in" terminal post (input to C_{92}) and advance the r.f. output until a 1.5kHz tone can be heard from the loudspeaker. Adjust the cores of L_9, L_8 and L_7 for maximum output while progressively reducing the signal generator output to avoid overloading the demodulator and the audio stages.

Make a screened-cable link from C_{62} to the drain of Tr_9, on the underside of the p.c.b. and temporarily connect R_{62} and R_{63} to a 1mA-movement S-meter. With no signal generator input, set the S-meter to zero by adjusting R_{63}. This will alter the a.g.c.-line potential because R_{63} and R_{65} interact, so it will be necessary to reset R_{65}. Repeat the two adjustments until the S-meter reads zero and the a.g.c. reads 5.5V. Set the signal generator output to 10mV and adjust the core of L_{12} for maximum S-meter reading. Reduce the signal generator output to 100µV. If all is well the meter should give about an S9 reading. When the transceiver is completed, R_{66}, which controls the S-meter sensitivity, can be set to obtain an S9 reading for a 50µV two-metre-band signal.

Reduce the signal generator output to zero, and the S-meter should return to zero. If it does not do this, it means that the carrier oscillator output is leaking into the i.f. amplifier. Connect C_{65} to one side of the balanced-modulator potentiometer, R_{45}, and adjust R_{45} and C_{65} in turn to balance the modulator and obtain a zero indication on the S-meter. If adjusting C_{65} does not improve the balance, remove the link and connect C_{65} to the other side of R_{45}. While making these adjustments ensure that the correct h.s.b. crystal (10,698.5kHz) is switched into operation. If balance cannot be fully obtained and C_{65} is at full capacity, wire a 25pF ceramic capacitor across C_{65} on the underside of the p.c.b. and readjust C_{65}.

F.m. generator unit

Connect a 100µA f.s.d. S-meter to the SM terminal post of the f.m. generator board. Turn the i.f. gain control, R_{81}, to

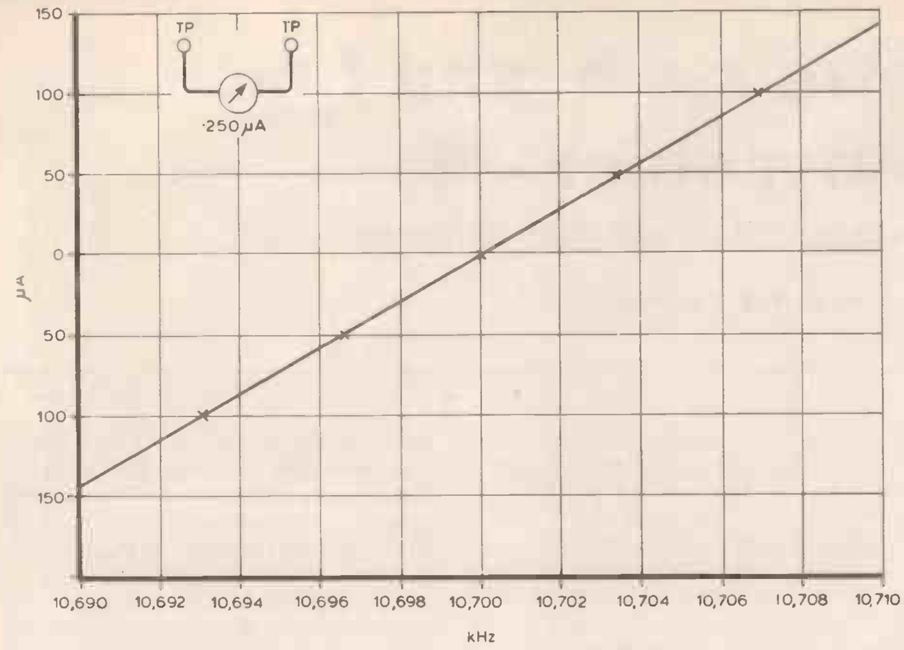


Fig. 18. S-curve for the CA3089E f.m. crystal discriminator

maximum, and inject exactly 10,700kHz, from the signal generator, into the "F.M. in" terminal post, at a level that starts to deflect the S-meter. (Note that the meter will read approximately 50μA with no signal input.) Adjust the cores of L_{14} and L_{15} to obtain maximum S-meter reading. At the same time as the tuned circuits are brought onto resonance, reduce the signal generator output to avoid overloading the i.f. stages.

Set the signal generator input to obtain an S-meter deflection of three-quarter full scale and connect the digital frequency meter in parallel with the signal generator so that the frequency can be monitored. Connect the AVO, on the 250μA range, to the two test points TP adjacent to IC_1. If the meter does not show a reading, reverse the connecting leads. Check that the meter is indicating 10,700,000Hz and carefully adjust C_{111} until the AVO reading falls to 0μA. Carefully alter the generator frequency until the AVO reads 50μA and make a note of the frequency. Repeat for 100μA and 150μA and note these frequencies too. Go back to the 0μA reading and reverse the AVO connecting leads. Set the frequency until the AVO reads 50μA, note the frequency and again repeat for 100μA and 150μA. Plot the readings taken on graph paper to obtain the crystal discriminator S-curve. This should look like the graph shown in Fig. 18, and it should be noted that a signal deviation of plus or minus 10kHz produces a detector output of plus or minus 150μA. The curve should be symmetrical about the 10,700kHz centre, and have straight lines indicating low distortion. Note that the crystal XL_3 must be cut for series resonance operation.

Connect the valve-voltmeter probe to "FM out" terminal post, and the +12V supply to the "+12V TX" terminal post. Set the slider of R_{101} to give maximum gate 2 voltage, and adjust the core of L_{19} for maximum r.f. output. Remove the valve-voltmeter and connect the d.f.m. to "FM out" terminal post. Adjust the core of L_{20} until the carrier crystal XL_4 is exactly on 10,700,000Hz. Note that crystal XL_4 must be cut for parallel resonance operation.

Wire the microphone to "Microphone in", and high impedance headphones to "Mod out". Set the slider of R_{117} for maximum audio gain. Speak into the microphone, and if all is well this should produce low-level crisp, clean audio in the headphones.

Phase-lock v.c.o. unit

The alignment instructions for the phase-lock v.c.o. unit assume that the three p.c.b.s and the MC7805 regulator have been assembled in the screening box, and the l.e.d. indicator D_{29} connected to C_{203} and C_{204}. All interconnections should be made, and supply and switching terminal posts wired to the appropriate box via 1,000pF feed-through capacitors. Measure the output voltage of the MC7805 regulator and ensure that this is 5.0V.

With a soldered link, short circuit TP_1 on the v.c.o. p.c.b. to the groundplane in order to disable the oscillator Tr_{30}. Apply the signal generator output to TP_2, and connect the valve-voltmeter probe to "RF out" terminal post. Set the signal generator to 134.3MHz and adjust the core of L_{24} for maximum r.f. output. Transfer the valve-voltmeter probe to "V.C.O. out" terminal post and adjust core of L_{23} for maximum r.f. output.

Wire an external single-pole two-way switch S_2 to C_{169} and C_{170} and +12V terminal posts. With a two turn link, couple the absorption wavemeter to L_{25} and set wavemeter to 62.5MHz. Set external switch S_2 to the position that will connect XL_5 into circuit, and adjust core of L_{25} for maximum r.f. output. Set S_2 to connect XL_6 into circuit, and with the wavemeter set to 63.0MHz ensure that the circuit is oscillating at approximately the same amplitude. Switch back and forth a number of times to be sure that each crystal "fires" first time – it may be necessary to slightly re-adjust the core of L_{25}. With XL_5 oscillating and wavemeter set to 125MHz, couple the two-turn link to L_{26}, and adjust core of L_{26} for maximum output. Set the wavemeter to 126MHz, switch to XL_6 and ensure that the r.f. output is approximately equal to 125MHz. If necessary, slightly readjust the core of L_{26}.

Connect the d.f.m. to test point TP_3, and with trimmers C_{171} and C_{172} trim each crystal as near as possible to the required frequencies 125,000kHz and 126,000kHz. Note that crystals for amateur use are normally supplied to a frequency tolerance of ±0.005% and it may not be possible to pull XL_5 and XL_6 completely on to the required frequency. Finally operate S_2 a number of times, and ensure that both crystals operate without hesitation and without frequency jumping. Remove the d.f.m. and connect the signal generator, set to 9,300kHz to test point TP_4 and the valve-voltmeter probe to "I.F. out". Adjust cores of L_{28} and L_{29} for maximum r.f. output.

Set the AVO to the 10V d.c. range, connect to "D.C. out" and observe reading which should be 4.9V. Remove the short-circuit link from TP_1 and the AVO should now read 0.85V. With the external switch S_2, select the 125MHz crystal and connect the signal generator, on 9.3MHz and 500mV r.f. output, to "V.F.O. in". Screw the core of L_{21} completely into the winding. The AVO will now read 4.9V. Slowly unscrew the core of L_{21} until the AVO indication drops from 4.9V to 2.9V. At this point the indicating l.e.d. will light. The loop is now locked.

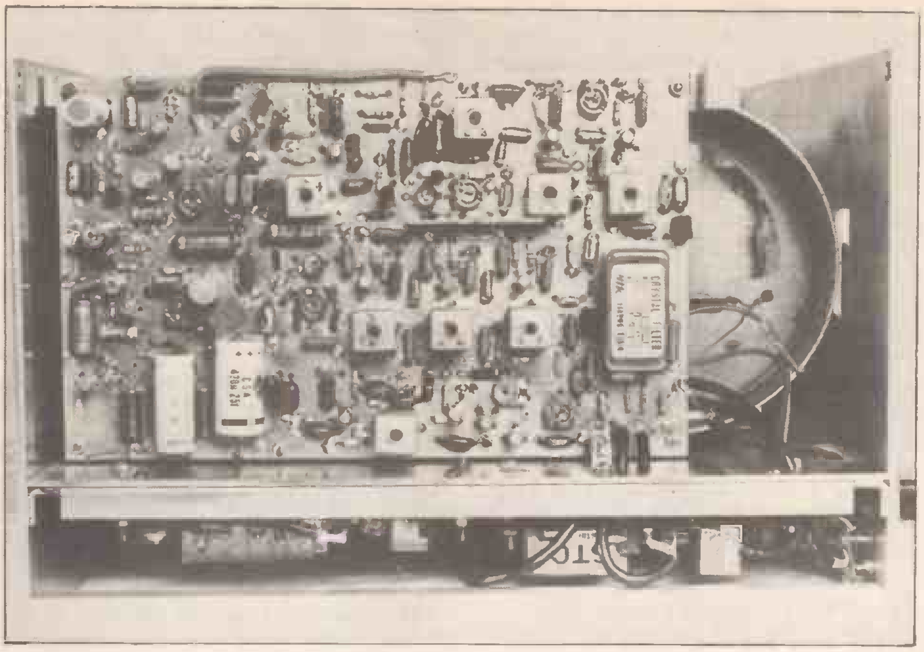
Operate the external switch S_2 to select the 126MHz crystal. The AVO should now read 4.5V and the l.e.d. should remain lit. Select the 125MHz crystal and tune the signal generator to 8.3MHz. The AVO should now read 1.6V with the l.e.d. illuminated. Switch to the 126MHz crystal and the AVO should read 2.9V with the l.e.d. illuminated.

It will be noted that with the 126MHz crystal selected and the v.f.o. (signal generator) input of 9.3MHz, the loop control voltage is 4.5V falling to 2.9V with a v.f.o. input of 8.3MHz. Swing the signal generator across the 1MHz tuning range and the control voltage will follow in step, within the above limits. Select the 125MHz crystal and repeat. The control voltage will follow in step within the limits of 2.9V to 1.6V.

As a final check of reliable phase-lock loop operation, short circuit the "I.F. in" terminal post to chassis earth. This should cause the AVO reading to change to 4.9V and the l.e.d. to cease illumination – loop unlocked. Immediately the short circuit is removed, the AVO should revert to its original reading and the l.e.d. should illuminate – loop locked. Switch the 12.7V power supply on and off a number of times, and check that the loop always locks reliably from switch on, at any 8.3 to 9.3MHz input frequency.

For reliable operation the v.f.o. input should be not less than 500mV r.m.s. The i.f. input at "I.F. in" will only appear when the loop is locked, and this, measured with the valve-voltmeter diode probe, will be in the range 0.6 to 1.2V r.m.s., depending on the v.c.o. operating frequency (133.3 to 135.3MHz).

Note that it is important that the v.f.o. input drives Tr_{39} and the i.f. input drives Tr_{40} as shown. If these input connections are reversed the MC4044P phase detector will be disabled and the loop will not lock.



Transceiver with top chassis rail removed to show detail of the s.s.b. generator p.c.b.

V.c.o. amplifier unit

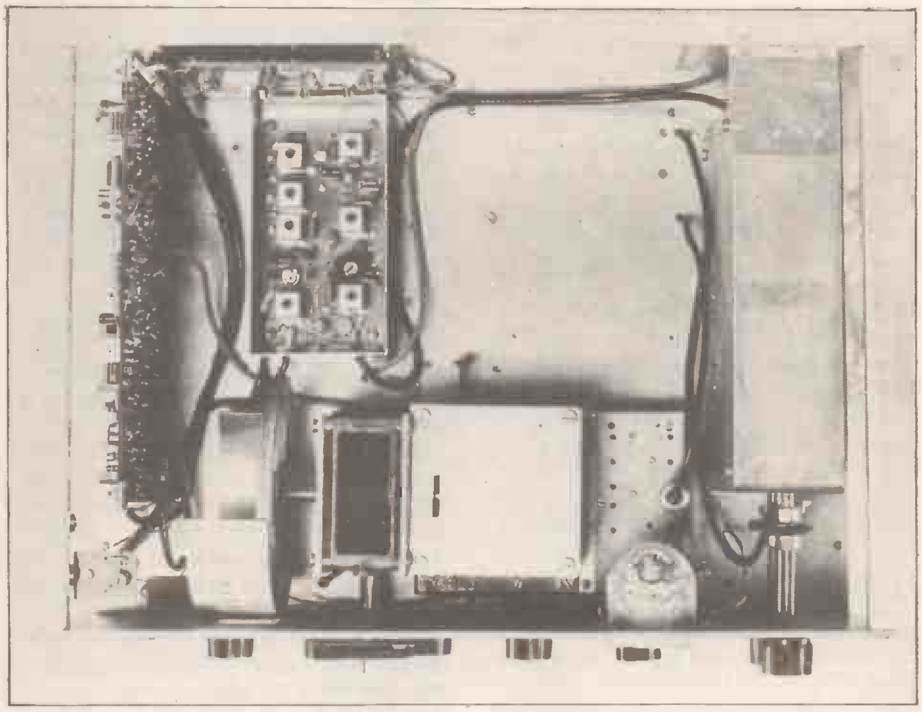
Connect the signal generator set to 134.3MHz to "V.C.O. in", and the valve-voltmeter probe to "Out RX".

Adjust cores of L_{30} and L_{31} to obtain maximum r.f. output. Transfer valve-voltmeter probe to "Out TX" and check that both readings are approximately the same. The measured output should be in the range 500 to 700mV r.m.s.

V.f.o. unit

These alignment instructions assume that a 100:1 ratio gear drive is being used (i.e. 50:1 for 180 degrees rotation of C_{222}) and that 40 turns of the tuning knob will change the v.f.o. by 1,000kHz, equal to 25kHz per turn.

Fully mesh the vanes of C_{222} and mark a reference point on the drum dial. Turn the tuning knob two complete turns clockwise. Mark a calibration point on the drum dial and number 0. This is 0kHz and is the start of the tuning drum scale. Now turn the tuning knob 40 complete turns, mark the calibration point on the drum dial and number 1,000. This is 1,000kHz and is the end of the v.f.o. tuning range.



Top view of the transceiver showing, left to right, the s.s.b. generator p.c.b., the transmit-converter p.c.b. with screening box, the reduction drive gear box and v.f.o. assembly, and the power amplifier screening box

Unscrew the cores of L_{33} and L_{34} so that they are outside the windings. Check that there is 8.5V feeding Tr_{45}, Tr_{46} and Tr_{47}. Connect the "V.F.O. out" terminal to the d.f.m. and with the dial at 0kHz adjust the dust core of L_{32} for an output frequency of 8,300kHz. Turn the drum dial to 1,000kHz and adjust C_{220} for 9,300kHz. These two adjustments interact with each other, and must be repeated until the d.f.m. readout is correct at each end of the tuning range. Once this has been achieved the drum dial can be calibrated each 100kHz with main divisions, and every 25kHz for intermediate divisions. Finally the tuning knob circumference is divided into 25 equal sections and numbered 0 to 24 so as to provide a calibration mark every 1kHz.

Disconnect the d.f.m. and replace with the valve-voltmeter probe and measure the r.f. output at 8,300kHz and 9,300kHz. The two readings should be approximately equal and in the range 0.9 to 1V r.m.s. (unloaded value). Set the v.f.o. output to 9,300kHz and screw in the cores of the low-pass filter L_{33} and L_{34} equally until the valve-voltmeter reading just begins to reduce. At this point unscrew each core by one turn. Alignment has been undertaken without any biasing potential on D_{31}. When in normal operation with R_{190} connected to the "Calibrate" control, the mean potential on D_{31} will be about 2V and this will reduce the capacitance by approximately 10pF. The v.f.o. can be brought back to correct calibration by re-adjusting C_{220}.

Receiver converter unit

Because a second signal generator is required for the heterodyning input (133.3 to 135.3MHz) to the receiver converter unit and the transmitter converter unit, it is at this stage an advantage to complete the construction by installing and wiring all units and panel controls in the main chassis – with the exception of the power amplifier.

Connect the valve-voltmeter probe to the "HET in" terminal and check that the input level is 500 to 700mV r.m.s. Set slider of R_{211} to mid position, and tuning dial to 144.9MHz. Couple 100mV output from signal generator via a two turn link, to L_{39} and adjust the transceiver tuning knob until a 1.5kHz tone can be heard from the loudspeaker. Adjust cores of L_{40} and L_{41} for maximum S-meter reading. Transfer the link to L_{38} and adjust C_{249} and C_{244} for maximum S-meter reading. Couple the signal generator to the aerial input socket and adjust C_{242} and C_{237} for maximum meter reading. As each circuit is brought into resonance reduce the signal generator output to avoid overloading the following stages.

Re-set R_{211} as necessary to give equal voltages at source connection of Tr_{51} and Tr_{52}.

Transmit converter unit

Fit a TO-5 clip-on heat sink to Tr_{56} and bend the vanes as necessary to clear the screening can of L_{52}. Check that the emitter potential is 0.15V indicating a collector current of 15mA. This is not critical and can be in the range 10 to 20mA. If outside these limits it will be necessary to withdraw the p.c.b. and adjust the value of R_{224}.

Set the transceiver tuning dial to 145MHz. Connect the valve-voltmeter probe to "HET in", and check that the input level is in the range 500 to 700mV r.m.s. Set the slider of R_{216} to mid position. Connect 75ohm dummy load to "RF out" via two feet of coaxial cable, with the valve-voltmeter probe in parallel with the 75ohm load. Set the dust cores of L_{49} and L_{52} so that each core is just level with the top of the screening can. Connect the signal generator, set to 145MHz, to test point TP_6. Operate the "press-to-talk" switch and adjust trimmers C_{276}, C_{277}, C_{281} and C_{282} for maximum output. Unscrew cores of L_{48}, L_{47} and L_{46} for maximum adjust C_{276}, C_{277}, C_{288} and C_{282} for any improvement in output. Transfer signal generator to test point TP_5 and adjust cores of L_{48}, L_{47} and L_{46} for maximum output.

Disconnect the signal generator from the test point TP_5. Connect the audio signal generator to the "Mic" input socket on the front panel, via a 40dB attenuator (1 megohm series arm, 1k-ohm shunt arm). Set the audio generator to 1.5kHz, operate "press-to-talk" switch and advance the audio output to drive the converter until the valve-voltmeter just begins to show a reading. Adjust cores of L_{45} and L_{44} for maximum output. As the circuits are brought into resonance reduce the audio drive to ensure that the following stages are not overloaded.

Finally adjust R_{216} for equal Tr_{53} and Tr_{54} source voltage.

Power amplifier

On the power amplifier, first check that the damping resistors R_{230} and R_{233} have been wired across the r.f.cs. to the bases of Tr_{58} and Tr_{59}. Unsolder the link between C_{288} and C_{289} and replace with a milliameter wired to extension leads. Connect the +12.7V supply to the +12V terminal. Adjust value of R_{227} to obtain Tr_{57} collector current of 10mA. Reconnect the link between C_{288} and C_{289}.

Unsolder the link between C_{303} and C_{314}. Connect stabilised 20V supply to C_{303} with the milliameter in series and adjust value of R_{229} to obtain Tr_{58} collector current of 40mA.

Connect a 20V supply to the +20V terminal with the milliameter in series. Adjust value of R_{232} to obtain Tr_{59} collector current of 90mA. Reconnect the link between C_{303} and C_{314}.

Assemble the amplifier in the die-cast screening box, install in the main chassis, and complete all connections.

Connect a 75ohm dummy load via a two foot length of coaxial cable to the junction of L_{66} and C_{312}, with the valve-voltmeter diode probe in parallel with the 75ohm load. Wire a suitable ammeter in series with the 20V supply. Couple a 1.5kHz audio tone into the "MIC" socket via a 40dB attenuator. Set the output of the audio generator to zero and operate the "press-to-talk" switch. Tr_{58} and Tr_{59} should be drawing the combined quiescent collector current of 130mA.

Set all trimmer capacitors and Tr_{59} tuning and loading capacitors to half value. Advance the audio generator output to drive the transmitter until a reading just begins to show on the valve-voltmeter. Adjust C_{283} and C_{284} for maximum output and immediately tune up C_{310} and C_{312}. Adjust C_{300}, C_{301}, C_{290} and C_{291} in that order. As the circuits are brought into resonance the ammeter reading will rise. Initially do not allow it to rise beyond 500mA by progressively reducing the audio drive as required. Now increase the drive from the audio generator to the maximum intended. which should be about 1.5 amps from the 20V supply and quickly re-adjust all capacitors for maximum r.f. output because they are all sensitive to the power level at which the associated transistor is running.

Disconnect the audio generator and plug the microphone into its socket. Whistle into the microphone to obtain a full output reading on the valve-voltmeter, and at the same time reduce the microphone amplifier gain with R_{25} (on the s.s.b. generator p.c.b.) until the power output just begins to drop.

At full output (single tone) expect a reading on the valve-voltmeter of 30 to 35V r.m.s. across a 75-ohm dummy load.

Set the "MODE" switch to the "FM" position, and adjust R_{101} (on the f.m. generator p.c.b.) until the power output just begins to drop.

Note that the continuous power output capability is limited by the available heat sinking. During the first weeks of operation it is a wise precaution to use a 20V power supply with an indicator ammeter. This enables the collector current of the power transistors Tr_{58} and Tr_{59} to be continuously monitored. If at any time the (zero signal) standing current starts to rise, it means that the transistors are being overdriven and denotes the onset of thermal runaway, (i.e., the dissipation is exceeding the capability of the heat sinking). Switch off immediately to allow the transistors to cool. Adjust the i.f. gain controls R_2 (s.s.b.) and R_{101} (f.m.) as appropriate to give some reduction to Tr_{58} and Tr_{59} power levels.

S.s.b. generator unit a.g.c. performance

Signal Input µV	Signal Input dB relative 1µV	A.g.c. Line (volts)	Audio Output relative that at 10µV signal mA	Audio Output relative that at 10µV signal dB
0		5.5		
10	20dB	4.4	20	0dB
100	40dB	3.9	27	+3dB
1,000	60dB	3.5	30	+3.5dB
10,000	80dB	3.2	33	+4dB
100,000	100dB	2.9	35	+5dB

Test procedure

1. Signal generator on 10,700kHz connected "IF in" terminal post.
2. A.g.c. volts. AVO 8 on 10Vd.c. range.
3. Audio output, AVO 8 on 100mA a.c. range in series with loudspeaker.
4. Source rail, 3.3 volts. (2.7V BZY88 zener).
5. R_{68} set at mid position (110 ohms).

It will be noted that the change in audio output is within 2dB for a change in i.f. input of 60dB and within 5dB for a change in i.f. input of 80dB. This represents very acceptable receiver i.f performance.

Dust core locking

It is most important that all the dust cores are an interference fit in the former and will hold their setting, and the material used must hold the core firmly but must not become solid, in case re-adjustment should be necessary at some future date. Before commencing alignment it is recommended that the screwed threads of each core and former are smeared with zinc ointment (obtainable from any chemist). The author has used this method for many years without any problems.

Operating notes

It is worth noting that the transmit output from the f.m. generator unit is a c.w. carrier and the frequency modulation on the final 144 to 146MHz signal is derived from the v.f.o. Deviation is controlled by the microphone amplifier gain control potentiometer R_{117} (on the f.m. generator p.c.b.), and, in the absence of a deviation meter, this can be set to accepted amateur band requirements by "on-the-air" reports. The "CALIBRATE" control – nominally set at the mid position – will provide the required reference bias of 2 volts for the varicap diode in the v.f.o. unit.

For a final check on s.s.b. carrier attenuation, connect the "Aerial" output socket to a 75ohm dummy load with the diode probe of the valve-voltmeter in parallel across the load. Set the valve-voltmeter to the 1.5 volt range and remove the microphone from its socket. Operate the "press-to-talk" switch, and if there is a reading on the valve-voltmeter this denotes carrier leakage. Carefully re-balance the transmit modulator on the s.s.b. generator p.c.b. by adjusting R_{11} and C_{18} in step, until there is zero reading on the valve-voltmeter.

For the c.w. operator, transmission is conveniently effected by keying an outboard transistorised 1kHz audio oscillator fed into the microphone input socket.

Both the receiver converter unit, and the transmitter power amplifier will work equally well into a 50ohm aerial system.

Modifications

As a result of more than two years "on-the-air" experience, two modifications have been incorporated to improve the s.s.b. operating convenience. These are as follows:

1. Wire a 10μF 10V capacitor across the end pins of R_2 on the printed circuit side of the s.s.b. generator p.c.b. This delays the gate 2 potential of Tr_1 and Tr_2 and prevents the transmission of a small "splash" of carrier caused by the switching transient when relay RL_1 changes over from "receive" to "transmit".
2. Relay RL_2 has a spare set of contacts which can be used to speed up the receiver a.g.c. recovery time, for those operators who like fast "break-in" operation. Connect the pole (pin 12) to chassis earth and the by-pass contact (pin 13) to chassis earth via a 47μF 25V capacitor. With a length of PVC-covered connecting wire routed along the fold of the chassis rear apron, connect pin 13 to gate 2 of the a.g.c. amplifier Tr_{17} (junction of R_{71} and R_{72} on the etched side of the p.c.b.) This modification shorts down Tr_{17}'s gate-2 potential to zero when transmitting, and prevents the switching transient feeding from the 10.7MHz i.f. amplifier into the a.g.c. system at high level.

Conclusion

This transceiver has been designed to provide a high level of performance on both transmit and receive, together with a high standard of reliability and convenience of operation.

For the f.m.-only operator, construction can be greatly simplified by omitting the s.s.b. generator unit. Repeater operation on any channel in the 145 to 146MHz section of the band can be provided by installing two crystals 300kHz apart, in the phase-lock unit. (That is, 63.0MHz and 62.7MHz giving heterodyne frequencies of 126.0MHz and 125.4MHz.) The switching lines can be taken to a spare set of contacts on the change-over relay RL_2, so that 126.0MHz is selected on "receive" and 125.4MHz on "transmit" for normal repeater operation. If reverse repeater operation is also required, it is only necessary to add a panel-operated, 2-pole 2-way switch and wire this so that the crystal switching lines can be reversed.

Because there is ample information in textbooks and other literature on stabilized power supplies, detailed constructional details have not been given. The two units used by the author incorporate simple series stabilization using BDY20 transistors with the usual BC108 and BZY88 reference diode, and have proved to be entirely satisfactory.

All prospective constructors are strongly advised to use – with the exception of the surplus S.T.C. 445-LQU 901B FM filter specified – only first class new guaranteed components and transistors.

Richard Thornley spent almost a lifetime in the electronics industry and during the last 20 years, before retiring in December 1977, worked for the Pye/Philips Group commissionining and planning v.h.f. wired television systems. He has been a licensed radio amateur for 41 years and is mainly interested in research, development and construction — particularly in the field of s.s.b. Richard is well known in the amateur movement for his many technical articles which the Radio Society of Great Britain published from 1959 to 1973. Among his many designs is a patented simple method of operating tetrode valves as linear power amplifiers for s.s.b. transmission, without the use of conventional bias and screen power supplies.

Notes on Part 3. Component suffixes for L_1 to L_{14} in Fig. 11 are incorrect and should read respectively: 53, 54, 55, 60, 57, 56, 59, 62, 61, 58, 63, 64, 65 and 66. C_{228} in line four of p78 should read C_{288}. Fourth line of last column on p79 should read "... die-cast box are mounted vertically at either end of the chassis platform, and the squelch unit is mounted vertically on the rear panel." Caption to Fig. 16 on p80 refers to Tr_{58} and Tr_{59} and not Tr_{227} and Tr_{228} as shown. Component suffixes for C_{50} to C_{54} in Fig. 17 are incorrect and should read respectively: 200, 206, 203, 204 and 193. **A table of d.c. voltage checks for this transceiver will be made available on request.**

Books Received

Manual of Avionics, by Brian Kendal, is said by the publishers to enable the layman to acquire a working knowledge of radio navaids, but to have as its primary aim the detailed analysis of electronics in civil aviation for the professional reader. The author, however, maintains that he has steered a middle course between the elementary and the mathematical analysis.

The book is certainly of interest to the layman, and is written at this level: it will probably not be of great help to the professional for the reasons given in the author's introduction — it is simply not possible to perform both tasks in one book. At the layman's level, it is extremely detailed, comprehensive and authoritative, if one bears in mind that the 'avionics' of the title is restricted to communications and navigational aids, including radar.

A short historical chapter, which manages to cover everything from Clerk Maxwell to cavity magnetrons in 26 pages, is followed by seven chapters on air traffic management, radio telephony and direction-finding, short-range navaids and radio landing systems, radar, and the hyperbolic systems and Doppler navigation.

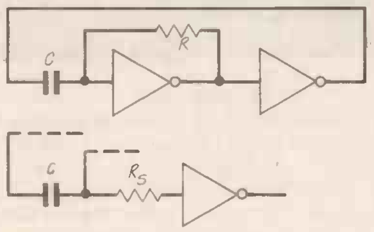
For anyone interested in gaining a fairly superficial (in professional terms) idea of the control and navigation of civil aircraft, the book can be highly recommended for its comprehensiveness and authority — the author is Senior Air Traffic Engineer of the Civil Aviation Authority. It is published by Granada Publishing, PO Box 9, Frogmore, St. Albans, Herts. at £10.

A Window in the Sky, by A. T. Lawton, is concerned with the possibilities opened up for astronomers by the use of equipment outside our atmosphere. In contrast to many works on astronomy, the book is not only immensely detailed and factual, it is also a 'good read.' Mr Lawton puts the case for extra-terrestrial instruments, discusses the techniques for putting them there and examines several possible 'sites' in space. When all the equipment is in place, there is then the problem of what to investigate and, after a detour into the physics of integrated circuits and optical and radio telescopes, the rest of the book is a survey of some of the astronomical phenomena already known and others only guessed at. The book is published in hardback by David and Charles, Brunel House, Newton Abbot, Devon, at £6.50.

Astables: Logic gate circuits

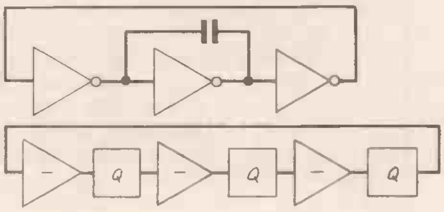
by Peter Williams, Ph.D. Paisley College of Technology

CMOS ASTABLE: DUAL INVERTER



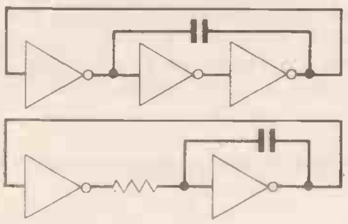
A widely quoted astable circuit using inverters from the c.m.o.s. logic family is shown, using one capacitor and one resistor. A modification using a second resistor R_s is also well-known but R_s plays no part in the frequency control; rather it isolates the protective diodes at the inverter input from the voltage step applied via the capacitor, thereby protecting the input and preventing the diodes from conducting heavily and disturbing the frequency. Because only two passive components are needed the circuit seems not to conform to any of types I to V (December issue). It does, however, contain a differentiator as in type IV and though the amplifier gain is much less the behaviour should be similar in this respect. The other amplifier has an inverting gain of relatively small magnitude and this corresponds to the see-saw amplifier of type IV. Hence this apparently new circuit is in fact type IV whether the inverters be c.m.o.s., t.t.l. or e.c.l.

CMOS ASTABLE: TRIPLE INVERTER



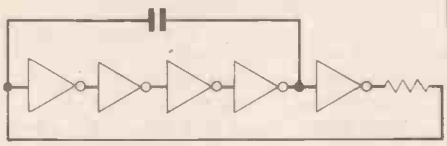
Another common form of astable circuit quoted in the literature uses three inverters and a single capacitor with no passive resistors. It is sometimes described in terms of a three-phase oscillator. Such circuits are used as sinusoidal oscillators with 60° phase-shift per stage and with feedback or attentuation to limit the gain of each stage such that oscillation is not excessive. The present circuit is then argued to be a development of this with one external capacitor to define a longer time constant and hence lower the frequency. It is not then clear how the other inverters contribute to the response and the circuit certainly seems quite different from types I to V. It is unwise to press arguments based on sinusoidal response too hard when applied to switching behaviour and vice versa. The absence of a passive resistor does not mean that the circuits have no resistance. The output slope resistance of a c.m.o.s. invertor is quite high and the maximum current may be limited to < 1mA. Hence to compare the circuit with one based on op.amps it has to be visualized with a resistor at each output.

ALTERNATIVE INTERPRETATION



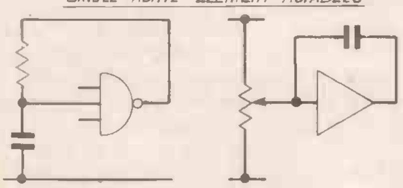
There is a simple change tht suggests a different interpretation of the circuit and allows it to be classified as a known type. The circuit is simply redrawn with the capacitor appearing to shunt two of the cascaded inverters rather than one. This involves no actual change since the capacitor *is* still connected across the single inverter — it is merely a changed appearance. The two cascaded inverters are equivalent to a single high-gain, non-inverting stage and, adding a resistor at the output of the first stage to represent its output resistance, the circuit is now seen to be functionally identical with type V. An inverting amplifier of finite gain drives a non-inverting amplifier with capacitive feedback via a resistive path. It is important to try re-arranging unfamiliar or difficult circuits to see if various sub-sections become recognizable. Many circuit diagrams have a layout that suits the whims of a designer or the convenience of a draughtsman; they have to be made to serve the understanding of the user.

MULTI-INVERTER ASTABLES



Other apparently more complex astable circuits can sometimes be simplified readily. In the circuit shown the cascaded inverters become equivalent to either a high gain inverting or non-inverting amplifier depending on whether an odd or even number of inverters is employed. Once this is noted, then this circuit is obviously a type V astable again. As in the previous circuit the external resistor offers a considerable advantage — the resulting time constant can be very large and hence the frequency can be very low while using only a small value of capacitance. If the resistor is omitted the frequency also becomes strongly dependent on supply voltage via the variation in output resistance of the individual devices composing the inverter. The multiple delays in the cascaded inverters limit the upper frequency of oscillation but the high gain makes lower frequencies less dependent on parameter variations. Such circuits are not recommended for stable frequency clock generators, a task normally performed by crystal-controlled oscillators.

SINGLE ACTIVE-ELEMENT ASTABLES



Astables can also be devised that use only a single active circuit and correspond to types I and II. In some logic families Schmitt circuits are already available often with more than one input. These add the AND function to the switching action. The circuit with the unused inputs inhibited beaves like an operational amplifier with series positive feedback and the signal applied to the inverting input, i.e. when the output is returned to the input via an RC section it becomes a type I astable. When the output is positive the capacitor charges until it reaches the upper threshold voltage, switching the output to zero and discharging the capacitor back toward the lower threshold. The op.amp. and potential divider in type II comprise a non-inverting amplifier of finite gain. If the combination is replaced by a non-inverting logic buffer an astable action should again result. The missing factor is that the circuit must have a quiescent state in the capacitor's absence that brings it into the linear region. A grounded resistor is not valid for a logic gate, and is here replaced by a potentiometer. When set in the linear region oscillations commence — an additional series resistor can be used to set the frequency.

Astables: Logic gate circuits

THEORY

● Both gates must enter their linear region for the loop gain to reach unity and initiate regenerative feedback. If these regions correspond to a small range of input voltages centred on $V_S/2$ the analysis is simple. For low-gain inverters both the waveforms and frequencies are less precise. It is assumed that input conduction is avoided (or minimized) as shown.

Under these conditions the outputs are anti-phase square waves with the transitions occurring as the differentiator input passes through $V_s/2$. On the positive going step this input is driven up to $V_s/2 + V_s = 3V_s/2$. At that instant the other end of the resistor is taken down to zero. Hence $V_1 = -3V_S/2$ while $V_2 = -V_S/2$

$$t_2 - t_1 = \tau \log_e 3 \approx 1.1\tau$$

The second part of the cycle has the differentiator input driven to $V_S/2 - V_S = -V_S/2$ while the other end of the resistor rises to V_S. Hence $V_1 = 3V_S/2$, $V_2 = V_S/2$ giving an identical time interval.

$$\text{Hence } T = 2\tau \log_e 3 = 2.2\tau$$

If the circuit is interpreted as a phase-shift circuit using analysis as for a sinusoidal response, invalid results are obtained.

● The modified form of the circuit has an inverter with a voltage-gain $\gg 1$. Hence its output is saturated for most of the timing cycle, and though type V in structure, a modified analysis is required. Again the thresholds are assumed to be close to $V_S/2$ and the CR junction is driven to $3V_S/2$ and $-V_S/2$ on the transitions.

This leads to comparable values of period and frequency, viz $T \approx 2.2\tau$

Second-order effects are important at high frequencies where gate delays modify the response. In each case an additional large value resistor should be added in series with any gate/inverter input subject to voltage steps going outside the supply lines.

● The first-order response is identical with that of the previous circuit. The Schmitt trigger is assumed to have upper and lower threshold voltages V_U and V_L. The time for the rising ramp is

$$t_2 - t_1 = \tau \log_e \left[\frac{V_2}{V_1}\right] = \tau \log_e \left[\frac{V_S - V_L}{V_S - V_U}\right]$$

$$\text{and for the falling ramp } \tau \log_e \left[\frac{-V_U}{-V_L}\right]$$

$$\text{The period is } T = \tau \log_e \left(\frac{V_S - V_L}{V_S - V_U}\right) + \log_e \left(\frac{V_U}{V_L}\right)$$

$$\therefore T = \tau \log_e \left[\frac{(V_S - V_L)V_U}{(V_S - V_U)V_L}\right] = \tau \log_e \left[\frac{\frac{V_S}{V_L} - 1}{\frac{V_S}{V_U} - 1}\right]$$

But for symmetrically placed thresholds

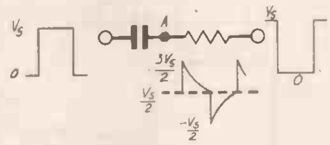
$$\frac{V_U + V_L}{2} = \frac{V_S}{2}$$

$$\therefore T = \tau \log_e \left[\frac{\frac{V_U + V_L}{V_L} - 1}{\frac{V_U + V_L}{V_U} - 1}\right] = \tau \log_e \left(\frac{V_U}{V_L}\right)^2 = 2\tau \log_e \left(\frac{V_U}{V_L}\right)$$

EXAMPLES

1. The c.m.o.s. astable has $R = 100\text{k}\Omega$ and is required to oscillate at 10kHz. Assuming that R_S is large enough to avoid conduction choose a suitable value of capacitance stating any assumptions.

The threshold of c.m.o.s. inverters is normally within the range 45 to 55% V_S. It is convenient to take the threshold as $V_S/2$.



$$\therefore V_1 = \frac{3V_S}{2} - 0$$

$$V_2 = \frac{V_S}{2} - 0$$

$$\therefore \text{Half-period } t_2 - t_1 = \tau \log_e \left(\frac{3V_S/2}{V_S/2}\right)$$

$$\frac{-V_S}{2} = \tau \log_e 3 = 1.1\tau$$

$$\therefore \text{Period} = 2.2\tau = 100 \,.\, 10^{-6}$$

$$C = \frac{100 \times 10^{-6}}{2.2 \times 10^5} = 470\text{pF}$$

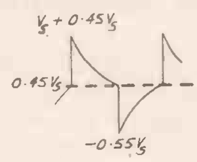
To check the effect of the variable threshold, assume each inverter switches at $0.45V_S$.

$\therefore V_1 = V_S + 0.45V_S$

$V_2 = 0.45V_S$

$\therefore$ First time interval

$$= \tau \log_e \left(\frac{1.45}{0.45}\right) = 1.170\tau$$



The second part of the cycle has

$V_1' = -1.55V_S$

$V_2' = -0.55V_S$

$\therefore$ Second time interval $= \tau \log_e \left(\frac{1.55}{0.55}\right) = 1.036\tau \quad \therefore T = 2.206\tau$

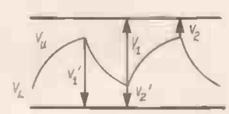
This compares with a value of 2.197 for the symmetrical case if $\log_e 3$ is evaluated more accurately i.e. on changing the threshold by 5% of supply (or 10% of its initial value) the mark-space ratio changes from 1:1 to 1:1.12 a change of 13%, though the frequency changes by only 0.4%.

2. An astable is constructed with a c.m.o.s. Schmitt circuit having upper and lower thresholds of 3V and 6.5V at a supply voltage of 10V. Estimate the frequency of oscillation with an RC section having $\tau = 500\mu\text{s}$.

$$T = \tau \left[\log_e \left(\frac{V_1}{V_2}\right) + \log_e \left(\frac{V_1'}{V_2'}\right)\right]$$

$$= \tau \left[\log_e \left(\frac{V_S - V_L}{V_S - V_U}\right) + \log_e \left(\frac{-V_U}{-V_L}\right)\right]$$

$$= \tau \left[\log_e \frac{(V_S - V_L)\ V_U}{(V_S - V_U)\ V_L}\right] \qquad \therefore T_1 = 1.47\tau,\ f = 1.36\text{kHz}.$$



For symmetrically placed thresholds but with the same hysteresis of 3.5V,

$V_U' = 5 + 1.75 = 6.75$

$V_L' = 5 - 1.75 = 3.25$

$$T' = 2\tau \log_e \left(\frac{V_U}{V_L}\right) = 1.46\tau$$

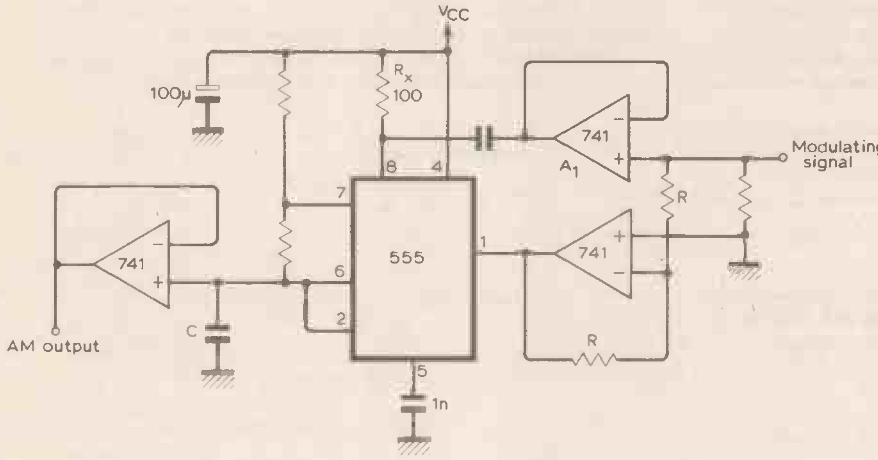
This result can be obtained from the general case above by substitution as in the analysis opposite.

Circuit Ideas continued

Amplitude modulator

With a 555 connected in the astable mode the timing capacitor charges and discharges between $V_H = 2V_{cc}/3$ and $V_L = V_{cc}/3$. By simultaneously increasing or decreasing V_H to V_L symmetrically about $V_{cc}/2$, amplitude modulation can be achieved. Resistor R_x is a compromise between excessive drop under d.c. conditions and loading of op-amp A_1.

A. D. Teckchandani
Faridabad
India

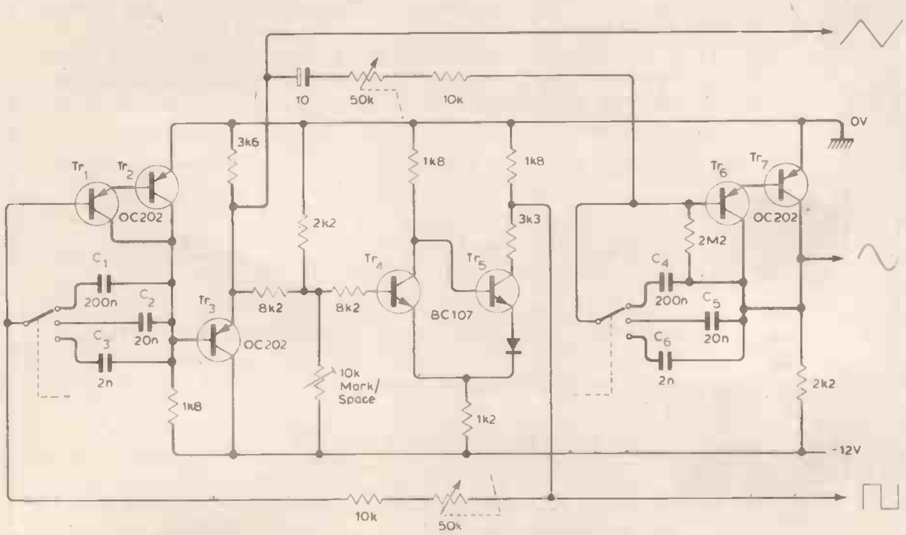


Simple waveform generator

For audio frequencies this waveform generator offers several advantages over the usual Wien bridge circuit. No amplitude stabilization is required, there are no spasmodic interruptions to the output when switching range, and a range of 10-1 is easily achieved with a standard twin-gang potentiometer.

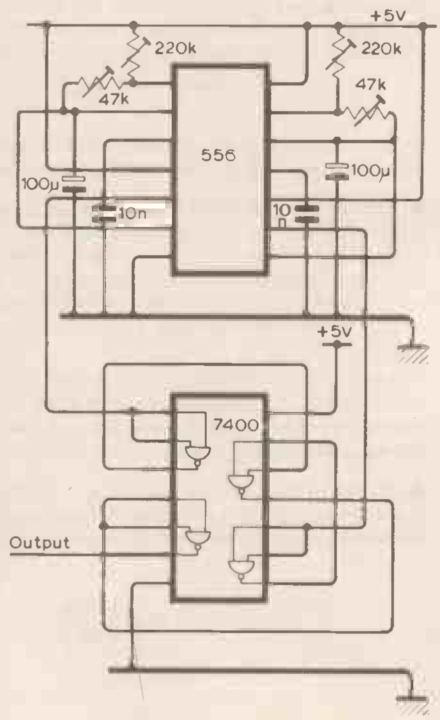
The integrator Tr_1 Tr_2, the emitter follower and the Schmitt trigger Tr_4 Tr_5 produce a triangular waveform at the collector of Tr_2. This output is of constant amplitude throughout the frequency range due to fixed triggering points. The triangular waveform also feeds a second integrator Tr_6 Tr_7 which produces a good sine wave of constant amplitude. The audio range is easily covered by three pairs of capacitors and the three outputs can be taken selectively to a single emitter follower.

F. V. Goodfellow
Southampton



Long duration timer

The two oscillators constructed from a 556 have periods $T_1 + t_1$ and $T_2 + t_2$, where the outputs of the oscillators are high during T_1 and T_2 and low during t_1 and t_2. Also, t_1 is much smaller than T_1 and t_2 is much smaller than T_2, but T_1 and T_2 are almost, but not quite, equal. When the supply is connected the oscillators start simultaneously and there is a long duration before the low periods of the oscillators overlap. When this occurs a short low pulse is produced by the 7400. The maximum interval between the pulses can be estimated as follows. Let $t_1 = t_2 = t$ and let $T_2 = T_1 + t$.



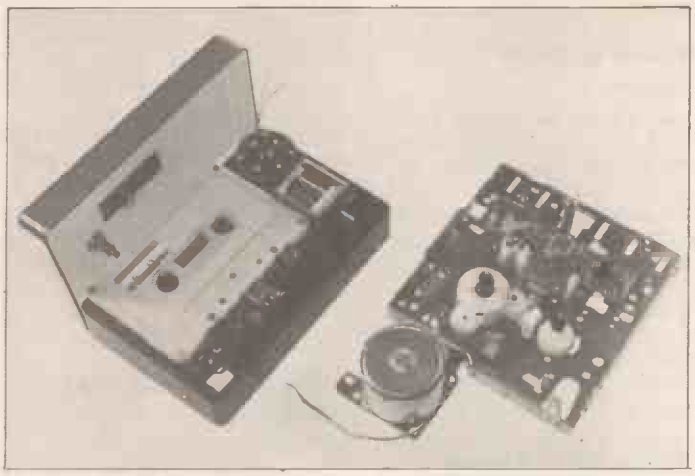
It then takes T_1/t periods of the slow oscillator to overlap at the low duration. Therefore, the time delay T is T_1T_2/t and can be very long. For example, if t is 50µs and T_1T_2 is 18 min, T is 778 years. In the practical circuit with a 556 or two 555s, such long periods are not possible because the well known current spike, caused when the output of a 555 goes high, triggers the other oscillator into a low state before its high period has been completed. However, the new 355 timer should produce better results.

O. B. Hellman
Turku
Finland

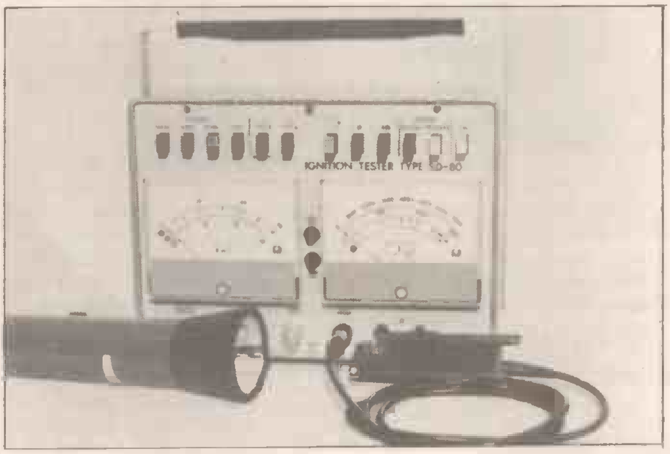
NEW PRODUCTS

Solenoid-operated cassette units

Typical applications of two new solenoid-operated cassette mechanisms, the Symot models LW 104 and YME 1006, include remote data acquisition, automatic annunciation, and processing activities in security systems. The LW 104 has been designed for use with continuous loop cassettes and is manufactured in corrosion-resistant plastic with a close-fitting translucent dust cover. The control solenoid, which operates on either 6V or 12V d.c., pulls on the pinch wheel and head assembly. The standard motor is an electronically-regulated type with an external circuit. YME 1006 is an all-metal skeleton mechanism for use with either continuous loop or conventional compact cassettes. Three forms are available — play only, record/replay with rewind facility and record/replay with cue and review facility. A (specially compounded) rubber capstan pinch roller permits permanent tape engagement without damage or roller indentation. Mono tape heads are fitted as standard and motors are mechanically regulated at 6V or 9V d.c. Symot Ltd, 22a Reading Rd, Henley-on-Thames, Oxfordshire RG9 1AG.
WW 301



WW 301



WW 302

Diagnostic engine tester

Diagnosis of engine timing and faults in the electrical system of petrol engines is the function of the SD-80 ignition tester manufactured by Albol Electronic and Mechanical Products. The unit is supplied from a 12V battery and the makers claim that, by its use, savings of about 10% can be made on petrol costs, although we assume that this presupposes that the engine is already operating below par. Functions covered by the tester include engine revs, ignition angle (with respect to t.d.c.), contact breaker make angle (dwell), battery voltage, h.t. voltage, plus two resistance checking ranges. The unit also powers a stroboscopic lamp for advance/retard measurement and dimensions are 250×310×170mm at a weight of 4.8kg (2.2lb). Price is £198 plus v.a.t. and a six-month guarantee is provided. Albol Electronic and Mechanical Products Ltd, 3 Crown St, London SE5.
WW 302

WW 303

7-segment l.e.d. display

Each of the seven segments of the Highland Electronics 31-019 l.e.d. display can be illuminated separately and the unit can be panel-mounted in a single 16mm diameter round hole. Terminations are provided on a miniature p.c.b., which is an integral part of the unit's construction and extends in a vertical plane from the moulded body of the display. The terminal print on the board aligns with a standard 7-way d.i.l. socket with 2.54mm terminal spacing. Alternatively, the unit may be hard-wired. Ten connections are provided, one for each segment, one for the decimal point and two commoned negative supply terminals. The display will operate on voltages between 1.7 and 2.7V (d.c.), with each segment and the decimal point drawing 15mA continuous, 80mA pulse, for 1ms at max. voltage. The display provides, apart from numerals, upper case letters ACEFHJLPUY and lower case letters bcdeghlnoruy. Highland Electronics, 8 Old Steine, Brighton, East Sussex BN1 1EJ.
WW 303

WW 304

Pocket frequency meter

Mobile communications applications are the areas of use which Electroplan quotes for the Labgear CM7044 portable frequency meter. This instrument covers the range 10MHz to 500MHz and it is powered by rechargeable batteries. A small antenna (with b.n.c. fitting) is provided enabling measurement of transmissions to be made without disturbing the transmitter or making internal connections. Readings are presented on a 7-digit l.e.d. display in two ranges — 10 to 50MHz and 50 to 500MHz. Electroplan Ltd, PO Box 19, Orchard Road, Royston, Herts SG8 5HH.
WW 304

WW 305

Radial component pre-former

An automatically fed machine, capable of forming and cropping up to 5000 components (radial capacitors and transistors) an hour is now available from Elite Engineering Ltd. The design of the machine allows the cropping and forming of components to the same form even where their bodies are different, without changing the tooling, although interchangeable tooling permits most different transistors to be cropped and formed for insertion in p.c. boards. Radial lead capacitors can be hopper fed if necessary or hand fed on to a belt if an especially difficult form is required. Demonstrations of the machine can be arranged or sample components sent to the makers for forming on standard

tools. Peter J. W. Noble, Elite Engineering Ltd, Unit 3, Saltern Lane, Fareham, Hants PO16 0TD.
WW 305

Power supply and ni-cad charger

Producing an output of 13.8V d.c. at 750mA for amateur radio transceiver operation and a second output at 45mA, constant current, for recharging nickel-cadmium batteries, the Lar Modules PS1200, permits trans-

mission from the base station while recharging is taking place. The transceiver output supply is regulated and all switching is automatic. Protection circuits are included and output 2 (charger) is at negative ground. LAP Modules Ltd, 27 Cookridge St, Leeds, LS2 3AG.
WW 306

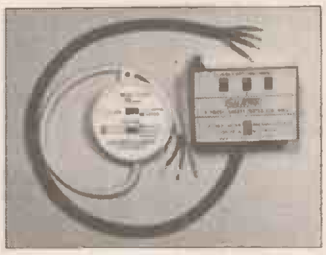
R.f.i. sealing paste

Described as "extremely fine in texture, consisting of a high concentration of pure silver particles in silicone resin" by the makers, Emerson and Cumming (UK) Ltd, Eccoshield SX is a conductive, non-hardening sealant and gasketing material for use as an r.f. shield. Volume resistivity of the paste is less than 0.005-Ωcm and it can be used at temperatures from −70°F to +400°F (−56°C to +204°C) with no adverse effects. The paste's consistency can be changed by thinning with toluene and the manufacturer quotes its use on cover plates of conduit junction boxes, to replace knitted metal gaskets and on bolt threads where it can help to assure continuous electrical contact and to prevent corrosion. The claim is also made that structures sealed with Eccoshield have a measured insertion loss in excess of 100dB

for both electric and magnetic fields in the frequency range 10kHz to 10GHz. Emerson and Cumming (UK) Ltd, Colville Rd, Acton, London, W3.
WW 307

Mains socket tester

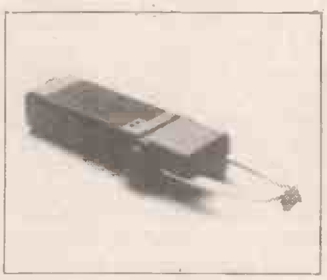
Constructed in the form of a 13A mains plug top, a socket tester with a visual display which indicates a variety of fault conditions in a domestic mains supply is available from Galatrek. The makers say that when the tester is plugged into a socket (any form, including 5A or 15A round pin, these are connected by a length of cable) the neon display indicates "correct," "live fault," "no earth," "live/neutral



reversed," "neutral fault," and "live/earth reversed." The tester costs £4.50 including v.a.t. and a 3-phase remote tester is also available at £8.95 inc. v.a.t. Galatrek, Scotland St, Lanrwst, Gwynedd, LL26 0AL, North Wales.
WW 308

Tape head demagnetizer

Demagnetization of tape heads without the need to withdraw the demagnetizing yoke away from the head at a constant speed is the claim made by TDK for its battery-operated electronic head demagnetizer, type No. HD11. The defluxing operation can be carried out in 1s, and the yoke is adjustable to settings of 15° and 30° from the horizontal. The design of the unit also makes it possible to carry out defluxing of heads on many older models of tape recorder, some of which are difficult in terms of head access. TDK Tape Distributor (UK) Ltd., 11th Floor, Pembroke House, Wellesley Rd, Croydon, Surrey.
WW 309



Auto transformers

A range of transformers intended for the adaptation of modernized equipment which has been imported from the US is now available from F. H. Radford Ltd. This comprises a series of single phase auto transformers for either 240 or 220V supply, this input being transformed to 115V, by means of a single connection change. Four basic models are available as 500, 1000, 2000 and 3000VA units, each of which is equipped with two American 15A 3-pin outlets and a 3-core output lead. F. H. Radford Ltd, 38 Charlotte St, London W1P 1HP.
WW 310

Magazine storage rack

A collapsible frame moulded from polythene and held together by four metal tubes constitutes the Multi-file magazine storage rack. The frame is designed to hold up to 24 issues of a fairly weighty A4 publication (such as *Wireless World*) although a few more can be squeezed in if required. Each magazine is fitted with two clips which pinch at either end of the spine, and located at the centre spread – these must be fitted carefully to avoid tearing – and the journal is then hung by these polythene clips from the rails at each side of the frame. The price, ex works, is £8.50 each, including v.a.t. or £3.50 each per unit per 1000 and the rack is available in four colours – brown, light grey, blue and yellow. Alternative colours and "house" branding can be arranged on orders over 5000 at extra cost. Multi-file Ltd, Sands Industrial Estate, Hillbottom Rd, High Wycombe, Bucks.
WW 311

Long scale panel meter

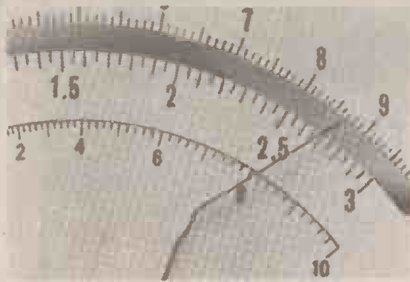
Applications requiring higher than usual accuracy are quoted by Bach-Simpson (UK) for its new range of panel meters featuring a 250° pointer deflection angle. These meters, specified as 2123L for d.c. and 2143L for a.c. (rectified) are self-shielded, permanent magnet moving-coil instruments with non-magnetic

pivots and spring-backed jewels; zero adjustment is via the front pivot. The facia dimensions of these meters are identical to the Simpson "Century" range of 3½ in panel meters. Bach-Simpson (UK) Ltd, Trenant Estate, Wadebridge, Cornwall, PL27 6HD.
WW312

Noise blanking chip

Designed for the removal of noise spikes from broadcast f.m. composite signals before decoding, the Toko KB4436 is claimed by the UK distributor, Ambit International, to be capable of providing an improvement of approximately 25 to 30dB on the unblanked signal to noise ratio. This i.c. is specifically intended for the removal of short duration impulse noise such as that generated by a car's ignition circuits or d.c. motors. In order to maintain the 19kHz pilot tone during blanking periods, a signal derived from the decoder v.c.o. is added to the input signal for a period determined by the setting of externally-controlled time constants. This method ensures that the blanking process does not impair the quality of the output signal. Further information for alternative applications is available from the distributor and the one-off price of the i.c. is £2.53 excluding v.a.t. Ambit International, 200 North Service Rd, Brentwood, Essex CM14 4SG.
WW313

Finally, you can have all the advantages of DMMs and none of the disadvantages of analogues for about the same price.



Our new 169 is a tough, lightweight, battery-powered digital multimeter for use in the field or on the bench. It is a 3½-digit, full 5-function DMM with respectable .25% DC accuracy.

Its low-parts-count, high-efficiency design keeps power consumption to a minimum for longer component life and fewer failures. MTBF is 20,000 hrs. or about 10 years.

All 5 functions are fully protected – 1400V peak on DCV and ACV, 300V on Ω, 2A (250V) on DCA and ACA. The fuse is externally accessible for quick replacement. Extensive vibration stress-testing assures the 169 will stand up to all the mechanical shock and abuse normally associated with tough applications.

Is this the end for Analogue meters?

Cost-conscious ease of maintenance is so thoroughly designed into the 169 that only one calibration adjustment a year is required. That adds up to a cost-of-ownership no other competitive DMM can touch. For example, the 169 needs only one battery change per year at a cost of about £1.50.

When you factor in features like function and range annunciation right on the display, auto-zero, auto polarity, 60% larger display than other DMMs and the easy-to-read, colour coded front panel, we think you'll get the point. No analogue meter or DMM can match the price/performance of the new 169. It costs £99 (plus VAT)

For information on the 169 or any Keithley DMM call (0734) 861287
Telex: 847047

Ex stock

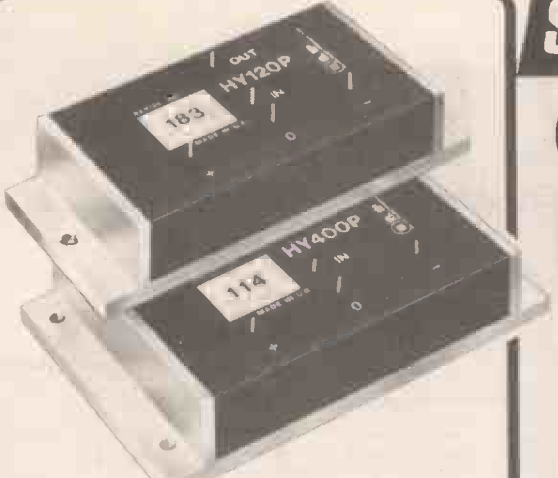
WW — 059 FOR FURTHER DETAILS

KEITHLEY

Keithley Instruments Ltd.
1, Boulton Road
GB-Reading, Berkshire RG2 0NL
UNITED KINGDOM
(0734) 861287 Telex: (851) 847047

Keithley Instruments GmbH
Heiglhofstrasse 5
D-8000 München 70
(089) 714-40-65
Telex: 521 21 60

Keithley Instruments SARL
44, Rue Anatole France
F-91121 Palaiseau Cedex
01-014-22-06.
Telex: (842) 204188



SIMPLY AHEAD - and staying there!

O.E.M. PLATE POWER AMPLIFIERS

MADE IN ENGLAND

I.L.P. offer for prompt delivery, a range of O.E.M. Plate Power Amplifiers in three useful output ratings. These units are typical of I.L.P. design and manufacture — encapsulated circuitry, rugged construction, just five pin connections, trouble-free mounting, no output capacitor or other external components to be added, and operation from split line power source. PRICES ARE KEENLY COMPETITIVE. **QUALITY AND MANUFACTURE OF THE HIGHEST POSSIBLE STANDARDS.** *Modules can also be manufactured to customer's own design.*

0.1% DISTORTION
WIDE BANDWIDTH
PROTECTED O/P TRANSISTORS
FULL LOAD LINE PROTECTION
NO EXTERNAL COMPONENTS
ONLY FIVE PINS TO CONNECT

UNIT PRICE FOR	100 +	250 +	500 +	1000 +	2500 +	5000 +
HY 120P 60W rms 8Ω	£10.30	£9.37	£8.51	£7.74	£7.04	£6.40
HY 200P 120W rms 8Ω	£13.18	£11.98	£10.89	£9.90	£9.00	£8.18
HY 400P 200W rms 4Ω	£19.26	£17.51	£15.92	£14.47	£13.16	£11.96

Sizes—
HYP 120P and HY 200P 116 × 50 × 23mm
HY 400P 116 × 75 × 23mm

ILP INDUSTRIAL

A division of I.L.P. ELECTRONICS LTD., GRAHAM BELL HOUSE, ROPER CLOSE, CANTERBURY, KENT, CT2 7EP (0227) 54778 : Telex 965780

WW—088 FOR FURTHER DETAILS

SOFTY

IN FACT IS AN INTELLIGENT EPROM PROGRAMMER

with a range of serial and parallel inputs – plus a keyboard for manual entry.
SOFTY presents a hexadecimal MAP OF MEMORY contents on a TV set. The user has an ASSEMBLER-FACILITY to manipulate the displayed data, and cassette-tape storage of working programs and useful routines.

When purchased as a microprocessor product development kit, Softy costs only £100.

For literature and the name of your local retailer, contact Dataman, P.O. Box 5, Dorchester, Dorset. DT2 7UB or Telephone 03002 700.

SOFTY

WW—092 FOR FURTHER DETAILS

WHOLESALE

ELECTRONIC COMPONENTS

	Stock	Price
AU113	120	.98
3k-Presets	2,000	.01
TBA800	500	.44
4700µF 16v Elec.	800	.14
7448 TTL	1,600	.20
16-Pin DIL Socket	5,000	.08
Z-80 P10 4MHz	30	6.50
2708 EPROM	500	4.39
2114 SRAM	800	3.51
4116 DRAM	800	4.50

And many more. Companies invited to send SAE for our up-todate price list.

Please phone for availability before ordering. All our prices include 15% VAT. Postage extra.

STRUTT
ELECTRICAL AND MECHANICAL ENGINEERING LTD.
ELECTRICAL COMPONENT DISTRIBUTORS

3c BARLEY MARKET ST.
TAVISTOCK
DEVON PL19 05F
Tel. TAVISTOCK (0822) 5439
Telex: 45263

The 7208 600 MHz Mini Counter

the quality low cost counter

FEATURES . . .

● All Metal Cabinet ● 8 Digit .4" LED Display ● Built-in Prescaler ● Automatic Dp Placement ● Gate Light ● IC Sockets Included ● 240V or 12V Operation ● Proportional Control Crystal Oven (Optional) ● Built-in VHF-UHF Preamp ● Completely Portable with Rechargeable Batteries (Optional).

DESCRIPTION

The Davis 7208 VHF-UHF Frequency Counter incorporates the latest LSI technology in a wide range portable instrument at a reasonable price. The 7208 offers outstanding features including an all metal cabinet for RF shielding, large 8 digit display, built-in prescaler, automatic DP, and with the built-in VHF-UHF preamp the 7208 can directly measure low level RF signals from RF generators. The 7208 can also be operated completely portable with the Ni-Cad battery option. **Price £145.00 + VAT.**

AVAILABLE FROM THE EXCLUSIVE U.K. DISTRIBUTORS:

SOTA COMMUNICATION SYSTEMS LTD.

26 CHILDWALL LANE, BOWRING PARK, LIVERPOOL L14 6TX
MERSEYSIDE. TEL. 051-480 5770 Telex 627110 SOTA G

NewBear Components

CALLERS AND MAIL ORDER: 40 Bartholomew Street, Newbury, Berks. Tel: 0635 30505

Microcomputing I.C.'s

MC6800	£ 7.15
MC6802	£ 8.50
MC6821	£ 4.63
MC6850	£ 6.74
MC6810AP	£ 3.61
MC6840	£ 12.72
MC8602P	£ 2.88
MC14536P	£ 3.69
MC3459	£ 2.43
Z80 CPU 2.5MHz	£ 8.99
Z80 P10 2.5MHz	£ 7.99
Z80 CTC 2.5MHz	£ 7.99
Z80A CPU 4MHz	£ 13.99
Z80A P10 4MHz	£ 10.00
Z80A CTC 4MHz	£ 10.00
SC/MP 11 (INS 8060N)	£ 8.88
INS 8154N	£ 8.18
8080A	£ 6.00
6502	£ 9.90
6522	£ 7.90
6532	£ 12.56
6551	£ 10.79
6545	£ 16.66
Z8001	£142.50
AMD 9511: arithmetic package	£136.50

ACORN......

6502 BASED MICRO KIT	£65.00
8K RAM KIT	£95.00
MAINS ADAPTOR	£ 5.00
V.D.U. KIT	£88.00

S100 at NEWBEAR

Z80 CPU BOARD	£26.25
8K STATIC RAM BOARD	£18.75
DISK INTERFACE BOARD	£26.25
V.D.U. BOARD	£18.75
2708/2716 EPROM BOARD	£18.75
PROTOTYPING BOARD	£18.75
RANGE OF MOTHERBOARDS	
S100 CONNECTORS	£ 3.95

Memories

4116 (16K DYNAMIC)	£ 6.99
2102-1*	£ 0.85
2102L-1*	£ 0.99
2112	£ 2.25
2114	£ 6.99
2708	£ 6.99
MC68031L7 (MIKBUG)	£ 13.65
2716 (INTEL)	£ 21.50

SPECTRONICS

UV Eprom-Erasing Lamp

PE14	Erases up to 6 chips. Takes approx. 19 mins.	£ 56.00
PE14T*	Erases up to 6 chips. Takes approx. 19 mins.	£ 76.58
PE24T*	Erases up to 9 chips. Takes approx. 15 mins.	£111.22
PR125*	Erases up to 6 chips. Takes approx. 7 mins.	£237.84
PR320T*	Erases up to 36 chips. Takes approx. 7 mins.	£384.09
PC1000*	Erases up to 72 chips. Takes approx. 7 mins.	£842.83

UV Eprom-Erasing Cabinet

PC2000*	Erases up to 144 chips. Takes approx. 7 mins.	£1227.69

* Includes a 60 min. Timer.

TERMS: Credit Sales (minimum £10.00) Barclaycard and Access Welcome. Please add 15% VAT.

CALLERS ONLY: 220-222 Stockport Road, Cheadle Heath, Stockport Tel: 061 491 2290

SEND FOR OUR NOVEMBER CATALOGUE AND BOOK LIST.

WW — 009 FOR FURTHER DETAILS

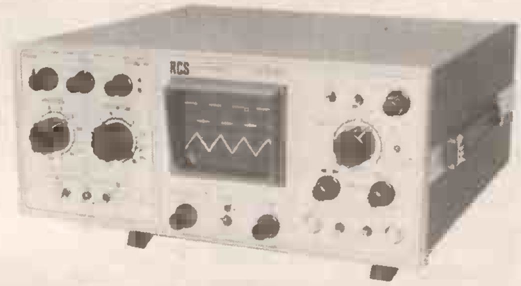
FREQUENCY COUNTERS — OSCILLOSCOPES — OFF-AIR RECEIVERS

20 MODELS AVAILABLE INCLUDING LED VERSIONS AND TALKING READOUTS

250MHz
801 B/M
£250
Crystal oven
3 parts 10⁹

401A	50MHz 6 Digit	**£150**
801B/M	250MHz 8 Digit	**£250**
901M	520MHz 8 Digit	**£325**
1001M	1-2GHz 8 Digit	**£550**
OFF-AIR RECEIVER		**£125**

MAINS
12V. BATTERY
PORTABLE
OSCILLOSCOPE



MODEL
S1500
15MHz
Dual Trace
£280

A professional standard model dual trace DC to15MHz. Usable to 25MHz with alternate, chop and single-channel A or B amplifier selection. 5mv/cm, accuracy 3%. Excellent triggering wide range time base.

RCS

R.C.S. ELECTRONICS, WOLSEY ROAD, ASHFORD, MIDDX. ASHFORD 53661

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

WW — 046 FOR FURTHER DETAILS

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.
Output device rating 360w per channel
Tone cancel switch. 2 tape monitor switches.
Metal case—comprehensive heatsinks
Complete kit only **£63.90 + VAT.**

INTRUDER 1 Mk. 2 RADAR ALARM

With Home Office Type approval

The original "Wireless World" published Intruder 1 has been re-designed by Integrex to incorporate several new features, along with improved performance. The kit is even easier to build. The internal audible alarm turns off after approximately 40 seconds and the unit re-arms. 240V ac mains or 12V battery operated. Disguised as a hard-backed book. Detection range up to 45 feet.
Complete kit £49.50 plus VAT.

Wireless World Dolby noise reducer

Trademark of Dolby Laboratories Inc.

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.

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.

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(TM) PROCESSOR BOARDS (92 x 87mm) with gold plated contacts and all components . . . . **Price £9.00** + VAT

Please add VAT @ 15%

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 — BARCLAYCARD VISA

All kits are carriage free

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.

Improved performance with linear phase IF and second generation IC decoder.

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

WW — FOR FURTHER DETAILS

INTO THE 80's WITH CATRONICS TELETEX DECODERS!

READY-BUILT DECODER SALE

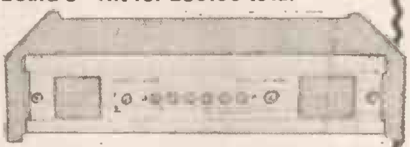
Specially reduced prices for ready-built Teletext Decoders . . . from only £160. Send SAE for details and current list

KITS including ULTRASONIC REMOTE CONTROL

Kits and PCBs are now available for the Ultrasonic Remote Control unit as described in recent issues of W.W. Kit includes plated-through hole "Board 5", RX and TX PCBs, all components and installation instructions.

Price only £67.92 + VAT + Post = £78.80 total
Character Rounding "Board 4" Kit £26.62 total
New Facilities "Board 3" Kit for £39.00 total

Catronics main kits contain all the printed circuit boards and components necessary to build the complete decoder.



A reprint of the series of articles is available at £1.95 + large 21p SAE (included free in complete kit).

Prices are for the Version with TEXAS X887 INCLUDING VAT.

Set of 5 PCBs	£27.40	+ 30p P&P
Components Kits incl. PCBs	£147.40	+ £1.50 P&P
Cabinet	£21.47	+ £1.00 P&P

Also **PLATED THROUGH** hole PCB at additional cost of £28.62
FULL FAULT-FINDING AND REPAIR SERVICE AVAILABLE.
COMPONENTS ALSO AVAILABLE SEPARATELY — SAE for price list.
READY BUILT AND TESTED DECODERS ALSO AVAILABLE

CHARACTER GENERATOR AND MEMORY I.C.S.

74S262N (X887) £12.95; 2102/2602, £1.11 + 15% VAT + 30p P&P

Everything covered by our THREE STAR GUARANTEE

Catronics

CATRONICS LTD.
(Dept. 21)
Communications House.
20 WALLINGTON SQUARE, WALLINGTON, SURREY.
Telephone: 01-669 6700

WW—921 FOR FURTHER DETAILS

RECHARGEABLE BATTERIES

TRADE ENQUIRIES WELCOME

Full range available to replace 1.5 volt dry cells and 9 volt PP type batteries, SAE for lists and prices. £1.25 for booklet. "Nickel Cadium Power," plus catalogue.

"Write or call at:

SANDWELL PLANT LTD.
2 Union Drive, Boldmere
Sutton Coldfield, West Midlands 021-354 9764

See full range at TLC, 32 Craven street, Charing Cross, London WC2.

WW — 038 FOR FURTHER DETAILS

Ceramic Capacitors **£3.50** per 100
Cable Sleeves and Markers from **£1.00** per 1,000
Compression Terminals from **£7.29** per 1,000
Pcb self-fixing Guides from **£4.86** per 100
Elma Knobs and Accessories

Phone, write or call for catalogue

Carbon Film Resistors from **£4.00** per 1,000
Polystyrene Capacitors from **£1.50** per 100

Send for lists of values available

PBRA LTD. **Hopfield (073274) 345**

Golden Green, Tonbridge, Kent, TN11 0LH

WW — 039 FOR FURTHER DETAILS

TRANSFORMERS
CONTINUOUS RATINGS

Please add VAT after P&P

VAT 15%

MAINS ISOLATOR

PRI 120 or 240V Sec 120 or 240V
Centre Tapped and Screened

Ref.	VA (Watts)	£	P&P
07★	20	**4.84**	.91
149	60	**7.37**	1.10
150	100	**8.38**	1.31
151	200	**12.28**	1.31
152	250	**14.61**	1.73
153	350	**18.07**	2.12
154	500	**22.52**	2.47
155	750	**32.08**	OA
156	1000	**40.92**	OA
157	1500	**56.52**	OA
158	2000	**67.99**	OA
159	3000	**95.33**	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 12v	Amps 24v	£	P&P
111	0.5	0.25	**2.42**	.52
213	1.0	0.5	**2.90**	.90
71	2	1	**3.86**	.90
18	4	2	**4.46**	1.10
85	5	2.5	**6.16**	1.10
70	6	3	**6.99**	1.10
108	8	4	**8.16**	1.31
72	10	5	**8.93**	1.31
116	12	6	**9.89**	1.52
17	16	8	**11.79**	1.52
115	20	10	**15.38**	2.39
187	30	15	**19.72**	2.39
226	60	30	**40.41**	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	**3.75**	.90
103	1.0	**4.57**	1.10
104	2.0	**7.88**	1.31
105	3.0	**9.42**	1.52
106	4.0	**12.55**	1.73
107	6.0	**16.57**	1.89
118	8.0	**22.29**	2.39
119	10.0	**27.48**	OA
109	12.0	**31.79**	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	**2.90**	.90
79	1.0	**3.93**	1.10
3	2.0	**6.35**	1.10
20	3.0	**6.82**	1.31
21	4.0	**8.79**	1.31
51	5.0	**10.86**	1.52
117	6.0	**12.29**	1.67
88	8.0	**16.45**	1.89
89	10.0	**18.98**	1.89
90	12.0	**21.09**	2.24
91	15.0	**24.16**	2.39
92	20.0	**32.40**	OA

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	**4.27**	1.10
126	1.0	**6.50**	1.10
127	2.0	**8.36**	1.31
125	3.0	**12.10**	1.39
123	4.0	**13.77**	2.12
40	5.0	**17.42**	1.89
120	6.0	**19.87**	2.12
121	8.0	**27.92**	OA
122	10.0	**32.51**	OA
189	12.0	**37.47**	OA

SCREENED MINIATURES Primary 240V

Ref.	mA	Volts	£	P&P
238	200	3-0-3	**2.83**	.63
212	1A, 1A	0-6, 0-6	**3.14**	.90
13	100	9-0-9	**2.35**	.44
235	330, 330	0-9, 0-9	**2.19**	.44
207	500, 500	0-8-9, 0-8-9	**3.05**	.85
208	1A, 1A	0-8-9, 0-8-9	**3.88**	.90
236	200, 200	0-15, 0-15	**2.19**	.44
239	50MA	12-0-12	**2.88**	.37
214	300, 300	0-20, 2-20	**3.08**	.90
221	700 (0C)	20-12-0-12-20	**3.75**	.90
206	1A, 1A	0-15-20, 0-15-20	**5.09**	1.10
203	500, 500	0-15-27, 0-15-27	**4.39**	1.10
204	1A, 1A	0-15-27, 0-15-27	**6.64**	1.10

HIGH VOLTAGE

MAINS ISOLATING
Pri 200/220 or 400/440
Sec 100/120 or 200/240

VA	Ref.	£	P&P
60	243	**7.37**	1.58
350	247	**18.07**	2.12
1000	250	**45.94**	OA

AUTO TRANSFORMERS

Ref.	VA (Watts)	TAPS	£	P&P
113	15	0-115-210-240V	**2.73**	.81
64	75	0-115-210-240V	**4.41**	1.10
4	150	0-115-200-220-240V	**5.89**	1.10
67	500	" "	**12.09**	1.91
84	1000	" "	**20.64**	2.39
93	1500	" "	**25.61**	OA
95	2000	" "	**38.30**	OA
73	3000	" "	**65.13**	OA
80s	4000	0-10-115-200-220-240	**84.55**	OA
57s	5000	" "	**98.45**	OA

Step Up or Step Down

BRIDGE RECTIFIERS

100v	25A+	**£2.10**
200v	2A	**45p**
400v	2A	**55p**
200v	4A	**65p**
400v	4A	**80p**
400v	6A	**£1.40**
500v	12A	**£2.35**

P&P 17p. VAT 15%

CASED AUTO TRANSFORMERS

240V cable input USA 115V Flat pin outlets

	£	P&P	Ref.
20VA	£6.55	1.03	56W
75VA	£8.50	1.31	64W
150VA	£11.00	1.31	4W
200VA	£12.02	1.67	65W
250VA	£12.55	1.67	69W
500VA	£20.13	1.89	67W
1000VA	£30.67	2.65	84W
1500VA	£42.82	OA	93W
2000VA	£54.97	OA	95W

MINI MULTIMETER

0C1000V, AC-1000V
AC/DC-1000Ω/V
DC-100mA. Res — 150K
Bargain at £7.20
VAT 15% P&P 71p

TEST METERS

AVO8 Mk. 5	**£91.50**
AVO71	**£38.00**
AVO73	**£50.70**
AVOMM5 MINOR	**£35.95**
WEE MEGGER	**£76.28**
EM272 316KΩ/V	**£59.80**
DA116 Digital	**£110.90**
Megger BM7 (Battery)	**£53.76**
Clamp Meter 300A	**£54.60**

Avo Cases and Accessories
P&P £1.32 VAT 15%

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 Edge 54mm x 14mm μa FSD . **£2.60**
VU Panel Ind. 48 x 45mm, 250μa FDS . . . **£2.60**
Carriage 76p VAT 15%

MINIATURE TRANSFORMER

0 Centre Tapped 15V 7.5-0-7.5V

Ref.	Amp	Price	P&P
171	500MA	**2.30**	.52
172	1A	**3.26**	.90
173	2A	**3.95**	.90
174	3A	**4.13**	.99
175	4A	**6.30**	1.10

U4315 Budget Meter 20Kv/Ω Rangers to 1000V 2.5A AC/0C 500Ku. Res in steel case **£15.85** P&P £1.32. VAT 15%.

NEW RANGE TRANSFORMERS

Pri 0-120; 0-100-120; (120V or 220-240V) Sec. 0-36-48 twice to give 72v or 92v.
2A **£13.35** PP £1.40 4A **£20.65** PP £2.11
3A **£16.17** PP £1.70 5A **£29.30** PP £2.47

ABS PLASTIC BOXES

Inset brass nuts, slots to take PC cards (boards) flush fitting lid.

PB1 80mm x 62 x 40	**.80p**
PB2 100mm x 75 x 40	**.90p**
PB3 120mm x 100 x 45	**£1.04**
PB4 215mm x 130 x 85	**£2.68**

P&P 33p. VAT 15%

METAL OXIDE RESISTORS 5% ¼W

(Electrosil)

390Ω - 470Ω - 510Ω - 560Ω - 820Ω 1K - 1K1 - 1K2 - 1K6 - 1K8 - 2K - 2K4 - 3K - 16K - 20K - 22K - 24K - 47K - 82K - 100K - 130K - 180K - 220K - 270K - 300K **£1.50** - 100.

ANTEX SOLDERING IRONS

15W **£4.58**. 25W **£4.58**
Stand for above **£1.75.** P&P 53p. VAT 15%.

ISOLATOR Ref. 30 240V: 240V 200VA **£4.54.** P&P £1.04
ISOLATOR Ref. 62 240V: 240V 250VA **£5.62.** P&P £1.04

MAINS ADAPTORS

MVA30. 6. 7. 5. 9V at 300mA plus dorect into 13A socket (fused) 4-way multi plug **£4.00**
3300-3-6-9-12V at 300mA plus straight to 13A socket (fused) with multiplug **£4.60**
15% VAT. 55p P&P

Send 15p for catalogue. Prices correct at 30/10/79

Barrie Electronics Ltd.
3, THE MINORIES, LONDON EC3N 1BJ
TELEPHONE: 01-488 3316/8
NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST.

WW — 031 FOR FURTHER DETAILS

Simply ahead . .

ILP'S NEW GENERATION OF HIGH

I.L.P. modular units comprise five power amplifiers, pre-amp which is compatible with the whole range, and the necessary power supply units. The amplifiers are housed and sealed within heatsinks all of which will stand up to prolonged working under maximum operating conditions.

With I.L.P. performance standards and quality already so well established, any advances in I.L.P. design are bound to be of outstanding importance – and this is exactly what we have achieved in our new generation of modular units. I.L.P. professional design principles remain – the completely adequate heatsinks, protected sealed circuitry, rugged construction and excellent performance. These have stood the test of time far longer than normally expected from ordinary commercial modules. So we have concentrated on improvements whereby our products will meet even more stringent demands such, for example, as those revealed by vastly improved pick-ups, tuners, loudspeakers, etc., all of which can prove merciless to an indifferent amplifier system. I.L.P. modules are for laboratory and other specialised applications too.

PRODUCTS OF THE WORLD'S FOREMOST SPECIALISTS IN ELECTRONIC MODULAR DESIGN

AVAILABLE ALSO FROM A NUMBER OF SELECTED STOCKISTS

Communications 80

Communications Equipment and Systems
National Exhibition Centre
Birmingham England
15 April - 18 April 1980

AN INVITATION TO

5th IN THE SERIES

Communications 80, the fifth in a series of international expositions dealing with the applications of communications equipment and systems, particularly in the major growth areas of data and business communications which are being created by the converging technologies of computing and telecommunications. The other important themes of the exposition are PTT telecommunications, civil fixed and mobile radio and emergency communications.

Communications 80 will attract visitors from all over the world (from 69 countries at the last event in 1978) who will be coming to see the latest developments in communications technology displayed by leading international manufacturers. Many of the visitors will also attend the integral conference, organised by the Institution of Electrical Engineers in association with leading international learned societies, to learn about the latest technical advances in communications equipment and systems.

Communications 80, the world's leading international exposition in the field, is actively supported by the International Telecommunication Union - the world telecommunications authority representing 153 governments; the British government, through the Home Office; the British Post Office; Cable and Wireless Ltd; and the two main UK trade associations - the Electronic Engineering Association and the Telecommunications Engineering and Manufacturing Association.

Please make a note of the dates and venue of **Communications 80** - Tuesday 15 April to Friday 18 April, 1980, at the National Exhibition Centre, Birmingham, England.

You cannot afford not to come if you make, use or specify communications equipment and systems.

I am interested in attending

Communications 80

Please send me details of exhibition ☐ conference ☐

Name ____________________

Position ____________________

Company ____________________

Address ____________________

Complete, detach and mail to

Tony Davies Communications
c/o Industrial and Trade Fairs Ltd, Radcliffe House,
Blenheim Court, Solihull, West Midlands B91 2BG, England.

Telephone: 021 705 6707 Telex: 337073

60

LINES FROM OUR VAST STOCKS — IMMEDIATE DELIVERY

NEW STOCKS BELOW MANUFACTURERS' PRICES. Postage & packing add 50p per order.

CALCULATOR CHIPS General instrument GIMT4 on anti-static foam 24 pin D.I.L. socket for use with Bowmar display **£1.50** ea. Pack of 25 chips **£25.** 100 for £30. 500 for **£350.**

DISPLAYS BY HEWLETT-PACKARD. Seven segment DL707 (5082-7750) **95p.** Common anode half inch red display, brand new in makers cartons, 6 for £5. 50 for **70p ea.** 1,000 for **55p** ea.

TBA 120A. T.V. I.C. amplifier Siemens **55p, 10** for **£5,** 100 for **£50,** 1,000 for **£350.**

BECKMAN 500 kcs Triggerable clocking oscillator for use with calculator chips 5v supply with circuit **£1,** 10 for **£8,** 100 for **£85.**

BURROUGHS 8 DIGIT Panaplex calculator display 7 segment 0.25" digits. Neon type with red bezel socket and data **£1.95** ea. 10 for **£17,** 100 for **£140.**

HONEYWELL PROXIMITY DETECTOR integral amplifier 8v D.C. **£3.50** ea. 10 for **£30.**

MULLARD TBA800. I.C. audio amplifier. **95p** ea. 10 for **£8,** 100 for **£70,** 500 for **£300.**

RCA CA3089. F.M. IF **£1.50,** 10 for **£12.**

RCA CA3090AO. F.M. decoder **£2.50,** 10 for **£20,** 100 for **£175.**

BU 205 MULLARD. £1.50 ea, 10 for **£12,** 100 for **£100.**

2N3055 80V version TO3 power, 10 for **£3.50,** 100 for **£28,** 500 for **£125,** 1,000 for **£200.**

BU208 TO3 Texas T.V. Power transistors. **£1.75** ea. 10 for **£15,** 100 for **£120,** 1,000 for **£1** ea.

MC1310P-SN76115N F.M. STEREO DECOOER. £1.20 each, 10 for **£1** ea, 100 for **85p** ea.

MULLARD AD161-AD162 Matched pairs. 1 pair 80p, 10 pairs **£6,** 100 pairs **£50.** Cartons of 600 pairs **£250 EX-STOCK.**

RADIATION DETECTORS Quartz Fibre Dosimeters Pen type with clip with lens and scale 0-50R. Originally over **£5 OUR PRICE 95p EACH, 10 for £8.** 100 for £60. 1,000 for £500.

CLOCKING OSCILLATOR (Pye-Dynamics), thick film 1mHZ supply 5v 19x25x8mm **85p,** 10 for **£7,** 100 for £80, 500 for **£250.**

TV TUNERS by Mullard. U.H.F. 38 mcs size 3¾x2¼x1¼ **£2.50** ea. 10 for **£20,** 100 for **£175,** 500 for **£750,** 1,000 for **£1,250.**

MULLARD TUNER MODULES with data. LP1171 combined AM/FM IF strip **£3.50.** LP1179 FM front end with AM tuning gang, used with LP1171 **£3.50.** LP1171 and 89 pair **£5.75,** 10 pairs for £50, 100 pairs for £400.

CA3085 RCA POSITIVE VARIABLE REG. 5volt 100m amp variable 1.8-24v 55p ea. 10 for **£6,** 100 for £35, 1,000 for **£300.**

MULLARD LP1157 AM tuner modules with circuit **£2.50** ea. 10 for **£20,** 100 for **£175.**

LUSTRAPHONE RIBBON MIKE £1.50, + pre amp on chassis **3x2x1in,** 10 for **£12.50.**

TAA661B (14-pin DIL) I.C. T.V. Sound & F.M. amplifier-detector by Ates on P. circuit board with other parts. Complete with data and connections. **60p.** 10 for **£5,** 100 for **40p** ea, 500 for **35p** ea.

AVO-8 METER MOVEMENTS for military version. Precision 37.5 micro-amp (50 μa with integral shunt) movement **£10.50.**

TV SOUND
High quality TV sound from your Hi-Fi. Simply plug into aerial socket of your FM tuner, £6.50 (UK P&P 50p).
As reviewed by "Popular Hi-Fi", July '79.

PHOTO CONDUCTIVE CELL £1.25. High power Cds cell 600 mw for control circuits. Resistance 800 ohm to 4K. Max volts 240. Size 1½x½in. 10 for **£11,** 100 for **£100.**

DYNAMIC MICROPHONE. Low imp. Foster inset. **£1.45,** 10 for **£11,** 100 for **£100.**

UHF TUNER BY GEC. 38mc/s with slow motion tuning. Size 5x3x2in. **£3** ea. 10 for **£25,** 100 for **£220,** 500 for **£1,000.**

TWO GANG MINIATURE VARICAP TUNER, 500pf with tuning knob, size 3x1½x1½in, **£1.25** ea. 10 for **£10,** 100 for **£85.**

ATES U14552 AUDIO I.C. AMPLIFIER 14 PIN D.I.L. 300 m. watts **55p** each, 10 for **£4.50.** 100 for **£35.**

GENERAL ELECTRIC 2+2 watt **I.C.** stereo audio chips with circuit & data **£1.95** each.

RCA CD4028AE 16 pin D.I.L. presettage up-down counter **85p** each, **25** for **£15,** 100 for **£50,** 1,000 for **£355** (in anti static tubes of **25**).

U.H.F. TV TUNER (preamp) with BF180 **55p** each. Built on P.C. board 2 x 2in (sold without data), 10 for **£4.50,** 100 for **£35,** 1,000 for **£250.**

MARCONI I.C. Oscillator Datil (TO99 can) **30p** each, 10 for **£2,** 100 for **£15,** 1,000 for **£125.**

PLESSEY SL432A I.C. IF amplifier (TO99 can) **85p** each, 10 for **£6,** 100 for **£39,** 500 for **£150.**

V.H.F. MODULATORS for TV games **55p each.** 2 transistor — on built P.C. sizes 2 x 2 x 1¼in. 10 for **£4,** 100 for **£35,** 500 for **£150.**

R.F. Filters for above modulators **20p** each with components and coils on built p. circuit, size 2 x 2 x 1¼in. 10 for **£3.60,** 100 for **£30,** 500 for **£125.**

HIGH VOLAGE TV TRIPLER DIODES BY I.T.T. stick type per 10 **£1.50,** per 100 **£18,** per 1,000 £85.

TBA825 ATES voltage regulators **55p** ea. 5 volts 100 m/amps (TO99) per 10 **£4.50,** per 100 **£39,** per 1,000 **£280,** 12v **TBA625A.** Also

16 PIN low profile D.I.L. **sockets 12p,** 10 for **£1,** 100 for **£8,** 1,000 for **6p** each.

THYRISTORS, Motorola 2N5061 0.8 amp 60 volt **19p,** 10 for **15p,** 100 for **13p,** 1,000 for **11p** each.

ULTRASONIC TRANSDUCERS. 40KCs. pair **£2.95, 10** pairs **£25,** 100 pairs **£220.**

HENRY'S

EXPORT ORDERS add 10% for carriage

All mail to:
404 Edgware Road
London W2 England
Phone 01-723 1008
TELEX 262284. REF 1400.

ASTRA-PAK

92 GODSTONE ROAD
WHYTELEAFE SURREY CR3 0EB

All prices include V.A.T. Add 25p for P&P (Extra for overseas). **Discounts** over £10 less 5%, over £20 less 5%, over £20 less 10%, over £50 less 15%, over £100 less 20%.
Send SAE for complete list of components.

7400	0.12	7495	0.54	74190	1.05	74LS113	0.36	4007	0.16	4085	0.72
7401	0.12	7496	0.60	74191	0.99	74LS114	0.36	4008	0.92	4086	0.76
7402	0.12	7497	2.38	74192	0.99	74LS123	0.82	4009	0.45	4089	1.55
7403	0.12	74100	0.94	74193	1,05	74LS124	2.45	4010	0.48	4093	0.65
7404	0.13	74104	0.40	74194	0.90	74LS125	0.44	4011	0.15	4094	1.80
7405	0.13	74105	0.40	74195	0.84	74LS126	0.44	4012	0.16	4095	1.10
7406	0.28	74107	0.28	74196	0.90	74LS132	0.69	4013	0.42	4096	1.10
7407	0.28	74109	0.45	74197	0.90	74LS136	0.40	4014	0.80	4097	3.50
7408	0.14	74110	0.46	74198	1.48	74LS138	0.53	4015	0.77	4098	1.12
7409	0.14	74111	0.70	74199	1.48	74LS139	0.53	4016	0.42	4099	1.90
7410	0.13	74116	1.60	74221	1.50	74LS151	1.05	4017	0.77	4404	1.00
7411	0.18	74118	0.82	74273	2.15	74LS153	0.50	4018	0.87	4412	0.30
7412	0.21	74119	1.30	74279	1.25	74LS154	1.20	4019	0.42	4428	0.80
7413	0.25	74120	0.82	74283	1.70	74LS155	0.86	4020	0.92	4445	1.50
7414	0.54	74121	0.25	74284	6.85	74LS156	0.86	4021	0.82	4449	0.30
7416	0.27	74122	0.40	74293	1.35	74LS157	0.47	4022	0.82	4501	0.17
7417	0.27	74123	0.53	74298	1.92	74LS158	0.53	4023	0.15	4502	0.88
7420	0.13	74125	0.44	74390	1.92	74LS160	1.22	4024	0.66	4507	0.50
7421	0.28	74126	0.45	74393	2.12	74LS161	0.69	4025	0.15	4508	2.25
7422	0.17	74128	0.82	74LS00	0.19	74LS162	1.22	4026	1.28	4510	1.05
7423	0.25	74132	0.68	74LS01	0.19	74LS163	0.69	4027	0.50	4511	0.98
7425	0.20	74135	0.68	74LS02	0.19	74LS164	1.20	4028	0.67	4512	0.92
7426	0.25	74136	0.75	74LS03	0.19	74LS168	2.00	4029	0.86	4514	2.85
7427	0.25	74137	0.94	74LS04	0.20	74LS169	2.00	4030	0.48	4515	2.80
7428	0.34	74141	0.58	74LS05	0.20	74LS170	1.76	4031	2.34	4516	1.02
7430	0.13	74142	2.00	74LS08	0.19	74LS173	1.05	4033	1.25	4518	0.99
7432	0.24	74143	2.00	74LS09	0.19	74LS174	1.12	4034	2.00	4519	0.50
7433	0.32	74144	2.00	74LS10	0.19	74LS175	1.05	4035	1.00	4520	1.05
7437	0.24	74145	0.64	74LS11	0.19	74LS189	2.85	4036	2.40	4521	2.00
7438	0.24	74147	1.30	74LS12	0.19	74LS190	0.81	4037	0.99	4522	1.35
7440	0.13	74148	1.18	74LS13	0.46	74LS191	0.81	4038	1.00	4527	1.60
7441	0.52	74150	0.99	74LS14	1.10	74LS192	1.80	4039	2.80	4528	0.92
7442	0.55	74151	0.60	74LS15	0.19	74LS193	1.80	4040	0.88	4529	1.10
7443	0.90	74153	0.60	74LS20	0.19	74LS195	1.12	4041	0.77	4536	3.56
7444	0.90	74154	1.05	74LS21	0.19	74LS196	1.20	4042	0.72	4553	4.20
7445	0.70	74155	0.63	74LS22	0.19	74LS197	1.20	4043	0.82	4555	0.85
7446	0.70	74156	0.63	74LS26	0.24	74LS221	1.12	4044	0.82	4556	0.85
7447A	0.64	74157	0.63	74LS27	0.40	74LS247	0.97	4045	1.40	4558	1.25
7448	0.60	74159	1.70	74LS30	0.19	74LS248	0.97	4046	1.32	4566	1.40
7450	0.13	74160	0.80	74LS32	0.25	74LS249	0.97	4047	0.96	4583	0.75
7451	0.13	74161	0.80	74LS37	0.27	74LS251	1.00	4048	0.60	4585	1.03
7453	0.13	74162	0.80	74LS38	0.27	74LS253	1.05	4049	0.42		
7454	0.13	74163	0.80	74LS40	0.19	74LS257	1.05	4050	0.42		
7460	0.13	74164	0.89	74LS42	0.53	74LS258	1.05	4051	0.84		
7470	0.28	74165	0.89	74LS47	0.97	74LS266	0.39	4052	0.84		
7472	0.22	75166	0.99	74LS48	0.97	74LS273	2.50	4053	0.84		
7473	0.26	74167	2.70	74LS49	0.97	74LS279	0.50	4054	1.10		
7474	0.26	74170	1.68	74LS51	0.19	74LS283	1.00	4055	1.00		
7475	0.30	74172	4.00	74LS54	0.19	74LS289	2.85	4060	0.98		
7476	0.26	74173	1.18	74LS55	0.20	74LS293	0.90	4066	0.48		
7480	0.45	74174	0.89	74LS73	0.30	74LS298	1.60	4067	3.50		
7481	0.90	74175	0.68	74LS74	0.34	74LS352	0.92	4068	0.24		
7482	0.80	74176	0.88	74LS75	0.45	74LS353	1.05	4069	0.17		
7483	0.72	74177	0.88	74LS76	0.32	74LS365	0.50	4070	0.17		
7484	0.90	74178	1.20	74LS78	0.32	74LS366	0.50	4071	0.17		
7485	0.88	74179	1.10	74LS83	0.78	74LS367	0.50	4072	0.17		
7486	0.26	74180	0.90	74LS85	0.90	74LS368	0.50	4073	0.17		
7489	2.00	74181	1.92	74LS86	0.35	74LS386	0.37	4075	0.17		
7490	0.35	74182	0.75	74LS93	0.95	74LS670	2.00	4076	1.05		
7491	0.65	74184	1.20	74LS95	1.10	4000	0.14	4077	0.46		
7492	0.44	74185A	1.20	74LS107	0.36	4001	0.15	4078	0.22		
7493	0.40	74186	7.20	74LS109	0.36	4002	0.16	4081	0.17		
7494	0.80	74188	2.70	74LS112	0.38	4006	0.92	4082	0.20		

WW — 094 FOR FURTHER DETAILS

U.K. RETURN OF POST MAIL ORDER SERVICE, ALSO WORLDWIDE EXPORT SERVICE

BSR DE LUXE AUTOCHANGER

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 cartridge.

£20 Post £1.60

HEAVY METAL PLINTHS

Cut out for most BSR or Garrard decks. Post £1.60
Silver grey finish.
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. **£3.50** each.
14½ × 12½ × 3in. **£3.50** each.
15¼ × 13½ × 4in. **£4.** 18 × 13¼ × 4in. **£6.**
17¼ × 9½ × 3½in. **£3.** 18 × 12½ × 3in. **£6.**
14½ × 14¾ × 2½in. Rosewood sides **£4.** Post £1.60
Ideal for record decks, tape decks, etc.

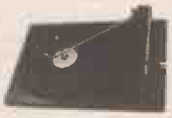
BSR SINGLE PLAYER

Ideal replacement or disco deck with cueing device and stereo ceramic cartridge. 3 speeds. Large turntable, modern design **£21** Post £1.60

TWO-SPEED BUDGET MODEL £15.

BSR P182 3 speeds flared aluminium turntable "S" shape arm, cueing device, ceramic cartridge **£24.** Post £1.60
BSR MP60/P128 Stereo Ceramic, balanced arm, cueing device. Bias compensator **£26.** Magnetic **£5** extra.

GARRARD HI-FI MINI CHANGER



3-speed stereo cartridge.
Plays all size records
£8.95 Post £1.60

B.S.R. P163 BELT DRIVE QUALITY DECK

Manual or automatic play. Two speeds. Precision balanced arm. Slide in head, cueing device. Bargain price
£30 Post £1.60
Suitable magnetic cartridge **£6.50.**

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 75p
20 watt woofer bass unit only **£7.95** Post 75p

LOW VOLTAGE POWER PACK for MODELS

Ready made. Famous make. Will supply 10 volts D.C. at 400mA. With terminals and mains lead. **£2.75** Post 50p

POTENTIOMETERS

With spindles
5kΩ to 2MΩ. LOG or LIN.
L/S **35p.** DP **60p.**
Stereo L/S **85p.** DP **£1.**
Edge Pot 5K. SP **45p.**
Sliders Mono **65p.** Stereo **85p.**

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

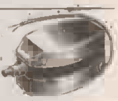
With tweeter and crossover. 10 watt. 3 or 8 ohm.
£9.95 Post 75p

With tweeter and crossover. 8 ohm. 15 watts.
£10.95 Post 75p

Bass woofer only 15 ohm. 20 watt. **£10.95** Post 75p

Suitable Bookshelf Cabinet
Teak finish. For EMI 13 x 8 speakers.
Size 16 x 11 x 8 inches approximately. **£9.50** Post £1.60

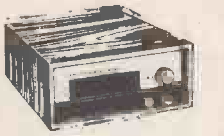
THE "INSTANT" BULK TAPE ERASER



Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/250V. Leaflet S.A.E.
Will also demagnetise small tools **£7.50**
Head Demagnetiser only £5.00 Post 50p

RELAYS. 12V DC **95p.** 6V DC **85p.** 240V AC **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—**20p.**
ALUMINIUM PANELS. 6 x 4—**24p**; 8 x 6—**38p**; 14 x 3—**40p**; 10 x 7—**58p**; 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 SP **30p.** DPST **40p.** DPDT **50p.**
MANY OTHER TOGGLES IN STOCK. Please enquire.
PICK-UP CARTRIDGES ACOS, GP91 **£2.00.** GP94 **£2.50.**
SONOTONE 9TAHC Diamond **£3.75.** V100 Magnetic **£6.50.**
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt **15p.**
CASSETTE MOTOR. 6 volt **£1.00.**
CASSETTE MECHANISM. Mono heads, no motor **£3.00.**

MAINS OPERATED SOLID STATE AM/FM STEREO TUNER



200/240V AC Mains. F.M./A.M. Stereo Tuner. Covering M.W., A.M. 540-1605KHz. V.H.F., F.M. 88-108MHz. Ferrite rod aerial for M.W. Full AFC and AGC on A.M. and F.M. Stereo Beacon Indicator. Built-in Pre-amps with variable output adjustable by pre-set control. Max. o/p Voltage 600mV R.M.S. into 20K. Simulated Teak finish cabinet. Will match almost any amplifier. Size 8¼in wide, 4in. high x 9½in. deep approx.
Only **£28** Post £1.60

RCS SOUND TO LIGHT KIT Mk. 2 £18

Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel. Suitable for home or disco. Post 50p
Easy to build. Full instructions supplied. Cabinet **£4.50** extra.
Will operate from 200MV to 10D watt signal.

"MINOR" 10 watt AMPLIFIER KIT £12.50

This kit is suitable for record players, guitars, tape playback, electronic instruments or small PA systems. Two versions available: Mono, **£12.50**; Stereo, **£20.** Post 45p. Specification 10W per channel; input 100mV; size 9½ x 3 x 2in. approx. SAE details. Full instructions supplied. AC mains powered.
Input can be modified to suit guitar.

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

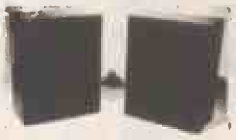
MAINS TRANSFORMERS ALL POST 75p.

250-0-250V 70mA, 6.5V, 2A	£3.45
250-0-250V 80mA, 6.3V 3.5A, 6.3V 1A	£4.60
350-0-300V 100mA, 6.3V 3.5 amp	£5.80
300-0-300V 120mA, 2×6.3V 2A C.T.; 5V 2A	£8.50
220V 45mA, 6.3V 2A	£2.60
HEATER TRANSFORMER, 6.3V ½ amp £2.00 3 amp	£2.20
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs available	
2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V	£6.00
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£6.00
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£9.50
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£12.50
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£16.00

12V, 100mA	£1.30	20V, 40V, 60V, 1 amp	£4.00
12V, 750mA	£1.75	12V, 3 amp	£3.50
10-0-10V 2amp	£3.00	10V, 30V, 40V, 2 amp	£3.50
30V, 5 amp and 17V-0-17V, 2 amp	£4.00	40V, 2 amp	£3.50
0, 5, 8, 10, 16V, ½ amp	£2.50	20V, 1 amp	£3.00
9V, 3 amp	£3.50	20V-0-20V, 1 amp	£3.50
25-0-25V 2 amp	£4.50	30V-0-30V, 2 amp	£8.00
30V, 2 amp	£3.50	2 of 18V, 6 amp, each	£11.00
30V, 1½ amp	£3.30	12-0-12V, 2 amp	£3.50
		9V, ¼ amp	£1.50

AUTO TRANSFORMERS 115V to 230V or 230V to 115V 150W .. £7.00
250W......£8.00. 400W......£8.00 500W......£10.00
FULL WAVE BRIDGE CHARGER RECTIFIERS.
6 or 12V outputs. 2 amp.....**75p.** 4 amp.....£1.60
CHARGER TRANSFORMERS: 1½ amp..£1.60. 3 amp..£4.00..4 amp..£6.50
12V, 1½ amp Half Wave Selenium Rectifier **25p**

COMPACT SPEAKERS



WHITE PLASTIC CABINET
13 × 10 × 6in. approx.
50 to 14,000 cps. 10 watts. 4 ohm
£16 pair Post £1.60

STEREO SPEAKERS £8 pair

Globe shaped cases in high gloss mouldings of red or green, are finished with chrome frontal trim. In addition, 2½ metres of twin lead already fitted with phono plug is supplied.
5in. diameter
Full Range Quality
Frequency Response
5 watts. 8 ohms 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**; 420mF/500V **£1.30.**
1000mF 12V **17p**; 25V **35p**; 50V **47p**; 100V **70p.**
2000mF 6V **25p**; 25V **42p**; 40V **60p**; 1200mF 76V **80p.**
2500mF 50V **62p**; 3000mF 25V **47p**; 50V **65p.**
4500mF 64V **£2**; 4700mF 63V **£1.20.** 2700mF/76V **£1.**
5000mF 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**
50/500V **£1.20**	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 **80p**; 500pF slow motion **75p.**
365 + 365 + 25 + 25pF, Slow motion drive **85p.** 120pF **50p.**
TRANSISTOR TWIN GANG, 50p.
NEON PANEL INDICATORS 250V. Amber or red **30p.**
ILLUMINATED ROCKER SWITCH. single pole. Red **65p.**
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.**

"VALVES" special offer subject to being unsold £1 ea. Post Free

6A1116	12K7GT	PCF82	PL84	EBF80	EF80
6K8G	35L6GT	PCF86	PY33	ECC83	EM84
6Q7G	954	PCL82	PY80	ECC84	EM85
6V6G	30PL1	PCL84	PY82	ECF80	EM87
12Q7GT	35Z4GT	PL81	PY83	ECL80	EY51
12K8M	PCC84	PL82	EB91	ECL82	EY86
25Y5G	PCC89	PL83	EBC81	EF41	EZ40

BAKER LOUDSPEAKERS "SPECIAL PRICES"

Post £1.50 ea.

Model 8 or 16 ohms	Size	Power in watts	Type	Our price	List price
Major	12	30	Hi-Fi	£12	£17.25
Deluxe Mk II	12	15	Hi-Fi	£14	£19.75
Superb	12	30	Hi-Fi	£22	£27.60
Auditorium	12	45	Hi-Fi	£20	£27.60
Auditorium	15	60	Hi-Fi	£30	£40.25
Group 35	12	40	PA	£12	£17.25
Group 45	12	45	PA	£15	£17.25
Group 50	12	60	PA	£20	£26.45
Group 50	15	75	PA	£30	£40.25
Group 75	12	75	PA	£24	£27.60
Group 100	12	100	PA	£29	£33.35
Group 100	15	100	PA	£35	£40.25
Disco 100	12	100	Disco	£29	£33.35
Disco 100	15	100	Disco	£35	£40.25

BAKER AMPLIFIERS

for PA Disco. General purpose with built-in mixers and pre-amps.

50 watt 2 inputs 3 outputs
Our price £63 List price £72.45
Post **£2.00** each.

150 watt 4 inputs 3 outputs
OUR PRICE £85 List price £97.75

LOUDSPEAKERS. FAMOUS MAKES "SPECIAL PRICES"

Post £1.50 ea.

Make	Model	Size	Watts Power	Ohms	Our Price
Seas	Tweeter	4in round	50	8	£7.50
Goodmans	Tweeter	3½in square	25	8	£4.00
Audax	Tweeter	3¾in square	60	8	£10.50
Seas	Mid-range	4in	50	8	£7.50
Seas	Mid-range	5in	80	8	£10.50
Seas	Mid-range	4½in	100	8	£12.50
Goodmans	Full-range	8in	20	8	£5.50
Seas	Woofer	8in	30	8	£14.00
Moscow	General	10in	30	8	£10.50
McKenzie	Disco-group	15in	150	8+16	£56.00
Celestion	Disc-group	18in	100	8+16	£59.00
Celestion	Disco-group	18in	200	8+16	£69.00

TEAK VENEERED HI-FI SPEAKER CABINETS
For 13x8in. or 8in. speaker **£9.50** Post £1.00
For 6½in. speaker and tweeter **£8.50** 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.

GOODMANS TWIN AXIOM 8 inch dual cone loudspeaker, 8 ohm, 15 watt hi-fi unit **£10.50.**
CROSSOVERS. TWO-WAY 3000 c/s 3 or 8 or 15 ohm **£1.90.** 3-way 950 cps/3000 cps, **£2.20.**
LOUDSPEAKERS PM 3 OHM 7x4in. **£1.50;** 6½in., **£1.95;** 8x5in., **£1.90;** 8in., **£2.50.**
SPECIAL OFFER: 64 ohm, 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., 2¾in., 3½in., 5in. dia. **£1.50 each.**
PHILIPS LOUDSPEAKER, 8in., 4 ohms, 4 watts, **£2.50.**
RICHARD ALLAN TWIN CONE LOUDSPEAKERS
8in. diameter 4W **£2.50.** 10in. diameter 5W **£3.50;** 12in. diameter 6W **£4.50.** 3/8/15 ohms, please state.
MOTOROLA PIEZO ELECTRIC HORN TWEETER. £6.50
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**

GOODMANS RUBBER SURROUND 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 £1.60

ALUMINIUM HEAT SINKS. FINNED TYPE.
Sizes 5" x 4" x 1" **95p.** 6½" x 2" x 2¼" **45p**
JACK PLUGS Mono Plastic 25p; Metal 30p.
JACK PLUGS Stereo Plastic 30p; Metal 35p.
JACK SOCKETS Mono 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.

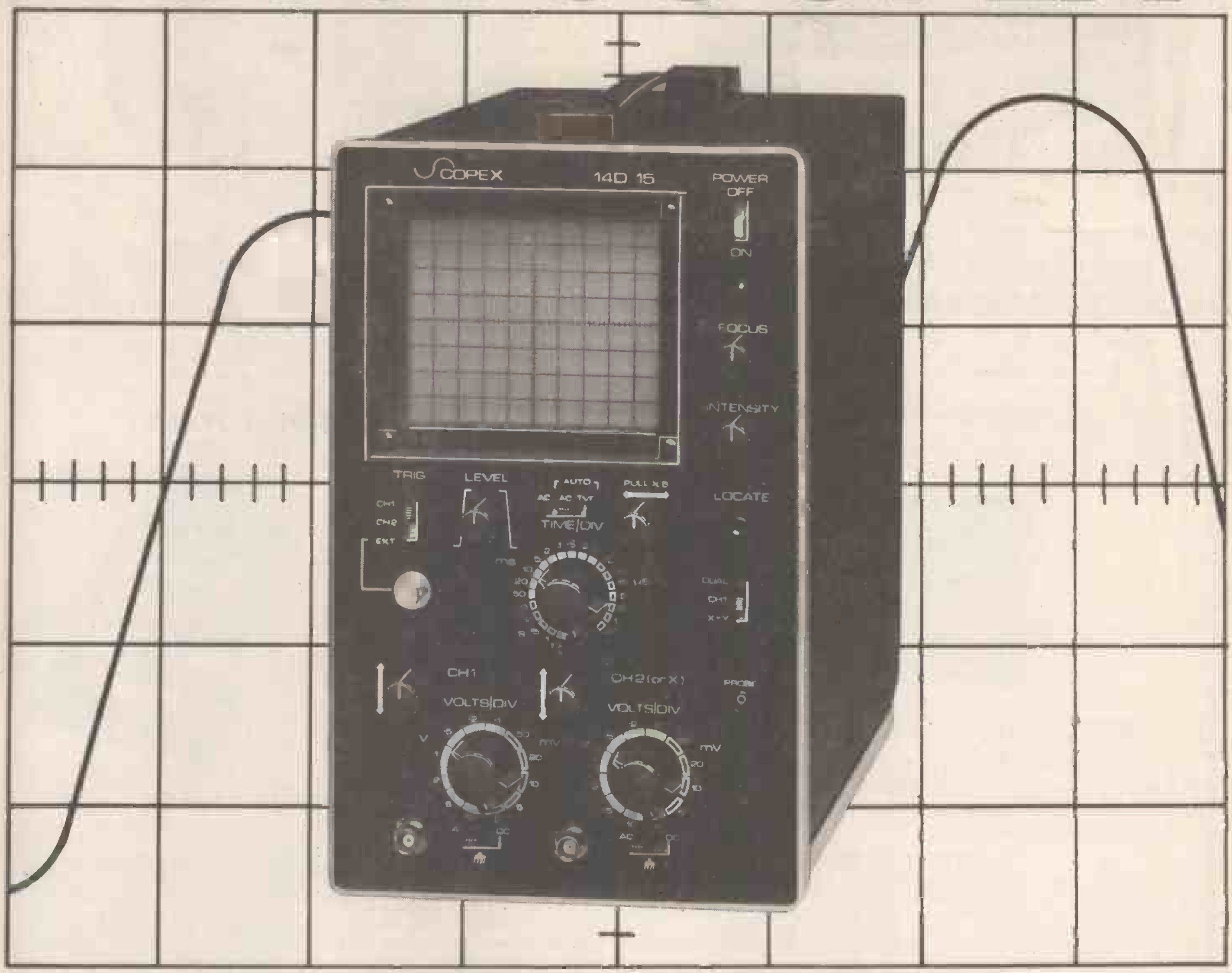
MONO PRE-AMPLIFIER. Mains operated solid state pre-amplifier unit designed to complement amplifiers without low level phono and tape input stages. R.I.A.A. equalisation on magnetic phono input and N.A.B. equalisation for tape heads. Phono sockets for input and output.
£5 Post 50p

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.) Access or Barclaycard please. Telephone: 01-684 1665 for same day despatch. Cash prices include VAT.

TRUST SCOPEX



The 14D-15 is the very latest addition to the Scopex range of brilliantly engineered, easy to use oscilloscopes.

Here's what it offers:-

- Large screen 10 cm x 8 cm
- Triggers on channels 1 and 2
- 2 mV – 10V/DIV sensitivity
- 3% accuracy – a Scopex speciality
- DC-15 MHz bandwidth over the entire screen
- Probe test output
- Wide time base range
- Switched mode power supply

Plus a host of well throught-out additional facilities, free delivery in the UK mainland and a very good price of £280 plus VAT.

Trust Scopex to get it right.

SCOPEX

Pixmore Avenue, Letchworth,
Herts. SG6 1JJ.
Telephone: 04626 72771.

WW—029 FOR FURTHER DETAILS

You've heard about it
Read about it — HERE IT IS

SCOOP OFFER

NASCOM-2

ONLY 500 KITS AVAILABLE AT THIS PRICE

AVAILABLE EX-STOCK
COMPLETE KIT AS PER
MANUFACTURER'S SPECIFICATION
With provision for 8K on board expansion. Excludes 4118 ×8*

INCLUDES FREE 16K EXPANSION
VALUE £140 includes ALL parts with every kit

NASCOM-2
ON DEMONSTRATION NOW

£295 + 15% VAT WITH FREE
16K EXPANSION WORTH £140

AVAILABLE ONLY FROM US ON THE COUPON BELOW

OPTIONAL EXTRAS
3 AMP POWER SUPPLY VAT 15%
£29.50 Post £1 50
For NASCOM-2

8 OFF 4118*
For NASCOM-2
PUR Chasers
£80 Early Delivery

RS232 COMPATIBLE
80 COLUMN PRINTER brand new
List price £550. If sent by carrier £5 extra
OUR PRICE **£325** + VAT 15%

FULL MANUFACTURER'S WARRANTY — DON'T DELAY, ORDER TODAY

Please send me my NASCOM-2 KIT with the FREE 16K EXPANSION for £295 + VAT.
I enclose remittance . . . . to cover
Name & Address . . . .

Also in stock NASCOM-1 ● ELF ● TRS80 as previously advertised

HENRY'S
Computer Kit Division
404 Edgware Road, London, W2, England
01-402 6822

DISPLAY ELECTRONICS

Would like to wish all their customers and business associates a Very Merry Christmas and Prosperous New Year

DISPLAY ELECTRONICS

Dept. W.W., 64-66 Melfort Rd., Thornton Heath, Surrey. Telephone: 01-689 7702

VALVES

Minimum Order £1.00

VALVES VAT IS INCLUDED

	£										
A1065	1.40	EH90	0.80	PL84	0.75	1A3	0.70	6F12	0.90	19G3	11.50
A2293	8.50	EL32	1.10	PL504	1.60	1L4	0.50	6F14	0.90	19G6	6.90
A2900	8.00	EL34	1.75	PL508	1.50	1R5	0.65	6F15	1.30	19H5	19.55
AR8	0.75	EL37	3.45	PL509	3.65	1S4	0.45	6F17	1.15	2001	0.75
ARP3	0.70	EL38	4.60	PL519	5.50	1S5	0.45	6F24	4.75	20F2	0.75
ATP4	0.60	EL81	1.20	PL802	3.15	1T4	0.45	6F33	4.75	20E1	1.30
B12H	3.35	EL82	0.70	PLL80	3.45	1U4	0.80	6H6	1.90	20P1	0.65
CY31	1.20	EL84	0.90	PY33	0.70	1X2B	1.30	6J4	1.60	20P3	0.80
DAF96	0.70	EL86	1.05	PY80	0.70	2021	0.80	6J4WA	2.00	20P4	1.30
DET22	21.95	EL90	0.90	PY81/800	0.70	2K25	12.40	6J5GT	1.35	20P5	1.30
DF96	0.70	EL91	3.25	PY82	0.60	2X2	0.90	6J6	0.85	25L6GT	0.95
DK96	1.05	EL95	0.80	PY83	0.60	3A4	0.70	6J7	0.90	25Z4G	0.85
DH76	1.00	EL500	1.85	PY88	0.80	3D6	0.50	6J7G	0.60	30C15	1.15
DL92	0.60	EL504	1.85	PY500	1.55	3D21	23.00	6K7	0.80	30C17	1.35
DY86/87	0.65	EL802	1.70	PY809	6.45	3E29	6.60	6K7G	0.50	30C18	2.10
DY802	0.65	EL822	7.50	PY801	0.70	4S4	0.60	6K8GT	0.65	(See PCF805)	
E55L	13.80	EM31	1.60	QQV03/10		4PR60B		6L6M	2.15	30F5	1.15
E80CF	8.32	EM80	0.70		2.85		106.80	6L6GT	1.75	30F12	1.70
E88CC/01	3.60	EM81	0.70	QQV03/12		5B/254M	8.80	6L7G	0.75	30FL12	1.45
E88CC	3.20	EM84	0.70		2.85	5B/255M	8.80	6L18	0.70	30FL14	2.05
E92CC	1.60	EM87	1.15	QQV03/20A		5B/258M	8.80	6LD20		30L15	1.15
E90CC	1.60	EY51	0.55		14.40	5R4GY	1.30	6Q7G	0.95	30L17	1.15
E180CC	1.60	EY81	0.65	QQV03/25A		5U4G	1.10	6SA7	0.65	30P12	1.15
E180F	6.80	EY86/87	0.65		21.30	5V4G	0.80	6SG7	0.90	30PL1	1.15
E182CC	3.95	EY88	0.65	QQV06/40A		5Y3GT	0.80	6SJ7	0.80	30PL13	1.25
EA76	2.25	EZ80	0.65		16.10	5Z3	1.15	6SJ7GT	0.60	30PL14	1.25
EABC80	0.60	EZ81	0.70	QV03-12	2.80	5Z4G	0.85	6SK7	1.05	35L6GT	1.15
EB91	0.65	GY501	1.05	SCL/400	4.50	5Z4GT	0.90	6SL7GT	0.85	35W4	0.80
EBC33	1.15	GZ32	0.75	SCL/600	4.50	6AB4 see EC92		6SN7GT	0.85	35Z4GT	0.85
EBF80	0.60	GZ33	3.95	SP61	0.95	6AB7	0.70	6SQ7	0.85	50C5	1.35
EBF83	0.60	GZ34	2.30	TT21	11.80	6AC7	0.70	6V6GT	0.95	50CD6G	1.45
EBF89	0.80	GZ37	2.80	TY2/125	52.80	6AH6	1.15	6X4	0.70	75	1.25
EC52	0.50	KT66	6.30	U25	1.15	6AK5	0.95	6X5GT	0.65	75C1	1.05
EC91	6.20	KT88	8.95	U26	1.00	6AK8	0.60	6Y6G	1.10	76	0.95
EC91	1.05	MH4	1.15	U27	1.15	6AL5	0.50	6Z4	0.75	78	0.95
ECC81	0.65	ML6	1.15	U191	0.85	6AL5W	0.80	6-30L2	2.06	80	0.90
ECC82	0.60	N78	10.45	U281	0.65	6AM5	3.25	7B7	0.90	85A2	1.45
ECC83	0.65	OA2	0.65	U301	0.65	6AM6	1.30	7V4	0.90	723A/B	12.80
ECC84	0.55	OB2	0.70	U600	11.50	6AN8	3.60	9D2	0.70	80	6.95
ECC85	0.60	PABC80	0.60	U801	0.90	6AQ4	6.20	9D6	0.85	805	20.70
ECC86	1.40	PC85	0.60	UBC41	1.20	6AQ5	0.90	10C2	0.70	807	1.15
ECC88	0.75	PC86	0.95	UABC80	0.90	6AQ5W	1.45	10F18	0.70	813	13.30
ECC189	0.95	PC88	0.85	UAF42	0.85	6AS6	0.90	10P13	1.20	829B	16.00
ECF80	0.60	PC900	1.45	UBF80	0.70	6AT6	0.85	11E2	12.40	832A	5.20
ECF82	0.55	PCC84	0.75	UBF89	0.60	6AU6	0.65	12A6	0.70	866A	3.20
ECF801	0.90	PCC85	1.05	UBL1	1.15	6AV6	0.60	12AT6	0.55	931A	12.00
ECH34	1.15	PCC89	0.65	UBL21	2.50	6AX4GT	0.95	12AT7	0.65	954	0.60
ECH35	1.70	PCC189	0.75	UCC84	0.75	6AX5GT	1.15	12AU7	0.60	955	0.70
ECH42	0.95	PCF80	0.95	UCC85	0.80	6B7	0.85	12AV6	0.80	956	0.60
ECH81	0.60	PCF82	0.70	UCF80	0.90	6BA6	0.50	12AX7	0.65	957	1.05
ECH84	1.20	PCF84	0.75	UCH81	0.70	6BE6	0.60	12BA6	0.60	1625	1.15
ECL80	0.70	PCF86	0.80	UCL82	0.85	6BG6G	1.15	12BE6	1.25	1629	0.85
ECL82	0.65	PCF200	1.05	UF41	0.90	6BH6	0.95	12BH7	1.10	2051	1.20
ECL83	1.40	PCF201	1.05	UF80	0.60	6BJ6	1.25	12C8	0.65	5763	4.40
ECL85	0.75	PCF801	1.05	UF85	0.70	6BQ7A	0.70	12E1	4.95	5842	7.50
ECL86	0.75	PCF802	0.75	UL41	1.20	6BR7	2.70	12J5GT	0.55	5933	3.50
EF22	3.40	PCF805	2.10	UL84	0.85	6BW6	5.18	12K7GT	0.70	6057	1.05
EF37A	1.70	PCF806	0.95	UM80	0.70	6BW7	1.15	12K8GT	0.80	6060	1.05
EF39	3.30	PCF808	2.06	UM84	0.70	6C4	0.70	12Q7GT	0.65	6064	1.05
EF40	0.80	PCH200	0.95	UY82	0.65	6C6	0.70	12SC7	0.65	6065	1.40
EF41	0.85	PCL81	0.70	UY85	0.60	6CH6	7.50	12SH7	0.85	6067	1.15
EF80	0.75	PCL82	0.75	VR105/30	2.15	6CL6	1.70	12SJ7	0.65	6080	4.90
EF83	1.70	PCL84	0.80	VR150/30	1.45	6CY5	1.15	12SQ7	0.85	6146	4.95
EF85	0.55	PCL86	0.80	X66	1.05	6D6	0.85	12Y4	0.55	6146B	5.20
EF86	0.90	PCL805/85		X61M	1.70	6EA8	3.20	13D6	0.70	6360	2.30
EF91	1.30		0.85	XR1/6400A		6F6GB	0.85	14S7	1.15	6550	6.60
EF92	0.85	PD500	4.35		82.90	6F8G	0.85	19AQ5	0.90	6870	14.00
EF95	0.95	PFL200	2.80	Z759	9.00						
EF183	0.85	PL36	0.95	Z800U	3.45						
EF184	0.90	PL81	0.85	Z801U	4.00						
EF804	2.30	PL82	0.60	Z803U	3.90						
EFL200	0.95	PL83	0.60	Z900T	2.55						

SPECIAL VALVES

4CX 1000A	YL 1430	BR 189
4CX 5000A	YL 1440	CV 6131
BM 25L	GXU 6	GMU 2
BW 153	CV1597	TY4-500
DM 25LB	CV 2116	BK485/5552A
YL 1420	4CX 1500B	MIL 5948/1754

VIDECON TUBE TYPE P863B
English Electric — £20

VALVES AND TRANSISTORS

Telephone enquiries for valves, transistors etc retail 749 3934 trade and export 743 0899

PRICES MAY VARY

TELUROMETER MRA3 DISTANCE MEASURERS
LOW RESISTANCE HEADPHONES TYPE CLB £1.50. 40p postage. VAT 15%.
CONTINUANCE TELEPHONE DRUM YC00433
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 CPRC 26
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
DRUM CABLE continuous connection YC 00433

INTEGRATED CIRCUITS

SN7401N	0.32	SN74L73N	0.38	SN76033N	1.95
SN5402N	0.28	SN7474N	0.30	MC6800P	8.20
SN5410F	0.32	SN7485N	0.95	MC68B00P	9.80
SN5470F	0.48	SN74L85N	1.10	MC14511BAL	2.95
SN54196J	1.20	SN7491AN	0.32	B1702AL	4.30
SN7407N	0.29	SN74123N	0.42	MM6300-1J	3.80
SN7408N	0.18	DM74123N	0.38	MCM6810AP	3.40
SN7445P	0.85	SN15836N	0.26	6340-1J	3.60
SN74453P	1.10	SN760013N	1.80	MIC945-5D	0.28
SN7453N	0.18	SN76003N	1.60	MIC936-5D	0.22

36' AERIAL MASTS consisting of 6 sections 6' 8" × 2¼" dia Complete with all accessories to erect and instal

Mullard C11. High power installation, 1000W. Technical details and prices available on request. For export only.

SPARES FOR AR88-D. Ask for list.

POSTAGE: £1-£3 30p; £3-£5 40p; £5-£10 45p; over £10 free.

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.

HI-FI TONE ARM BARGAINS
—from Britain's Leading Audio Store

ARISTON 8A 100 — low mass high quality arm. S shaped. Low compliance. Universal SME type Head Shell Complete with anti-skating device. SONIC PRICE **£15.95**

AUDIO TECHNICA AT-1007
S shaped arm. Low compliance magnesium universal head shell. Low capacitance heads. High trackability. SONIC PRICE **£29.95**

ALL LEADING MAKES OF HI-FI and MANY OTHER ACCESSORY BARGAINS AVAILABLE FROM THE COMMUNICATIONS CENTRE:

ALL GOODS SUPPLIED WITH FULL 2 YEARS GUARANTEE
OPEN 9.00am 6.00pm Mon Sat
ACCESS BARCLAYCARD DINERS CLUB & AMERICAN EXPRESS WELCOME INSTANT CREDIT FACILITIES

LONDON'S LEADING HI FI SPECIALISTS
SONIC SOUND AUDIO
248-256 Tottenham Court Road London W1
Tel HI FI Dept 01 580 9311 RADIO Dept 01 637 1908

WW — 084 FOR FURTHER DETAILS

NO COMPETITION

The superb 3.77 is the only choice in compact professional recorders.

Who says?

Hundreds of satisfied professional users—Broadcast authorities, studios, record companies, universities etc etc.

What makes it the best?

The 3.77 provides more performance and features for your £ than any other model. Like 3 speeds, flat metal facia with excellent editing facilities, 100% variable speed control, logic control with motion sensing, line-up oscillator.

An ITA Product.

1-7 Harewood Avenue, Marylebone Road, London NW1. Tel: 01-724 2497. Telex: 21879

WW — 086 FOR FURTHER DETAILS

OLIVETTI PRINTER & KEYBOARD type Te 300

with PUNCH & READER. Upper case ASCII with V24 Interface. 240 volt operation.

£125 each

INFRA RED IMAGE CONVERTER type 9606 (CV 144)

1¾x2" diameter. Requires single low current 3KV to 6KV supply. Individually boxed. With data.

£12.50 each P&P 75p.

Infra Red Lamps also advertised

TELETYPES KSR33

Upper case ASCII with 20MA Loop. This is a printer with Keyboard (no Punch or Reader on this model).

£225 each

HONEYWELL VDU

1920 Character Upper Case ASCII. With edit and block transmission. Limited quantity with data.

NEW LOW PRICE £200 each

BRUEL & KJOER EQUIPMENT

AUDIO FREQUENCY SPECTOMETER type 2112 **£175 ea.**
BEAT FREQUENCY OSCILLATOR type 1013 **£140**
BEAT FREQUENCY OSCILLATOR type 1014 **£140**
BEAT FREQUENCY OSCILLATOR type 1022 **£140**
AUTOMATIC VIBRATION EXCITER CONTROL type 1018 **£90**
AUTOMATIC VIBRATION EXCITER CONTROL type 1019 **£90**
AUTOMATIC VIBRATION EXCITER CONTROL type 1016 **£90**

POLARAD SPECTRUM ANALYSER

5" Display. These are supplied with STU 2 plug-in. 1 to 4.5GHZ

£125 each.

MARCONI SPECTRUM ANALYSER Type TF1094

This gigantic but superb analyser covers from 100HZ to 30MHZ with a 6HZ resolution. 5" display. Complete with trolley.

£75 each.

TRANSISTOR INVERTOR 115V 50/60 HZ INPUT

These run at 20KHZ. They can be modified to be a switching power supply or to provide EHT for VDU, Oscilloscopes, etc. or the output core could be rewound to provide any voltage/current within the units rating. As supplied they have multiple outputs. A schematic is provided. Size 3½×4×8⅛". All units are tested before dispatch.
£3.25. P&P £1.50.

CROWN replacement MOTOR for IBM GOLF-BALL TYPEWRITERS.

115 volt 50HZ 1350 rpm.
£4.50 each P&P £1.50.

STEPPING MOTORS

6/12 position with additional where the rotor is coils. Device can be used as a tacho. Diagram supplied. Will actually work on 5 volts. 12/24 recommended.
£1.50 each P&P 75p or **5 for £5** P&P £1.50.

R&S GEN BN 41026 SCR 1000-19000MHZ	£120
R&S GEN BN 41027/2 SBR 1700-2700MHZ	£140
R&S GEN BN 41022 SDR 300-1000MHZ	£90
R&S GEN BN 41023/2 SOAF AM/FM Video	£200
R&S GEN BN 1524 USVU 0.9-2.7 GHZ	£180
R&S GEN BN 4105 SMLM Power Sig Source	£160
R&S GEN BN 2412/50 NRD 0-3200MHZ	£120
R&S GEN BN 4242 SWH 50KHZ-12MHZ	£120
R&S POLYSKOP BN 4244 SWOB	£300
R&S GEN BN4105 SMLM 30-305 MHZ	£75
R&S GEN BN1523 USVD 280-940 MHZ	£120 ea.
R&S GEN BN422 WID 30-300MHZ	£120
FERROGRAPH Recorder Test Set RTS 2	£350
HEWLETT PACKARD Oscilloscope type 120B	£190
HEWLETT PACKARD AC Convertor type 3461A	£240
HEWLETT PACKARD Synchronizer type 8708A	£260
RACAL Auto Freq Convertor 803R 500MHZ	£80
COHU DC Voltage Standard 303B	£350 ea.
AVO Precision meter	£75 ea.
PYE pH Meter Model 79	£120
POLARAD Sig source Model 1208A 7-11GHZ	£120
FLUKE RMS Voltmeter type 910A	£60
TELONIC SWEEPER SM2000 0-1800MHZ in 3 plug-in units	£150
WAYNE KERR Bridge CT 530 with adaptor	£150 ea.
TELONIC SWEEPER SD-3 450-900MHZ with markers	£65 ea.
TWENTY MILLION Megohm meter 8by E.1.	£40 ea.
SCOPEX oscilloscope type 4D10	£190 ea.
AVO 8 Mk 3 or similar	from £50
HEWLETT PACKARD Oscilloscope type 140A with Reflectometer plug-in	£250
MARCONI Gen type TF801D/1	£150
COSSOR CDU130 small, compact main/battery Oscilloscope. Batteries supplied	£240
MARCONI GEN type TF144H	£150
LABGEAR UHF/VHF PAL Colour Bar Gen. CM6052/C8	£90 ea.
MARCONI GEN TF1066B	£350
RANK FLETTER Meter type 1740	£50 ea.
AVO Sig Gen HF135/Taylor 68A/M	£120 ea.
TEK scope 545A with H plug-in	£125 ea.
TEK scope 545A with CA plug-in	£175 ea.
H.P. scope 175A 50MHZ Dual trace	£175 ea.
Single Trace	£125 ea
WAYNE KERR Universal Bridge CT375	£75 ea.
MARCONI Wave Analyser TF2330	£500 ea.
NOISE GENERATOR CT410 — covers audio to VHF	£8 ea.
NAGARD Pulse Generator 5002C	£50 ea.
MARCONI Wave Analyser type TF455E	£50 ea.
SOLARTRON DVM LM1420 with AC unit LM1477	£40 ea.
CALCOMP Drum Plotter type 564	£1,500
MARCONI Bridge TF868B	£120
VARIACS EX-Equipment Good condition 8 Amps	£25 ea.
20 AMPS	£35 ea.

Some 3 phase available. Please enquire.
CARRIAGE ALL UNITS £4 ea.

CRYSTALS
19.2KHZ FLAT METAL CASE — **50p each.**
10 MHZ B7G **50p each.**

EX-NAVAL 4ft dia **STEEL DISHES** NEW CRATED. 1 ft deep at centre. These are plain steel dishes with holes for various aerial options. **£22.50 ea.** Carriage £4.

LISTS AVAILABLE — WRITE OR PHONE.

TRANSFORMERS — Standard Mains input.
Secondary outputs.
6KV 0 125A **£15** ea.
3440V 0.66A with matching 40H Choke **£30** the pair.
8V 600 Amps **£25.**
5V 0-20-30-40-50-60V 40 Amps **£20. 5KV 300MA £15.**
12KV 30MA **£20.**
3KV 50MA £8 ea. 4 Volts 250 Amps **£10** ea.
18KV 30MA **£60.**
22.5KV 110MA **£50** ea.
60KV 0.0273 **£150.**
Input 200V 50HZ Sec 100KV 0.05 **£150.**
MULTI PURPOSE MAINS TRANSFORMER 4 windings each winding 0-10-110-125 at 4 8A **£15** ea.
425V 50HZ 2 Wire Input. Output 8 5KV 2.55KVA. Could be run on 240V at ½ rating **£15** ea.
STEP DOWN ISOLATING TRANSFORMER. Input 220, 250V 50HZ Output 115V 1.8KVA BRAND NEW. These are very conservatively rated **£20** ea.
CAPACITORS
10mfd 10KV DC Working **£4** ea.
2mfd 5KV **£4** ea.
0.5 mfd 5KV **£4** ea.
200mfd 4KV Rapid discharge **£10** ea
0.5 mfd 10KV £4 ea.
8 mfd 2.5KV £4 ea.
CARRIAGE on these units will be charged at cost.

INFRA RED QUARTZ LAMPS. 230V 620 Watts. Size 13½" × ⅛" dia. **£1.50.** P&P 50p.
BRIDGE RECTIFIER. 2 Amp **50p** ea.
PHOTODIODE DETECTOR 4" fly leads, **25p ea.**
A SUPERIOR KEYBOARD. Size 3 × 2½ × 2" high with 12 Alma Reed Switches. Blue keys marked in green 0-9 and a star with one black. NOW **£4 ea.** P&P 75p.
AMPHENOL. 17-way chassis mount edge connectors 0.1 spacing. **15p ea.**
I.E.C Standard **MAINS LEAD.** Moulded (3 vertical flat pins centre offset) **60p ea. P&P 50p**
FANS, 115V 13 Watts. Size 3¼ × 3¼ × 1½" BRAND NEW. **£4.50 ea.** Secondhand **£2.50 ea.** P&P 75p.
MOTOROLA REGULATORS, type 7812 12V 1 amp **65p ea.**
Miniature **MOTORS** 12V with geared wheel (8 teeth 3/16" dia). Size 1¼ × ⅞" dia New **30p ea.**
MOTOR 12V DC with pulley and integral semiconductor Speed Control New **£1 ea.** P&P 50p.
LEDEX ROTARY SOLENOIDS. 115V DC. No switch assembly. **15p ea.**
DIAMOND H CONTROLS ROTARY SWITCH. Single pole 10-way. Printed Circuit Mount. New **10p ea.**
DELAY LINE. 50 nanosecs. 3 connections, ground-in-out. Size 2× 7/16 × 16". New **25p ea.**
PULSE TRANSFORMER. Sub min. Size ½ × 5/16 × ¼". Secondary centre tapped. New **20p ea.**

MICROSWITCH. V3 style. Button 250V 6A. **15p ea.**
MOTOR by Inland Motor Corp. DC High Torque. Reversible. Usable torque at 5V. Max voltage 24V **£2.50 ea.** P&P £1.50.
REMO TY TYPE MULTIPLIER. Two high voltage outputs and focus **£2 ea.** P&P £1.
DON'T TAKE CHANCES. Use the proper **EHT CABLE. 10p per meter** or **£7.50 per 100 meter drum.** P&P £1.50.
MOTOR by Eastern Air Devices Inc 125V reversible with toothed shaft (10 teeth ¼" dia). Size 2¼ × 2⅛" dia **75p ea.** P&P £1
PHOTOGRAPHIC LAMPS. Pearl 230V 500 watt. Screw cap **75p ea.** Box of 12 **£5.50** P&P £1.50.
Decoupling **CAPACITORS** 0 05mfd 10V Size 0.25" between leads ¼" height **100 for £1.** P&P 50p.
CAPACITORS 0.01mfd. Size 5/16" between leads. ½" height. **100 for £1.** P&P 50p.
MYSTERY IC PACK. Some 40 pin — good mixture — all new devices **25 ICs for £1.** P&P 50p. You find out what they are and we will buy the information from you.

SUPERB 19" RACK CABINET. Approx 4' 6" high × 33" deep. Instrument front panel position can be adjusted. Chocolate colour These are new but have slight scratches and imperfections — hardly noticeable. **£35 each.** Carr £4.
VACUUM PUMPS — TRAPS, ETC. Send for list.
10-Way Multi-Colour Ribbon Cable New 40p per metre. P&P 50p.

SPEAKERS 2½". 50 ohm 0.2W New **40p each.** P&P 50p.
RAPID DISCHARGE capacitors 8mfd 4kV. **£5 each.** P&P £1.50.
GEC UHF 4 button tuner. **£2.50 each.** P&P 85p.
BIG INCH Motor 110V AC 3 rpm 50 cycle. Very small **50p each.** P&P 50p.
CENTAUR 115V AMS. 4.5 × 4 × 1½" **£4.50 each.** P&P 75p.
EX-USED Equipment, tested **60p each.** P&P 75p.
POTTER & BRUMFIELD TIMER RELAY, 115V AC. Heavy duty. 7 pole c/s with 2 second delay Charge R & C for different timing **50p each.** P&P 85p.
CONTRACTORS. Heavy Duty 24V DC 5 brake **£1** each. P&P 85p.
GPC UHF/VHF 6 button tuner **£4.50 each.** P&P £1.
DIGITAL 24-HOUR CLOCK with built-in alarm as used in Braun Digital clocks. Silent running. Large illuminated numerals. AC mains Size 6½ × 2¼ x 2¼" **ONLY £3.75 each.** P&P 50p.
531A PHOTO MULTIPLIER in stainless steel container with window and built-in resistor network **£2 each.** P&P £1.
SLIDER CONTROL 500W. Log Single track. Complete with knob. Length 3½". **25p each.** P&P 25p.
RANCO 250V 18A THERMOSTATS with Control knobs calibrated 50-200 degree F. **£2.50 each.** P&P £1.
SOLID STATE UHF TUNERS. 30 acs **£1 each.** P&P 75p.
BRAND REX blue wire wraps. 30 metres for **£1.** P&P 25p.
5in SOLID RUBBER RINGS (1" dia. rubber). Keep the kids (or dog) happy. **4 for £1.** P&P £1.25.

TRANSFORMERS
AUTO 240V input 115V. 1 Amp output **£1.25 each.** P&P £1.25.
240V input 8 ac, 6V. 1.86A 8kw 2½ × 2 × 2" Good quality **£1.50 ea.** P&P £1.
240V input 8ac. 12V 0.92A. Size 2½ × 2 × 2" Good quality. **£1.50 ea.** P&P £1.
240V input 12V100MA. Size 60 × 40 × 42mm. **50p each.** P&P 75p.
240V input 8ac 12-0-12V 50MA. Size 53 × 45 × 40mm **£1 each.** P&P 75p.
115V input. 8ac. 5V 250MA. Size 1 11/16 × 1 5/16 × 1¼" **2 for 50p.** P&P 75p.

SEMICONDUCTORS
At 2p each.
1M3063 1344.
At 5p each.
80147, BC148S, 8C157, 8C158, BC237, BC197, OA90, OA81, 8A154, BA243.
At 25p each.
DP31 TIP41A 2N5296, AF139, 2TX341
BY123 **10p.** BF181 **20p;** BD239 **40p;** BD241 **40p,** MA343AT **40p;** 6D228 **50p.** B0233 & BD234 Comp Pair 25W — **80p per pr at 50p each.**
Regulator TBA635 8 to 20V in — 5V out 180MA TD5 Con. **50p. each.** BF266C. 20p.
TV AMPLIFIER TBA 12D **20p each.**

Integrated Circuits

7453	5p	709	15p	75325	£1
7451	5p	74H74	12p	SN15862	4p
7401	5p	74H51	7p	MC4028	60p
7402	12p	74538	10p	7417	14p
7476	20p	74502	12p	7441	40p
7495	35p	74154	70p		

MOTOROLA DUAL in Line 6 pin Opto Coupler **30p each.** Gold plate tester version **50p each.**
AM9140 4K RAMS STATIC 5 Volt ceramic **£4 each.**
2708 **£5.50 each.** P&P 25p.
TELEPHONES. 706 style Black or Grey **£5.50 each.** 746 style Black of Grey **£7.50 each.** Older style Black **£2.50 each.** Postage £1 each.
Honeywell humidity Controllers **50p each.** P&P 40p
THYRISTOR TIMER. Solid State. 15 secs adjustable (reset) in plastic relay case. Standard 7 pin base Series delay **50p each.** P&P 85p.
MINIATURE PC MOUNT SLIDE SWITCH. Single pole 3-way **10p each.**
DIGITAL to ANALOGUE CONVERTER. 8 bit will fit standard TT1 socket. With data **£2.50 each.** P&P 25p
VARIACS. 2 amp Standard 240 Volts **£10 each.** P&P £1.50
ELECTROSTATIC VOLTMETERS. 7 5KV **£8 each.** P&P £1
Other ranges available Please enquire.
TRIMMERS. Sub min 0 25 to 1.25pf 1 to 4 5pf. 7 to 45pf. **All at 6p each.**

Minimum order £3 value of goods. P&P or Carriage and VAT at 15% on total must be added to all orders.
CALLERS VERY WELCOME STRICTLY BETWEEN 9am-1pm and 2-5pm Monday to Saturday inc.
BARCLAYCARD (VISA) and ACCESS taken. Official orders welcome

CHILTMEAD LTD

NORWOOD ROAD, READING **TELEPHONE NO. READING 669656**

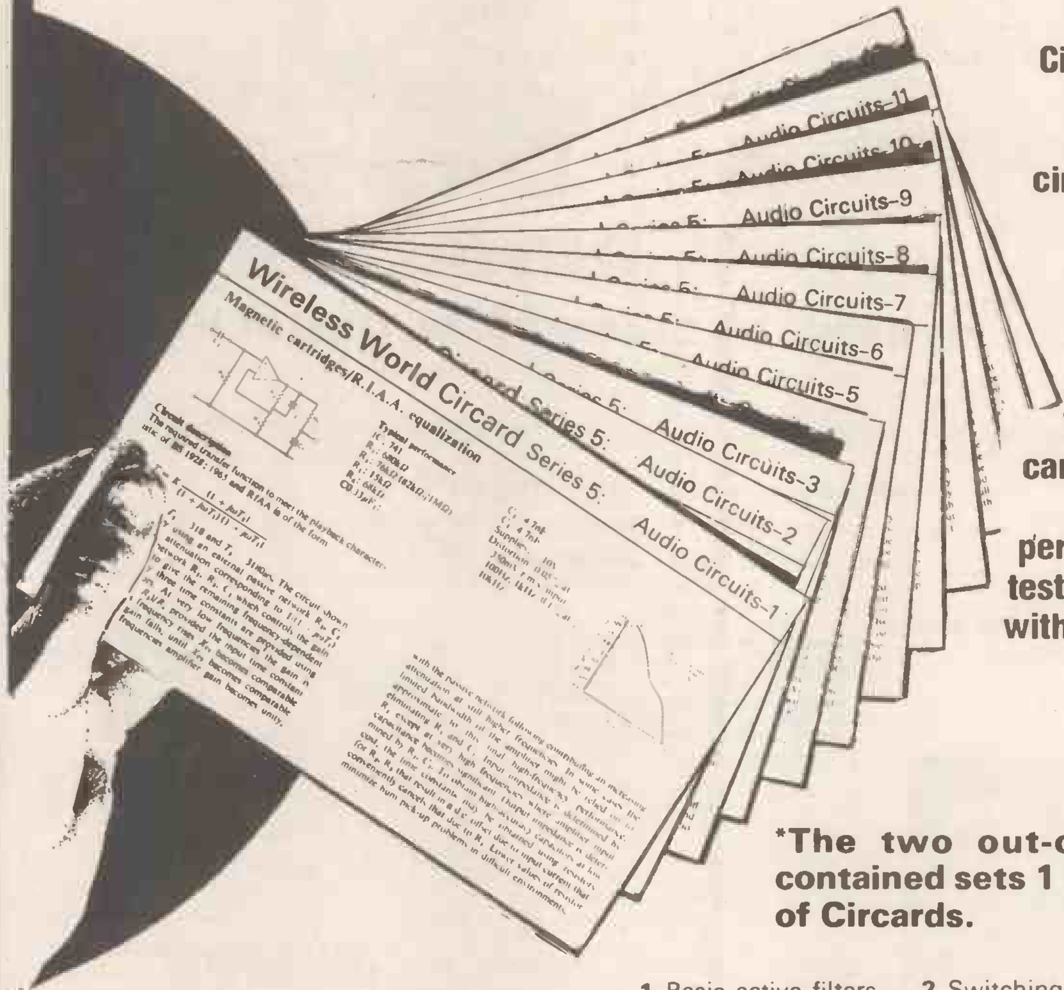
(2nd turning left past Reading Technical College in King's Road then first right — look on right for door with "Spoked Wheel")

Wireless World wishes to apologise to all parties concerned for any inconvenience caused by the publication in the December 1979 issue, of an advertisement purportedly on behalf of Nevenco Ltd. This was published due solely to an error on the part of Wireless World and not as the result of an order by any advertiser.

YOUR LAST CHANCE to obtain Wireless World Circards.

We still have some copies of the original Wireless World circuit cards, even though the companion bound volumes Circuit Designs 1 & 2* are out of print. Fill the gaps in your circuit files with these sets of 5 × 8in. (127 × 204mm) cards in plastic wallets — and at 1976 prices!

These unique circuit cards normally contain descriptions and performance data of 10 tested circuits, together with ideas for modifying them to suit special needs.



***The two out-of-print volumes contained sets 1 to 10 and 11 to 20 of Circards.**

1 Basic active filters **2** Switching circuits, comparators and Schmitts **3** Waveform generators **4** AC measurements **5** Audio circuits **6** Constant current circuits **7** Power amplifiers **8** Astable circuits **9** Optoelectronics **10** Micropower circuits **11** Basic logic gates **12** Wideband amplifiers **13** Alarm circuits **14** Digital counters **15** Pulse modulators **16** Current differencing amplifiers-signal processing **17** Current differencing amplifiers-signal generation **18** Current differencing amplifiers — measurement and detection **19** Monostable circuits **20** Transistor pairs **21** Voltage-to-frequency converters **22** Amplitude modulation and detection **23** Reference circuits **24** Voltage regulators **25** RC oscillators — 1 **26** RC oscillators — 2 **27** Linear cmos — 1 **28** Linear cmos — 2 **29** Analogue multipliers **30** Rms/log/power laws **31** Digital multipliers **32** Transistor arrays **33** Differential and bridge amplifiers **34** Analogue gate applications — 1 **35** Analogue gate applications — 2

To: General Sales Department, IPC Electrical-Electronic Press Ltd., Room CP34, Dorset House, Stamford Street, London SE1 9LU.

Please send me the following sets of Circards:

. . . .

£2 each, £18 for ten, inclusive.

I enclose cheque/money order for £

Make cheques payable to IPC Business Press Ltd.

Name . . . .

Address . . . .

. . . .

Company registered in England. Registered address, Dorset House, Stamford Street, SE1 9LU, England. Registered Number 677128

WW1

ELECTRO-TECH COMPONENTS LTD.

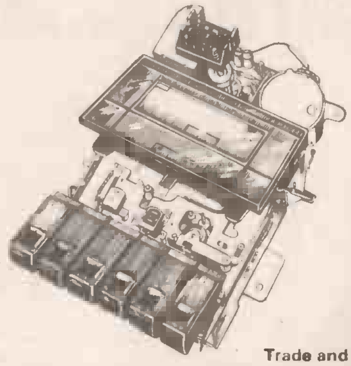
364 EDGWARE ROAD, LONDON, W.2. TEL: 01-723 5667

JVC-VICTOR HIGH FIDELITY STEREO CASSETTE TRANSPORT MECHANISM

ELECTRO-TECH COMPONENTS have secured a very large quantity of cassette transport mechanisms, equipped with all the latest improvements, as well as "SEN-ALLOY" type 1.5 micron record/replay heads, and solenoid-controlled auto-stop action. These were manufactured by JVC/VICTOR of Japan to specification of TANDBERG OF NORWAY, for inclusion in a cassette deck costing over £250. This mechanism alone would normally cost over £50.

FEATURES:

★ Close-tolerance, high-quality, top loading transport
★ "Sen-Alloy" (SA type) R/P head
★ Solenoid-driven autostop circuit
★ Automatic head cleaning device
★ Air damped "soft" cassette eject
★ Miniature microswitches for switching
★ Pre-aligned heads and calibrated motor speed regulator built in
★ Three-digit tape position counter
★ Six-function keyboard controls: "Record," "Rewind," "Forward," "Play," "Stop/Eject," "Pause."
★ PCB connectors and cables attached
★ High-mass balanced flywheel with permanent lubrication spindle
★ Full specifications for motor, heads, and switches available on request.



Price of above unit **£14.95**

Plus £1 P&P VAT Inc.

Trade and Export Enquiries Invited

Regular readers of WIRELESS WORLD will know of the original LINSLEY-HOOD CASSETTE DECK design, published in May 1976. Subsequent articles by Mr. Linsley-Hood have confirmed that the design far exceeded his original expectations, so much so that he published a number of improvements, modifications, and additional features to the original design, which are now incorporated in our:

★CASSETTE DECK KIT BASED ON DESIGN OF MR. LINSLEY-HOOD★

We have developed an outstanding stereo cassette kit with the aid of Mr. Linsley-Hood, to complement the improved specification and latest important advances in cassette electronics since the original design was published.

Included in the kit are two fibreglass PCB's, drilled and plated for immediate assembly, two VU meters, Dual LED Peak Meters, Variable Bias system, Power Supply, over 10 micro-circuit IC's for the most up-to-date performance, as well as monitoring amplifier, test and calibration cassette, etc.

Price of Kit (without transport mech.) £15.95 plus £1.00 P&P. VAT inc.

Also available: A custom-designed case for the Kit, this is a fully screened enclosure, sloping panel, satin anodised, wood end panels, professional finish.

Price of Case £9.75 plus £1.00 P&P. VAT inc.

HERE IT IS! THE BRAND NEW 8022A HAND-HELD DMM

Consider the following features:
6 resistance ranges from 200 ohm-20 ohms
8 current ranges from 2mA-2A AC/DC
10 voltage ranges from 200 mv-1000v DC-200 mc-750V AC
Pocket size — weighing only 370 gms.
Full overload protection — will withstand 6kv spikes
Rugged construction — virtually indestructable
Meets tough military specs — drop proof
In line, pushbutton operation for single-handed useage
Incorporates low power cmos chip for low power consumption
All this plus a 2-year full guarantee

For only £89
Carriage and Insurance £3

Even much more sophisticated the Fluke 8020A.
Identical in most respects to the 8022A but in addition incorporates a conductance range from 2mS-200nS.

£112

Carriage and insurance £3.00
A handsome soft carrying case is available for the 8020A and 8022A at £7.

OFF THE SHELF DELIVERY ON THESE

FLUKE ®

DIGITAL MULTIMETERS

BRAND NEW FROM FLUKE!!!
NOW AVAILABLE
THE 8024A HAND HELD DMM

This model incorporates all the features of the 8020A but in addition has:

A peak hold switch which can be used in AC or DC for volts and current functions.

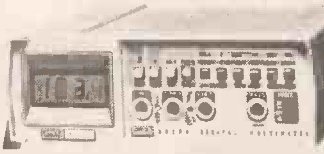
Audible continuity testing and level detection for sensing logic levels.

A temperature (°C) range for use with a thermocouple.

£135
Carriage and Insurance £3

The following accessories are in stock now

Y8008 Touch and Hold Probe	£18.00
80K-40 High Voltage Probe	£45.00
81RF RF Probe to 100 MHZ	£32.00
80T-150C Temperature Probe (C)	£55.00
801-600 Clamp-on AC Current Probe	£50.00



8010A AND 8012A BENCH MODEL D.M.M.s

The 8010A is a general purpose, bench/portable digital multimeter with more functions and features than ever offered for such a low price. Its companion, the 8012A, has identical characteristics except that it has two additional low resistance ranges, 2Ω and 20Ω to replace the 8010A's 10 ampere current range.
The 8010A and 8012A feature:
10 voltage ranges from 200mv - 1000v dc, 200mv - 75v ac.
3 conductance ranges from 2mS - 200 nS.
6 resistance ranges from 200Ω - 20mΩ - the 8012A has two additional resistance ranges 2Ω and 20Ω.
10 current ranges from 200μA - 2A AC/DC — the 8010A has two additional current ranges 10A AC and 10A DC.

8010A **£159** 8012A **£179**
Carriage and Insurance £3

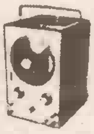
..e 80 10A is also available with two rechargeable Nicad size C batteries installed in option -- 01 at £179.00.

LOW COST, AUTORANGING MULTI-FUNCTION COUNTER

- Autoranging in both frequency and period measurement modes
- Wide Frequency range —5 Hz to 80 MHz
- High sensitivity —25 mV, typically 15 mV
- Six digit LED display with leading zero suppression, automatic annunciation and overflow
- Optional internal battery pack providing 4 hours continuous operation
- Autoreset on all gate times, all function switches
- Four manually selected gate times providing resolution to 0.1 Hz
- Event counting to 10^6 events with overflow indicator
- Signal input conditioning with switchable 1 MHz low pass filter and attenuator
- Rugged moulded case with convenient tilting/carrying handle
- Optional parallel data output with decimal point and annunciation
- Traditional high Fluke quality
- Self check

£175
Carriage and Insurance £3

TE20D R.F. SIGNAL GENERATOR



Accurately covers 120 KCS. To 500 MCS in 6 bands.
Directly calibrated. Variable R.F. Attenuator 240v AC.
Dimens. 140 x 215 x 170mm.

£52.95
P.&P £1.25

TMK500 MULTITESTER 30,000 OPV
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 x 110 x 55 mm

£20.50. P &P 75p

PLEASE ADD 15% VAT TO ALL ORDERS
CALLERS WELCOME
We are open 9 a.m.-6 p.m. Monday-Saturday
We carry a very large selection of electronic components and electro-mechanical items
Special quotations on quantities

IT 1/2 20,000 OPV
AC volts: 0 to 10, 50, 100, 500, 1000.
DC volts: 0 to 5, 25, 50, 250, 500, 2500.
DC 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 x 3¼ x 1 inch.

£10.95
P &P 75p

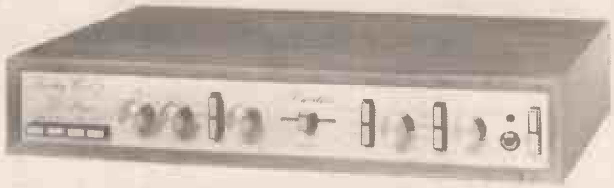
Y7206 EN 20,000 OPV
AC Volts. 0-10, 50, 250, 500, 1000.
DC Volts: 0-0.5, 5, 25, 125, 250, 500, 1000.
DC Current: 0-0.05, 5 250 mA
Resistance 0-3k ohms, 300k ohms, 3 meg ohms.
Decibels. —20— +63 db
Dims. 127 x 90 x 32 mm.

£10.95 P &P 75p

ELECTRONIC KITS OF DISTINCTION FROM POWERTRAN

DE LUXE EASY TO BUILD LINSLEY-HOOD 75W STEREO AMPLIFIER £99.30 + VAT

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring whilst distortion is less than 0.01%.



WIRELESS WORLD FM TUNER £70.20 + VAT

A pre-aligned front-end module makes this Wireless World published design very simple to construct and adjust without special instruments. Features include an excellent a.m. rejection push-button station selection as well as infinitely variable tuning and a phase locked loop stereo decoder, incorporating active filters for "birdy" suppression.

LINSLEY-HOOD CASSETTE DECK £79.60 + VAT

This design, published in Wireless World, although straightforward and relatively low cost provides a very high standard of performance. There are separate record and replay amplifiers and switchable equalisation together with a choice of bias levels are also provided. The mechanism is the Goldring-Lenco CRV with electronic speed control.

TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

As featured in Electronics Today International

Cabinet size 24.6"x15.7"x4.8" (rear) 3.4" (front)

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 £168.50 + 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.

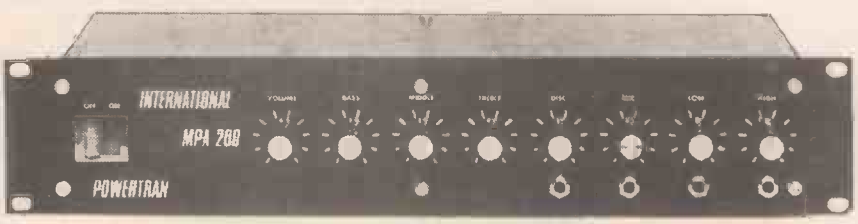
Kit includes fully finished metalwork, fibreglass PCB, controls, wire, etc. — Complete right down to the last nut and bolt!

COMPLETE KIT ONLY £49.50 + VAT

Panel size 19.0"x3.5". Depth 7.3"

MPA200 100W MIXER/AMPLIFIER

Featured as a constructional article in Electronics Today International the MPA 200 is an exceptionally low-priced but professionally finished general purpose, rugged, high-power amplifier which has an adaptable range of inputs such as disc, microphone, guitar, etc. There are 3 wide range tone controls and a master volume control. Mechanically the design is simplicity in the extreme with minimal wiring making construction very straightforward. Kit includes fully finished metalwork, fibreglass PCB's, controls, wire, etc. — Complete right down to the last nut and bolt!



Panel size 19.0"x3.5". Depth 7.3"

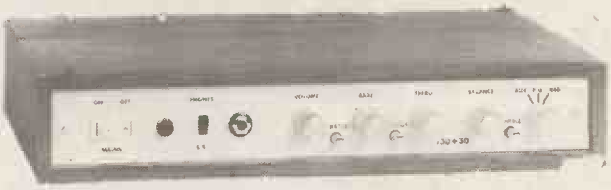
COMPLETE KIT ONLY £49.90 + VAT

All kits also available as separate packs (e.g. P.C.B. component sets, hardware sets, etc.). Prices in FREE CATALOGUE.

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

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 + VAT

T30+30 KIT PRICE £38.40 + VAT

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

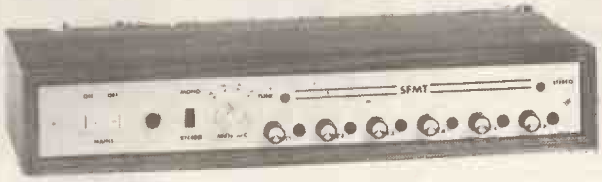
WWII TUNER

SPECIAL PRICE FOR COMPLETE KIT £47.70 + VAT

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 + VAT

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.

WE'VE MOVED!

NEW FACTORY UP! PRICES DOWN!

INCREASED CAPACITY AT OUR BIG NEW FACTORY MEANS MANY PRICES DOWN! ALL OTHER FROZEN!

Another superb design by synthesizer expert Tim Orr!

TRANSCENDENT DPX

As featured in Electronics Today International August, September October, 1979 issues

DIGITALLY CONTROLLED, TOUCH SENSITIVE, POLYPHONIC, MULTI-VOICE SYNTHESIZER

The Transcendent PDX is a really versatile new 5 octave keyboard instrument. There are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound — fully polyphonic i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano or a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass at the lower end (the keyboard is electronically split after the first two octaves) or vice versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive? The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrato comes in only after waiting a short time after the note is struck for even more realistic string sounds.

Cabinet size 36.3"x15.0"x5.0" (rear) 3.3" (front)
Also available as separate packs — prices in free catalgoue

COMPLETE KIT ONLY £299.00 + VAT!

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.

As the system is based on digital circuitry data can be easily taken to and from a computer (for storing and playing back accompaniment with or without pitch or key change, computer composing etc., etc.) and an interface socket (25 way D type) is provided for this purpose.

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.

The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug — you need buy absolutely no more parts before plugging in and making great music! When finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1200!

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, 1980, if this month's advertisement is mentioned with your order.
Errors and VAT rate changes excluded.

U.K. ORDERS. Subject to 15%* surcharge for VAT. 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. 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.

NEW FACTORY ON SAME INDUSTRIAL ESTATE
ADDRESS AND PHONE NUMBER UNCHANGED

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

POWERTRAN ELECTRONICS

PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3NN

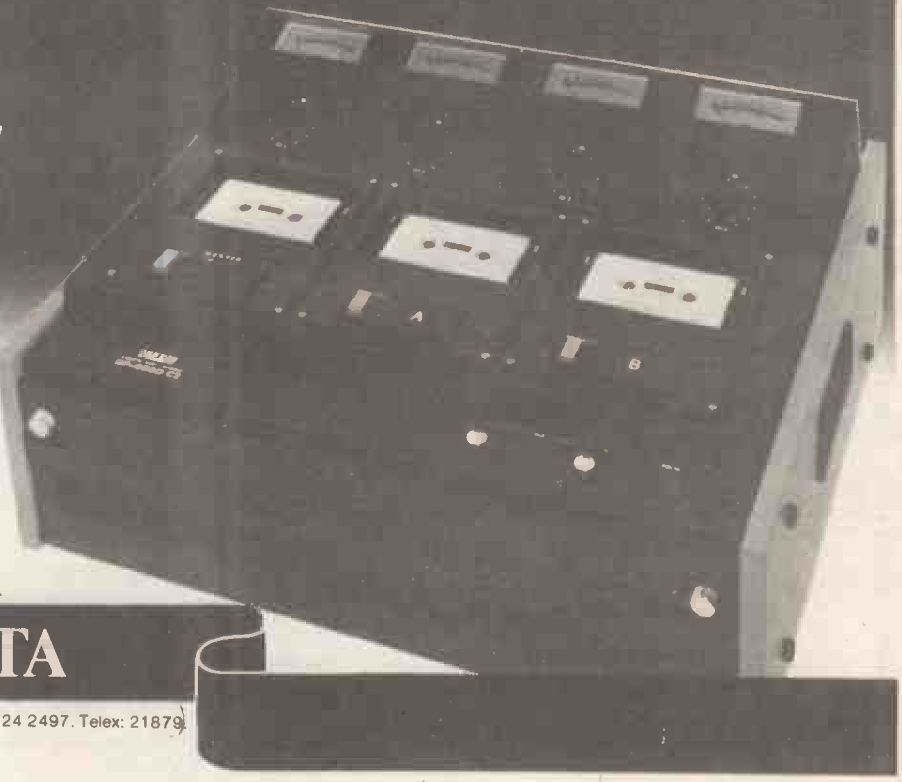
ANDOVER
(STD 0264) 64455

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 WINDWARD ISLANDS CANADA MALTA

Now-highest quality copying at low cost

OTARI DP4050 C2 cassette duplicator



The first low cost copier to give you reliability and performance to professional standards. No other copier can match its precision engineering, and it is the only budget copier suitable for music programmes.

* One master, 2 slaves.
* Add on units available up to 11 slaves.
* Automatic rewind.
* Ferrite heads.
* 16:1 duplicating ratio.
* Modular slave decks with DC servo motors.

Also available: Reel to cassette version with 6 slaves.

OTARI from ITA

1-7 Harewood Avenue, Marylebone Road, London NW1. Tel: 01-724 2497. Telex: 21879

WW — 086 FOR FURTHER DETAILS

CHILTERN ELECTRONICS
B.C.M. BOX 8085
LONDON WC1V 6XX

PDP8 COMPUTERS:

PDP8E. Latest version with 16K Core, as new	£800
PDP81 8K with high speed tape reader/punch	£450
PDP81 and PDP8L 4K processors from	£200

All above with teletype interface and ready to use — software available includes BASIC, FOCAL, FORTRAN, etc.
UDC8 Industrial Interface for PDP8 — provides 50 inputs and outputs isolated and buffered for process control. Brand new, with all data and cables £450
All spare PDP8 modules and add-on memory in stock!

TERMINALS:

GE TERMINET — modern 30 ch/sec silent terminal. Full ASCII set, correspondence quality upper and lower case. Ideal for word processors. RS232 Interface.

As new with keyboard	£350
Without keyboard	£200

JUST ARRIVED FROM U.S.A. . . .

INCOTERM SPD 10/25 Intelligent terminals. Top quality VDU with powerful computer. Memory 4K Core and 4K MOS. Two RS232 ports. Second video output. Detachable ASCII keyboard. Cost over £5,000. Offered at only £750
TELETYPES/CENTRONICS PRINTERS/VDUs — lots more in stock .... from £50 to £500
ELLIOTT Paper Tape Readers, 250 ch/sec optical .. £40
IBM 8-level readers with step motor, no data £20

Add 15% for VAT. For more details please send SAE or ring Nigel Dunn on 0494 714483

WW — 093 FOR FURTHER DETAILS

TAKE A DAY OFF

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

VEROSPEED

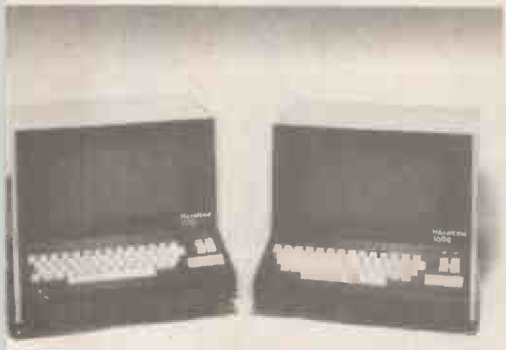
Barton Park Industrial Estate,
Eastleigh, Hampshire SO5 5RR
Tel: (0703) 618525

WW — 095 FOR FURTHER DETAILS

Electronic Brokers

49/53 Pancras Road London NW1 2QB Tel: 01-837 7781. Telex 298694

No.1 in Second User Minis & Peripherals



Hazeltine 'Glass Teletype' VDUs 12" screen choice of 2 switch-selectable baud rates (from range 110 9600) standard RS232 (V 24) Interface Model H 1000 (12 lines of 80 characters) **£350.00.** Model H 1200 (24 lines of 80 characters) **£375.00.**

DEC PDP11/40 SYSTEM

PDP11 40 48KW Parity Core Processor complete with KT11D Memory Management
DL11 Asynchronous Interface
RK11D Disc Controller
4 x RKO5J Disc Drives
2 x 6ft Rack Cabinets
Fully DEC-maintained — in immaculate condition **£12,750** (or could be reconfigured to suit)

ICL TERMIPRINTER 7075

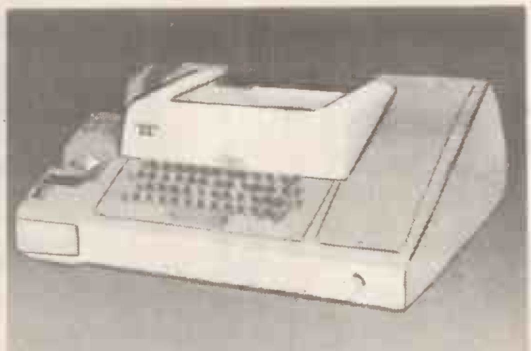
Typewriter-quality Keyboard Send/Receive Impact Printer providing full upper and lower case character set, switch-selectable print speeds of 10, 15 and 30cps, 118-column print line with pin-feed platen suitable for paper rolls or continuous stationery (paper width 12.85") Standard V.24 (RS232) interface **£575.00.**

GE TERMINET 1200

TYPEWRITER QUALITY impact printer with switch-selectable print speeds of 10, 30 and 120cps 80 print positions with adjustable pin-feed paper tractor, full upper and lower case ASCII character set, current loop (20mA) interface **£695.**

BALL MIRATEL MONITOR

9" diagonal P4 phosphor tube Bandwidth 12MHz (−3dB) Input voltage 220V 50 60Hz 24W Output voltage + 15V DC (short circuit protected) + 12kV DC 12 6V rms Separate horizontal and vertical sync Supplied complete with high and low voltage power supplies amplifier and attractive moulded plastic housing including space for keyboard Case dimensions — 20" x 19" x 10½" (including keyboard space 20" x 7") Full technical manual provided **£95** (total including carriage and VAT £123)



ASR33 and KSR33 TELETYPES

Input/Output terminals with 64 ASCII character set. 110 baud operation. Paper tape punch and reader (ASR33 only). Choice of interface (20mA or RS232) KSR33 — **£425.00.** ASR33 — **£650.00.** Pedestal **£30.00.**

DEC EQUIPMENT

PDP11/04BD 9-slot 5¼" Processor with 8KW MOS and DL11W Interface. BRAND NEW SURPLUS £3,250.00
PDP11/05 5¼" Processor with 8KW core memory £1,850.00
RKO5J Add-on disk drive £1,850.00

Large stocks of DEC modules and add-ons

PRINTERS & TERMINALS

CENTRONICS 101 Matrix Printer £750.00
COSSOR UNITEL II Visual Display Unit £295.00
HAZELTINE H-2000 Editing Visual Display Unit .... from £395.00
SCOPE DATA Electrosensitive Printer . £495.00
TEXAS 725 Portable Terminal £695.00
TEXAS 733ASR Terminal .... from £1,450.00

NEW ASCII KEYBOARDS —NEW LOW PRICES

		Mail Order Total
KB756 56-station ASCII Keyboard mounted on P.C.B.	£45.00	£53.48
KB756MF As above, fitted with metal mounting frame for extra rigidity	£50.00	£59.23
KB710 10-key numeric pad, supplied with connecting cable	£8.00	£9.78
KB701 Plastic enclosure for KB756 or KB756MF	£12.50	£15.24
KB702 Steel enclosure for KB756 or KB756MF	£25.00	£30.48
KB2376 Spare ROM Encoder	£12.50	£15.24
KB15P Edge connector for KB756 or KB756MF	£3.25	£4.31
DC-512 DC convertor to allow operation at 5V only (plugs in to P.C.B.)	£7.50	£9.20
KB771 71-station ASCII Keyboard including numeric/cursor control cluster, mounted in steel enclosure	£95.00	£115.00
DB25S Mating connector for KB771	£4.25	£5.46
PERK 56-station ASCII Keyboard for PET. Complete with PET interface, built-in power supply and steel enclosure	£145.00	£172.50

Discounts available for quantities

MISCELLANEOUS

CALCOMP 565 Drum Plotters £1,250.00
DIGITRONICS P120 Paper Tape Punches £75.00
EMI 15" Diagonal TV Monitors £100.00
SEALECTRO 11x20 Patch Boards £12.50
SHUGART SA400 5¼" Floppy Disc Drives £195.00
SHUGART SA800 8" Floppy Disc Drives £395.00

WW—120 FOR FURTHER DETAILS

Electronic Brokers

49/53 Pancras Road London NW1 2QB Tel: 01-837 7781. Telex 298694

ONLY SMALL SELECTION OF OUR VAST STOCKS SHOWN HERE — SEND FOR LATEST CATALOGUE

Electronic Brokers unique catalogue contains 62 pages plus update of second user Test Equipment, and Mini Computers and Peripherals. Vast lists of Signal Sources, Oscilloscopes, DVMs, Counters, Recorders, DEC Computers, VDUs, Teletypes, etc. Largest stocks — most cost effective.

LATEST EDITION JUST OUT. SENT FREE IN UK.
Airmail to overseas addresses £2.00

MARCONI INSTS.
TF 2162 M.F. Attenuator
0-111 1dB. Steps of 0.1 dB.
DC-1MHz 600Ω
Large Stocks
£135.00

SOLARTRON
7055 Microprocessor Controlled D.M.M.
Without processor option **£975.00**
With processor option **£1300.00**

HEWLETT PACKARD
1703A Storage Oscilloscope
35MHz Delayed Sweep. Dual Channel
£1850.00

HEWLETT PACKARD
Spectrum Analyser System
141T Display
8552A IF Section
8554L RF Section
500KHz-1250MHz
TOTAL PRICE **£5,250**

WAYNE KERR
B642 Autobalance Univ. Bridge.
Typically 0.1% accuracy. L.C.R. & G measurements
£695.00

MARCONI INSTRUMENTS
TF 2300B FM/AM Modulation Meter
Carrier Freq. 4 to 1200MHz. Deviation range up to 500KHz
Measures AM depth up to 95% at carrier freqs. up to 400MHz
£950.00

Unless otherwise stated all equipment offered in the Electronic Brokers 4-page advertisement is refurbished and in the case of Test Equipment also calibrated. Test equipment is guaranteed for 12 months; computer peripherals for 3 months.

Hours of Business:
9 a.m.-5 p.m., Mon.-Fri.
Closed lunch 1-2 p.m.

A copy of our trading conditions is available on request.

Add 15% VAT to ALL PRICES

Carriage and Packing charge extra on all items unless otherwise stated.

WW — 107 FOR FURTHER DETAILS

MARCONI INSTRUMENTS
TF2333 M.F. Transmission Test Set.
Freq. Range 30Hz-550kHz
£600

PHILIPS
PM 3240 Scope
50MHz Dual trace and Sweep Delay
£950

No.1 in Second User Test Equipment

BRIDGES

GENERAL RADIO
Immitance Bridge 1607A ... £750
1608A LCR Bridge. Accuracy typically 0.05% ... £1450

MARCONI INSTS.
Univ. Bridge TF1313A (0.1%) £790
In Situ Univ. Bridge TF2701 . £395
Univ. Bridge TF1313 ... £395

WAYNE KERR
Univ. Bridge B221 (0.1%) .. £275
Low impedance Adaptor Q221 £75

CALIBRATION EQUIPMENT

HEWLETT PACKARD
DC Voltage Source & AC/DC Diff. Voltmeter 741B ... £975

FLUKE
333AB AC/DC Differential Voltmeter ... £975

TEKTRONIX
Time Mark Generator 184 .. £275
Time Mark Generator 2901 . £450
nS Pulse Generator 2101 .. £525

DIGITAL COUNTERS

GOULD ADVANCE
00MHz Counter TC15 + 15P1 ... £495
0MHz Counter TC17 or TC17A ... £195

FLUKE
125MHz Multi-Function Counter 1910A-01 ... £285
125 MHz Multi-Function Counter 1910A ... £199
520MHz Communications Counter 1920A-06 ... £490
125MHz Multi-Function Counter 1925A ... £405
125MHz Univ. Timer Counter 1953A-15-16 ... £850

PHILIPS
0MHz Timer Counter PM6612 £405
GHz Timer Counter PM6615 £795
0MHz Freq. Counter PM6661 £185
12MHz Freq. Counter PM6645 ... £710
20MHz Automatic Freq. Counters PM6664 ... £305
20MHz Counter PM6614 .. £450
0MHz 9 digit Univ. Counter PM6611/02 ... £350

SYSTRON DONNER
0MHz Counter Timer 6250 . £175
Freq. Counter 6220 ... £160

DIGITAL VOLTMETERS & MULTIMETERS

ADVANCE
True R.M.S. Voltmeter DRM6 £150

DATRON
½ digit D.M.M. 1051 ... £995

FLUKE
½ digit D.M.M. 8600A ... £290
½ digit D.M.M. 8600A-01 . £335
8300A D.M.M. ... £199
8800A D.M.M. 5½ digit ... £599

HEWLETT PACKARD
½ digit D.M.M. 34702A + 34740A ... £295

PHILIPS
digit D.M.M. PM2424 ... £300
½ digit DC D.V.M. PM2443 £430
½ digit D.M.M. PM2513A .. £95
Autoranging D.M.M. PM2514 £125
Autoranging D.M.M. PM2527 £400
D.M.M. PM2517E ... £120
D.M.M. PM2522A ... £200

SCHLUMBERGER-SOLARTRON
5½ digit Digital Multimeter A243 ... £675
4½ digit D.M.M. 7050 ... £350
D.M.M. (Microprocessor Controlled) 7065 ... £1,150
— with processor option .. £1,450

OSCILLOSCOPES

ADVANCE
Storage Scope OS2200 ... £745

COSSOR
35MHz Dual Trace CDU 150 £450
75MHz Dual Trace 4100 ... £695

HEWLETT PACKARD
500KHz High Sensitivity 130C £345
75MHz Dual Trace 1707B .. £925
T.D.R. System 140A + 1415A ... £1200
T.D.R. System 140B + 1415A ... £1500

PHILIPS
5MHz Battery Miniscope PM3010 ... £325
15MHz Portable Dual Trace PM3211 ... £450
25MHz Portable Dual Trace PM3212 ... £625
25MHz Portable Dual Trace PM3214 ... £700
120MHz Portable Dual Trace PM3260 ... £1095
100MHz Portable Dual Trace PM3262 ... £1300
50MHz Storage Scope PM3243 ... £2000

TEKTRONIX
10MHz Dual Trace Battery Miniscope 326 ... £900
24MHz Dual Trace 545B + CA £299
50MHz Dual Trace 547 + 1A1 £775
25MHz Split Screen Storage Scope 434 ... £1600
Large stocks of Plug ins for 500 series mainframes at new low prices. Details on request.

TELEQUIPMENT
10MHz Single Trace P7CRT S54AR (Mint) ... £175
50MHz Dual Trace D75 ... £695
Curve Tracer CT71 ... £400

OSCILLOSCOPE PROBES

ELECTRONIC BROKERS (NEW)
X1 Probe Kit EB90 ... £9
X10 Probe Kit EB91 ... £11
X1X10 Probe Kit EB95 ... £15

RECORDERS

AMPEX
FM/DR Tape Recorder PR2200 ... £6500

BRUSH
Multipoint 8 Channel Chart Recorder 816 ... £695

PHILIPS
Single Channel Chart Recorder PM8110 ... £225

RACAL
Store 4FM Tape Recorder .. £2600

SHANDON SOUTHERN
6 Channel Recorder 10-650 . £725

WATANABE
6 Channel Chart Recorder MC641 ... £2250

YOKOGAWA
2 Channel Chart Recorder 3047 £530

SIGNAL SOURCES

HEWLETT PACKARD
203A Variable Phase Sine & Square Wave Generator 0.005Hz-60kHz ... £495
651B Oscillator 10Hz-10MHz. 0.1mV-316V into 50 or 600Ω Sine Wave only. Metered O/P ... £415
608D VHF Signal Generator. 10-420MHz. 0.1μ V-O 5V into 50Ω AM: 0-95% ... £420
608E VHF Signal Generator. 10-480MHz ... £450
608F VHF Generator. 10-455MHz ... £450
612A UHF Signal Generator. 540-1230MHz ... £850
4204A Decade Oscillator. 10Hz-1MHz ... £750
8640A AM-FM Signal Generator. 500kHz-512MHz ... £1800

MARCONI INSTRUMENTS
TF144H/4 AM Signal Generator. 10kHz-72MHz ... £750
TF144H/4S AM Signal Generator. Same spac. as 144H/4 but hermetically sealed meters ... £550
TF801D/1 AM Signal Generator. 10kHz-470MHz ... £400
TF801D/8S AM Signal Generator. Similar spec. to TF801D/1 .. £600
TF801D/5M1 AM Signal Generator. 10-400MHz 0.1 μV-1V into 50Ω. AM 0-90% @ 1kHz Demodulator output, 75MHz Crystal ... £450
TF995B/2AM/FM Signal Generator. 200kHz-220MHz ... £675
TF1066B/6 AM Signal Generator. 10-470MHz ... £675
TF1101 R-C Oscillator. 20Hz-200kHz. Metered O/P ... £100
TF1370A R-C Oscillator ... £275
TF2000AF Oscillator. 20Hz-20kHz ... £325
TF2012 UHF Signal Generator. 400-520MHz ... £900
TF2005R Two Tone AF Signal Source. 2 identical oscillators 20Hz-20kHz + 10dBm O/P 0-111dB attenuator ... £299
TF2101 MF Oscillator. 30Hz-550kHz ... £115
TF2102M/1 AF Oscillator. 3Hz-30kHz ... £195
TF2950/5 Mobile Radio Test Set. 65-108MHz. 138-180MHz. 420-470MHz. AM/FM Generator. 1kHz audio oscillator. RF power meter. AF mV/meter. AM/FM modulation meter ... £1250

RACAL
9081 Synthesized Signal Generator. Frequency Range 5-520MHz. AM/FM. Phase & Pulse modulation £1900

SINGER
FM-10 Decade Switched FM Signal Generator. Up to 500MHz . £1200

PHILIPS
PM5167 Function Generator. 1MHz-10MHz Sine, square ± pulse, ramp, triangle, single shot with variable phase ... £675
PM5326X AM/FM Signal Generator. 100kH-125MHz ... £735
PM5127 Function Generator. Sine/sqaure/triangle/pulse signals £395
PM5108 Function Generator. Sine, square/triangle/pulse signals £395 offset. TTL output. Stepped and continuous attentuation. Frequency range 1Hz-1MHz ... £250

TELONIC
2003 Sweeper Main Frame c/w 3302, 3331, 3341, 3351, 3360 and 3370 modules. Frequency range 0-300MHz sweep width with 0-100% of the range 0-62dB O/P attenuator in 1dB steps. O/PZ 75 Sweep time 0.01-50S. Internal 5 & 10MHz markers. Internal AM/FM modulation. Internal detector ... £1150

TEXSCAN
VS40 Sweep Generator. Frequency range 1MHz-300MHz ... £650

WAVETEK
135 Lin/Log Sweep Function Generator. 0-2Hz-2MHz. 10V into 50Ω. Sine square triangle. Sweep time 10μS-10000S ... £275

SOUND LEVEL METERS

BRUEL & KJAER
Sound Level Meter 2203 ... £500

GENERAL RADIO
Portable Sound Level Meter, 1983 ... £190
Portable Sound Level Meter 1981 ... £575
1933 & 1935 Portable Sound Level Meter with data cassette recorder ... £2600

MISCELLANEOUS

BIOMATION
16 Channel Logic Analyser 1650 ... £4100

BOONTON
True R.M.S. Voltmeter 93A . £375

BRADLEY
DC Voltage Calibrator 126B . £275

DATA LABS
Power Line Disturbance Monitor £300

DYMAR
LF Wave Analyser 1771 ... £375
AM/FM Mod. Meter 1785 .. £300
LF Distortion Meter 1765 ... £250

GERTSCH
Complex Ratio Bridge CR1B . £600

GENERAL RADIO
Vibration Analyser 1911A . £2100

HEWLETT PACKARD
Power Meter 432A+478 ... £450
Camera 195A ... £295
Camera 198A ... £200
True R.M.S. voltmeter 3400A £505
16 Channel Logic Analyser 1600A ... £2050

MARCONI INSTRUMENTS
AF Transmission Test Set TF2332 ... £425
Quantization Distortion Tester TF2343 ... £400
Deviation Meter TF791D ... £195
Electronic Voltmeters TF2604 £250
Q meter system TF1245/46/47 ... £875
Divider TF2422 ... £75
Sine SQ. Pulse & Bar Generator TF2905 ... £450
AM/FM Mod. Meter TF2300A £550
RF Millivoltmeter TF2603 .. £525
Diff. Voltmeter TF2606 ... £200
D.F.M. TF2331 ... £475
Wave Analyser TF2330A ... £725

PHILIPS
Pulse Generator PM715 ... £575
AC Millivoltmeter PM2454B . £299
Pattern Generator PM5501 . £180
Wow & Flutter PM6307 ... £275

Appointments

Advertisements accepted up to 12 noon Monday, January 21st for February issue, subject to space being available.

DISPLAYED APPOINTMENTS VACANT: £10.00 per single col. centimetre (min. 3cm).
LINE advertisements (run on): £1.50 per line, minimum three lines.
BOX NUMBERS: 70p extra. (Replies should be addressed to the Box Number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London SE1 9LU.)
PHONE: Neil McDonnell on 01-261 8508
Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.

ELECTRONICS TEST ENGINEERS

We need your skills to stay true to type

Staying true to type is our business.
We're Linotype-Paul, world leaders in the design, development and marketing of an advanced range of photo-typesetting equipment.
Our highly sophisticated computer-controlled machines are revolutionising the graphics industry and setting increasingly higher standards of type production.
Keeping our systems on the leading edge of technology is our aim — and to back us in our efforts, we need more skilled electronics test engineers.
If you have 2-3 years experience of testing complex digital equipment, ideally reinforced by ONC or equivalent, you could build a great career with us. A knowledge of analogue circuitry would be an added advantage.
The work is deeply interesting and stimulating — and never routine. Staff facilities include superb working conditions, sick pay scheme, a subsidised canteen and relocation expenses where appropriate.
And salary structures are highly competitive.
Posts are open to both men and women. For full details, write or telephone to the Personnel Department, Linotype-Paul Limited, Runnings Road, Cheltenham. Tel: Cheltenham 45001.

Linotype-Paul (9827)

THORN CONSUMER ELECTRONICS LTD.

Advance Study Engineer

Thorn Consumer Electronics Limited, leading manufacturers of television and audio equipment in the U.K. wish to appoint an experienced Engineer for their Advance Study Group situated in the Research and Engineering Centre at Enfield.

The successful applicant will join a team investigating new ideas and systems including digital techniques and microprocessors as well as modern analogue methods.

He/she should preferably be under 35 years of age with a degree or H.N.C. or relevant experience, recent graduates will be considered.

Please apply in writing to:
The Personnel Manager (ASE/WW),
Thorn Consumer Electronics Limited,
Great Cambridge Road, Enfield, Middlesex EN1 1UL
or telephone 363 5353 extension 2201 for an application form.

THORN

(9948)

UWIST

University of Wales

DEPARTMENT OF PHYSICS ELECTRONICS AND ELECTRICAL ENGINEERING

M.Sc./DIPLOMA COURSE IN ELECTRONICS

Applications are invited for places in the full-time one-year M.Sc./Diploma course in Electronics, commencing October 1, 1980.

Further details and application forms (returnable as soon as possible) may be obtained from the Academic Registrar, UWIST, Cardiff CF1 3NU.

(9914)

AMPEX

AMPEX MOSCOW 1980

OFFICIAL SUPPLIERS

AMPEX CORPORATION, a world leader in analogue and digital data recording technology, has been designated the official supplier of video recording and magnetic tape products to the 1980 Moscow Olympics.

Early in 1980 the Group's Training Department in Reading will need an additional

INSTRUCTOR

IN BROADCAST TELEVISION COLOUR CAMERAS AND VIDEO TAPE RECORDERS

This is an opportunity to join a company in the forefront of technological innovation in a position involving contact with engineers from all over the world and some overseas travel.

The essential qualification are:

★ experience as, or personality to become, an expert instructor training engineers of many nationalities.

★ sound knowledge of advanced electronics, particularly in the broadcast television field.

★ sound knowledge of foreign language would be useful.

An attractive salary and benefits package is offered.

Please telephone Clive Legg on Reading 85200, Ampex Great Britain Limited, Acre Road, Reading, Berks.

(9906)

QUEEN ELIZABETH COLLEGE
Kensington
(University of London)

ELECTRICAL LABORATORY/ WORKSHOP TECHNICIAN GRADE 5

Technician needed with particular interests in electrical safety aspects of equipment and instruments in science laboratoris. Work will involve inspection of existing and new equipment, advice on installation, drawing up (in conjunction with College Safety Officer) safety checking schedules. Knowledge of electronics useful, but post will be located in Electronics Unit, which will provide assistance. Maintenance and repair also involved.

Salary in range £3,700 - £4,320 p.a. (under review) plus London weighting of £780 p.a.

Applications with brief particulars of education and experience to the College Secretary, Queen Elizabeth College, Campden Hill Road, London W8 7AH.

(9944)

CA CAPITAL APPOINTMENTS LTD.

FREE JOBS LIST

for

FIELD SERVICE ENGINEERS BASIC SALARIES TO £8,000 + CAR

(9879)

30 Windmill Street, London, W1
01-637 5551

TESTERS, TEST TECHNICIANS, TEST ENGINEERS. Earn what you're really worth in London working for a World Leader in Radio & Telecommunications. Phone Len Porter on 01-874 7281, or write: REDIFON TELECOMMUNICATIONS Ltd., Broomhill Road, Wandsworth, London, SW18. (9856

ANTENNA SALES ENGINEER

Unusual opportunity for introducing Kathrein FM, TV and communication transmitting antennas to UK customers and to increase sales of Spinner and Kabelmetal products in same market.

The job entails calling on existing customers throughout the UK, developing new customers, the preparation of quotations and tenders and assisting customers with their technical problems.

The successful candidate will be over 25 and preferably have good sales ability, suitable experience and qualifications. A good salary and an above average car will be offered. Four weeks' holiday per annum and a non-contributary pension scheme complete the package.

Please apply in writing, marked confidential, to:

The Managing Director

Hayden Laboratories Limited

Hayden House
Churchfield Road
Chalfont St Peter, Bucks

HAYDEN

(9918)

Foreign and Commonwealth Office

Telecommunications Officers

. . . in London and at Hanslope Park, Milton Keynes, for work in the installation, modification, maintenance and operation of HF, VHF, UHF and microwave receivers, associated test equipment, recorders, telephone and teleprinter equipment, electronic ancillary apparatus (some using analogue and digital techniques), voice frequency telegraph and other specialised equipment.

Candidates must have served an apprenticeship or have had equivalent training. They should normally have 3 years' relevant experience, and hold ONC in Engineering (with pass in Electrical Engineering 'A') **or** Applied Physics **or** TEC/SCOTEC certificate or equivalent qualification in a relevant subject. **Ex-Service personnel** who have had suitable training and at least 3 years' appropriate service (as Staff Sergeant or equivalent) will also be considered.

Salary:£4,575-£6,100; London £780 more. Starting salary may be above the minimum for those with additional relevant experience. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 17 January, 1980), write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). **Please quote T/5274.**

(9943)

AMPEX

AMPEX MOSCOW 1980

BROADCAST VTR ENGINEERS

FOR MIDDLE EAST AND AFRICA BASED IN ATHENS

We seek HNC calibre Electronics Engineers or those with equivalent experience, to whom product training will be given. They will be required to travel and work independently and to join our highly professional team serving this area from its Regional Office in Athens.

Salaries reflect the demanding nature of the job. Assistance with relocation, rent, education expenses will be given. Pension, medical expenses and insurance.

Write fully to Don Cameron, AMPEX, P.O. Box 45, Halandri, Athens, Greece, or for application form from Clive Legg, Ampex Great Britain Ltd., Acre Road, Reading, Berks. on Reading 85200.

The Group parent company, Ampex Corporation, has been designated the official supplier of video recording and magnetic tape products to the 1980 Moscow Olympics.

(9915)

London Borough or Bromley
RAVENSBOURNE COLLEGE OF ART AND DESIGN

SENIOR ENGINEER

TELEVISION AND BROADCASTING

A senior television broadcast engineer is required to manage a small engineering section of the television department. Duties will include installation and maintenance of the broadcast standard colour television installations which are used by the department.

The successful applicant should be qualified to H.N.D. level with recent experience in the unsupervised maintenance of colour television broadcast studio and video systems, including cameras and quadruplex video tape equipment.

Salary on grade T5 within the range £5610 to £5937 including London Weighting.

Further details and application forms from the: **Registrar, Ravensbourne College of Art and Design, Walden Road, Chislehurst BR7 5SN.**

(9899)

Electronic Engineers – What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £8000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you.

All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL PERSONNEL SERVICES,
12 Mount Ephraim,
Tunbridge Wells,
Kent. TN4 8AS.

Tel: 0892 39388

TJB

Please send me a TJB Appointments Registration form:

Name ....

Address ....

....

(9238)

THE POLYTECHNIC OF CENTRAL LONDON
Engineering Division

ELECTRICAL WORKSHOP/ LABORATORY TECHNICIAN GRADE 3

Salary: £3456-£3861 inclusive of London Allowance (Under Review)

Technician required for an expanding group working in communication and computer fields. Experience in electronics and workshop practice necessary. Workload includes laboratory and research projects.

The following qualifications are required: ONC with 3-5 years' experience (inclusive of training) or the equivalent and/or appropriate industrial experience.

Application form and further details from the Establishment Officer, PCL, 309 Regent Street, London W1R 8AL. (Tel: 01-580 2020 ext. 212).

(9894)

TELECOMMUNICATIONS ENGINEER

Salary £7,000

Good all round engineer required for an International Company with worldwide telecommunication network.

Good knowledge of telecommunications peripherals and multiplexing. Facsimile experience an advantage. Some international travelling will be necessary.

Apply in the first instance to:

Miss L. J. Walker, United Press International, 8 Bouverie Street, LONDON EC4Y 8BB.

(9909)

RADIO OFFICERS

If your trade or training involves radio operating, you qualify to be considered for a Radio Officer post with the Composite Signals Organisation.

A number of vacancies will be available in 1980/81 for suitably qualified candidates to be appointed as Trainee Radio Officers. Candidates must have had at least 2 years' radio operating experience or hold a PMG, MPT or MRGC certificate, or expect to obtain this shortly.

On successful completion of 40 weeks' specialist training, appointees move to the Radio Office Grade.

Salary Scales:

Trainee Radio Officer	Radio Officer
Age 19 **£3271**	Age 19 **£3961**
Age 20 **£3382**	Age 20 **£4107**
Age 21 **£3485**	Age 21 **£4243**
Age 22 **£3611**	Age 22 **£4359**
Age 23 **£3685**	Age 23 **£4571**
Age 24 **£3767**	Age 24 **£4854**
Age 25+ **£3856**	Age 25+ **£5166**

then by 5 annual increments to £6981 inclusive of shift working and Saturday, Sunday elements.

For further details telephone **Cheltenham 21491 Ext. 2269,** or write to the address below.

GCHQ

Recruitment Office

Government Communications Headquarters

Oakley, Priors Road, Cheltenham GL52 5AJ (9493)

MARTIN-BAKER (ENGINEERING) CO. LTD.

has a vacancy for an

ELECTRONIC TECHNICIAN

AT CHALGROVE AIRFIELD, OXFORD

The successful applicant will be required to assist small team, on commissioning and operation of telemetry and instrumentation systems for ejection seat trials.

QUALIFICATIONS — Ability to make prototype units from rough drawings and test to specifications using standard test equipment. Knowledge and experience of U.H.F. Trans/Recs., tape recorders and logic systems. (Gained as a radio amateur perhaps).

Salary range £5500-£5700 per annum. Weekly paid. 40-hour week. 22 days' holiday per year, non-contributory pension scheme after five years.

Enquiries to: **Mr. G. B. Thompson, Martin-Baker (Eng) Co. Ltd., Chalgrove Airfield, Oxford OX9 7RJ. Telephone: 0865-890251.**

(9807)

Editorial writer for Wireless World

Wireless World *needs a new person on its editorial staff. Technical experience in electronics and/or communications and an ability to write are essential. The work is varied and includes writing technical news reports and other material, attending meetings, exhibitions, press conferences and other events, some abroad, and editing contributed technical articles. A good deal of freedom will be given to a person who shows ability and responsibility. Preferred age range 25 to 35.*

Write to: The Editor
WIRELESS WORLD
Dorset House, Stamford Sreet
London SE1 9LU

(9947)

TELEVISION PROJECTS ENGINEERS

We have vacancies in our expanding Projects Section for Junior and Intermediate engineers. Responsibilities cover all stages of custom-built vision/audio switching system manufacture from customer liaison through design, production and test to final acceptance.

The positions offer the chance for energetic engineers with initiative to join a small, expanding company manufacturing and supplying electronic equipment to many professional TV broadcasters in the UK and Europe. A certain amount of travel here and abroad could be involved.

In particular this opportunity would suit engineers possessing some experience in electronic testing wishing to expand their horizons and gain experience in television broadcast systems.

In addition to a good salary the company offers profit-sharing and non-contributory pension schemes, free BUPA membership, a friendly environment in rural settings and excellent career prospects.

For more details contact David Steel at:

pro-bel LIMITED

TERRACE ROAD, BINFIELD, BRACKNELL
BERKSHIRE, RG12 5QN, ENGLAND
telephone BRACKNELL (0344) 56969/56960

(9958)

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
Engineering and Technical Recruitment
11 Westbourne Grove
London W2. 01-229 9239

(9257)

VIDEO ENGINEERS

Experienced Video Engineers are required for important work, mainly in the field of high security systems. Some work on short contracts is available in the Middle East, North Africa etc, if required, but not mandatory. A company car, pension scheme and generous salary can be expected but loyalty and a determination to do the job well are necessary. We are looking for Engineers who expect to earn £4,000 - £7,000.

Please apply to:

ANDROMICA (T.V.) LTD.
34 Rockingham Road
Uxbridge, Middlesex
Tel. Uxbrige 57971

(9956)

HNC Level Engineers~

(Electrical or Electronic)

Train for the future as a Broadcast Transmission Engineer

Through our network of over 500 transmission stations the IBA is responsible for the transmission of all Independent Television and Local Radio services. With a steadily increasing number of stations, the preparations for the fourth television channel and more local radio stations now underway we are taking on increased responsibilities.

We take great pride in the fact that our system is one of the best in the world and great importance is placed on maintaining the efficiency of the service. To do this we have teams of highly trained and experienced engineers all over the country.

Internal promotions and continued expansion have created a number of opportunities for H.N.C. or H.T.C. or equivalent level engineers (male or female) to train for a challenging future. Our carefully devised training programme, which will commence this summer, can lead to a recognised Diploma and combines theoretical study and practical training. This comprehensive training is a step beyond traditional learning and gives a grounding in broadcast engineering that is second to none. Naturally, course fees, accommodation and meals will be paid during the course. A full driving licence is required, but if you do not already have one, we will assist you by arranging and paying for instruction.

On the satisfactory completion of the training programme, your salary will be £5,880 per annum and then rise annually to £7,280 per annum, with further progression to £8,202 per annum. (During the training period you will receive a salary of up to £4,700 per annum, depending upon experience.)

At higher levels it will be up to you to demonstrate your ability as promotions are based on internal competition – all of our Regional engineering managers started their careers at transmitting stations.

Employment benefits include Free Life Assurance and Personal Accident Schemes, a Contributory Pension Scheme, generous relocation expenses and subsidised mortgage facilities.

Please write or telephone Mike Wright for a fully illustrated information package and application form, at IBA, Crawley Court, Winchester, Hampshire SO21 2QA. Telephone: Winchester 822574.

IBA INDEPENDENT BROADCASTING AUTHORITY

(9920)

SOUTHERN ELECTRICITY
Littlewick Green, Maidenhead

SECOND ENGINEER (TELECOMMUNICATIONS)

CHIEF ENGINEER'S DEPARTMENT HEAD OFFICE

SALARY WITHIN THE RANGE £6,830-£8,955 PER ANNUM

Applications are invited for the above post in the Technical Services Section of the Chief Engineer's Department.

The successful applicant will be part of a team engaged in the design, commissioning, and subsequent maintenance of telecommunications systems throughout the Southern Electricity Board, and must be able to spend periods away from Head Office when carrying out these duties.

Schemes in progress include telecontrol, data communications, medium capacity microwave links, multi-channel line circuits and radio and line telephony systems. Applicants should have had experience in some of this work and preferably be in possession of suitable technical qualifications.

The successful candidate will be required to drive a motor vehicle which may be either a private car or a Board-owned car.

Appropriate relocation assistance will be provided.

Applications on forms obtainable from the Secretary, Southern Electricity, Southern Electricity House, Littlewick Green, Maidenhead, Berks., SL6 3QB, and returned to him quoting 76/79 by not later than January 11, 1980.

(9916)

FIELD ELECTRONICS ENGINEERS

Gardline Surveys are a leading Hydrographic and Geophysical Survey Company providing shipping, offshore positioning and site investigation services to oil companies and other clients.
Due to continuing expansion we have vacanices for the following personnel:

SEISMIC ENGINEERS—with a strong electronics background, a familiarity with digital acquisition systems and preferably with marine or shallow marine operations.

UNDERWATER SYSTEMS ENGINEERS—with a sound background in electronics and an aptitude for practical work and fault finding. Gardline operates a variety of equipment including Huntec Deep Tow Boomers, E. G. and G. Sidescan Sonars, Magnetometers, Sparkers, etc. Experience with one or more of these systems is desirable but not essential.

POSITIONING ENGINEERS—with experience in the field of survey vessel navigation or oil rig positioning. Gardline operates a variety of positioning systems including Satellite Navigation, 2MHZ Systems, Syledis and Trisponder. A computer and track plotter are usually used in conjunction with the above equipment. Familiarity with digital techniques and the ability to fault-find desk top calculators would be an advantage.

Whilst formal qualifications are an advantage, experience and the ability to work effectively in a field environment is considered to be of prime importance. We expect our engineers to be adaptable and willing to learn to use systems that they are not familiar with at present.

Employment will be based at Great Yarmouth or if required Aberdeen. Operations are primarily North Sea based but there are good prospects of overseas employment through our branch offices in Houston and Sharjah (U.A.E.).

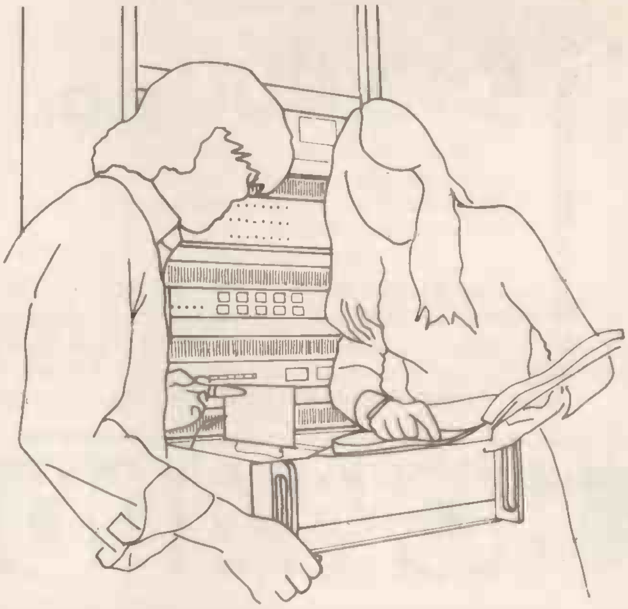
Salary is fully negotiable and with sea pay is likely to be around £8,000.

There is a company pension scheme and 4 weeks' annual leave plus roster leave accrued whilst at sea.

Applicants should write or telephone **The Technical Manager, Gardline Surveys, Oilmar House, Admiralty Road, Great Yarmouth, Norfolk. Tel. Great Yarmouth (0493) 50723.**

(9926)

Professional Careers in Electronics



All the others are measured by us...

At Marconi Instruments we ensure that the very best of innovative design is used on our range of communications test instruments and A.T.E. We have a number of interesting opportunities in our Design, Production and Service Departments and we can offer attractive salaries, productivity bonus, pension and sick pay schemes together with help over relocation.
If you are interested to hear more, please fill in the following details:-

Name ____________ Age ____

Address ____________

____

Telephone Work/Home (if convenient) ____

Years of experience	0-1	1-3	3-6	Over 6
	☐	☐	☐	☐
Present salary	£2,500-3,500	£3,500-4,500	£4,500-5,500	over £5,500
	☐	☐	☐	☐
Qualifications	None	C & G	HNC	Degree
	☐	☐	☐	☐

Present job ____________

____

Return this coupon to John Prodger, Marconi Instruments Limited, FREEPOST, St. Albans, Herts, AL4 0BR. Tel: St Albans 59292

Marconi Instruments
A GEC MARCONI ELECTRONICS COMPANY

(9200)

HOLLAND

Holland, the most 'English' country in continental Europe offers you high salaries and excellent opportunities for advancement.

If you have the following background you could earn around

£13,000 p.a.

on a long-term contract in Holland.

We have an immediate need for:

Technical Authors and/or Instructors

with either an electronics, radar/sonar or weaponry background.

Contact Norma Baxter on 01-952 8092 or evenings between 6pm and 8pm on 01-207 1725.

The Howard Organisation enjoys an international reputation and you are invited to benefit from our experience and success.

Howard Organisation International Ltd
Employment Business Section
Russell House, 140 High Street, Edgware, Middx HA8 7BS

HOWARD

(9922)

ENGINEER

for Deaf Teaching Equipment

(MALE OR FEMALE)

£4,317-£4,770 **Epsom**

For the Media Resources Centre, Glyn House, Church Street, Ewell. To carry out on-site service/repair work to electronic equipment used for teaching deaf children (VHF radio microphones, speech trainers, group hearing aids, audiometers, etc). To remove from site and repair in Ewell workshop those items best serviced by bench work. You will be expected to travel from school to school and school to base in your own vehicle, for which Casual User car allowance will be paid. You will be expected to diagnose and repair the special equipment as necessary, working alone in schools.

Proven ability to carry out the above work and a current driving licence are essential requirements. The Centre is situated within easy access to public transport and ample free car parking is available on-site.

Application form from Media Resources Centre, Tel. 01-393 0208.

SURREY COUNTY COUNCIL

(9939)

TAITO

ELECTRONICS ENGINEER

An enthusiastic and self-motivated engineer required to work on the latest microprocessor controlled coin operated video games, with a rapidly expanding company in the leisure industry.

Applicants should possess a good working knowledge of fault finding techniques to component level.

Excellent working conditions and highly competitive salary for the right candidate.

Applications (in writing) should be addressed to the **Personnel Officer,**

TAITO ELECTRONICS LIMITED
264 Water Road, Wembley, Middx.

(9957)

MINISTRY OF DEFENCE

require

Telecommunications Professional and Technology Officers III

for

BRITISH FORCES GERMANY

For (a) management and development planning for a private telephone network, (b) maintenance and repair of a multi-channel radio and relay network, (c) maintenance and repair of a colour TV transmission system. Candidates should be British Subjects, hold a current British driving licence, and must possess a City and Guilds certificate for telecommunications technical final or Part II (or intermediate plus 3 B subjects, which must include mathematics and tele-communications principles) or radio television and electronics technicians final or Part II, or an equivalent or higher acceptable qualification. Candidates must have served a recognised apprenticeship or had equivalent training and have at least three years' appropriate operating experience. Ex-Service candidates who do not fulfil the above requirements will be considered only if, after completing a course of approved technical training they have served for at least three years in an approved technical capacity in HM Forces with the rank of Staff Sergeant or equivalent. A knowledge of German, although not essential, would be an advantage.

Salary: £4984-£5551 (currently under negotiation) plus an allowance equal to Inner London Weighting of £780 and Foreign Service allowance ranging from £1365-£2810. There are additional grants and allowances dependent on individual circumstances.

For further information and an application form (to be completed and returned by 18th January, 1979) please write, quoting reference NW, to: Ministry of Defence, CM(S)3e2, Room 317, Adelphi, John Adam Street, London WC2N 6BB, or telephone 01-217 4677/5128.

(989

YOUR CAREER STARTS HERE with

GELLER BUSINESS EQUIPMENT LTD.

London, W.1

This company, leading distributors of electronic point of sale systems and up market calculators, needs

1. JUNIOR ELECTRONIC TECHNICIAN

(aged 18 approx.) to train in fault locating and repair of printed circuit boards and associated equipment.

Some formal qualifications desirable, but enthusiasm and ability to benefit from training are equally important.

2. SENIOR ELECTRONIC TECHNICIAN

(aged 24 approx.). City & Guilds standard to work with 'state of the a microprocessor based units.

Following training, the work will involve modification and programming advanced electronic cash registers and educating users.

THESE JOBS OFFER TOP PAY RATES AND FULL OPPORTUNITY TO DEVELOP TALENTS, FURTHER KNOWLEDGE AND ENCOURAGE THE ENTHUSIASTIC.

OUR TECHNICAL SECTION COMPRISES A SMALL GROUP OF YOUNG, FRIENDLY PEOPLE, WHO WORK AS A TEAM AND DEVELOP THEIR ABILITY BY MUTUAL ASSISTANCE.

Write fully or Telephone:

Norman Geller
GELLER BUSINESS EQUIPMENT LTD.
15 PERCY STREET,
TOTTENHAM COURT ROAD
LONDON W1P 0EX
Telephone No. 01-580 1614

GELLER

(934

Senior Electronics Engineer

for component and standards evaluation

GEC-Computers is a world leader in the design, development and manufacture of highly sophisticated computers for both commercial and military applications.

Within the Techniques and Components Section of our Engineering Department at Borehamwood, we now require a Senior Electronics Engineer to work on a wide variety of components ranging from the latest semiconductor devices through to state-of-the-art printed circuit boards.

It's a job calling for a man or woman qualified to degree, HNC or equivalent level with several years' sound practical experience of component and standards evaluation, application rules and packaging techniques. Specialist training can, however, be given where specific experience is lacking.

We offer a competitive salary; attractive benefits, including assistance with relocation expenses, and the opportunity of working in a challenging environment as a member of a highly professional team.

Write with details of experience to Ivan Hickmott, GEC-Computers Limited, Elstree Way, Borehamwood, Herts. WD6 1BR. Telephone: 01-935 2030.

1979 The Queen's Award for Technological Achievement

GEC GEC Computers Limited

(9903)

TEST/ COMMISSIONING ENGINEER

To £6,500 plus car

MIDDLESEX

We make an extensive range of environmental test systems, covering every application from strain measurement to the vibration of vehicles and buildings.

If you are:
—self-motivated and self-reliant;
—qualified to HNC or equivalent in electronics/radio and TV, and also interested in mechanics;
—experienced in analogue and/or digital work;

Then we can offer you a wide variety of testing and commissioning experience, working with newly developed modular control systems, in house and also at customers' premises in the U.K. and abroad.

SERVOTEST LIMITED
Sarsfield Road
Greenford, Middlesex UB6 7AA
Tel. 01-998 1552

SERVOTEST

(9900)

Technical Manager

Radio Communications

London

. . . to be responsible for the management of staff engaged on type testing of communication equipment for maritime and land services to approved Home Office specifications. Work will involve development of specifications and participation in national and international technical committees and working groups dealing with maritime radio communications.

Candidates must have an HNC or equivalent qualification in a relevant subject. They must also have electrical/electronic engineering experience and a detailed knowledge of radio communications.

Salary starting at £8,440 and rising to £9,380. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 17 January, 1980), 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/5266.**

HOME OFFICE

(9954)

DIAL 01-741 4011

Think of the Op Amp and the NAND Gate and your are through to:
CHARLES AIREY ASSOCIATES
4 Hammersmith Grove
London W6 ONA

CURRENT VACANCIES INCLUDE:

Chief Control Engineer for multi-million pound company engaged in the manufacture of roof tiles. Managerial ability as important as the ability to create a new generation of process automation products. Surrey. Excellent salary.

Young Entrepreneurial Engineers to join a multidisciplinary company with interests in: radio-controlled target systems, range finders, aerospace products, etc. Good microprocessor hardware/software experience. Wilts. Salary good.

Microprocessor Hardware/Software Engineers to design systems and supply modules for a very wide range of applications. Experience in either: M6800, R.P.A. 1802, GM 1650 or INTEL 8085. Berks. Salary — "What 'es worth."

INTEL Microprocessor Engineers for message switching systems based on a minicomputer and the INTEL 8080/85/86. Surrey — to £9,000.

Digital Engineers for exceptionally advanced technology associated with an MPU control system for shipborne aerials or early warning radar. To £9,000. Berks.

Computer Engineers for either technical support, field service, permanent site or systems test. Vacancies througout the U.K.

For further details, please contact:

(9940)

Charles Airey Associates

4 Hammersmith Grove, London W6 ONA. Tel: 01-741 4011

"PROBABLY THE BEST KNOWN SUPPLIER OF ELECTRONIC ENGINEERS IN THE COUNTRY"-Financial Times.

ELECTRONIC ENGINEER

We are a research laboratory engaged in detergency and toiletry projects which range from inception through development to pilot plant operation and are seeking to strengthen our instruments section by filling the following vacancy:

INSTRUMENTATION DESIGN ASSISTANT

An Electronics Engineer is required to join a Design team working on the development of scientific instruments.
The job will require knowledge of analogue and digital techniques, together with some experience in applying microprocessors and interfaces to design problems.
Applicants with City & Guilds, ONC, HNC or graduate qualifications will be considered.
Day release will be offered to persons already following a suitable course.
A progressive salary will be offered to the successful candidate and re-location where necessary. Flexible working hours operate in the Laboratory.
Those interested should write or telephone for an application form quoting ref: **PS 655 AMA.**

The Employment Officer
Unilever Research
Port Sunlight Laboratory
Port Sunlight, Wirral
Merseyside, L62 4XN
Tel: 051-645 2000, Ext. 8408

Interested persons should write to the address below for an application form.
Employment Officer, Unilever Research, Port Sunlight Laboratory, Port Sunlight, Wirral, MERSEYSIDE L62 4XN

unilever research

GEOSOURCE

OVERSEAS APPOINTMENTS

ELECTRONICS TECHNICIANS

Petty-Ray Geophysical Division of Geosource is one of the leading companies in the field of oil exploration, and due to our ever-increasing workload, require single personnel, in the age range 21-25, who are looking for a varied and interesting career working overseas.

You should be educated to ONC/HNC in Electronics or C&G Radio and TV Technician level, and on appointment, you will be assigned to one of our field crews either in AFRICA or the MIDDLE EAST for on-the-job training in the operation and maintenance of digital seismic recording equipment.

Candidates must be in possession of a current driving licence.

We offer a good starting salary which is paid NET, food and accommodation will be provided, and rest leaves are generous.

If you would like to have more information about these positions please write giving brief career details to the Personnel Officer.

GEOSOURCE
3/5 The Grove • Slough • Berkshire SL1 1QG

Commissioning Editors
£7000 negotiable

Butterworths, publishers of legal, medical, scientific and technical books, are looking for two experienced Commissioning Editors to develop lists of books on electronic engineering, electrical engineering and computers. One Editor will be required to work with professional engineers and academic staff to provide reference books, monographs and textbooks.

The other is needed to take over and extend a programme of publishing for enthusiast constructors, personal computer users and electrical and electronic servicing personnel.

Our modern offices are in pleasant rural surroundings about 50 minutes from London.

Please write to:

Linda Stammers,
Personnel Assistant,
Butterworth & Co. (Publishers) Ltd.,
Borough Green, Nr. Sevenoaks, Kent.

Butterworths

ELECTRONIC SEISMIC ENGINEERS

We are looking for young electronics engineers, with degree or equivalent qualifications, to join our marine seismic acquisition company.

This is a field position, with the successful applicants joining the technical crew of our exploration vessel for on-board training in seismic techniques. They will start as Assistant Technicians with a salary of £6,000+ per annum, and one month's leave after each two months on the crew.

The seismic industry offers an interesting career with world-wide travel, and rapid promotion for the right person.

Sefel Geophysical is a member of the Sefel Group, which has seismic processing centres in Houston, Denver, Calgary and London.

Please write with full curriculum vitae to:

SEFEL

Marine Manager
Sefel Geophysical
Turriff Building
Great West Road
Brentford
Middlesex TW8 9HY

(9946

No more long goodbyes

Radio Officers

With the Post Office Maritime Service, you can do the job you're trained for, and still work close to home!

Several coast stations need qualified Radio Officers to carry out a wide variety of duties ranging from Morse and teleprinter operating to traffic circulation and radio telephone operating. It's a secure job that pays well, and if you're ambitious, 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. Preferably you should have some sea-going experience.

The starting pay at 25 or over will be about £5,381; after 3 years service this figure rises to around £7,087. (If you are between 19 and 24 your pay on entry will vary between approximately £4,229 and £4,937). 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 Kathleen Watson on Freefone 2281 or write to her at the following address: ETE Maritime Radio Services Division ( ), ETE17.1.1.2, Room 643, Union House, St. Martins-le-Grand, London EC1A 1AR.

Post Office Telecommunications

Radio Communications

Electronics Engineers and Software Designers

Mid-Sussex—S.W. London **Salaries up to £8,000**

To join our expanding R&D Laboratories covering a wide range of R.F. spectrum, from L.F. to V.H.F. Equipments include transmitters and receivers for marine- and land-based use, radio navaids and radio monitoring remote computer-controlled systems.

Electronics Engineers should have experience in transmitter or receiver design, analogue or digital circuit design, microprocessor applications. Software Designers should be experienced Programmers with an interest in control, signal processing or navigational software.

Attractive salaries are complemented by excellent prospects and generous benefits.

Contact: **David Bird, Redifon Telecommunications Limited, Broomhill Road, Wandsworth, London, S.W.18. Phone: 01-874 7281** (reverse charges).

(9938)

DEPARTMENT OF NUCLEAR PHYSICS, UNIVERSITY OF OXFORD

has a vacancy in the

EXPERIMENTAL ELECTRONICS LABORATORY

giving an opportunity for work with a wide range of the most modern electronic equipment. A suitable candidate would preferably be of HNC standard, and have experience in servicing, development and construction of analogue and digital equipment. The laboratory encourages staff to learn new skills and where appropriate arrangements are made to attend relevant courses. **Salary £3700-£4320** with further award from April, 1980. Eight weeks' paid leave per year. **Write to the Administrator, Nuclear Physics Laboratory, Keble Road OX1 3RH,** mentioning reference A209 and giving details of education, qualifications, and job experience.

(9905)

Marine Radio Service Engineers

Glasgow, Aberdeen, Tilbury, Cardiff and Newcastle

International Marine Radio Co., a member of the STC Group of Companies, is engaged in the manufacture of high quality marine communication equipment. We have vacancies for Marine Radio Service Engineers in our Glasgow, Aberdeen, Tilbury, Cardiff and Newcastle Depots.

The work will be concerned with installation and service of communication equipment on board commercial vessels of all types.

Ideal candidates, male or female, will have had at least three years sea experience as a Radio/Electronics Officer. A company vehicle is provided for business and personal use.

For further details on these positions please contact: Jonathan Smith, International Marine Radio Co. Ltd., Intelco House, 302 Commonside East, Mitcham, Surrey CR4 1YT. Tel: 01-640 3400.

IMRC

SITUATIONS VACANT

Come to Somerset to make the most of your Electronics experience

At Wells, EMI Electronics Limited are developing new 'state of the art' electronic systems.

Current projects include microwave systems, radar signal processing, computer simulation and real-time software programmes.

Our established reputation for performance and reliability is dependent on quality requirements being incorporated in projects from inception to completion.

Due to expansion we have vacancies for:

Project Quality Engineers

To work with research, development and design teams with responsibility for ensuring that the engineering data produced complies with the quality requirements.

Applicants should be qualified to at least HNC standard and have previous experience in related fields.

Test Gear Engineers

To install, commission, calibrate and service a wide variety of proprietary and company designed test equipment.

Applicants should hold an HNC or equivalent and have practical experience of servicing, fault diagnosis and maintenance of modern complex electronic test equipment.

Test Engineers

To ensure that our microwave or digital assemblies and systems conform to design performance and quality standards.

Applicants should be qualified to at least City & Guilds final technician certificate standard and have relevant experience.

Transformer Test Technicians

To undertake reliability tests on R.F. Transformers and Chokes in a small batch production environment.

Necessary specialist training will be given to the appointed applicant who will have previous experience in similar fields.

Technical Supervisor (Electrical)

To plan and control the work of a team of electrical inspectors. Applicants should be qualified to at least ONC standard, be familiar with MOD electrical inspection requirements in the Electronics Industry and preferably have previous supervisory experience.

Starting salaries are commensurate with the importance of the posts, other benefits include subsidised meals, sports and social club and the opportunity to live and work in the heart of Somerset. Where appropriate, assistance with relocation will be discussed at interview.

In the first instance please write or 'phone Wells (0749) 72081 for an application form (quoting ref. no. WW135) to D. K. Shires/F. M. Taylor, Personnel Department, EMI Electronics Limited, Wookey Hole Road, Wells, Somerset BA5 1AA.

EMI EMI Electronics Limited, Wells, Somerset

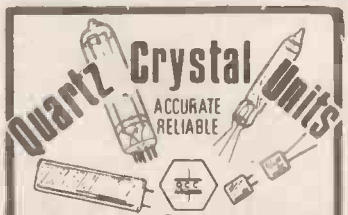
A member of the EMI Group of companies—International leaders in music, electronics and leisure.

ARTICLES FOR SALE

TELEQUIPMENT E1011 SCOPE, only nine months old, twin trace, variable time base, first-class order, £245 inc. VAT. Dorset (09297) 257. (9883

WIRELESS WORLD, 1952 to 1966. Offers? — Chamberlain, 60 Harpool Rd., Redditch, Worcs. Tel. (0527) 24995. (9882

VHF MONITOR RECEIVERS, Air or Marine band from £50. FM Business bands from £90. For leaflets send 50p P.O., not stamps. Radio Communications Ltd, 13 Clos du Murier, St Sampson, Guernsey, Channel Isles. (9874



Private enquiries, send 13p in stamps for brochure

THE QUARTZ CRYSTAL CO. LTD.

Q.C.C. WORKS, WELLINGTON CRESCENT
NEW MALDEN, SURREY 01-942 0334 & 2988

8493

GWM RADIO LTD., 40/42 Portland Road, Worthing, Sussex. Tel: 0903 34897 for surplus supplies. AVO 8 £43. Model 7 MK II with power, capacity and decibel ranges £32 inclusive p&p. Receivers, atalanta marine for AC, mains £115 plus carriage. B40 ex-Govt. communications receiver for AC, mains. £65 plus carriage. Sound powered telephones type 76 intrinsically safe, as new. 40ft pneumatic masts by Scam Clark £321, in original unopened makers box gross weight 4 cwt. Radio telephones bought & sold. Many one off items in stock. No lists, we are worth a visit. (9773)

TWO WELL maintained recently serviced ASR-33 teletypes with 20mA interface for sale. In good working order. Each £600. Box No. 9830.

MICRO COMPUTER — Nascom with T4 monitor, power supply built, tested, and working £180. — Phone Charles Frater, 01-937 3347. (9839

1IN COMPUTER tape ½in computer tape, can be used as video tape on some machines. Three teleprinter 54's. Phone for further details 0622 50350. MKS, 27 Upper Stone St, Maidstone, Kent. (9442

SITUATIONS VACANT

Production Manager

For Quad
£9,500+car
Huntingdon, Cambridgeshire

The Acoustical Manufacturing Company produces amplifiers and loudspeakers under the brand name 'Quad' and is one of the world's most respected hi-fi equipment manufacturers. 'Quad' products have an enviable reputation for quality and technical excellence.

We require a fully experienced Production Manager to be responsible to the Managing Director for every aspect of the running of a medium sized manufacturing plant producing domestic audio equipment at the rate of 1,000 units per week.

Candidates, male or female, should be aged around 35 years with qualifications or experience at graduate level. The candidate should have proven success in running an electronic assembly plant coupled with experience of the latest automatic assembly and test methods and of metal finishing.

There is a good range of benefits, including a non-contributory pension scheme, subsidised restaurant and sickness provision. Huntingdon offers a wide variety of reasonably priced housing; recreational amenities are excellent and London is within easy reach.

For an application form and Company information, please write to or telephone The Acoustical Manufacturing Co. Ltd., St. Peters Road, Huntingdon PE18 7DB. Telephone 0480 55480.

QUAD
for the closest approach to the original sound

1979

ARTICLES FOR SALE

RCA SOLID STATE COS/MOS MEMORIES.
MICROPROCESSORS AND SUPPORT SYSTEMS DATA BOOK
by RCA Price: £5.75

H/B OF ELECTRONICS CALCULATIONS FOR ENGINEERS & TECHNICIANS
by M. Kaufman Price: £14.70
ELECTRONIC DESIGNER'S H/B
by K. Hemingway Price: £13.25
ACTIVE FILTERS FOR COMMUNICATIONS & INSTRUMENTATION
by Bowron P. Price: £7.00
DESIGN OF ACTIVE FILTERS WITH EXPERIMENTS
by H. M. Berlin Price: £6.45
DESIGN OF PHASE LOCKED LOOP CIRCUITS WITH EXPERIMENTS
by H. M. Berlin Price: £6.45
Z80 ASSEMBLY LANGUAGE PROGRAMMING
by L. A. Leventhal Price: £5.75
LOGIC & MEMORY EXPERIMENTS USING TTL IC'S BK I
by D. G. Larsen Price: £7.60
TELETEXT & VIEWDATA
by S. A. Money Price: £6.00
THE EUROPEAN CMOS SELECTION
by Motorola Price: £7.75

★ALL PRICES INCLUDE POSTAGE★

THE MODERN BOOK CO.
Specialist in Scientific & Technical Books
19-21 PRAED STREET LONDON W2 1NP
Phone 402-9176
Closed Sat. 1 p.m.

(8974)

TO MANUFACTURERS, WHOLESALERS & BULK BUYERS ONLY

Large quantities of Radio, T.V. and Electronic Compinents.
RESISTORS CARBON & C/F ⅛, ¼, ½, ⅓. 1 Watt from 1 ohm to 10 meg.
RESISTORS WIREWOUND. 1½, 2, 3, 5, 10, 14, 25 Watt.
CAPACITORS. Silver mica, Polystyrene, Polyester, Disc Ceramics, Metalamite, C280, etc.
Convergence Pots, Slider Pots, Electrolytic condensors, Can Types, Axial, Radial, etc.
Transformers, chokes, hopts, tuners, speakers, cables, screened wires, connecting wires, screws, nuts, transistors, ICs, Diodes, etc., etc.
All at Knockout prices. Come and pay us a visit. Telephone 445 2713. 445 0749.
BROADFIELDS & MAYCO DISPOSALS
21 Lodge Lane, N. Finchley, London, N.12. 5 mins. from Tally Ho Corner (9461)

THE SCIENTIFIC WIRE COMPANY
PO Box 30, London, E.4

ENAMELLED COPPER WIRE

SWG	1lb.	8oz.	4oz.	2oz.
10 to 19	2 65	1 45	75	60
20 to 29	2 85	1.65	90	70
30 to 34	3 05	1 75	1 00	75
30 to 40	3 40	1.95	1 15	84
41 to 43	4 56	2 55	1 95	1 30
44 to 46	5.05	3.05	2 15	1 70
47	8 00	5 00	3 00	1 80
48	15 00	9 00	6 00	3 30

SILVER PLATED COPPER WIRE

14 & 16	4 50	2 25	1 44	90
20 & 22	5 00	2 85	1 74	1 06
24 & 26	5 70	3 31	2 00	1 22
28 & 30	6 67	3.86	2 35	1 44

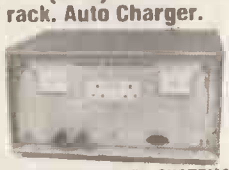
Prices include P&P and VAT
SAE brings list of copper & resistance Wires
Dealer Enquiries Invited (9063)

TRANSFORMER PROBLEMS?

1VA-1KVA Prototypes in 7-10 days. Phone Vince Sellar on 06076-66716.
TRENT TRANSFORMERS LTD.
26 Derby Road
Long Eaton, Nottingham (8363)

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 (9101)

MSF CLOCK

NEW! Shows continuous Date, Hours, Minutes, Seconds, 8 digit LED, also parallel BCD output, auto-reset after power failure, auto GMT/BST, only 5x8x15cm, built-in 60KHz antenna, 1000Km range, all parts, case, pcb, instructions, postage etc, money back assurances, send £48.80 for the RIGHT TIME — NOW.
CAMBRIDGE KITS
45 (WA) Old School Lane, Milton Cambridge

ARTICLES FOR SALE

COLOUR, UHF AND TV SPARES (miniature size 4½ x 3½ x 2⅛). New Saw Filter IF Amplifier plus tuner (complete and tested for sound and vision, £28.50, p/p £1.
TELETEXT, Ceefax and Oracle in Colour, Manor Supplies "easy to assemble". Teletext kit including Texas Tifax XM11 Decoder. External unit aerial input, no other connections to set. Wide range of facilities in colour include 7-channel selection, Mix, Newsflash and Update. (Price: Texas Tifax XM11 £130, Auxiliary Units £88, Case £14.80. p/p £2.50). Demonstration model at 172 West End Lane, NW6. Also latest Mullard Teletext 610LVM module available. Call, phone or write for further information.
COMBINED COLOUR BAR AND CROSS HATCH GENERATOR KIT (MK 4) UHF aerial input type. Eight pal vertical colour bars, R-Y, B-Y, Grey scale etc. Push-button controls £35 p/p £1; Battery Holders £1.50; Alternative Mains Supply Kit £4.80; De Luxe Case £4.80; Aluminium Case £2.60. Built and tested (battery) in De Luxe Case £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; De Luxe Case £4.80; Aluminium Case £2 p/p 85p. Built and tested in De Luxe Case £23.80 p/p £1.20.
UHF SIGNAL STRENGTH METER KIT £16.80, alum. Case £1.50, De Luxe Case £4.80 p/p £1.
CRT TEST AND REACTIVATOR KIT for Colour and Mono £20.80, p/p £1.30; TV 625 IF Unit for Hi-fi amps or tape rec. £6.80, p/p 75p. Surplus Bush IF panels. A816 £2.80, TV312 (single IC) £5. BC5600 (Exp) £5, A823 (Exp) £2.80 p/p 85p. Bush A823 (A807) Decoder panel £7.50 p/p £1. A823 Scan Control panel £3.50, blue lat, 75p. Philips G6 single standard convergence unit £3.75 p/p 90p. GEC 2040 ex rental panels, Decoder £5, Time Base £5 p/p 90p. Thorn 3000 ex rental panels, Video, Decoder, frame, IF £5 p/p 90p. Colour Scan coils, Plessey £6, Yoke £3.50, blue lat, 76p (Mullard also available). Mono Scan coils Philips/Pye £2.80. Thorn £2.80 p/p 85p. Philips G8 Decoder panels, salvaged for spares £3.80 p/p 90p. Varicap UHF tuners Gen Instruments £3.50, ELC 1043 £4.50, ELC1043/05 £5.50; Philips G8 £5.50 p/p 35p. Salvaged UHF Varicap tuners £1.50 p/p 35p. UHF/VHF ELC2000S Varicap tuner £8.50 p/p 65p. Varicap control units, 3 pos. £1.20, 4 pos. £1.50, 5 pos. £1.80, 6 pos. (special offer) £1.80, 7 pos. £3.80 p/p 45p. Touch Tune control unit Bush 6 pos. £5 p/p 75p. UHF transtd tuners, rotary incl. slow motion drive £2.50, 4 pos. push button £2.50, 6 pos. push button £4.20 p/p £1. (Thorne, GEC, Bush, Decca, etc., special types available, details on request). Delay Lines DL20, DL5 £3.50, DL1 80p p/p 65p. Remote Control Thorn-type Transmitter, receiver £2 pair p/p 45p. Large selection of lopts, triplers, mains droppers, and other spares for popular makes of colour and mono receivers.
MANOR SUPPLIES, 172 WEST END LANE, WEST HAMPSTEAD, LONDON NW6, SHOP PREMISES, EASILY ACCESSIBLE, WEST HAMPSTEAD-BAKERLOO, JUBILEE TUBE, and BRITISH RAIL N. LONDON (RICHMOND-BROAD ST.) and ST. PANCRAS-BEDFORD. BUSES 28, 159, 2, 13. Callers welcome. Thousands of additional items available at shop premises not normally advertised. Open daily all week including Saturday (Thursday half-day). MAIL ORDER: 64 GOLDERS MANOR DRIVE, LONDON NW11 9HT. Tel. 01-794 8751. VAT. Please 9HT. Tel. 01-794 8751. All prices subject to 15% VAT.

SOLATRON 10 MHz scope, twin trace trig. delay, valve set, good working order. A snip at £60. Dorset (09297) 257. (9882

TELEQUIPMENT E1011 SCOPE, only nine months old, twin trace, variable time base, first-class order, £245 inc. VAT. Dorset (09297) 257. (9883

SITUATIONS VACANT

WE'VE FORMED A NEW R&D GROUP

to make our shaving products even better

As one of Britain's leading manufacturers of Razor Blades, we are continuously looking into better ways to shave, better methods and systems of production, and on line control. So in the interests of speed and efficiency of communication we are bringing our Research and Development teams together to form one multi-discipline group at our factory in Acton.

The group will be mainly concerned with the Research, Design and Development of new shaving systems and concepts. Join it in any of the following positions and we can promise you plenty of opportunities to apply your problem solving abilities to our modern technology.

Process Control Department Senior Electronic Engineer

The successful candidate will head our Control and Instrumentation Department as Section Leader. The work involves the design and implementation of a wide range of systems from Research and Development instrumentation to Production line control systems. Candidates should have a degree or H.N.C. in electronics or control engineering plus several years' experience of practical electronic engineering.

Electronic Design Engineer

Applicants should have several years experience of practical circuit design of both analogue and digital systems. The work involves the design of a wide range of production line control systems, and specialised electronic equipment required by our Research and Development Departments.

We offer excellent salaries and all those benefits expected of a major organisation.

Interested men and women should write with details of age, qualifications and experience, or phone for an application form to: Senior Personnel Officer, Wilkinson Sword Ltd., 287 Acton Lane, London W4 5LE. Tel: 01-994 3666.

(9930)

WILKINSON SWORD

THE UNIVERSITY OF LEEDS, School of Medicine, The Electronics Workshop of the Multidiscipline Laboratories has a vacancy for a Grade 3 Technician. The successful candidate will assist in the repair, maintenance, development and construction of a wide variety of electronic equipment used both for teaching and research. The post would ideally suit applicants who having gained a basic grounding in electronics wish to broaden their experience and work with modern biological equipment, including microprocessors, in a stimulating environment. (Consideration will be given in appropriate cases to day release for a relevant course). Applicants should hold an ONC or equivalent qualification and have a minimum of three years' relevant experience. Salary on the scale £3,122 - £3,553 a year (under review). Further information may be obtained from Dr J. Fourman, Multidiscipline Laboratories, Medical and Dental Building, University of Leeds, Leeds LS2 9NL, tel. 31751, ext 7542, to whom applications in writing should be sent giving details of age, qualifications, experience and the names of two referees. (1432

VIDEO SALES ENGINEER required by Studio 99 Video, the leading industrial and commercial CCTV systems company. High level sales experience required and some video/electronics knowledge essential. Good salary, company car: Phone Roger Betts 01-328 3282.

ARTICLES FOR SALE

LOGIC MONITOR. Clips over TTL I.C. to show logic states on 16 LED display. Fully buffered. £22.50 inc. p&p. Also latching model available. SAE details. J. E. Sinclare & Co., 139a Sloane St., London SW1X 9AY. (9934

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

TELETYPE 33 KSR (6,0,6) £120, 8 unit readers and punches £20.25. Phone Braintree 24118. (9924

TEKTRONIX 545 B and IAI plug-in £350. AR88 receiver £60. Phone: 0228 24029 (Carlisle). (9933

ARTICLES FOR SALE

1IN COMPUTER tape ½in computer tape, can be used as video tape on some machines. Three teleprinter 54's. Phone for further details 0622 50350. MKS, 27 Upper Stone St, Maidstone, Kent. (9442

VHF MONITOR RECEIVERS, Air or Marine band from £50. FM Business bands from £90. For leaflets send 50p P.O., not stamps. Radio Communications Ltd, 13 Clos du Murier, St Sampson, Guernsey, Channel Isles. (9874

ENCAPSULATING, coils, transformers, components, degassing, silicone rubber, resin, epoxy. Lost wax casting for brass, bronze, silver, etc. Impregnating coils, transformers, components. Vacuum equipment low cost, used and new. Also for CRT regunning met allising. Research & Development. Barratts, Mayo Road, Croydon, CR0 2QP. 01-684 9917. (9678

TELEPHONE ANSWERING machine available for outright purchase. — Telephone Burton-on-Trent (0283) 47427. (9609

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

EX-GOVT. TAPE RECORDERS: E.M.I., Ferrograph, Tandberg, Uher, Vortexion, etc. S.a.e. for details, A. Wright, 'Sunningdale', Broadheath, Worcester. (9831

BRADLEY 158 Oscilloscope Sampling Adaptors DC-1, 2GHz two off for sale. As new and guaranteed complete with manuals. First offer secures. Glass Electronics, 7 Commonhead Road, Kilmarnock, Ayrshire. 0563-33536. (9898

"VERO 19" card frames (SU). Suit Newbear 77-68. Includes case and extras for £15. PP £4. Details 04895 5355, anytime. (9895

ARTICLES FOR SALE

EXCLUSIVE OFFER

RACK MOUNTING CABINETS
HIGHEST QUALITY 19"

Ref	Ht"	width"	Depth"	Price
PE	10	21	13	£10.00
LL10	54	21	18	£20.00
TT	64	25	26	£45.00
SL	71	25	26	£50.00
ST	85	22	24	£70.00
Racal cabinets for RA-17/117				£30.00
Uniframe, single				£30.00
Uniframe, double				£40.00
Uniframe, triple				£50.00

Over 60 types available from 12" to 90" high.
Also twins, triples and consoles. Above are only a few types. Please send for full list.

AUDIO AND INSTRUMENTATION-TAPE RECORDER-REPRODUCERS

★ Ferrograph YD 2 track ¼"/EMI RE-301
★ Ampex FR1300 7 track ½" UHER 4000 ¼"
★ Consolidated 2800 7 track ½"
★ Plessey ID33 Digital Units. 7 track ½"
★ Plessey M5500 Digital Unit. 7 tracks ½"
★ Ampex FR-1100. 6 speeds, stereo ¼"
★ Ampex FR600. 4 speeds, 7 track ½"
★ D.R.I. RC-I. 4 speeds, 4 tracks ¼"
★ Min-com CMP-100. 6 speeds, 7 tracks ¼", ½", 1"
★ Ampex 351 2 speed 2 tracks ¼"
★ 3M. H. 4 speeds 14 track 1"

Prices of above £70 to £500
Also Transport Decks only available

We have a large quantity of "bits and pieces" we cannot list — please send us your requirements. We can probably help — all enquiries answered.

All our serial equipment is professional MOD quality

★ Marconi HR-23 T.S.B. Receivers £320.00
★ K.B. Discomatic Juke Boxes £85.00
★ SCR-625 Mine Detectors in chests £40.00
★ Marconi TF/868 Universal Bridges £110.00
★ Hewlett Packard 400H VT Metres £95.00
★ Hewlett Packard 211A Sq. Wave Gen £80.00
★ Astrodata & Ikor Meteorological Equipment
★ Ion Pump E.H.T. Power Supplies £60.00
★ Haynes D.W. 500W Cased Transformers 240/115V £18.00
★ Racal RA66 Adaptors £130.00
★ Racal MA 1350 Synthesizers £125.00
★ G.B. Kalee Flutter Meters. Model 1740D/A £90.00
★ Telequipment C.I. Oscilloscope Calibrators . £90.00
★ Tektronix 551 Scopes £270.00
★ Tektronix 555 Scopes £300.00
★ Teleonic VR2M Sweeps £260.00
★ Hell Schriber RC-28 .... £95.00
★ Lenkurt Model 26D Data Sets £115.00
★ Panoramic SB 15A Analysers £125.00
★ Aerial Multicouplers from £25.00
★ Marconi TF 1168 Disc Oscillators £120.00
★ Hughes Memoscopes £170.00
★ Nems Clarke 1306 VHF Receivers £260.00
★ Telefunken Surveillance Receiver £175.00
★ Helix Aerials 11" & 18" and Reflectors ... £26.00
★ Textronix 543A Oscilloscopes CA. Plug-ins £210.00
★ Textronix 545A Oscilloscopes D. Plug-ins . £140.00
★ Textronix 561A Oscilloscopes 80. Plug-ins £220.00
★ Marconi TF 2200A Oscilloscopes £260.00
★ Solatron 1016 Oscilloscopes £90.00

Simon Mobile 80 foot Tower Hydraulic 80ft extended, 12' 6" closed. Mounted on 4 wheel drive Bedford Truck, self levelling, raised and lowered in 10 minutes. Used for servicing dish aerials. .... P.U.R.

★ Racal RA-17 P Receivers (new) £950.00
★ Eddystone 770/U VHF Receivers £170.00
★ Collins KWT 6 Transmitter Receivers SSB .. P.U.R.
★ Roband RO 50A Oscilloscopes £190.00
★ B & K 2407 Electronic Voltmeters £160.00
★ Winston "5" Band Spectrum Analysers .... P.U.R.
★ Airmec 352 Sweep Generators D £130.00
★ Advance Transistor Testers TT-1S £45.00
★ Marconi TF 329 Magnification Meters ... £140.00
★ Marconi TF 1066B FM Signal Generators . £390.00
★ Marconi TF 801/D/1 AM Signal Generators £220.00
★ Ferranti 7.5KVa Auto Voltage Regulators . £150.00
★ Manson TFM-101 Multipliers £240.00
★ Servomex 2kw Auto regulators £130.00
★ 125ft. Lattice masts, 26" sides .... P.U.R.
★ 30ft. Lattice Masts, 15" sides £115.00
★ 10ft Light Lattice Sections, 6" sides £18.00
★ EMI ½" Audio Tape 3600ft 10½" nab. New £4.50

D.R.I. Model RC-1 Professional Tape Recorder-Reproducers. 4 tracks ¼" 4 speeds. 1⅞", 3¾", 7½ & 15", 4 amplifiers Monitor Scope. All rack mounting & Transistorised £250.00

★ SE4/2B C.R.T.s £18.00
★ SE5/2A C.R.T.s £19.00
★ 3AZP/Z (DMN-9) C.R.T.s £19.00
★ Plessey 3 & 6 KCS S.S.B. filters £14.00
★ AVO CT 471A Electronic Multimeters £75.00
★ EMI R301 Tape Recorders £50.00
★ Stonorette L Tape Recorders £29.00
★ Uniselectors. 10 Bank 25-way £3.50
★ 40ft. Sectional Aluminium Masts, complete £55.00
★ Multi-purpose Trolleys with Jacks 19 x 17 . £16.00
★ Advance 3KVA CV Transformers £150.00
★ Metal V.O.U. Tables 30" x 36" x 30" £24.00

MANUALS

We have a quantity of Technical Manuals and Periodicals of Electronic Equipment, not photostats. 1940 to 1960. British and American. No lists. Enquiries invited.

★ Data Efficiency Respoolers 240v £28.00
★ Belling Lee 100 Amp Interference Filters .. £76.00
★ Oscilloscope Trolleys from £18.00
★ Racal MA1978 pre-Selectors £65.00
★ Rack Mounting Operator Tables £10.00
★ 75ft. Aluminium Lattice Masts, 20" sides . £400.00
★ Racal MA-175 L.S.B. Modulators (new) ... £45.00
★ Tally 5/8 Track Tape Readers Track Spooling £65.00
★ Racal RA-63 SSB Adaptors, new £70.00
★ Racal RA 298 I.S.B. Transistorised Adaptors (new) £120.00

We have a varied assortment of industrial and professional Cathode Ray Tubes available. List on request.

PLEASE ADD CARRIAGE AND V.A.T.

P. HARRIS
ORGANFORD, DORSET,
BH16 6BR
(0202) 765051

8981

Classified

SITUATIONS VACANT

Experienced All-Round Video Engineer

required for operational and maintenance work.

We are one of the leading video and audio companies in Belgium, distributing Sony, JVC, National, Barco, CV3, Shintron, Microtime, etc . . .

The successful applicant will work in an enthusiastic team and will have the possibility to take charge of our technical department.

Promotion prospects are excellent in this expanding company. We offer an attractive salary and 4 weeks' holiday a year.

Written application in the first instance, giving experience and qualifications can be sent for the attention of W. KLINKEMALLIE, Personnel Manager, and will be treated in strict confidence.

VIDEOSCOPE

Avenue Moliére, 116
1060 Brussels
Belgium

(9960)

Test Engineers

A rewarding outlook for the 80's

We at Tektronix are not modest about being the acknowledged world leader in Test and Measurement Instrumentation and at our Hoddesdon location in rural Hertfordshire we manufacture the world famous range of Telequipment oscilloscopes.

To keep our products to the highest possible standard we are looking for Technicians/Engineers qualified to at least ONC with two years' test and fault finding experience to component level, an enquiring mind and the ability to work on their own initiative.

Excellent salaries, profit sharing, generous holidays, sick pay, free life assurance, non-contributory pension and relocation expenses where applicable all add up to make Tektronix the best break you've ever had.

To get all the facts phone Norman Spreckley on Hoddesdon 67151 or write to him at Tektronix UK Ltd, Pindar Road, Hoddesdon, Herts.

(9961)

Tektronix®
COMMITTED TO EXCELLENCE

Electronics & Computer Test

To £7,500

Use your C&G/ONC/HNC/Forces Training and good DIGITAL/ANALOGUE/RF experience to advantage. Working with state-of-the-art MINI/MICRO PROCESSOR; LASER; ATE; COMMUNICATIONS; NUCLEONIC; CCTV and similar equipment. Most UK areas; from Technician to Manager.

For free confidential counselling and practical career advice contact GRANT WILSON ref: GW470.

TECHNOMARK, 11 Westbourne Grove, London W2 4UA.
Tel: 01-229 9239 (01-229 4218—24 hrs).
Engineering Recruitment Consultants.

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

(9123)

A.R. Sinclair

Electronic Stockholders
Stevenage 812193

We purchase all types of Mechanical and Electronic Equipment and Surplus stocks.

(9206)

ARTICLES WANTED

WANTED

All your gold washed scrap. Plugs, sockets, edge connectors, P.C. boards, pins, etc

We collect and pay cash for any amount from 1cwt.

Minimum price £100-£200 per cwt

P. Skellern Metals, The Iron Yard (Est. 1935), Cutlers Green, Thaxted, Essex CM19 2PL. Telephone: Thaxted 830 862.

SPOT CASH

paid for all forms of electronics equipment and components.

F.R.G. General Supplies
550 Kingston Road
London SW20 8DR
Tel: 01-404 5011
Telex: 24224. Quote Ref. 3165

(8742)

WANTED: Recording equipment of all ages and varieties. (California, U.S.A.). Tel. (415) 232-7933. (9814

VALVES RADIO. — T.V.-Industrial-Transmitting. We dispatch valves to all parts of the world by return of post, air or sea mail, 4,000 types in stock 1930 to 1976. Obsolete types a speciality. List 50p. Quotation S.A.E. Open to callers Monday to Saturday 9.30 to 5.00. Closed Wednesday 1.00. We wish to purchase all types of new and boxed valves. Cox Radio (Sussex) Ltd., Dept WW, The Parade, East Wittering, Sussex PO20 8BN, West Wittering 2023 (STD Code 024366). (9082

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

HU-GO offer prompt settlement for surplus electronics components, TV/audio spares are of particular interest. Contact Miss Hughs, 9 Westhawe, Bretton, Peterborough. Tel. 265219. (9731)

WW — 056 FOR FURTHER DETAILS

WANTED

Test equipment, receivers, valves, transmitters, components, cable and electronic scrap, any quantity. Prompt service and cash. Member of A.R.R.A.

M & B RADIO
86 Bishopsgate Street
Leeds LS1 4BB
0532-35649

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. (9509

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

EQUIPMENT FOR SALE

SCOPES. TEK. 545B & CA £200. Cossor 4100 75MH. £350. — Crawley 884382. (9907

ARTICLES FOR SALE

With 38 years' experience in the design and manufacturing of several hundred thousand transformers we can supply:

AUDIO FREQUENCY TRANSFORMERS OF EVERY TYPE

YOU NAME IT! WE MAKE IT!

OUR RANGE INCLUDES

Microphone transformers (all types). Microphone Splitter/Combiner, transformers. Input and Output transformers. Direct Injection transformers for Guitars. Multi-Secondary output transformers. Bridging transformers. Line transformers. Line transformers to G.P.O. Isolating Test Specification Tapped impedance matching transformers. Gramophone Pickup transformers. Audio Mixing Desk transformers (all types). Miniature transformers. Microminiature transformers for PCB mounting. Experimental transformers. Ultra low frequency transformers. Ultra linear and other transformers for Valve Amplifiers up to 500 watts. Inductive Loop Transformers. Smoothing Chokes. Filter inductors. Amplifier to 100 volt line transformers (from a few watts up to 1000 watts). 100 volt line transformers to speakers. Speaker matching transformers (all powers). Column Loudspeaker transformers up to 300 watts or more.

We can design for RECORDING QUALITY, STUDIO QUALITY, HI-FI QUALITY, OR P.A. QUALITY. OUR PRICES ARE HIGHLY COMPETITIVE AND WE SUPPLY LARGE OR SMALL QUANTITIES AND EVEN SINGLE TRANSFORMERS. Many standard types are in stock and normal dispatch times are short and sensible.

OUR CLIENTS COVER A LARGE NUMBER OF BROADCASTING AUTHORITIES, MIXING DESK MANUFACTURERS, RECORDING STUDIOS, HI-FI ENTHUSIASTS, BAND GROUPS, AND PUBLIC ADDRESS FIRMS. Export is a speciality and we have overseas clients in the COMMONWEALTH E.E.C., USA, MIDDLE EAST etc.

Send for our questionnaire which, when completed, enables us to post quotation by return

SOWTER TRANSFORMERS

Manufacturers and Designers
E. A. SOWTER LTD. (Established 1941), Reg. No. England 303990
The Boat Yard, Cullingham Road, Ipswich IP1 2EG
Suffolk. P.O. Box 36 Ipswich IP1 2EL, England
Phone: 0473 52794 & 0473 219390
(9822)

TEK 545 B mainframe	£80
TEK 547 mainframe	£150
TEK 151 Sampeling plug in	£100
1 L10 Spectrum analyser plug in	£450
TEK 422 15 MHZ portable	£350
RACAL 9913 200 MHZ counter	£150
SYSTEM Donner 5008 500 MHZ sweeper	£495
POLYSKOP 1 400 MHZ	£350
POLYSKOP 2 1200 MHZ	£850
POLYSKIP 3 110 MHZ	£600
FLUKE 8300 DMM AC/DC/OHMS	£195
BRADLEY 233 post generator	£250
PHILIPS PM 6505 television analyser	£100
MARCONI TF 144 H sig/gen	£195
MARCONI TF 868/1 LCR bridge	£85
MARCONI TF 1370/9 oscillator	£100
MARCONI TF 2162 attenuator	£85
MARCONI TF 2201 30 MHZ scope	£195
MARCONI TF 2169 pulse modulator	£195
HP 3200 B VHF oscillator	£395
HP 211A square wave gen	£75
HP 400H voltmeter	£75
HP 140 A mainframe	£175
HP 1416 A swept freq ind	£300
HP 8694 A 8-12.4 GHZ sweeper plug in	£400
HP 8694 B 7-12.4 GHZ sweeper plug in	£400
HP 8693 A 3.7-8.3 GHZ sweeper plug in	£400
HP 1403 vertical plug in	£75
HP 1420 horizontal plug in	£75
SINTEL Capacitance bridge	£150
ADVANCE DVM5	£75
BPL CZ 960 component comparitor	£175
AVO 7	£30
AVO 8	£50
TELEQUIPMENT S 51 E oscilloscope	£95
TELEQUIPMENT S 52 scope	£110
TELEQUIPMENT S 61 A scope	£185

All + 15% VAT

ALL EQUIPMENT WORKING & CALIBRATED

DUTCHGATE LTD

**94 ALFRISTON GARDENS
SHOLING, SOUTHAMPTON
SOTON (0703) 431323**
(9875)

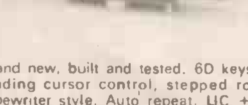
SPEAKER KITS

Two great new kits from KEF – the Speaker Engineers respected by HiFi enthusiasts all over the world.
One is based on the Model 104aB and the other on the larger, free standing Cantata.
We'll give you helpful advice and full instructions.
And you can hear how good the speakers are before you build.

BADGER SOUND SERVICES

**46 Wood Street
Lytham St. Annes
Lancs FY8 1QG
Tel: 0253-729247**
(9658)

USE A REAL KEYBOARD



Brand new, built and tested. 60 keys including cursor control, stepped rows, typewriter style. Auto repeat. UC + LC ASCII coded. £44.75 (£53.19 inc p&p and VAT).
S.a.e. for details: **TIMEDATA Ltd., 57 Swallowdale, Basildon, Essex.**
(9864)

SERVICES

SMALL BATCH

Productions assembled from Sample or Drawings. Quick deliveries. Competitive prices. Design Service also available. Write or telephone:
**SYNERGY BRITON ELECTRONICS LIMITED
BRITON HOUSE, 62 RAILWAY ROAD
DOWNHAM MARKET
NORFOLK PE38 9EL
Telephone (036 63) 5222** (9942)

ELECTRONIC DESIGN SERVICES. Wide engineering experience available for the design of basic circuits to complete systems. Analogue DC to 1GHz and Digital. Write or phone Mr Anderson, Andertronics Ltd, Ridgeway, Hog's Back, Seale (Nr. Farnham), Surrey. Runfold 2639. (9140

REPETITION SHEET METALWORK on Wiedemann turret press. Long/short runs. Highly competitive. Quick deliveries commission for introductions. — EES Ltd., Clifford Rd., Monks Rd., Exeter. 36489. (8060

DESIGN SERVICE. Electronic Design Development and Production Service available in Digital and Analogue Instruments, RF Transmitters and Receivers for control of any function at any range. Telemetery, Video Transmitters and Monitors, Motorised Pan and Tilt Heads etc. Suppliers to the Industry for 16 years. Phone or write Mr. Falkner, R.C.S. Electronics, 6 Wolsey Road, Ashford, Middlesex. Phone Ashford 53661. (8341

SMALL BATCH PCB's produced from your artwork. Also **DIALS, PANELS, LABELS.** Camera work undertaken. **FAST TURNAROUND.** — Details: Winston Promotions, 9 Hatton Place, London EC1N 8RV. Tel. 01-405 4127/0960. (9794

PRINTED CIRCUIT MANUFACTURE. Very fast, reliable service. Lowest prices. Prototypes welcome. Inhouse photography. Phone 06474-573 for instant quote or write to AKTRONICS Ltd., 42/44 Ford Street, Moretonhampstead, Devon. (9857

EURO CIRCUITS

Printed Circuit Boards — Master layouts — Photography — Legend printing — Roller tinning — Gold plating — Flexible films — Conventional fibre glass — No order too large or too small — Fast turnround on prototypes. All or part service available NOW . (963

**EURO CIRCUITS TD.
Highfield House
West Kingsdown
Nr. Sevenoaks, Kent. WK2344**

TEST EQUIPMENT CALIBRATION AND REPAIR

Quick turn round, attractive rates, ring f details on Southampton (0703) 431 323

DUTCHGATE LTD.
94 Alfriston Gardens, Sholing Southampton (938

CIRCUIT DRAUGHTING work post. — Details, 051-526 4534. (9

PRINTED CIRCUIT BOARDS ma factured single/double sided. Fr circuit diagrams to assembled a tested boards. Any intermedi stages of manufacture undertak 3 day turn round on prototyp — Phone Maldon (0621) 741560 write to Bancol & Co., 4 The Dri Maylandsea, Chelmsford, Es CM3 6AB. (9

SHEET METAL WORK fine general front panels chass covers, boxes, prototypes. 1 off batch work fast turnround. 01- 2695. M. Gear Ltd 179A Victo Road, New Barnet, Herts. (9

DESIGN DEVELOPMENT MA FACTURE. We can offer a h quality, professional service, cov ing all aspects from original des to small batch production. Digi Analogue prototypes welcome. competitive pricing and quick livery phone Mr. Flower, Digit Ltd., 9, Milldown Road, Goring- Thames, Oxfordshire. Tel: 049 3162. (9

FOR CLASSIFIED ADVERTISING RING NEIL McDONNELL ON 01-261 8508

CAPACITY AVAILABLE

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. 50 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 133-151

	PAGE
Acoustical Mfg. Co. Ltd.	14
AEL Crystals	32
Aero Elec (AEL) Ltd	33
Ambit International	112
Antex	66
Apex	85
Aspen Electronics Ltd.	27
Astra Elec. Comps	110
Avo Ltd	11
Barrie Electronics Ltd.	107
BIB Hi-Fi	Cover iv
Bi-Pak Semiconductors Ltd.	101
Bull, J.	123
Butterworth & Co. Ltd.	26
Cambridge Learning	4, 5
Carston Electronics Ltd.	24, 25
Carter Associates	26
Catronics	107
Chiltern Electronics	128
Chiltmead Ltd.	119
Cintec	7
CIL	132
Circard No. 5	123
Colomor (Electronics) Ltd.	116
Communications '80	110
Compec (Europe) '80	30
Computer Appreciation	122
Continental Specialities	99
Crimson Elektrik	10
Cropico Ltd.	18
Datong	15
Display Electronics	116
Dominus	104
Drake Transformers	86
Eagle Internatinal	17
Edicron	34
Eddystone Radio Ltd.	10
Electronic Brokers Ltd	129, 130, 131, 152
Electro-Tech Comps Ltd	124
Electrometric Services	26
Electrovalue	15
Elvins/Dalston	15
Eraser	122
Faircrest Eng.	114
Farnell Instruments Ltd.	28
Feedback Instruments	86
Fylde Electronic Labs Ltd.	22

	PAGE
GEC Semiconductors	76
GEC M-O Valve	27
Hameg Ltd.	2
Harris Electronics (London) Ltd.	22, 32
Hart Electronics	114, 116
Henry's Radio	110, 116, 120
H.L. Audio	23
I.L.P. Electronics Ltd.	98, 108, 109
Industrial Tape Applications	117, 128
Integrex Ltd.	102, 103
Intel Electronic Comps. Ltd.	85
Intersil	13
ITF/IEA	9
K.A.C. Electronic Investment	106
Keithley Insts.	97
Kelsey Acoustics Ltd.	122
Kirkham Amplifier	35
Langrex	115
Larsholt Electronics	106
Lascar Electronics	12
Legal Ad	120
Leevers-Rich Equip. Ltd.	18
Levell Electronics Ltd.	3
Lindos Electronics	28
Lowe Electronics Ltd.	34
Maclin-Zand Electronics Ltd.	21
Maplin Electronic Supplies	Cover iii, 16
Marshall, A. & Sons (London) Ltd.	118
Medelec	112
Microcircuits Ltd.	21
Milward, G.F.	120
Multicore Solders Ltd.	Cover iv
Newbear Computer Store	22, 100
Newtronics	23
Olson Electronics	33
OMB Electronics	33
PBRA Ltd.	107
Powertran Electronics	121, 126, 127
Precision Instruments.	19
Pyrdex Components	34

	PAGE
Quantum Electronics	4
Racal Recorders	6
Radio Components Specialists	111
Radio Shack	104
Ralfe, P.	118
R.C.S. Electronics	100
R.S.T. Valves	115
Sabtronics International	65
Sandwell Plant Ltd.	107
Sasgan	132
Science of Cambridge	75
Scopex Instruments Ltd.	113
Service Trading	105
Shure Electronics	36
Softy Ltd.	98
Sonic Sound Audio	8, 116
Sota Communications Systems Ltd.	100
Southern Electronics	15
Special Products Ltd.	106
Star Devices	29
Strumech Eng. Ltd.	27
Strutt Elec. & Mech'l Engrs. Ltd.	98
Sugden, J. E. & Co. Ltd.	104
Surrey Electronics Ltd.	114
Swanley Electronics Ltd.	122
Symot Ltd.	106
Tally Computer	8, 9
Tandy Corporation	20
Technomatic Ltd.	125
Tektronix (U.K.) Ltd.	Cover ii
Teleradio Electronics	106
Texas Instruments	12
Toolrange Ltd	28
Valradio Ltd.	18
Vero Electronics Ltd.	120
Vero Speed	128
Vero Systems	122
West Hyde Developments Ltd.	104
Wilmslow Audio	31
Wolfsen Electronics	32
Z. & I. Aero Services Ltd.	32, 132

OVERSEAS ADVERTISEMENT AGENTS:

France & Belgium: Norbert Hellin, 50 Rue de Chemin Veat, F-9100, Boulogne, Paris.

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) 63074
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 Tim 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 Street, 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 Distribution Inc., 14th floor, 111 Eighth Avenue, New York, N.Y. 10011.

MAPLIN

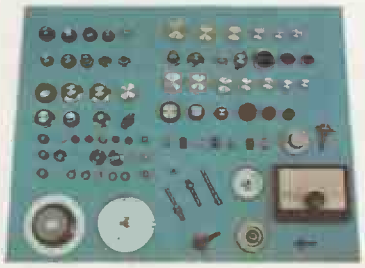
Post this coupon now for your copy of our 1979-80 catalogue price 70p.
Please send me a copy of your 280 page catalogue. I enclose 70p (plus 37p p&p).
If I am not completely satisfied I may return the catalogue to you and have my money refunded.
If you live outside the U.K. send £1.35 or ten International Reply Coupons.
I enclose £1.07.

NAME ____________________

ADDRESS ____________________

WW 180

This superb organ – build the first working section for just over £100. Full specification in our catalogue.



A range of highly attractive knobs is described in our catalogue. Our prices are very attractive too!

Touch operated rhythm generator, the 'Drumsette'. Construction details 25p. (Leaflet MES49). Specification in our catalogue.

The 3800 synthesiser build it yourself at a fraction of the cost of one ready-made with this specification. Full 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.

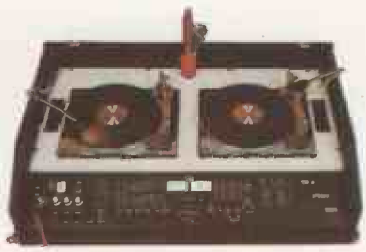
A pulse width train controller for smooth slow running plus inertia braking and acceleration. Full construction details in our catalogue.

A wide range of disco accessories at marvellous prices. Our catalogue has all the details.

A very high quality 40W per channel stereo amplifier with a superb specification and lots of extras. Full construction details in our catalogue.

61-note touch-sensitive piano 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 the coupon now!



A genuine 150W per channel stereo disco to build 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.

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) 554000.

WW—002 FOR FURTHER DETAILS