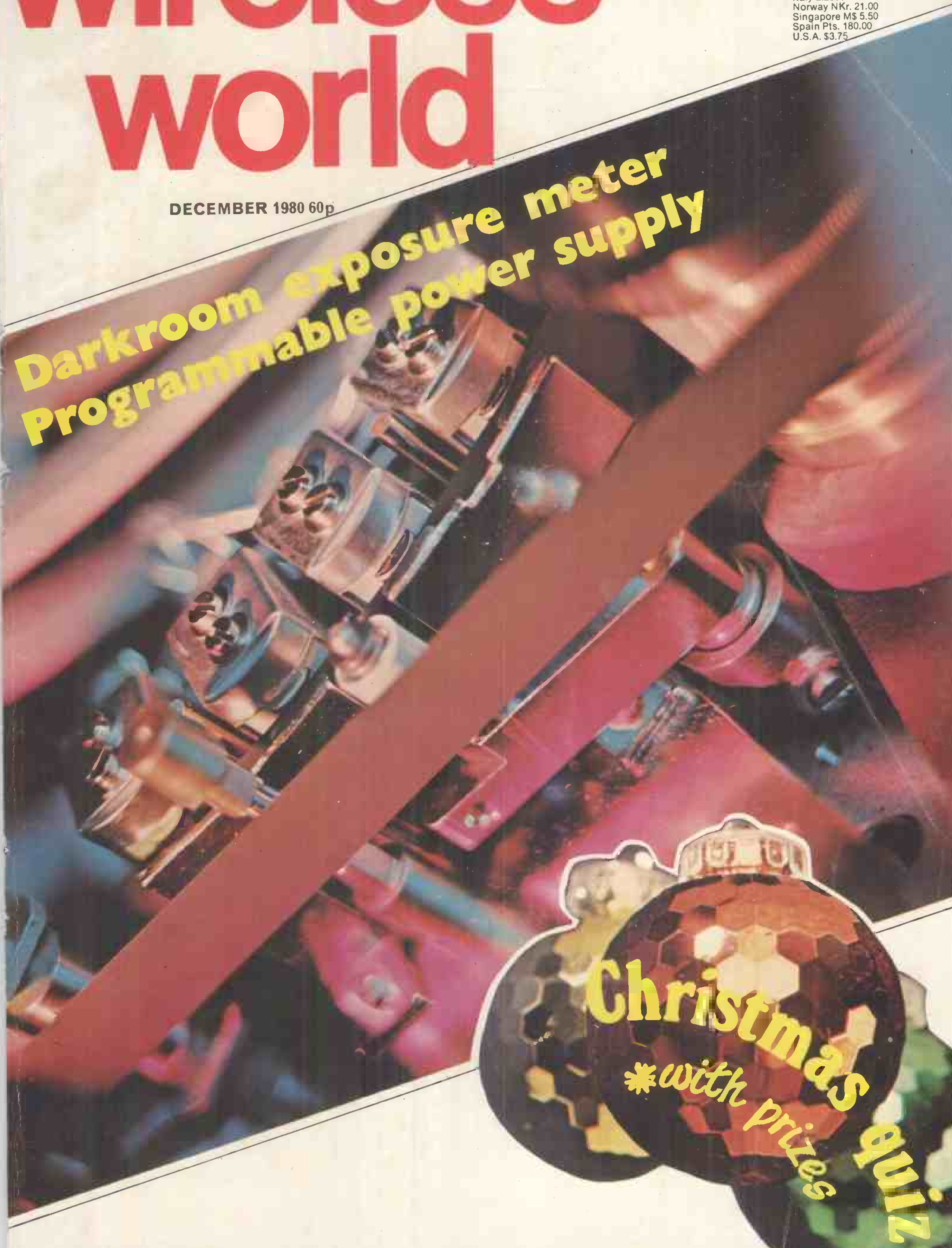
wireless world

Australia A$ 2.40
Canada C$ 4.25
Denmark DKr. 20.25
Germany Dm. 6.00
Greece Dra. 125.00
Holland Dfl. 5.75
Italy L.2300
Norway NKr. 21.00
Singapore M$ 5.50
Spain Pts. 180.00
U.S.A. $3.75

DECEMBER 1980 60p



Darkroom exposure meter
Programmable power supply

Christmas quiz
*with prizes

DATA PRECISION

digital instruments...

...off the shelf

MULTIFUNCTION TIMER-COUNTER

Data Precision 5740

Frequency 5Hz to 100MHz
Pulse 0 to 10^8 pps

Single period 1 to 200,000μS

Period average 9,999.999 to 999,999.9

Totalizing (event counting)
0 to 9,999,999 and beyond

Sensitivity 10mV

Accuracy field adjustable to 0.1ppm

Stability ± 0.01ppm/sec
± 0.6ppm/month
± 4.0ppm/year

Mains powered

Optional bcd output, electrical start-stop, external clock input

UK price £195 delivered ex VAT

Featured here is just one of Data Precision's wide range of economically priced digital instruments. We believe they offer more value and versatility than any other range you can buy from. They are the world's leading source of 4½ digit portable DMMs.

That's why we stock them. That's why we offer full service and recalibration facilities using USA trained technicians. That's why you should know more about Data Precision products. Use this magazine's reply system now to obtain detailed brochures and prices.

Sole UK Agent:

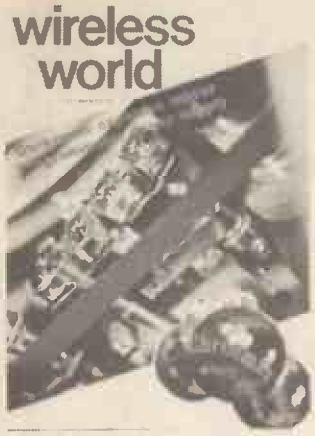
Farnell International

For more details circle the appropriate numbers on the enquiry card

935	3½ digit hand hold DMM	001
936	3½ digit hand hold DMM	002
938	3½ digit hand hold capacitance meter	003
940	Hand hold thermometer	004
1350	3½ digit low cost bench DMM	005
1351	As above to 20A	006
175	3½ digit portable DMM	007
1750	3½ digit bench DMM	008
248	4½ digit portable DMM	009
258	4½ digit portable DMM	010
2480	4½ digit bench DMM	011
3400	4½ digit lab DMM	012
3500	5½ digit lab/systems DMM	013
7500	5½ digit systems DMM	014
3505	Single range DVMs	015
8100	Dual output dc volts standard	016
585	8 digit portable frequency meter 250MHz	017
5800	8 digit bench frequency meter 520MHz	018
5740	7 digit multifunction timer-counter	019
	Short form catalogue	020

FARNELL INTERNATIONAL INSTRUMENTS LIMITED · WETHERBY · WEST YORKSHIRE LS22 4DH · TELEPHONE 0937 61961 · TELEX 557294 FARIST G

REGIONAL OFFICE SOUTH: HARPENDEN TELEPHONE 05827 69072



Front cover is a Paul Brierley photograph of the tape system in a Philips analogue instrumentation recorder.

IN OUR NEXT ISSUE

Microprocessor trainer. **Designed to familiarize the complete beginner with microprocessors, this small unit with hex keyboard and six-digit display has enough facilities to make a useful tool later on.**

Off-air frequency reference **provides a 10MHz signal phase locked to the 200kHz Droitwich transmission. Modifications allow for the eventual change of Droitwich to 198kHz.**

Multiplex keying system **for organs gives flexible control of pipe or electronic organs through t.d.m.**

Current issue price 60p, 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 96p, back issues (if available) £1.50, 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 £10.00 UK and $33.80 outside UK.
Student rates: 1 year £5.00 UK and $16.90 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

Change of address

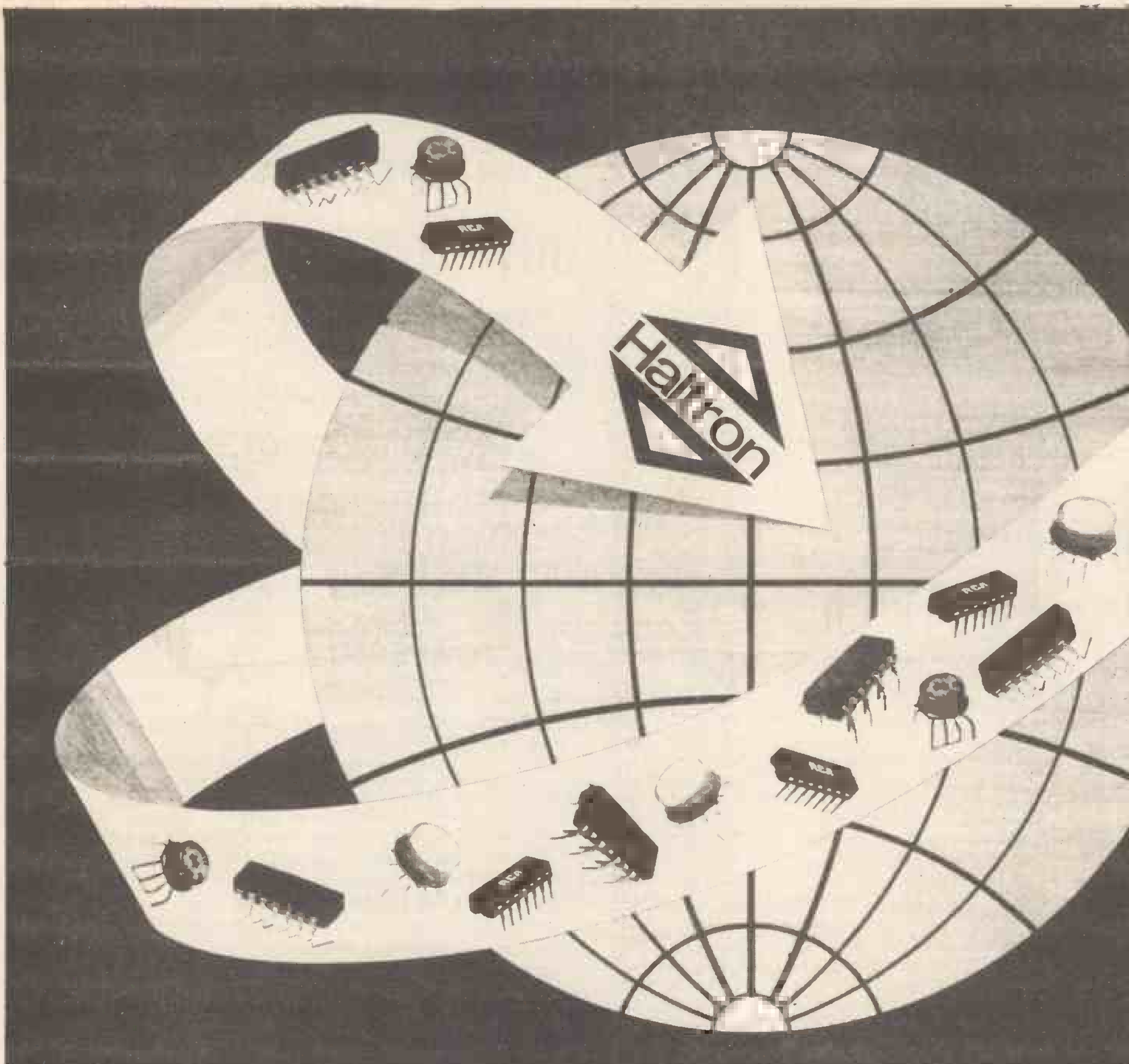
With the December issue, editorial and advertisement offices will be at the following new address

Quadrant House,
The Quadrant,
Sutton, Surrey,
SM2 5AS
Tel 01-661 3500
Telex 892084
Answer code BISPRS G

wireless world

ELECTRONICS/TELEVISION/RADIO/AUDIO

DECEMBER, 1980 Vol 86 No 1539



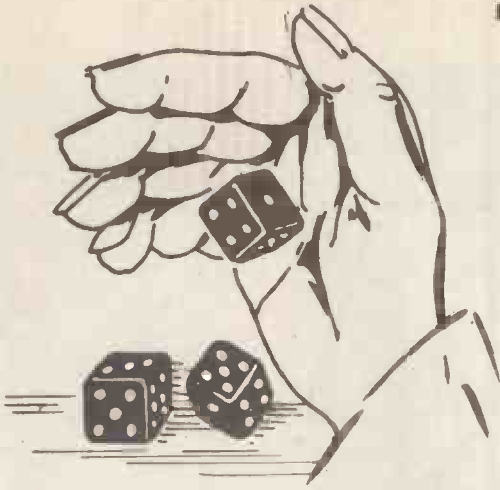
The world over- You get the best service from Haltron

For high quality electronic valves, semiconductors and integrated circuits – and the speediest service – specify Haltron. It's the first choice of Governments and many other users throughout the world. Haltron product quality and reliability are clearly confirmed. The product range is very, very wide. And Haltron export expertise will surely meet your requirements. Wherever you are, get the best service. From Haltron.

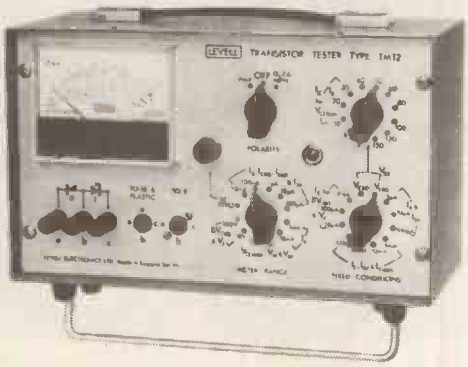
Haltron

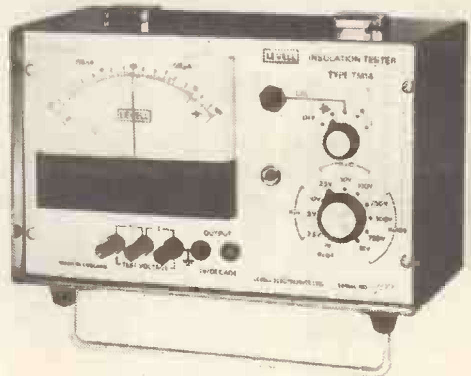
Hall Electric Limited,
Electron House,
Cray Avenue, St. Mary Cray,
Orpington, Kent BR5 3QJ.
Telephone: Orpington 27099
Telex: 896141

WW — 069 FOR FURTHER DETAILS



DON'T GAMBLE WITH PERFORMANCE BUY LEVELL TESTERS





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

TRANSISTOR RANGES (PNP OR NPN)

I_{CBO} & I_{EBO}:	10nA, 100nA, 1µA, 10µA and 100µA f.s.d. acc. ±2% f.s.d. ±1% at voltages of 2V, 5V, 10V, 20V, 30V, 40V, 50V, 60V, 80V, 100V, 120V, and 150V acc. ±3% ±100mV up to 10µA with fall at 100µA < 5%+250mV.
BV_{CBO}:	10V or 100V f.s.d. acc ±2% f.s.d. ±1% at currents of 10µA, 100µA and 1mA ±20%.
I_B:	10nA, 100nA, 1µA ... 10mA f.s.d. acc. ±2% f.s.d. ±1% at fixed I_E of 1µA, 10µA, 100µA, 1mA, 10mA, 30mA, and 100mA acc. ±1%.
h_{FE}:	3 inverse scales of 2000 to 100, 400 to 30 and 100 to 10 convert I_B into h_{FE} readings.
V_{BE}:	1V f.s.d. acc. ±20mV measured at conditions on h_{FE} test.
$V_{CE(sat)}$:	1V f.s.d. acc. ±20mV at collector currents of 1mA, 10mA, 30mA and 100mA with I_C/I_B selected at 10, 20 or 30 acc. ±20%.

DIODE & ZENER DIODE RANGES

I_{DR}:	As I_{EBO} transistor ranges.
V_Z:	Breakdown ranges as BV_{CBO} for transistors.
V_{DF}:	1V f.s.d. acc. ±20mV at I_{DF} of 1µA, 10µA, 100µA, 1mA, 10mA, 30mA and 100mA.

type TM12 **£160**

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

RESISTANCE RANGES

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

CURRENT RANGE

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

MEASUREMENT TIME

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

RECORDER OUTPUT

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

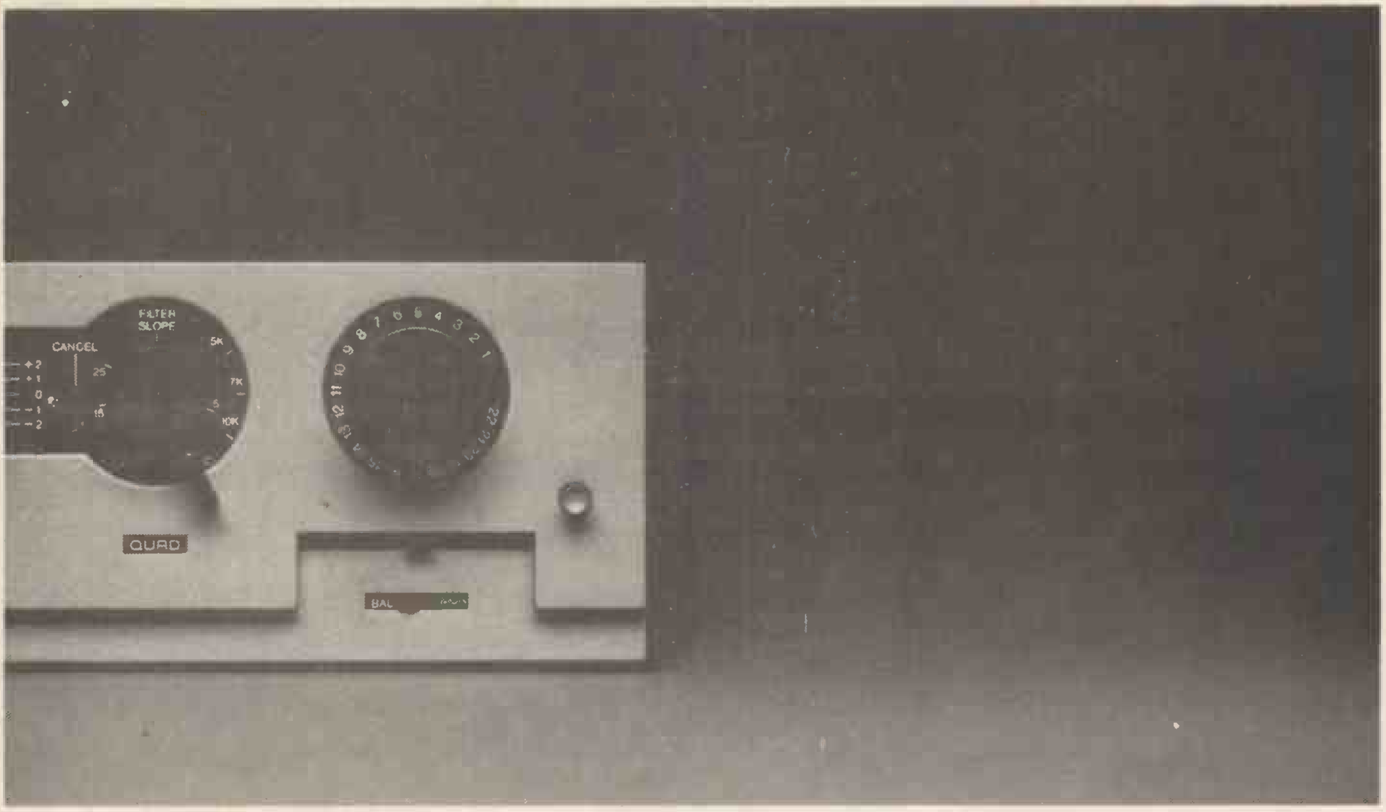
type TM14 **£170**

Optional extras are leather cases and mains power units. Prices are ex works, V.A.T. extra in U.K.

LEVELL ELECTRONICS LTD.

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

WW — 035 FOR FURTHER DETAILS



If everything were perfect...

...a control unit would consist of an on/off switch, a volume control and a programme selector switch.

In practice, correctly designed tone controls can make a significant contribution.

For a constant sound level, replay from a gramophone record produces distortion which increases very rapidly at high frequencies – doubling in fact for every major third increase in pitch.

There comes a point when the contribution of this distortion is increasing at a greater rate than the musical content and this is what decides the optimum setting of the comprehensive Quad filter system, an essential and integral part of every Quad pre-amplifier.

The rate of attenuation can be set anywhere between 0 and 25dB per octave starting at one of three frequencies 5k, 7k, or 10kHz and an appropriate setting can be found for each record to provide more of the music and less of the distortion.

To learn all about the Quad 44 write or telephone for a leaflet.

The Acoustical Manufacturing Co. Ltd., Huntingdon PE18 7DB. Telephone: (0480) 52561.

QUAD

for the closest approach to the original sound

QUAD is a registered trade mark.

1978

Carston Electronics

Prices from £

Bridges

GENRAD
GR1657 Digibridge LCR, auto, LED display — 850

CINTEL
277 Measures iron core inductances 0,01H-1000H (with a Q value not less than 2) — 130

HEWLETT PACKARD
4342A 'Q' Meter QLC complete — 1250

MARCONI
TF1245 'Q' meter. Freq. range 1kHz-300MHz using external osc — 360
TF868A Universal Bridge — 250
TF1313A Universal LCR Bridge 0.1% — 375

WAYNE KERR
B224 Wide range LCR Bridge — 475
B500 Log LCR Bridge — 225
B601 RF LCR Bridge (Detector and Oscillator not incl). — 125
B641. Measures L/C/R/G Accuracy of 0.1% — 450
Q801. Y parameter test set. Plus transistor adaptor unit — 230

Cable Test Equipment

MARCONI
TF2333 Transmission Test set — 575

HEWLETT PACKARD
3556A For psophometric measurements from 20 Hz-20kHz. 0.1mV-30V input level — 475

NEC
TTS-37B. Noise, level and VU measurement. Sensitivity -80dBm up to +20dBm — 275

STC
74216A Noise Generator CCITT — 240
74261A Psophometer CCITT — 475

WANDEL u. GOLTERMANN
DLM-1. Send/receive system — 1500
LDS-2. 200Hz-600kHz sender for measuring group delay and attenuation variations — 3250
LDEF-2. Filters for DLM unit — 250

Counter Timers

HEWLETT PACKARD
5300A/5303B DC-520 MHz 6 digits — 210
5300A Display Module. 6 Digits. 3×10^7 — 90
5300B Display Module. 8 Digits. 2×10^8 — 140
5302A DC-50 MHz. 100mV sens. Time interval. Period. Ratio. Totalise. — 75
5303B DC-520 MHz. (Plug-on) 125mV sens. 50Ω — 120
5308A 0-75 MHz. Universal Module. 50mV sens. 1MΩ — 100
5267A Time Interval Plug-in 10ns — 120
5345 DC-500 MHz Time Int. Ave. Burst Total Ratio — 1225
10590A Adaptor converts 5245 Plug-ins to 5345 — 225

RACAL
835. DC-15 MHz 6 digits Time interval/Period/Ratio — 100
9024 10 Hz-600 MHz 7+1 digits — 250
9835 6 Digit DC-20 MHz 10mV — 100
9837 DC-80 MHz 6 digits — 130

SYSTRON DONNER
6053 9 Digit 20 Hz-3 GHz BCD O/P — 860
6054A/04 11 Digit 20 kHz-18 GHz BCD O/P — 2800

Function Generators

HEWLETT PACKARD
3310 0.0005 Hz-5 MHz. Multi-Mode. 10V/50Ω sine, square, triangular — 250

INTER-STATE ELECTRONICS
F51A Multi-Mode. + and - offset: 0.0005 Hz to 10 MHz. 10/15V/50Ω — 250
F55A Multi-Mode, 0.0025 Hz-10 MHz. 10V/50Ω. Ext. VGC. Burst O/P up to 100k bursts/sec — 350

PHILIPS
PM5127. 0.1 Hz-1 MHz. Sine/Square/Triangular/Pulse outputs. External sweep facility 30Vp. p max output — 325

Logic Analysers

HEWLETT PACKARD
1601L Logic state analyser 12 channel display — 250
1600A 16 channel 20 MHz clock MAP A & B store — 1850
1607 16 channel 20 MHz clock (Display scope required) — 1500

TEKTRONIX
7D01F 16 channel up to 50 MHz clock MAP — 2650

Mains Monitors

COLE
T1007 200-260V. 35-65 Hz Thresholds 10V, 50V, 100V, 200V — 75

DATALAB
DL019 Power line interface for transient recording — 350
DL905 Digital Storage Unit DC-3 MHz 10mV — 1055

DRANETZ
606-3 Disturbance Analyser Avg, Sag/Surge — 2625

GAY
LDM Records +ve/−ve transients of 50ns on AC or DC Lines — 1250

Modulation Meters

AIRMEC
409 3-1500 MHz. AM/FM — 295

MARCONI
TF2300A 1-1000 MHz. AM/FM — 450

Oscilloscopes

ADVANCE
OS1000A DC-20 MHz. dual trace — 310
3300B Dual Trace DC-50 MHz 5mV/div. Dual Timebase — 600

COSSOR
3100 Dual Trace DC-40 MHz — 400

DYNAMCO
7210. DC-15 MHz. Dual Trace 1 mV sensitivity on CHI. Delayed Timebase — 300

GOULD ADVANCE
OS1000B DC-20 MHz Dual Trace X-Y TV Sync — 400

HEWLETT PACKARD
1703A Storage 1000Div/ms. DC-35 MHz. Dual trace Mains/Ext DC — 1200
1707B/020 DC-75 MHz. Dual trace. Dual Time Base. — 700
1707B/012 As 1707B/020 with Internal Battery fitted — 750
181A Storage 1000Div/ms DC-100 MHz Main frame only — 650
182C DC-100 MHz Mainframe, large screen — 525

MEDELEC
M-scope 4 channel DC-100 kHz U/V Chart — 1650

PHILIPS
PM 3211 DC-15 MHz Dual Trace 2mV — 425
PM3233 Dual Beam DC-10 MHz 2mV/div. — 400

SCOPEX
40-10B Dual Trace DC-10 MHz — 180

TEKTRONIX
475 Dual Trace DC-200 MHz 2mV — 1125
485 Dual Trace DC-350 MHz 50Ω 1 MΩ 250 MHz — 2100
545B/1A1. DC-30 MHz. dual trace. Delayed timebase — 325
561A/3A6/3B1. DC-10 MHz. Dual Trace. High persistence tube. Delayed Timebase — 275
585A/82. DC-80 MHz. dual trace 10 mV sensitivity — 525
547/1A1. DC-50 MHz. dual trace DTB — 525
547/1A4. DC-50 MHz. four trace DTB — 625
7403N DC-60 MHz 3 Plug-in Mainframe — 450
7704A DC-200 MHz. CRT Readout. Mainframe for 4 Plug-in — 1200

TELEQUIPMENT
D63/V1/V3 DC-35 MHz. Depending on sensitivity. 50μV or 1 mV Sensitivity — 675
D34 Dual Trace DC-15 MHz 2mV Mains/Batt — 525
D75 Dual Trace DC-50 MHz Dual Timebase — 600
D83 DC-50 MHz. Dual trace. Large 6½" CRT. Dual Time Base — 650

Oscilloscope Plug-ins

HEWLETT PACKARD
1804A DC-50 MHz Four channel 20 mV-10V/div. — 575
1825A Dual Timebase 50ns-1s/div. — 525
1805A Dual Trace DC-100 MHz 5mV. 1MΩ/50Ω — 550

TEKTRONIX
Type R. Transistor R.T. tester. Pulse rate 120 pulses/sec. R.T. Less than 5 mμs — 100
Type G. Differential amplifier. 100:1 CMR DC-20 MHz. 50 mV sensitivity Plug-ins for 500 series — 50
1A1 dual trace Plug-in DC-50 MHz — 225
1A2 dual trace Plug-in DC-50 MHz — 180
1A4 four trace Plug-in DC-50 MHz — 375
1A5 Differential Plug-in — 175
Z Differential Plug-in — 140
81 Adaptor Plug-in 1A Series to 580 Series — 75
7A12 Dual Trace DC-105 MHz 5mV/div. — 410
7A18 Dual Trace DC-75 MHz 5mV/div — 370
7A22 High gain diff. amp. 0.1 Hz-1 MHz 10μV — 450
7A26 Dual Trace DC-150 MHz 5mV-5V/div. — 525
7B53A Dual Timebase 5ns-5s/div. — 550

Oscilloscopes (storage)

TEKTRONIX
549/1A1. DC-30 MHz. 5mV sensitivity. Dual trace. Storage scope. Writing speed: 5cm/μs with enhancement. Includes trolley — 675
564/3A74/3B4. DC-2MHz. four channel. 20 mV sensitivity. Writing speed up to 500cm/ms — 650
564B/3A6/2B67. DC-10 MHz. Dual trace 10mV sensitivity, split screen storage oscilloscope — 750
466 Storage 1350 cm/μs Variable Persist DC-100 MHz — 2225
7313 Split screen 4.9 cm/μs. DC-25 MHz (M/F for 3 Plug-ins) — 1650

TELEQUIPMENT
DM64 Storage 250 Divs/ms. DC-10 MHz Dual trace. — 400

Phase Meter

DRANETZ
301A 5 Hz-500 kHz. Z in 100kΩ. Accuracy ±1° to ±2°. Analogue O/P — 400

Power Meters

DYMAR
2081/100 True RMS. DC-500 MHz. 30mW-100W — 425

HEWLETT PACKARD
432A 10μW-10mW, 10 MHz-10GHz — 195
478A Thermistor Mount for 432A — 90
435A 0.3μW to 100mW 5 MHz-18GHz — 475
8481A Power Sensor for 435A — 200

MARCONI SANDERS
6460 10 MHz-40 GHz (Depending on Head) — 300
6420 10 MHz-12.4 GHz 10mw — 110
6422 10 MHz-12.4 GHz 1mw — 85
6428 26.5-40 GHz 10mw — 150

MARCONI
TF2512 DC-500 MHz 0.5-30w 50Ω — 130
TF 893A 10 Hz-20 kHz. 20μW-10W. — 120

Power Supplies

ADVANCE
1V1 12V DC to 240V 50 Hz, 150w Inverter — 125

BRANDENBURG
475R 10-2100V 5mA DC Stab. — 150

FARNELL
L30B 0-30V 1A DC Stab. — 55

FLUKE
415B 0±3100V 30mA 0.005% reg. Protected — 350

As New Ex Stock delivery

OSCILLOSCOPES

TEKTRONIX 465 DC-100 MHz Dual Trace 5mV-5V/Div 0.05μs-0.5s/Div Delayed T/B XY DC 4 MHz — £1250

TEKTRONIX 475A DC-250 MHz Dual Trace 5mV-5V/Div 0.01μs-0.5s/Div Delayed T/B XY DC 3 MHz — £1950

These instruments sold with
ONE YEAR FULL GUARANTEE

Bigger stock investment greater equipment range means wider choice

Prices from £

ITT
Power Lab. up to 30V Dual Supply 90

MARCONI
TF2154/1 0-30V 1A. 0±15V 2A 0±7.5V 4A 60

SMITHS
4701 5-7V o/p Power Pack 32

SORENSEN
DCR 300-2.5 0-300V 2.5A DC Stab. 375

Pulse Generators

DB ELECTRONICS
150. I.C. pulse generator 50

EH RESEARCH
122. 1 KHz-200 MHz 5V/50Ω RT 12ns 220
139(L). 10Hz-50 MHz 10V/50Ω RT 5ns 175
1221. Timing Unit 6 Channel 0-10 MHz 5V/50Ω RT 8ns 50
G710. 5V/50Ω 30 Hz-50 MHz RT 5ns 100
132AL. 50V/50Ω 5 Hz-3 MHz RT 12ns 175

HEWLETT PACKARD
214A 100V/50Ω. Double pulse O/P. W50ns-10ms. 10 Hz-1 MHz. 15ns RT 350

MARCONI
TF2025 0.2 Hz-25 MHz ±10V/50V RT 7ns 350
PM5776 3V/50Ω. 1 Hz-100 Mz. Rise/fall Times less than 1ns. 275

Recorders and Signal Conditioning Equipment

AMPEX
PR2200 Instrumentation Recorder up to 16 channels. FM/DR. Record replay all speeds. 1" tape FM/DR I.R.I.G. DC-40 kHz FM. 100 Hz-300 kHz DR 6500

BRUNO WOELKE
ME102B. Wow and flutter meter 75
ME102C. Wow and flutter meter 90

BRUEL & KJAER
2305B Bench type. Mains operated. Log recording of AC: 2 Hz-200 kHz and DC.50 or 100mm paper width. 750
ZR0001 Linear Pat DC: 10-35 mV 59
ZR0002 Linear Pat DC: 10-110V 79
ZR0004 25 dB Potentiometer 52
ZR0005 50 dB Potentiometer 59
ZR0006 75 dB Potentiometer 69

Prices from £

BRYANS SOUTHERN
29000 X-Y Recorder A4 0.25mV-10V/cm 525
BS314 4 channel 1mV-10V 16 speeds 1650
BS316 6 channel 1mV-10V 16 speeds 2350
29300 X-Y Single pen A4 0.25mV-10V/cm 0.1s-50s/cm 545

HEWLETT PACKARD
680M. 5 inch. Stripchart Single Pen 5mV-120V I/P 20cm/min 2.5 cm/Hr 275
7046A Two pen A3 0.25mV-5V/cm 995

KUDELSKI
Nagra 4.2 LSP Professional Audio Recorder (Batt optd) 1215

NAGRA
Mains Unit for 4.2 LSP 95

PHILIPS
PM 8251 Single pen 10in chart 10mV-50V FS 450

RACAL
Store 4. Uses D/4 inch magnetic tape. Will record 4 F.M. channels. Operates at 7 different speeds. 1675

S E LABORATORIES
6150/6151 12 channel UV 1250 mm/s-25 mm/min 6 in chart 1400
994 6 Channel Pre-Amp ± 1% ± 1V o/p 450
6008 25 Channel µV 8 In 4m/sec to 25mm/min 895

SMITHS INDUSTRIES
RE541.20 Single Pen. 0.5mV-100V FSD. 3-60cm/min and hour 350

YOKOGAWA
3046. 10 inch Chart Single Pen. 0.5 mV-100 VI/P2.60cm/min and/hr 350
3047. 2 Pen Version of 3046 425

Signal Sources and Generators

BOONTON
102B 4.3-520 MHz Int/Ext FM/AM 0.1µV-1V 50Ω 1725

DYMAR
1525 100 kHz-184 MHz Int/Ext AM/FM Batt/Mains 525

GOULD ADVANCE
SG70 5 Hz-125 kHz 600Ω 4w 85

HEWLETT PACKARD
204D 5 Hz-1.2 MHz. 600Ω. 80dB att. O/P 5V RMS 150

Prices from £

608E. 10-480 MHz AM 410
620B 7-11 GHz 50Ω FM/PM 1mw 1100
8614A 800 MHz-2.4 GHz + 10dBm to − 127 dBm 50Ω AM/FM 1950
8616A 1.8-4.5 GHz Ext AM/FM/PM 10 mw 925

MARCONI
TF144 H/4S HF Generator 10 kHz-72 MHz AM 550
TF791. FM Deviation Meter 4-1024 MHz 95
TF801/D1. 10-470 MHz AM. FM. 256
TF995A/2. 1.5-220 MHz AM. FM. 350
TF2171 Digital Synchroniser for TF2015 525
TF2002/AS 10 kHz-72 MHz FM/AM 0.1-1V o/p 625
TF2012 UHF, FM 400-520 MHz, 0.03µV. Counter o/p 650

RACAL
9081 5-520 MHz LED Display O/P — 130dBm AM/FM 1875

ROHDE & SCHWARZ
SWDB 11. 0 5 1200 MHz 50Ω 850

SCHAFFNER
NSG101 Mains Interference Simulator. Superimposes Pulses on mains for testing immunity of equipment to interference Pulse amplitude ±800V Rise Time 0.25µs Width 50 & 200µs 300
NSG330 Ignition Interference Attachment 150
NSG200B Mains Interference Simulator (Mainframe) 260

STC
74216 Noise Generator 20 Hz-4 kHz Flat/CCITT Wtg 315

TEXSCAN
9900 10-300 MHz. Sweep generator with CRT display 525
TV Markers set of 5: 31.5, 32.5, 35, 39.5 & 41.5 MHz 196

Spectrum Analysers

HEWLETT PACKARD
8443A Tracking Gene/counter 100 kHz-110 MHz 850
8445A Automatic pre-selector 10 MHz-18 GHz 1300
8555A RF Plug-in 10 MHz-18 GHz 1 kHz Res 3000
8558B For 180 Mainframe 100 kHz-1.5 GHz 1 kHz-res 1760

NELSON ROSS
011 DC-20 kHz 80dB dynamic range Dispersion. 100 Hz 6 kHz 350
022 DC 100 kHz. Dynamic range 60dB fits into various 500 series CRO's 350

TEKTRONIX
3L5. Plug-in unit fits into various 500B series CRO's. 50 Hz 1 MHz. Greater than 60dB dynamic range 475

Prices from £

Sweep Generators

HEWLETT PACKARD
8690B Mainframe. Int/Ext AM. Ext FM 600
8693B/100 3.7-8.3 GHz.5mW. PIN levelled 'N' connectors 600
8699B/100 0.1-4 GHz.6mW. 120mW to 2 GHz). PIN levelled. 'N' connectors 1200

TEXSCAN
9900 Sweep Generator 10-30 MHz CRT Display 525
VS60 Sweep Generator 5-100 MHz Rate 60 Hz 950
LN40A Log Amplifier 105

T.V. Test Equipment

PHILIPS
PM5508B Pattern Generator. 625 lines PAL. UK Systems 225

Voltmeters-Analogue

AVO
8 Mk IV AC/DC V.AC/DC Amps.Ω 70

BOONTON
92AD/01/09 10 kHz-1.2 GHz 1999 FSD 10µV Res 525
92C 10 kHz-1.2 GHz 500µV-3V. 1% of FS 350

HEWLETT PACKARD
400E Millivoltmeter 10 Hz-10 MHz B/W 1mV FSS 99
427A AC DC Ω multimeter 275
3406A. 10 kHz 1 2 GHz 345
8405A Vector Voltmeter 1-1000 MHz B/W Auto Phase Lock 850
3400A 10 Hz-10 MHz 1mV-300V True RMS 350

KEITHLEY
610C Electrometer DC 1mV-100V, Amps 10^{-14} Recorder o/p 350

LEVELL
TM3B 5µV-500VAC 1 Hz-3 MHz + 50 to 100 dB 80

LINSTEAD
M2B DC AC 10 Hz 500 kHz 25

MARCONI
TF2603 AC voltmeter to 1.5 GHz 300

PHILIPS
PM2454B 1mV 300V 10 Hz 12 MHz Z in 19MΩ DC O P 300

RACAL
9301 RMS Millivoltmeter 10 kHz-1.5 GHz with carry case 475

Voltmeters-Digital

ADVANCE
DMM 7A/01 1999 FSD AC/DC/Ω/Current 115

FLUKE
8000A 1999 FSD AC/DC/OHMS/Current 115

HEWLETT PACKARD
34740A/34702A 9999 FSD.AC/DC/OHMS 180

SOLARTRON
LM1420.2 2300 FSD DC only 0 05% 75
LM1420.2BA. 2300 FSD AC True RMS/DC 110
A200 19999 FSD DC only 160
A203.19999 FSD AC/DC/Ω. Sensitivity. (1µV DC, 10µV AC, 100mΩ resistance) 300
A205 19999 FSD AC/DC/Ω 300
A243. 119999 FSD AC/DC/Ω. Sensitivity (1µV DC. 10µV AC. 10mΩ resistance) 325
7050.99999 Auto AC/DC/Ω 350

Voltmeters Vector/Phase

DRANETZ
305B 9999 FSD Mainframe for PA 3001 module 575

HEWLETT PACKARD
3490A 100000 FSD 1µV-1000V DC 0.01% 10µV-1000V AC & Ω 625

ALL PRICES LISTED ARE EXCLUSIVE OF VAT (Standard Rate).

Prime Equipment

HEWLETT PACKARD
8640B Precision AM FM Signal Generator £3550
141T Spectrum Analyzer Mainframe £1300
8552B Spectrum Analyzer IF Section £2200
8553B Spectrum Analyzer RF Section £1650
8555A Spectrum Analyzer RF Section £4400
8556A Spectrum Analyzer LF Section £1650
1600A 16 Channel Display Logic Analyzer £2150

PHILIPS
PM 3212 Dual Trace 25 MHz 2mV Div Oscilloscope £525
PM 3214 Dual Timebase Dual Trace DC-25 MHz Oscilloscope £625

RACAL
9081 5 520 MHz Generator 130 dBm AM/FM £1975

TEKTRONIX
485 Dual Trace 350 MHz Oscilloscope £2995
T912 Dual Trace Storage Oscilloscope DC-10 MHz 250 cm ms writing speed £699
7313 Storage Oscilloscope Mainframe 4 9 cm/µs writing speed DC-25 MHz £1900
7A22 Differential Plug-in. As new DC-1 MHz 10µV 10V Div (12 month guarantee) £670
7A26 Dual Trace Plug in. DC 150 MHz 5mV-5V Div £780
7B53A Dual Timebase 5ns-5s Div CRT Readout £650

Carston Prime Equipment brings you recent "State-of-the-Art" instruments at competitive prices, with fast delivery (2-4 weeks). Every "Prime" instrument carries the Carston 90 Day Full Guarantee covering parts and labour.

PLEASE NOTE:
LISTED HERE IS ONLY A SELECTION OF OUR WIDE STOCK OF EQUIPMENT — FOR SPECIALIST NEEDS OR FOR DETAILS OF OUR FULL STANDARD RANGE OF EQUIPMENTS —
RING US TODAY!

Redundant Test Equipment
Why not turn your under-utilized test equipment into cash? Ring us and we'll make you an offer.

Carston Electronics

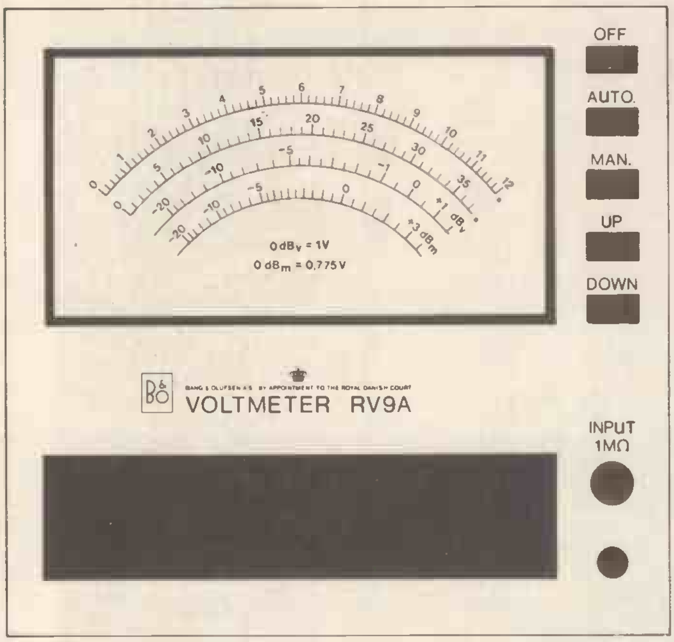
Contact Brian Hollingsworth or Noel Jennings
CARSTON ELECTRONICS LTD
SHIRLEY HOUSE, 27 CAMDEN RD.,
LONDON NW1 9NR Telex 23920

01-267 5311/2

WW — 046 FOR FURTHER DETAILS

VOLT-METER

automatic RV9A



Bang & Olufsen RV9A is an automatic millivoltmeter and measuring amplifier.

The instrument switches automatically to the actual measurement range securing the best possible resolution and accuracy.

Voltmeter:	100µV – 317V in 12 ranges
Amplification:	-50 dB – +60 dB in 12 steps
Accuracy:	±0.1 dB at 1 kHz
Frequency	10 Hz – 1 MHz ±0.2 dB
characteristics:	10 Hz – 10 MHz ±1.0 dB

Bang & Olufsen electronic instruments are also wow/flutter meters, power supplies, oscillators, milliohmmeters, voltmeters, and distortion meters.

UK agent: Danbridge (UK) Limited, Sherwood House, High Street, Crowthorne, Berkshire RG11 7AT
Tel: (034 46) 2369 TLX: 847782

Bang & Olufsen

DK – 7600 Struer

WW — 024 FOR FURTHER DETAILS

People who listen for a living...

More than 50% of professional recording engineers choose Beyer Dynamic headphones.
Why? For the same reasons that our headphones are ideal for home use.
For Clarity. Beyer Dynamic headphones are backed by more than fifty years of pioneering research and production experience to give you the purest, most authentic sound available.
For Comfort. A recording engineer spends long periods listening through headphones. For him, Beyer Dynamic lightness and softness is essential. For you, it's part of the pleasure of listening to be able to forget you're wearing headphones at all.
For Reliability. Your private listening will not make such demands on a pair of headphones as recording studio work, but it's good to know that the quality you enjoy is lasting quality.
Beyer Dynamic headphones. Prices from £20

listen to us.

Beyer Dynamic

Beyer Dynamic (GB) Ltd., 1 Clair Road, Haywards Heath, Sussex RH16 3DP. Tel (0444) 51003.

WW — 027 FOR FURTHER DETAILS

The alternative source that's near to hand . . . KGM. A video production line with high volume capability, here in Europe. Ready to meet your orders for open frame monitor chassis that neatly replace those long-range imports you're using currently. Same mounting, same international-standard connections. But one big, competitive advantage . . .

We're so much nearer, with the stocks, fast production response, spares and service you could only expect from a home based source. KGM prices are highly competitive too, especially on big orders. We can prove that with a quote, but how about product performance? . . .

The specifications you want... bright, clear CRT data display, with superior resolution. The quality you get from years of video experience. Your popular screen sizes, in any phosphor colour. Latest miniaturised pcb construction of course, in an open chassis that allows screen tilt and mounting variations to fit your package.

So if you buy video display this way . . . call KGM now. See how keen we are to win your next order.

KGM ELECTRONICS LIMITED
Clock Tower Road, Isleworth, Middlesex TW7 6DU, England.
Telephone: 01-568 0151. Telex: 934120

KGM ELECTRONICS LIMITED

The finest amplification kits from Crimson Elektrik

★★★★★ LATEST DEVELOPMENTS ★★★★

CRIMSON ELEKTRIK Power amplifiers are the most sophisticated on the market today. Yet now with the latest Issue 5 innovations THEY ARE EVEN BETTER! We have included sonic improvements and developed a unique electronic protection circuit which obviates the need for output fuses. In fact, such fuses can seriously degrade the performance of an amplifier. They can blow under heavy drive conditions — even with non-faulty loads (due to thermal fatigue), they can be a time-consuming nuisance and even dangerous to replace, but more importantly they are responsible for 'envelope distortion' i.e., dynamic compression of the signal, even fuses in the feedback loop suffer from the first two disadvantages, and the latter to a lesser extent.

★ ★ ★ ★ BEST VALUE ★★★★

CRIMSON have an enviable reputation for supplying the best value amplifier kits. You can prove this to yourself by checking out the competition in the following crucial areas: ★ professional grade phono sockets for ALL signal connections ★ Silver/Gold plated switch contacts ★ Adequate heatsinking for full-rated output ★ Available from stock ★ Manufactured by a specialist company with a reputation for friendly and helpful service before and AFTER sale ★ Forms the basis for high quality active loudspeaker systems. Considering the advantages of CRIMSON Kits, why choose anything else?

★ ★ ★ ★ ★ SOUND ADVICE ★ ★ ★ ★ ★

Crimson Amplifiers are versatile and dependable. The new CP3000 will give up to 300 watts into 4 ohms at 0.03% THD and is the obvious choice for P.A. and Discos requiring the best performance. For Hi-Fi we produce the ever-popular pre- and power amp hardware kits which enable our advanced modules to be houses in attractive metalwork and include everything down to the last nut and bolt.

Our Pre-amplifier can be fitted with the moving coil module allowing it to be used with the latest M.C. cartridge (which can now be bought for as little as £30).

Write for details, specifications and full price list or send 50p, cheque/P.O. for our comprehensive application/user's manual.

Space precludes us from publishing all our products and prices, below are just a few examples:

★ Power Amp Modules (single channel)	
CE 608 (60 WRMS/8 ohms)	£23.10
CE 1708—(170 WRMS/8 ohms)	£38.50
CP 3000 —(300 WRMS/4 ohms)	£58.00
★ 60 + 60 watt stereo pre and power amplifier complete kit	£208.86
★ Stereo Moving Coil Pre-Pre Amplifier Module MC1	£28.50
★ 3 Way Active Crossover (single channel)	£32.60

Don't forget, Crimson modules are available throughout the country from all branches of Marshalls and Mail Order from Badger Sound Services and, of course, Crimson Elektrik.

Prices include V.A.T. and post to anywhere in the U.K.

CE Crimson Elektrik

BARCLAYCARD

1A STAMFORD STREET, LEICESTER LE1 6NL
TELEPHONE: 0533 553508

Buy it with Access

WW — 051 FOR FURTHER DETAILS

SEMI-CONDUCTORS

Extensive range of Germanium and Silicon semi-conductors. Quick delivery from stock. Exporters of international repute, established over 20 years. Direct supplies for OEM, industrial and rental users and wholesalers. Private and retail users please send for list of distributors. Overseas distributor enquiries welcomed. Write, ring or telex for details and prices:

High quality - good value

Edicron

Edicron Ltd., Redan House, Redan Place, London W2 4SA
Telephone: 01-221 4717 Telex: 265531

Germanium and Silicon Semi-conductors • Valves • Tubes • TV tube guns

WW — 026 FOR FURTHER DETAILS

the NEW

VIDEOTONE

YOU CANNOT BUY CHEAPER – YOU CAN ONLY GET LESS FOR YOUR MONEY!

Introduces DIRECT SELLING – the Ultimate Discount!!!

DISCOUNT SELLING PRICE £50.00

LOUDSPEAKERS

The complete fully reviewed range of Videotone Speakers which dominate within their class. Now at lowest ever prices.

D 100	£38
Minimax 11	£44
GB3	£50
GB2	£60
GBS	£207
D 93	£40

CORAL CARTRIDGES

Fast becoming one of the top names

MOVING COIL

UK's No. 1 Cartridge

MC 81	£48.87
777EX	£35
777E	£25

MOVING MAGNET

555SX	£7.28
555E	£14.22
666E	£32.48

HEAD AMP

H300	£51.75
T100	£24.75

HEADSHELLS

S100	£6
S101	£7
S200	£4

MICROPHONES

MU 105-22	£29.30
MU 105-12	£22.25
MU 25 C	£17.39

TURNTABLES

Sansui SR222 Mk2	£69.00
JVC LA 11	£64.00
JVC SLQ 3	£140.00

DISCOUNT SELLING PRICE £68.00

DISCOUNT SELLING PRICE £75.00

ELECTRONICS

This new range of Electronics from Videotone redefines the words quality and value for money to a new high.

30 watt amp MC input SA4130	£75.00
Stereo Tuner ST4120	£68.00
Cassette full features SC3200	£98.00
50 Watt amplifier WA7700	£77.00
20 Watt amplifier LA2020	£58.00

A MESSAGE FROM VIDEOTONE

Dear Customer You will find that the products advertised on this page are the best possible value for money. They are only low in price because we have eliminated large amounts of selling costs that other brands have to suffer. These savings are passed directly on to you. We have full brochures on any specific item you may be interested in and a competent realistic staff of engineers at our London Showrooms to help you in your choice. Our consumer protection packages are comprehensive and we offer every form of financing you may require. We carry out our own servicing and are dedicated to giving Value for Money. We are confident our products are unbeatable. You may purchase with confidence because our Engineers have specially selected them from competitive sources throughout the world and we import them directly ourselves.
Remember, you have 21 days trial period on all products. That is the measure of our confidence.

Cliff Hardcastle
Managing Director

DISCOUNT SELLING PRICE £9.69

HEADPHONES

HP 90 Headphone	£12.65
HP 80 Headphone	£9.69

Superbly made with top flight performance.

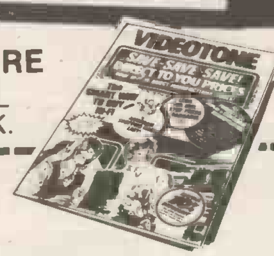
VIDEOTONE

ALL PRODUCTS ON DISPLAY & CONTINUOUS DEMONSTRATIONS

ALL PRICES INCLUDE VAT

SEND FOR OUR LATEST FREE BROCHURE

AND DETAIL LIST OF LOCAL SALES OUTLETS IN THE U.K.



VIDEOTONE
98 CROFTON PARK ROAD,
CROFTON PARK, LONDON SE4
Tel: 01-690 8511/2

Please send me your Direct Selling Brochure and list of sales outlets.

Name ____________________

Address ____________________

WW 12/10

AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

LINEAR ICs - NUMERIC LISTINGS

- TBA120S 1.00
- L200 1.95
- U237B 1.28
- U247B 1.28
- U257B 1.28
- U267B 1.28
- LM301H 0.67
- LM301N 0.30
- LM308H 0.96
- LM308N 0.65
- LM339N 0.66
- LM348N 1.86
- LF351N 0.38
- LF353N 0.76
- LM374N 3.75
- LM380N-14 1.00
- LM380N-8 1.00
- LM381N 1.81
- ZN419CE 1.95
- NE544N 1.80
- NE555N 0.30
- NE556N 0.50
- NE560N 3.50
- NE562N 4.05
- NE564N 4.29
- NE565N 1.00
- NE566N 1.60
- NE570N 3.85
- SL624 3.28
- TBA651 1.81
- uA709HC 0.64
- uA709PC 0.36
- uA710HC 0.65
- uA710PC 0.59
- uA741CH 0.66
- uA741CN 0.27
- uA747CN 0.70
- uA748CN 0.36
- uA753 2.44
- uA758 2.35
- TBA810AS 1.09
- TBA820M 0.75
- TCA940E 1.80
- TDA1028 2.11
- TDA1029 2.11
- TDA1054 1.45
- TDA1062 1.95
- TDA1072 2.69
- TDA1074A 5.04
- TDA1083 1.95
- TDA1090 3.05
- HA1137 1.20
- HA1196 2.00
- HA1197 1.00
- TDA1220 1.40
- LM1303 0.99
- LM1307 1.55
- MC1310P 1.90
- MC1330 1.20
- MC1350 1.20
- HA1370 1.90
- HA1388 2.75
- TDA1490 1.86
- MC1496P 1.25
- SL1610P 1.60
- SL1611P 1.60
- SL1612P 1.60
- SL1613P 1.89
- SL1620P 2.17
- SL1621P 2.17
- SL1623P 2.24
- SL624C 3.28
- SL1625P 2.17
- SL1626P 2.44
- SL1630P 1.62
- SL1640P 1.89
- SL1641P 1.89
- TDA2002 1.25
- TDA2020 3.00
- ULN2242A 3.05
- ULN2283B 1.00
- CA3080E 0.70
- CA3089E 1.84
- CA3090AQ 3.35
- CA3123E 1.40
- CA3130E 0.80
- CA3130T 0.90
- CA3140E 0.46
- CA3189E 2.20
- MC3357P 2.35
- LM3900N 0.60
- LM3909N 0.68
- LM3914N 2.80
- LM3915N 2.80
- KB4400 0.80
- KB4406 0.60
- KB4412 1.95
- KB4413 1.95
- KB4417 1.80
- TDA4420 2.25
- KB4420B 1.09
- KB4423 2.30
- KB4424 1.65
- KB4431 1.95
- KB4432 1.95
- KB4433 1.52
- KB4436 2.53
- KB4437 1.75
- KB4438 2.22
- KB4441 1.35
- KB4445 1.29
- KB4446 2.75
- KB4448 1.65
- NE5044N 2.26
- NE5532N 1.85
- SD6000 3.75
- SL6270 2.03
- SL6310 2.03
- SL6600 3.75
- SL6640 2.75
- SL6690 3.20
- SL6700 2.35
- ICL8038CC 4.50
- MSL9362 1.75
- MSL9363 1.75
- HA11211 1.95
- HA11223 2.15
- HA11225 1.45
- HA12002 1.45
- HA12017 0.80
- HA12402 1.95
- HA12411 1.20
- HA12412 1.55
- LF13741 0.33
- SN76660N 0.80

FREQUENCY DISPLAY & SYNTHESISER ICs

- SAA1056 3.75
- SAA1058 3.35
- SAA1059 3.35
- 11C90DC 14.00
- LN1232 19.00
- LN1242 19.00
- MSL2318 3.84
- MSM5523 11.30
- MSM5524 11.30
- MSM5525 7.85
- MSM5526 7.85
- MSM5527 9.75
- MSM55271 9.75
- ICM7106CP 9.55
- ICM7107CP 9.55
- ICM7216B 19.25
- ICM7217A 9.50
- SP8629 3.85
- SP8647 6.00
- 95H90PC 6.00
- HD10551 2.45
- HD44015 4.45
- HD12009 6.00
- HD44752 8.00

CMOS 4000 SERIES

- 4001 0.17
- 4000 0.17
- 4002 0.23
- 4008 0.80
- 4009 0.58
- 4010B 0.58
- 4011AE 0.20
- 4011B 0.20
- 4012 0.55
- 4013 0.55
- 4015 0.95
- 4016 0.52
- 4017 0.80
- 4019 0.60
- 4020B 0.93
- 4021 0.82
- 4022 0.90
- 4023 0.17
- 4024 0.76
- 4025 0.17
- 4026 1.80
- 4028 0.72
- 4029 1.00
- 4030 0.58
- 4035 1.20
- 4040 0.83
- 4042 0.85
- 4043 0.85
- 4044 0.80
- 4046 1.30
- 4047 0.99
- 4049 0.52
- 4050 0.55
- 4051 0.65
- 4052 0.65
- 4053 0.65
- 4063 1.09
- 4066 0.56
- 4068 0.25
- 4069 0.20
- 4070 0.20
- 4071 0.20
- 4072 0.20
- 4073 0.20
- 4075 0.20
- 4076 0.90
- 4077 0.20
- 4078 0.20
- 4082 0.20
- 4093 0.78
- 4175 0.95
- 4503 0.69
- 4506 0.51
- 4510 0.99
- 4511 1.49
- 4512 0.98
- 4514 2.55
- 4518 1.03
- 4520 1.09
- 4521 2.36
- 4522 1.49
- 4529 1.41
- 4539 1.10
- 4549 3.50
- 4554 1.53
- 4560 2.18
- 4566 1.59
- 4568 2.18
- 4569 3.03
- 4572 0.30
- 4585 1.10

TTL N and LSN

- 7400N 0.13
- 74LS00 0.20
- 7401N 0.13
- 74LS01 0.20
- 7402N 0.14
- 74LS02 0.20
- 7403N 0.14
- 74LS03 0.20
- 7404N 0.14
- 74LS04 0.24
- 7405N 0.18
- 74LS05 0.26
- 7406N 0.28
- 7407N 0.38
- 7408N 0.17
- 74LS08 0.24
- 7409N 0.17
- 74LS09 0.24
- 7410N 0.15
- 74LS10 0.24
- 7411N 0.20
- 74LS11 0.24
- 7412N 0.17
- 7413N 0.30
- 7414N 0.51
- 74LS15 0.24
- 7416N 0.30
- 7417N 0.30
- 7420N 0.16
- 74LS20 0.24
- 7421N 0.29
- 74LS21 0.24
- 7423N 0.27
- 7425N 0.27
- 7427N 0.27
- 74LS27 0.44
- 7428N 0.35
- 74LS28 0.32
- 7430N 0.17
- 74LS30 0.24
- 7432N 0.25
- 74LS32 0.24
- 7437N 0.40
- 7438N 0.33
- 74LS38 0.24
- 7440N 0.17
- 74LS40 0.24
- 7441N 0.74
- 7442N 0.70
- 74LS42 0.99
- 7443N 1.15
- 7444N 1.12
- 7445N 0.94
- 7446N 0.94
- 74LS47 0.89
- 7448N 0.56
- 74LS48 0.99
- 74LS49 0.99
- 7451N 0.17
- 74LS51 0.24
- 7453N 0.17
- 7454N 0.17
- 74LS54 0.24
- 74LS55 0.24
- 7460N 0.17
- 74LS63 1.24
- 7470N 0.28
- 7472N 0.28
- 7473N 0.32
- 74LS73 0.38
- 7474N 0.27
- 74LS74 0.28
- 7475N 0.38
- 7476N 0.37
- 74LS76 0.38
- 74LS78 0.38
- 7480N 0.48
- 7481N 0.86
- 7482N 0.69
- 7485N 1.04
- 74LS85 0.99
- 74LS86 0.40
- 7489N 2.05
- 7490N 0.33
- 74LS90 0.90
- 7491N 0.76
- 74LS91 1.10
- 7492N 0.38
- 74LS92 0.78
- 7493N 0.32
- 74LS93 0.99
- 7494N 0.78
- 7495N 0.65
- 74LS95 1.14
- 7496N 0.58
- 74LS96 1.20
- 7497N 1.85
- 74LS107 0.38
- 74109N 0.63
- 74LS109 0.70
- 74110N 0.54
- 74111N 0.68
- 74LS112 0.38
- 74LS113 0.38
- 74LS114 0.38
- 74118N 0.83
- 74120N 1.15
- 74121N 0.42
- 74122N 0.46
- 74123N 0.73
- 74LS124 1.75
- 74125N 0.38
- 74LS125 0.44
- 74126N 0.57
- 74LS126 0.44
- 74128N 0.74
- 74132N 0.73
- 74LS132 0.78
- 74LS136 0.40
- 74LS138 0.60
- 74141N 0.56
- 74142N 2.65
- 74143N 3.12
- 74144N 3.12
- 74LS145 0.97
- 74147N 1.75
- 74148N 1.09
- 74LS148 1.19
- 74150N 0.99
- 74151N 0.55
- 74LS151 0.84
- 74153N 0.64
- 74LS153 0.54
- 74154N 0.96
- 74155N 0.54
- 74LS155 1.10
- 74156N 0.80
- 74157N 0.67
- 74LS157 0.55
- 74LS158 0.60
- 74159N 2.10
- 74160N 0.82
- 74LS160 1.30
- 74161N 0.92
- 74LS161 0.78
- 74LS162 1.30
- 74163N 0.92
- 74LS163 0.78
- 74164N 1.04
- 74LS164 1.30
- 74165N 1.05
- 74LS165 1.04
- 74167N 2.50
- 74LS169 2.00
- 74170N 2.30
- 74LS170 2.00
- 74LS174 1.20
- 74175N 0.87
- 74LS175 1.10
- 74176N 0.75
- 74177N 0.78
- 74181N 1.65
- 74LS181 3.50
- 74LS183 2.10
- 74184N 1.35
- 74185N 1.34
- 74LS190 0.92
- 74192N 1.05
- 74LS192 1.80
- 74193N 1.05
- 74LS193 1.80
- 74194N 1.05
- 74196N 0.99
- 74LS196 1.10
- 74LS197 1.10
- 74198N 1.50
- 74199N 1.60
- 74LS247 0.93
- 74LS257 1.08
- 74LS260 1.53
- 74LS279 0.52
- 74LS283 1.20
- 74LS293 0.95
- 74LS365 0.49
- 74LS366 0.49
- 74LS367 0.43
- 74LS368 0.49
- 74LS374 1.80
- 74LS377 1.95
- 74LS379 1.30
- 74LS393 1.40

VOLTAGE REGULATORS

- 78series 0.95
- 79series 1.00
- 78Mseries 0.65
- 78Lseries 0.35
- 79L05 0.85
- 78MGT2C 1.75
- 79MGT2C 1.75
- 723CN 0.65
- L200 1.95
- TDA1412 0.75
- NE5553N 1.25
- LM317MP 1.48
- LM337MP 1.48

MICROMARKET

- 8080A/2 7.50
- 8212 2.30
- 8214 3.50
- 8216 1.95
- 8224 3.50
- 8251 6.25
- 8255 5.40
- 6800P 7.50
- 6810 5.95
- 6820 7.45
- 6850 4.90
- 6852 4.85
- MC2708 7.50
- 2114 6.50
- 4027 5.78
- 2102 1.70
- 2112 3.40
- 2513 7.54
- HM4716 4.50
- 81LS97 1.25

VARICAP TUNING DIODES

- BA102 0.30
- BA121 0.30
- ITT210 0.30
- BB204B 0.36
- BB105B 0.36
- BB109 0.27
- MVM125 1.05
- BB212 1.95
- KV1210 2.45
- KV1211 1.75
- KV1226 1.95
- KV1225 2.75
- KV1215 2.55
- KV1225 2.75

SWITCHING AND PIN DIODES

SHOTTKY DIODES

- 1N6263 0.62
- BA182 0.19
- BA244 0.17
- BA379 0.35
- TDA1061 0.95

SIGNAL DIODES & RECTIFIERS

- 1N4148 0.06
- 1N4001 0.06
- 1N4002 0.07
- 1N5402 0.15
- OA91 0.07
- AA112 0.25
- BRIDGES:
- 1A/50V 0.35
- 6A/200V 0.75

TOKO COILS AND FILTERS SEE THE EXTENSIVE SECTION IN OUR NEW PRICE LISTS AND CATALOGUE

LF/HF FIXED INDUCTORS —FULL E12 RANGE

- 7BA series 1uH-1mH 0.16
- 8RB series 100uH-33mH 0.19
- 10RB series 33mH-120mH 0.33
- 10RBH series 120mH-1.5H 0.55
- PIEZO SOUNDER PB2720 0.44

CRYSTAL FILTER PRODUCTS

- 10.7MHZ 2 POLE TYPES:
- 10M15A 15KHZ BW 2.49
- 10.7MHZ 8 POLE TYPES:
- 10M4B1 15kHz BW 14.50
- H4402 7.5KHZ BW 15.50
- 10M22D 2.4KHZ SSB 17.20
- HF FIRST FILTER:
- B34F8A 34.5MHz HF 32.00

RADIO CONTROL CRYSTALS

(No splits available)

- AM TX:-
- 3rd OT 30pF HC25U 1.65
- AM/FM RX:-
- 3rd OT 30pF HC25U 1.65
- FM TX :-
- Fund 20pF HC25U 1.85
- Pairs FM 3.25
- Pairs AM 3.10

CRYSTALS

- 32.768 kHz 2.70
- 100kHZ 3.85
- 455kHZ 5.00
- 1.0MHz 3.00
- 3.2768MHz 2.70
- 4.000MHz 2.00
- 4.19439MHz 2.30
- 6.5536MHz 2.10
- 10.0MHz 2.50
- 10.6985MHz 2.50
- 10.7015MHz 2.50
- 10.245MHz 2.50
- 10.7MHz 3.00
- 11.52MHz 2.50
- 100MHz 3.00

LEDs

- 5MM RED 0.12
- 3MM RED CLEAR 0.15
- 3MM RED 0.15
- 2.5 X 5MM RED 0.17
- 5MM GREEN 0.15
- 3MM GN CLEAR 0.16
- 3MM GREEN 0.16
- 2.5 X 5MM GN 0.20
- 5MM YELLOW 0.15
- 3MM YELLOW CL 0.16
- 3MM YELLOW 0.18
- 2.5 X 5MM YE 0.20
- 5MM ORANGERED 0.20
- 5MM ORA CL 0.29
- 3MM ORANGERED 0.19
- 2.5 X 5MM ORA 0.24
- 5MM INFRA RED 0.56
- BPW41 IR DET 1.51
- IR OPT CPLR 1.44
- 5MM CLIP 0.04

LCDs

- 3.5 digit 9.45
- 4 digit 8.95
- 5 digit 8.95

SCHOTTKY DIODE BAL MIXERS (SBL1=MD108)

- SBL1 1-500MHz 4.25
- SBL1-8 .1-200MHz 4.55
- SBL1-X 10-1000MHZ 5.75
- SRA1 .5-500MHz 8.45
- SRA1-1 .1-500MHz 9.25
- SRA1H .5-500MHz 13.35
- SRA3 .025-200MHz 10.25

LCD Module

CM161. Miniature clock, 12/24 hr., alarm, day, date, backlight. All for......9.95

TRANSISTORS

AUDIO DEVICES

- BC237 0.08
- BC238 0.08
- BC239 0.08
- BC307 0.08
- BC308 0.08
- BC309 0.08
- BC413 0.10
- BC414 0.11
- BC415 0.07
- BC416 0.08
- BC546 0.12
- BC556 0.12
- BC550 0.12
- BC560 0.12
- BC639 0.22
- BC640 0.23
- 2SC1775 0.18
- 2SA872A 0.14
- 2SD666A 0.30
- 2SB646A 0.30
- 2SD668A 0.40
- 2SB648A 0.40
- 2SD760 0.45
- 2SB720 0.45
- 2SC2546 0.19
- 2SA1084 0.20
- 2SC2547 0.19
- 2SA1085 0.20

AUDIO POWER DEVICES

- 2SB753 2.34
- 2SB723 2.34
- 2SK133 3.00
- 2SJ 48 3.00
- 2SK134 3.10
- 2SK135 3.75
- 2SJ 50 3.75
- BD535 0.52
- BD536 0.52
- BD377 0.33
- BD378 0.33
- BD165 0.30
- BD166 0.31

SMALL SIGNAL RF DEVICES

- BF194 0.18
- BF195 0.18
- BF224 0.22
- BF241 0.18
- BF274 0.18
- BF440 0.21
- BF441 0.21
- BF362 0.49
- BF395 0.18
- BF479 0.66
- BF679S 0.55
- BFR91 1.33
- BFW92 0.60
- BFT95 0.99
- BFY90 0.90
- 40238 0.85

RF POWER DEVICES

- VN66AF 0.95
- 2N3866 0.85

SMALL SIGNAL RF FET/MOSFET

- BF256 0.38
- 2SK55 0.28
- 2SK168 0.35
- J310 0.69
- J176 0.65
- 40823 0.65
- 40673 3SK51
- 3SK45 0.49
- 3SK51 0.54
- 3SK60 0.58
- MEM680 0.75
- BF961 0.70
- BF960 1.24
- 3SK48 1.64

CAPACITORS

All 5mm or less spacing

- CERAMIC 50v
- 2P2,3P3,4P7,6P8
- 8P2,10P,15P,18P..0.04
- 22P,27P,33P,47P
- 56P,68P,82P,100P.0.05
- 150P,220P,270P
- 330P,390P,470P...0.055
- 1N0,2N2,3N3,4N7..0.06
- 10N (0.01uF)....0.05
- 22N,47N.........0.06
- 100N,220N........0.09
- MONOLITHIC CERAMIC
- 10N,100N.........0.16
- FEEDTHRU
- 1N0 SOLDER IN....0.09
- POLYESTER (SIEMENS)
- 10mm LEAD SPACING
- 10N,22N,33N......0.17
- 47N,68N,100N.....0.19
- 220N,470N....,...0.22
- 1uF.............0.29
- POLYESTER (GENERAL)
- 10mm LEAD SPACING
- 10N,15N,22N,33N..0.06
- 47N,68N,100N.....0.08
- 220N............0.11
- 20mm LEAD SPACING
- 220N,330N,470N...0.18
- MYLAR
- 5mm LEAD SPACING
- 1N0,10N,22N,33N..0.08
- 100N............0.09
- 20mm LEAD SPACING
- 220N,470N....... 0.17
- POLYSTYRENE
- 10P,15P,18P,22P,
- 27P,47P,56P,68P..0.08
- 100P,180P,220P,
- 270P,330P,390P...0.09
- 470P,680P,820P...0.10
- 1N0,1N2,1N5,1N8..0.11
- 2N2,2N7,3N3,3N9..0.12
- 4N7,5N6,6N8,10N..0.13
- TANTALUM BEAD CAPS
- 16v: 0.22,0.33,
- 0.68,1.0.........0.18
- 16v: 2.2,4.7,10..0.19
- 6v3: 22,47.......0.30
- 10v: 22,100......0.35

ALUMIN ELECTROLYTICS RADIAL (VERT. MOUNT)

- (uF/voltage)
- 1/63,2.2/50,4.7/35
- 10/16,15/16,22/10
- 33/6.3..........0.08
- 22/16,33/10,
- 47/10..........0.09
- 10/63,22/50,33/50,
- 47/16,100/16.....0.10
- 47/63,100/25,220/16
- 470/6.3.........0.12
- 100/63,470/16,
- 1000/10.........0.18
- 1000/16,470/63...0.23
- 1000/63,2200/16..0.30
- 3300/25.........0.69
- 1000/100........0.88
- 10000/70........3.00
- AXIAL (HORIZ. MOUNT)
- 1/25,4.7/16,6.4/25
- 10/16...........0.08
- 4.7/63,22/10,22/16
- 33/16...........0.09
- 47/25,100/16.....0.10
- 100/25..........0.11
- 1000/16.........0.25
- 2200/16,1000/25..0.36
- 1000/35,4700/16..0.45
- 1000/50.........0.58

RESISTORS

- 0.25W, 5% E12 CARBON
- 1ohm-10M........0.02
- 0.25W 1% E12 METAL FILM
- 1.1ohm-1M........0.05
- HORIZ CARBON PRESETS
- 10mm TYPE
- 100ohms-2M5......0.12
- HORIZ CERMET PRESETS
- 1k, 10k.........0.27

Please send an SAE with all enquiries. Access/Barclaycd (min £5 please) Callers welcome

PRICES EXCLUDE VAT - PLEASE ADD 15%* Postage 35p per order. CWO please. (*UK only)

ambit INTERNATIONAL

CWO PLEASE : Commercial MA terms on application. Goods are offered subject to availability, prices subject to change - so please phone and check if in doubt.

CATALOGUES 2 & 3....60p ea 4..........75p (4 inc. rev. of part 1) ALL PARTS : ....£1.75......

200 North Service Road, Brentwood, Essex

TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG

WW — 080 FOR FURTHER DETAILS

Britain's first complete computer kit.

The Sinclair ZX80.

£79.95

Price breakdown
ZX80 and manual: £69.52
VAT: £10.43
Post and packing FREE

Please note: many kit makers quote VAT-exclusive prices.

You've seen the reviews...you've heard the excitement...now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (*including* VAT and p&p) you get everything you need to build a personal computer at home...PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or colour); *everything!*

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The ZX80 is programmed in BASIC, and you can use it to do quite literally anything from playing chess to managing a business.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done: connect it to your TV...link it to an appropriate power source*...and you're ready to go.

Your ZX80 kit contains...
- Printed circuit board, with IC sockets for all ICs.
- Complete components set, including all ICs–all manufactured by selected world-leading suppliers.
- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOADed on to a portable cassette recorder.)
- FREE course in BASIC programming and user manual.

Optional extras
- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately–see coupon).
- Additional memory expansion boards allowing up to 16K bytes RAM. (Extra RAM chips also available–see coupon).

*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

The unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

The unique Sinclair BASIC interpreter offers remarkable programming advantages:
- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability–takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input–to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions. USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

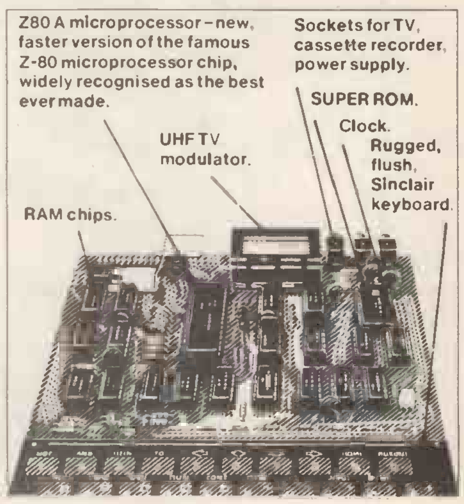
Fewer chips, compact design, volume production–more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer–typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.



plete

ZX80 software – now available!

See advertisements in Personal Computer World, Electronics Today International, and other journals.

New dedicated software – developed independently of Science of Cambridge – reflects the enormous interest in the ZX80. More software available soon – from leading consultancies and software houses.

The Sinclair teach-yourself BASIC manual.

If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-page book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs. (Available separately – purchase price refunded if you buy a ZX80 later.) A hardware manual is also included with every kit.

The Sinclair ZX80. Kit: £79.95. Assembled: £99.95. Complete!

The ZX80 kit costs a mere £79.95. Can't wait to have a ZX80 up and running? No problem! It's also available, ready assembled and complete with mains adaptor, for only £99.95.

Demand for the ZX80 is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt – and we have no doubt that you will be.

sinclair ZX80

Science of Cambridge Ltd
6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Tel: 0223 311488.

ORDER FORM

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Remember: all prices shown include VAT, postage and packing. No hidden extras.
Please send me:

Quantity	Item	Item price £	Total £
	Sinclair ZX80 Personal Computer kit(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	£79.95	
	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual and mains adaptor	£99.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	8.95	
	Memory Expansion Board(s) (each one takes up to 3K bytes).	12.00	
	RAM Memory chips – standard 1K bytes capacity	16.00	
	Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer).	5.00	

NB. Your Sinclair ZX80 may qualify as a business expense. **TOTAL** £

I enclose a cheque/postal order payable to Science of Cambridge Ltd for £______

Please print

Name: Mr/Mrs/Miss______

Address______

WW 12/80

WW – 075 FOR FURTHER DETAILS

S-2020TA STEREO TUNER/AMPLIFIER KIT

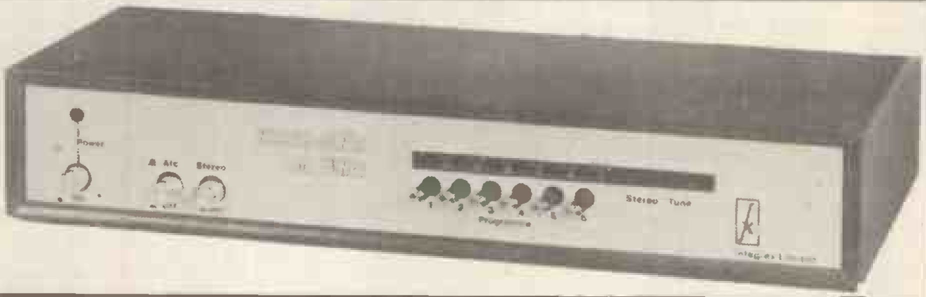
NEW HIGH PERFORMANCE TUNER

A high-quality push-button FM Varicap Stereo Tuner with pilot cancel decoder combined with a 24W r.m.s. per channel Stereo Amplifier, using Bifet op. amps.

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. **High Slew Rate.** Low noise op. amps used throughout. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section uses UM 1181 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC pilot cancel, stereo decoder, LED tuning and stereo indicators. Tuning range 88-108MHz 30dB mono S/N @ 0.7μV THD 0.3%

PRICE: £69.95 + VAT

NELSON-JONES Mk. 2 STEREO FM TUNER KIT



A very high performance tuner with dual gate MOSFET RF and Mixer ready built front end, triple gang varicap tuning, linear phase I.F. and 3 state MPX decoder.

PRICE: £74.95 + VAT

NRDC-AMBISONIC UHJ SURROUND SOUND DECODER

The **first ever** kit specially 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 2 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 **£57.70** + VAT or ready built and tested **£76.95** + VAT

S5050A STEREO AMP

Very high performance kit

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 **£69.95** + VAT

(Also available our 20w/ch BIFET S2020 Amp)

INTRUDER 1 Mk. 2 RADAR ALARM

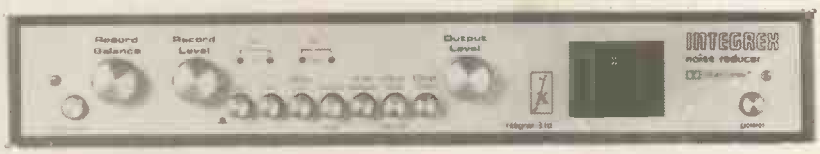
With Home Office Type approval

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. Internal mains rated voltage free contacts for external bells etc.

Complete kit **£52.50** plus VAT, or ready built and tested **£68.50** plus VAT.

Wireless World Dolby noise reducer

Trademark of Dolby Laboratories Inc.



Typical performance
Noise reduction better than 9dB weighted
Clipping level 16 5dB above Dolby level (measured at 1% third harmonic content)
Harmonic distortion 0.1% at Dolby level typically 0.05% over most of band, rising to a maximum of 0.12%
Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal at Dolby level) at Monitor output
Dynamic range >90dB
30mV sensitivity

Complete Kit **PRICE: £49.95** + VAT (3 head model available)

Also available ready built and tested .... **Price £67.60 + VAT**
Calibration tapes are available for open-reel use and for cassette (specify which) .... **Price £2.75 + VAT**
Single channel plug-in Dolby (TM) PROCESSOR BOARDS (92 x 87mm) with gold plated contacts and all components .... **Price £10.50 + VAT**

We guarantee full after-sales technical and servicing facilities on all our kits, have you checked that these services are available from other suppliers?

All kits are carriage free

INTEGREX LIMITED

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

New KONTAKT Sprays

for the Electronics & Electrical Industries

KALTRON 601
A new cleaner for Magnetic Recording Units. Kaltron 601 has an extremely low surface tension thereby enabling the cleaning of magnetic sound heads leaving no deposit or other traces.
It is chemically pure (99.8%) — non conductive — non-flammable.
It can be used on energised electrical installations and electronic equipment, e.g. video units, tape recorders, data processing systems etc.

Also NEW

PRINTER 66
Spray cleaner for type wheel printers, matrix printers and chain printers. Can also be used for cleaning normal typewriters.

SCREEN 99
Specially for the cleaning of all types of screens, including data terminals and T.V. Screens.

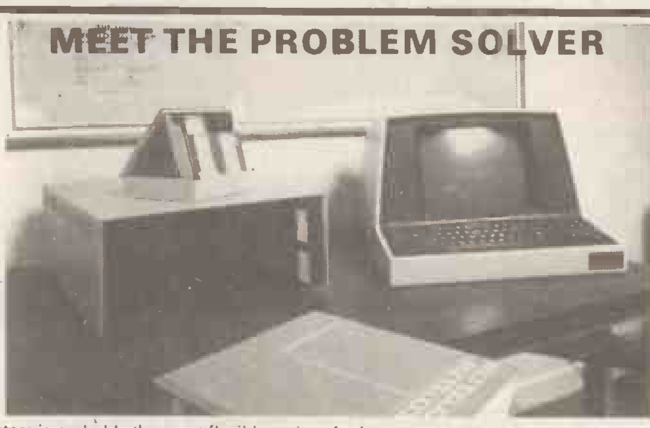
VASELINE SPRAY 701
For use in communications engineering and construction of antennae. Proved successful as corrosion inhibitor for cable clamps, connecting screw joints etc. Application from spray can with capillary tube is clean and simple.
Distributed by:

Special Products Distributors Ltd.
81 Piccadilly, London, W1V 0HL

Tel: 01-629 9556 : Cables: Speciprod, London, W.1
Telex: 265200 (answerback RACEN)

WW — 091 FOR FURTHER DETAILS

MEET THE PROBLEM SOLVER



The 'System One' series of micro computers is probably the most flexible series of micro computers available today.
Flexibility of hardware coupled with a wide range of software, allows the user to choose the most cost effective hardware/software configuration to solve his/her problem.

HARDWARE CONFIGURATION
Internal storage from 32 to 64K.
1 or 2 single-sided 5¼" or 8" floppy disks.
1 or 2 double-sided 5¼" or 8" floppy disks.
Support for most popular makes of printers. 1 or 2 terminals.

SOFTWARE FROM

FORTRAN Compiler	BASIC Compiler	STRUBAL Compiler	LABEL BASIC
Text Editor	Text Processor	Assemblers	PILOT

Basic interpreter both sequential and Random Access Versions. Plus full development and debugging software.
You even have a choice of two Operating Systems. SSBDOS or FLEX.
With all this to choose from you might begin to think you could not afford it — well a 32K storage system one with dual-single sided 5¼" floppy disks, SSBDOS and a basic interperter would cost you £1,650.
If you require a terminal as well, the above system together with the ACT-1 keyboard and 9" video monitor would cost you £1,970.
Call SEED at our Brownhills office for further details of demonstration.

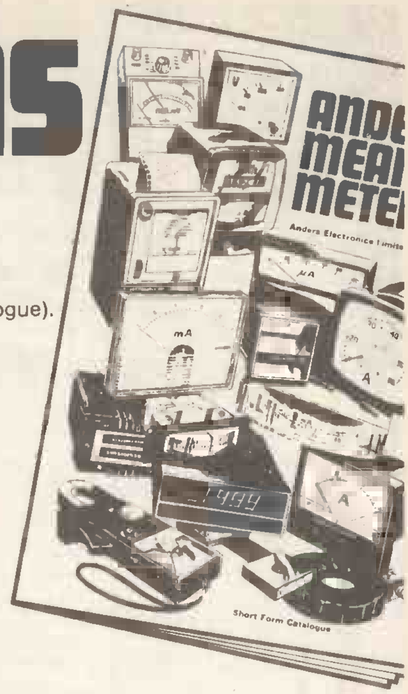
seed

STRUMECH ENGINEERING ELECTRONIC DEVELOPMENTS LTD.
Portland House, Coppice Side, Brownhills, Walsall
West Midlands. Telex 335243 SEL. Tel. No. 054-33 78151

WW — 098 FOR FURTHER DETAILS

Meters means Anders.

(The proof is the Anders Electronics Catalogue).



The Anders Catalogue is your guide to what is probably the most comprehensive and competitive range of panel mounting and portable meters available from any single source in the UK.

Contents include digital, moving coil, moving iron and thermocouple meters; voltmeters, ammeters, motammeters, frequency meters (deflectional and resonant reed), tachometers (including resonant reed), wattmeters, power factor meters, maximum demand meters and metal relays. Ancillary products include current transformers, shunts, transducers and tachogenerators.

This extensive range of instruments is backed by some 30 years' experience in, and understanding of, modern meter technology. Recent developments have resulted in the enlargement of our range of DPM's (including the advanced OEM-1 miniature display module) plus the introduction of new edgewise meter styles.

All of which explains why Anders are so easily able to offer OEMs and other meter users the service they require. Our Sales Engineers are always available to advise on the suitability of an instrument for your application and will quote you competitive prices with significant quantity discounts. Many products are available rapidly from our extensive stocks. Special items receive the urgent attention of our prototype service.

Meters, as we say, means Anders, and the proof is the - Anders Electronics catalogue. Send for your personal copy right away.

ANDERS

Foremost in meters

Anders Electronics Limited, 48-56 Bayham Place, Bayham Street, London NW1 0EU. Tel: 01-387 9092. Telex: 27364.

Helping Business to Communicate

We took yesterday's teleprinter and replaced mechanics with microprocessor electronics.

We have given you a keyboard like an electric typewriter, a noise level even less and higher operating speeds.

The traditional paper tape has been replaced with an electronic memory which gives you an easy way of editing text, changing or inserting words or paragraphs so that accurate messages can be sent to line.

We provide full operator training and a nationwide technical support and service.

- **Microprocessor reliability.**
- **Compatible with older teleprinters.**
- **Standard paper and ink-ribbons.**
- **Speeds up to 30 characters per second.**
- **Nationwide sales and service.**
- **For telex or private circuit use.**
- **British made.**

TRANSTEL

Transtel Communications Limited,
Mill Street, Slough, Berkshire SL2 5DD, England.
Telephone: Slough (0753) 26955. Telex: 849384.

WW — 093 FOR FURTHER DETAILS

sales

COUNTERS
MARCONI TF.2411 7 Digit DC-50MHz Counter/Timer £100.00
MARCONI TF.2416 7 Digit DC-50MHz Counter/Timer £140.00
MARCONI TF.2415 6 Digit DC-20MHz Counter/Timer £95.00
PHILIPS 6620 6 Digit DC-45MHz £125.00
PHILIPS 6630A 8 Digit DC-160MHz £200.00
HEWLETT-PACKARD 5300A/5302A 6 Digit 10Hz-50MHz £400.00
HEWLETT-PACKARD 5245L/5252A/5260A 7 Digit 10Hz-12.5GHz £800.00

METERS
HEWLETT-PACKARD 3400A RMS Voltmeter 10Hz-10MHz 1mV-300V £400.00
MARCONI TF.1020A/1 Power Meter 0-50-100W 250MHz £100.00
RADIO METER BKF6 Distortion Meter 20Hz-20KHz £185.00

OSCILLOSCOPES
TEKTRONIX 603 Storage Display Monitor DC-2MHz £500.00

POWER SUPPLY UNITS
KINGSHILL 18VS P.S.U. 0-18V 5A £60.00
KINGSHILL 501 P.S.U. 0-50V 1A £40.00

SIGNAL SOURCES
HEWLETT-PACKARD 8011A Pulse Generator 0.1Hz-20MHz O/P 16V 50 Ohms £400.00
HEWLETT-PACKARD 606B 50KHz-65MHz O/P 0.1uV-3V 50 Ohms £750.00
HEWLETT-PACKARD 8443A Tracking Generator 100KHz-110MHz 7 Digit Display £1750.00
MARCONI 801D/8S 10MHz-485MHz Signal Generator £350.00
MARCONI TF.1099 Sweep Generator Variable to 24MHz O/P 0.3-3V £175.00
PHILIPS PM.5168 Function Generator 0.0005 .... £100.00

RECORDERS
B & K 2305 Level Recorder c/w 50dB Pot. £500.00

MISCELLANEOUS
MONTFORD UCL/K25/A Test Chamber —70°C to +170°C ± 0.1°C £1000.00
MONTFORD UP/K82/C/Mk.II Process Chamber with Thermal Shock —50°C to +100°C £1200.00
WAYNE KERR TM.60 Mk. I Testamatics £100.00
AVO TT.537 Transistor & Diode Testers £60.00
MARCONI/SAUNDERS 6458 Signal Source 4-12GHz £200.00
SANYO VCA700 Security T.V. System, Camera Talk £250.00

NEW EQUIPMENT FROM KEITHLEY'S

130 DIGITAL MULTIMETER 3½ digits, 25 Ranges, 5 Functions 100uV: 1uA: 0.1Ohm sens 100V DC: 750V AC. 20Mohms £77.00. Optional Case £7.00.
169 BENCH MODEL DIGITAL MULTIMETER 3½ digit 25 Ranges, 5 Functions. 100uV: 1nA: 0.1Ohm. 1000V DC 1000V AC 2 Amps 20 Mohms £99.00.
Cash with Order unless accredited account.

NEW BRITISH OSCILLOSCOPES FROM SCOPEX

4S6 Single Beam DC-6MHz 10mV sens £144.00
4D10B Dual Trace DC-10MHz 10mV-50V/cm X-Y operation. Z Modulation. Acc. ±3% c/w 2 Probes. £210.00
4D25 Dual Trace DC—25MHz 10mV sens. £360.00

CARRIAGE & VAT EXTRA ON ALL ITEMS

USED EQUIPMENT

ANALYSERS
TEKTRONIX 1L5 50Hz-1MHz 10uV/cm-2V/cm £800.00
TEKTRONIX 1L10 1MHz-36MHz £950.00

BRIDGES
CROPICO RS1 1Ohm: 10 Ohms: 100 Ohms: 1 Kohm: 0.02 Ohm .... From £40.00
DANBRIDGE 5 Decade X100: X1Kolm: X10Kohm: X100Kohms: X1MOhm +0.1% £50.00
HEWLETT-PACKARD 4260A Universal Bridge £450.00
J. J. LLOYD J.70 7 decade X1: X10: X100: X1Kohm: X10Kohm: X100Kohm: X1MOhm £50.00
MARCONI 2701 Universal In Situ Bridge 80Hz & 1Khz 1% £200.00
WAYNE KERR B.601 R.F. Bridge 15KHz-5MHz 1% £125.00
WAYNE KERR B.641 Autobalance 4 Digit 0.1% £300.00
WAYNE KERR B.224 Universal Bridge 200Hz-50KHz 0.1%. Mains/Battery £400.00

MARTIN ASSOCIATES
34 Crown Street
Reading
Berks. RG1 2SE
Tel. Reading (0734) 51074

WW — 073 FOR FURTHER DETAILS

LOW COST
SPEECH OUTPUT

— for any computer or logic system
— convert digital output to SPEECH

Modus Systems Ltd. is sole UK distributor for Telesensory Systems speech products, and we can offer 24-word or 64-word fixed vocabulary speech boards at prices shown below. The boards are approximately 2.6" x 2.9" x 0.5" and 1 oz. in weight. A six-bit code is sent to the board to select any given word, and analogue speech output is sent out. The result requires a filter and an amplifier, and these are provided by our interface board which also contains power supply and 6-bit latch for easy interfacing. The resulting system is fully TTL compatible. Complete technical details are sent with each board.
Applications include any situation where an operator must read a digital display at the same time as watching and performing another activity — speech output frees up his or her eyes.

Vocabularies and prices: ★★ UNLIMITED SPEECH COMING SOON

S2A (£39.95 + 80p PP + VAT: SPECIAL INTRO OFFER)
24 — Calculator type words: 0-9, +, —, X etc. —
S2B (£67.5 + 80p PP + VAT) 64 words.
As for S2A plus "ten", "twenty", etc., "pounds", "cm", "ounces", etc.
S2C (£67.5 + 80p PP + VAT) 64 words.
FULL ASC11 set — each ASC11 Code verbalised in sequence.

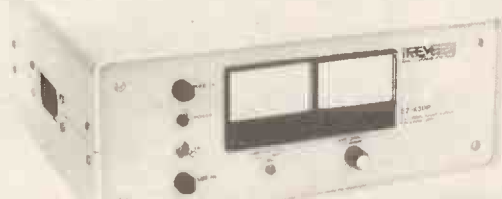
Interface Board (Kit) (£14.95 + 80p PP + VAT)
S2A, B, C board plugs into on-board socket. This PCB contains latches, audio filter, PSU, audio amplifier, I/O plug and socket.
THE EDUKIT (£34.95 + 80p PP + VAT)
★★Use it to evaluate our speech products.
— as mentioned recently in new products section (WW) and review in Practical Electronics (April issue). With its excellent manual, this single-board microcomputer is specially designed to provide an introduction to "bits and bytes", machine-code programming and hardware control. NOT THE BASIS OF A PERSONAL COMPUTER, BUT A DOWN-TO-EARTH TRAINING AID. A hexadecimal key pad and hex display plus 256 bytes of memory combined, with the RCA 1802 mpu to introduce the basics of hardware to anyone with or without a technical background, of any age. At present the unit is in wide use in schools, colleges, industrial training units of every kind, and sales extend world-wide. The 1802 is particularly suited to hardware control.

MODUS SYSTEMS LTD.
29A EASTCHEAP, LETCHWORTH SG6 3DA
PHONE (04626) 74468/76392

WW — 048 FOR FURTHER DETAILS

ELECTRONIC POWER UNITS
FOR XENON ARC AND MERCURY ARC LAMPS
UNITS AVAILABLE FOR LAMPS RANGING FROM 75 TO 6500 WATTS.

Lamp housings and lens systems manufactured as standard off the shelf models or to specific design.



IREM

K. T. Manners Design Ltd.
P.O. Box 936, London, W4 4NW Telephone: 01-994 7155. Telex: 28604

WW — 033 FOR FURTHER DETAILS

FREQUENCY COUNTERS—OFF/AIR RECEIVERS

250MHz
801 B
£250
Crystal oven
3 parts 10⁹

OFF/AIR RECEIVER TYPE 103 PRICE £135

401A	50MHz 6 Digit	£130
801B/M	250MHz 8 Digit	£250
901M	520MHz 8 Digit	£325
1001M	1-2GHz 8 Digit	£550

20 models available including LED versions

RCS
RCS ELECTRONICS
WOLSEY ROAD
ASHFORD, MIDDX.
Phone 53661

WW — 063 FOR FURTHER DETAILS

Gets you into China

TRADELINK

Gets sales leads out

China

Guaranteed Distribution
Tradelink has a guaranteed circulation of 11,000 copies in China. It is published jointly by IPC Business Press (London), Girardet (Essen), and the China Council for the Promotion of International Trade, Peking. CCPIT is responsible for translation and distribution. The magazine is printed by the Beijing Printing Industry Company.

The Right Market
Each issue of Tradelink is a special issue — the 11,000 copies go only to potential customers in the field covered.

Reader Reply Cards
Tradelink has a reader reply card service backed by the CCPIT.

The Industrial Equipment issue of Tradelink has already prompted more than 150 enquiries from Chinese end-users. Every company with a full page or half page entry in the magazine has received at least one enquiry, and some as many as 10.

We do it for you
To make it as easy as possible for you, we write the copy, translate it, and then lay out your page. You simply approve the page or tell us how to do it better — we listen.

TRADELINK

ADVANCED TECHNOLOGY AND PRODUCTS FOR CHINA

ORDER FORM

To: Tradelink
IPC Industrial Press Limited, Quadrant House
The Quadrant, Sutton, Surrey SM2 5AS
Telephone: 01-661 3500 Telex: 892084 BISPRS G

Please send me further information about Tradelink

Name (please print) ....

Company ....

Address ....

....

....

Telephone ....

Telex ....

ILP

SIMPLY AHEAD and staying there

The range grows bigger... better...

New Profile Amplifiers - Two New Series

HY120

HY60

MOSFET

CHOOSE AN I.L.P MOSFET POWER AMP when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P's exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connection is via five pins on the underside. **I.L.P MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.**

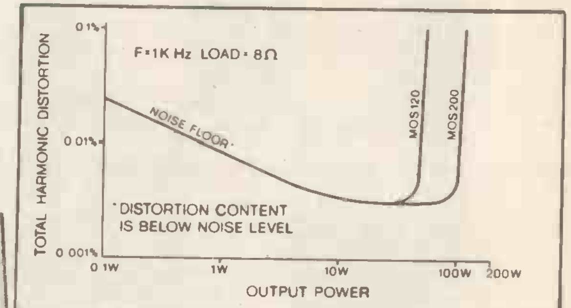
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

BIPOLAR

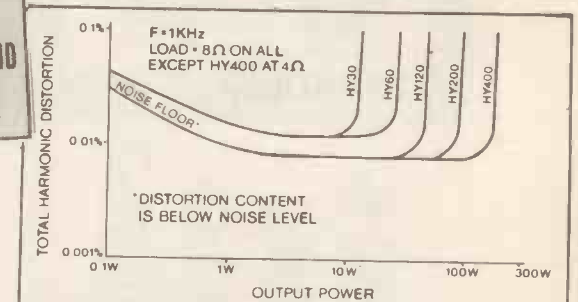
CHOOSE AN I.L.P BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£6.34 + 95p
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.24 + £1.09
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£15.20 + £2.28
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£18.44 + £2.77
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£27.68 + £4.15

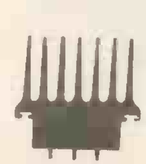
ILP POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE



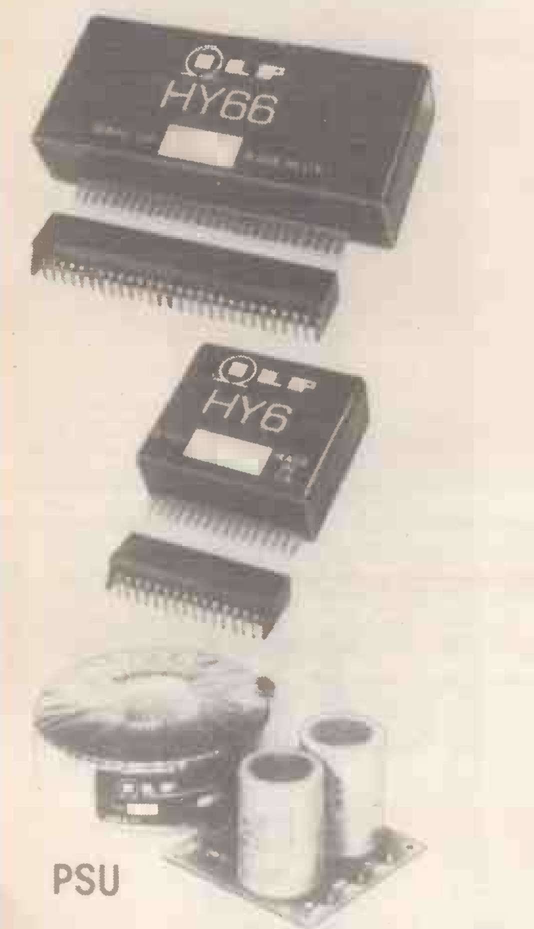
Load impedance both models 4Ω - ∞ Input sensitivity both models 500mV
Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB



Load impedance all models 4Ω - ∞ Input sensitivity all models 500mV
Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz – 3dB



THE NEW PROFILE EXTRUSIONS
The introduction of standard heatsink extrusion for all I.L.P power amplifiers achieves many advantages: – Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for lower thermal conductivity. Extrusions vary in size according to module number.



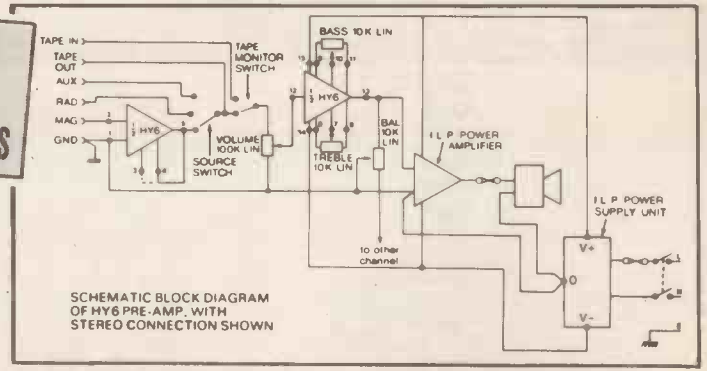
NO QUIBBLE 5 YEAR GUARANTEE
7-DAY DESPATCH ON ALL ORDERS
BRITISH DESIGN AND MANUFACTURE
FREEPOST SERVICE

NEW PRE-AMPS

HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.
Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** – 90 x 20 x 40 mm.
Active Tone Control circuits provide ±12dB cut and boost.
Inputs Sensitivity – Mag. PU. –3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £5.60 + 84p VAT Connectors included
HY66 stereo £10.60 + £1.59 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

COMPATIBLE WITH ALL ILP MODULES



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE-AMP, WITH STEREO CONNECTION SHOWN

- **DISTORTION TYPICALLY 0.005%**
- **S/N RATIO – 90dB (Mag. P.U. – 68 dB)**
- **38 dB overload margin on Mag. P.U.**
- **LATEST DESIGN HIGH QUALITY CONNECTORS**
- **ONLY POTS, SWITCHES AND PLUGS/SOCKETS NEED ADDING**
- **NEEDS ONLY UNREGULATED POWER SUPPLY ±15 to ±60v**

NEW POWER SUPPLY UNITS

IN A RANGE OF 11 MODELS USING LATEST TOROIDAL TRANSFORMERS

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amps you choose.

PSU30 ±15V at 100mA to drive up to 12 x HY6 or 6 x HY66	£4.50 + 0.68p VAT
● *THE FOLLOWING WILL ALSO DRIVE I.L.P PRE-AMPS*	
PSU36 for use with 1 or 2 HY30's	£8.10 + £1.22 VAT
● *ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS*	
PSU50 for use with 1 or 2 HY60's	£9.75 + £1.46 VAT
PSU60 for use with 1 HY120	£9.75 + £1.46 VAT
PSU65 for use with 1 MOS120	£9.75 + £1.46 VAT
PSU70 for use with 1 or 2 HY120's	£13.61 + £2.04 VAT
PSU75 for use with 1 or 2 **MOS120**	£13.61 + £2.04 VAT
PSU90 for use with 1 HY200	£13.61 + £2.04 VAT
PSU95 for use with 1 **MOS200**	£14.75 + £2.21 VAT
PSU180 for use with 1 HY400 or 2 HY200	£23.02 + £3.45 VAT
PSU185 for use with 1 or 2 **MOS200**	£24.20 + £3.63 VAT

1971-1980
TEN YEARS OF PLANNED PROGRESS

When, in 1971, Ian L. Potts founded his now world-famous company, he saw the need for a different and more rational approach to exploiting to the full, the potential that lay in modular construction. New thinking was badly needed. The result was a range of modules revolutionary in concept. The rightness of this new thinking is shown by the size of the company today, its new factory, its vast exports, its acceptance by constructors as *the* modules to build with. The range grows bigger and better. Exciting new lines (in no way conflicting with existing ones) are well past drawing board stage. This is why I.L.P are simply ahead and staying there.

★ **Freepost facility**
When ordering or writing about I.L.P products, you do not need to stamp the envelope. Mark it FREEPOST plus the code shown in the address below. We pay the postage for you.

★ **TO ORDER** Send cheque or money order payable to I.L.P Electronics Ltd and crossed. Or pay by ACCESS or BARCLAYCARD. Cash payments must be in registered envelope; if C.O.D. payment is wanted, please add £1.00 to TOTAL value of order.

BRITAIN'S FASTEST GROWING MODULE SUPPLIERS

To: I.L.P ELECTRONICS LTD. CANTERBURY CT2 7EP
Please supply ....
.... Total purchase price £..............
I enclose Cheque ☐ Postal Orders ☐ International Money Order ☐
Please debit my Access/Barclaycard Account No. ....
NAME ....
ADDRESS ....
Signature ....

ALL U.K. ORDERS DESPATCHED POST FREE

I.L.P ELECTRONICS LTD.
FREEPOST 5 Graham Bell House, Roper Close, Canterbury, Kent CT2 7EP.
Telephone (0227) 54778 |Technical (0227) 64723| Telex 965780
Available also from MARSHALLS, WATFORD ELECTRONICS and certain other selected retailers

wireless world

Save our public service broadcasting

"Listen to the BBC while you can, because it is getting quieter every day and it is going to get quieter a lot quicker than you think". These words from Allen Holden, the recently retired manager of Radio London, might be thought alarmist by people who have not been following the latest events in British broadcasting. They are in fact a fair comment on a process of attrition that has been affecting the BBC for almost a decade. During 1980 this process has been accelerated by the Government's decision to cut down the Corporation's resources – forcing reductions in staff and projects and preventing the colour tv licence fee from being raised to the £41 that was needed. (George Howard, the new chairman of the BBC's board of governers, has said he could get no satisfactory reason from the Government for this last refusal.) And the process has been officially confirmed by Ian Trethowan, the Corporation's director-general, in stating (what many people have noticed anyway) that the BBC's services are deteriorating absolutely.

These restrictions may be intended as a temporary measure but they will permanently impair public service broadcasting relative to commercial broadcasting in Britain. For example, on the engineering side the BBC has had to postpone the development of studio centres, local radio stations, teletext and v.h.f. sound transmitters. The damage done on the programme side is well known. But apart form these actions the present government has further increased the financial imbalance between public service and commercial broadcasting by handing over the fourth tv channel to the IBA (as we write the Broadcasting Bill is just about to be enacted). For years the BBC has been contending with the growing strength, professionalism and revenues of commercial broadcasting. This may well be the final blow. From the position where it now finds itself the BBC can move in only two directions: it can either retire into a minority service, like public service broadcasting in the USA – a move which the commercial broadcasters would of course welcome – or it can compete for large audiences on the terms set by commercial broadcasting – a process which has already started – and so become virtually indistinguishable from that type of service.

Which of these alternatives do we, the public, want? The answer must be a resounding *Neither!* British life will be impoverished without a good, strong-voiced public service broadcaster, independent of the state, creative and risk-taking, with the kind of standards and values which the BBC has maintained throughout its fifty-odd years' life. And if we want such a public service we must be prepared to pay for it, at the proper rate for the job. Let us not be misled by the polite euphemism "independent" used to disguise commercial broadcasting. It is not independent at all, but closely *interdependent* with trading activity, stimulating sales of food, drink and toilet-rolls and drawing its revenues from the proceeds, which come out of our pockets. It does not even sell programmes directly to the public, in the manner of theatres or book publishers, but, with the money from advertisements, produces the programmes it calculates will get the largest possible audiences for those advertisements and the quickest possible sales of the products. It is in the game for profit, and the service it provides is incidental, a means to that main purpose.

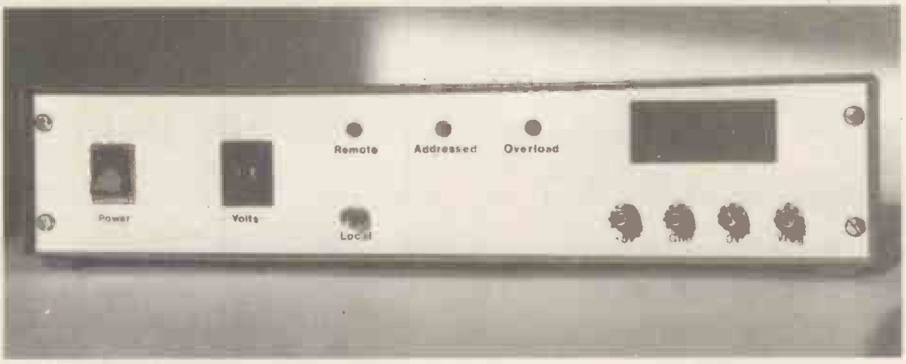
To achieve this purpose the output of commercial broadcasting is designed to insulate people from reality, to keep them quiet, uncritical and accepting. It purveys a synthetic culture in which safe routines ensure predictable responses and the glossy package becomes a substitute for the real thing. If this is what is to become the predominant "British" broadcasting, then it will be for the BBC to change its name and become our Independent Broadcasting Corporation.

Programmable power supply

Digital control via the IEEE–488 General Purpose Interface Bus

by J. Summers, B.Sc., M.Sc., M.Inst. P.

The General Purpose Interface Bus, defined by IEEE Std 488 (1978) and IEC 652-1, provides a facility whereby electronic instruments can communicate using a standard for the hardware circuits and recommended practice for the data and software protocol. This article describes an interface for a programmable power supply which can be used as a listener/talker via the GPIB.



The heart of the GPIB interface contains a 96LS488 low-power Schottky l.s.i. device, see Fig. 1, which is dedicated to interpreting the bus commands and messages outlined in Fig. 2. The remaining logic decodes ASCII digits from the bus and stores the b.c.d. numbers which are converted to a binary format and then passed to a d-to-a converter as shown in Fig. 3. The d-to-a output is amplified and current-boosted to provide the appropriate power supply output. Additional features include thumbwheel-switched programming for manual operation, an overload detection circuit which signals the fault to the bus controller, and a remote reset facility which allows the controller to set the power supply voltage to zero and clear any overload condition by a single command message. In this design the power supply operates in the listener/talker mode with single-byte addressing. During the Listener Active State (LACS) the interface automatically receives data transmitted over the GPIB by a talker and, in particular, recognizes and stores two ASCII-coded decimal digits. The message is terminated by an ASCII carriage return which, if the power supply manual controls are disabled by the controller, passes the received digits to the d-to-a converter.

At switch on, the interface is in the offline initialized state, the data registers are cleared and the power supply is in the manual mode. If the GPIB controller sends a listen address which corresponds to the d.i.p.-switch programming, the "addressed" l.e.d. is illuminated. The "remote" l.e.d. is also switched on if the front panel "local" switch is not pushed and the controller is continuously sending the Remote Enable (REN) message.

If the remote l.e.d. is on, the power

Fig. 1. 96LS488 functional block diagram.

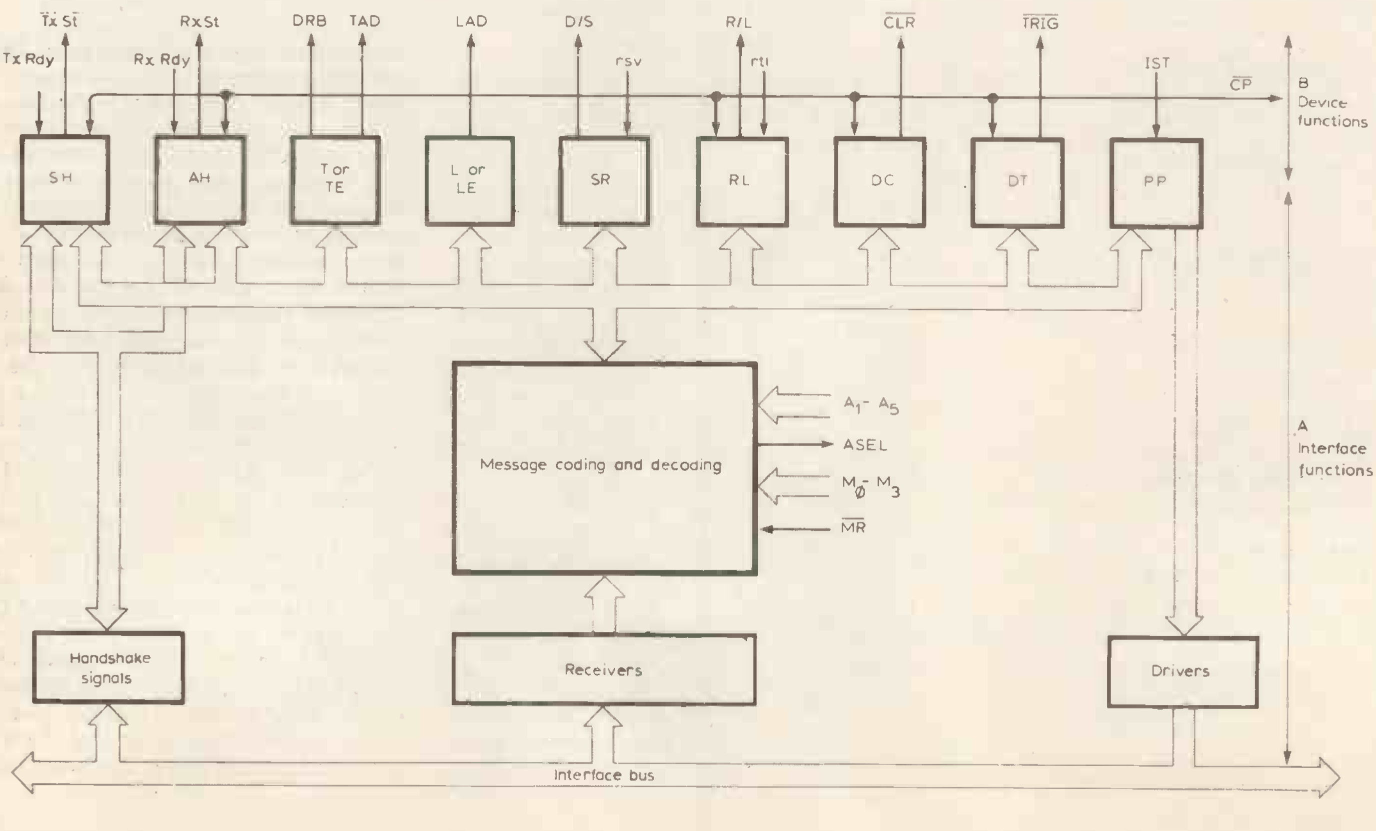


Table 1. The programmable power supply responds to the following GPIB remote interface messages.

MLA	My Listen Address, set by d.i.l.-switch. On receipt goes into Addressed state.
DAB	Data Byte. ASCII digits and Carriage Return (CR).
DCL	Device Clear message, may be received at any time. Sets the remotely programmed voltage to zero and clears the overload condition if active.
SDC	Selected Device Clear (only when Addressed). Function as DCL.
LLO	Local Lockout, prevents the operator returning the supply to the local control state.
GTL	Go to Local. The GPIB controller allows the supply to be programmed locally by the operator.
REN	Remote Enable. If this message is true, then receipt of MLA sets the supply in the remotely controlled state.
MTA	My Talk address. Used by the controller to set the supply interface in the Talker mode to send a status byte(s). Used to transmit the overload condition.
SPE	Serial Poll Enable. Used in conjunction with MTA.
SPD	Serial Poll Disable.
IFC	Interface Clear } Reset the GPIB interface logic.
UNT	Untalk } Reset the GPIB interface logic.
UNL	Unlisten } Reset the GPIB interface logic.

The supply will send the following GPIB messages.

SRQ	Service Request, in response to overload condition (rsv=request service).
RQS	Requested Service, transmitted as bit 7 (D107) of the status byte in response to the MTA and SPE messages. RQS will be active if rsv was active. The remaining bits of the status byte have no meaning and are transmitted passive false.
PPR_n	Parallel Poll Response n, programmed by the GPIB controller. The local message "individual status" (ist) is in this case hard-wired to the overload condition signal. An active Parallel Poll response in PPAS therefore indicates an overload condition if ist=1, or no overload if ist=0.

GPIB interface function subsets incorporated in the power supply.

SH1	Source Handshake.
AH1	Acceptor Handshake.
T6	Talker.
TE0	No Extended Addressing.
L4	Listener.
LE0	No Extended Addressing.
SR1	Service Request.
RL1	Complete Remote/Local.
PP1	Parallel Poll with Remote Configuration.
DC1	Device Clear.
DT0	No Device Trigger Capability.
C0	No Controller Capability.

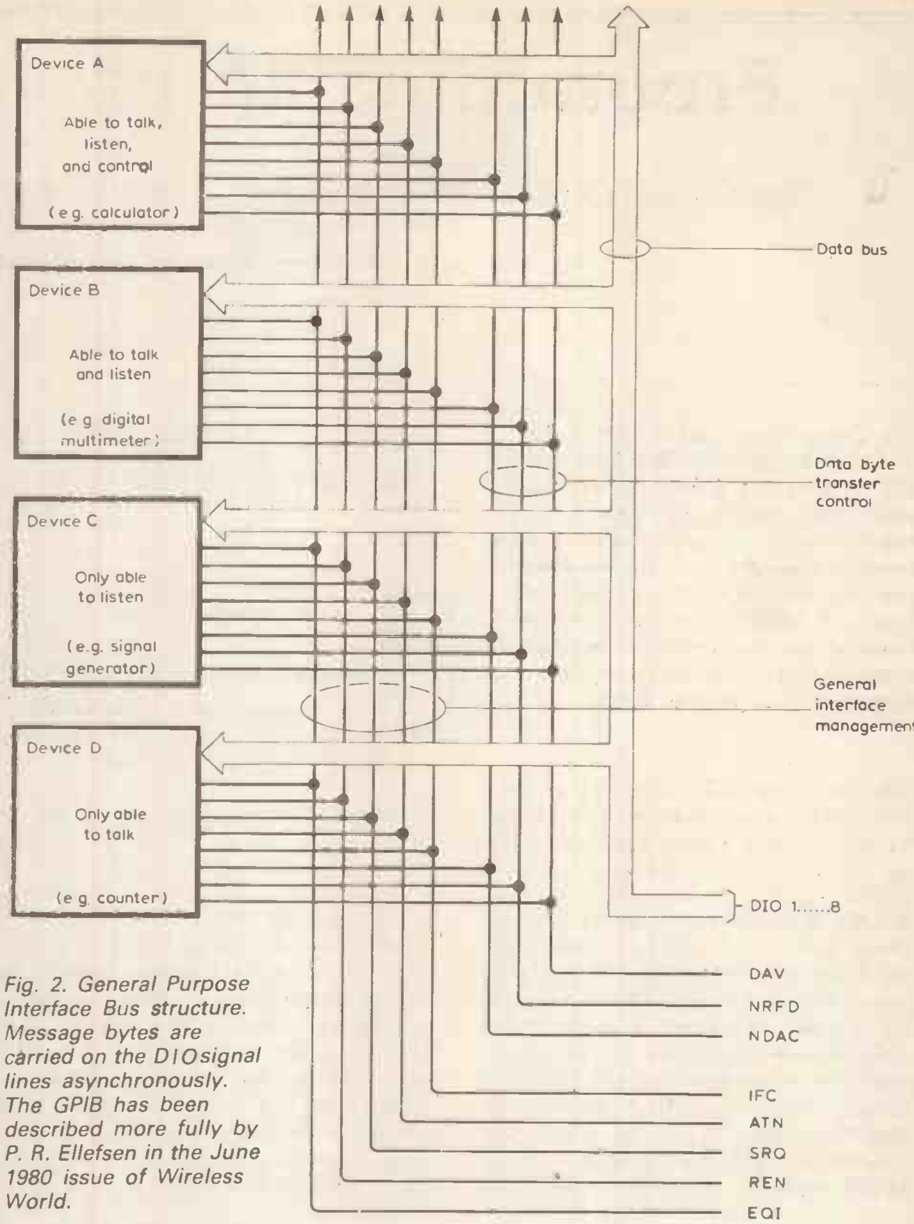


Fig. 2. General Purpose Interface Bus structure. Message bytes are carried on the DIO signal lines asynchronously. The GPIB has been described more fully by P. R. Ellefsen in the June 1980 issue of Wireless World.

supply output voltage will be zero because the data register is empty. Pushing the local switch restores the unit to manual control. However, the controller may issue a Local Lockout (LLO) message which prevents the user from returning to manual control. This facility allows an automated program to remotely set a voltage and prevent interference by accidental button-pushing. The power supply may be unaddressed by the Unlisten (UNL) command or by the system command Interface Clear (IFC), either of which will leave the unit in the remote state. If the controller sends the REN message false, the supply will revert to the manual mode.

The programmed voltage can be altered by the controller re-addressing the supply and sending two digits followed by a carriage return. Alternatively, the voltage may be set to zero by a Device Clear (DCL), or Selected Device Clear (SDC) command which is functional only on listener-addressed instruments. The "clear" messages also clear the overload latch. If the supply output is overloaded, the condition is detected and a latch is set which illuminates a warning light, forces the d-to-a output to 0V, activates the "request service" (rsv) input to the bus interface, and passes the overload signal to the "individual status" (ist) input of the bus interface. Under manual control, the operator can try to clear the overload by pressing the overload reset switch. If the fault condition disappears, the supply will return the output to the previous programmed voltage. If the fault condition persists, the overload latch will remain in the set state. The 96LS488 relays the rsv input to the controller via the Service Request (SRQ) message. The SRQ line is a wire-OR of all the service request messages on the bus, and the controller should be programmed to conduct a serial poll of instruments on the bus to determine which have requested service. To perform a serial poll on the power supply, the controller issues the talk address (which is in this case the same as the listen address) and the Serial Poll Enable (SPE) command. During a serial poll the 96LS488 in the power supply outputs the Requested Service (RQS) signal, which is bit 7 of the 8-bit data byte. In this design the other seven

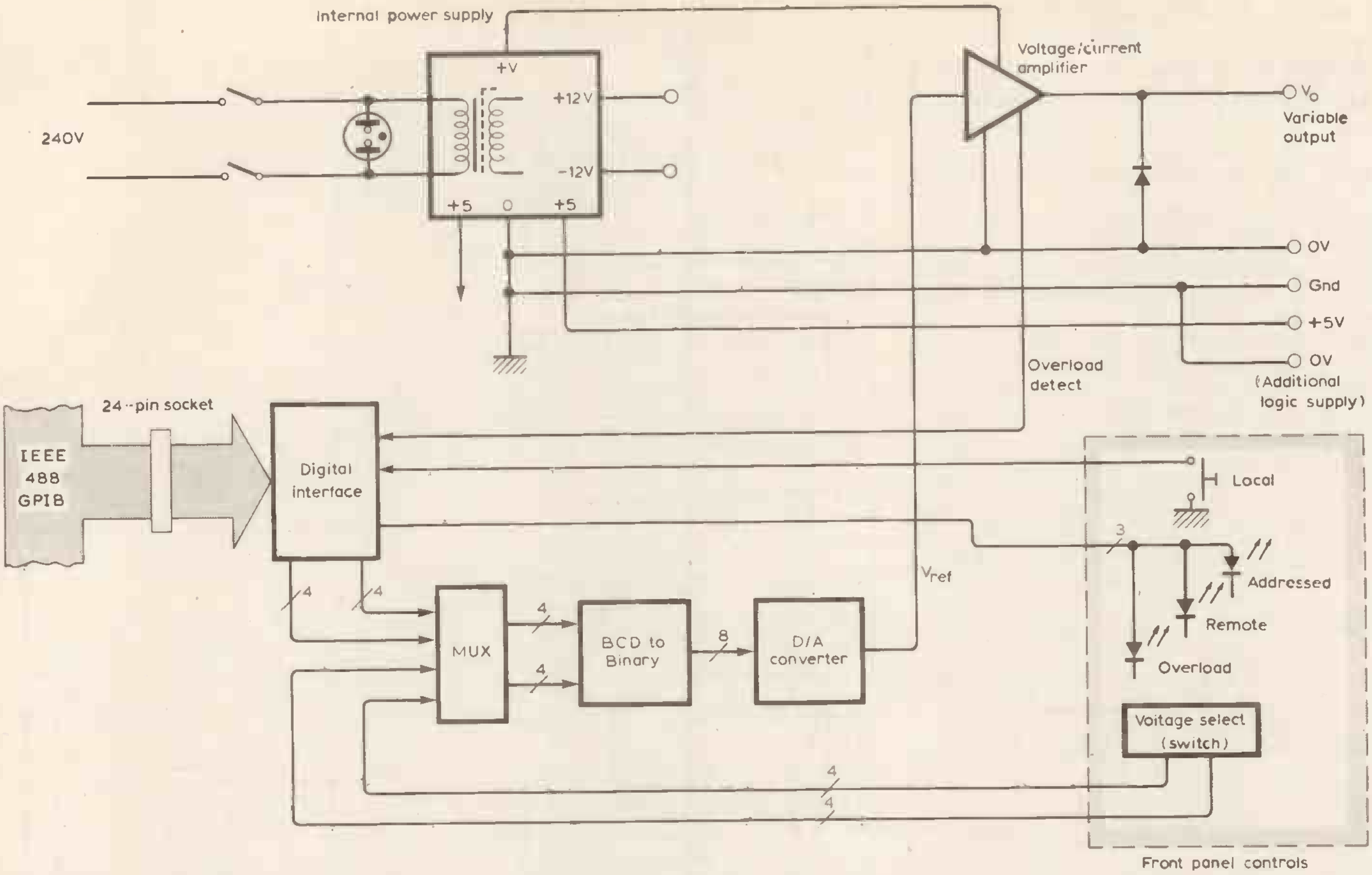


Fig. 3. Programmable power supply block diagram.

bits are unused and will be received as zeros. In a more complex instrument the seven bits can be transmitted as useful information in a Status Byte (STB), the RQS message reflects the rsv input. In this case, RQS is transmitted as a one if an overload condition exists. The controller should take some action to remedy the problem, such as issuing the Clear command and resetting the output voltage. The ist message input to the parallel poll function allows the controller to determine the state of the overload latch at any time.

Logic operation

The 96LS488 is assumed to be a black box with only the named pins in Fig. 4 connected to the circuit – the Acceptor Handshake RxSt (output) RxRDY (input), the Listener Addressed ($\overline{LAD}$) Remote/Local ($\overline{R}$/L), and Clear ($\overline{CLR}$) outputs, and the Source Handshake pins Status Strobe (StSt) and Ready (St RDY). Inputs from the power supply are the Return to Local (rtl) and Request Service (rsv) signals. Other necessary connections are the mode pins (M0 to M3), used to maintain the bus interface in the listener/talker (addressable) state, and the switchable address inputs (A1 to A5) which provide 31 talk and listen addresses. A reset pin ($\overline{MR}$) initializes the clock and the interface at power-on. The i.c. can use a crystal oscillator on the Xtal and $\overline{CP}$ pins but, because there is no critical timing within the power supply, a relaxation oscillator running at about 10MHz is adequate.

When the 96LS488 is in the Listener Active state, the $\overline{LAD}$ output is active low and drives the addressed l.e.d. The bus data uses negative logic so the 74LS240 inverting buffer provides positive logic signals within the supply. The message format is <nn CR> where n is an ASCII digit and CR is ASCII carriage return. The strobe signal (RxST) is active high when valid data are present. Referring to Fig. 4, RxST is the clock input to two 4-bit 74LS173 registers (positive clock) and one half of a 74LS73 JK flip-flop (negative clock). Initially the JK is reset so Q is low, which enables the clock to the units latch ($\overline{E1}$). Because $\overline{Q}$ is high, the clock enable of the tens latch is high and the clock is ineffective. If an ASCII digit is present it is detected by the three gates connected to the second clock enable ($\overline{E2}$) of both latches. The code for an ASCII digit is 011xxxx, where xxxx is the b.c.d. representation of the number. Therefore, the clock will only be effective when a digit is present. This ensures that only b.c.d. digits can be loaded into the registers. The 74LS73 is clocked on the trailing edge of RxST, Q goes high which disables the units latch and enables the tens latch. If the second data byte received is an ASCII digit, it is clocked into the tens latch by the next positive edge of RxST. Therefore, the two sequential ASCII digits are stored as b.c.d. data in the two registers. RxST is inverted and fed back to the RxRDY input of the 96LS488, which causes the Acceptor Handshake function to cycle synchronously with the local clock. The power supply does not hold up the three-wire handshake because the 96LS488 is probably the fastest interface adaptor connected to the bus. The $\overline{RxST}$ signal is taken with the buffered bus data to an ASCII carriage return decoder comprising a 74LS27 NOR gate and a 74LS138 eight-way demultiplexer. Output $\overline{07}$ of the demultiplexer goes active-low when an ASCII CR is present and RxST is active, denoting valid data. The detection of CR is terminated when RxST goes inactive.

Carriage return has two functions, it sets the J input of the 74LS73 to zero so that the falling edge of RxST clocks the flip-flop to the reset state. Secondly, the positive edge of $\overline{07}$ clocks the 74LS273 8-bit intermediate register. The two b.c.d. digit output of the octal register is used as the input to the b.c.d.-to-binary and binary-to-analogue circuits. The purpose of dual-rank registers is to prevent spurious variations in the power supply output before a carriage return message delimiter has been received from the bus.

The logic is expandable to more digits by replacing the JK flip-flop with a binary counter and adding further data registers. The flip-flop in this system operates as a counter to identify the two ASCII digits. By using an n-bit counter with fully-decoded states, 2^n digits can be stored in an equivalent number of registers. A diagram of this system is shown in Fig. 5. Further possible enhancements include the recognition of remote programming parameters such as V for volts preceding the ASCII digits. Delimiting the data string at each end has the added benefit of increased data protection because the supply will only respond to a remote message comprising <Vnn CR>. An alternative delimiter such as A for amps can be used to load a different set of register if, for example, a current-limit control is included.

The two b.c.d. digits in the 74LS273 are multiplexed with the b.c.d. data on the

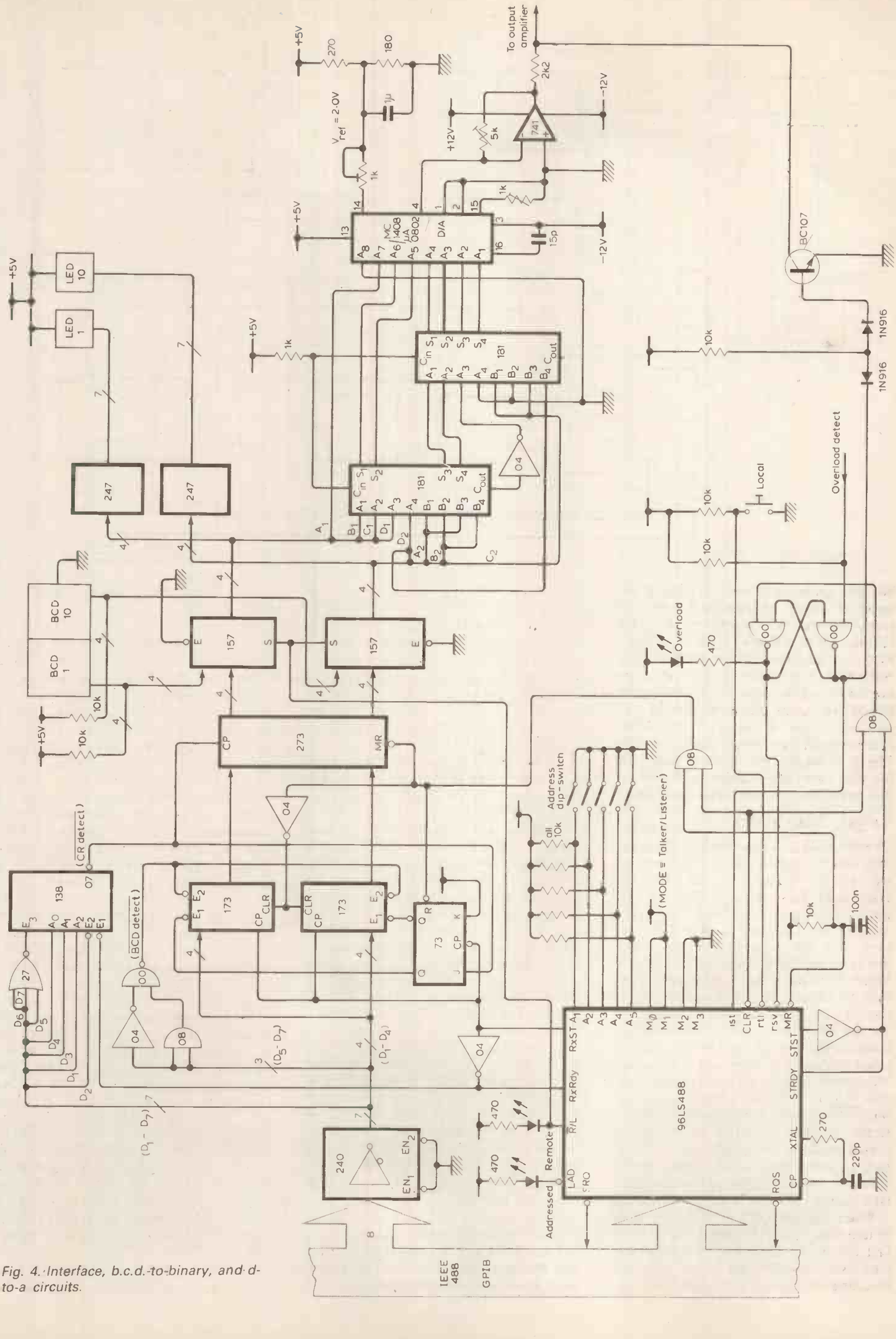


Fig. 4. Interface, b.c.d.-to-binary, and d-to-a circuits.

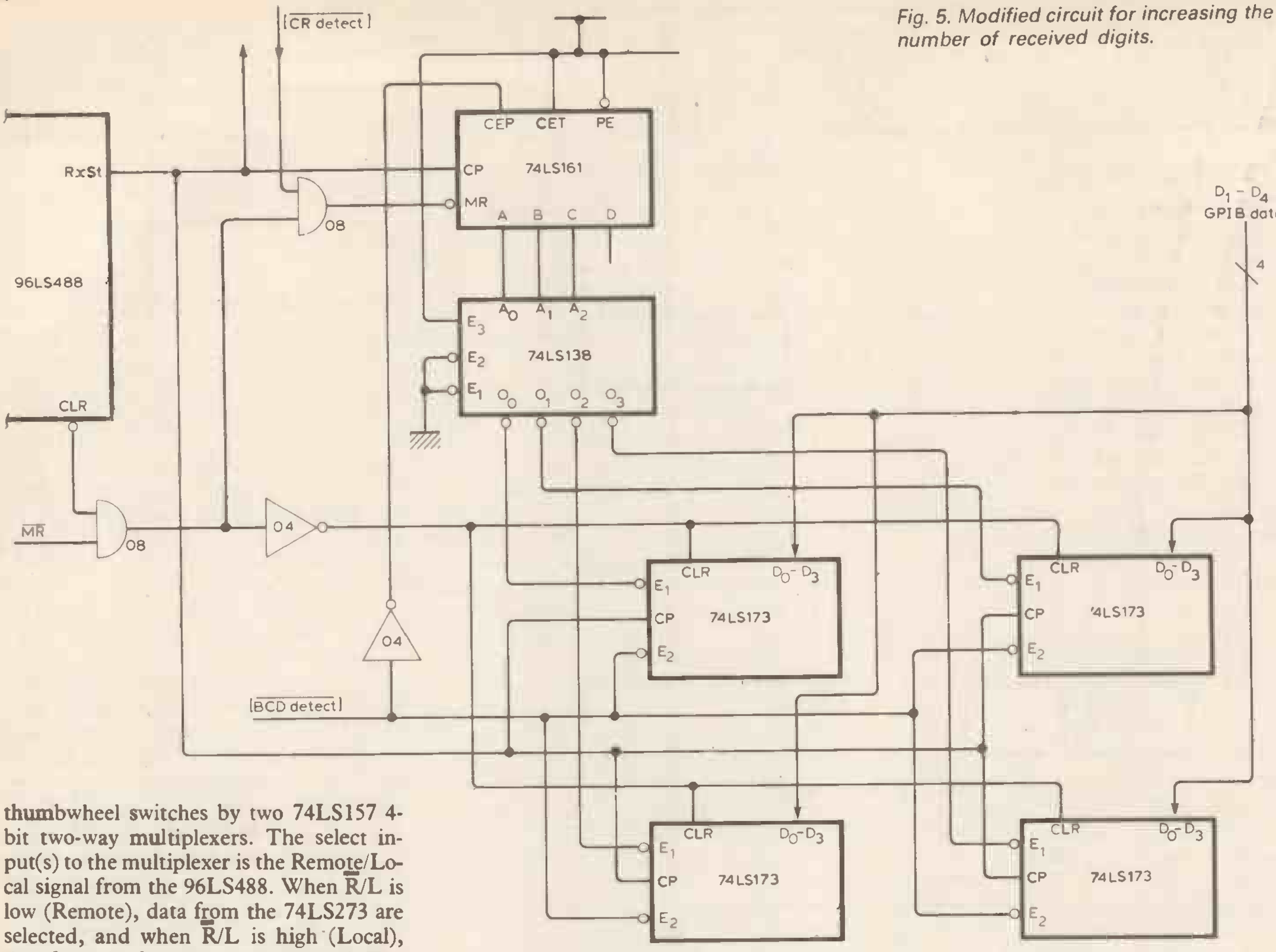


Fig. 5. Modified circuit for increasing the number of received digits.

thumbwheel switches by two 74LS157 4-bit two-way multiplexers. The select input(s) to the multiplexer is the Remote/Local signal from the 96LS488. When $\overline{R}$/L is low (Remote), data from the 74LS273 are selected, and when $\overline{R}$/L is high (Local), data from the front panel are selected. The d-to-a converter uses a binary-coded digital input. The two b.c.d. digits are converted to a binary equivalent by two 74LS181 4-bit adders. This technique, which can be expanded for more than two digits, allows for the binary weighting of each bit in the b.c.d. digits. The conversion takes place by adding the appropriate weighting to each decimal line. Therefore, the units digit contains the weighting values 2^0, 2^1, 2^2, 2^3,

A^1	2^0			
B^1		2^1		
C^1			2^2	
D^1				2^3

and the tens digit contains weighting values 2^1, 2^2, 2^3, 2^4, 2^5, 2^6, summed as shown below.

A^{10}	2^1		2^3			
B^{10}		2^2		2^4		
C^{10}			2^3		2^5	
D^{10}				2^4		2^6

If more digits are required, more adders can be included to sum the binary weightings of higher order digits.

The Master Reset ($\overline{MR}$) input to the 96LS488 and data registers is active at power-up to initialize the bus interface and clear the data registers. $\overline{MR}$ is gated with the Clear ($\overline{CLR}$) bus message output from the 96LS488 so that the bus controller can re-initialize the power supply and clear the data registers at any time. The overload-detect signal from the analogue circuit is fed, via an RS latch, to the bus interface as the request service (rsv) interrupt. The overload-detect latch also drives the overload l.e.d., and is cleared by the operator, by a bus Clear message or by a Serial Poll, which causes the Source Handshake signal Status Strobe (STST) to pulse active high.

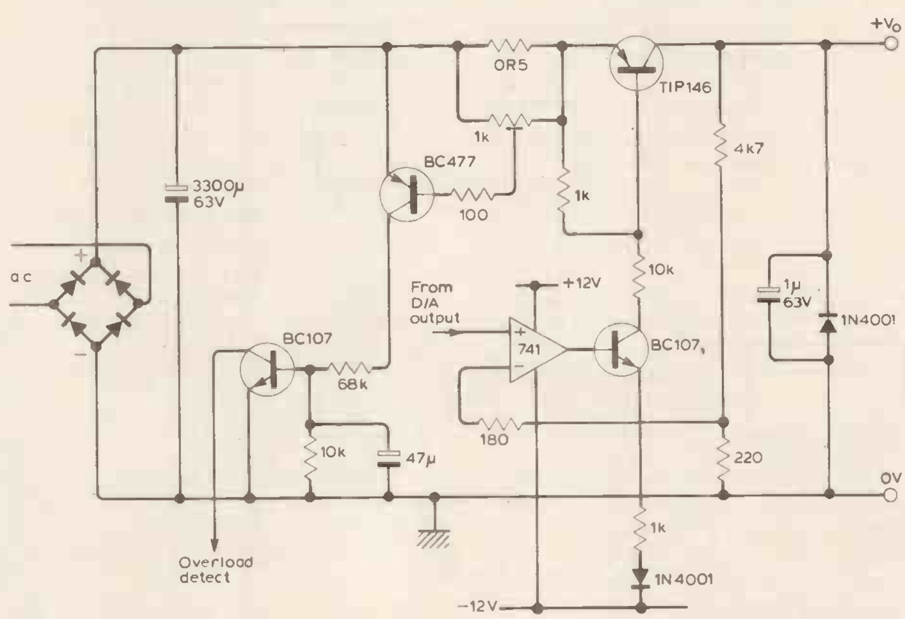


Fig. 6. Output amplifier and current trip. This circuit can be modified to provide alternative outputs.

Analogue circuits

The d-to-a converter is referenced to +5V by a simple resistive divider, which is adequate unless a highly stable and accurate output is required. The output is buffered and normalized to one quarter of the supply output voltage by a 741 op-amp as shown in Fig. 6. The output buffer provides a voltage-gain of four and a current capacity of two amps. A current-limiting circuit detects excessive current and signals this overload condition to the logic

Continued on page 57

WORLD OF AMATEUR RADIO

Transhorizon microwaves

Transhorizon propagation on frequencies above 30MHz is generally considered an unwanted, anomalous phenomenon by telecommunications and broadcast engineers, causing interference to carefully planned systems. But for the enthusiast such conditions are the very essence of his endeavours to work over ever longer distances with low power, no matter how fleeting and unpredictable may be the contacts. The results of experiments carried out over several years by British Telecom (Post Office) are thus likely to be more welcome to amateurs than to professionals, (papers by M. T. Hewitt and A. R. Adams presented at URSI Commission F Symposium, Canada, May 1980). For they show that measurements made over 1300 hours on 11GHz signals received at Martlesham, Suffolk from Rockonje, Netherlands, a mostly sea path of 191km, indicate some degree of signal enhancement due to ducting for no less than 10 per cent of the total time, with a daily maximum occurrence around 1800GMT, apparently due to the presence over the path of air originating on the mainland during the warmest part of the day. Very long events (over 64 hours) have been recorded when an air flow around an anticyclonic system produces a drift of warm air from the mainland over the cooler sea air, producing ducts that can extend over several hundreds of kilometres. Good results have been achieved in identifying periods of advection from temperature and humidity data while subsidence inversions can be identified from radiosonde levels. British Telecom are also carrying out research into 17GHz transhorizon propagation.

Martlesham and Ipswich amateurs won the RSGB's 1980 VHF National Field Day with equipment that included a solid-state 120W 70MHz transmitter (two BLY90 transistors in final amplifier); 144 and 432MHz equipment based on transmitters using 4CX250B valves; and a 1.3GHz transmitter producing 200W output from four 7289 valves. Their receiver front-end devices included SD306 (70MHz), BFT66 (144MHz), NE21935 (432MHz), NE64535 (1.3GHz).

EMC and domestic equipment

The problems of operating transmitters in close proximity to domestic electronic equipment (i.e. electromagnetic compatibility or e.m.c.) continue to occupy the thoughts of those concerned with the regulatory aspects of amateur radio. The IARU Region 1 Bureau has recently released a report covering replies to a questionnaire on e.m.c. matters sent to its member-societies. This shows that attitudes towards radio-frequency interference by different licensing authorities differ considerably, ranging from those that are sympathetic to the amateur and recognise that the problem stems basically from the poor immunity of many domestic equipments, to those holding the amateur responsible for any interference not only to broadcast reception but even to non-broadcast equipment such as electronic organs, record-players, etc. The Sierra Leone society was in the happy position of being able to reply that "there has been no report on record of interference by amateur radio".

In a number of countries (Poland, Cyprus etc.) all cases of interference are referred to the national society. Norway insists that equipment showing insufficient immunity is modified by the manufacturers or importers fitting any necessary filters. In Denmark the offical attitude is generally favourable to the amateur operator but cases can involve delays during which he has to cease operation at those times when interference may be caused. The Swiss authorities are very helpful to the amateur but there is an unofficial recommendation that equipment should not be expected to provide immunity at levels above 1V/m (which does not cover all circumstances) and efforts are being made by the USKA society to raise the immunity level to 5 or 10V/m. Dutch amateurs complain that they cannot persuade their authorities to admit that "an electronic organ is not a radio receiver" and this makes it difficult for the VERON society to co-operate with the PTT licensing authority (Dutch amateurs seem to be particularly badly placed). The Swedish manufacturers supply, free upon request, highpass filters and/or mains filters; radio dealers are authorised by the Swedish Electrical Testing Authority (SEMKO) to make minor modifications to equipment to increase their immunity to radio-frequency interference.

Licence delays

The annual autumn bulge in applications for new amateur licences has been resulting in delays of up to about 8 weeks. With over 2500 "passes" at the May Radio Amateurs' Examination, and with all signs pointing to an unusually large number of candidates for the December exam, the Home Office licensing section is also having to cope with the public response to the invitation to comment on the "Open Channel" proposals. This may be one reason why the Home Office is not showing any enthusiasm towards the proposals for the introduction of a British "novice" licence.

It is not widely know that while the Home Office accepts RAE "pass slips" from licence applicants, it issues an "Amateur Radio Certificate" to persons who have passed both the RAE and the Post Office Morse Test but who do not wish to take out their own station licence: this certificate permits operation of amateur stations under the direct supervision of the licence holder.

Around the bands

Further experiments aimed at establishing 144MHz "meteor scatter" contacts across the Atlantic during the summer came near to success. A group of British amateurs, using the callsign G4DGU/P, set up a temporary station in North Devon with a 400-metre-long rhombic aerial erected on four 8-metre poles. Positive identification of signals from this station were made by Andy McLellan, VE1ASJ in St John, New Brunswick, Canada, but no two-way contacts proved possible. It is hoped to hold further tests during the August 1981 Perseids meteor shower.

Stewart Perry, W1BB, long-time 1.8MHz enthusiast, is proposing a "gentleman's agreement" for 1.8MHz long-distance operation in which 1800 to 1810kHz is reserved for c.w. only, 1810 to 1825kHz for s.s.b./c.w. and 1825 to 1830kHz ("the dx window") for c.w. only. Band-planning problems should be eased when the 1979 WARC allocations come into effect since these will include a common international allocation whereas at present different countries impose different band limits.

The Radio Amateur Invalid and Blind Club has reminded its members that it is possible to take an oral or written Radio Amateur's Examination at home, provided that application, with a doctor's certificate, is made in good time to the City and Guilds of London Institute (Mrs S. Conacher).

The Royal Signals Amateur Radio Society now has more than a thousand members, membership having risen to 1084 of whom 575 are life members . . . Attempts are being made to raise £40,000, half of the estimated cost of replacing the OSCAR "3A" satelitte lost last May. A further Ariane launch opportunity may occur in early 1982 . . . A v.h.f. repeater operated by the Amateur Radio Association of Bahrain on 144MHz channel R6 enables amateurs on vessels in the Arabian Gulf to work over distances of up to about 300 miles. Since it is regularly used by only four local A9X amateurs, other amateurs sailing in the Gulf are welcome to make use of this repeater which has an output of 20 watts from an aerial height of 220 feet above sea level . . .The death has been reported of Patrick Conway, E13Z a veteran Irish amateur and long-time reader of the IRTS's Sunday morning 3.5MHz news bulletins. . . . West Germany has introduced a new form of transitional licence (prefix DH) providing limited facilities for c.w. and rtty operation between 3520 to 3600kHz and 21090 to 21,150kHz.

PAT HAWKER, G3VA

Intermodulation at the amplifier-loudspeaker interface

Part 2: Causes/how to avoid it/measurements on four types of amplifier circuit

by **Matti Otala and Jorma Lammasneimi** Technical Research Centre of Finland

The effect described is but one of the numerous phenomena affecting the quality of low-frequency sound reproduction. It does not seem probable that its distortion could be dramatically higher than the measured SMPTE – intermodulation distortion of the amplifier, unless protection circuitry malfunctions. However, the theory presented may explain some of the subtle differences in the sound quality between different circuit topologies having otherwise equal standard measurement data. Noting that most valve amplifiers have basically a high open-loop output impedance and employ moderate amounts of feedback (the situation is the inverse for many solid state amplifiers), the theory may also explain some of the audible differences of these amplifiers.

The analysis of part 1 shows that the loudspeaker reflects back to the amplifier signal which may be of the same order of magnitude as the original drive signal. The situation is worse when the open-loop output impedance of the amplifier is comparable to, or greater than, the specified load impedance.

Inside the feedback loop, the amplifier must now handle two simultaneous large signals – the original drive signal and the loudspeaker reaction signal. If the amplifier has any internal non-linearities, these two signals may interfere and produce intermodulation components with each other. As the input signal is normally composed of a full frequency spectrum, but the loudspeaker-generated reaction consists predominantly of frequency components near the cone resonances and crossover filter resonances, the nature of this distortion is to add coloration to the sound. In addition, the positive maxima shown may cause unwanted clipping near amplifier maximum output power.

The basic reasons for the distortion are that (a) the loudspeaker does not simply consume energy; it also stores and returns it. (b), Although the closed-loop output impedance of the amplifier is apparently very low, it is not a true physical impedance as it has been generated by feedback. The feedback, in turn, forces the loudspeaker reactive current to cause a corrective signal which circulates around the feedback loop. (c) In the internal non-linearities of the amplifier this signal will intermodulate with the forward signal to produce a change in the spectral composition of the distortion products.

The two basic characteristics affecting the magnitude of this distortion are the open-loop output impedance and the amount of feedback. The dependence is fundamental, i.e. if one or both of these characteristics is brought to zero, interface intermodulation will not occur. The effect increases with feedback if the feedback is small or moderate say, below 20 dB. Above that, increasing feedback will no longer increase distortion. Also, it is generated in the internal non-linearity of the amplifier. As it is basically a low-frequency effect, the stage where the non-linearity is situated in the forward path is immaterial.

The above analysis requires sufficient linearity from the amplifier for the transforms to be valid. In high-quality audio amplifiers this condition is usually met in the normal operating range of the unit. However, a large reaction signal can cause the amplifier to enter a region of severe non-linearity when operated in the vicinity of its maximum output power. The need of a non-linear analysis is indicated in this case.

We propose the following general definition

Interface intermodulation is a form of distortion in a feedback two-port network, caused by non-linear interaction between the input signal of the two-port and a signal externally injected to the output port propagating into the input via the feedback network.

This general definition is specifically used in sound reproduction equipment to denote the distortion caused by the energy stored or generated in the loudspeaker system re-entering the output of the power amplifier.

Measurement

It is possible to measure interface intermodulation by using normal distortion measurement methods. In this case the standard output loading resistor is replaced with a simulated reactive load or with a real loudspeaker. In many cases the measured distortion is increased and the spectral composition of the distortion products changes. However, in the real-world situation, a set of standardized loudspeaker loads would be needed and, because of the frequency dependencies of these loads, it would be necessary to resort to swept CCIF-type difference tone measurements. This tedious procedure can be replaced by a simpler universal method described below. The loudspeaker reaction can be simulated by letting the amplifier operate on a forward signal, while injecting a backward signal to its output. If interface intermodulation is generated, it will manifest itself through intermodulation products between the two signals appearing at the

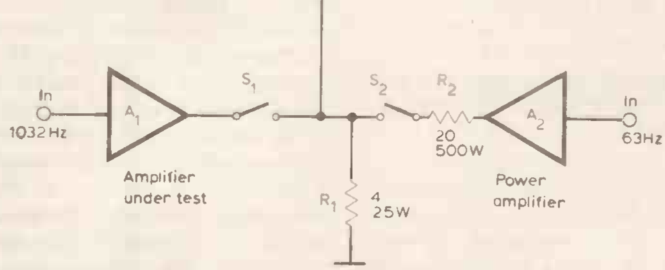


Fig. 8. Measurement setup for interface intermodulation. Amplifier under test A_1 is fed by audio frequency signal while high-quality high-power auxiliary amplifier A_2 delivers a low-frequency signal. By alternately closing switches S_1 and S_2 both signals are adjusted to have same power level in load resistance R_1. After closing both switches, intermodulation products are measured with a spectrum analyzer and referenced to the audio frequency signal. Numerical values shown are for the tests detailed in text.

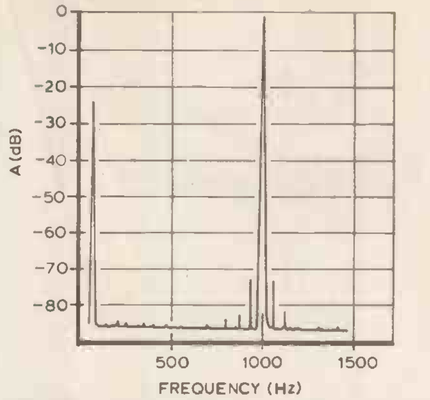


Fig. 9. Typical measurement result from high-quality commercial power amplifier using the method described in text. Note how the 63 Hz signal has been attenuated 24 dB by the feedback. Interface intermodulation in this case was 0.038%.

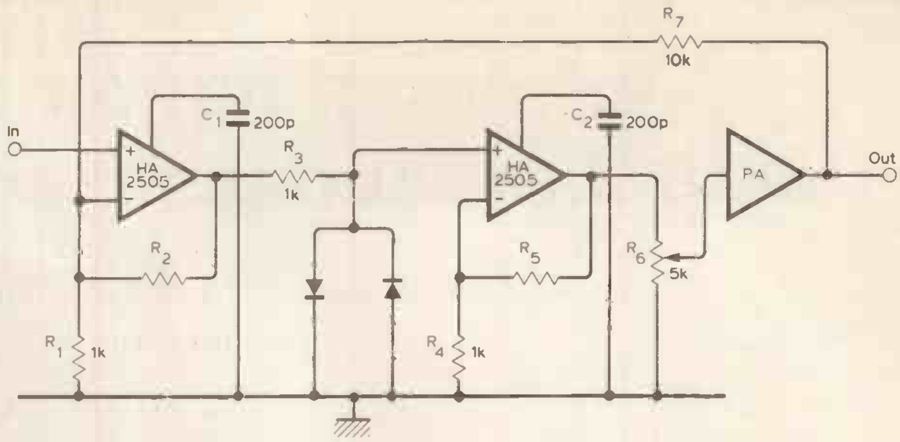


Fig. 10. Circuit used in the distortion measurements. Operational amplifiers HA2505 form the driver stages, and diodes constitute the dominant non-linearity. Various output sections PA are shown in Figs 11 to 14.

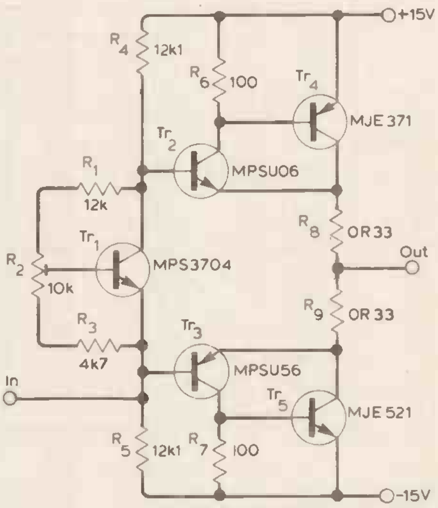


Fig. 11. Compound-stage circuit (A). Quiescent current 100 mA, open-loop output impedance 0.9 ohm.

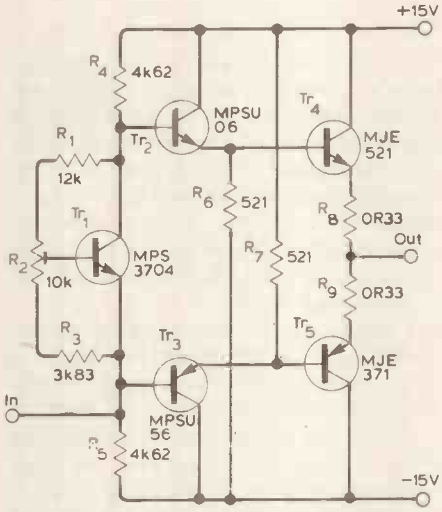


Fig. 12. Complementary double emitter-follower circuit configuration (B). Quiescent current 500 mA, open-loop output impedance 1.2 ohm.

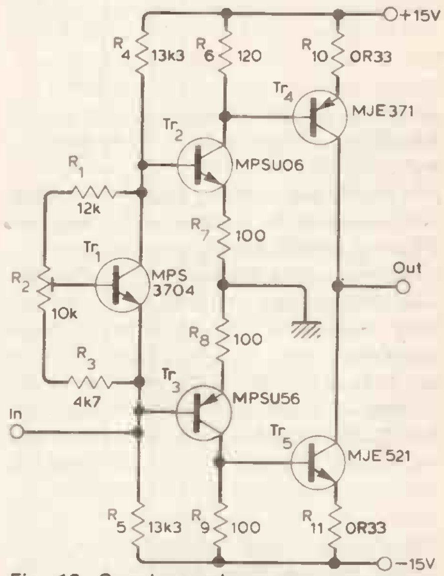


Fig. 13. Quasi-complementary power amplifier circuit (C). Quiescent current 100 mA, open-loop output impedance 2.7 ohm.

output. The measuring procedure is thus a variant of the two-tone difference-frequency method. In real life there is a dependence between the forward and backward signals. In this method, these signals are independent, to facilitate measurement. However, as far as the generation of intermodulation in the amplifier is concerned, this does not change the physical phenomenon considered.

A proposal for a measurement method is depicted in Fig. 8. The procedure is

1. Switch S_1 is closed and S_2 opened. An audio-frequency sinusoidal signal is connected to the input of the amplifier under test A_1 and is adjusted to yield a desired output level to a specified load resistance R_1.
2. Amplifier A_1 output is disconnected from the load R_1 by opening switch $S_1$1. A low-frequency sinusoidal power source A_2 is connected to the load by closing switch S_2 and is adjusted to yield the same output level across load R than in step 1. Note: power source A_2 has to have sufficient internal resistance R_2 so as not appreciably change the apparent load of A_1 when switch S_1 is closed. This power source must also have sufficient power output. A safe rule is that the rating of the power source is five to ten times greater than that of the amplifier under test.
3. Both switches S_1 and S_2 are closed, with both output signals being fed simultaneously to the load. The intermodulation products between the two signals are measured across the load by using a spectrum analyser or an intermodulation distortion analyser.
4. The r.m.s. sum of all intermodulation products (i.e. neglecting all harmonic components of the primary signals) is calculated and the distortion indicated as a percentage, referenced to the audio-frequency signal at the output of A_1.

The test frequencies used are in most cases not critical and can be selected to minimize the effect of such external disturbances as mains frequency hum. Their frequency ratio may be optimized so that the harmonic frequencies of the low-frequency signal do not coincide with the frequencies of the intermodulation products. Various frequencies and load resistances may be used in different countries, depending on mains frequency and standard loudspeaker impedances. The results reported were obtained using a load resistance of four ohms and frequencies of 63 Hz and 1032 Hz. A typical measurement result is given in Fig. 9, which shows the intermodulation spectrum generated.

Comparison of amplifier circuit topologies

The theory developed predicts that the amount of interface intermodulation distortion depends primarily on three basic power amplifier characteristics: Open-loop output impedance, amount of feedback, and closed-loop non-linearity of the circuit. The first two properties especially vary considerably among amplifier circuit topologies. To make a valid overall comparison of different topologies, all the circuits should have

– the same closed-loop gain
– equal closed-loop distortion, and
– same output damping factor, i.e. closed-loop output impedance.

These rules represent the market place reality of various commercially competing

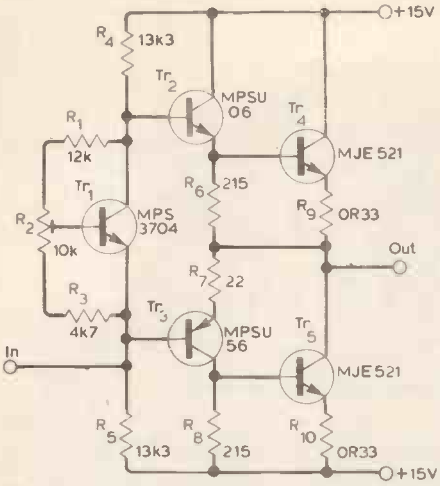


Fig. 14. Grounded-emitter complementary output circuit (D). Quiescent current 100 mA, open-loop output impedance 60 ohm.

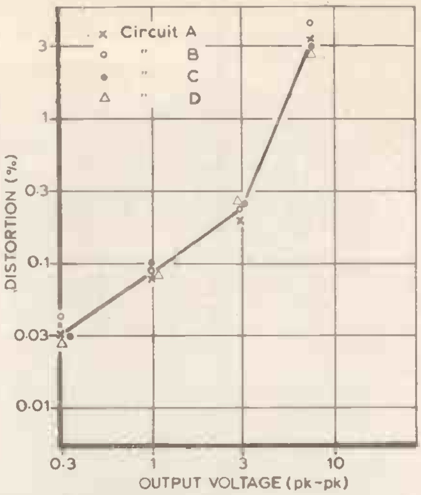


Fig. 15. Measured closed-loop intermodulation distortion for the various amplifier topologies after adjustment detailed in text.

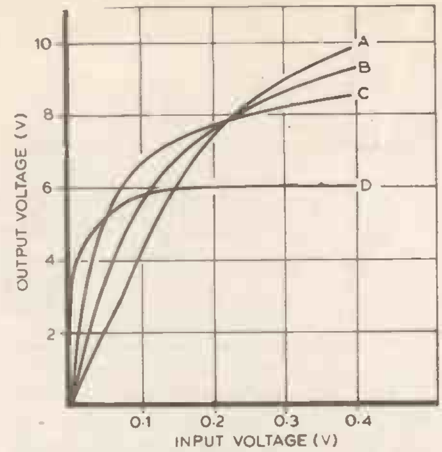


Fig. 16. Measured open-loop transfer characteristics of the various circuits after adjustment discussed in text.

amplifier designs having similar overall specifications, irrespective of basic topology.

The first rule is based on the assumption that amplifiers of equal output power and equal input sensitivity are compared.

The second rule is based on the fact that commercial amplifier designs are limited by a fixed budget. The number of active devices and thus their total gain-distortion quotient is therefore fixed in competing designs of comparable price. Local feedback and overall feedback can then be used in various proportions, but in otherwise optimal designs the total closed-loop intermodulation distortion tends to be the same irrespective of topology, especially at low frequencies which are of interest in the case of interface intermodulation.

The third rule is dictated by the commercial necessity of having a reasonable or comparable damping factor specification, irrespective of topology.

The circuit shown in Fig. 10 was used for the comparative measurements. Diodes 1 and 2 create an artificial non-linearity, the magnitude of which can be adjusted by changing values of R_2, R_5 and R_6. The same resistors also set the open-loop gain and thereby the amount of overall feedback and damping factor.

In the measurements four different output stage configurations were used for the section PA in Fig. 10. Circuits representing popular topologies found in commercial power amplifiers are shown in Fig 11-14. The operating characteristics of the four circuits to be compared were set up as follows.

- Open-loop gain was increased until the r.m.s. closed-loop output impedance decreased to 0.20Ω.
- Closed-loop total intermodulation distortion was adjusted to 0.2% r.m.s. at an output voltage of 3V pk-pk. By injecting two signals of equal amplitude (63Hz and 1032Hz as in previous case) to the input of the amplifier, the r.m.s. distortion at the output was measured using a resistive 4Ω load and referencing the distortion to the 1032 Hz signal.
- These two were repeated several times in iterative fashion, as a change in the open-loop non-linearity affected the effective amount of feedback and thereby the output impedance.

In all the measurements, it was made certain that the intrinsic non-linearities of the various output circuits were negligible, as compared to the logarithmic non-linearity of D_1, D_2 in Fig. 10.

Figure 15 shows the measured closed-loop intermodulation distortion of the various circuits, while Fig. 16 shows the measured open-loop transfer characteristics of the circuits. After adjustment of the circuits, intermodulation measurements were carried out following the procedure outlined earlier. The main results are summarized in the table. Fig. 17 shows the measured values of distortion as functions of the output level. The results are in agreement with the theory presented. They also coincide accurately with earlier results measured for the same circuits using a constant value of feedback in the comparisons[2].

The results demonstrate clearly the role of the open-loop output impedance of a power amplifier in the generation of interface intermodulation distortion, the various amplifier topologies differing with each other by almost two decades. However, you must not draw far-reaching conclusions of the general usefulness of the various output circuits tested. There may exist ingenious ways to modify any of the topologies so that they will satisfy criteria for low interface distortion. Furthermore, the circuits seem to differ considerably in

continued on page 55

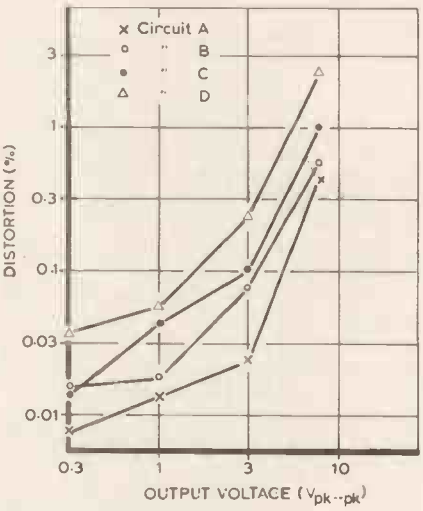


Fig. 17. Measured interface intermodulation distortion for the various amplifier circuit topologies. Results indicate clearly the roles of open-loop output impedance and feedback.

Summary of measurement results and conditions

	A compound	B grounded collector	C quasi-complementary	D grounded emitter
Interface distortion at 3V [%]	0.005	0.01	0.1	0.2
Open-loop output impedance [Ω]	0.9	1.2	2.7	60
Open-loop gain [dB]	33	36	43	70
Feedback [dB]	13	16	23	50
R_2 [kΩ]	1	1.5	3.2	1000
R_5 [kΩ]	42	36	32	13

General conditions for circuits: closed-loop gain 20dB; closed-loop output impedance 0.2Ω; closed-loop intermodulation distortion (CCIF) 0.2%; interface intermodulation distortion shown at output level of 3V pk-pk.

NEWS OF THE MONTH

Japanese giants begin war for home video standard

Early in July, Sony unveiled its Video Movie unit, which represents the hardware end of its professed aim to establish a home video standard format, similar in scope to the 8mm worldwide film standard. This is based on the Sony XCI c.c.d. camera, 13 of which were supplied to Nippon Airways in January.

Blaupunkt, Eumig and Kodak are rumoured to be in the act of producing similar machines but Sony seems to have got in first, if only with non-production samples.

Most of the cameras will feature, as do the Sony and Hitachi, "dubbed sound" which can be added during or after filming.

The challenge, according to Sony, has been to develop a colour video camera and video recorder in the same box which could rival the portability of 8mm film cameras. Although the unit was demonstrated at the recent Photokina Exhibition in Cologne, Sony say they "don't want too much said about it at the moment, because it will not be available to the public for about five years." Even so, many interested parties have been provided with technical material.

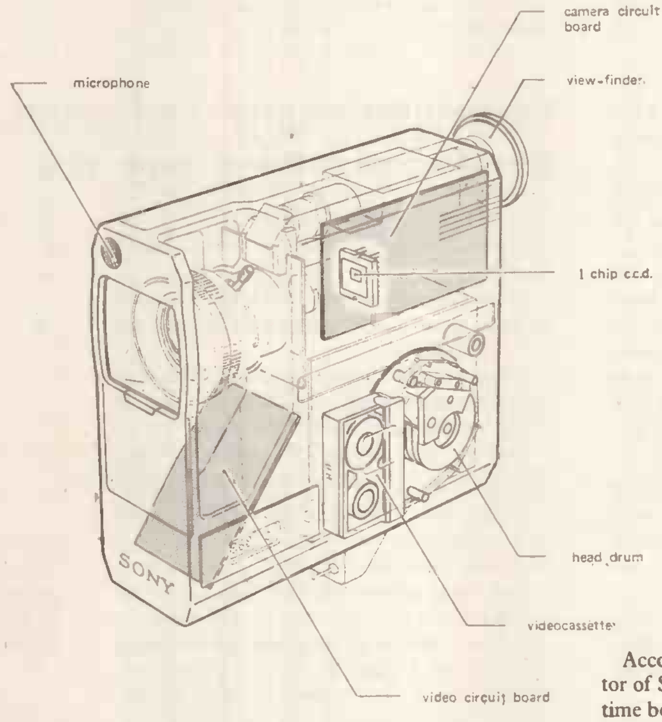
Whatever the reason for this reticence it seems that the Video Movie, which uses a flat 1×1.2cm charge-coupled device image sensor and 8mm metal particle tape as well as featuring "fast search" and "still-frame playback", it is likely to suffer stiff competition, especially from Hitachi, who demonstrated the "Mos Camera" in Tokyo in September. Hitachi say their camera will be ready for production early next year, complementing the company's "Mag Camera," which appeared simultaneously.

It seems that all these units will depend upon a portable electro-optical system which replaces the conventional vidicon-based camera and offers advantages such as the capacity to deal with 100 times more light than the vidicon type without "blooming" or producing a "burn-in," which appears as a black spot on the face of the tube.

However, there are some notable differences between the Sony and Hitachi cameras including 12.7mm wide tape in the Hitachi and a difference in weight, with the Hitachi at 7.5lb and the Sony at 4.4lb. While the Hitachi runs for 2 hours the Sony runs for 20 minutes, but since no details of tape speed have been given for the Hitachi camera (Sony unit runs at 2cm/s) it's difficult to make a direct comparison.

The self-contained v.c.r. in the Sony unit employs the helical scan, slant-azimuth technique used in the company's highly successful Betamax video system and although it is by no means certain that identical principles are used in the Hitachi version, the description "Mag Camera – portable v.c.r. camera combination" suggests a common circuit approach. Power consumption of the Sony unit is 4W, with energy supplied by rechargeable cells (replay, editing and/or format transfer units are mains powered) and the camera slots into the replay unit where it is wound back before being viewed on the user's TV receiver. During filming, exposure control is automatic.

Sony's apparent hurry to get the public interested in the Video Movie is presumably an attempt to bring commercially advantageous order to the currently chaotic state of the home video market place, where three incompatible systems are fighting for ascendancy, each with little chance of breaking through to be come an accepted world standard system. Clearly, the companies in the field, including Sony and Hitachi at the front line, are preparing to exploit to the full potential of new devices, without threatening (if possible) the conventional home video range of products – this could account for Sony's apparent ambivalence in not wanting too much said. The public reaction to the sudden partial redundancy of several relatively bulky units already purchased (the hardware of the VHS, Betamax and V2000 systems) may well be a matter of acute concern to the home video marketing men.



Matsushita has also demonstrated a prototype machine, using what it calls "charge priming transfer," reputed to combine the dynamic range of m.o.s. devices with the very low noise of c.c.d. devices and this unit is expected to go into production within two years.

The price of all such video camera units is likely to be close to £700, which is the figure predicted for the Hitachi machine at its introduction to the Japanese market in Spring 1981.

According to Howard Steele, managing director of Sony Broadcast Ltd, it is only a matter of time before a domestic c.c.d. camera/recorder is developed for ENG (electronic news gathering) in television broadcasting.

Computer servicing course at Slough College

A unique course designed to educate and train people with backgrounds in engineering, science, or computing, and to fit them for employment as customer service engineers in the computer industry, began this year in Slough.

The first meeting to discuss the proposed course was held at Slough College of Higher Education in March 1978 and was attended by several computer manufacturers, representatives of the Manpower Services Commission and college lecturers. A working party including manufacturers and lecturers was set up and the result was a completely new course, which duly received approval by the Technician Education Council (TEC) as being suitable for the award of a Higher Technician Certificate in Computer Technology. At the same time a moderator was appointed, who visits the college at regular intervals to check progress.

In February 1980 the first full-time one-year course began for students who had been carefully selected by the three manufacturers responsible for their periods of industrial training (Data General, Digital Equipment and Hewlett Packard), also by the Manpower Services Commission (offering support under the TOPS scheme) and by computing and engineering lecturers at Slough.

The industrial training slot (ten weeks during the Easter and summer vacations) ensures that students will be skilled in aspects additional to those presented at the college. Hewlett Packard has lent a HP 2100 computer to the college to provide training in the use of disc systems and programming techniques and they, along with the other companies involved, have given lectures on specialist subjects.

Recruitment for the sixteen TOPS-supported places for the next course, which runs from January 1981 to December 1981, has begun. Some previous work experience is essential, the course having been intended for people who want to be re-trained for the computer industry, and initial qualifications can be wide-ranging.

Further details of entry requirements and the course structure are available from Dr E. Huzan, Head of Computing Division, Slough College of Higher Education, Wellington Street, Slough SL1 1YG, Berks. Telephone Slough 34585, ext. 37.

European drive on microelectronics

Because individual European electronics companies, left to themselves, are obviously unwilling to compete with the Americans and Japanese in integrated circuits, the European Communities Commission says there is now an urgent need for concerted action within the Common Market group of countries. If one of the Commission's proposals goes through this could mean that, from January 1981, up to fifty per cent of the cost of R&D in the manufacture of devices using sub-micron technology could be paid for directly out of public funds. This aid would include the development of prototype equipment intended to come on the market by 1985. It would also include up to 50 per cent of the cost of the lease or purchase of the prototypes by users, as well as engineering work to be carried out by them and by the equipment suppliers to bring the equipment to the required performance.

Conditions for aid, however, would require commitment from a number of Community companies to use the prototypes from a particular manufacturer and to invest their resources in the necessary engineering work. The number of companies would vary according to the type of equipment concerned and would be settled type by type. The Commission suggests that approved projects should be nationally financed within a co-ordinated framework of commitment and that, where at least three Community countries are participating, *governments* of member countries could be reimbursed by the Community up to half the cost of the support they are providing. Such a financial method would be a compromise designed to combine the advantages of using national resources and mechanisms quickly, with the Community providing a coherent framework and incentive subsidies when the project had a true Community dimension.

The ECC is worried by the fact that the Community lags behind the USA and Japan in both the production and the application of microelectronic devices. It notes that it is 65 per cent dependent on imports of integrated circuits and has a far higher dependence on the most advanced digital i.cs. The weakness of European production (under 10 per cent of the total today) is the more unfortunate because this is a growing world market, expected to reach some $70 billion in 1980-84, and the USA and Japan are the only major competitors. They, however, have invested millions in well planned strategies, while The Community market remains fragmented.

To try and change this situation the Council of Ministers in September 1979 asked the Commission to submit proposals for specific joint projects at Community level with a view to encouraging the Community to take a leading role in developing this technology. The Commission has now produced its proposals for a Community strategy for 1985, based on discussions with governments and industry and unanimous agreement on technical objectives that need to be achieved if European industry is to be competitive with the USA and Japan in 1985.

The strategy includes a co-ordination of national programmes. The Commission is proposing to set up a data bank and arrange for systematic distribution of information (taking confidentiality into account) to interested governments of the member countries. In addition research into new concepts is thought to be needed, and a committee has identified four major areas of work covering chip architecture, device modelling, language and data structure, and testing. This could be undertaken by universities and research institutes in close co-operation with industry.

The strategy also identifies the need to promote a European equipment industry. The Commission sees this as the weakest Community sector. Production knowledge and equipment has generally been licensed or purchased from the USA, when it is usually already out of date. There is need for investment and close collaboration between prospective European users of the equipment and the equipment manufacturers if the Community is to make headway in this field, but national markets alone are too small and resources inadequate for development on the scale needed.

The proposals to help European microelectronics are in fact part of a much larger initiative on "telematics" (a word derived from "telecommunications" and "informatics") – the combination of telecommunications and computers which is becoming known as information technology. The ECC says that Europe is losing out in the "telematics revolution" to its competitors in the USA and Japan. Even though today, within the European Community, national governments are spending millions of pounds to support the new technology, the fragmentation and lack of standardisation in the Community market hinders development. If the Community is not increasingly to rely on external suppliers for the most dynamic growth industries of the latter part of the century, says the ECC, there must be greater co-ordination of national plans and cross-frontier co-operation in research, development and marketing of products. Given a determined strategy, thinks the Commission, with its population of 260m the Community can catch up where it is now lagging seriously behind. "But it will have to act fast."

A strategy to deal with information technology has been decided and the principles were approved by heads of government at their European Council summit in November 1979.

Communications and computing should be controlled under one roof, says ACARD

The main recommendation of a report published in September by ACARD, the Advisory Council for Applied Research and Development, is that one minister and one government department should be responsible for organising what it calls information technology (IT).

These initials have been coined to cover the wide range of technical activities which fall under the headings of communications and computing, covering conventional radio communication, the use of word processors, digital telephone exchanges, electronic mail, viewdata systems and other aspects of digital information propagation and processing including optical fibre networks.

The report surveys the developments which are likely in IT, the possible applications in different sectors of the economy and contrasts (as does the Labour Party's report entitled *Microelectronics*, also reviewed in this issue) the absence of coherent government policies in the UK with the developed and developing French strategy for exploitation of the technology.

A further important recommendation is that the Post Office (or its successor) should "have the mandate to provide a world-competitive UK communications network and should have sufficient finance for procurement and installation, whether from private or public sources."

Further recommendations include modification of the copyright laws to cover information held in forms other than paper, thus giving protection to users of IT. Perhaps more important, they urge the government to bring forward proposals for data protection legislation immediately, i.e. to implement the recommendations of the Lindop Committee.

The failure of the government to act upon such recommendations, taken with strident criticism in the technical press *New Scientist* equates the work of a commission with "wise monkeys", playing on the keys of a typewriter long enough to write all of Shakespeare's plays) must give pause for thought about the usefulness of numerous reports which are seldom, if ever, acted upon by government.

Sir Monty Finniston, whose report on the engineering profession was published in April and which has largely been ignored by the present government, said last year that in the course of his work he had read upwards of 30 such reports produced since 1852 – none had been acted upon! The Finniston Report cost £401,000 and, as reported in *Wireless World* (October 1980), although not completely ignored by the government, it has not been implemented in the way Finniston recommended.

● It seems very odd that British taxpayers and engineers continue to tolerate this gigantic waste. Quite as serious is the fact that little is done to point out to the non-technical decision-makers in government that, for example, the electronics industry and its offshoots are least likely of all western industrial processes to fall apart. After most of the UK's heavy industry has disappeared, the electronics/communications industries will be thriving and yet the British government and people do not see it (i.e. the need to invest both cash and initiative) and the British engineer does not shout loud enough about it.

The most extraordinary aspect of the subject is the utter docility of those who are both British tax-payers and engineers – to deny status simultaneously with ignoring the economic importance of the industry and the engineer's personal contribution would probably result in continuous lobbying of M.P.s in many Continental countries, but in the UK it is left to the press and dedicated people like Finniston to harangue impotently an apathetic and ignorant legislature.

Even when fundamental financial action is clearly imperative, as in the case of Inmos, where the government stalled over providing the essential second payment, the obsession with saving cash holds sway over more intelligent acts of enterprise.

It is amazing that the frustration of engineers has not turned into an angry demand reverberating through the institutions.

Information Technology is available from HMSO or on order from booksellers, price £3.30.

News in brief

Creative Strategies International, a California-based market research firm, predicts that the world-wide market for teleprinters in 1985 will exceed $1 billion, reflecting a compound annual growth rate of 21%. Most of the increase is likely to be due to the extension of business-based data communications networks and automatic mail systems.

The BBC's money

Background to this month's editorial: According to a participant in a "Man Alive" BBC television programme last May the independent television companies had a total income of £385 million in the year 1978/79 to run their one television network, whereas in the same year the BBC received £315 million to run its two television networks and the whole of its sound broadcasting services. In 1980 both of these figures can be expected to be higher, in excess of £400 million. The Home Secretary, William Whitelaw, stated in a *Radio Times* interview (4 October, 1980) that the BBC's "net income for this financial year and the next one together should be about £1000 million." For ITV, the new franchises for programme companies, due to be announced on 28 December, have been reported to be worth about £560 million p.a.

It is well known that a large number of engineers in the IBA and the ITV programme companies have been recruited from the BBC. Another participant in the "Man Alive" programme mentioned that about 70% of applications for engineering jobs in ITV were received from BBC staff. The salary differences that could account for much of this drift have been substantial. For a particular senior engineering job in ITV the maximum salary in 1979 was £8,600, whereas the BBC maximum for the equivalent job was £6,480. In general the salary differences at that time ranged from 25% to 33%. At present the BBC is not losing many engineers to ITV. They say they are having no difficulty in recruiting staff now that they are reducing the number of available jobs and there is much unemployment anyway.

The engineering economies which the BBC has made in response to Government pressure have been in both jobs and capital spending. General policy has been to arrange the cuts to have the least possible effect on programme production. Consequently the Corporation has not done anything to impair the operation of its transmitters and communications systems. Staff levels in engineering training have also been maintained since this training has to continue to keep the programmes going out.

On capital projects (studios, transmitters, buildings etc) staffs are being kept at a level matching the capital spending which the television, radio and external broadcasting directorates are able to budget for. Without the present restrictions staffs in these departments would have had to be increased.

Other engineering departments have in general suffered a 15% cut in permitted expenditure. Very largely this has meant a 15% cut in jobs, amounting to about 130 in the whole of the Engineering Division. This is being achieved by natural wastage rather than by redundancies. In research and design work this has meant a corresponding reduction in the range of projects which can be pursued. In engineering information there is a slowing in rate of response to demand for transmitter surveys and investigation of reception problems, and also a reduction in the range and amount of published technical information and participation in exhibitions. Fewer technical manuals are being produced for maintenance engineers and others.

In capital spending there has been a deferment of new developments, such as studio centres in the regions, additional local radio stations, regional extension of Ceefax services and a new radio production centre in Central London. There has also been a slowing down in the re-development of the radio v.h.f. transmitter network. Capital spending is being concentrated on the replacement of worn-out plant.

G.I. to expand its Scottish base

A new plant, fully supported by government grants and costing £8.5 million, is to be built by General Instrument Microelectronics (a subsidiary of the US General Instrument Corporation) at its establishment in Glenrothes, Scotland.

This expansion, due for completion in 1985, follows a previous grant to the company by the Department of Industry to aid the completion of a non-volatile memory production unit on the same site under the Microelectronics Industry Support Scheme.

G.I. is the only company manufacturing r.o.m. chips in Europe at present and in addition produces a wide range of devices for operation in microcomputer systems, telecommunications equipment and entertainment systems and games. When complete, the workforce at Glenrothes is expected to be twice its present size.

News in brief

The ubiquitous microprocessor finds yet another (general) application with the introduction by the National Physical Laboratory of a counselling service for manufacturers of measuring equipment, gauges, and other forms of measuring tools, generally grouped under the heading of "metrology." The NPL can provide teams which specialise in measurement techniques and combine this expertise with a knowledge of computing methods to produce simplified measurement practice, giving faster and more accurate methods to those small firms which constitute the major company element in the measurement and scientific instrument industries. Full details of the service can be obtained from Mr A. Williams, Division of Mechanical and Optical Metrology, National Physical Laboratory, Teddington, Middlesex TW11 0LW, telephone 01-977 3222, ext. 3031.

The BBC's tape reclamation equipment which was recently brought into service for radio and external services in London, is being used here to make tapes suitable for re-use, no matter what their previous recording function. The service is expected to be extended to regional departments fairly soon.

New regulations governing the control of human exposure to lead come into force on 18 August 1981. It has been estimated that 10,000 people in the UK are "significantly" exposed to lead and the new requirements will extend the scope of the 1961 Factories Act, which was largely industry-based. Copies of The Control of Lead at Work Regulations 1980 are available from HM Stationery Office, price £1.40.

A plague of fleas at Plessey's telephone equipment factory in Beeston, Nottingham, led to a walk-out of more than 100 shop floor workers early in October. They returned to work a few days later after the factory had been fumigated.

After holding meetings throughout the UK to test public opinion of current IBA day-time TV programmes, the corporation is to interview 43 contenders for the 15 commercial TV franchises which come up for renewal by Christmas 1981.

A microprocessor-controlled fuel injection system for diesel engines is to be developed jointly by Lucas and TRW, the American conglomerate with interests in optics and semiconductors. The sensors, actuators and other hardware will be manufactured by Lucas and the system is expected to be ready for production by mid-1983. Oddly enough, economy of fuel use is not a major objective and a spokesman for Lucas points to the US Environmental Protection Agency's exhaust emission requirements as the main purpose of the unit's use.

Microelectronics and Labour

The Labour Party's discussion document entitled Microelectronics, published in September, apart from one or two howlers such as that on page 1, where we learn that "semiconductors are popularly known as "chips" (!) contains a wealth of depressing conclusions about the state of the British microelectronics industry, as well as some worrying international comparisons in technical education and management.

At the same time it emphasises (predictably) the need for far more national involvement and ownership of companies in the field, with special reference to GEC, which it describes as playing "a particularly malign role in British microelectronics." The need for more national investment is stressed by quoting Sir Arthur Knight's conclusion (as the new chairman of the NEB) that the private market does not provide enough capital for the sector and that even under the last labour government, it was not enough to ensure success."

The document refers to what it sees as Sir Keith Joseph's "political attack" upon the Post Office, through the break-up of the monopoly, at least where the supply of terminal equipment is concerned and comments that "The combined effect of these measures will certainly be to reduce the profitability of the new Telecommunications Authority by allowing private companies to cream off the most lucrative business and so put their major investment programme at risk." At the end of this section, the point is made that such action could lead to increased imports of telecommunications equipment, to the detriment of the major UK suppliers and the workers employed by them. . . . "In accordance with party policy these powers and activities will be restored to public ownership and control by the next Labour government."

The comparisons between, for example, the French and British telecommunications programmes are in some aspects startling, by mentioning that the French are committed to increasing the number of telephone subscribers from 14 million to 34 million by 1992, the provision of a free viewdata terminal to each subscriber (to permit the eventual replacement of telephone directories) and the introduction of a direct broadcast telecommunications satellite for business use.

Comparisons are also made between the level of state aid in the two countries, the example of Inmos being used, where the amount of aid is less than the total provided by the French government to three small-company projects in France. The conclusion is drawn that large sums of money must be spent if progress is to be made – "where private industry does not or cannot spend, government must – a point accepted by the government of every advanced economy but our own."

The discussion document refers to research policy in a manner which suggests that bodies such as ACARD (see news report in this issue) are little more than toothless bulldogs. "The new microtechnology clearly throws up a need to fill (the) gap which ACARD (attached to the cabinet office and composed largely of employers' representatives and academics) does not meet." Apart from these criticisms, the document notes the need for legislation to protect personal privacy, in the face of the power provided to organisations such as the police by computers and other interconnected data systems.

In a section called "Wider Horizons," the idea of a better use for "own time" is mooted but not developed. The possibiloities offered by technological change in the development of leisure activities seem to emerge as a pretext for a puffing piece of political dogma, uncharacteristic of the document as a whole.

The main recommendations, however, are linked with the main areas of criticism, covering research and development, where private industry funds only about 30% (this, the document says, should be extended by harnessing the expertise of public corporations, universities and government laboratories), public purchasing, telecommunications and public investment.

In the two latter subject areas, the report says that the development of optical fibre transmission systems and the extension of System X must not be restricted by the imposition of strict cash limits. "Britain needs to match the political and financial commitment that the French have shown towards their telecommunications system." In the section on public investment, the activities of the NRDC and NEB are provided as examples of methods of filling the "equity gap."

The final points concern Labour's objectives for the application of new technology, where the point is made that this necessarily differs from the approach of private enterprise in that the profit motive should not be the major consideration, where at present resources are put into entertainment systems rather than medical electronics, into broadcasting rather than personal communications and into missiles rather than computer aids for education.

Perhaps the most damning comment, which occurs earlier in the document, is in the section dealing with education, science and research, where Britain's failure to respond properly to the challenge of the chip is emphasised and one important factor isolated – that we have "consistently undervalued practical technological understanding and this in turn has produced generation after generation of decision-makers in our society who do not have it."

More jobs lost to recession

Within the next 18 months, another 3,800 jobs will be lost in the radio and tv manufacturing industry. The £10 million Rank-Toshiba link-up, formed two years ago and crowned by a £3 million modernization programme as well as saving many jobs in Rank's Plymouth and Redruth factories, has fallen foul of the strong pound and the cheap goods challenge from the Far East, according to Rank.

About 2,700 jobs, many of them re-deployed after the closure of the Stoke plant by Rank, are currently in danger. Meanwhile, Philips has announced the closure of its tv manufacturing plant in Lowestoft, with the loss of 1100 jobs, the actual closure being planned for mid-1982. This factory has been making domestic radio and tv sets for 30 years and all future production will be transferred to the company's remaining factory in Croydon.

Another British-Japanese consumer electronics business in trouble is the GEC-Hitachi joint venture colour tv plant at Aberdare, Wales. A GEC spokesman told the *Observer* (19 October): "There is a lack of consumer demand and the pressure on margins is continuing . . . if there is no improvement in the future then its lack of viability will have to be faced."

Data Recording Heads at Egham, Surrey, has had to lay off 97 of its 295 employees because of "crippling recession". The managing director has said: "We have no choice . . . the cutbacks are to ensure the survival of the company."

News in brief

The prizes offered by the Department of Industry to secondary schools participating in a competition launched in April and reported in our June/July 1980 issue, have now been awarded. Schoolchildren were asked how a microcomputer would benefit their school and the range of suggestions included the development of a school teletext system, programming of new dance movements(?) and the running of the school's administration. Winners were selected from 650 entries and 117 microcomputers were eventually awarded (100 planned) with six "star" prizes being awarded by Sir Keith Joseph to schools in Renfrewshire, C. Armagh, Uttoxeter, Mid-Glamorgan, Ewell and Camberley. The idea behind the competition was to act as a catalyst in a national effort to spread computing experience quickly into education. Several companies and organisations, including Shell, GEC, Plessey and the Post Office have made major financial contributions and are offering individual schools continuing help.

On the heels of Teac and Marantz, who recently introduced cassette recorders using DBX noise reduction circuits, Matsushita has now made an agreement with DBX, a wholly-owned subsidiary of the UK company BSR, to market cassette recorders using the system under its Technics brand name. DBX claims that its noise reduction technique offers the best signal to noise ratio available and that it "virtually eliminates tape hiss." Distribution will begin in Japan at first, followed by world-wide distribution.

The 7th European Conference on Optical Communication will be held in Copenhagen from September 8 to 11 1981. A call for papers has been issued in relation to the conference and further details are available from the Secretary of 7th ECOC, M. Danielsen, Electromagnetics Institute, Technical University of Denmark, DK-2800 Lyngby, Denmark.

Zaerix Electronics has acquired the Rochester-based Mazda radio valves and tubes marketing business from Thorn Brimar Ltd. The complete valve stock, as well as the testing facilities, have been taken over by Zaerix and customer service and quality control procedures will be maintained at the company's headquarters at 46 Westbourne Grove, London, W2.

Background information on legislation and current safety standards relating to electrical equipment exported to the US has been published by the British Standards Institution. The document surveys the most widely used certification schemes and details are give of organisations which test and certify electrical products. The survey, called *Electrical Equipment Certification in the USA* has been prepared by the BSI's Technical Help to Exporters service and costs £24 to THE members or £30 to non-members. It is available from THE Sales Office, British Standards Institution, Maylands Avenue, Hemel Hempstead, Herts HP2 4SQ.

Inmos will be opening its first large-scale production factory in Newport, Gwent during the summer of 1982. The factory will manufacture v.l.s.i. products. Production samples of 16k static r.a.m. devices are now available from the company's Colorado Springs unit.

Darkroom exposure meter and enlarger timer

Measures print exposure time and controls enlarger

by G. G. R. Rutter

The unit described will measure the required exposure for a black and white print, giving a digital readout in seconds and tenths; it will then time this exposure. The meter may also be used as a ten minute process timer to count minutes and seconds. Two such meters have now been in use for over a year, and have proved to be accurate, stable, and convenient to use.

The circuitry is constructed from easily available components, largely using c.m.o.s. logic, at a cost of about £30, which is less than commercial units offering much inferior performance.

Most of the circuitry of the meter/timer is in one box, which provides control of manual exposure setting, 'on' and 'off', 'expose' and 'time', together with a paper-speed adjustment. The sensor is contained in a separate small box, with the 'measure' switch, used for the meter-set exposure time.

Circuit operation

The circuit diagram of the sensor is shown in Fig. 1. D_1 is the sensing photodiode, a Siemens LD57C, which is intended by the makers for use as a l.e.d., but which is used here as a blue-green sensitive photodiode because of its ready availability. Its sensitivity to orange safelight is very low, probably roughly equivalent to printing paper. The 'C' suffix denotes the high-output type.

The current from D_1 and D_2 is integrated by IC_1, Tr_1, the output of which feeds a Schmitt trigger ($Tr_{2,3,4}$). Feedback to the integrator is via D_2 and D_3, both small, red l.e.ds, D_2 being used as a photodiode – an arrangement which provides excellent isolation of the sensitive input of the integrator. The output of the Schmitt trigger is in the form of negative pulses, whose length is inversely proportional to the current through D_1, or the incident light, and directly proportional to the required exposure.

The specified input leakage current for the CA3140 (IC_1) is 10pA, but this seems to be much reduced by operating the inputs at earth potential, and nine out of ten samples leaked considerably less than this. It is thus possible, with selected devices, to resolve currents of 10^{-16}A. In normal operation, D_1 gives a current of at least 1pA, and although this sounds an excessively small current for accurate measurement, it does not give rise to problems if the circuit is constructed on good-quality, glass-fibre p.c. board. The integrating capacitor is very small (about 1pF), and must have a very low leakage; I found that two lengths of 1-2cm 30s.w.g. enamelled wire, twisted together, perform better in this application than commercial capacitors, and, furthermore, can be trimmed to size.

The Schmitt trigger, $Tr_{2,3,4}$, has a temperature-sensitive hysteresis, to compensate for the increased sensitivity of D_1 with temperature rise.

The output of the Schmitt is taken to the logic circuit which is given in Fig. 2. When measuring exposures, $IC_{2,3,4}$ are used to count pulses from a v.c.o., which is controlled by the paper speed potentiometer, during the negative periods of the output of the sensor circuit. At the completion of each count, the measured exposure is transferred to $IC_{5,6,7}$ and displayed. If the count runs overrange, the 'carry' output triggers IC_{14}, and the count stops at 000.

Manual setting of exposure time can be accomplished using four buttons, providing fast and slow, up and down counting. The frequencies (10 and 100Hz) are derived from the rectified 50Hz mains waveform via Schmitt trigger IC_{9d}. Switching is by two latches ($IC_{8a,8c}$) to abolish contact bounce. Each pulse, in addition to clocking $IC_{2,3,4}$ also sets $IC_{5,6,7}$.

After either manual or sensor-determined setting, the exposure time is left in $IC_{2,3,4}$. $IC_{5,6,7}$ may then be used as a timer without losing this information. In this mode, after initial setting to zero, IC_5 is clocked by 1Hz pulses from IC_{13}. IC_6 is reset at a count of 6, so that IC_7 counts minutes.

For timing exposures, $IC_{2,3,4}$ count 10Hz pulses down to zero, the exposure time being set into $IC_{5,6,7}$ before counting starts. On reaching zero, the carry output goes high, terminating the exposure, and setting the counters again for repeat exposures. An exposure may be terminated early by pressing the "Off" button.

The display circuit in Fig. 3 includes a separate voltage regulator (D_4 and Tr_6). This is because the LM723 (IC_{17}) was found to give inadequate regulation for the v.c.o. when loaded by the display l.e.ds. Also included in the display circuit is the variable mark-space ratio strobe oscillator IC_{18}, which may be omitted if a variable brightness display is not needed.

The voltage-controlled oscillator in Fig. 4 deserves special mention. For convenience, the paper speed control is logarithmic: a linear potentiometer is used, to control a log. v.c.o. IC_{16} is a CA3046 transistor array, used as a temperature-controlled log. voltage-to-current converter. This i.c. consists of five n-p-n transistors on a single chip, the transistors therefore being accurately matched, and having close thermal coupling. Four are used as a thermostat: set to about 40°C, the oscillator is stable to better than 2%, and settles in 15 seconds. The reference voltage for thermostat and log. converter is derived from the 7.15V reference of the 723 regulator. IC_{15}, an NE555, is the oscillator, whose capacitor is charged rapidly by the 1kΩ resistor, and discharged relatively slowly by the log. converter; thus, the frequency is closely proportional to the discharge current.

As shown, the adjustment range on the speed control is approximately ×10, a further preset adjustment of ×10 being provided by the 1kΩ preset. The range

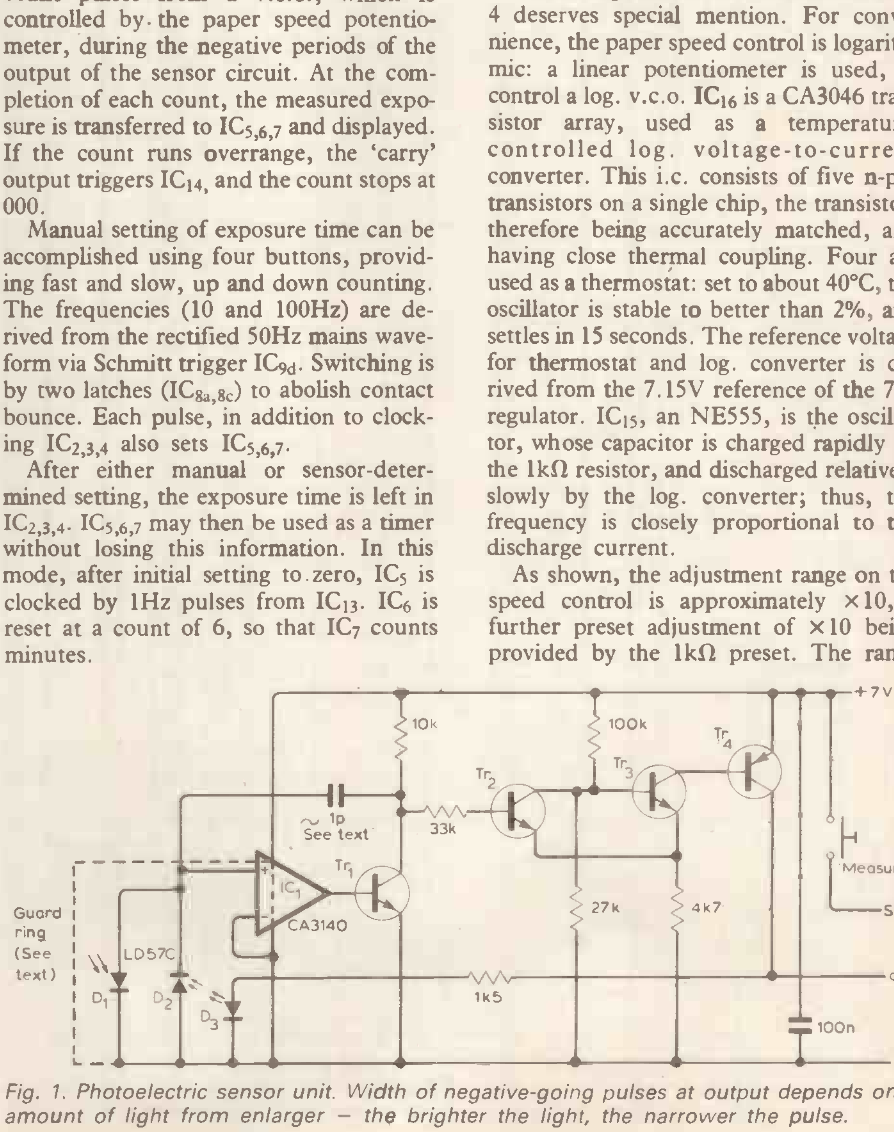
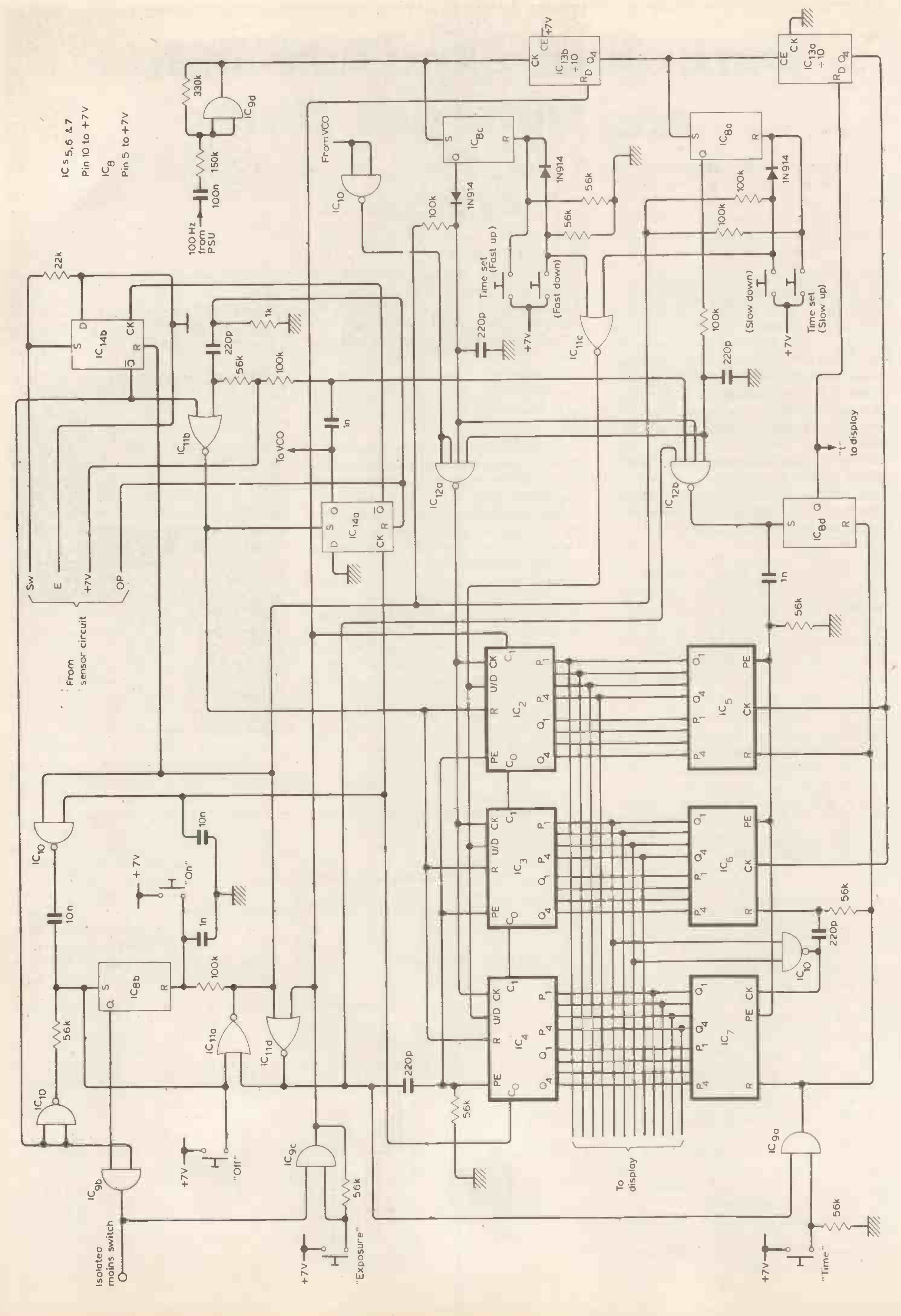
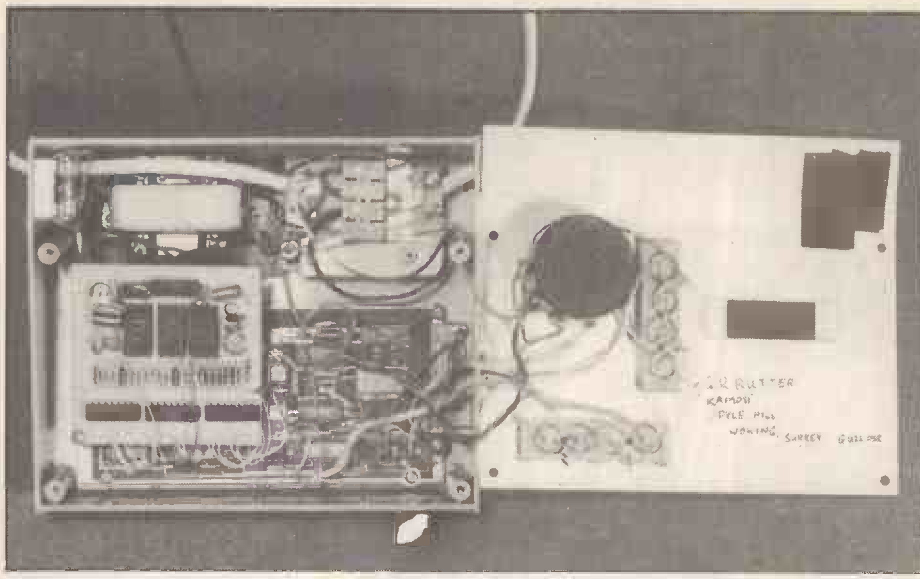


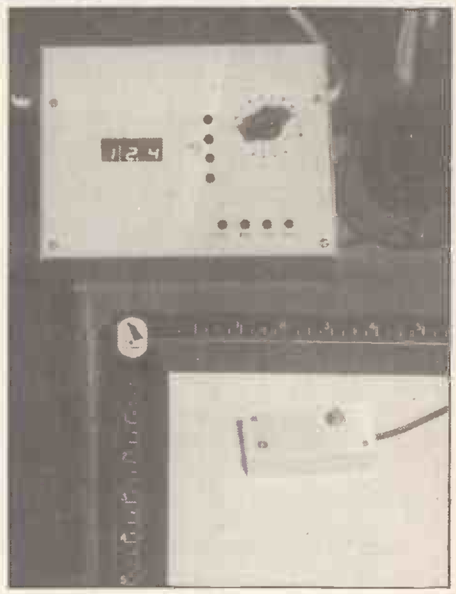
Fig. 1. Photoelectric sensor unit. Width of negative-going pulses at output depends on amount of light from enlarger – the brighter the light, the narrower the pulse.



ICs 5, 6 & 7 Pin 10 to +7V
IC8 Pin 5 to +7V
100 Hz from PSU
100n
150k
330k
IC9d
IC13b ÷10
CK CE R D Q4
+7V
IC13a ÷10
From VCO
IC10
IC8c
IC8a
1N914
100k
56k
Time set (Fast up)
(Fast down)
(Slow down)
Time set (Slow up)
220p
IC11c
22k
IC14b
1k
IC11b
1n
To VCO
IC14a
IC12a
IC12b
"t" to display
IC8d
Sw
E
+7V
OP
From sensor circuit
IC2
IC3
IC4
IC5
IC6
IC7
U/D CK C1 P1 R P4 Q1 PE C0 Q4
10n
"On"
IC8b
IC11a
IC11d
IC9b
IC9c
IC9a
"Off"
"Exposure"
"Time"
Isolated mains switch
To display

Fig. 2. Control logic circuit. Display is driven by counters IC_5 to IC_7. Omitted from the diagram are the connexions of the carry pins: IC_5 carry in (pin 5) is connected to earth; IC_5 carry out (7) is connected to IC_6 carry in (5); and IC_7 carry in (5) to earth.





may be widened by increasing the 6k8 resistor.

The isolated mains switch is shown in Fig. 5. The power supply is derived from the mains, using the transformer primary as a current limiter. Some triacs require a trigger current of 50mA, and in this circuit, narrow, high-current pulses are provided by the NE555 oscillator. A current of 0.5mA through the optical isolator l.e.d. will stop the oscillator and turn the enlarger off.

Construction

I constructed the meter on four printed circuit boards: one double-sided, with the main logic circuitry, power supply stabilizer, and log. v.c.o., a separate, single-sided board for the display circuit and two small boards for the sensor circuit and isolated triac switch.

All except the sensor circuit were housed in a "BIMBOX" 6006 (Boss Industrial Mouldings): the sensor was fitted into a home-made metal and plastic box, which must be electrostatically screened by a layer of aluminium cooking foil.

Layout of the majority of the circuit is not at all critical. The isolated triac circuit, since it is at mains potential, should be suitably shielded. The sensor circuit should be arranged to minimize leakage current to the input of the integrator. IC_1 is mounted in a socket made of Soldercon pins, which provide no additional leakage path. Pin 1 has no connexion, and no socket to allow a complete earthed guard ring to be put around pins 2 and 3, and D_1 and D_2. The use of an i.c. socket allows the CA3140 to be changed, to select one with a low leakage. D_1, as supplied, has a domed encapsulation, to provide focusing, which makes it highly directional, so that it is necessary to grind this off, leaving a flat top. Emery paper is suitable for this, finishing on fine grit (600), then metal polish: some care is necessary to avoid straining the leadouts. D_1 should, obviously, be under a transparent window in the box. D_2 and D_3 face each other, and should be shielded from the light illuminating D_1. All components at the input of the integrator, including IC_1, should be clean: fingerprints could cause leakage currents.

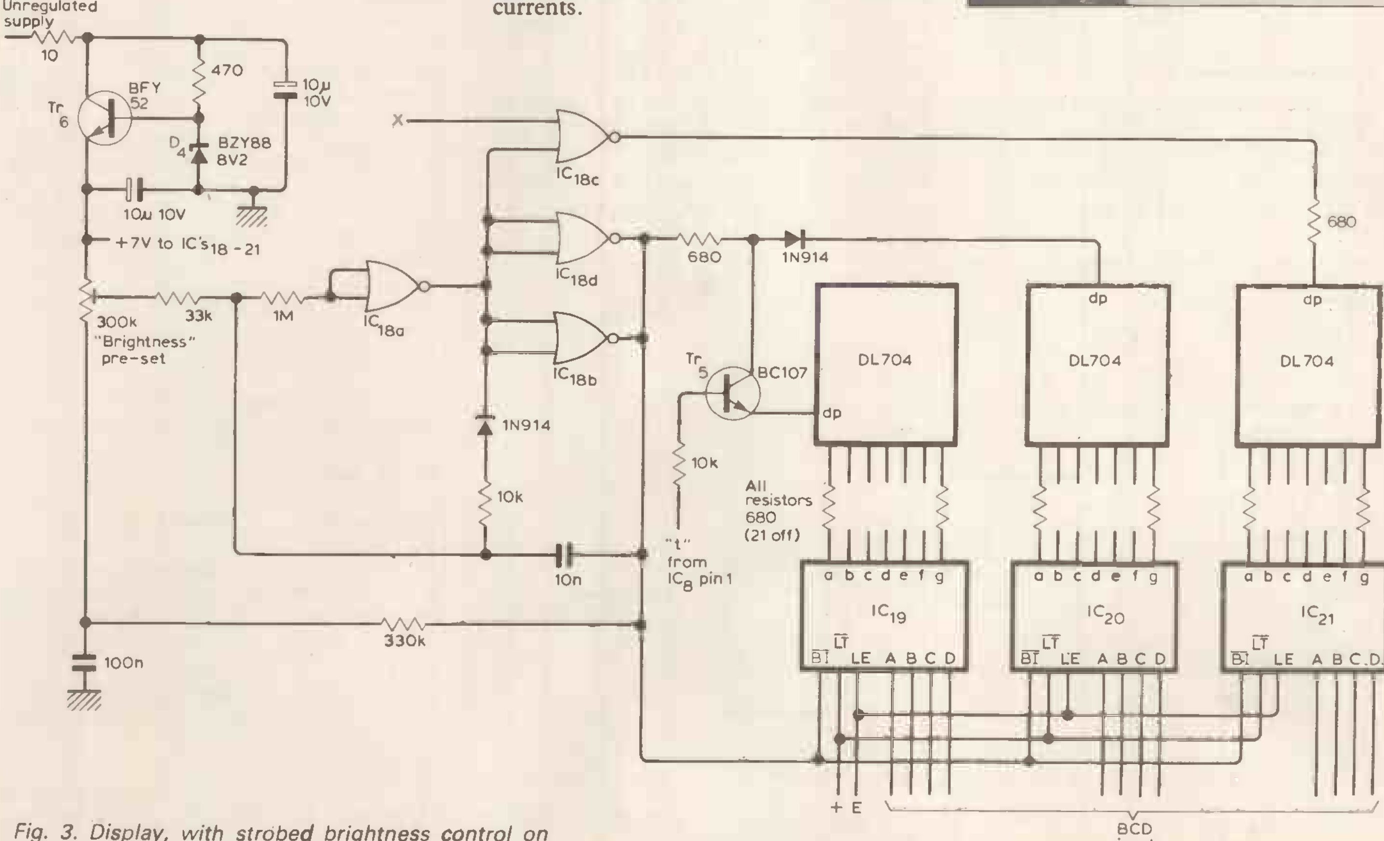


Fig. 3. Display, with strobed brightness control on blanking inputs of decoder.

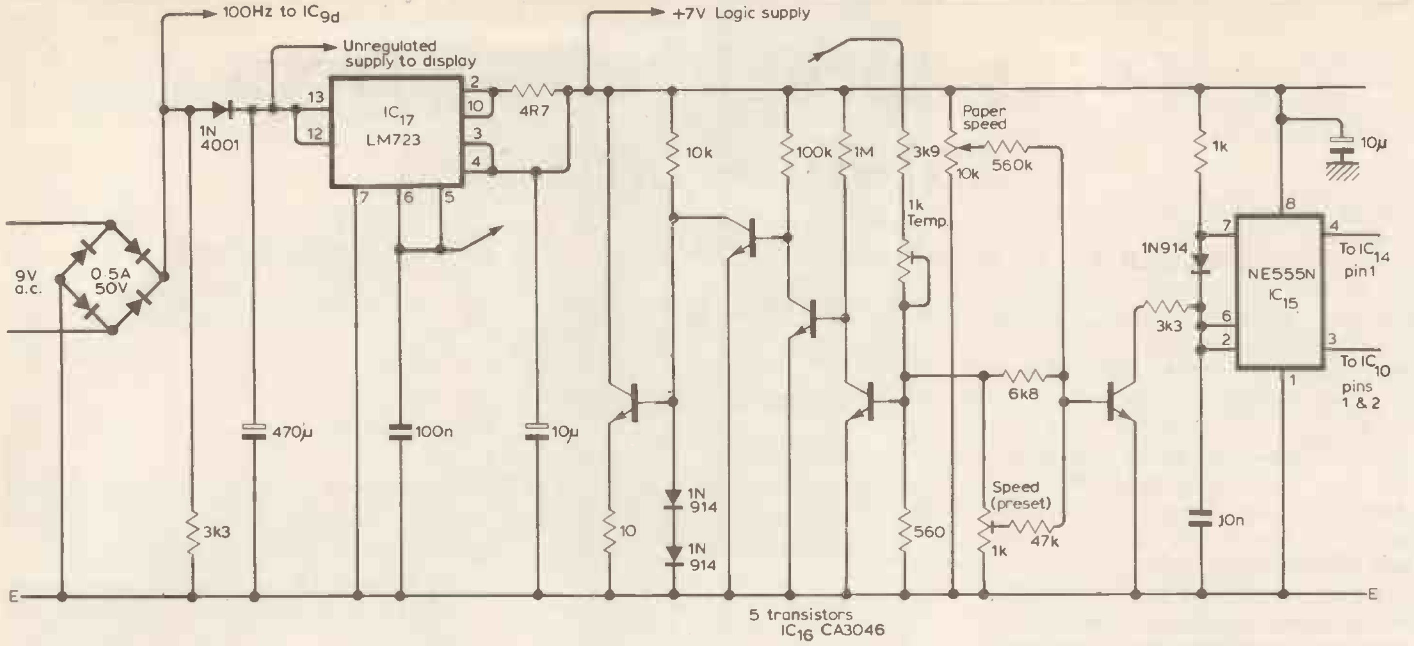


Fig. 4. Voltage-controlled oscillator and p.s.u. Four transistors of CA3046 on left form thermostat.

Setting up

After checking the circuit and supply voltages, the first thing to set up is the log. converter, whose temperature should be set to about 40°C: this is not, however, critical. Assuming an ambient temperature of 20°C, one method is as follows: set the 1kΩ "temp" preset to minimum resistance, and check that no current flows in the 10 ohm resistor of the heater transistor. Connect a 56kΩ resistor across the 3k9 resistor, and the 1kΩ preset, raising the base voltage of the temperature-sensing transistor by about 40mV. The 1kΩ preset can now be adjusted until current just begins to flow in the 10 ohm resistor. Removing the 56kΩ resistor now reduces the base voltage by 40mV; a rise in heating current should now be seen which reduces over about 30 seconds to a value sufficient to maintain the temperature.

The sensor circuit should now be checked. In light corresponding to a long exposure of about 100 seconds, the negative output pulses should be approximately 2 seconds long. In total darkness, these pulses should be at least 10 times longer; if not, try another 3140. Adjustment of the output pulses is by trimming the 1pF capacitor (made of twisted wire). The paper speed preset is adjusted to give a suitable span on the panel mounted control, calibration being by trial and error, with test strips. Paper manufacturers do not usually quote a speed, so each box needs to be tried, and the appropriate speed setting noted down.

Using the instrument

In measuring exposures, a piece of ground glass, or other diffuser is placed under the lens, and the sensor placed on the printing frame directly under the lens, before pressing the "measure" button on the sensor box. The display should now show a stable reading, and the enlarger should be on. Moving the iris should alter the exposure reading accordingly. Upon releasing the button, the enlarger will turn off, and the exposure will be held on the display. Pressing the "expose" button will turn the enlarger on for the displayed time. The "on" and "off" buttons are to control the enlarger for focussing, etc.

The manual setting buttons should cause the display to count up or down, fast or slow. Pressing "time" causes the decimal point to move one digit left (to between the left and middle digits), sets the display to 0.00, and starts it counting seconds and minutes. This is cancelled by any other function except "on" and "off", and the previous exposure time is recovered.

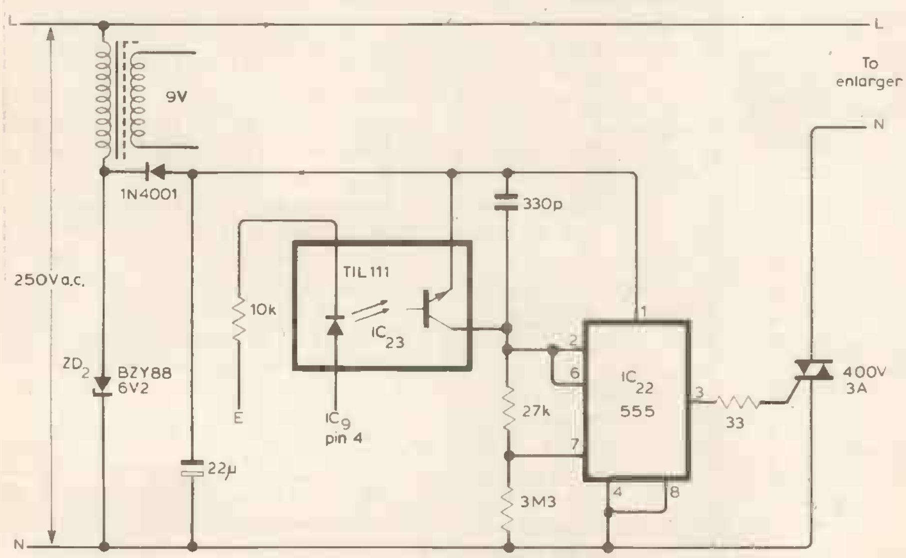


Fig. 5. Triac mains switch. Mains transformer primary winding acts as dropper for NE555 supply. IC 23 provides isolation.

Component list

Integrated circuits

1	CA3140
2-7	4510 (b.c.d. up/down counter)
8	4043 (quad. 3-state Nor R/S latch)
9	4081 (quad. 2-input And gate)
10	4011 (quad. 2-input Nand gate)
11	4001 (quad. 2-input Nor gate)
12	4012 (dual, 4-input Nand gate)
13	4518 (dual, b.c.d. up counter)
14	4013 (dual, D flip-flop with R/S)
15	NE555
16	CA3406
17	LM723
18	4001 (quad. 2-input Nor gate)
19-21	4511 (b.c.d.-to-7-segment latched encoder/driver)
23	TIL111

Transistors

1-3	ZTX109
4	BC214
5	BC107
6	BFY52

Triac 3A, 400V

Zener diodes

4	BZY88 C8V2
5	BZY88 C6V2

L.e.ds

1	LD57C (Marshall's, Kingsgate House, Kingsgate Pl., London NW6 4TA)
2,3	TIL209, DL 704

Passive components as in circuit diagrams.
Resistors ⅛W, carbon film, presets miniature carbon
Transformer 9V, 150mA

Orbit predictions from satellite images

Calculating orbit predictions using scanning-radiometer pictures

by M. L. Christieson

Images from polar orbiting satellites, such as those from TIROS-N and NOAA-6, can be used by the amateur to make reasonably accurate orbit predictions. This article describes a method which has enabled a.o.s. (acquisition of signal) time to be predicted to within a half a minute for up to a fortnight. After this period, some updating of data is required if the accuracy is to be maintained.

A significant problem encountered by amateurs receiving images from polar orbiting satellites such as TIROS-N and NOAA-6 is the need to maintain reasonably accurate orbit predictions. The degree of accuracy needed depends on the level of automation, and if the station is fully automatic it is often necessary to keep errors to less than half a minute in time and one degree of equator crossing longitude.

The simplest solution is to obtain a reference orbit from an outside source, and, using the orbital period, calculate successive orbits either manually or by using a simple computer program. It soon becomes apparent that without occasional updates the drift of the prediction is intolerable. Further data can be obtained from outside, but this is not always easy to obtain, and sometimes can be quite inaccurate because of the long term nature of their production. It is very difficult even using large professional computer systems to produce accurate long-term predictions because the magnitude of the drag on a satellite in a low-orbit depends on the outer atmosphere, which is affected to a large extent by solar activity. The level of solar activity is difficult to predict and hence errors can reach tens of minutes over a period of months.

It is therefore necessary to update both reference orbits and orbital parameters regularly; say every two weeks or so. Assuming that the amateur wishes to be independent, some direct observational method must be used. The most obvious is to use an astronomical telescope to observe the satellite, and provided it is well calibrated, these observations will give the required data. There are several disadvantages to this method:

– the capital outlay in equipment is large.
– It requires some expertise to use it.
– Observations are restricted to a time when the sky is dark but the satellite is not in the earth's shadow.
– It must be known approximately where to look and when.
– It is dependent on the weather.

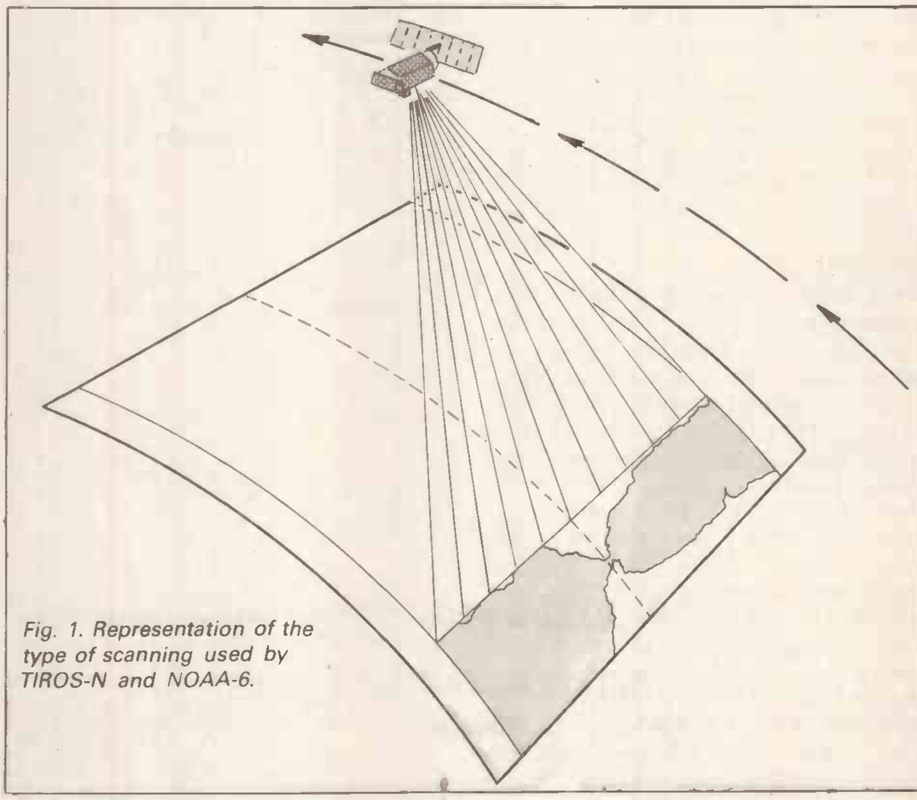


Fig. 1. Representation of the type of scanning used by TIROS-N and NOAA-6.

In most cases this method would, apart from radar observation, be the only available solution, but the earth imaging satellites are sending pictures looking down at the Earth, and it is possible to use these to find out where the satellite is at a given time. The scanning-radiometer pictures from TIROS-N and NOAA-6 lend themselves easily to this. Fig. 1 shows this type of scanning. It can be seen that as the imaging is sent in real-time, the pixels (picture elements) representing the point directly below the satellite (the sub-satellite point) are sent at the time the satellite was directly over this point.

Fig. 2. represents the satellite image from the v.h.f. scanning radiometer signal and the line *ab* is the satellite track. The satellite passes directly overhead all points on the line *ab* at different times during the pass. The exact latitude and longitude of one point on the line must be measured and this is obtained from the physical detail on the image. It is also necessary to determine the exact time that the pixels representing this point were sent. The accuracy with which this information is extracted from the image has an important effect on the final accuracy of the method.

Latitude and longitude extraction

It is essential that the line *ab* is drawn down the exact centre of the image section of the picture. This section does not include sync, grey-scales and timing-marks. When the centre-line has been drawn, the features visible on it are examined for something that can be readily identified – a particular shape on a coastline or a lake for example. If the centre-line passes only over sea or cloud it is not possible to use that particular image. Once a point has been selected it must be re-identified on an atlas map, and the exact latitude and longitude measured. In order that the longitude may be measured most accurately a point near to the equator should be used, where the longitude lines are widest apart. It is not possible to identify a random point in order to measure the longitude of the centre-line because even after processing on board the spacecraft the image scale is not linear.

Time extraction

The v.h.f. signal also contains timing marks down one side of the image (Fig. 2.) These are short horizontal lines set one minute apart. In order to measure time exactly these marks must be referenced against an outside time standard. This must be done in real-time, and if a tape recording technique is used for printing it must be done as the picture is recorded. In the prototype, which in fact also prints the pictures in real time, a small white line is added every ten minutes. This ten-minute marker can be readily identified on the image, and from an approximate starting time the minute markers referenced. This technique is also shown in Fig. 2. which illustrates the construction lines. The accuracy of time measurement also has a significant effect on the final accuracy of the method.

Calculation of the result

This sections deals with calculations relevant to an ascending orbit, Fig. 3(a), and the formulae used are based on spherical geometry. For a satellite in a circular orbit with period P minutes and orbital inclination to the equator ϕ the sub-satellite latitude is given by

$$lat = \sin^{-1}\left[\sin\left(\frac{360t}{P}\right)^{\circ} \sin\phi\right] \qquad (1)$$

t minutes after it crosses the equator. The value for the inclination is well published and varies only slowly with time. Using the value for lat (L_{obs}) from the observation, and an approximate value for P, which is also well published, the value of t can be calculated by rearranging the equation

$$t = \left[\sin^{-1}\left(\frac{\sin L_{obs}}{\sin\phi}\right)\right]\left[\frac{P}{360}\right] \qquad (2)$$

The time of the observation is known, so

$$t_{eq} = t_{obs} - t$$

where t_{eq} is the time the satellite crossed the equator. This is the required result.

The longitude of the satellite is given by an equation consisting of three parts

$$LG = \cos^{-1}\left[\left(\cos\frac{360t}{P}\right) \div \cos L_{obs}\right] + \frac{t}{4} + L_{eq} \qquad (3)$$

where LG is the longitude and L_{eq} is the longitude at which the satellite crossed the equator. The first part of the equation is the actual movement of the satellite, the second is to take account of the Earth's rotation, and the third the starting longitude. All the variables in the equation are known except for L_{eq} which is required.

$$L_{eq} = LG_{obs} - \cos^{-1}\left\{\left[\cos\left(\frac{360t}{P}\right)\right] \div \cos L_{obs}\right\} - \frac{t}{4} \qquad (4)$$

This gives the equator crossing longitude which, together with the time, represents a reference orbit.

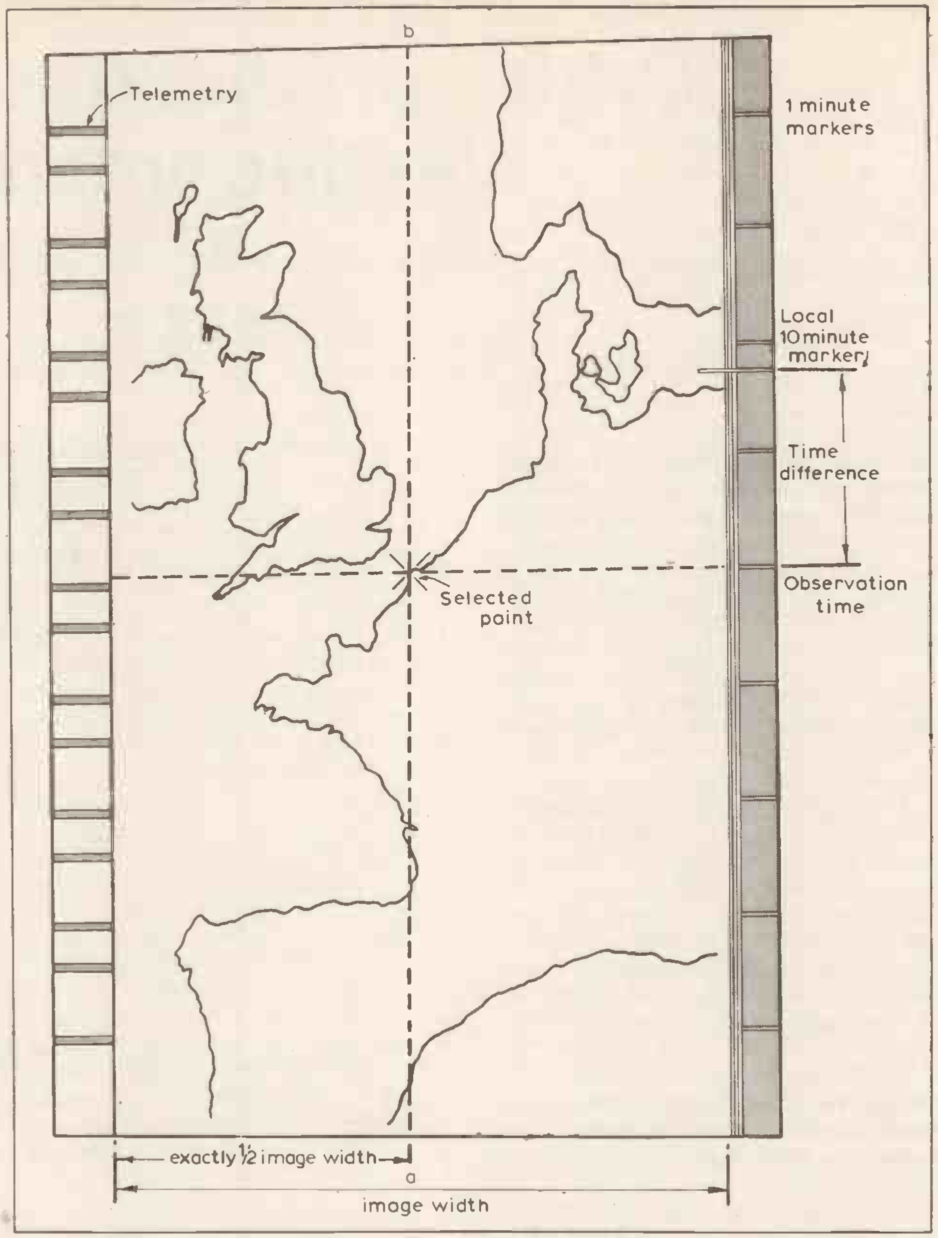


Fig. 2. Typical compilation of a scan received from the satellite. The horizontal line has been chosen to cross ab, the satellite path, at a point on the coast to enable accurate determination of latitude and longitude from a map.

A more accurate value of period is required for longer term prediction, and this can be calculated from two observations taken some days apart and the total number of minutes between the two calculated. This is divided by the approximate value of period. Obviously the result should represent an integral number of orbits, so it is rounded up to the nearest integer and the total number of minutes divided by that. This gives the orbital period. The procedure can be repeated regularly to keep the value of period accurate.

Descending orbits

The equations given above are valid for ascending orbits only, i.e. those that cross the equator into the observer's hemisphere on the same side of the Earth as the observer. This type of orbit is shown in Fig. 3(a). Half the usable passes a day result from orbits crossing the equator on the other side of the Earth, coming over the Pole and into the user's view, and then crossing the equator into the other hemisphere. This type of orbit, a descending orbit, is shown in Fig. 3(b). If the observation is made on a descending orbit, the existing equations must be modified. At the point when the orbit goes over the Pole, the equations go through a discontinuity thus becoming useless. A convenient solution is to imagine the orbit to be inclined to the equator in the opposite sense,

$$\phi' = 180 - \phi$$

Using equation 2, the value of t can be calculated using the modified value ϕ' This produces the time taken for the satellite to reach the equator crossing into the other hemisphere. Therefore the equator crossing into the observer's hemisphere was half an orbit before, ie. $P/2$ minutes, so:

$$t_{eq} = t_{obs} + t - \frac{P}{2}$$

In order to calculate the equator crossing longitude equation 4 must be modified. For inclinations of less than 90° the sign before the first part of the equation must be reversed. (ϕ' will now be less than 90° if ϕ was greater than 90°). As the equation is being used in reverse the sign before the $t/4$ term must be reversed due to the fact that the earth is rotating in the opposite direction. The equation now becomes

$$L_{eq}' = LG_{obs} + \cos^{-1}\left\{\left[\cos\left(\frac{360t}{P}\right)\right] \div \cos L_{obs}\right\} + \frac{t}{4}$$

This value of L_{eq}' is the equator crossing-longitude passing from the observer's hemisphere. To calculate the value of the crossing-longitude half an orbit before, 180° plus a correction for the rotation of the earth must be subtracted.

$$L_{eq} - L_{eq}' - 180° - \frac{P°}{8}$$

This, together with the time, represents another reference orbit.

Source of errors

Several assumptions are made during the calculation of reference orbits. There are two main ones:

1. The satellite radiometer looks directly downwards, i.e. the scanning plane is at right-angles to the axis of motion.
2. The orbit is perfectly circular.

The results using this method are reasonably accurate indicating that the errors resulting from these assumptions are quite small. It is also assumed that the observer is not located very close to either the North Pole or South Pole. Errors involved with the measurement of time depend to a large extent on the user. If a suitable method is used, the contribution to the total error is small.

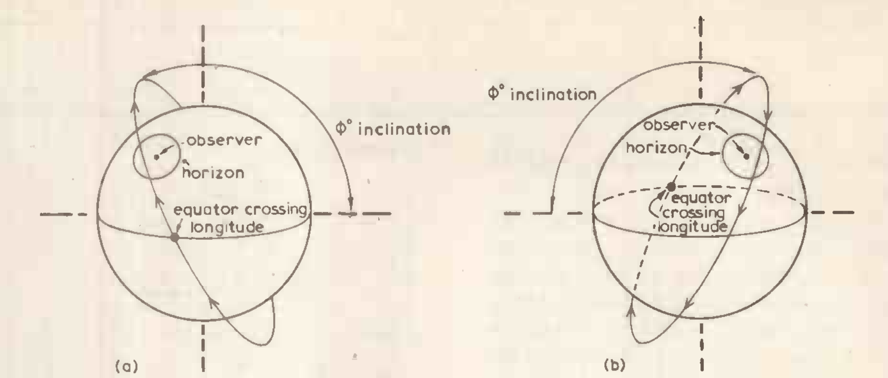


Fig. 3. Ascending (a) and descending (b) orbits shown in relation to an observer.

The two main areas of significant error lie in the identification of a selected point, its transfer to the atlas map and conversion to latitude and longitude. The size of the image has a large effect on the first of these, and the quality of the atlas an effect on the second. Both these errors will be reduced with practice. In order to reduce errors generally it is best to use a point as near to the equator as possible.

Use of a computer

It is very much easier to calculate the result by means of a computer program. This method was developed using Fortran-4 routines on a mainframe computer, but it could easily be implemented on a microcomputer, using Basic. The computer also makes the generation of longer term predictions easier, using a simple looping program based upon parameters and reference orbits obtained from this method. If a computer is used, care must be taken to prevent longitudes from being negative. This was achieved by using Fortran-4 IF statements for results either side of zero longitude. All longitudes were expressed as degrees west.

Conclusions

The results achieved using this method have enabled orbit predictions to be held better than half a minute for a.o.s. The equator crossing longitudes are used by an antenna tracking computer which has also proved most satisfactory. It has been found necessary to update the reference orbit approximately once every two weeks, and the value of period every month. If a greater error could be tolerated, only occasional updating would be necessary.

Acknowledgement. I would like to thank Miss C. Thoburn of the Royal Greenwich Observatory, Herstmonceux, for her ever helpful remarks during the preparation of this article. □

---

continued from page 44

their distortion behaviour close to clipping. Although these questions would be of great interest, they are not discussed as the purpose of this article is only to illustrate the basic theory.

The analysis and measurements show

- a loudspeaker, being reactive by nature, is capable of storing much of the energy it receives from the amplifier.
- this stored energy will be reflected back to the amplifier output terminals.
- the closed-loop output impedance of an amplifier is normally very low, but the open-loop impedance may be several ohms. To damp the reflected signal, feedback will generate a correction signal within the amplifier.
- the signal in the forward path of the amplifier thus consists of two components; the original input signal and the loudspeaker reaction signal, both of the same order of magnitude.
- these two signals may interact in the non-linearities of the amplifier, generating intermodulation products between the two.
- this distortion, termed interface intermodulation, will be most prominent at low frequencies where the loudspeaker reactive load is largest.

Amplifier design rules to avoid interface intermodulation

The output should provide a low open-loop output impedance to adequately attenuate the loudspeaker reaction signal so that the need for a feedback-generated damping is minimized.

Heavy overall feedback should be applied with caution.

- the susceptibility of the amplifier to interface intermodulation can be measured by using a modified difference-tone method, where one of the signals is injected to the input and one to the output of the amplifier. To create conservative worst-case test for this effect, the latter signal may be increased to equal in power the rated output power of the amplifier.

This investigation was performed under a research grant from the Technical Research Centre of Finland and under partial support of Harman/Kardon, Inc. We are grateful to Eero Leinonen for many discussions during the early stages of this work, and Kari Nieminen for performing a part of the measurements presented. Both are with the Technical Research Centre of Finland. Prof. J. Robert Ashley of the University of Colorado, and Robert Cordell of Bell Laboratories are gratefully acknowledged for their constructive expert criticism of an early version of this paper. Several people have also contributed in numerous discussions, notably Leon Kuby and Robert Furst of Harmon International Industries, Inc. and Richard Heyser of the NASA Jet Propulsion Laboratory.

References — 2

Measurement of IIM in commercial power amplifiers, *Radio Gijyutsu*, 1979, pp.164-8 (in Japanese).
Lammasniemi, J. and Otala, M. Power amplifier design parameters and intermodulation distortion in the amplifier-loudspeaker interface, 65th AES convention 1980, London, preprint 1608. Intermodulation distortion in the amplifier-loudspeaker interface. 59th AES Convention 1978, Hämburg, preprint 1336. IIM, ou la distortion dans l'interface amplificateur-en-ceinte acoustique, *l'Audiophile*, no.6, 1978, pp. 23-33. Intermodulationsverzerrungen in dem Verstarker--Lautsprecher-Kopplung, *Funktechnik*, 1979, pp.102-13. □

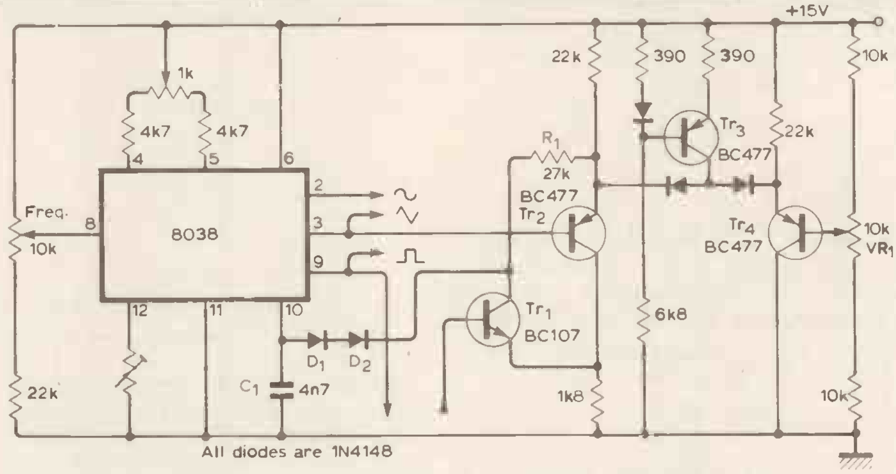
CIRCUIT IDEAS

Waveform gating with the 8038

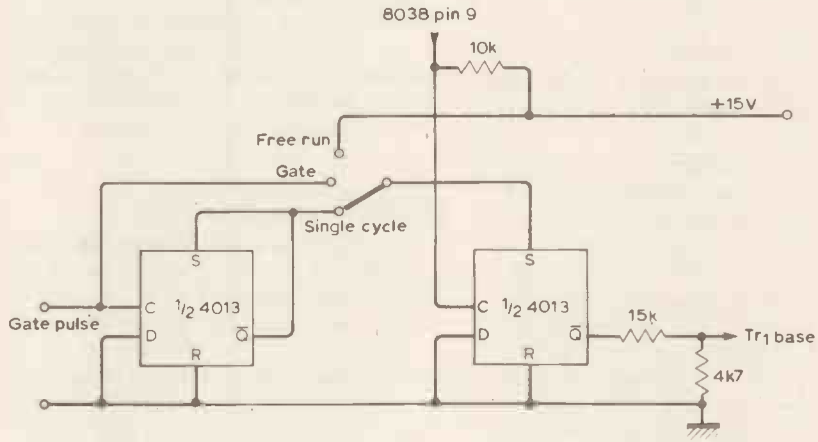
In Fig. (a), Tr_1 to Tr_4 form a unity gain Voltage-follower which prevents oscillation by balancing the positive current source in the 8038, and feeds C_1 with an equal but opposite current from Tr_1 via D_1 and D_2. The voltage-follower is disabled by a gating pulse which removes the bias to Tr_1 and allows its collector to rise about 0.7V above the voltage on C_1. This reverse biases D_1, D_2 and allows normal operation of the 8038.

When the logic enables Tr_1 at the next positive transition of the 8038 square-wave output, D_1 and D_2 are still reverse biased and waveform generation continues until the triangle waveform reaches the voltage set by VR_1. At this point D_1 and D_2 become forward biased and the oscillation stops. In the single-cycle mode, the gating signal produces a short pulse on its rising edge which allows one full cycle of oscillation. Fig. (b) shows a c.m.o.s gating circuit and Fig. (c) illustrates a faster t.t.l. version.

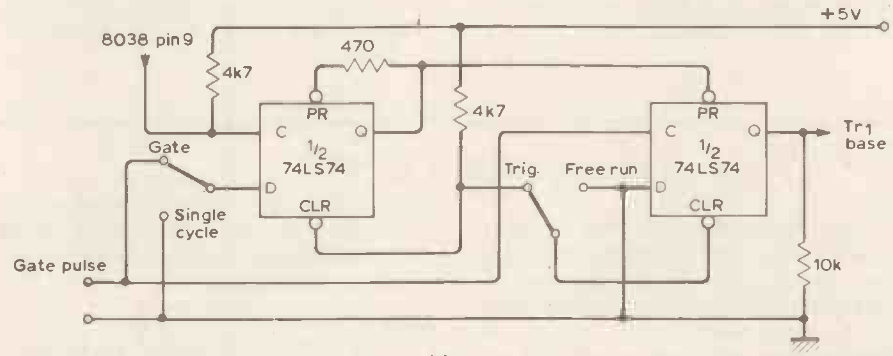
A. J. Strike
Norwich
Norfolk



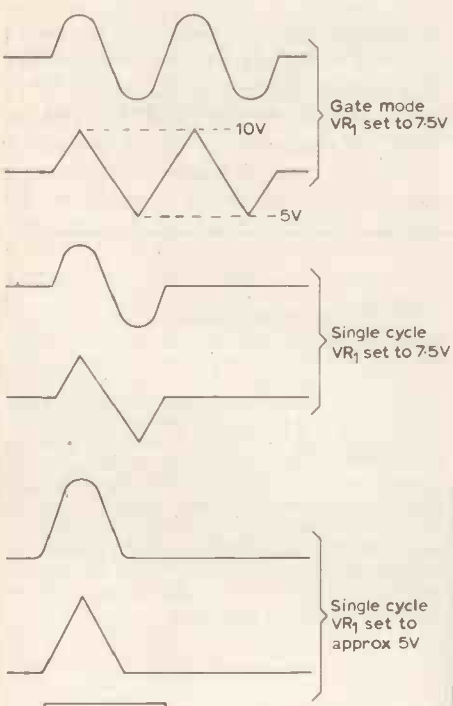
(a)



(b)

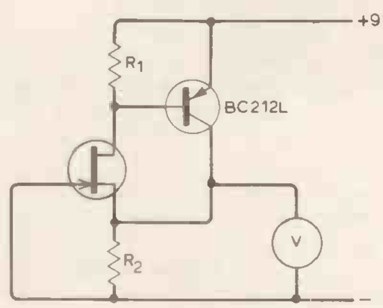


(c)



F.e.t. tester

Because the pinch-off voltages of f.e.ts of the same type vary considerably, it is often necessary to test them before use. This simple circuit reveals the bias required for a given current. Resistor R_1 is chosen to equal $0.6/I$ so that the bipolar transistor provides sufficient current to produce the required bias across R_2, which is measured by a voltmeter. The value of R_2 should be less than the reciprocal of the f.e.t's mutual conductance at zero bias, and for most devices 150Ω is suitable. The meter does not need a high impedance, and for accurate matching, a d.v.m. can be used.

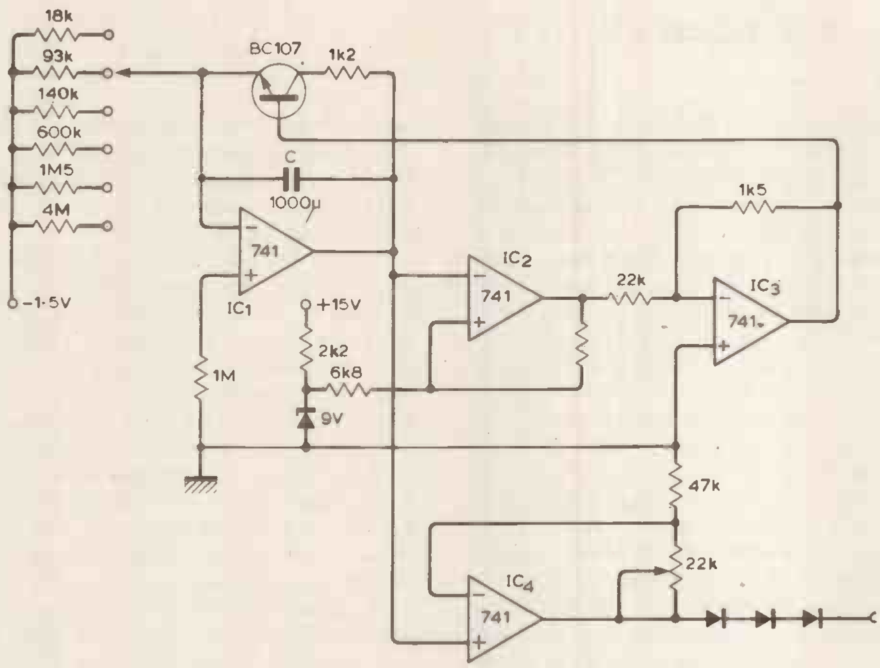


F. N. H. Robinson
Oxford

Time-base generator

Components IC_1 and C form an integrator with time constants controlled by the range resistors. Schmitt trigger IC_2 controls the discharge of C through IC_3 attenuator and the transistor. IC_4 is a buffer with a gain control to change the output amplitude.

H. A. Eassa
Cairo
Egypt



Programmable power supply

continued from page 40

board. The overload latch then sets to zero the input voltage to the output amplifier. The voltage is maintained at zero until the overload condition is cleared and the reset command is received.

Maximum output voltage of the circuit is dependent on the transformer rating and the voltage/current rating of the series pass transistor. The prototype used a 100VA transformer rated at 40V/2A. However, with two decimal digits of programming, the potential output is 99V with suitable modifications.

The current-limit sense amplifier is conventional and allows variation of the trip current with a preset potentiometer. An unusual feature of this circuit is the use of a t.t.l. i.c. in the power-down feedback loop.

A wholly digital interface would permit further improvements in the power supply. For example, if the d-to-a converter is driven by optically coupled devices, and the overload-latch is also optically-coupled, the analogue section of the supply can be electrically floating. This system retains the features of remote programming but does not need complex linearization feedback networks normally necessary in optically-coupled analogue circuits.

A very accurate power supply with four significant digits of programming could incorporate digital correction of the output signal by monitoring the analogue output with a digital voltmeter and comparing it with the programmed voltage present at the d-to-a converter input. The difference between the two values is added to the binary signal to correct the analogue output. Such a system provides very accurate outputs with excellent long-term stability. □

Floppy disc system

continued from page 76

explained in Table 6, two controller commands have to be altered, 1D63 to write the complete track, and 1E47 to delete the attempt to verify the head position after the seek operation, as presumably the track is being re-formatted because it is impossible to verify on that track.

Re-formatting is accomplished by proceeding as with a standard Write operation, giving the start of the block as a source and dummy data, say 1, 1 and 1 for the track, sector and number of sectors. The head should move in, load itself and write the track. After this has occured and the head has released, the computer should be manually reset using the Reset key or, preferably, Control Z. □

Table 7. Sequence for a DRQ interrupt. Note that interrupts can be accepted during LD, SP, HL, in which case the HALT will not be executed, but instructions up to and including LD, SP, HL are always executed unless $\overline{NMI}$ occurs.

(Mode 2 Interrupt)	9½ µs	
IN A,1D	5½ µs	Data read in
CPL	2 µs	Data inverted to true
LD (DE),A	3½µs	Stored in memory
INC DE	3 µs	Move to next location
EI	2 µs	Enable interrupt
LD SP,HL	3 µs	Pull back SP
HALT	2 µs	Halt for interrupt
	30½ µs	

Tone filters for electronic organs

Part 2: design procedure and practical problems

by C. E. Pykett B.Sc., Ph.D.

This article derives frequency responses of tone filters for four organ tones, whose acoustic spectra were given in part one. It completes the design procedure, discusses the number of filters needed per stop and the combining of tone colours, and various other practical points.

The frequency response of the required filter is obtained by subtracting the sawtooth spectrum from the relevant organ pipe spectrum. In practice this merely means that the numbers in Table 2, representing the individual harmonic amplitudes, are subtracted one by one from the corresponding numbers in Table 1. The resultant four series of values are presented in Table 3, and graphically in Fig. 5. (In all cases the frequency response is represented on a scale that does not indicate absolute frequency but is normalized to the frequency of the first harmonic or fundamental of the original spectra. To implement a real filter circuit one needs to first convert the frequency scale back to true frequency values, which immediately begs the question of which design frequency is chosen for the filter, a subject treated later.

Also shown in Fig. 5 by the full lines are the frequency responses of four actual filters intended to simulate the frequency responses suggested by the discrete points on the four graphs. (The circuit diagrams of these filters are given in Fig. 6 and they are more fully discussed later.) It is, of course, permissible to draw the frequency response of a real filter as a continuous curve as the filter has a defined gain/loss at all frequencies in contrast to the experimentally derived points of Table 3, which exist at harmonic frequencies only. An additional feature in Fig. 5 is the presence of broken lines corresponding to Bode plots used in the filter design process. This is discussed later, but for the present a short qualitative discussion of the form of these responses follows as this leads naturally onto filter implementation. It is necessary that the reader is familiar with the amplitude versus frequency response of simple filter sections and (where appropriate) their equivalent Bode plot representations. Particularly important are first, second and third-order passive RC networks, and parallel resonant (LC) sections.

The claribel flute filter is characterized by a rapid increase in attenuation for the first six or seven harmonics, Fig. 5(a), after which the attenuation remains roughly constant at about 35dB below the value at the fundamental frequency. After the 15th harmonic no further experimental data are available. The nature of the experimental points in this diagram shows why flutes are among the most difficult tones to emulate. It is difficult to discern a simple trend from the available information, though an interesting feature is that the attenuation at the first few even harmonics is consistently higher than at the adjacent odd harmonic frequencies. This suggests that the flute stop in question consisted of

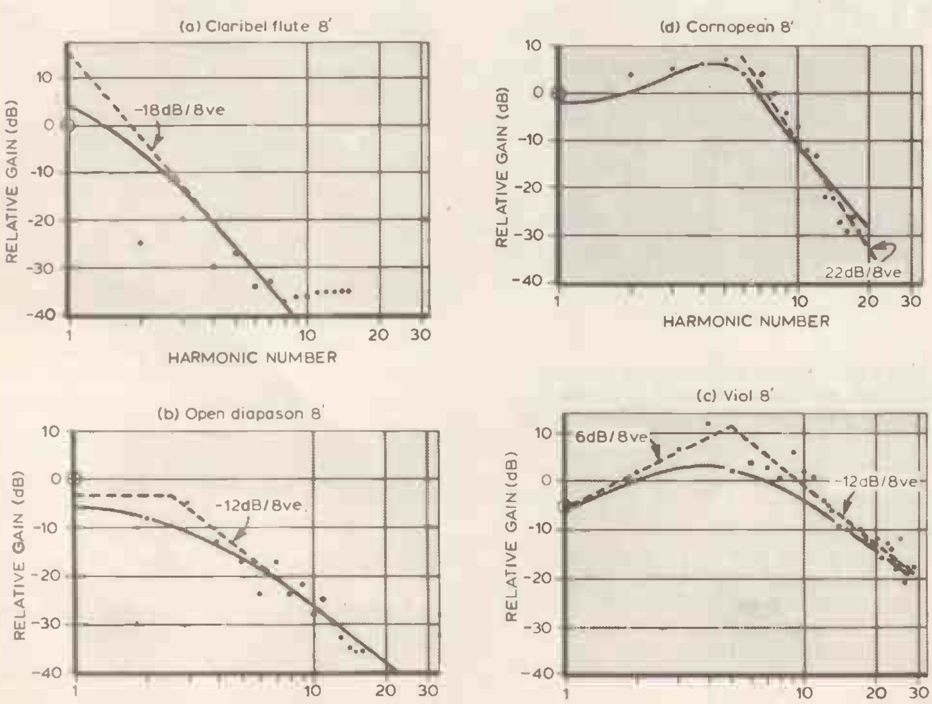


Fig. 5. Filter frequency response curves for the tones in Fig. 2. Dots represent values of the required response at the harmonic frequencies as in Table 3. Full lines are measured frequency responses of actual filters, broken lines are Bode plots. Responses calculated assuming a sawtooth driving waveform.

Table 3. Normalized frequency responses in dB of tone filters for four organ tones assuming a sawtooth drive waveform corresponding to Fig. 5.

	organ stop name			
harmonic	claribel flute	open diapason	viol	cornopean
1	0	0	−5	0
2	−25	−8	2	4
3	−20	−5	7	5
4	−30	−13	12	6
5	−27	−17	2	7
6	−34	−24	4	4
7	−33	−17	3	4
8	−37	−24	1	0
9	−36	−22	6	−4
10	−36	−28	2	−7
11	−35	−25	1	−12
12	−35	−30	−4	−13
13	−35	−33	−6	−22
14	−35	−35	−9	−22
15	−35	−36	−10	−27
16	–	−36	−10	−29
17	–	–	−10	−26
18	–	–	−12	−29
19	–	–	−13	–
20	–	–	−12	–
21	–	–	−16	–
22	–	–	−13	–
23	–	–	−14	–
24	–	–	−18	–
25	–	–	−12	–
26	–	–	−21	–
27	–	–	−18	–
28	–	–	−18	–
29	–	–	–	–
30	–	–	–	–

stopped pipes, though it was not possible to confirm this by an examination of the interior of the organ. Whilst a stopped construction is unusual for claribel flutes, this assumption enabled a filter response to be chosen that was based on the first four or five odd harmonic frequencies only; even harmonics were ignored. This filter consisted of a third-order passive RC network whose breakpoint was the fundamental frequency. Driven with a sawtooth wave, a reasonably satisfactory flute resulted though the effect when using a square wave was not satisfactory. (This is at odds with the strong suggestion from the filter response that odd harmonics ought to predominate.) It seems that the relative proportions of odd to even harmonics are critical for flutes, and experiments with other filter configurations in which particular harmonics were selectively reinforced confirmed this. The simple filter just described makes no attempt to emulate the part of the frequency response suggested by frequencies above the tenth harmonic. Even though such high-order structure may be crucial to the production of a good flute tone as previously discussed, it was found difficult to derive a straightforward way of doing this that also yielded subjectively good results.

Turning now to the open diapason, the response fits a second-order Bode plot very nicely, with the break point occurring at a frequency equal to 2.6 times the fundamental. The actual response of such a filter (full curve) fits the experimental points well, with only a few reaching a maximum divergence of 6dB. Subjectively this simple diapason filter produced entirely acceptable and realistic sounds that were hard and bright rather than dull and woofy. A complete diapason chorus, from a 16-foot double diapason to a three-rank mixture, was built up using a total of 32 such filters and the effect had something of the tonal excitement of a similar flue chorus on a pipe organ.

The experimental points for the viol filter suggest a bandpass characteristic, and they are again well approximated by the Bode plot illustrated in the diagram. This consists of a 6dB/octave rise changing to a 12dB/octave fall, the transition between the two being at the fifth harmonic of the fundamental. Such a filter has the true response indicated by the full curve. The subjective verdict on this filter was again favourable, though it was too stringy for some tastes. This is possibly due to the fact that this filter was derived from Boner's data[2], in which measurements were made in a free field with the microphone close to the pipe. In an organ, a viol rank would be placed well inside the organ case and almost certainly inside a swell box (a large box equipped with movable shutter to enable the volume to be varied). Therefore significant high frequency attenuation would result, with the tone of ther pipe sounding less stringy to a listener in the auditorium.

Finally, the cornopean data are again strongly suggestive of a bandpass characteristic. In this case the filter was implemented using a parallel resonant circuit

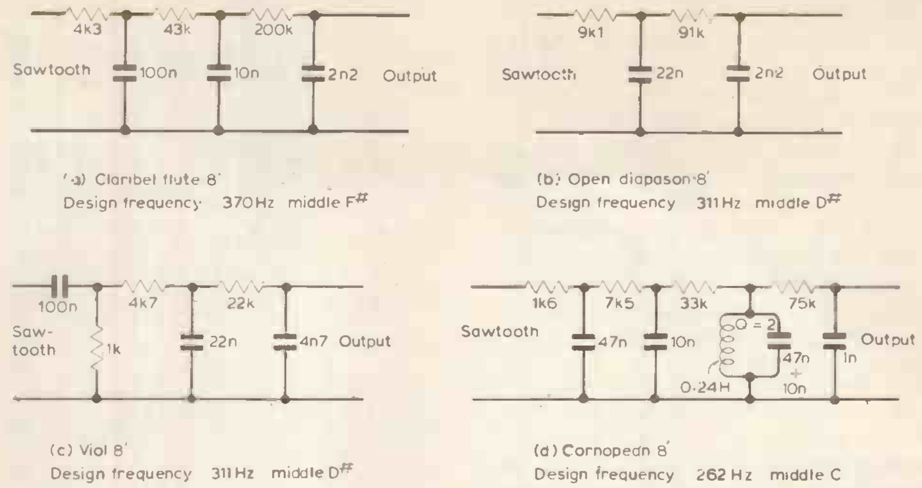


Fig. 6. Filter circuits giving the frequency responses of Fig. 5. Inductor in (d) can be realised electronically.

tuned to the fifth harmonic with a Q of about 2. To achieve the asymmetry of the response, which rapidly falls above resonance, a third-order RC filter was also used breaking at the eighth harmonic. The reasons for using this particular bandpass filter configuration instead of one akin to the viol are given in the next section. For the present the actual response is seen to fit the experimental values closely. The effect of this filter was a convincing bright reed tone, definitely typical of a cornopean or a trumpet rather than of a close-toned tromba or tuba. Again, a family of such filters was built with worthwhile results. The unique tone of an organ reed pipe seems, in part at least, to be due to an harmonic structure that is relatively constant in amplitude up to an harmonic order between the fifth and tenth, depending on the particular tone. After this frequency the amplitude falls off rapidly; this falling characteristic is reflected in the filter response. It is therefore essential to copy the "asymmetrical resonance curve" of the filter, as without the rapid attenuation above resonance the effect is completely synthetic and quite unlike the original.

Hardware realisation

Filter response need not be matched exactly to the calculated values at each harmonic frequency of the driving waveform. These points originate from experimental measurements in which a large number of variables, most of them uncontrollable, affect the results such that divergences of a few dB can be neglected provided they are random rather than noticeably systematic.

Flue pipe tones can nearly always be well approximated by the use of a simple passive RC filter

- flutes generally need a third-order lowpass system
- diapasons generally need a second-order lowpass system
- strings generally need a bandpass system.

Circuit examples of these types of filter are given in Fig. 6(a), (b) and (c).

Reeds can nearly always be well approximated by implementing the asymmetrical bandpass characteristic previously described. It is usually found that the Q of the hump in this bandpass is significantly greater than unity for reeds, whereas for strings (which also require a bandpass) the Q tends to be less than this. Therefore, whilst a simple RC passive bandpass filter can be used for strings as noted above, a resonant circuit or its equivalent is usually necessary for reeds. If a parallel LC circuit is used, as in the example in Fig. 6(d), the rapid rolloff on the high frequency side of the resonant peak can be achieved by using an additional passive RC network. In Fig. 6(d) this network is of third order.

The majority of organ tones are best derived from a sawtooth wave, or one that has both odd and even harmonics. However, there are some important exceptions where a waveform containing only the odd harmonics (e.g. a square wave) is preferable if not actually essential. A partial list of stops where odd harmonics predominate might have names such as stopped diapason, lieblich gedackt, bourdon (all stopped flue pipes), and clarinet, vox humana, cromorne (reed pipes with cylindrical resonators).

These design guidelines just given apply to the filter circuits in Fig. 6. For flue pipe tones, the Bode plot of an appropriate passive network is first matched to the experimental points and then the corresponding filter is implemented. This procedure requires a certain amount of experience and judgement; for the first example turn to the open diapason frequency response in Fig. 5(b). The Bode plot best suited to the experimental data appeared to be a second-order system in which there is first a horizontal line (zero slope) followed by a line of slope −12dB /octave. The breakpoint is the frequency at the point of intersection of the two line segments. The −12dB/octave part of the response was drawn so that it fitted the slope of the experimental data as well as possible as judged by eye, then the breakpoint was adjusted bearing in mind that the actual response at this frequency will be 6dB less in amplitude. A breakpoint of 2.6 times the fundamental frequency resulted. The frequency response of the filter is given by the full line in Fig. 5(b) and Fig. 6(b) gives the circuit. This corresponds to the particular form of the Bode plot in that the two sections have the same time constant (RC product) and they are arranged such that they do not mutually load each other. (It is usually possible to avoid buffer amplifiers by choosing the component values to avoid mutual interaction). The circuit was designed for a fundamental sawtooth frequency of 311Hz, so that each section has a time constant of

$$RC = \frac{10^6}{2\pi \times 311 \times 2.6}$$

where R is in kohm and C in nF. The question of how to choose the design frequency of the filter is deferred until later as it raises some important practical issues.

The flute filter of Fig. 6(a) was designed in exactly the same way, though in this case the frequency response data of Fig. 5(a) offered less precise guidance as to the form that the Bode plot should take. A third-order system was used, matched to the first few odd harmonics for the reasons stated previously. The three time constants were again equal and the three RC sections were again buffered. The breakpoint was chosen to be the fundamental frequency which in this case was 370Hz. There would have been little point in using a breakpoint lower in frequency than the fundamental; this would merely have resulted in greater overall insertion loss with little effect on the tone quality.

For the viol frequency response, Fig. 5(c) there were two segments clearly indicated, forming a Bode plot with slopes /z6dB/octave and –12dB/octave. The breakpoint turned out to be at the fifth harmonic. This is a simple bandpass filter formed from three RC sections in which one is highpass and the other two lowpass. The particularly simple form of the Bode plot means, again, that the time constants are all equal and that the sections must not interact. Such a circuit is shown in Fig. 6(c) and was designed for optimum operation at 311Hz.

Reed tones generally require bandpass characteristics with Qs not less than 1.5 and often more, which implies the use of circuits such as LC resonant sections. The higher the Q, the more "reedy" the tone and the smaller the frequency range over which the circuit is effective. A Q in excess of three or four is seldom required for the imitation of organ reeds. The cornopean frequency response in Fig. 5(d) has a clearly defined resonance peak at the fifth harmonic, and a Q of about 1.5 is implied by the locus of the experimental points below resonance. To achieve the rapid attenuation above resonance, an additional rolloff of about –22dB/octave starting at the eighth harmonic is also indicated. This result was obtained after a certain amount of juggling with ruler and pencil on the original graph points. The filter constructed used a resonant circuit with a Q of 2 rather than 1.5 because it sounded better and a –18dB/octave rolloff instead of

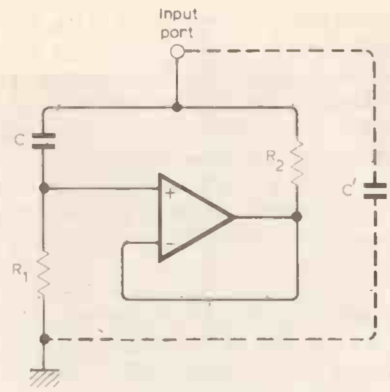


Fig. 7. Simple electronic inductor realisation using op-amp where C' is the tuning capacitor.

–22dB/octave, for practical reasons. A version of this circuit designed for a 262Hz sawtooth is shown in Fig. 6(d), and its frequency response is the full curve in Fig. 5(d). The first two and the final RC sections produce a slope of –18dB/octave at the eighth harmonic, and the central LC section is responsible for the resonant characteristic. A parallel tuned circuit has to be driven and terminated so that its Q is not significantly affected by the adjacent circuitry. The terminating impedance can simply be a sufficiently large resistor which in this case is also used as an element of one of the low-pass sections. The source resistor feeding the resonant circuit must then be chosen according to the following conflicting criteria. It must not appreciably load the preceding RC section nor must it reduce the Q of the resonant circuit. Hence its value must be as high as possible. The insertion loss of the complete filter is influenced by the value of the source resistor because the effective resistance of the LC section at resonance equals Q^2R, where R is the equivalent resistance of the inductor. Hence the source resistor and the LC section itself form a potential divider that controls the amount of signal handed on to the rest of the circuit. For this reason the value of the source resistor should be as low as possible.

The circuit in Fig. 6(d) thus contains a certain amount of compromise, though mainly in the interests of economy. If total component cost is of no account, the various sections of the filter can be buffered using active devices thereby easing the design process. Such a course seems scarcely worthwhile when it is possible to approximate to the desired response as well as is indicated by Fig. 5(d).

In the interests of simplicity it had been implied that the resonant circuit was constructed with a wound inductor. This was not the case since an electronic inductor was synthesized using a simple circuit, Fig. 7. The advantages are that the filter can be readily adjusted until a subjectively optimum effect is produced; it is much cheaper than its wound counterpart, consisting only of two resistors, a small capacitor and a cheap operational amplifier; and it is much less bulky.

Design equations are as follows:

$$L = \frac{QR_2}{2\pi f}$$

where f is the resonant frequency

$$C = \frac{L}{R_1R_2}$$

(Suitable values for R_1 and R_2 are 82Ω and 1Ω respectively.) The value of the parallel capacitance C required to tune the circuit to f is

$$C' = \frac{1}{4\pi^2 f^2 L}$$

The final version of the cornopean filter using an electronic inductor based on the above is in Fig. 8.

Qualitatively at least, Fig. 5(d) is suggestive of a Q-enhanced Sallen and Key active filter response, though in practice this alone would not achieve the rate of attenuation required above resonance and additional sections would be required. Nevertheless, the use of this type of circuit is a distinct possibility instead of the parallel LC circuit used, and design information is available from many sources for those wishing to experiment. Linsley Hood[6], for example, describes a related system for achieving high frequency pre-emphasis in his cassette recorder instead of using coils.

How many filters per stop?

A single tone filter, implemented at one design frequency, will not produce the same tonal effect across an entire keyboard which (in the case of five octaves) might represent a frequency range of 32:1. Yet there is evidence in favour of using single filters when cost is paramount: the single filter approach often produces subjectively reasonable results. In my experience this statement is true for flue pipe tones that

6. Linsley Hood, J.L. Low-noise, low-cost cassette deck, Wireless World May, June & August 1976 and Feb. 1978.

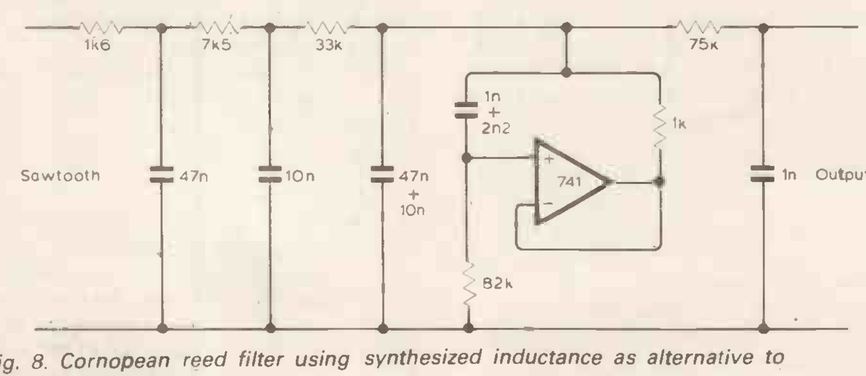


Fig. 8. Cornopean reed filter using synthesized inductance as alternative to circuit of Fig. 6(d).

are simulated using simple low-pass filters (flutes and diapasons), where an effective range of three or four octaves can be obtained without difficulty. Beyond this, these tones begin to sound unnaturally stringy in the bass and too characterless in the treble, and in addition there is an overall reduction in amplitude when going from low to high frequencies. This last problem can be mitigated by grading the isolating resistors that are nearly always found in the keying system.

There are two reasons why a single low-pass filter has such a large effective frequency range. First, it is easy to show that if the filter characteristic and the source waveform spectrum both approximate to linear slopes, not necessarily numerically identical, over a sufficiently large frequency range then the relative harmonic proportions in the output signal remain constant over this range. There is also an overall amplitude variation that can be dealt with as previously described. These approximations are valid for the claribel flute filter and the sawtooth spectrum already discussed, and also for the open diapason though to a lesser extent. The second reason why a single filter is usable in these cases is that to achieve a uniform acoustic output, the pipes in a real diapason or flute stop are scaled so that they have a relatively larger proportion of higher order harmonics in the bass than in the treble. This effect is the same as that produced by driving a single flute or diapason type filter over a wide frequency range.

With other tones (strings and reeds) an effective range of only two octaves or less is usual because of the more selective frequency response of the filter networks. Beyond this range the effect is artificial, particularly in the bass, where the stops sound "sizzly" and thin. There is little that can be done in these cases except to use multiple filters for each stop, each one designed to operate over a particular segment of the keyboard. The limiting extreme, of course, is to employ one filter per note, a tour-de-force that has certain advantages in spite of the enormous component count. The advantages stem from the ability to regulate the tone quality and loudness on a note-by-note basis, and the audible "breaks" between filters that can be troublesome when a lesser number is used do not exist. However, entirely ade- quate results can be achieved using different filters for each half-octave; indeed even this is usually an overkill. I have built a classical instrument of 36 speaking stops, all of which employ only four filters and the result is most satisfactory, especially with regard to such features as the sound of reed choruses at the bass end of the keyboard. The method used to combine the outputs of the filters comprising one stop is illustrated in Fig. 9. Each is terminated in a resistor R′ that can be used to regulate its amplitude. Judicious variation of the relative amplitudes is useful in hiding the breaks between each pair of filters, yet another psychoacoustic feature of the auditory system that works in our favour. Overall gain variation is provided by making part of the negative feedback resistor R variable.

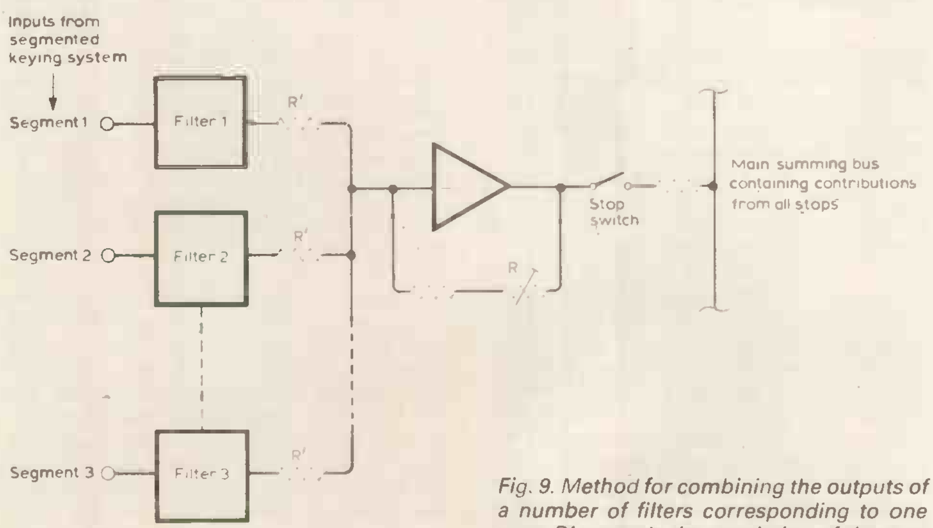


Fig. 9. Method for combining the outputs of a number of filters corresponding to one stop. R′ controls the regulation of the stop across the keyboard, R controls the overall amplitude of the stop.

More practical points

All of the filters discussed here must be driven from a low impedance source, in practice a few tens of ohms, and terminated in a high impedance, at least five times greater than the impedances involved in the final stage of the filter. Straightforward operational amplifier techniques are suitable here.

A pronounced change can be imparted to particular tones if only one or two harmonics are selectively augmented. For example, increasing the level of the third harmonic in the claribel flute Fig. 2(a) changes the tone to that of quite a good lieblich gedackt. Similarly, diapasons and flutes can be distinctly brightened by augmenting the second harmonic. In each case this can be done by borrowing the appropriate sawtooth wave from the multiple keying system that usually exists in which several frequencies are switched simultaneously for each note. The additional frequencies are combined in the filter simply by providing more input resistors, as in Fig. 10. This shows the claribel flute filter together with an additional input which is supplied with a sawtooth wave at the same amplitude as the existing one but at three times the frequency, i.e. at the interval of a twelfth above the note being keyed. The twelfth corresponds to 2⅔′ in footage nomenclature if the stop is of eight foot pitch. Three points to remember:

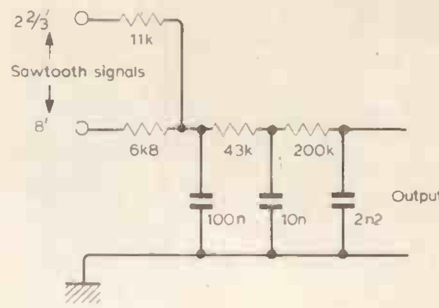


Fig. 10. Converting the claribel flute into a lieblich gedackt by augmentation of the third harmonic.

–It is important that the impedance of the sawtooth wave sources should be low, otherwise incorrect summation will result.

–The parallel combination of the various input resistors must approximate to the resistance calculated for the original filter.

–It is not necessary that the frequency relationships between the fundamental and the augmented harmonics be mathematically exact. This makes it possible to borrow the required harmonics from an equally-tempered tone generating system. Such borrowing can only be done to a limited extent; some intervals will be grossly out of tune, though in the case of the twelfth the effect is not serious. For all octavely related intervals, of course, this is irrelevant. A certain amount of trial and error is required to achieve the desired results by this means.

Many organs use a single generator system from which all tones are derived. This means that all stops of the same footage are fed with the same waveform when a given key is depressed, and the various signals emerging from the tone filters are then usually electronically recombined before being amplified and fed to a loudspeaker system. Take care that filters do not introduce inadvertent phase shifts due to the indiscriminate use of inverting amplifiers within the filter itself. Such amplifiers might have been used for buffering purposes. Without first designing the tone forming system as a whole and taking account of detailed points such as this, the ability to add stops one to another will be adversely affected. Buffers are therefore best implemented using non-inverting amplifiers, for example, voltage followers. The problem of combining tone colours is further considered below.

The construction of analogue filter circuits for most purposes usually involves close-tolerance components, and the free use of resistors from the E24 range in the tone filters illustrated in these articles might imply that the same applies in this case. These values were used simply because they were available; for most purposes resistors from the 5% E12 range should be adequate. Capacitors in active filters, e.g. the synthetic inductor circuits, should be at least 5% but elsewhere 10% should prove satisfactory. The object is not to produce a highly precise scientific instrument but to reproduce musical effects in a context where 3dB in amplitude (around 30%) is fortunately of little significance.

Combining stops

Regardless of deliberately introduced phase inversion filters normally produce a certain amount of phase shift, usually frequency dependent. With a common generator system, in which the same waveform is split into several paths through various filters before being recombined and amplified, there is bound to be a degree of emphasis or attenuation of particular harmonics in the final signal. This has the practical effect that the result of adding stops will be the production of a composite sound that is not necessarily the subjectively expected result of adding the individual tone colours. The effect is most noticeable for stops of the same footage, and if the problem is troublesome then various remedies can be used. The best technique is to have a multi-rank generator system in which there are as many ranks as stops that are likely to be combined. The various ranks are not phase locked to each other but must run independently. Whilst there are various technical problems inherent in this approach, not to mention cost, the chorus effect of the result can rival that of a pipe organ and it is worthwhile if economics allow. The other method, less effective but still expensive, is to retain a single generator system but only allow recombination of the filter outputs to occur acoustically through the use of a multiplicity of sound channels. Electronic "chorus" can also be judiciously applied to each channel to enhance the effect.

The combining problem is sometimes exaggerated, and a cost-effective compromise is obtainable at minimal expense simply by applying a few artistic guidelines when developing the specification (stop list) of a new instrument. In normal pipe organ registration, that is the art of selecting stops to achieve a particular tonal effect, it is preferable to minimize the number of stops of the same footage that are used. Even with the pipe organ, which has the ultimate in chorus effects owing to its huge variety of non-synchronized tone sources, it is inartistic to pile tone on tone when one or two carefully chosen stops would suffice. When major tonal build-ups are required, this should be achieved by adding stops of different footages, and exactly the same guidelines apply to an electronic organ of whatever sort though particularly if it only has a common generator system. In this case, the addition of a 4′ stop to an 8′ one introduces a new harmonic series that only interferes, in the technical sense, with half as many harmonics in the basic 8′ tone as would be the case if a second 8′ stop had been added. The resultant tone is much more realistic in general. The only expense involved in following this principle is that the single generator rank has to be extended upward by the appropriate number of octaves to cater for the extra upperwork present in the stop list, and the keying system is also made correspondingly more complex.

It might be thought that adjustable filters can be used in the filter design process to quickly arrive at a subjectively satisfactory result simply by twiddling knobs. A useful configuration, it might be argued, would be a resonance filter module as used in synthesizers in which the tuned frequency and Q are independently variable through the use of state-variable techniques. This approach has been eschewed as it represents a return to the total empiricism that negates the design methodology outlined. If it is possible to calculate a frequency response, then the starting point should be a filter that approximates this response in a reasonably cost-effective manner. This does not disallow small changes to the prototype circuit to secure a better result, but too much dabbling will quickly lead the ear in a false direction that becomes all too obvious if an A-B comparison is subsequently attempted. If it is impossible to achieve a satisfactory simulation of the desired sound, then the original experimental data should be suspected as being unreliable, and an attempt to obtain new data should be made. □

Audio gain controls – corrections

In Part 1 of this article by Peter Baxandall in the October issue, the figure shown as 2 in the p. 59 footnote should be $\sqrt{2}$. In Fig. 16, the secondary of the microphone input transformer should, of course, be connected to the control-grid of the valve. In Fig. 1 caption "Two small gain controls" should read "Two simple gain-control arrangements". Fig. 3 caption should read "Dotted line shows noise variation . . . .". Fig. 6 caption should end " – varying emitter resistance and varying collector load resistance." For "equivalent" in Fig. 8 caption read "approximately equivalent". The caption given for Fig. 14 is, of course, equally applicable to most of the other circuits! The Fig. 15 caption should read "Curves showing calculated performance of Fig. 14 circuit for two values of R_b". The simplified circuit diagram of the BBC OBA9 microphone amplifier shown in Fig. 17 should have been acknowledged as taken from "Studio Engineering for Sound Broadcasting" by J. W. Godfrey. BBC Eng. Training Manual, pub. by Iliffe & Sons, 1955.

Literature received

Intelligent v.d.us, namely the BH912 and BH920, are the subjects of two new publications which are available on request from Burnt Hill Electronics. They illustrate the terminals and provide data on operating features, together with keyboard layouts and dimensions etc. Burnt Hill Electronics, Holder Rd, Aldershot, Hampshire GU12 4RH.

A folder containing a selection of data sheets on **analogue monolithic i.cs** has been sent to us by Pascall. Analog Systems, who manufacture the products described, seem to specialize in making devices with "out of the ordinary" specifications such as an audio op-amp with a t.h.d. of typically 0.0002% and a wide-band op-amp with a 1.5GHz gain bandwidth product. Application notes are included on the sheets and some of the other products available through this distributor are described on the actual folder. Price list and "short-form" data list were also included in the package. Pascall Electronics Ltd, Hawke House, Green St, Sunbury-on-Thames, Middx TW16 6RA.

Full data for the range of fixed frequency and tunable **quadrature oscillators** manufactured by Frequency Devices Inc. is available in catalogue form from their UK representatives, Lyons Instruments Ltd. A series of modular power supplies is also described in the catalogue which is available free of charge from Lyons Instruments Ltd, Hoddenson, Herts.

Twelve articles are included in volume eight of the series of Chromatography Newsletters from Perkin-Elmer Ltd. These regular publications feature articles on advanced technology applications in both **liquid and gas chromatography**, the latest of which can now be obtained from Perkin-Elmer Ltd, Post Office Lane, Beaconsfield, Bucks, at no cost by requesting order number CHN-15.

Solid-electrolyte **tantalum chip capacitors** for use in hybrid circuits are described in an "Engineering Bulletin" received from Hy-Comp Ltd. This two-page leaflet gives full data for the Type 194 Midget series and is available from Hy-Comp Ltd, 7 Shield Rd, Ashford Industrial Estate, Ashford, Middx TW15 1AV.

Details of Evershed & Vignoles' **stepping motors** based on three different design principles, namely permanent magnet, variable reluctance and hybrid types, are given in a six-page brochure. Specifications provided include holding torque, maximum pull-out torque, no-load pull-in rate, rotor inertia and physical dimensions. The company's range of unipolar RL and bipolar chopper drives are also described in the brochure, copies of which are available from Evershed & Vignoles Ltd, Acton Lane, Chiswick, London W4 5HJ.

Commodore have provided us with a package which gives comprehensive information not only on their range of personal and business **computers** but also on **software**, microcomputer **training courses** and seminars, and the Pet users' club. One of two "newspapers" included was the first issue of Microcomputers in Schools and Colleges which, although obviously Pet biased, should provide useful information to teachers and lecturers who are thinking of acquiring a computer for use as a teaching aid. Commodore Information Centre, 360 Euston Road, London NW1 3BL, for details.

Take a leaf out of our book.

Or better still send for the complete works.

Our main illustration shows just one page from Feedback's new Test Instruments Catalogue: a comprehensive guide to the ten test instruments in the renowned '600 Series,' comprising function generators, variable phase generators and measuring instruments, together with another six instruments which also provide the kind of performance and reliability that is synonymous with the Feedback name.

All Feedback test instruments put an emphasis on high performance and value for money, are rugged and reliable, and carry an unconditional two-year guarantee. Complete the coupon and this important new book is free for the asking.

Please send me my free copy of the new Feedback Test Instruments Catalogue

Name

Position

Company

Address

Telephone

WW12

Feedback Instruments Limited, Park Road, Crowborough, Sussex. Telephone (08926) 3322

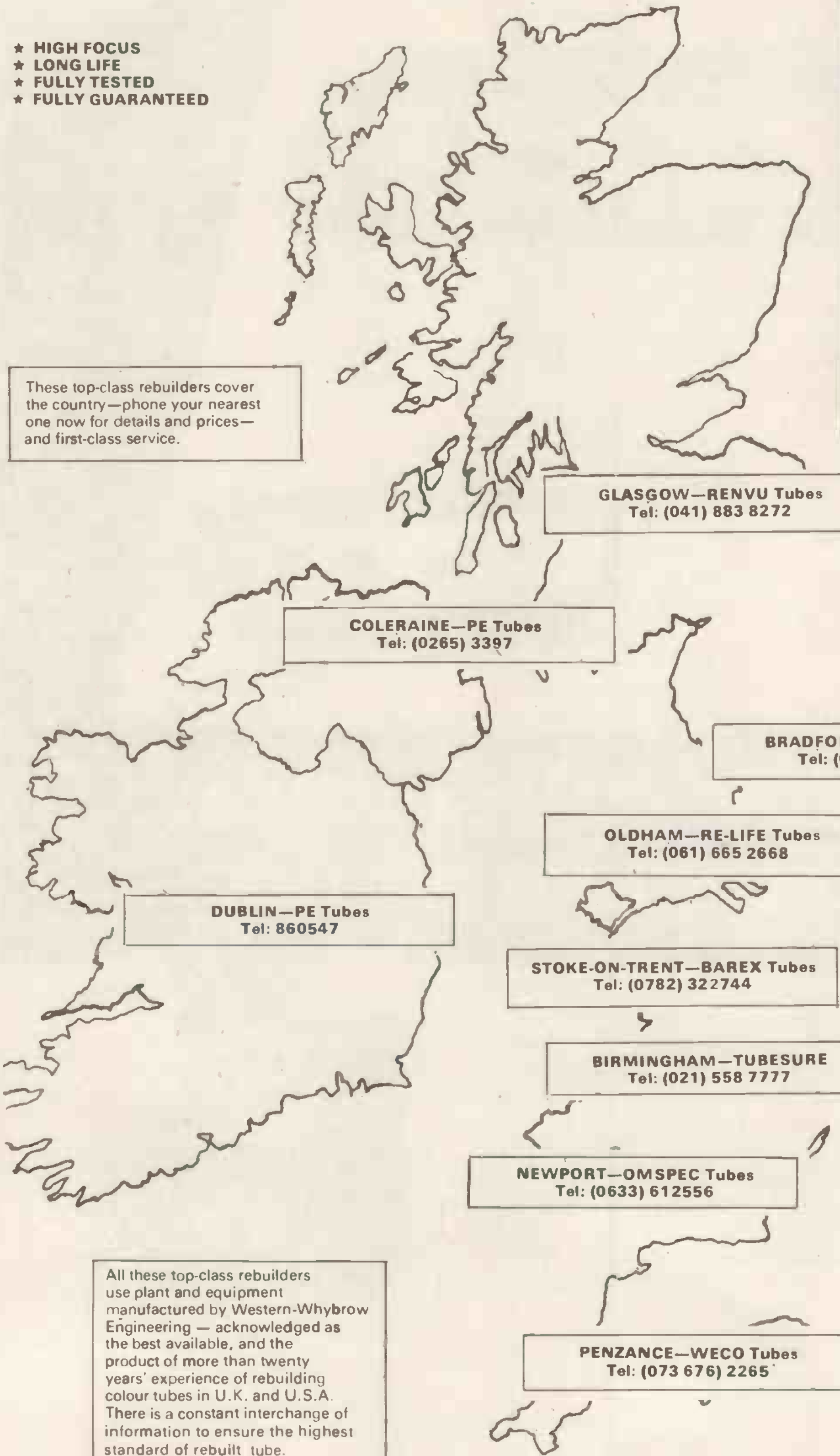
FEEDBACK

TOP QUALITY REBUILT TV TUBES

Rebuilt on the most modern equipment to original manufacturers' specifications

★ HIGH FOCUS
★ LONG LIFE
★ FULLY TESTED
★ FULLY GUARANTEED

These top-class rebuilders cover the country—phone your nearest one now for details and prices—and first-class service.



All these top-class rebuilders use plant and equipment manufactured by Western-Whybrow Engineering — acknowledged as the best available, and the product of more than twenty years' experience of rebuilding colour tubes in U.K. and U.S.A. There is a constant interchange of information to ensure the highest standard of rebuilt tube.

Developments in air traffic control

Royal Signals and Radar Establishment looks ten years ahead

An expected huge increase in the number of aircraft using UK airports and airspace (between 50% and 100% over the next two decades) would overload existing air traffic control equipment and procedures to an impossible degree, causing greatly increased delays in handling aircraft and consequent increases in fuel consumption and engine hours. The kind of display a controller uses means that he needs to carry some kind of mental picture of the position, height and direction of flight of many aircraft and attempt to predict the situation as far ahead as possible. Currently, two to three minutes is as far as he can go.

Since the late 1960s, the Royal Signals and Radar Establishment at Malvern has been working on several projects to alleviate the pressure on controllers. On behalf of the Civil Aviation Authority, scientists at RSRE have evolved a system known as ADSEL, which is Address-Selective secondary radar. They also have some novel ideas on ways to avoid aircraft being inadvertently directed to fly too close to each other, and on methods of smoothing out the flow of traffic on arrival at and departure from airports.

ADSEL

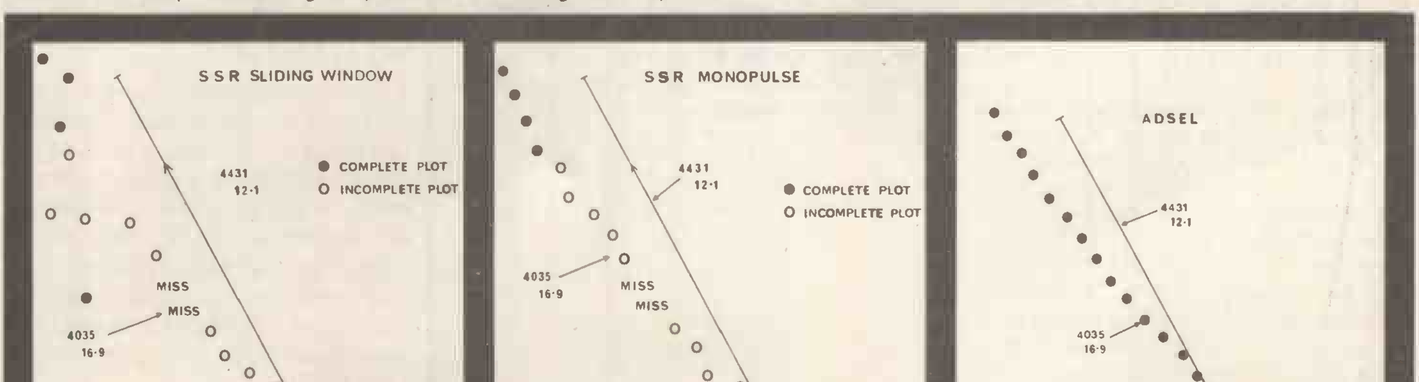
For many years, secondary surveillance radar has been the mainstay of air traffic control. Its shortcomings have been accepted in the past, but a growth in the number of aircraft may make it unacceptable: ADSEL is suggested as an alternative.

Secondary radar relies on the aircraft under control carrying a transponder, which receives pulses from the ground at 1030 MHz when the aircraft is in the beam, and immediately responds with a series of pulses at 1090 MHz to form a 12-bit code for identification purposes. (In primary radar, the transmitted pulse is reflected from the aircraft which, incidentally, necessitates a much more powerful ground transmitter.) During the time the aircraft is in the beam, it receives and responds to around 30 interrogations. Range is easily measured, since it corresponds to the time taken for the aircraft's response to be received, or the distance from the centre of the controller's plan position indicator (p.p.i.) tube to the brightened-up, coded group of responses. Bearing is more difficult, since the group of responses is as wide as the beam, and is undertaken by a computer plot extractor, which attempts to find the 'centre of gravity' of the group by a 'sliding-window' technique. In a perfect set of replies, the centre would be aligned with the aircraft and would correspond to the bearing, but missed responses would mean that the plot extractor would determine a false 'c.of.g.' and give a wrong bearing, or even misread the imperfect set as two aircraft.

Missed responses, perhaps due to the aircraft banking and obscuring its aerial or trying to reply to two ground stations and not succeeding with either, are not the only problem. If two aircraft are on roughly the same bearing and are at about the same slant range from the transmitter, their groups of replies overlap, rendering them unreadable, or 'garbled'. There is also the condition known as 'fruit', which is the reception at the ground station of replies to interrogation by other transmitters. These are not synchronous and are not, therefore, as serious a fault as garbled replies but, nevertheless, constitute a lowering in readability of the display.

ADSEL, which is being developed in parallel with a very similar American system, called Discrete-Address Beacon System (DABS) because the Americans refer to s.s.r. as 'beacon', avoids most of the above trouble by selecting the aircraft the controller wishes to respond. In ordinary s.s.r. two pulses are transmitted (actually three, but that is irrelevant to this discussion) all aircraft being thereby commanded to respond with their codes. In contrast, after first interrogating all aircraft (all-call), ADSEL's computer determines each aircraft's position at the next scan and transmits a uniquely coded interrogation when it is next in the beam, ensuring that only one replies, after which all-call is locked out. If a subsequent reply is lost, the interrogator reverts to the all-

Comparison of displays of one aircraft (4035) overtaking another (4431), using ordinary s.s.r. with 'sliding window', ordinary s.s.r. with a monopulse receiver and aerial and ADSEL. ADSEL suffers no misses due to garbling and the monopulse technique used in ADSEL produces a greatly increased bearing accuracy. The track of 4431 is shown idealized.



call mode. Garble is thereby avoided and, since only a single reply is received per scan for each aircraft, the number of redundant responses on the display is much reduced. Up to four repeat interrogations are transmitted in the event of a missed response.

The interrogation and reply include message bits, which could be used to pass instructions and the transponder to send information on airspeed, rate of turn, air temperature, etc. Interrogations carry a 24-bit parity/address field, which ensures a very low probility of undetected error in the presence of s.s.r. interference.

To complete the set of data, the target's bearing must be determined using the single reply which, since the bearing of the target is indeterminate to an extent depending on the width of the transmitted beam, dictates on extremely narrow beam. A technique known as monopulse is the answer here. Instead of a single transmitter aerial, a split type is used in an interferometric configuration. As the beam tracks across the target, its return signals at the two halves of the aerial vary in phase; only when the aircraft is exactly on the boresight (centreline) are the two signals exactly in phase. On reception, both halves of the aerial are used, in such a way that sum and difference signals are combined. Separate, logarithmic i.f. amplifiers are followed by a circuit which subtracts the log. sum from the log. difference. Since the ratio of the two is the same at any bearing, the video amplitude is the same at all ranges. The position of any aircraft within the beam can be measured to an accuracy of 5 minutes of arc.

The increased bearing-determination accuracy of the monopulse technique means that the track of an aircraft is not a somewhat irregular succession of returns on the controller's screen, but a smoothed-out, almost perfectly regular train of dots. (The final appearance of a target on the screen is not the 'raw' response, but a computer-manipulated symbol composed of a dot with the aircraft's identification and height.) Indeed, the CAA and RSRE take the view that the use of monopulse alone would improve the quality of the display enough to cope with expected traffic increases until 1990.

ICR

The current jargon for the process of using a computer to stop aircraft hitting each other is Interactive Conflict Resolution (ICR). The use of a computer to generate the annotated dots on the controller's screen is being taken further by RSRE to predict the future by up to 15 minutes. He will be provided with a 'rolling-ball' control to allow him to advance the state of play and to see which aircraft are likely to come into a state of conflict if they are not given alternative instructions. A 'menu' of possible changes in flight plan is displayed on the screen, the ideal being to choose one which disturbs the pilot's chosen flight profile by the smallest amount, since large changes in speed or height consume extra fuel and wear engines. The controller can 'try out' any of the possible changes and the computer will indicate whether the alteration would resolve the conflict. If not, he tries another possibility until the computer indicates "no conflict for this aircraft", whereupon he returns to real time and instructs the pilot accordingly. The computer will also warn automatically of impending conflicts.

Terminal control

Computers and v.d.u.s are also of use in the scheduling of aircraft on the ground, using data from other a.t.c. centres to ensure that flights are not allowed to take off if, by doing so at that particular time, they are likely to arrive at a 'pressure point' (a congested sector of airspace) at the same time as another. The computer shows all such aircraft at the correct times at each pressure point, the display changing minute by minute, and allows the controller to determine when a flight can be allowed to leave without possible conflict en route.

RSRE and CAA are at pains to point out that the work described is in the experimental stages. ADSEL is well advanced, several sets of equipment having been evaluated successfully, but even so, it will not be in service for two or three years, chiefly for economic reasons – it requires aircraft to carry updated transponders and ground stations to instal new interrogators. Re-equipment will take time and, since a.t.c. is international, ICAO will need to agree ADSEL/DABS before it can be used although it is compatible with s.s.r. and can be introduced gradually. ICR is in the early stages and may not be in service for ten years, although equipment working in a shorter time frame may be introduced sooner than this.

The ICR system, and other applications of computers to activities which involve safety, are responsible for a certain amount of psychological questioning. Some controllers who have used ICR in simulations of actual air activity have noticed a tendency in themselves to rely rather too much on the computer. If it indicates 'no conflicts', they find themselves a little too ready to believe it: they do not care for the feeling they have of losing part of their control of the situation. The University of Aston and the RAF Institute of Aviation Medicine are working with CAA and RSRE to investigate the effects this kind electronic 'assistance' can have on people.
P.R.D. □

IN OUR NEXT ISSUE

Microprocessor trainer

Designed to familiarize the complete beginner with microprocessors, this small unit with hex keyboard and six-digit display nevertheless has enough facilities to become a useful tool later on. The circuitry contains 9 i.cs on one double-sided p.c.b. with storage of 4Kbytes of e.p.r.o.m. and over 1Kbyte of r.a.m.

Off-air frequency reference

This instrument provides a 10MHz signal phase locked to the BBC's 200 kHz Radio 4 Droitwich transmission. Modifications are available to allow for the eventual change of the transmission to 198kHz. The reference comes from a 10MHz crystal oscillator tuned via a varicap diode from the error signal in a phase locked loop.

Multiplex keying for organs

A technique for flexible control of pipe or electronic organs through time-division multiplexing. Not only does it eliminate a lot of the drudgery of repetitive wiring but also allows use of hitherto impractical features in small organs such as mixture stops, transposition and pizzicato effects.

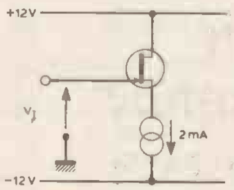
On sale 17 December

Test your knowledge

Multiple-choice quiz for students and circuit designers

by R. W. Ellingham and B. L. Hart North East London Polytechnic

1. A low power bipolar junction transistor operates at a temperature of 26°C in the forward active mode at a collector current of 1.5 mA. The mutual conductance in mS is approximately
(a) 20
(b) 40
(c) 60
(d) 80.

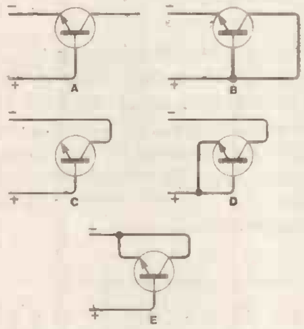


2. The junction f.e.t. shown has an ideal square-law mutual characteristic with I_{DSS} 4 mA, V_P (pinch-off voltage) −4 V. The f.e.t. enters the pre-pinch-off state when V_I, in volts, reaches
(a) 6
(b) 8
(c) 10
(d) 12.

3. *Assertion:* When a bipolar junction transistor is operated in the saturated mode the magnitude of the collector-emitter voltage must always exceed zero, *because*
Reason: the operation of a bipolar device depends on the existence of two polarities of carrier.

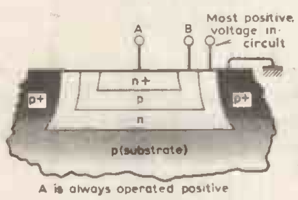
(a) both assertion and reason are true statements and the reason is a correct explanation of the assertion
(b) both assertion and reason are true statements but the reason is not a correct explanation of the assertion
(c) the assertion is true but the reason is a false statement
(d) the assertion is false but the reason is a true statement
(e) both assertion and reason are false statements.

The figure shows five ways in which the leads of a monolithic integrated circuit transistor can be connected to obtain a diode type volt-ampere characteristic.



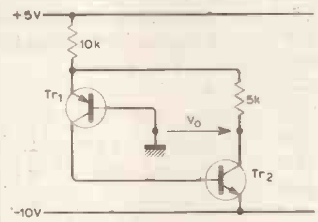
4. For medium and high current levels the highest forward conductance is exhibited by connection
(a), (b), (c), (d) or (e).

5. For a given forward current and specified reverse current the connection exhibiting the smallest minority carrier storage time is
(a), (b), (c), (d) or (e).

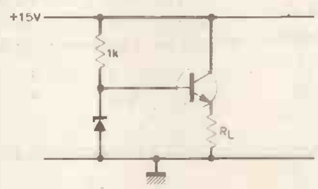


A is always operated positive with respect to B

6. The diagram represents a cross-section of a monolithic integrated circuit structure. The element between the terminals A and B is designed to function primarily as a
(a) resistance
(b) diode
(c) capacitance
(d) silicon controlled rectifier
(e) lateral transistor.
A is always operated positive with respect to B.

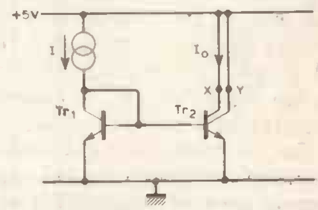


7. For the circuit shown the transistors both have $h_{FE} > 100$. Assuming that the forward voltage drop of the base-emitter junction of a conducting transistor may be taken as zero volts, the approximate value of v_O, in volts, is
(a) +5
(b) +2.5
(c) −2.5
(d) −5
(e) −10.

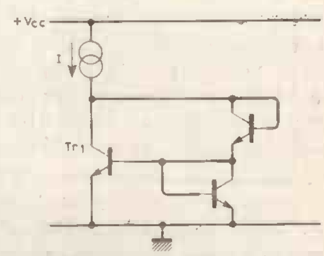


8. The circuit arrangement of a simple voltage stabilizer is shown. For the 200mW zener diode V_Z is 5V and for the transistor $I_C/I_B=10$. The maximum current in the load R_L, in mA, for which the load voltage is stabilized is
(a) 90
(b) 100
(c) 110
(d) 150
(e) 165.

9. In the voltage stabilizer circuit a load current in R_L of 99 mA is switched on for 1 ms and off for 1 ms continuously. The mean power is dissipated in the zener diode under these conditions, in mW, is approximately
(a) 55
(b) 50
(c) 27.5
(d) 25
(e) 22.5.



10. The circuit shows two monolithic transistors in a current mirror configuration. The emitter area of Tr_1 is A units, whereas the emitter area of Tr_2, which has two separate identical collector regions with output terminals at X and Y, is $3A$ units. The current I_o at terminal X, neglecting transistor base currents, is
(a) $I/3$
(b) $I/2$
(c) $2I/3$
(d) I
(e) $3I/2$.



11. Assume the monolithic transistors are identical. For each device the d.c. behaviour is completely specified by $|I_C|=\alpha|I_E|$. In terms of I, the collector current of Tr_1 is

(a) $\frac{\alpha I}{(1+\alpha)}$

Christmas Quiz Prizes

Prizes for the Christmas Quiz will be copies of "Circuit Designs 3", the latest volume of collected Circards from the Wireless World series produced by P. Williams, J. Carruthers, J. H. Evans and J. Kinsler (normally £14). Winners may, however, choose the alternative prize of a one-year free subscription to Wireless World (normally £10 in the UK, $33.80 overseas).

UK prizewinners will be the first ten entries with the correct answers opened after 5 January 1981. More time has to be allowed for the distribution of the journal to readers outside the UK, so in this case the prizewinners will be the first ten overseas entrants with the correct answers opened after 2 March 1981. The correct answers will be published in the Apiril issue Wireless World.

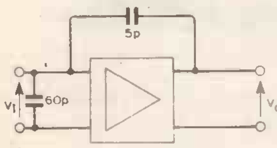
Your entry must contain your name and full address and also a note stating which of the two prizes you would like if you qualify as a winner. Send your entry to: Christmas Quiz, Editorial Department, Wireless World, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS, England.

(b) $\frac{I}{2}$

(c) $\frac{I}{(1+\alpha)}$

(d) $\frac{\alpha I}{2}$

(e) $\frac{2\alpha I}{(\alpha+2)}$.



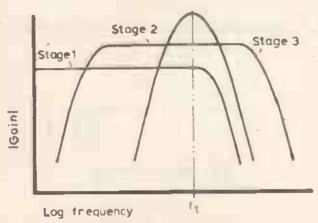
12. The amplifier shown has a voltage gain $A_v = V_o/V_i = 9\angle 180°$. The effective input capacitance C_i, in pF, is
(a) 20
(b) 65
(c) 100
(d) 105
(e) 110.

13. An amplifier of nominal gain $A=1000$ has negative feedback applied so that the gain with feedback A' has a nominal value of 100. The feedback is constant. If A increases to 1500, A' is
(a) 103.4
(b) 105
(c) 125
(d) 133.3
(e) 150.

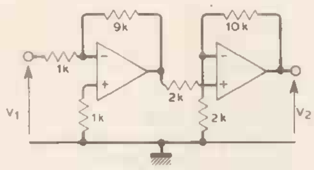
14. An amplifier consists of three identical stages in cascade. Each stage has a voltage gain G at any frequency f (MHz)

$$G = -\frac{10}{1+j10f}$$

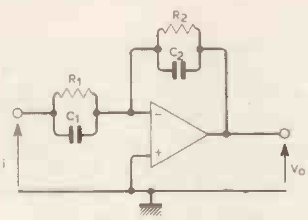
A real positive fraction β of the output voltage is fed back to the input circuit to reduce the overall gain at low frequencies. The value of β required to provide a gain margin of 12 dB is
(a) 0.001
(b) 0.002
(c) 0.004
(d) 0.008
(e) 0.016.



15. The frequency response of each of three cascaded amplifier stages is shown. The asymptotes to the response slopes increase or decrease 6 dB/octave and each stage introduces a phase inversion at the frequency f_1. Overall feedback (real positive feedback fraction) is introduced. As the feedback fraction is progressively increased the three-stage amplifier will
(a) remain unconditionally stable
(b) oscillate at a frequency f_1
(c) oscillate at a frequency less than f_1
(d) oscillate at a frequency greater than f_1
(e) oscillate at frequencies less than and greater than f_1



16. Assuming each of the operational amplifiers to be ideal, the ratio of the incremental voltages, V_2/V_1, in the circuit arrangement shown is
(a) +54
(b) +45
(c) −45
(d) −50
(e) −54.



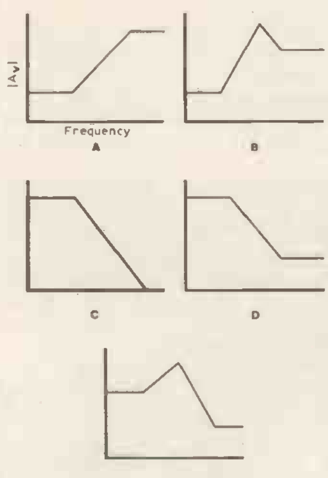
17. The operational amplifier in the circuit arrangement shown is ideal and

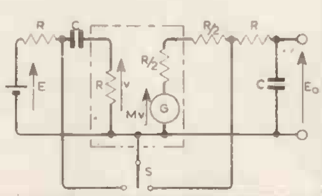
$$\frac{C_2}{C_1} > \frac{R_1}{R_2}$$

The frequency response

$$|A_v| = \left|\frac{V_o}{V_i}(j\omega)\right|$$

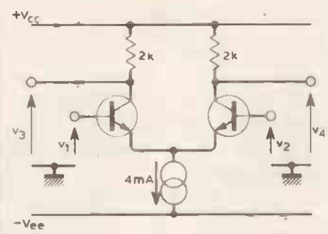
approximately as shown at A, B, C, D or E.





18. In the basic circuit of a chopper amplifier shown, if $CR \gg T$, where T is the period during which the contacts of the switch S are open or closed, the output voltage E_o is approximately
(a) $\frac{ME}{9}$
(b) $-\frac{ME}{9}$
(c) $\frac{ME}{4}$
(d) $-\frac{ME}{4}$

Perfectly matched bipolar junction transistors are used in the emitter-coupled amplifier shown and v_1, v_2, v_3 and v_4 denote incremental voltages. Assume $KTq=25$ mV, where K, T and q have their usual meanings.

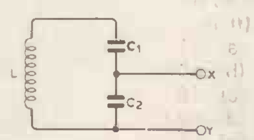


19. If $v_1 = -v_2 = 0.5$ mV the differential output voltage $v_3 - v_4$, in mV, is approximately
(a) 0
(b) 80
(c) −80
(d) 160
(e) −160.

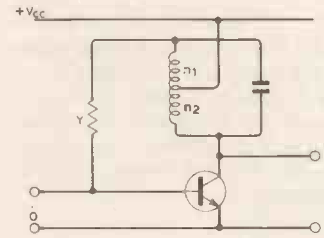
20. If $v_1 = v_2 = 1$mV the differential output voltage $v_3 - v_4$, in mV, is approximately
(a) 0
(b) 160
(c) −160
(d) 320
(e) −320.

21. If $v_1 = 1$ mV and $v_2 = 0$ the single-ended output voltage v_4, in mV, is approximately
(a) 0
(b) 80
(c) −80
(d) 160
(e) −160.

22. An emitter-coupled amplifier has a differential gain magnitude of 1000 and a common-mode rejection ratio of 100. For input voltages of 1.1 mV and 0.9 mV a possible value for the magnitude of the differential output voltage, in mV, is
(a) 200
(b) 210
(c) 220
(d) 400
(e) 420.



23. In the parallel tuned circuit shown the capacitors are loss-free and the effective parallel loss resistance of the inductor L is 90 kΩ. So that the connection of a load resistor, resistance 10kΩ, between X and Y results in a resonant circuit Q factor of one half of the unloaded value, the ratio of the capacitance of C_1 to the capacitance of C_2, is
(a) 1/3
(b) 1/2
(c) 2
(d) 3.

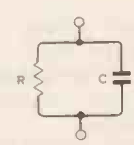


24. For the transistor used in the single-stage narrow-band tuned amplifier shown

$y_{11} = (0.6 + j7.2)$mS $y_{12} = j0.2$ mS.

The coil is tapped at $2n_1 = n_2$ turns. For neutralization of the stage the value of the admittance Y, in mS, is
(a) 0.6−j7.0
(b) j0.1
(c) −j0.1
(d) j0.4
(e) −j0.4.

25. The mean square open-circuit thermal noise voltage generated between the ends of a resistor R at absolute temperature T in a bandwidth of 1Hz is directly proportional to the product of R and T. The thermal noise power dissipated in two equal resistors in parallel at temperatures of 300 K and 330 K exceeds that in the two resistors at the same temperature of 300 K by
(a) 1%
(b) 2½%
(c) 5%
(d) 10%
(e) 15%.

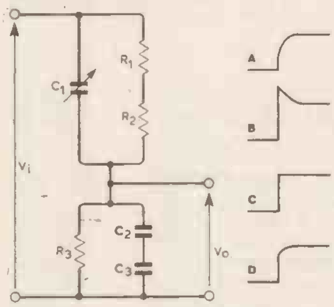


26. In the circuit arrangement shown the resistance of R is doubled, the capacitance of C is halved and the temperature of both components is unchanged. The r.m.s. value of the noise voltage developed across the terminals will
(a) increase by a factor of 2
(b) increase by a factor of $\sqrt{2}$
(c) not change
(d) decrease by a factor of 2
(e) decrease by a factor of $\sqrt{2}$

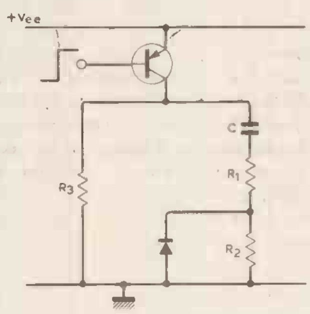
27. An amplifier is matched to a signal source of purely resistive

internal impedance. If the only noise generated within the amplifier is thermal noise in the input resistance the noise figure of the amplifier, in dB, is approximately
(a) 0
(b) 1
(c) 2
(d) 3
(e) 6.

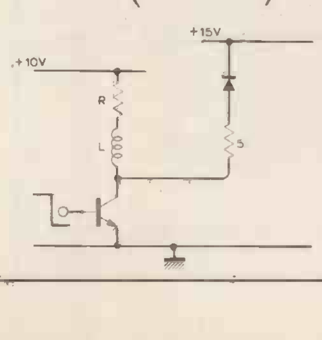
28. In the amplifier of the previous question the internal resistance of the signal source is decreased without change to the signal e.m.f. The effect on the signal-to-noise ratio at the output of the amplifier is
(a) an increase
(b) no change
(c) a decrease
(d) indeterminate.



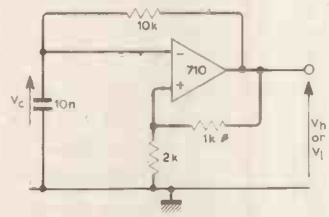
29. If $v_i(t)$, for the circuit shown, is a positive-going voltage step and C_1 is adjusted for the condition $C_1(R_1+R_2)=(C_2+C_3)R_3$, then the shape of the output voltage waveform $v_o(t)$ is most closely represented by A, B, C or D.



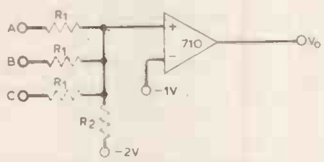
30. Assume the transistor and diode have the characteristics of perfect switches. When the transistor is abruptly switched off, from a state of saturation, the initial current in the diode decays with a time constant
(a) CR_3
(b) $C\left(R_3+\dfrac{R_1R_2}{R_1+R_2}\right)$
(c) $C(R_1+R_3)$
(d) $C\left(R_2+\dfrac{R_1R_3}{R_1+R_3}\right)$.



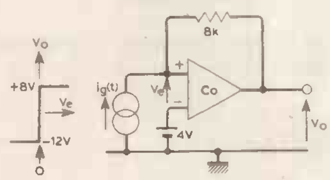
31. The saturated transistor maintains a steady 0.5 A in the relay coil till the transistor is abruptly cut off. Ignoring carrier storage and depletion layer capacitance effects, and assuming the voltage drop across the diode when conducting, is constant at 1 V, the minimum collector-emitter voltage rating to prevent breakdown is
(a) 16.0
(b) 18.5
(c) 21.0
(d) 28.5.



32. The type 710 comparator used in the astable circuit arrangement shown has V_h 3.3V and V_l −0.6V. The amplitude of the voltage waveform V_C, in volts, is
(a) 0.9
(b) 1.3
(c) 1.8
(d) 2.6
(e) 3.9.



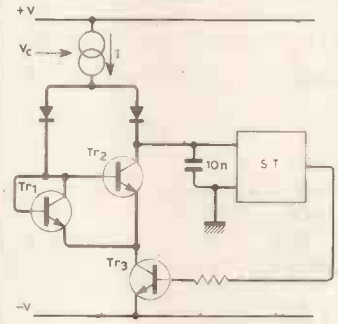
33. In a majority logic gate, circuit arrangement as shown, each input A, B, C can be either 0 V or 5 V. The maximum ratio R_1: R_2 to ensure V_o is high when any two inputs are at 5 V is
(a) 18
(b) 13
(c) 12
(d) 6
(e) 5.



34. The Schmitt trigger circuit shown includes an integrated circuit comparator, C_o, which has the d.c. transfer characteristic given. Neglecting the input current to the comparator, the upper trip current level in mA on the waveform $i_g(t)$, is
(a) −1
(b) +1.5
(c) +2
(d) +3.

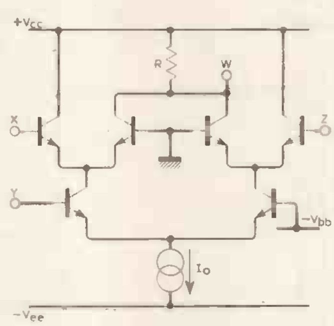
35. Referring to the previous question, the lower trip current level, in mA, on the waveform $i_g(t)$ is
(a) −1
(b) −0.5
(c) 0
(d) +0.5
(e) +1.

In the voltage-controlled oscillator circuit shown, transistors Tr_1 and Tr_2 are closely matched. The conducting state of the saturating switching transistor Tr_3 is controlled by the output of the Schmitt trigger circuit, ST. The controlled current source is variable over the range 200μ to 2mA and the upper and lower trip levels of ST are 3V and 1V respectively.

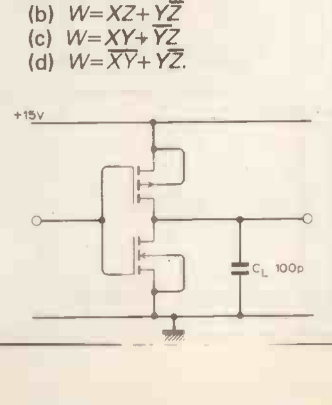


36. The maximum frequency of oscillation, in kHz, is
(a) 5
(b) 10
(c) 25
(d) 150
(e) 100.

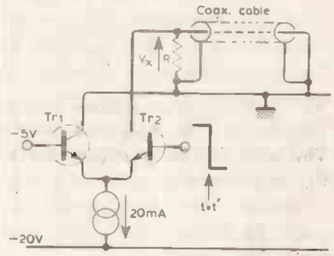
37. The minimum frequency of oscillation, in kHz, is
(a) 5
(b) 10
(c) 25
(d) 50
(e) 100.



38. For the integrated-circuit current switching logic scheme shown the input voltage logic swing is ±0.5 V about the reference potential applied to the base of the associated transistor of a long-tailed pair. Using the positive logic convention the output, W, in terms of the inputs X, Y, Z, is
(a) $W=\overline{X}Y+\overline{Y}\overline{Z}$
(b) $W=XZ+Y\overline{Z}$
(c) $W=XY+\overline{Y}\overline{Z}$
(d) $W=\overline{X}\overline{Y}+Y\overline{Z}$.



39. A c.m.o.s. inverter stage is shown in which device leakage currents may be ignored and inter-electrode capacitances are negligible compared with the load capacitor. The power dissipation in the stage, in μW when the input switches between 0 and V^+, at an operating frequency of 10 kHz, is approximately
(a) 56
(b) 113
(c) 225
(d) 450.



40. Transistor Tr_2 is on, Tr_1 is off, and d.c. conditions prevail. At $t=t'$, Tr_2 is assumed to switch off instantaneously following the application of a suitable step voltage at its base.
Assertion: If the collector-base capacitance of T_2 is ignored v_x does not change when T_2 switches off, *because*
Reason: v_x=0 for $t<t'$ and there is no collector current in Tr_2 for $t \geq t'$.
(a) both assertion and reason are true statements and the reason is a correct explanation of the assertion
(b) both assertion and reason are true statements but the reason is not a correct explanation of the assertion
(c) the assertion is true but the reason is a false statement
(d) the assertion is false but the reason is a true statement
(e) both assertion and reason are false statements. □

Solutions will be published in the April issue.

Designing with microprocessors

6 – Illustrating a test-and-skip system

by D. Zissos and Laurelle Valan
Department of Computer Science, University of Calgary, Canada

The previous article in the October issue described step-by-step procedures for the design and implementation of microprocessor-based systems using the test-and-skip mode. The authors now go on to illustrate these steps by means of a fully worked out example of a printing operation. The implementation assumes either the Intel 8080 or the Motorola 6800 microprocessor.

The problem chosen for illustration is to design and implement a test-and-skip system that would allow the programmer to produce a hard copy of data, which is stored in consecutive memory locations. The problem requires the use of an action-/status printer and either the Intel 8080 or the Motorola 6800 to implement the design.

Solution

Our first three design steps are independent of the microprocessor, and therefore are common to both solutions.

Step 1: aim of the design. The aim of the design is to expose the inexperienced reader to uncomplicated procedures for designing and implementing microprocessor-based systems using the test-and-skip mode.

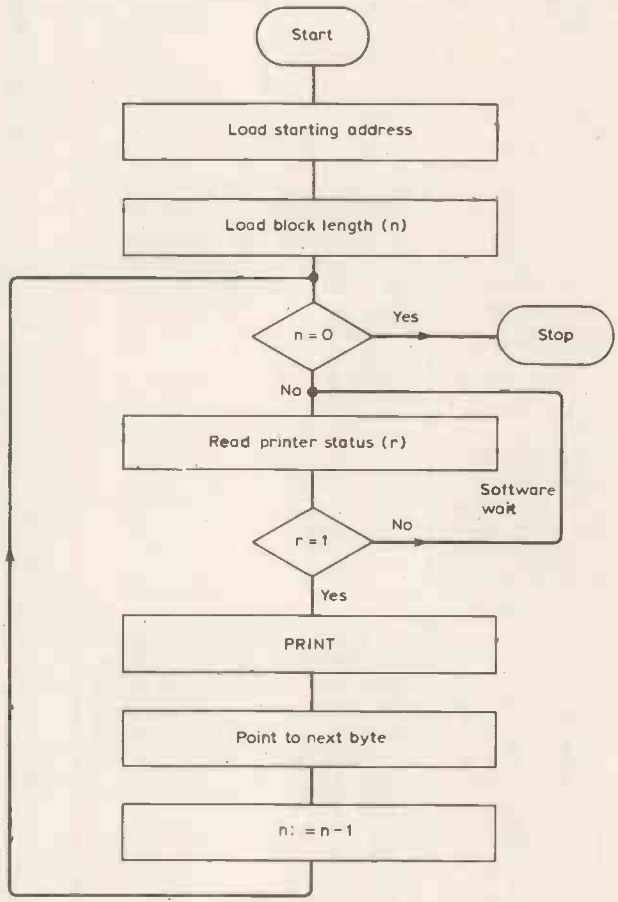


Fig. 1. Step by step operation of a test-and-skip system used to PRINT.

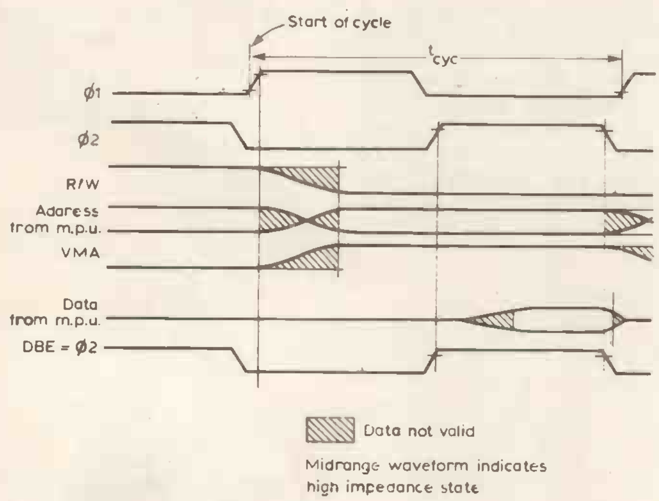


Fig. 2. Read data from memory or peripherals – M6800.

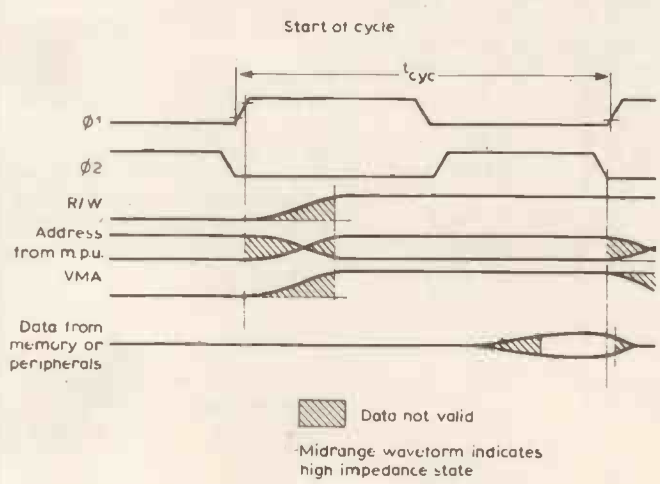


Fig. 3. Write data in memory or peripherals – M6800.

Table 1: Hex listing of the PRINT problem when implemented using the test-and-skip mode and the Motorola 6800.

	Hex address	Hex listing	Mnemonics	Comments
	0300 01 02	CE 20 40	LDX	Load index register with line 40 on page 20 – location of the first byte to be printed
	03 04	86 n	LDAA	Load acc. A with block length (n)
	05 06 07	97 01 60	STAA	Copy acc. A (n) into memory location (line 10 page 20) to be used as a counter
	08 09	27 10	BEQ	Branch (+16) to L1 if n = 0
L2:	0A 0B 0C	A6 20 07	LDAA	Read printer status
	0D	49	ROLA	Rotate left through carry
	0E 0F	27 FA	BEQ	Branch (-6) to L2, if printer not ready
	10 11	A6 00	LDAA	Copy into acc. A next byte to be printed
	12 13 14	B7 20 06	STAA	PRINT
	15	08	INX	Point to next byte
	16 17 18	7A 20 10	DEC	Decrement byte count (held in memory location 2010)
	19 20	20 F0	BRA	Branch (-16) to L2
L1:	21	3E	WAI	Stop

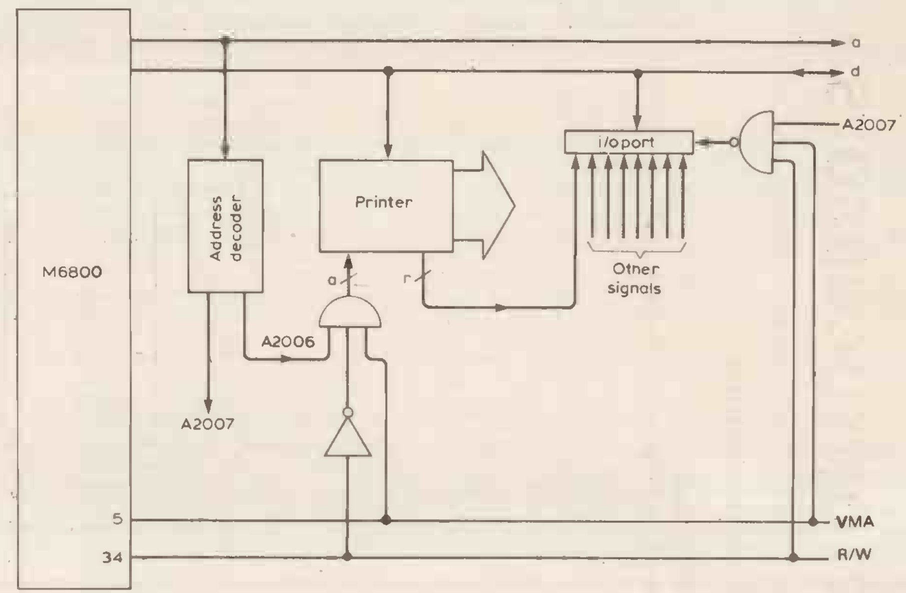


Fig. 4. Interface hardware of the PRINT problem using test-and-skip and the M6800.

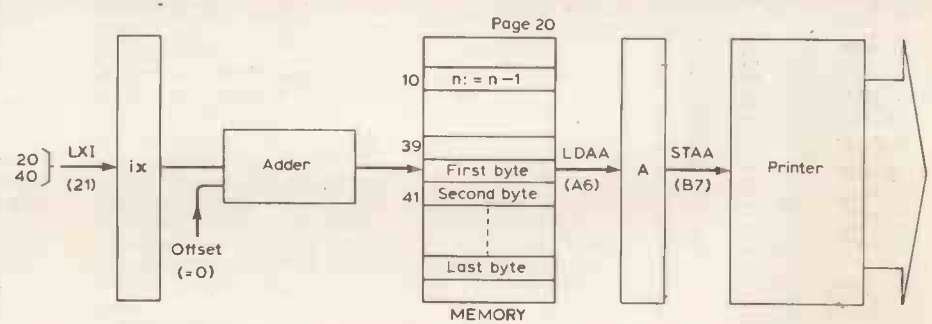


Fig. 5. Programming model for the PRINT problem using the M6801.

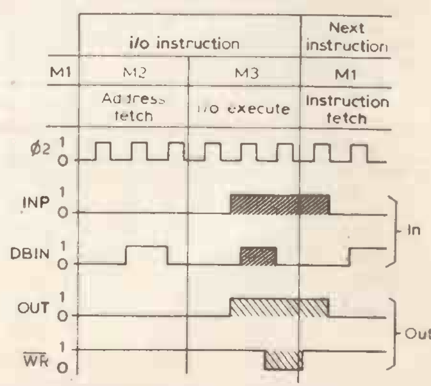


Fig. 6. Input/output (i/o) signals of the Intel 8080.

Table 2: Instruction set for the Intel 8080

Mnemonic	Description	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Clock (2) Cycles	Hex Code
AC1	Add immediate to *A* with carry	1	1	0	0	1	1	1	0	7	CE
ADC M	Add memory to *A* with carry	1	0	0	0	1	1	1	0	7	8E
ADCr	Add register to *A* with carry	1	0	0	0	1	*S*	*S*	*S*	4	
ADD M	Add memory to *A*	1	0	0	0	0	1	1	0	7	86
Add r	Add register to *A*	1	0	0	0	0	*S*	*S*	*S*	4	
ADI	Add immediate to *A*	1	1	0	0	0	1	1	0	7	C6
ANA M	Add memory with	1	0	1	0	0	1	1	0	7	A6
ANA r	And register with *A*	1	0	1	0	0	*S*	*S*	*S*	4	
ANI	And immediate with I	1	1	1	0	0	1	1	0	7	E6
CALL	Call unconditional	1	1	0	0	1	1	0	1	17	6D
CC	Call on carry	1	1	0	1	1	1	0	0	11/17	D6
CM	Call on minus	1	1	1	1	1	1	0	0	11/17	FC
CMA	Complement *A*	0	0	1	0	1	1	1	1	4	2F
CMC	Complement carry	0	0	1	1	1	1	1	1	4	3F
CMP M	Compare memory with *A*	1	0	1	1	1	1	1	0	7	BE
CMP r	Compare register with *A*	1	0	1	1	1	*S*	*S*	*S*	4	
CNC	Call on no carry	1	1	0	1	0	1	0	0	11/17	4
CNZ	Call on no zero	1	1	0	0	0	1	0	0	11/17	C4
CP	Call on positive	1	1	1	1	0	1	0	0	11/17	F4
CPE	Call on parity even	1	1	1	0	1	1	0	0	11/17	EC
CPI	Compare immediate with *A*	1	1	1	1	1	1	1	0	7	FE
CPO	Call on parity odd	1	1	1	0	0	1	0	0	11/17	E4
CZ	Call on zero	1	1	0	0	1	1	0	0	11/17	CC
DAA	Decimal adjust *A*	0	0	1	0	0	1	1	1	4	27
DAD B	Add *B* & *C* to *H* & *L*	0	0	0	0	1	0	0	1	10	09
DAD D	Add *D* & *E* to *H* & *L*	0	0	0	1	1	0	0	1	10	19
DAD H	Add *H* & *L* to *H* & *L*	0	0	1	0	1	0	0	1	10	29
DAD SP	Add stack pointer to *H* & *L*	0	0	1	1	1	0	0	1	10	39
DCR M	Decrement memory	0	0	1	1	0	1	0	1	10	35
DCR r	Decrement register	0	0	*D*	*D*	*D*	1	0	1	5	
DCX B	Decrement *B* & *C*	0	0	0	0	1	0	1	1	5	0B
DCX D	Decrement *D* & *E*	0	0	0	1	1	0	1	1	5	1B
DCX H	Decrement *H* & *L*	0	0	1	0	1	0	1	1	5	2B
DCX SP	Decremental stack pointer	0	0	1	1	1	0	1	1	5	3B
DI	Disable interrupt	1	1	1	1	0	0	1	1	4	F3
E1	Enable Interrupts	1	1	1	1	1	0	1	1	4	FB
HLT	Halt	0	1	1	1	0	1	1	0	7	76
IN	Input	1	1	0	1	1	0	1	1	10	DB
INR M	Increment memory	0	0	1	1	0	1	0	0	10	34
INR r	Increment register	0	0	*D*	*D*	*D*	1	0	0	5	
INX B	Increment *B* & *C* registers	0	0	0	0	0	0	1	1	5	03
INX D	Increment *D* & *E* registers	0	0	0	1	0	0	1	1	5	13
INX H	Increment *H* & *L* registers	0	0	1	0	0	0	1	1	5	23
INX SP	Increment stack pointer	0	0	1	1	0	0	1	1	5	33
JC	Jump on carry	1	1	0	1	1	0	1	0	10	DA
JM	Jump on minus	1	1	1	1	1	0	1	0	10	FA
JMP	Jump unconditional	1	1	0	0	0	0	1	1	10	C3
JNC	Jump on no carry	1	1	0	1	0	0	1	0	10	D2
JNZ	Jump on no zero	1	1	0	0	0	0	1	0	10	C2
JP	Jump on positive	1	1	1	1	0	0	1	0	10	F2
JPE	Jump on parity even	1	1	1	0	1	0	1	0	10	EA
JPO	Jump on parity odd	1	1	1	0	0	0	1	0	10	E2
JZ	Jump on zero	1	1	0	0	1	0	1	0	10	CA
LDA	Load *A* direct	0	0	1	1	1	0	1	0	13	3A
LDAX B	Load *A* indirect	0	0	0	0	1	0	1	0	7	0A
LDAX D	Load *A* indirect	0	0	0	1	1	0	1	0	7	1A
LHLD	Load *H*& *L* direct	0	0	1	0	1	0	1	0	16	2A

Mnemonic	Description	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Clock (2) Cycles	Hex Code
LXLB	Load immediate register Pair *B* & *C*	0	0	0	0	0	0	0	1	10	01
LXLD	Load immediate register Pair *D* & *E*	0	0	0	1	0	0	0	1	10	11
LXLH	Load immediate register Pair *H* & *L*	0	0	1	0	0	0	0	1	10	21
LXLSP	Load immediate stack pointer	0	0	1	1	0	0	0	1	10	31
MVI M	Move immediate memory	0	0	1	1	0	1	1	0	10	36
MVI r	Move immediate register	0	0	*D*	*D*	*D*	1	1	0	7	
MOV M_1r	Move register to memory	0	1	1	1	0	*S*	*S*	*S*	7	
MOV r_1 M	Move memory to register	0	1	*D*	*D*	*D*	1	1	0	7	
MOV $_{r2}$	Move register to register	0	1	*D*	*D*	*D*	*S*	*S*	*S*	5	
NOP	No-operation	0	0	0	0	0	0	0	0	4	00
ORA M	Or memory with *A*	1	0	1	1	0	1	1	0	7	B6
ORA r	Or register with *A*	1	0	1	1	0	*S*	*S*	*S*	4	
ORI	Or immediate with *A*	1	1	1	1	0	1	1	0	7	F6
OUT	Output	1	1	0	1	0	0	1	1	10	D3
PCHL	*H* & *L* to program counter	1	1	1	0	1	0	0	1	5	E9
POP B	Pop register pair *B* & *C* off stack	1	1	0	0	0	0	0	1	10	C1
POP D	Pop register pair *D* & *E* off stack	1	1	0	1	0	0	0	1	10	D1
POP H	Pop register pair *H* & *L* off stack	1	1	1	0	0	0	0	1	10	E1
POP PSW	Pop *A* and Flags off stack	1	1	1	1	0	0	0	1	10	F1
PUSH B	Push register Pair *B* & *C* on stack	1	1	0	0	0	1	0	1	11	C5
PUSH D	Push register Pair *D* & *E* on stack	1	1	0	1	0	1	0	1	11	D5
PUSH H	Push register Pair *H* & *L* on stack	1	1	1	0	0	1	0	1	11	E5
PUSH PSW	Push *A* and Flags on stack	1	1	1	1	0	1	0	1	11	F5
RAL	Rotate *A* left through carry	0	0	0	1	0	1	1	1	4	17
RAR	Rotate *A* right through carry	0	0	0	1	1	1	1	1	4	1F
RC	Return on carry	1	1	0	1	1	0	0	0	5/11	D8
RET	Return	1	1	0	0	1	0	0	1	10	C9
RLC	Rotate *A* left	0	0	0	0	0	1	1	1	4	07
RM	Return to minus	1	1	1	1	1	0	0	0	5/11	F8
RNC	Return on no carry	1	1	0	1	0	0	0	0	5/11	D0
RNZ	Return on no zero	1	1	0	0	0	0	0	0	5/11	C0
RP	Return on positive	1	1	1	1	0	0	0	0	5/11	F0
RPE	Return on parity even	1	1	1	0	1	0	0	0	5/11	E8
RPO	Return on parity odd	1	1	1	0	0	0	0	0	5/11	E0
RRC	Rotate *A* right	0	0	0	0	1	1	1	1	4	0F
RST	Restart	1	1	*A*	*A*	*A*	1	1	1	11	
RZ	Return on zero	1	1	0	0	1	0	0	0	5/11	C8
SBB M	Subtract memory from *A* with borrow	1	0	0	1	1	1	1	0	7	9E
SBB r	Subtract register from *A* with borrow	1	0	0	1	1	*S*	*S*	*S*	4	
SBI	Subtract immediate from *A* with borrow	1	1	0	1	1	1	1	0	7	DE
SHLD	Store *H* & *L* direct	0	0	1	0	0	0	1	0	16	22
SPHL	*H* & *L* to stack pointer	1	1	1	1	1	0	0	1	5	F3
STA	Store *A* direct	0	0	1	1	0	0	1	0	13	32
STAX B	Store *A* indirect	0	0	0	0	0	0	1	0	7	02
STAX D	Store *A* indirect	0	0	0	1	0	0	1	0	7	12
STC	Set carry	0	0	1	1	0	1	1	1	4	37
SUB M	Subtract memory from *A*	1	0	0	1	0	1	1	0	7	96
SUB r	Subtract register from *A*	1	0	0	1	0	*S*	*S*	*S*	4	
SUI	Subtract immediate from *A*	1	1	0	1	0	1	1	0	7	D6
XCHG	Exchange *D* & *E*, *H* & *L* Registers	1	1	1	0	1	0	1	1	4	EB
XRA M	Exclusive Or memory with *A*	1	0	1	0	1	1	1	0	7	AE
XRA r	Exclusive Or register with *A*	1	0	1	0	1	*S*	*S*	*S*	4	
XRI	Exclusive Or immediate with *A*	1	1	1	0	1	1	1	0	7	EE
XTHL	Exchange top of stack, *H* & *L*	1	1	1	0	0	0	1	1	18	E3

Notes: 1. *DDD* or *SSS* 000 *B*-001 *C*-010 *D*-011 *E*-100 *H*-101 *L*-110 Memory-111 *A*.
2. Two possible cycle times. (5/11) indicate instruction cycles dependent on condition flags.

Step 2: device characteristics. The terminal characteristics of our printer are shown in Fig. 6 of Part 5 in the October issue.

Step 3: system design. The block diagram of our general solution was shown in Fig. 7 in the October issue. Its step-by-step operation is flowcharted here in Fig. 1. We shall use index addressing to retrieve each character from memory. Addressing modes have been discussed in Part 3 in the August issue.

6800 Solution

Step 4: hardware design. The i/o signals of the Motorola 6800 are shown in Figs. 2 and 3. Reference to these figures shows that our In signal in Fig. 7, October issue, is generated by Anding VMA and R/W, the outputs of pins 5 and 34 of the 6800 chip. Similarly our Out signal is generated by Anding VMA with the inverted form of R/W. Note that line R/W is high during a read operation and low during a write operation. The interface hardware consisting of two And gates and an inverter is shown in Fig. 4.

Step 5: software design. Our programming model is shown in Fig. 5. Memory location 10 on page 20 is used as a counter, and the first byte is stored in line 40 of the same page.

By direct reference to our programming model in Fig. 5 and to the M6800 instruction set, reproduced in the previous article, we derive the hex listing of our test-and-skip software – see Table 1.

8080 Solution

Step 4: hardware design. The i/o signals of the Intel 8080 are shown in Fig. 7. Reference to this figure shows that our In and Out signals in Fig. 7 of the October issue are generated by Anding INP with DBIN and WR with OUT. The interface hardware consisting of two And gates and an inverter is shown in Fig. 7 here.

Note the similarity between the 8080 and the 6800 hardware implementations. The almost-identical nature of our solutions applies to all present-day microprocessors and to all their modes of operation, as we shall be demonstrating in future articles.

Step 5: software design. Our programming model in the case of the Intel 8080 is shown in Fig. 8 Microprocessor register C is assumed to be available to be used as a counter. The first byte is stored in line 40 of page 20 in memory.

By direct reference to our programming model in Fig. 8 and to the Intel 8080 instruction set (shown in Table 2), we derive the hex listing of our test-and-skip software. It is shown in Table 3.

The next article will deal with wait/go systems.

Table 3: Hex listing of the PRINT problem when implemented using the test-and-skip mode and the Intel 8080.

	Hex address	Hex listing	Mnemonics	Comments	
	1000	21	LXI HL	Set memory pointer to	
	01	40		line 40 on page 20 – location	
	02	20		of the first byte to be printed	
	03	0E	MVI C	Load register C with block	
	04	n		length (n)	
	05	CA	JNZ	Jump to L1 if n=0	
	06	16			
	07	10			
L2:	08	DB	IN	Read printer status	Software wait
	09	60			
	0A	07	RLC	Rotate left through carry	
	0B	D2	JC	Jump to L2 of carry	
	0C	08		flag (printer not ready) is	
	0D	10		set	
	0E	7E	MOV, A, M	Move into A next byte to be printed	
	0F	D3	OUT	PRINT	
	10	61			
	11	23	INX HL	Point to next byte in the block	
	12	0D	DCR C	Decrement byte count (held in C)	
	13	C3	JMP	Jump to L2	
	14	08			
	15	10			
L1:	16	76	HLT	Stop	

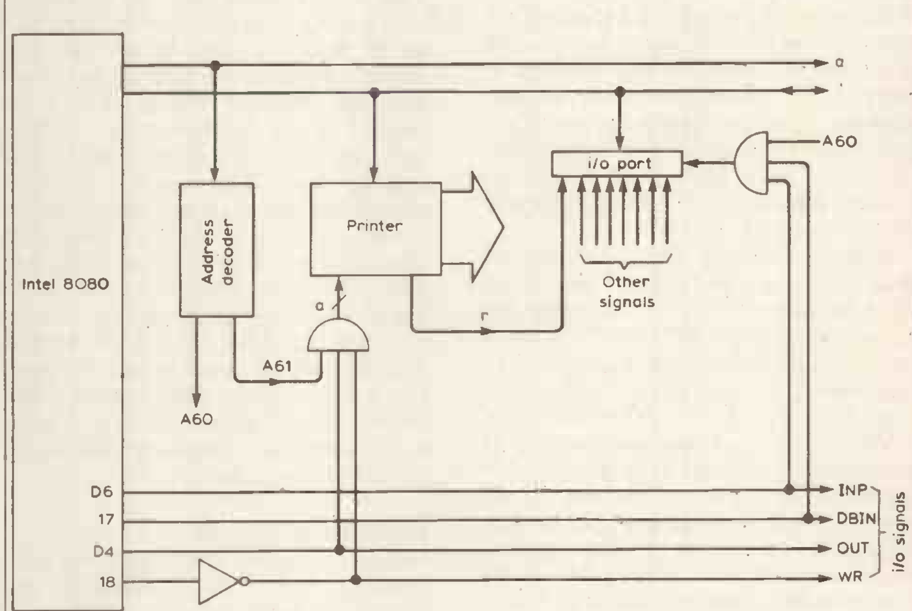


Fig. 7. Interface hardware of the PRINT problem using test-and-skip and the Intel 8080.

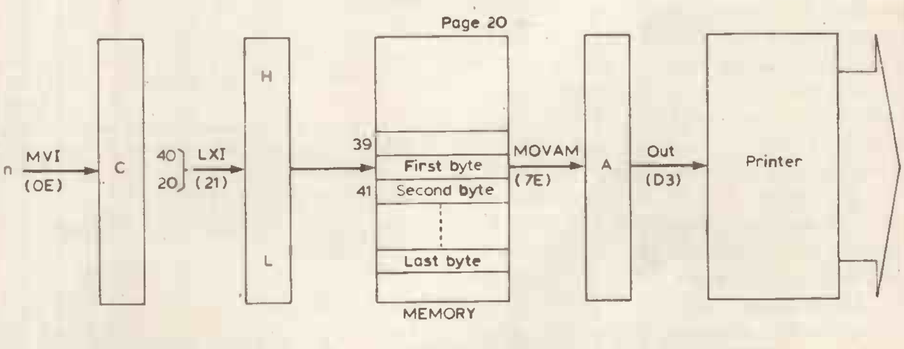


Fig. 8. Programming model for the PRINT problem using the Intel 8080.

Floppy disc system for the scientific computer – 2

Interfacing a disc drive to the controller

by J. H. Adams, B.Sc., M.Sc.

This interface has been designed to operate with the Data Recording Equipment model 7100 8in disc drive, but should be easily adapted to suit others. The main advantage of an 8in drive over a 5¼in system is its greater storage capacity, 77 tracks of 3¼Kbytes each using the IBM format described in part one, compared with 35 tracks of 2¼Kbytes each. The disadvantage is greater cost. This concluding article describes how the drive is matched to the floppy-disc controller, and illustrates the salient points to check when considering other drives.

Whichever drive is used, the length of the cable, flat or twisted pairs, between the drive and the interface must be kept as short as is reasonably possible, and separate from the power cables. Each power cable should have its own return and there must be a good connection between the frame of the drive and the case of the computer.

When considering the signals to and from the drive, their polarity and timing must be examined. Most drives use the active-low principle for their inputs and outputs, i.e. a true state is logical zero (represented by $0 \leq V \leq 0.4V$) and a false input is logical 1 (represented by $2.5V < V < 5.25V$). Open collector drivers are generally used for outputs, and low value pull-up resistors on the inputs provide a full 5V swing and keep the line impedance down, both of which improve noise immunity. One implication of this arrangement is that, to pull a line to zero, the driving device will need to sink the current supplied by the receiving gate and by the pull-up resistor, typically 40mA. For a logical 1, no current is required from the driving device. The controller i.c. signals are mostly active-high, so inverters are used as receivers on all inputs except $\overline{IP}$ (index pulse) and $\overline{WPRT}$ (write protect), and 220Ω pull-up resistors are used with high current-sinking, inverting, open-collector drivers on the five active outputs. If a drive with some active-high inputs is used, the equivalent non-inverting buffers, 7407, or pairs of 7406 in series must be used. Note that ordinary t.t.l. is used for driving the interface cable because the L and LS series do not have the required current-sinking capacity. Table 3 gives some timing information for the 5¼in drive, the 7100 and the WD1771 controller.

When used with an 8in unit, the WD1771 must be clocked at 2MHz, whilst with a 5¼in disc 1MHz is used. This is necessary to meet the standard data rates used for the two sizes, and results in the doubling of all pulse timings for the i.c. when used with the smaller disc. There are other timing requirements connected with the application of power and selection of the drive, but these can be allowed for in the programming of the computer.

Stepping time

Most drives offer the option of keeping the head permanently loaded against the disc. This speeds operations by eliminating head-loading delay, but does increase wear on the head and disc. In this operating system, the head is only loaded when necessary which is usually after it has stepped to the track required. Settling time is irrelevant if it is less than the head loading time. The interval between stepping pulses is programmable by the bottom two bits of the Step instruction byte as described on page four of the data sheet. With the 7100 drive the fastest (6ms) rate can be used, whereas with the 5¼in unit, the drive can only just keep up with the slowest stepping rate. Stepping rate is probably the most critical timing factor because if a drive cannot step as fast as the controller's slowest rate, the two are virtually incompatible.

Stepping pulse

Virtually all drives can step on the pulse provided by the 1771. However, one exception found by the author is an obsolete version of the 7100. As this unit may still be available, the interface has been designed to operate with it and the current version.

The obsolete 7100 is most easily recognised by the absence of three d.i.l. sockets and header plugs next to the edge connector on the p.c.b., and the presence of two power resistors and three power transistors instead of one resistor and four transistors near the opposite corner to the edge connector. To allow compatibility, a monostable stretches the stepping pulse to 10μs.

Head-loading time

Ten milliseconds after the HLD (Head Load) output of the controller becomes active (20ms for the 5¼in disc), the HLT (Head loaded test) input is sampled and when it is low the controller proceeds. If the combined loading and settling time for the head is less than 10ms, this input can be wired low. If the disc-drive electronics provide a head-loaded and ready signal, this can be connected to HLT. If neither is true, as it is for both of these drives, HLD should trigger a monostable to produce the necessary delay before HLT becomes low. Because most drives will need this monostable if they are to be used with the head normally un-loaded, it is important to establish the total delay before the head is ready for use, i.e. the loading and settling time. Note that one value cannot be inferred from the other by comparing the stepping rate figures for the two drives.

Drive options

Most drives offer wiring options, and in this system one for direct control of head loading by the controller is used. To select this option on the current model, remove the link joining pins 13 and 14 on plug PP2 (the middle one of three referred to earlier)

Table 3. Timing information for disc drivers and the controller.

	5¼in drive	WD1771 @ 1MHz	DRE 7100 8in drive	WD1771 @ 2MHz
Track to track stepping + settling times	40 + 10ms	programmable to 12, 20 or 40ms	4 + 14ms	programmable to 6, 10 or 20ms
Stepping pulse width	1μs min.	8μs	600ns (10μs on older units min.)	4μs
Head load and settling time	75ms	HLT sampled after 20ms, therefore monostable is required	30ms	HLT sampled after 10ms, therefore monostable is required

and join pins 3 and 14 together. On the obsolete version, remove the short wire link joining the points marked HL and SI and connect a wire from HL to the pad at the end of the p.c.b. track coming from the edge connector tab numbered 18.

This change allows the controller to drive the head-load circuit through the previously unused pin 18 on the edge connector. The current and obsolete units should now be interchangeable.

System software

The software in table 4 is not a full disc operating system, but it illustrates the basic functions required to position the head, read and write records of any length from 128bytes to 256Kbytes with error checking, and to re-format corrupted tracks. With the drive and interface connected to the computer, move the head towards the centre of the drive by turning the stepping motor by hand. Apply mains to the motor and then switch on the computer. Put a disc into the unit and close the door. If the system is working, the head should quickly step to the outermost track 00 because the charging delay, caused by the RC network on pin 19 of the controller i.c., holds that pin (master reset) momentarily low in a similar way to the circuit used on the Z80. One of the actions which takes place during the resetting sequence is a Restore command, which moves the head out in this way. If it doesn't, check that the wiring is correct. If it steps out but does not stop, check that the track 00 line from the drive to the controller functions. With the software loaded, RUN 1D00 and then READ space. In response to the prompts DESTINATION: TRACK: SECTOR: NUMBER OF SECTORS: type 8200 40 space 0 space 8 space respectively. The head should move in to track 40 and load 8 sectors (1Kbyte) of data from the disc, starting with sector 0 to computer locations 8200 to 85FF, i.e. onto the v.d.u. With the IBM formatted disc, these should appear as percentage or proportional symbols.

At the end of the read, which should take less than one second, the head should release from the disc and READY occur. If a reading error occurs, the computer will attempt to re-read the particular sector up to twenty times. A corruption should be evident by rubbish appearing on the v.d.u., the controller recognises it by computing the CRC from a permutation of the data from the sector and comparing it with the pre-recorded CRC. Each sector takes up two lines on the v.d.u. If the corruption begins in a line and keeps changing, the data is corrupted. If the reading process seems to stop at the end of a line, the controller is having trouble recognising the Ident Field for the track or sector and, therefore, the track needs to be re-formatted (described later). With an undamaged disc most reads are successful first time, but if the operation fails for the 20 times that it is attempted, the message ERROR AT TRACK XXX SECTOR XXX appears. To force an error into the system and observe this feature, try

1D00	ED 5E 3E 1D	ED 47 DD 21	E4 1D DB 05	DB 1D 3E FF
1D10	D3 A0 FB 76	76 08 76 FE	20 20 FE 08	CD C6 03 FE
1D20	12 20 21 CD	61 02 04 05	13 14 09 0E	01 14 09 0F
1D30	0E 3A 20 1D	CD DE 03 CD	C6 03 CD FD	1D 3E E7 CD
1D40	57 1E 18 F9	FE 17 20 33	CD 61 02 13	0F 15 12 03
1D50	05 3A 20 1D	CD DE 03 CD	C6 03 CD FD	1D 3E 71 32
1D60	F3 1D 3E 57	D3 A0 FB 76	3E F5 C1 C1	CD 57 1E 18
1D70	EC 1A 2F D3	B8 13 FB F9	76 18 ED FE	06 20 64 CD
1D80	C6 1E 79 32	A3 1D 21 00	C0 06 28 36	FF 23 10 FB
1D90	06 06 36 00	23 10 FB 36	FC 23 06 1A	36 FF 23 10
1DA0	FB 11 01 38	0E 1A 06 06	36 00 23 10	FB 36 FE 23
1DB0	72 23 36 00	23 73 23 36	00 23 36 F7	23 06 11 36
1DC0	00 23 10 FB	36 FB 23 06	80 36 E5 23	10 FE 36 F7
1DD0	23 06 1B 36	FF 23 10 FB	1C 0D 20 CA	06 00 36 FF
1DE0	23 10 FB C7	FF FF FF DB	1D 2F 12 13	FB F9 76 18
1DF0	72 F9 1D E7	1D DB 1D 18	F3 DB 05 2F	C9 CD 61 02
1E00	14 12 01 03	0B 3A 20 1D	CD C6 1E DD	71 00 CD C6
1E10	03 CD 61 02	13 05 03 14	0F 12 3A 20	1D CD C6 1E
1E20	DD 71 01 CD	C6 03 CD 61	02 0E 15 0D	02 05 12 20
1E30	0F 06 20 13	05 03 14 0F	12 13 3A 20	1D CD C6 1E
1E40	DD 71 02 CD	B9 1E 3E EB	D3 A0 FB 76	E6 18 20 F6
1E50	E5 21 00 00	39 D1 C9 32	F3 1D 06 14	3E 77 D5 D3
1E60	A0 FB 76 E6	18 28 34 D1	3E 73 10 F2	11 80 82 CD
1E70	61 02 05 12	12 0F 12 20	01 14 20 14	12 01 03 0B
1E80	20 1D DD 7E	00 CD DA 1E	CD 61 02 20	13 05 03 14
1E90	0F 12 20 1D	DD 7E 01 CD	DA 1E C7 C1	DD 35 02 CA
1EA0	00 00 DD 34	01 DD 7E 01	FE 1B 20 0D	DD 36 01 01
1EB0	DD 34 00 3E	A3 D3 A0 FB	76 DD 7E 00	2F D3 B8 DD
1EC0	7E 01 2F D3	B0 C9 76 E6	0F 4F 76 FE	20 C8 E6 0F
1ED0	47 79 07 4F	07 07 81 80	18 EF C5 CD	EA 1E C6 30
1EE0	EB 76 23 71	23 77 23 EB	C1 C9 06 30	48 FE 64 38
1EF0	05 04 D6 64	18 F7 FE 0A	38 05 0C D6	0A 18 F7 C9

Table 4. System software.

Table 5. Software subroutines.

1DF9	Used in READ and WRITE to convert the typed in track number, sector number and number of sectors from decimal to binary, and then dump them into locations 1DE4 to 6 respectively using the index register. These bytes are then sent to the controller, which is then told to step into this track and, by reading an indent field, verify that the head is over the correct track. Also, by reading the CRC, verifies that the track number has been correctly read and does not match the track register's contents by chance. The data destination/source address is transferred from HL to DE and, by clearing HL and adding SP to it, the contents of the stack pointer register are loaded into HL.
1E57	Used in READ and WRITE. On entering this routine, the A register holds a byte which is dumped at 1DF3 to be used by a DRQ interrupt as the lower part of the interrupt routine address (1DE7 for READ, 1D71 for WRITE, 1DF5 for VERIFY WRITE). 20_{10} is loaded into B and DE, which holds the destination/source address, is saved on the computer stack in case a re-read or -write is necessary. The controller is then instructed to read a sector of data to that and succeeding locations. After the read, at 1E63, a check is made for the correct CRC and for the existence of the track and sector. If no faults have occurred, execution jumps to 1E9B where the saved DE is discarded from the stack into BC and, using indexed operations, the number of sectors byte is decremented. If this operation sets the byte to zero, an exit is made because the READ is complete. Otherwise, the sector and, if necessary, the track number are updated for the next sector to be read, the information is sent to the controller registers and another sector is read. If the operation to read the sector fails, the starting address of the data is popped back off the stack and B is decremented. If this does not reduce it to zero, a re-read is attempted and after 20 attempts execution passes to 1E6C et al and the error message appears.
1EC6	Loads decimal data from the keyboard and converts it to binary in register C.
1EDA	Displays the contents of A, converted to decimal, on the v.d.u.
1DE7	The READ interrupt routine, called by a DRQ. This routine transfers the byte in the controller's data register to the Z80, inverts it to its true form, stores it in the location pointed to by DE, and increments DE ready for the next byte. The interrupt system in the Z80 is automatically disabled when an interrupt is accepted so that the Z80 can service the interrupting device without interference from the interrupting device itself. Standard service routines usually finish with a re-enabling of the interrupt system and then a return. To ensure that the return will occur, the Z80 does not re-enable the interrupt until it has executed the instruction after the enabling instruction F3. This service routine does not have a return, but it uses this one protected instruction after the F3, F9, to load HL into the stack pointer, SP, register. SP is increased by two when the subroutine 1DF9, which loaded HL with the SP,

ended and the return address was popped off the stack. When the DRQ interrupt was accepted, the current PC (program counter) contents were pushed onto the stack and SP decreased by two, as is normal at the calling of any subroutine. Therefore, for the first DRQ, HL and SP are the same and F9 has no effect. The next byte in the subroutine is a HALT, at which the Z80 stops and waits for the second DRQ which, when it arrives, jumps the execution back to the start of the subroutine and pushes another return address onto the stack. When the data byte is read and the F9 is executed, SP, which decremented when the second interrupt was accepted, is pulled back to where it was before the interrupt occurred. Therefore this, and all future DRQs are demoted from calls to being, effectively, simple jumps to 1DE7. Whilst each return address is written on top of the last as the DRQs progress, the first call from the main program remains unaltered one position further up the stack. When all 128 DRQs have passed and the SP has been pulled back again, the INTRQ interrupt occurs and this, having a conventional return at its end, returns execution to the first popped address, i.e. where the original "read a sector" command was given. This forms a neat method of writing the main program because it makes the controller appear as part of the main processor and, more important, it saves time. There are only 32μs during which data can be transferred from the controller to the memory, and the Z80 made ready for the next interrupt. If the sequence servicing the controller takes longer than this, data will be lost and the controller will halt the reading sequence. A conventional return takes 5½μs and the jump from this returning point to the "wait for a DRQ" point requires a further 6μs. The single F9 instruction only takes 3μs, which achieves the same purpose, but just within the 32μs limit.

1D71 The WRITE interrupt routine called by DRQ. This is similar to the previous routine in that the progress of the stack pointer is arrested by repetitive loading from HL. This routine differs because the first two DRQ-pushed addresses are saved, 1D68 and 1D79 respectively. When the 128 DRQs have occurred, INTRQ causes a jump to the status reading routine after which the return occurs to 1D79 at which a jump pushes execution on the 1D68. Here the other DRQ is popped off the stack and a new vector byte, F5, is placed into the A register ready for the third type of DRQ.

1DF5 When checking a written sector, 1E57 is used as the reading subroutine. Because we are interested in the CRC and not the data on the disc, 1DF5 acts like 1DE7 when handling DRQs, except that it makes no attempt to store the unwanted data and just waits for the INTRQ. When this arrives, 1DF5 returns to the point in the main program where the CRC can be checked to see if the track just written has verified itself.

reading any sector track 77, which does not exist! Note that spaces are required after decimal information – the track, sector and number of sectors, but not after the hexadecimal destination address.

If the Read has worked type RUN 1D00, which should cause the unloaded head to return to track 00. Next type WRITE space, and in response to SOURCE type 0000, for TRACK: 40 space, for SECTOR: 0 space, and for NUMBER OF SECTORS 32 space. The head should move in and write to track 40, step to track 41 and continue writing, so that the first 26 sectors fill track 40 and the final 6 fill sectors 0 to 5 track 41. The write operation is slower because after each sector is written it is read back and checked for errors. As before, up to 20 attempts are made before the operation terminates and the ERROR message occurs. Nevertheless, it should only take a few seconds to record the entire 4K monitor.

Explanations of the software subroutines are given in Table 5. To follow the main program 1D00 to 1DFC, a disassembler such as the one given in a recent computer newsletter is useful. The interrupt mode 2 is set and the I register, which is used (as described in part one) to form the top half of the interrupt addresses, is set at 1D and the IX index register is set at 1DE4. The index register is useful as a pointer to an area of memory because any indexed Z80 instructions, i.e. instructions prefixed by DD, will use a byte in the instruction to say which byte relative to 1DE4 is to be used in the instruction. In this case byte number 00 (i.e. 1DE4 itself) stores the required track number, byte number 01 (1DE5) stores the required sector number and byte 02 (1DE6) stores the number of sectors. The status and data registers are read next (not for their contents) to reset the INTRQ and DRQ interrupt lines if they are active due to the power-on sequence. Note that this unit is designed to operate with the mark III operating system, (see the scientific computer newsletter) which contains these same four bytes, DB,05, DB and 1D. They are executed in the high level so that the MM57109 interrupts are not upset by the disc controlled conditions. 1D0E-14 illustrates the way instructions are sent to the controller. The instruction byte loads into A, in this case a Restore instruction, it is sent to the command register, the interrupt is enabled and the Z80 is halted to wait for the interrupt. When it arrives, in this case a INTRQ, the computer reads the interrupt controller byte Fl, adds it to the 1D previously stored in the I register and then reads in the byte at 1DF1 and 1DF2 as the address of the INTRQ subroutine, which is 1DF9. Execution passes to this address when the status register is read and inverted back to a true state.

Re-formatting a disc

As well as reading and writing individual sectors, the controller can read and write whole tracks using the index pulse as the start and finish of the operation. As described in part one, even before use the disc is fully recorded with ident fields and dummy data. If the ident fields become magnetically corrupted, the entire track has to be re-recorded, or re-formatted, before it can be used in the sector mode again. To do this, a block of length 5¼K bytes must be set up in r.a.m. and then recorded en bloc. Assembley of this block requires extra r.a.m. over the basic computer's memory and, given this, the operating system can synthesise the track format. I used a 32Kbyte expansion (referred to in the computer newsletter) and assembled this block at C000. To accommodate other r.a.m. locations, the byte at 1D88 must be altered. After RUN 1D00, type FORMAT space and then the track number, in decimal, to be altered. As

continued on page 57

Table 6. Floppy-disc controller commands used. The asterisked addresses are where modifications to the software are made when a track is re-formatted.

Address	Byte	Command	Function
1D0F	FF	00	RESTORE the head to track 00 and clear the track register.
1D63	57	A8	Assuming the head is to be loaded against the disc, WRITE a single record of IBM format to the track and sector specified by the respective registers, using FB as the data mark.
1E47	EB	14	SEEK the track specified by the data register by stepping the difference between it and the contents of the track register. Then, by reading an Ident Field from the track, verify that it is the correct one.
*1E5D	77	88	Assuming that the head is loaded against the disc, READ a single record of IBM format from the track and sector specified by the respective registers.
1E69	73	8C	As above, but it begins by issuing the HLD, head load, signal and waiting for the HLT signal to become active before proceeding.
1EB4	A3	5C	Load the head against the disc and then STEP IN by one track, updating the track register. Perform a verify of the track as described above.
*1D63	0B	F4	WRITE TRACK. Starting at the index pulse, data is written continuously up to the next index pulse.
*1E47	EF	10	On a badly corrupted track, it is not possible to verify the head position after a SEEK, so this version of the command omits it.

"I NEVER KNEW COLOUR VIDEO COULD COST SO LITTLE"

Don't be put off by what you may have heard – or imagined – about the cost of colour video.

Talk to Bell & Howell or one of our Video Centres and get the current facts.

The fact, for example, that a portable JVC colour camera costs little more than an ordinary black-and-white camera.

And the further fact that by adding a JVC VHS you have a complete colour recording system for as little as £1,300 plus VAT. For playback, a standard TV receiver is all you need.

At these prices every user can benefit from colour. Training will be easier to understand; publicity more compelling; management communications more interesting; rôle-playing more effective. After all, we live in a coloured world.

PUSH-BUTTON FEATURES

Don't think for one minute that the low price has been achieved at the expense of useful features. Among other things the camera has an iris control which automatically adjusts lens aperture to match lighting conditions; a 6:1 power or manual zoom, giving close-ups as close as 50 mm; TTL indicators which automatically show exposure level, auto-white balance, operating mode and power level.

BETTER STILL

Or, if you feel inclined to make even fuller use of the camera's capabilities, couple it to a JVC ¾-inch U-format recorder.

The picture will be improved. You'll have another sound track to use for foreign-language commentaries or question-and-answer training routines.

On ¾-inch, moreover, you'll be in the right format to edit and duplicate – or add in library material. And still

the cost of the system needn't exceed £2,700 plus VAT. Alternatively, at very attractive rates, it can be leased.

SEE FIRST, THEN DECIDE

You can, of course, spend more. At any Bell & Howell Video Centre you'll see more expensive cameras, video recorders and electronic editing equipment that wouldn't be out of place in a national network.

But do you need them?

Let the Video Centre, or Bell & Howell, help you decide.

Whatever your decision, two things are certain.

One, colour video now costs a lot less than it used to (as well as being highly dependable and very easy to use).

Two, every unit in the system you choose qualifies for the Supershield warranty, unique to Bell & Howell.

Under Supershield, all adjustments, repairs and replacements (except for tubes and tapes) are free for two years after purchase. And if a job can't be done on the spot we also provide free transport anywhere in mainland Great Britain to and from a fully equipped Supershield video workshop.

Convert to (or start with) colour. With JVC video equipment. And the Bell & Howell Supershield guarantee.

Let Bell & Howell show you the answer.

To Pieter Glas, Bell & Howell A-V Ltd., Freepost, Wembley, Middlesex HA0 1BR.
Please send me more information about video equipment and a list of your Video Centres.

Name

Organisation

Address

WW 6/12

BELL & HOWELL
BELL & HOWELL
BELL & HOWELL

JVC CAMERAS. JVC RECORDERS. JVC STUDIO EQUIPMENT. JVC MONITORS. ELECTROHOME MONITORS. FUJI VIDEO TAPES.

WW — 104 FOR FURTHER DETAILS

The death of electric current

A contribution to electromagnetic theory

by **Ivor Catt** CAM Consultants

Conventionally a signal can be understood either in terms of electricity in conductors, with associated fields, or in terms of electric and magnetic fields terminating on those conductors. In this article the author steps outside the accepted dualism and proposes a mechanism of signal transmission based on Oliver Heaviside's 'energy current' without recourse to 'conductors' in their conventional role.

A major advance in electromagnetic theory, which I shall call the transition from Theory N to Theory H, was made by Oliver Heaviside a century ago. What is proposed here is a transition from Theory H to a third theory, Theory C. It is to be hoped that the response to Theory C will be more perceptive than was the general response to Theory H a century ago, as typified by Sprague, quoted in this article. Until it was revived recently by CAM Consultants, Theory H had been ignored and then suppressed for a century. It was revived because of its great value in digital electronic design.[1,2]

Theory C has major implications across a whole spectrum of subjects. It could trigger an exciting renaissance in many fields of endeavour.

Whereas the conventional approach to electromagnetic theory is to concentrate on the electric current in wires, with some additional consideration of voltages between wires, Heaviside concentrates primarily on what he calls 'energy current', this being the electromagnetic field which travels in the dielectric between the wires. It has an amplitude equal to the Poynting Vector, $E \times H$. Heaviside's phrase, "We reverse this"; points to the great watershed in the history of electromagnetic theory – between the 'ethereals', who with Heaviside believe that the signal is an 'energy current' which travels in the dielectric between the wires, and the 'practical electricians', who like Sprague believe that the signal is an electric current which travels down copper wires, and that if there *is* a 'field' in the space between the wires, this is only a result of what is happening in the conductors.

Oliver Heaviside announced Theory H a century ago[3]:

"Now in Maxwell's theory there is the potential energy of the displacement produced in the dielectric parts by the electric force, and there is the kinetic or magnetic energy of the magnetic induction due to the magnetic force in all parts of the field, including the conducting parts. They are supposed to be set up by the current in the wire. We reverse this; the current in the wire is set up by the energy transmitted through the medium around it . . ."

The importance of Heaviside's phrase, "We reverse this;" cannot be overstated. It points to the watershed between the 'practical electricians', who have held sway for the last half century, promulgating their theory – which we shall call 'Theory N', the Normal Theory: that the cause is electric currents in wires and electromagnetic fields are merely an effect – and the 'ethereals', who believe what we shall call 'Theory H': that the travelling field is the cause, and electric currents are merely an effect of these fields.

Opposition to any attempted change from the familiar Theory N to Theory H was forceful and successful for the next century. Sprague, a 'practical electrician' wedded to Theory N, with its retention of a phlogiston-like 'fluid'*, electricity, at the centre of the electromagnetic stage, wrote[4]:

"A new doctrine is becoming fashionable of late years, devised chiefly in order to bring the now important phenomena of alternating currents under the mathematical system. It is purely imaginery . . . based upon Clerk-Maxwell's electromagnetic theory of light, itself described by a favourable reviewer as 'a daring stroke of scientific speculation,' alleged to be proved by the very little understood experiments of Hertz, and supported by a host of assumptions and assertions for which no kind of evidence is offered; but its advocates now call it the 'orthodox' theory.

"This theory separates the two factors of electricity . . ., and declares that the 'current', the material action, is carried by the 'so-called conductor' (which according to Dr Lodge contains nothing, not even an impulse, and according to Mr O. Heaviside is to be regarded as an obstructor), but the energy leaves the 'source' (battery or dynamo) 'radiant in exactly the same sense as light is radiant', according to Professor Silvanus P. Thompson, and is carried in space by the ether: that it then 'swirls' round (cause for such swirling no one explains) and finds its way to the conductor in which it then produces the current which is apparently merely an agency for clearing the ether of energy which tends to 'choke' it, while the conductor serves no other purpose than that of a 'waste pipe' to get rid of this energy . . .

"This much, however, is certain; that if the 'ether' or medium, or di-electrics carry the energy, the practical electrician must not imagine he can get nature to do his work for him; the ether, &c., play no part whatever in the calculations he has to make; whether copper wire is a conductor or a waste pipe, that is what he has to provide in quantity and quality to do the work; if gutta percha, &c., really carry the energy, he need not trouble about providing *for that purpose;* he must see to it that he provides it according to the belief that it prevents loss of current. In other words, let theoretical mathematicians devise what new theories they please, the practical electrician must work upon the old theory that the conductor does his work and the insulation prevents its being wasted. Ohm's law (based on the old theory) is still his safe guide.

"For this reason I would urge all practical electricians, and all students who desire to gain a clear conception of the actual operations of electricity, to dismiss from their minds the new unproved hypotheses about the ether and the abstract theory of conduction, and to completely master the old, the practical, and common sense theory which links matter and energy together, . . . "

Sprague accurately described Theory N.

One of the few supporters of Theory H was J. A. Fleming, who wrote[5]:

"It is important that the student should bear in mind that, although we are accustomed to speak of the current as *flowing in the wire* in one direction or the other, this is a mere form of words. What we call *the current* in the wire is, to a very large extent, a process going on in the space or material outside the wire. Just as we familiarly speak of the sun rising and setting, when the effect is really due to the rotation of the earth, so the ordinary language we use in speaking about electric currents flowing in conductors retains the form impressed upon it by older and erroneous assumptions as to their nature."

Heaviside's view

As time went by, support for Theory H gradually died out. Let us end Theory H with a long discussion by its originator[6]:

"Consider the electric current, how it flows. From London to Manchester, Edinburgh, Glasgow, and hundreds of other places, day and night, are sent with great velocity, in rapid succession, backwards and forwards, electric currents, to effect mechanical motions at a distance, and thus serve the material interests of man.

* Phlogiston was a 'subtle fluid' postulated by the German chemist G. E. Stahl (1660-1734). It was thought to be combined with a 'calx' or ash in combustible materials and to be given off by these materials in the process of burning, leaving the ash behind. This hypothesis was strongly held in the 18th century but was eventually upset by Lavoisier's deductions leading to the theory of the conservation of mass. – Ed.

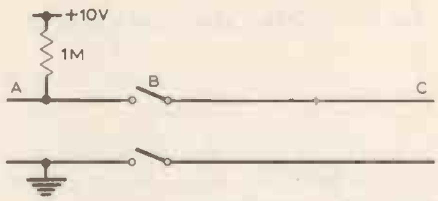
"By the way, is there such a thing as an electric current? Not that it is intended to cast any doubt upon the existence of a phenomenon so called; but is it a current – that is, something moving through a wire? Now, although nothing but very careful inculation at a tender age, continued unremittingly up to maturity, of the doctrine of the materiality of electricity, and its motion from place to place, would have made me believe it, still, there is so much in electric phenomena to support the idea of electricity being a distinct entity, and the force of habit is so great, that it is not easy to get rid of the idea when once it has been formed. In the historical development of science, static phenomena came first. In them the apparent individuality of electricity, in the form of charges upon conductors, is most distinctly indicated. The fluids may be childish notions, appropriate to the infancy of science; but still electric charges are easily imaginable to be quantities of a something, though not matter, which can be carried about from place to place. In the most natural manner possible, when dynamic electricity came under investigation, the static ideas were transferred to the electric current, which became the actual motion of electricity through a wire. This has reached its fullest development in the hands of the German philosophers, from Weber to Clausius, resulting in ingenious explanations of electric phenomena based upon forces acting at a distance between moving or fixed individual elements of electricity.

"Return to our wire from London to Edinburgh with a steady current from the battery in London. The energy is poured out of the battery *sideways* into the dielectric at a steady rate. Divide into tubes bounded by lines of energy-current. They pursue in general solenoidal paths in the dielectric, and terminate in the conductor. The amount of energy entering a given length of the conductor is the same wherever that length may be situated. The lines of energy-current are the intersections of the magnetic and electric equipotential surfaces. Most of the energy is transmitted parallel to the wire nearly, with a slight slant towards the wire in the direction of propagation; thus the lines of energy-current meet the wire very obliquely. But some of the outer tubes go out into space to an immense distance, especially those which terminate on the further end of the wire. Others pass between the wire and the earth, but none in the earth itself from London to Edinburgh, or vice versa, although there is a small amount of energy entering the earth straight downwards, especially at the earth "plates". If there is an instrument in circuit at Edinburgh, it is worked by energy that has travelled wholly through the dielectric, then finding its way into the instrument . . ."

If we keep to Theory H, the theory that the field $E \times H$, travelling along between the wires at the speed of light – what Heaviside called the 'energy current', is the cause, then electric charge and electric current are merely what define the *edge* of an energy current. If electric current is that which defines the side of an energy current, then we may with equal justification postulate 'displacement current' as that which defines the front face of a step of energy current[1].

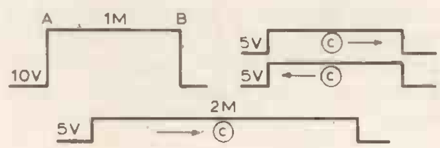
Now let us move on to Theory C, when we drop the dualism – circuit and field – that has until now been the foundation of electromagnetic theory. First we shall discuss the reed relay pulse generator, which illustrates some of the ideas underlying Theory C.

The reed relay pulse generator was a means of generating a fast pulse using rather primitive methods. A one-metre section of 50-ohm coaxial cable AB was charged up to a steady 10 volts (say) via a one megohm resistor, and then suddenly discharged into a long piece of coax BC by the closure of two switches.



A five-volt pulse two metres wide was found to travel off to the right at the speed of light for the dielectric on closure of the switches, leaving the section AB completely discharged. (The practical device lacked the second, lower switch at B, which is added in the diagram to simplify the argument).

The curious point is that the width of the pulse travelling off down BC is twice as much as the time delay for a signal between A and B. Also, the voltage is half of what one would expect. It appears that after the switch was closed, some energy current must have started off to the *left*, *away* from the now closed switch; bounced off the open circuit at A, and then returned all the way back to the switch at B and beyond.



This paradox, that when the switches are closed, energy current promptly rushes *away* from the path suddenly made available, is understandable if one postulates that a steady charged capacitor is not steady at all; it contains energy current, half of it travelling to the right at the speed of light, and the other half travelling to the left at the speed of light.

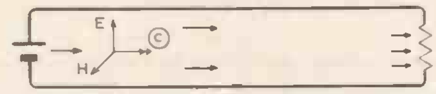
Now it becomes obvious that when the switches are closed, the right-wards travelling energy current will exit down BC first, immediately followed by the leftwards travelling energy current after it has bounced off the open circuit at A.

We are driving towards the principle that *energy (current) $E \times H$ cannot stand still; it can only travel at the speed of light.* Any apparently steady field is a combination of two energy currents travelling in opposite directions at the speed of light[7].

E and *H* always travel together in fixed proportion Z_0.

Electric charge does not exist according to Theory C. The so-called electric charge is merely the edge of two reciprocating energy currents. In the case of the so-called steady charged capacitor, the electric fields of the two energy currents add but the magnetic fields cancel, so that it has come to be thought that a charged capacitor is devoid of magnetic field.

Now let us consider a simple circuit with battery and resistor. Two conductors guide the energy current from battery to resistor. It enters the resistor *sideways*



(Kip 1962)[6]. 'Electric current' is merely the side of a wave of energy current. If a 'conductor' is perfect, the energy current has a sharp side; the so-called 'electric current' has infinite density in the outside surface of the 'electric conductor', which Heaviside called an obstructor.

Energy current penetrates an imperfect conductor in the same way as it enters a resistor, from the side. In this case, the region containing a variation in energy current density, the so-called 'electric current', widens and penetrates into the conductor; skin depth is no longer zero.

Nothing exists behind a mirror; nothing happens there. The velocity of the 'things' behind a mirror does not depend on the medium, or material, behind the mirror[8].

As Maxwell's equations show,[9] 'electric current' is always derivable as the gradient on the side of a wave of energy current. Unlike energy current (but like the images in a mirror), electric current contains no energy, it has no function, and it explains nothing. Electric current does not exist.

Although a cloud cannot exist without edges, the *edges* of a cloud do not exist. They have no width, volume, or materiality. However, the *edges* of a cloud can be drawn. Their shapes can be manipulated graphically and mathematically. The same is true of the so-called 'electric current'.

In the following analogies, the sheep represent energy, the dogs electricity.

Theory N. The sheep are forced out of the pen by the sheep-dogs. The dogs then run alongside the sheep. There can only be a forward flow if sheep-dogs first advance on both sides of the flow of sheep, which the dogs direct and cause.

Theory H. The sheep rush out of the pen into the great open spaces. They will go forward regardless, but their direction is actively guided by the sheep-dogs running alongside, the front of the line of dogs always keeping level with the foremost sheep.

Theory C. There are no sheep-dogs. The sheep leave the pen and flow out into the great open spaces. Some of the space is rougher. (This rough space was previously thought to be the terrain preferred by the dogs.) Here fewer sheep go, and their rate of advance is slower. Some ground is very obstructive, nearly impassable for sheep.

Although it might appear that the sheep are actively guided by the rough terrain towards the smooth terrain, this is not so. Neither does a grease mark on blotting paper actively guide the ink towards the ungreasy areas. There is no active guidance mechanism; greasy paper is merely bad blotting paper with poor capillary action, passively guiding the ink.

The excision of sheep-dogs from the theory is a giant simplification. Nothing flows in the conductor; nothing happens therein. Heaviside was right to call it an obstructor. Half of the primitives in electromagnetic theory disappear, and it ceases to be a dualistic theory. ρ and $\mathcal{J}$ disappear, becoming merely the physically non-existent results of the mathematical manipulation of E and H, with no more significance than "circularity"' (Letters, June 1979 issue, p. 82).

The direct transition from Theory N to Theory C is similar to the change in combustion theory from phlogiston to oxidation, but is more difficult. Phlogiston is very similar to electricity, being a strange 'fluid' which permeates solids. But whereas the oxygen which 'replaced' phlogiston was still within the same body, the energy current which replaces electricity is not where the electricity was; it is where it was not. This is a very difficult transition. If the idea of replacing the well known phlogiston by oxygen caused mirth at High Table, we have to expect Theory C to generate widespread hilarity.

I would like to thank David Walton and Malcolm Davidson of CAM Consultants for their dogged support for six years. This article is taken from the book Electromagnetic Theory Vol 2, pub. CAM Publishing, 17 King Harry Lane, St. Albans, England.

References

1. Catt, I., Davidson and Walton 1979, The History of Displacement Current, *Wireless World*, March 1979, pp.67-68.
2. Catt, I., 1979, The Heaviside Signal, *Wireless World*, July 1979, pp.72-74.
3. Heaviside, O., 1892, Electrical Papers Vol 1, p.438.
4. Sprague, J. T., 1892, Electricity: Its Theory, Sources and Applications, p.239.
5. Fleming, J. A. 1898, Magnets and Electric Currents, p.80.
6. Heaviside, O., 1892, ibid, p.434. Kip, A. F., 1962, Fundamentals of Electricity and Magnetism, pub. McGraw-Hill, p.327.
7. Catt, I., Walton and Davidson, 1979, Digital Electronic Design Vol 2, pub. CAM Publishing, p.248.
8. Catt, I., 1979, Electromagnetic Theory Vol 1, pub. CAM Publishing, p.93.
9. Bell, D. A., 1980, *Wireless World*, September 1980, p.50, first sentence.

Appendix

Definition of a perfect conductor: $\epsilon=\infty$.
It follows that velocity of energy current

$$=\frac{1}{\sqrt{\mu\epsilon}}=0$$

Impedance $Z_0=\sqrt{(\mu/\epsilon)}=0$

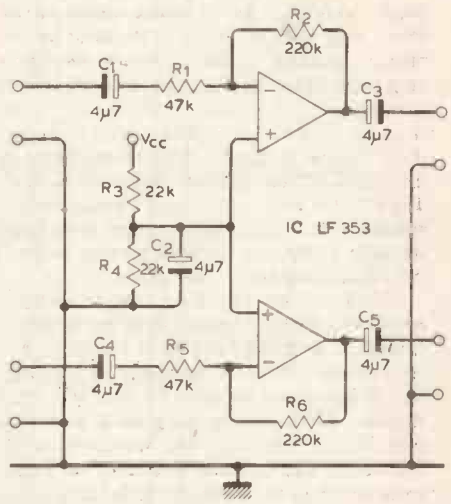
In an imperfect conductor, ϵ is very high.
Impedance $(=Z_0)\rightarrow 0$
Penetration velocity is very slow. □

Solid-state level meter – further notes

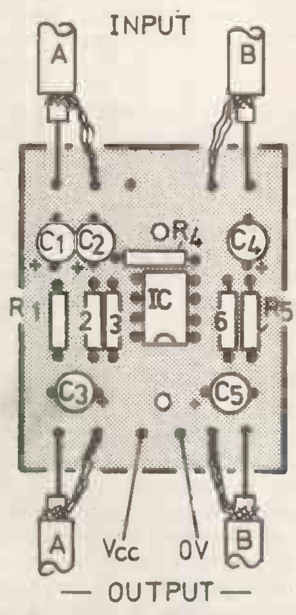
Several points were not fully explained in Quentin Rice's article on his level indicator in the August issue. The peak hold function was a late addition. Achieved by taking a terminal adjacent to R_4 to 0V, this effectively switches off the decay voltage and is extremely useful for peak detection. Although the unit has no graduations, the author says it is a linear and accurate piece of equipment, and the user can employ whatever scaling is required. The attack time of the circuit is about 2ms f.s.d., which is well within any p.p.m. specification, but if this is felt to be too fast, increase the value of R_9.

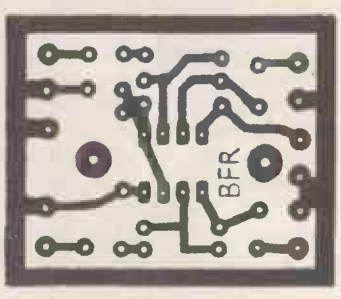
When the unit was used with an oriental cassette recorder of dubious electronic integrity (expensive but no input h.f. rolloff, and no monitoring facility), intermodulation occurred because the meter was taken directly from the medium-impedance record output. This is overcome in such cases by using a buffer to isolate the signal and to provide adequate gain to bring the signal up to a useable level. With low impedance lines, this presents no problems.

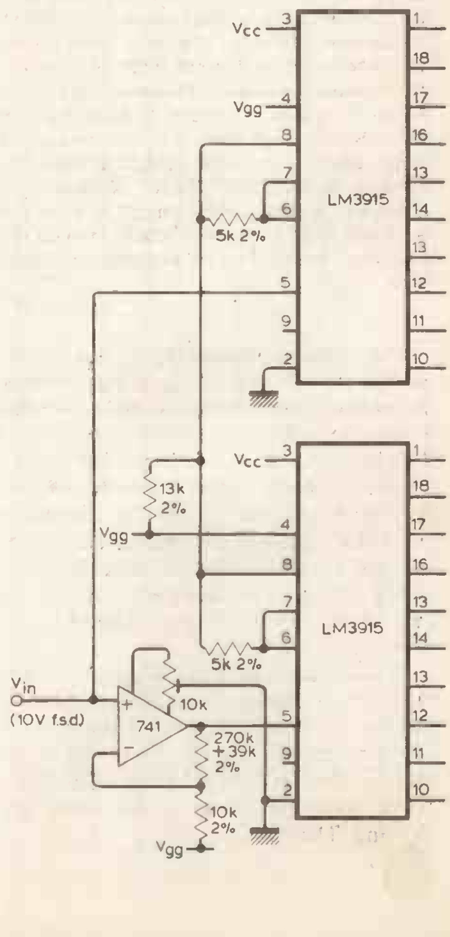
Mention was made of the LM3915 and 3916 devices. As the data are quite recent, no consideration for these was made in the original design. The LM3915 may be cascaded like the 3914, giving twenty steps of 3dB, but an extra op-amp is required to provide 30dB gain and offset. The regulator is changed for a 24V type, and D_6 is changed to 12V. It should be borne in mind that the decay is no longer linear as it follows the law of the display. The LM3916 is not cascadable, but it can be used with the LM3915 to give a mixed law display with a 40dB range, albeit with only 19 l.e.ds and without the linear decay. In this circuit, the dot/bar mode select is difficult to implement. For further information, consult the National Semiconductor literature. □



Circuit for 60dB display range, left, uses LW3915 V_{cc} 24V, V_{gg} 12V. Buffer circuit, above, and board patterns are for use with medium-impedance outputs. V_{cc} can be 15 to 30V, unregulated. In the p.c.b. pattern on page 32 (August issue), pins 6 & 7 of IC3 should be linked to pins 4 & 8 of IC_4.



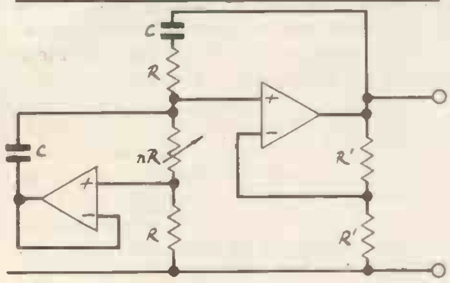




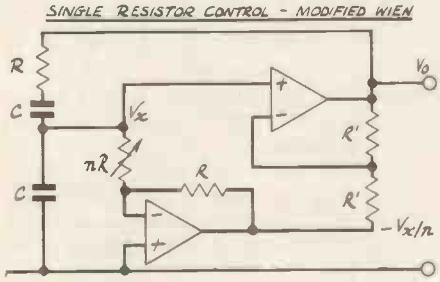
RC oscillators: single-element frequency control

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

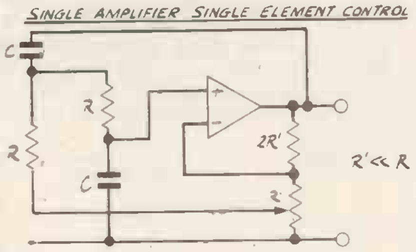
MODIFIED WIEN OSCILLATOR: SINGLE ELEMENT CONTROL



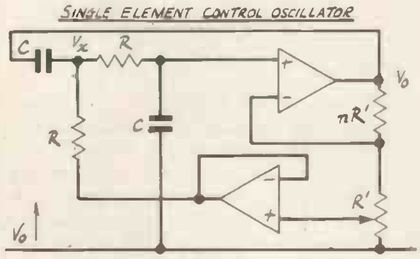
SINGLE RESISTOR CONTROL - MODIFIED WIEN



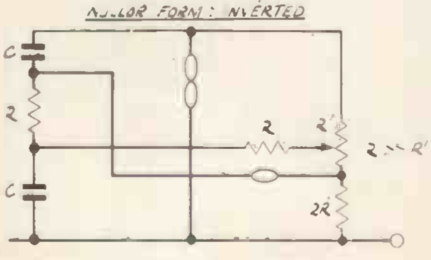
SINGLE AMPLIFIER SINGLE ELEMENT CONTROL



SINGLE ELEMENT CONTROL OSCILLATOR



NULLOR FORM: INVERTED



The best-known RC oscillator is based on the Wien network, usually in the form of a bridge activated by an operational amplifier or other high-gain equivalent. It shares with the related lead-lag and lag-lead circuits the need for simultaneous adjustment of two components if the frequency is to be varied without change in the loop gain. A number of elegant alternatives have been devised to overcome these limitations, usually at the expense of an additional amplifier. In this example the shunt capacitor of the Wien network is driven instead via a unity-gain buffer from a tapping on the resistor. By varying the resistor shown the frequency of oscillation is controlled over >100:1 range without change in the oscillatory condition (excepting second-order effects due to amplifier impedances, bandwidth etc.). This allows the amplitude to be controlled by a suitable amplitude sensing circuit with only minor shifts in the operating point of the sensing element. The ratio of resistors differs from that of the conventional bridge. At either extreme of the frequency range the distortion increases and the second-order effects shift the amplitude but good performance over a 10:1 range is readily achieved with the single variable resistance.

This circuit uses the current in the resistance path of the shunt CR network to provide a drive voltage for what would otherwise be the ground point on the feedback potential divider. Again variation of the single resistor changes the frequency of zero phase shift. At the same time the auxiliary amplifier injects a correcting signal into the potential divider to restore the gain condition. It is no coincidence that this and the previous circuit use the same components; this circuit was published first and the previous one derived from it by drawing in nullor form and manipulating the nullators and norators to produce new circuits, equivalent internally but differing for example in the point on the passive network is grounded. There are yet other practical forms but these two appear most useful each being tunable over a 100:1 range using a single variable resistor. Clearly the output of the auxiliary amplifier must vary with frequency of oscillation and the original output is the one that would normally be stabilized. Any of the stabilization methods applicable to the Wien bridge oscillators are equally applicable here.

The lead-lag and lag-lead oscillators are known to have identical transfer functions to Wien network for equal R and C values throughout. The impedance properties internal to the networks are different and there is no direct equivalent to the previous one. Another family of oscillators have been described using lag and lead networks with the addition of a second variable gain amplifier that, appropriately connected, again controls the frequency while leaving the oscillator gain condition unchanged. A simple alternative to a variable gain amplifier is a constant gain preceded by variable attenuation. In one of the configurations it is found that varying the gain from 0 to +1 gives control of frequency from its usual value of $f=1/2\pi CR$ toward zero. The amplifier is then a unity-gain buffer though a high input impedance stage such as a source follower is a convenient alternative. The useful frequency range in this circuit is of order 100:1 with a low distortion and stable amplitude readily achievable over more than a 10:1 range.

To reduce the number of variable components and achieve single-element control of frequency it has been necessary to introduce a second amplifier (or to permit the gain condition to vary widely placing a strain on the amplitude controlling circuitry). In the previous circuit a very simple step eliminates the extra amplifier. Because the variable-gain requirement has been reduced to variable attenuation the amplifier is being used only to buffer the lead-lag network from the potential divider. With modern operational amplifiers, particularly those with f.e.t. input stages, the ratio of the lead-lag resistances to the potential divider resistance can be large enough that the loading effect is negligible for the buffer amplifier to be omitted. In the final circuit shown, R«R and oscillation can be extended to low frequencies using relatively low values of capacitance – both because R may be large and because the configuration reduces the frequency further as the tapping point on the potentiometer is increased from 0 to 100%. This circuit achieves frequency variation with a single potentiometer while requiring only a single operation amplifier. The loading effect cannot be completely ignored but the usable frequency range though less than for the two-amplifier circuits readily exceeds 10:1.

A powerful design tool in creating these variants is the nullor. If the single amplifier circuit is re-drawn in nullor form and inverted its internal behaviour remains the same. The shift in ground point to the other end of the norator then allows a new operational amplifier form to be produced. The same component values result in the same frequency of oscillation. The differences in performance may be significant as the common mode swing at the amplifier input terminals is ⅔ of the output instead of ⅓. An advantage of this configuration is that the resistance 2R' is grounded which makes it easier to control via an amplitude sensing network. It is such practical points that make it advisable to consider alternatives to known circuits – they will not often provide dramatic improvements but each new form may have particular advantage that can be exploited in particular circumstances.

RC oscillators: single-element frequency control

THEORY

● In each of the first two examples the resistor ratio to give the appropriate gain condition is assumed; the frequency condition then follows simply. In the third case the analysis is fuller with no prior assumption.

Oscillator frequency corresponds to network attenuation of 0.5. Impedance of series arm is $R+1/sC$

Admittance of shunt arm $\dfrac{1}{(n+1)R}+\dfrac{n\,.\,sC}{n+1}$

$$\therefore (n+1)R=(1+nsCR)(R+1/sC)$$

$$s=-\frac{1}{nC^2R^2}$$

$$\omega=\frac{1}{\sqrt{n}}\cdot\frac{1}{CR}=\frac{\omega_0}{\sqrt{n}} \quad \text{where } \omega_0=\frac{1}{CR}$$

● The impedance convertor interpretation is not appropriate to the second form of oscillator.

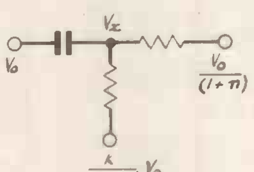
$$\frac{v_0}{v_x}=1+Z_sY_p$$

$$1+(R+\frac{1}{sC})(sC+\frac{1}{nR})=2+\frac{1}{n}+sCR+\frac{1}{nsCR}$$

$$\text{But } \frac{v_0-\frac{v_x}{n}}{2}=v_x \text{ or } v_0=v_x(2+\frac{1}{n})$$

$$\therefore \frac{v_0}{v_x}=2+\frac{1}{n}=2+\frac{1}{n}+sCR+\frac{1}{nsCR} \quad \text{and} \quad \omega=\frac{1}{\sqrt{n}}\cdot\frac{1}{CR}$$

● If v_x is derived (i) from the RC potential divider driving the non-inverting input (ii) by applying Millman's theorem (or superposition) and the two results equated, an equation leading to the frequency and gain conditions is obtained.



(i) $v_x=\dfrac{v_0}{1+n}(1+sCR)$

(ii) $v_x=\dfrac{v_0\left[sC+\dfrac{k}{(n+1)R}+\dfrac{1}{(n+1)R}\right]}{sC+1/R+1/R}$

$$(1+sCR)(sC+2/R)=(1+n)\,(sC+\frac{1}{R}\cdot\frac{k+1}{n+1})$$

$$(1+sCR)(2+sCR)=RsC(1+n)+k+1$$

$$2+3sCR+(sCR)^2-sCR(1+n)-(k+1)=o$$

Equating real and imaginary separately to zero

$$(1+n)=3$$

$$2-(k+1)=(\omega CR)^2$$

$$\omega=\frac{\sqrt{1-k}}{CR} \quad \text{where } \omega_0=\frac{1}{CR}$$

● As $k\rightarrow 1$ $\omega/\omega_0\rightarrow 0$ and low frequencies of oscillation are attained without the need for large time constants. The theory is applicable to the single-amplifier circuit provided $R'\ll R$ as then the loading effect on the potential divider remains negligible. The algebra is equally valid for the nullor equivalent circuit, its inverted form and any operational amplifier forms derived from them.

EXAMPLES

1. The first oscillator is required to have a frequency range from 100Hz to 3kHz. Choose suitable component values, given that the available variable resistors have a contact resistance of 10Ω and that the op amp input resistance with feedback is 10MΩ.

The constraints suggest that the variable resistor has to be $\gg$ 10Ω to avoid significant frequency shifts due to contact resistance variation. Similarly to avoid loading by the op amp the resistance should be $\ll$10MΩ. To meet the frequency range with a dependence on $1/\sqrt{n}$, the resistance has to change by $(3000/100)^2$ over the whole range i.e. 900:1. This is just possible while meeting the constraints if say R_{min} = 330Ω and R_{max} = 300kΩ. Then

R_{min} = 33 x contact resistance

R_{max} = $\dfrac{\text{op-amp input resistance}}{33}$

with consequent errors of a few percent at the extreme ends of the range.

This example illustrates the difficulty of achieving wide frequency variation with a single control element — though possible it requires considerable attention to detailed design.

2. The single-amplifier single-element-control oscillator uses a thermistor for amplitude control. The thermistor has optimum performance when its p.d. is 1V rms and it is dissipating 2mW. Choosing an appropriate value for the potentiometer, select R, C values to give a frequency of oscillation of 1kHz when the potentiometer is set at its mid point.

The thermistor has to be placed at location 2R′ to control the amplitude — as the amplitude increases the thermistor is heated causing its resistance to fall. This provides more negative feedback, reducing and then stabilizing the amplitude.

$$\text{Thus } P=\frac{v^2}{(2R')}$$

$$2R'=\frac{1^2}{2.10^{-3}}$$

$$R'=\frac{10^3}{4}=250\Omega$$

This is a standard potentiometer value and presents no problem. The R values of the lead-lag network must be $\gg R'$ to avoid loading of the potentiometer, but should not be so high as to be loaded in turn by the op amp inputs. The latter constraint can be virtually removed by using f.e.t. input op amps, though increased susceptibility to hum pick-up can be a problem.

These considerations suggest R = 100kΩ as a suitable compromise (400 x R′).

For k = 0.5

$$\omega=2\pi 10^3=\frac{\sqrt{1-0.5}}{C\ 10^5}$$

$$\therefore C=\frac{0.707}{2\pi\ 10^8}$$

$$=1.12\text{nF}$$

LETTERS TO THE EDITOR

DESIGNING WITH MICROPROCESSORS

I read the letter from R. M. O'Connor in the October issue with great dismay and I suspect that it has put off a few would-be micro system designers and made them think again.

I would like to describe, as briefly as possible, a microprocessor based system that I have designed and built in just two months. I was not put off by any fears of components becoming out of date overnight. The objective was to design and make a machine, and it was achieved with great success.

My business needed a machine to off-line direct mail letter production. We already have a Research Machine 380Z but this is in full time use doing other work. The machine needed: (a) the ability to read a serial keyboard and a cassette deck; (b) between 2 and 4 kilobytes of r.o.m. and about 4 kilobytes of r.a.m.; and (c) a driver for a fast daisywheel printer. (No screen was needed; the daisywheel provides the user-machine interface.)

After browsing through several back copies of your journal I realized that the Z80 is the best and most popular processor around; also, because our Research Machines 380Z uses a Z80A, then this could be used to assemble the program which would control the new machine.

Careful scrutiny of the *WW* articles on Z80 type systems (particularly those by John Adams on the Scientific Computer) showed that there are not many ways of putting the support logic around a Z80. I therefore 'learned' how to design a system by studying these articles.

A design was made, carefully checked and improved. A printed circuit was then designed (double sided) and this was etched by a local firm. The whole was then assembled and tested. To my absolute delight it worked more or less first time. The faults were in the printed circuit tracks being fractured; there was no design fault at all.

Next, software. A book on Z80 assembly programming was purchased and studied. The program to control the machine was written and assembled on the 380Z. It was not possible to test it on the 380Z because of the way input-output was implemented. Very careful desk checking was time well spent; there was no method of tracing the program once it was on the 'new' machine. The program (approx. 1500 bytes) was burnt into two 2708 e.p.r.o.ms and the machine was tested. It worked, although not quite properly – subsequent sorting out did not take long.

To summarise: *It does help a great deal* to understand how a particular microprocessor works. It is vital to understand the connections to the processor. It is futile to worry that a particular processor will become out-dated. If every designer held this view then nothing would be designed! The Z80 has been, and will be, around for many many years.

I now have a machine that does exactly what I require and if a 32-bit machine comes along that is 500 times faster than my Z80 I will not worry one bit. I have had the satisfaction of designing from scratch, and with help from the many contributors to *WW*, a simple yet very useful machine for very little cost (£150). I now have considerable confidence in tackling further microprocessor based systems. It really is not that difficult.

Finally, and in defence of ICL, Mr O'Connor has got it all wrong about the 2900 range of machines. The majority of these machines use 'microcode' rather than hard wired instructions. This enables them to 'pretend' to be any machine, not just the ICL machine models that they replace. It is not true that they are 'very inefficient indeed'. They run at the same speed regardless of the machine they are emulating and their performance is very high. Does Mr O'Connor seriously believe that users would accept performance of the kind he describes? No, the 2900 range is one of the best in the world – the sales figures clearly demonstrate that.

Charles Coultas
Reading
Berks

CRANKY VIEWS

I have news for S. Frost (October letters). The millibel, to use John Stuart Mill's own words, *is* an absolute certainty – a concept that is probably beyond the comprehension of most modern politicians, let alone one of the greatest of the nineteenth century.

So I still stand firmly by what I said in my original letter (May issue) – that in the context of its proposed *application*, it was rubbish; and if, in doing so, I was impolite, that too was intentional.

My second comment ought to have been read more carefully. I would never deny the right to a platform for cranky views; good heavens, there are plenty of those around already and they are freely available on any bookstall. But is it not reasonable to plead for one oasis where rational and carefully considered ideas can be discussed? Or is it the intention of *Wireless World* to go the way of the comic papers that masquerade as technical journals?

And since, sir, we are getting into a quoting match, may I parry with one from the same source: "The liberty of the individual must be this far limited; he must not make himself a nuisance to other people".

Can we now get back to good engineering and leave political philosophy to others?

Reg Williamson
Norwich

ENGINEERS IN THE ARMS RACE

It is a sad day for me, having studied *Wireless World* for more than 60 years, to be reading an editorial in it openly urging civil rebellion, thereby laying itself open to a charge of treason (November issue). And on a basis of untrue and libellous statements too.

You say, in effect, that our post-war governments – Labour and Conservative – and our military and industrial leaders consist of megalomaniacs and insane persons, not amenable to reason but only to force applied by popular insurrection. I comfort myself with the thought that such a rebellion is unlikely to result from your intemperate outburst.

There is certainly a case (to which during recent months you have not neglected to give prominence in what is supposed to be a technical journal) for suggesting to readers that they give conscientious thought to the morality of their vocations. There is also a case for asking them to take account of the fact that whereas world war II broke out 21 years after world war I, the latter ended 35 years ago and still there is no world war III in spite of the imperialistic aims of the Soviet 'Union,' and its many annexations effected by the mere threat of nuclear power. Have you in mind bringing present authority in the West to an end, thus introducing a state of chaos hitherto unknown here, and handing ourselves over to the mercies of the Soviets through the removal of the deterrent which (it is not unreasonable to argue) has extended the duration of general peace so much longer than last time in spite of at least as great aggressive intentions?

I realise that in saying this, and in failing to rally to the call to rebel, I have put myself among your demented class. Personally, instead of taking for granted that all who think, however reluctantly, that there is a case for the nuclear deterrent, are out of their minds and must be forcibly locked up, I would rather be charitable enough to give them credit for having given serious thought to the matter with the object of preventing any repetition of the dreadful scenes described in your quotation. It is very very difficult to know what to do. But of one thing I am sure, that your dogmatic and insulting attitude is unlikely to make matters any better.

M. G. Scroggie
Bexhill
Sussex

My son, who is a test engineer, bought a copy of the November issue of *Wireless World* yesterday and showed me the editorial on page 37 entitled "Microchips and megadeaths." My husband, son and I were all most impressed by the wording and presentation of this article. I would like to say how heartened I was to read your editorial as I sometimes get depressed by people who call me a traitor, especially as I am a perfectly ordinary middle-age woman with no strong political affiliations.

Mary Davies
Reading
Berks

Since the publication of my letter in November 1979, whether by coincidence or otherwise this subject has not been discussed in your magazine. I see in the September issue a letter by Peter G. M. Dawe who, in my opinion, is highly irresponsible. He says it is dangerous to have a nuclear capability. I submit that it would be suicide not to have one – and at best we would be puppets of the Russians. We need these brilliant people he suggests should be put on the dole – the designers, the constructors, the project leaders. We are also told they have serious gaps in their knowledge. As a technical person I know this to be rubbish, having known a few of these highly skilled people.

The freedoms we all enjoy today were fought for at a terrible price in the first and second world wars. Defence costs are part of the continuing price of freedom and we should therefore keep our heads out of the sand and refrain from making a third mistake.

Peter C. Gregory, G4HXV
Ashton-under-Lyne

Your November editorial "Microchips and megadeaths" made me very proud. Thank you for printing it.

I perceive two great threats to mankind: first is the use of the ultimate weapon, second is the passive acceptance of the idea that such a weapon will inevitably exist in all futures. The second frightens me more; we have to live with its paranoia.

If sanity is left in the hands of the engineers, then surely we can perfect the megachip and the microdeath?

Philip Atkin
Gonville and Caius College
Cambridge

Congratulations on your editorial "Microchips and megadeaths" in the November issue. You are so right. No arms race without the active cooperation of the technical world. We need a new style of conscientious objection.

Bruce Kent
Campaign for Nuclear Disarmament
London WC1

E MADE EASIER

I found Mr Finlay's three-part article on e (December, February, April issues), of absorbing interest. For me, he certainly succeeded in enlivening what I recall from my student days as a rather dull subject.

Perhaps I can make a contribution by outlining another method for evaluating e on a cheap pocket calculator: a method which I suggest is easier to memorise and more accurate than most cited by Mr Finlay.

Mr Finlay showed from first principles that e $\approx (1 + 1/n)^n$ when n is large, but this converges rather slowly. Faster convergence is obtained with the allied formula

$$e \approx \left[\frac{n+1}{n-1}\right]^{n/2}$$

Now translate this to binary form, viz.:

$$e \approx \left[\frac{2^n+1}{2^n-1}\right]^{2(n-1)}$$

This can be applied on an ordinary four-function calculator, even without memory – provided only that it will treat the display both as multiplicand and multiplier (as most do).

For instance, select $n = 8$. It requires little mental effort to find $2^8 = 256$. Enter 257 ÷ 255 =. Then press x = seven times. The result on my calculator is 2.7182703 – having an error, when rounded, of only one unit in the fifth decimal place.

ODDBALL IDEAS

"Mixer", writing in the August issue, is concerned about the shops which are closed to oddball ideas. Strangely enough, we academics (not my own choice of phrase, but more apposite than 'we scientists,' which I might reasonably claim to be in the view of the lay public) find ourselves on both sides of the counter in these shops. We are, it is true, sometimes bothered by 'flat earthers', if one might coin a phrase for the kind of people that have alternative ideas that are no more useful than one's own. But equally, we also send 'original' papers to unsuitable magazines, or the editor suggests that we have simply re-invented the wheel, or his referee has written the standard text book on the subject which is still selling well in its umpteenth paperback edition.

But what I think troubles me occasionally, and less reasonably, is the oddball letter that I find unintelligible. If a letter is couched in language that betrays an ignorance of the specific meanings of words and phrases that are commonly used in scientific and technical intercourse, then there is no way that I can be sure that I understand what the author means. Sometimes I can pass it to somebody with specialist knowledge and hope that he can discover its meaning or lack of it. Occasionally I have been referred to in my turn, and only once have I been able to say 'yes, this chap is not off his rocker, his proposal is feasible, and may be useful'. And what of the 'seeker after truth' person, who is difficult to convince of the pointless task of seeking right and wrong in physics? A physicist is more likely to 'borrow' a new idea if he thinks it useful, than to reject it on the grounds that Newton was always 'right'. But it has to be couched in standard scientific language or it doesn't even get to first base. As Heaviside discovered.

I am of course always fascinated by encounters of the Dingle-McCrea, Snow-Leavis, and now in *WW* the 'Displacement Current', kind, where the Gods are fighting it out way above my head, and cries of 'oddball' must disturb the calm of editorial offices almost daily. From the safety of *my* ivory tower, I can enjoy the wrangles of Tweedledum with Tweedledee for a mere 60p a month.

Desmond Thackeray
Department of Music
University of Surrey

INERTIA OF THE ELECTRON

In the article on the inertia of the electron by T. B. Tang in the May issue we find references to numerical coincidences which have been used to develop some possible models for the universe. Dr Tang's interesting article could also be a plausible one and it is suitable for further development.

Just to add to the number of models, I devised another one which can be summarized by the equation:

$$G = \frac{c}{\pi h}\left(\frac{c}{2\pi}\;\frac{e}{2\pi}\;\sqrt{\alpha(2-\alpha)}\right)^4$$

where G is the constant of gravitation, c the speed of light, e the charge of the electron, h is Planck's constant and α is the fine structure constant.

Of course there is a theory behind it where the electron is considered as a black hole with the result that both e and α take up new dimensions, thus rendering the equation dimensionally balanced. But its real interest is that the accuracy by which G can be computed is much higher than any experimental value so far found. In fact, G comes out to be $6{,}673019.10^{-11}$ N m^2 kg^{-2} with a precision better than 20 parts in a million.

It is still a coincidence?

D. Di Mario
Milan
Italy

The author replies:
The expression given by Mr Di Mario for the gravitational constant G may indeed be interesting because, as he has mentioned, G has been measured only to an accuracy of several parts per million whereas the four physical constants appearing in the l.h.s. of his expression are all known to better than several p.p.m. However, the resulting numerical coincidence can have no meaning when the expression is dimensionally incorrect; I fail to see how the dimension of the l.h.s. may match that of G, which is (length)^2 (in the system $c=h/2\pi=1$). The theory mentioned in which an electron is considered as a black hole would, to me, be considered as a dark alley.

T. B. Tang

ELECTRONIC ORGAN TONE FILTERS

Pipe organ technology is limited in its ability to imitate musical instruments but the sounds produced by combinations of organ stops are varied and pleasing. Electronic organs imitate pipe organs and current developments are concerned with perfecting this imitation (Dr Pykett's article in the October issue). Thus in general we have a good imitation of a poor imitation of a mixed bag of musical instruments – some obsolete (what were diapasons and cornopeans anyway?).

Surely it would be better to imitate electronically modern musical instruments and thus have the modern symphony orchestra sound available to the keyboard player – which was probably the goal of the original pipe organ builders in their time. (We could even see stops called "Galway Flute" or "Perlman Violin" etc.)

On a broader front, electronic musical instruments lack any way for human beings to express themselves as compared with what they can do on conventional musical instruments which can be bowed, blown or struck. This results in gimmicky and sterile music without warmth.

Perhaps the conventional forms of musical instrument expression input could be put into electronic instruments, which could then produce the sound of the best conventional instrument of that type, e.g. bowed input would give the sound of a Stradivarius violin. Of course it would also be possible to produce the best trumpet sound from a bowed input at the flick of a switch!

M. Robins
Rugby

The author replies:
Mr Robins's assertion that the pipe organ attempts to emulate a symphony orchestra is mistaken. The organ reached its pinnacle of development as a musical instrument in Northern Europe during the Baroque era as exemplified by the works of J. S. Bach, well before symphonies or symphony orchestras appeared! The tonal design of the better modern instruments is mainly based on Baroque principles, though the presence of a few stops with "orchestral" names is a legacy (not necessarily an unmusical one) from the romantic period around the turn of the century. Therefore the organ is an instrument in its own right, and its musical literature has little connection with that of the orchestra or any other ensemble of players. Consequently there are several reasons why a good imitation of the organ is a valid pursuit, not the least of them being that the electronic version is smaller and cheaper than the real thing and thus more suited to the domestic environment.

With regard to his query concerning the names of stops, "diapason" is derived from the Greek – it has no connection with any other instruments and is peculiar to the British organ.

"Cornopean" is probably a corruption of "cornet à pistons" and is of Victorian origin.

In widening the discussion to include other forms of electronic music we are going beyond the scope of my article, but Mr Robins's final comments call to mind the application of devices such as vocoders in modern music. His criticism that electronic instruments are unmusical is too generalised; any musical instrument is merely a machine for producing sound and the utmost in sophistication or craftsmanship cannot make good the inadequacies of an incompetent performer. A Stradivarius is indeed a wonderful instrument, but it would still sound appalling in the hands of many a beginner.
C. E. Pykett

The type of electronic organ Dr Pykett is describing in his current articles is basically identical with the Allen-Rockwell types which produced from r.o.m.-plus-d.a.c. approximations to waveforms collected from more than one organ. The largest of these belongs to the indefatigable Carlo Curley who nearly filled the Albert Hall with people, not to mention sound, in an event involving also the resident Fath Willis organ and three or four catehdral organists.

I want to suggest that there are about twenty difficulties confronting the designer of electronic organs and wish Dr Pykett every success with them. I think it was at the Great Exhibition of 1851 that an organ was powered by steam to the extent that housewives thought it was the Last Trump and knelt to pray in the streets. By the turn of the century some church organs roared very loudly indeed, nearly drowning the noise of the gas-engine driving the blower. It took Albert Schweitzer to stop people ripping out baroque organs which among other things worked at a very low pressure and had broad lines on the frequency analyser, or in other words they produced filtered noise.

Strange materials such as pure tin are used for some pipes, and the board they are set in functions as a soundboard. This all tends to the production of a very complex sound on organs. One electronic organ constructed for an English parish church used waveforms derived from bistables triggered by noise gated alternately to R and S at the fundamental frequency, to broaden the spectral lines.

Many amateur constructors seem convinced that each manual should have its own speaker system and Curley's organ has 400 speakers. This resembles the situation where rock music can be played through normal speakers but a bass electric guitar has to have a specially strong speaker. There is perhaps a problem here of occasional peaks building up. Thus if one is simulating 100 pipes at different pitches sounding at 1W each measured on the way to the speakers, with a single speaker system a 10kW capacity is needed to prevent overloading when all the peaks coincide, to provide 100 times the sound peak pressure arising from one "pipe".

I think there is room to doubt the validity of any approach which averages harmonic spectra right across the keyboard even though this is only four octaves. Piano design is based on systematic drooping of harmonic amplitudes as one ascends the keyboard; even then end-effects on the lowest strings give overtones which are not true harmonics and I would expect the same trouble with flue pipes. The point is important because it affects the choice between filtering out a tone and building it up from components, since a filter affects each note differently.

Of course organ pipes have different envelopes for the different partials and presumably this will be a residual difficulty for some time to come. But pipe organs can only get more expensive and electronic organs, *hoffentlich*, will get cheaper and better simultaneously. I recommend that readers building organs simulate some reverberation, in fact a good deal of it, and turn their loft into an organ loft lit only by a small lamp over the music rack, and pretend they're the cantor of Leipzig.
Bernard Jones
London W1

FAILURE OF DISTRESS SIGNALS AT SEA

With reference to Mr Wiseman's letter of June 1979, although the gist of his remarks is relevant, some of his letter may prove very misleading to non-seagoing readers.

It is true that all ships compulsorily fitted with wireless telegraphy (i.e., those of 1,600 gross registered tonnage and over) carry a battery powered W/T transmitter operating on 500 kHz. This is only an emergency installation and is a back-up to the ship's main m.f. transmitter which, today, has a p.e.p. output in the region of 1.5kW.

The supply for the main installation is taken from the vessel's main distribution board fitted in the engine room. This is also covered by an emergency supply consisting of a diesel driven generator set of sufficient output capacity to provide all essential supplies should the main generators fail. This supply is so connected as to cut in automatically when the main power fails. From this is will be seen that in most emergency situations the ship's radio officer has access to his main W/T transmitter, the emergency diesel set usually being installed outside the engine room and above the water line (mainly on the boat deck).

I should not like to take up Mr Wiseman's remarks about the aerial situation. It is my experience that the loss of radiation can only be blamed slightly on deck or bulkhead feed-through insulators. The fault must lie in the practice of designing modern ships with the bridge, accommodation and engine room casing all on top of each other, leaving little room to rig a realistic aerial system. One can add to this the lack of thought which is put into using it efficiently.

Recently, while serving on board a 250,000 deadweight tonnage supertanker, I had the very disturbing experience of not being able to raise any ship carrying a doctor in what should normally have been good m.f. range. An engineering officer was suffering from second-degree scald burns and, although I knew that within help range there were at least five Russian, Polish or East German freighters or fish factory vessels (having passed a couple earlier), I could not raise one in reply to my emergency signals. In fact, a nearby British tanker, whose emergency alarm was activated by my signals, advised me over v.h.f. that my signals were just about readable at under 15 miles.

Atmospherics were normal for the tropics, humidity was a little on the high side (but no more than had been experienced in past years) but the strain aerials were neutralised by a deposit of salt from spray and carbon from funnel gases. The particular aerial layout consisted of two horizontal nine-metre lengths connected in parallel to a 13-metre downlead. This arrangement was slung between the signal mast on top of the bridge house and a 60-ft high funnel casing to the top of which it was secured at the end of a 3-ft iron bracket and held up by a wire hallyard made fast at the base of the funnel casing.

Under normal conditions one could (with the transmitter in use) expect to register 10 amps on the aerial ammeter on 500kHz but as soon as any high humidity was experienced I_{ae} dropped to 1 amp or less. Despite dropping the main aerial on as many occasions as possible (a practice frowned on by most ship's deck officers as it interferes with the essential work of painting) to wash off carbon and salt from the strain insulators, after a couple of days the old problems showed up again after dark.

When one's main aerial was rigged between two high masts and led into the radio room using an aerial of the inverted 'L' or a 'T' configuration the problem was practically non-existent. The writer remembers the many occasions when contact was established on m.f. with Capetown radio (ZSC) using an IMR M-100a half-wave rectified main transmitter at 2,500 nautical miles, or Auckland radio (ZLD) at 3,000 miles across the Pacific with the help of a Marconi type 380 ¼-watt full-wave set.

Okay! So it was at night, and in the tropics, and conditions were good, but normally one could work within 500 miles to a shore station and over 300 miles to another ship. Today, even with the most sophisticated 1.5kW synthesized transmitter one can get a better DX on the v.h.f.

It is felt that more care should be used in the siting of modern aerial installations, or more use (certainly in British ships, where the practice seems to be frowned on) made of the 'capacitance hat' type, or the folded unipole type, of free-standing radiators. Good examples of such installations can be observed on Norwegian, German or Swedish vessels (for the use of mast radiators) or Japanese ships for conventional types of aerials.

However, when these points were raised recently (after my emergency experience) with a ship's superintendent, he raised his hands in horror at the idea of the vessel's owners being asked to foot a bill of (his figures) $10,000 upwards for a newly designed aerial system. When tackled as to whether seafarers' lives were not considered to be worth an extra $10,000, he refused to commit himself. I wonder what his thoughts would have been if *he* had been chief engineer of my ship and *his* engineer officer had been the man to require medical aid. Probably he would have put it down to the P.B.R/O.

If this letter only makes some of your aerial design readers think, I shall be well rewarded. However, I must admit my remarks are going to be raised with my association for consideration by it, and all other seafarers' organisations. I've only one life; I don't want it to be jeopardised by a lousy bit of wire.
John J. Boyd (Radio Officer)
Birkenhead
Merseyside

LEVY ON BLANK TAPES

I learn with some misgivings that the Mechanical Copyright Protection Society is considering the promotion of a Bill to allow the levying of a surcharge on the price of blank magnetic tapes.

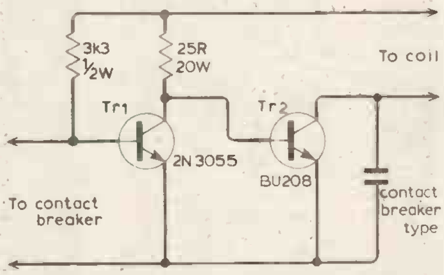
While I support the attempts of musicians and their agents to obtain a just reward for their labours, I do not think this is a suitable way to go about it. It sets a poor legal precedent, in that it attempts to penalise people for something they might do – akin to compulsorily levying the price of a dog licence from everyone in case they may get a dog.

Should the Society feel compelled to persist with this proposal, I would like to have their assurance that users of magnetic tape for purposes other than the duplication of copyright material will be exempted from this levy. As a reminder, these purposes include: dictation; word processing; information storage in both amateur and professional computing equipment; data logging; amateur recording of live music; tape 'letters'; recording of broadcast programmes for educational purposes; wildlife recording; recording of effects for amateur dramatics; recording of interviews and spoken pieces for local radio; telephone answering machines; and recording of messages transmitted by licensed amateur radio operators.

R. C. Simmons
Chipping Norton
Oxfordshire

ELECTRONIC IGNITION

I have been interested to read of the problems your correspondents have been having with their electronic ignition systems. I used to have starting troubles with my car and decided to do the main switching of the coil by transistors rather than using the contact breaker directly for this purpose. The circuit is very simple and costs less than £3 to make. It has now been in use for more than three years (40,000 miles), and the points themselves are still in perfect condition. The contacts still need adjusting every 12,000 miles or so because there will be wear on the cam follower causing the gap to narrow slightly with age.



The circuit is as shown. With the contacts closed, Tr_1 is off, and hence Tr_2 is hard on. So hard in fact that the voltage drop across it is in the order of 0.3 volts. Since it is passing a current of about 4 amps, it is only dissipating just over 1 watt and has worked perfectly well without extensive heatsinking.

The contact breaker is now switching just 4mA at the most, and this is purely resistive, hence the total lack of pitting etc.

D. J. Cope
Southport
Merseyside

ADVERTISEMENTS IN WIRELESS WORLD

As a regular *Wireless World* reader I think the number of full-page advertisements is excessive for the price of this otherwise interesting magazine. It would probably be true to say most readers would pay another 5p or so to reduce the full page ads that seem to increase in number every month.

The point is here that ads on ITV are free* but in this magazine and others you pay to see them. I realize this is a large source of income but it will not be if your readership is reduced because of them. I think a better idea is to cut down on some of the ads but increase those in the appointments section. With rising unemployment this would serve a more useful purpose to help the electronics community as a whole.

"Worried"
Haverhill
Suffolk

*See the current editorial on this subject – Ed.

TV VIEWING AIDS

Mr Fred Holloway (October letters) has suggested that television sets should be provided with headphone sockets for the benefit of viewers who are hard of hearing. May I suggest that there is also a strong case for the provision of this facility for another reason? In many homes there are conflicting simultaneous demands for television sound for one or more persons and quietness for others who may wish to read, do homework or listen to the radio on phones.

A related subject is that of room lighting. Use of the conventional room lighting reduces effective luminance contrast and colour saturation, while the absence of lighting produces eyestrain. At an early Television Society lecture a manufacturer demonstrated a receiver with an illuminated area surrounding the screen. Such an arrangement would not be appropriate with today's larger screens, but I find that a 13-watt fluorescent tube fitted at the rear of a receiver provides a good "halo". (An incandescent lamp of similar brightness would need to dissipate about 60 watts and would increase the ambient temperature undesirably.)

It would be more convenient if manufacturers would provide these facilities.

Roy C. Whitehead
Sutton
Surrey

TV SETS FOR THE HARD OF HEARING

In your October issue Fred Holloway of the Essex League of the Hard of Hearing recounted his difficulties in obtaining a television receiver with earphone facility. The implication of course was that British industry was once again seen to be behind its foreign competitors. Not so – Decca produce 14in, 20in, and 22in sets all with a choice of headphones only or both loudspeaker and headphones plus tape recording and with full remote control if required. To this will be added in the autumn of this year a new range of 30AX models each with the same facilities. According to our information at least three other British manufacturers also supply sets fitted with earphone sockets.

We shall be glad to send full details to anybody interested in this particular problem.

Ian C. Rule
Decca Radio & Television Ltd
Willenhall
West Midlands

Mr Holloway's letter in the October issue draws attention to the lack of headphone outputs on many tv sets, and the resultant problems for the hard of hearing. The following comments might be of interest to people in a similar position.

Several sets, mainly portable types, have a 3.5mm socket for use with a low impedance earpiece. This can be used with normal headphones and a suitable adaptor; the socket can be easily modified to stop switching of the speaker. If a socket is to be added to an existing set, an isolating output transformer is usually necessary due to the lack of an earthed chassis.

For those who do not wish to modify the set, the following are available: small battery amplifiers using a microphone placed near the speaker and a lightweight headset or phones; for those with a suitable hearing aid, similar microphone amplifiers to drive a simple inductive loop placed round the room. Several firms including ourselves make suitable models. The RNID also issue a leaflet on the various types of "aids" available.

P. Royall
Sarabec Electronics
Middlesborough
Cleveland

INDUSTRIAL ROBOTS

Granted that industrial robots have been successfully applied to routine repetitive tasks in the automotive industry, the question nevertheless first arises as to whether we want every motor car on the road to look and be like every other. If, as you say in September News, "the natural growth area lies in flexible manufacturing systems, where a large number of different product types will be demanded by an increasingly sophisticated market", the answer to the question seems to be definitely in the negative.

If that is so, we may not need robots to make motor cars, or indeed much else, for that matter. There might well come a time, for example, when I may not like to have my motor car designed or built by anyone or anything that cannot properly appreciate Beethoven's 4th symphony or Renoir's "Le Moulin de la Galette", i.e. that cannot clearly distinguish between good art and bad art. A high level of sophistication maybe, but one that is certainly conceivable to me.

The amount of "fast-acting tactile, visual and aural sensory devices" that you would have to build into a robot to enable it to meet this level of sophistication would certainly have to be pretty enormous. I would respectfully suggest, therefore, that one might have much better luck, or success, by endeavouring to employ some of the two million unemployed "fast-acting tactile, visual and aural sensory" individuals who are at present on the labour market.

Peter G. M. Dawe
Oxford

AERIAL INSULATORS AT SEA

John Wiseman, in his August letter on the subject of the distress frequency at sea, has clearly defined the necessity for thoughtful antenna design, with fewer (parallel) insulators, better shielding, and greater capacitance. Mr Wiseman also makes reference to the Admiralty Handbooks, and I would like to supplement his reference by quoting from the 1931 Edition as follows: "It is, therefore, the duty of the wireles staff to keep all these scrupulously clean, especially after heavy steaming, heavy rain or bad weather, since under these conditions the insulators will probably be covered with a semi-conducting layer of 'stokers', dirt, or dried salt."

It is the semi-conducting layer that spoils radiation, not so much a flushing of the insulators with rain or sea-water. Thus, if the insulators are cleaned regularly, as their Lordships of Admiralty once instructed, it is almost a certainty that no difficulties will be experienced except in special circumstances such as arise in areas like the Persian Gulf, where sand and spray may combine.

With the modern base insulated medium frequency antennae, the cleaning of the insulator poses little difficulty, and there is no excuse at all for it to become salt, stokers, or dirt encrusted.

Mr Venekamp's low impedance antenna (August letters) may contribute to a solution, but I don't think we should avoid cleaning it.

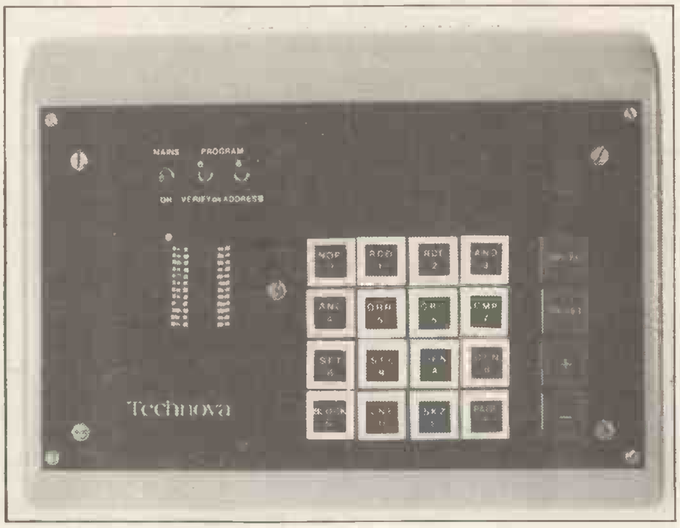
P. J. W. Sawyer
Natal, Republic of South Africa

NEW PRODUCTS

E.p.r.o.m. programmer

A low-cost programmer for use with Intel 2716 e.p.r.o.ms has been introduced to the market by Technova Developments Ltd. After a sequence is written into the programmer, addresses can be incremented automatically. Also, addresses already entered can be selected for verification and/or alteration to allow possible errors to be corrected before the e.p.r.o.m. is programmed. Crystal control is used for the program pulse length to increase programming reliability and, at a one-off price of £475+v.a.t., the unit could be useful to development engineers who wish to program e.p.r.o.m.s for prototypes, or to modify existing programs. Technova Developments Ltd, Francis House, Blofield Heath, Norwich, Norfolk NR13 4SF.

WW 301



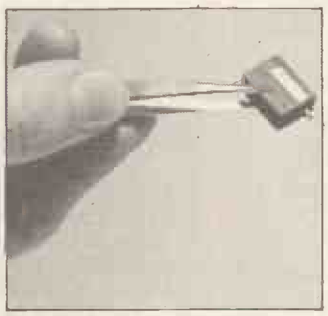
WW 301

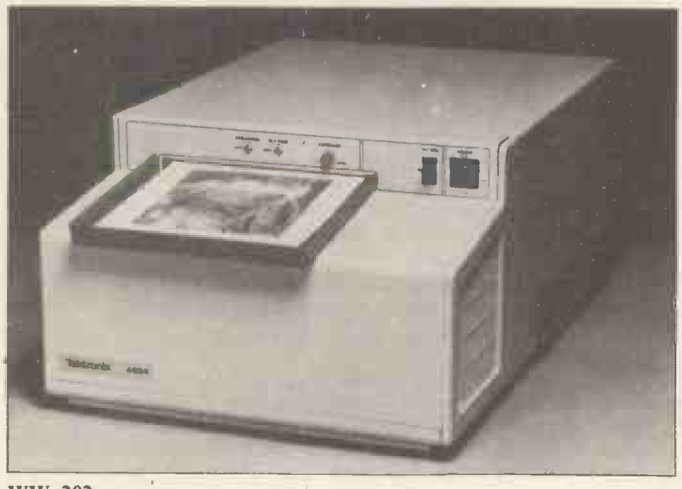
Microwave detector

Now that microwave ovens used in hotels and restaurants must comply with the regulations of the Health and Safety at Work Act, the need for cheap, simple but effective methods of detecting microwave leakage has increased. This battery-powered "pocket" tester, the model TS256 from Bach-Simpson, gives both an audible and a visible alarm when r.f. leakage greater than 4.5mW/cm² is detected, and its only control is a combined on/off and "battery-test" switch. Designed for use in the ISM band, the TS256 is calibrated at 2450MHz and is said to be practically immune to failure caused by excessive field strength or physical abuse. Possible leakage is detected by simply switching the tester on and passing it around the seals of the oven, the only stipulations being that the oven is switched on at "high", and has been for a period of one minute prior to testing, and that the oven has in it a plastic vessel containing around 275ml of water. The price of the TS256 is £24.50. Bach-Simpson (UK) Ltd, Trenant Estate, Wadebridge, Cornwall PL27 6HD.

WW 302


WW 302


WW 304


WW 303

Hard-copy unit

High-resolution, continuous-tone copies can be produced in a matter of seconds from raster-scan video sources using the Tektronix 4364 imaging hard-copy unit. With an image of 15×20cm, the copier uses a fibre-optic cathode-ray tube to record onto dry-silver paper without the use of toners or developers. Front control panel and front paper load/exit allow the unit to be unobtrusively mounted into a video system. The 4634 is self-contained, usually requires only a single cable connection and can be interfaced to most video sources whether analogue or digital. An a.g.c. circuit is included which tracks the input signal to reduce the effects of variations at the input and a grey-scale range with twelve levels is also featured. The makers say that the unit was designed to provide photographic quality images and claim it is a cost-effective alternative to other display recording devices with a similar image quality. Tektronix UK Ltd, Beaverton House, P.O. Box 69, Harpenden, Herts.

WW 303

Miniature motor

With a supply potential of 1.2V, the 712L d.c. motor from Portescap can develop a mechanical power of 70mW although it measures only 7×12×16mm. These features, together with a starting torque of 2.5×10^{-4}Nm, a no-load speed of 11,000r.p.m. and low-inertia, are said to have been made possible by combining the use of new materials with established design techniques. Gold-alloy brushes, samarium-cobalt magnets, sintered-bronze bearings and the maker's ironless rotor are all included in the design. Portescap (UK) Ltd, 204 Elgar Rd, Reading RG2 ODD.

WW 304

Strain meter

Field measurements can be made with the DMD20 battery powered and portable strain meter with digital readout. Hottinger Baldwin Messtechnik GmbH, represented by Carl Schenk Ltd, manufacture the instrument which provides energizing for transducers, and operates with a carrier frequency of 225Hz. Strain-gauge half and full bridge circuits with resistances from 60 to 2000Ω can be used in conjunction with the meter to indicate strains of up to ±1999μm/m and gauge matching and balancing facilities are built in. Although primarily designed to indicate static values, the meter has an analogue output which allows the recording of low-frequency dynamic values also. The same manufacturers have also announced extensions of their range of strain gauges. Carl Schenk (UK) Ltd, Stonefield Way, Ruislip, Middx HA4 OJT.

WW 305

Continuous coverage receiver

Any frequency in a range from 50kHz to 29.7MHz can be tuned in, using the McKay DR 33C communications receiver, distributed by Lee Engineering Ltd, which makes use of phase-locked digital frequency synthesis, with crystal control, to enable continuous and accurate coverage of the full range, and a large, six-digit, display for frequency readout. Demodulation for either a.m., u.s.b., l.s.b. or c.w. (also r.t.t.y. with an external converter) is switch-selectable, as are r.f. filtering, which ranges from four to eight kHz, and noise limiting. A high-level r.f. front end, and a double-balanced diode ring-mixer are used for good i.m. rejection and sensitivity, whilst crystal filters in the first and second i.f. amplifiers, and a ceramic filter in the third, are provided for the rejection of all undesired frequencies and good selectivity. A.m. envelope detection is carried out using a class D configuration, which has the advantage of giving low-distortion, even at high modulation levels. Variations on the DR 33C model are available, as are an active all-wave antenna, and passive r.f. preselectors ranging from 0 to 30MHz in 9 bands. The DR 33C costs around £950. Lee Engineering Ltd, Napier House, Bridge St, Walton on Thames, Smurrey KT12 1AP.

WW 306

Keyboard protection

Moulded rubber covers to protect keyboards can be made to manufacturers' specifications by Kea Flex Ltd. These covers make possible the use of keyboards outdoors and in dusty, humid enviroments such as process plants and mills. One such cover already made by this manufacturer for Racal Datacom has individual raised keypads to improve tactile response, bonded white key symbols, and is made from silicone rubber to give it mechanical flexibility and resistance to high temperatures and chemical contamination. Kea Flex say that they can provide a complete design, development, toolmaking and moulding service specially geared to handle difficult customer requirements. Kea Flex Mouldings Ltd, Broxhead Works, Linford, Bordon, Hampshire.

WW 307

16k modem

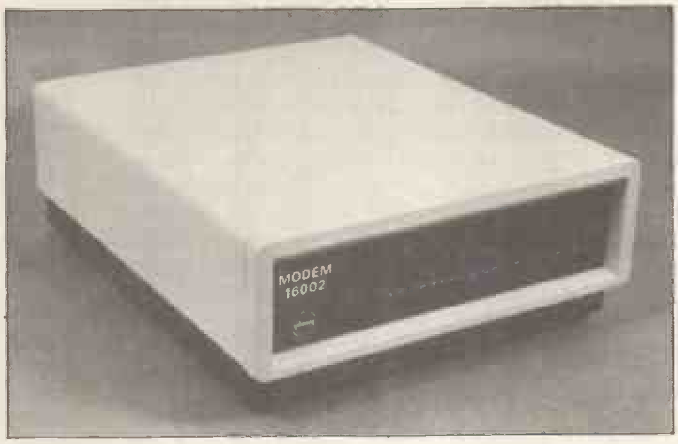
The world's first 16,000bit/s modems to be made available commercially is the claim made by Plessey for their 16000 series. An improvement on the 16001, the first design in the series, is expected to be available in January and is designated the 16002. The second version is suitable for data communication as well as digital speech transmission and also offers improved performance on poor lines. Quadrature amplitude modulation has been chosen as the means of carrying information over voice frequency lines as it offers high noise immunity. The two carriers in quadrature are at a frequency of 1700Hz and each can have eight possible amplitudes. In order to reduce the effects of line noise which would normally cause unacceptably high error rates, a forward correction module will also be available as an optional extra. Plessey Digital and Network Systems Ltd, Taplow Court, Taplow, Bucks.

WW 308

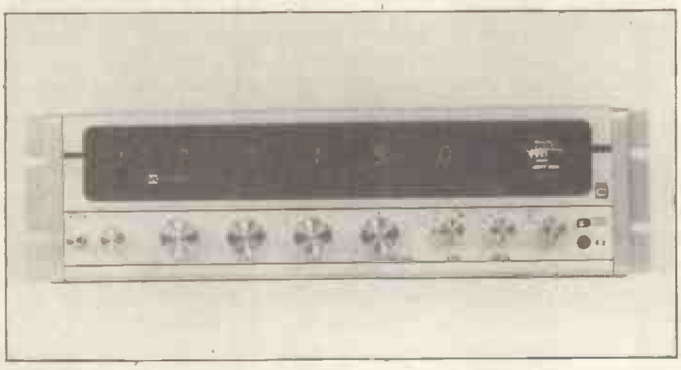
Humidity control switch

Natural hair is used as the sensing-element in this control unit, the Regin type-HR room humidistat from Appliance Components Ltd. Any desired relative humidity limit value from 30 up to 90% can be set

WW 307



WW 308



WW 306

WW 309

using a dial on the front of the unit, and the hysteresis of the limit switching point is low at ±1.5% r.h. The taut hair of the sensor stretches as the humidity of the air around it increases. This means that if the sensing-element should break, become wet or not be recalibrated after a certain period of time, the humidity of the room will tend to decrease rather than increase, an inherent safety function not found in for example cotton-type sensors which shrink with increasing humidity. Calibration of the 165×60×38mm wall-mounting unit is simple, and its control microswitch has a contact-rating of 10A at 480V a.c. into a resistive load. Possible applications of the type-HR include the control of humidity in computer rooms, air-conditioning systems and laboratories. The 100-off price is around £17.34 per unit. Appliance Components Ltd, Cordwallis St, Maidenhead, Berks SL6 78Q.

WW 309

C.r.t. controller

Design aims of this r.o.m. programmable c.r.t. controller were to reduce the manufacturing costs of intelligent c.r.t. terminals, word processors and information display equipment produced in large quantities. The S68045 from AMI Microsystems Ltd is pin compatible with existing software programmable devices and can directly replace those such as the MC6845 and SY6545 once character fonts and display formats have been established. Two complete character and display programs are stored in r.o.m. in the S68045, which makes use of the same power supplies and clocks as the devices it is to replace. This offers, the manufacturers say, cost savings of up to 40%. AMI Microsystems Ltd, Princes House, Princes St, Swindon, Wilts SN1 2HU.

WW 310

F-V converter

Low drift and high reliability are claimed for the Teledyne Philbrick 4736 hybrid frequency to voltage converter which is available through Technical Selling Services. With a guaranteed linearity error of less than 0.008%f.s., the 4736 can operate at frequencies of up to 1MHz and gives an output voltage which is linearly proportional to the input signal frequency regardless of the waveform used. Mounting onto a p.c.b. is simple as the hybrid-type package used has a 24 pin d.i.l. layout. Minimum and maximum input potentials are 1.6V (threshold voltage) and 12V respectively, while the maximum output voltage is 11V, and the maximum output current is 20mA. Versions are available which have undergone 100% screening similar to MIL-STD 883, method 5008. Technical Selling Services, 80a High St, Camberley, Surrey GU15 3RS.

WW 311

SIDEBANDS

By Mixer

All very well, but . . .

It isn't often I can report what seems to me a hopeful sign of renascent sanity, but it's all the more welcome for its rarity. If you can be bothered with the rest of the issue after reading this page, you may come across a piece by one of our hacks on air traffic control in which the said hopeful sign makes a brief appearance.

In a few year's time, it is the intention of the civil aviation people to provide air traffic controllers with all manner of computery, which it is hoped will enable them to see what is going to happen in about a quarter of an hour unless they tell the pilots to do something else. In this way, they will be able to tell whether everything will proceed in an orderly and thoroughly British manner, or whether there is going to be an almighty bang.

To the naive, this is just the ticket, and one might imagine that controllers would be absolutely delighted to exchange important parts of their anatomy for such equipment. But air traffic controllers are not noted for their naivete, and engineers rather less so, if anything, so they're all looking at the gear through noticeably narrowed eyes.

What they don't like much, they say (and the people developing the stuff quite see their point) is that the displays are so convincing that they find themselves taking the computer's word for Gospel, and they're realistic enough to insist that nothing is that perfect. Well, you can see what they mean – when a couple of airliner captains come on the air to point out that they haven't been trained for close-formation flying, and would you mind awfully making the other one go away, it is absolutely not on to explain that it's all right really, because the computer says so.

So, you see, there's hope. So long as there are some people left who can still say "Yes, but . . . .", we can rest easier in our economy-class, battery-passenger cells.

". . . by any means make money"

"It is in the game for profit, and the service it provides is incidental, a means to that main purpose." Thus the editorial at the other end of this month's issue, independent television being the target.

It is just possible that there may be a couple of you out there who think the above remark is going a bit far. The programmes aren't that bad, you might think, and they have to show adverts to pay for the programmes, which are obviously the reason for broadcasting at all. They are, aren't they? Well, actually no, they're not. The programmes seem to be regarded by the companies as a rather time-wasting and expensive way of filling the time between adverts. Admittedly, with some of the stuff they put out, I wouldn't argue with them, but for a method of propagating information as prodigal of bandwidth as television to be used by a few people to make vast amounts of money by advertising seems to me obscene.

I can vouch for the prevalence of this view of television among the companies and will illustrate it by reference to a visit I once paid to Yorkshire Television. I'd gone there to see some new equipment they'd had installed, and arrived just after a breakdown lasting some hours. I commiserated and said "How awful" and "Dear, dear" and all the usual things and was a bit taken aback when the very senior engineer I was talking to said that it hadn't been all that disastrous, really, because they'd only lost about fifteen minutes.

Apparently the loss of several programmes didn't count: it was the fifteen minutes of adverts down the drain and the consequent loss of revenue that had caused them to hop around briskly mending fuses or whatever they do. So there you are – never mind the programmes; feel the ads!

The game of the name

The Dutch are a fine race, and I have often thought it was a crying shame they never learned to speak properly. Still, they do keep trying, and to prove it, a Dutch publisher recently sent a letter, couched in the unlikely combination of characters that I am reliably informed passes for a language over there. Words like 'wij' and 'mogelijk' abound.

Now, my adventures in foreign languages, apart from those that are dead and therefore 'useless', have been confined in the main to a discussion of extraordinary females who, for some inscrutable reason, insist on keeping a supply of pens in the garden. I am not, therefore, well prepared to decipher communications even in single Dutch. Luckily, the newest member of our editorial team has been exposed to the lingo for some years and is able to make sense of it. So I asked him to cast his eye over it and give me the gist, which he did.

It seems that two magazines, *Elektronica Hobbie* and *ELO* are to merge under a new name, which they have decided is to be Hobbit. It does have a hyphen – *Hob-bit* – but it is pretty clear that it has appeared in translation.

I have no quarrel with the name Hobbit. As names go, it is a perfectly good name. I am not sufficiently enthusiastic about it to want to read books on the subject, but it seems harmless enough. But to call an electronics magazine after a hairy-footed denizen of Middle Earth does indicate a certain self-imposed limitation in circulation figures. We shall see, but it's going to need some very explicit covers if confusion is to be avoided. Maybe they don't read Tolkien in Holland: or perhaps Hobbit is spelt with a lot of 'j's and 'k's in Dutch – I wouldn't be a bit surprised.

Best of luck to *Hob-bit*, anyway.

Real estate

As befits a journal with a readership of *Wireless World*, the standard of letters we receive is a cut above the normal run of 'letters to the press'. I have been terribly impressed by all the erudition displayed over displacement current and electrons, and only wish I could contribute myself. But I have always thought it important to know one's limitations, and displacement current, relativity and many other rarefied subjects are well on the 'no-go' side of mine.

I do feel, however, that all this about e ought not to be allowed to go unrecognized. You never know when you might be caught short without either guessing stick or calculator, and experience an urgent need to know the value of e. I've noticed several letters offering valuable advice here, and this is an area where I do think I could be of assistance. I doubt whether many folk would be able to remember those funny sentences, such as 'In Wapping, a quantity of penguins I glowered at grumpily fled', so I've come up with another idea.

My method could be used in any circumstance, but preferably while standing in a 54.365636568 acre tract of land – a wood, or moor or whatever is to hand: one of the Ordnance Survey plans should be helpful here. Stand there until you have managed to attract the attention of twenty passers-by – more or less could be used, but the arithmetic becomes inconvenient. Now get them to distribute themselves equally over the area you have chosen (offers of money or quantities of alcohol make this easier). This done, you mark out the land by drawing lines exactly midway between people, and then you can tell them all to go away. It should be possible to do this without causing offence, but if not, you might find it necessary to feign madness – this often averts aggression. It only remains to measure one of the small areas enclosed by the lines you have drawn, which will be found to be 2.7182818284 acres.

Alternately, you could try remembering 2.7 1828 1828 4.

be complete with ANTEX

All ANTEX soldering irons have bits which slide easily on and off stainless steel shafts. *Inside* these shafts are the heating elements for maximum efficiency of heat transfer. There are no screws or screw threads to corrode and stick to shaft. Bits are heavily Iron plated for long life.

* Model C Miniature — 15 Watts Price £4.20 * Model CX — 17 Watts Price £4.40 * Model X25 — 25 Watts Price £4.40 * S.T. 3 Stand to fit all irons Price £1.60 * Model S.K. 1 Kit contains a 15 Watt miniature iron with 2 spare bits, a coil of solder, a heat sink and a booklet "How to Solder" Price £6.25 * Model S.K. 3 Kit contains Model CX 230 iron — 17 Watts with the S.T.3 Stand Price £6.00 * Model S.K. 4 Kit contains Model X25/240 iron — 25 Watts with the S.T. 3 Stand Price £6.00.

Model TCSUI. Temperature controlled soldering stations, now made from the toughest of tough plastics, have anti-static earthing connections to protect your MOS devices. They come with either the miniature CTC or the XTC low voltage (24V) iron. Included also is a range of 3 sizes of bits, 2m anti-static cable, jack, crocodile clip, separate sponge tray. Zero voltage switching to prevent spikes or arcing; no magnetic fields. Temperatures can be set between 65° and 420°C. Current leakage is negligible. Price £38.00
All prices are exclusive of VAT and postage.

A N T E X

Please send me the following:

Quantity	Model	Price

ANTEX (Electronics) Ltd.,
Mayflower House, Plymouth, Devon.
Telephone: Plymouth (0752) 67377/8.
Telex: 45296 Giro: 2581000

☐ Please send me the Antex Colour Catalogue.
I enclose cheque/P.O./Cash Value
Name ....
Address ....
....
Telephone: ....

W.W.12

Stocked by many wholesalers and retailers or direct from us ..

WW—090 FOR FURTHER DETAILS

8K ON BOARD MEMORY!
5K RAM, 3K ROM or 4K RAM, 4K ROM (link selectable). Kit supplied with 3K RAM, 3K ROM. System expandable for up to 32K memory.

2 KEYBOARDS!
56 Key alphanumeric keyboard for entering high level language plus 16 key Hex pad for easy entry of machine code.

GRAPHICS!
64 character graphics option — includes transistor symbols! Only £18.20 extra!.

MEMORY MAPPED
High resolution VDU circuitry using discrete TTL for extra flexibility. Has its own 2K memory to give 32 lines for 64 characters.

KANSAS CITY
Low error rate tape interface.

2 MICROPROCESSORS
Z80 the powerful CPU with 158 instruction including all 78 of the 8080, controls the MM57109 number cruncher. Functions include +, −, *, /, squares, roots, logs exponentials, log functions, inverses, etc.
Range 10^{-99} to 9×19^{-99} ro 8 figures plus 2 exponent digits.

EFFICIENT OPERATION
Why waste valuable memory on sub routines for numeric processing? The number cruncher handles everything internally!

RESIDENT BASIC
With extended mathematical capability. Only 2K memory used but more powerful than most 8K Basics!

1K MONITOR
Resident in EPROM.

SINGLE BOARD DESIGN
Even keyboards and power supply circuitry on the superb quality double-sided plated through-hole PCB.

PSI COMP 80

Z80 Based powerful scientific computer. Design as published in WIRELESS WORLD

COMPLETE KIT NOW ONLY £225+VAT!

Cabinet size 19.0″ × 15.7″ × 3.3″

Television not included in price

The kit for this outstandingly practical design by John Adams published in a series of articles in Wireless World really is complete!

Included in the PSI COMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board, 2 keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer, 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.

KIT ALSO AVAILABLE AS SEPARATE PACKS
For those customers who wish to spread their purchase or build a personalised system the kit is available as separate packs e.g. PCB (16″×12.5″) £43.20. Pair of keyboards £34.80. Firmware in EPROMS £30.00. Toroidal transformer and power supply components £17.60. Cabinet (very rugged, made from steel, really beautifully finished) £26.50. P.S. Will greatly enhance any other single board computer including OHIO SUPERBOARD for which it can be readily modified. Other packs listed in our FREE CATALOGUE.

PSI COMP 80 Memory Expansion System

Expansion up to 32K all inside the computer's own cabinet!

By carefully thought-out engineering a mother board with buffers and its own power supply (powered by the computer's transformer) enables up to 3 8K RAM or 8K ROM boards to be fitted neatly inside the computer cabinet. Connections to the mother board from the main board expansion socket is made via a ribbon cable.

Mother Board:	Fibre glass double sided plated through hole PCB 8.7″×3.0″ set of all components including all brackets, fixing parts and ribbon cable with socket to connect to expansion plug	£39.90
8K Static RAM board	Fibre glass double sided plated through hole PCB 5.6″×4.8″	£12.50
	Set of components including IC sockets, plug and socket but excluding RAMs	£11.20
	2114L RAM (16 required)	£4.50
	Complete set of board, components, 16 RAMS	£89.50
8K ROM board	Fibre glass double sided plated through hole PCB 5.6″×4.8″	£12.40
	Set of components including IC sockets, plug and socket but excluding ROMs	£10.70
	2708 ROM (8 required)	£6.00
	Complete set of board, components, 8 ROMs	£68.50

NEW!

ETI VOCODER

COMPLETE KIT ONLY £195+VAT

Published in Electronics Today International

Panel size 19.0″×5.25″. Depth 12.2″

14 CHANNELS!
NOISE GENERATOR!
SLEW RATE CONTROL!

2 OSCILLATORS!
voiced/unvoiced detector!
LED PPM METERS!

Kit includes FREE foot control and test oscillator!

Like all our kits, the ETI VOCODER really is complete — fully finished metalwork, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc. — even a 13A plug!

Kit also available as separate packs - See Catalogue

MANY MORE KITS
ON PAGES 95, 97

POWERTRAN

Value Added Tax not included in prices

PRICE STABILITY: Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until January 31st, 1981, if this month's advertisement is mentioned with your order. Errors and VAT rate change excluded.
EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1 handling and documentation.
U.K. ORDERS: Subject to 15% surcharge for VAT. NO charge is made for carriage. Or current rate if changed.
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 computer from the factory. Call at Sales Counter. Open 9 a.m.-12 noon. 1-4.30 p.m. Monday-Thursday.

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

POWERTRAN ELECTRONICS

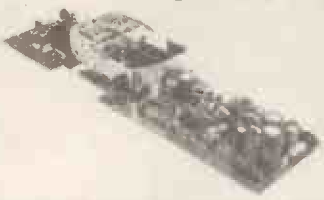
PORTWAY INDUSTRIAL ESTATE ANDOVER
ANDOVER HANTS SP10 3NN (0264) 64455

LINSLEY HOOD CASSETTE RECORDER 2

Our new improved performance model of the Linsley Hood Cassette Recorder incorporates our VFL 910 vertical front mechanism and circuit modifications to increase dynamic range. Board layouts have been altered and improved but retain the outstandingly successful mother and daughter arrangement used on our Linsley Hood Cassette Recorder 1.

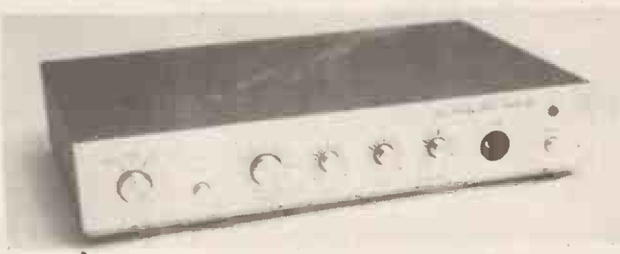
This latest version has the following extra features. Ultra low wow-and-flutter of .09% — easily meets DIN Hi-fi spec. Deck controls latch in rewind modes and do not have to be held. Full Auto stop on all modes. Tape counter with memory rewind. Oil damped cassette door. Latching record button for level setting. Dual concentric input level controls. Phone output. Microphone input facility if required. Record interlock prevents re-recording on valued cassettes. Frequency generating feedback servo drive motor with built-in speed control for thermal stability. All these desirable and useful features added to the excellent design of the Linsley-Hood circuits and the quality of the components used makes this new kit comparable with built-up units of much higher cost than the modest **£94.90** + VAT we ask for the complete kit.

SUPER BARGAIN TUNER OFFER



Brand new by famous manufacturer. MW/LW/FM Tuner and Stereo Decoder Board. Features include capacitor tuned mosfet front end, integrated circuit I.F. strip, and phase locked loop stereo decoder chip. Stabilised power supply and rectifier on board only requires 19V AC at 175MA to power. Size 12½ × 3½ × 1¾.
Supplied complete with circuit diagram and ferrite rod aerial. FM section fully aligned and tested before despatch. Fantastic value at **ONLY £9.99** plus VAT. P.P. £1.

LINSLEY-HOOD 30 WATT AMPLIFIER



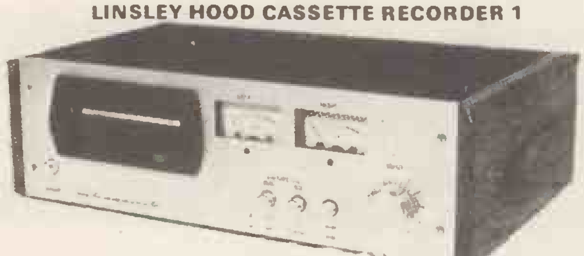
The very latest amplifier design to be published and in our opinion the best yet. The concept was to produce an amplifier that sounded as good as the authors 75 watt design but which was cheaper and simple to build for applications where the higher power is not needed. This new kit is designed to match the Linsley-Hood Cassette Recorder 2 and a tuner will be available later to make a complete stackable system. A very advanced assembly system has been devised by us to make construction ultra simple and anyone who can solder components in a printed circuit board will find it great fun. Conventional wiring is at an irreducible minimum, only being needed to connect the mains transformer and pilot light. For an amplifier of this quality this kit represents incredible value for money.

All parts can be bought separately at a total cost of **£79.12** but complete kits are available at a special introductory discount price of only **£72** + VAT.

SUPER BARGAIN OFFERS
LENCO FFR CASSETTE DECK

For those who missed our recent bargain CT4s we now are delighted to be able to offer Brand New Lenco FFR Decks complete with motor speed and auto-stop control board fitted and tested. These will operate with any supply between 9 and 16 volts. This deck can be used for both record and playback applications and is fitted with an erase head. A mono record/play head is fitted and we can supply an extra stereo head, if ordered with the deck at the very special price of £2 plus VAT. We also supply, with each deck and completely FREE, one of our specially moulded escutcheons. This deck would normally cost about **£25** but we are able to offer them, while they last, at only £9.99 plus VAT.

LINSLEY HOOD CASSETTE RECORDER 1



We are the Designer Approved suppliers of kits for this excellent design. The Author's reputation tells all you need to know about the circuitry and Hart expertise and experience guarantees the engineering design of the kit. Advanced features include: High-quality separate VU meters with excellent ballistics. Controls, switches and sockets mounted on PCB to eliminate difficult wiring. Proper moulded escutcheon for cassette aperture improves appearance and removes the need for the cassette transport to be set back behind a narrow finger trapping slot. Easy to use, robust Lenco mechanism. Switched bias and equalisation for different tape formulations. All wiring is terminated with plugs and sockets for easy assembly and test. Sophisticated modular PCB system gives a spacious, easily built and tested layout. All these features added to the high-quality metalwork make this a most satisfying kit to build. Also included at no extra cost is our new HS15 Sendust Alloy record/play head, available separately at **£7.60** plus VAT, but included FREE as part of the complete kit at **£75** plus VAT.
REPRINTS of the 3 articles describing this design **45p**. No VAT.
REPRINT of Postscript article **30p**. No VAT.

STUART TAPE CIRCUITS
(For reel-to-reel decks)

These circuits are just the thing for converting that old valve tape deck into a useful transistorised recorder. Total system is a full three head recorder with separate record and replay sections for simultaneous off tape monitoring. We also stock the heads. This kit is well engineered but does not have the detailed instructions that we give with our more recent designs. We would not therefore recommend it to beginners. Reprints of the original three articles **45p**. Post free. No VAT.

CASSETTE HEADS

HS15 SENDUST ALLOY SUPER HEAD. Stereo R/P. Longer life than Permalloy. Higher output than Ferrite. Fantastic frequency response. Complete with data	**7.60**
HC20 Stereo Permalloy R/P head for replacement uses in car players, etc.	**4.25**
HM90 Stereo R/P head for METAL tape. Complete with data	**7.20**
H561 Special Erase Head for METAL tape	**4.90**
H524 Standard Ferrita Erase Head	**1.50**
4-Track R/P Head. Standard Mounting	**7.40**
R484 2/2 (Double Mono) R/P Head. Std. Mtg.	**4.90**
ME151 2/2 Ferrite Erase. Large Mtg.	**4.25**
CCE/8M 2/2 Erase. Std. Mtg.	**7.90**

All prices plus VAT

We regret that due to the latest increase in postal costs we must now charge for carriage. Please add as follows:

Order up to £10 — 50p
Orders £10 to £49 — £1
Over £50 — £1.50

P&P

Export Orders — Postage or shipping at cost plus £2 Documentation and Handling

Please send 9x4 SAE for lists giving fuller details and price breakdowns.

Instant easy ordering, telephone your requirements and credit card number to us on Oswestry (0691) 2894

Personal callers are always welcome but please note we are closed all day Saturday

4118

HART ELECTRONIC KITS LTD
PENYLAN MILL OSWESTRY
SHROPSHIRE
phone (0691) 2894
Telex 35661
Hartel G

TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

Designed by consultant Tim Orr (formerly synthesizer designer for EMS Ltd.) and featured as a constructional article in ETI, this live performance synthesizer is a 3 octave instrument transposable 2 octaves up or down giving sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.

The kit includes fully finished metalwork, fully assembled solid team 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 fibreglass 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 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 many times the price.

Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more elaborate than a multi-meter and a pair of ears!

COMPLETE KIT ONLY £168.50 + VAT!

Cabinet size 24.6" × 15.7" × 4.8" (rear) 3.4" (front)

NEW! TRANSCENDENT POLYSYNTH

Cabinet size 31.1" x 19.6" x 7.6" (rear) 3.4" (front)

EXPANDABLE POLYPHONIC SYNTHESIZER

AS FEATURED IN Electronics Today International

COMPLETE KIT from £320 + VAT

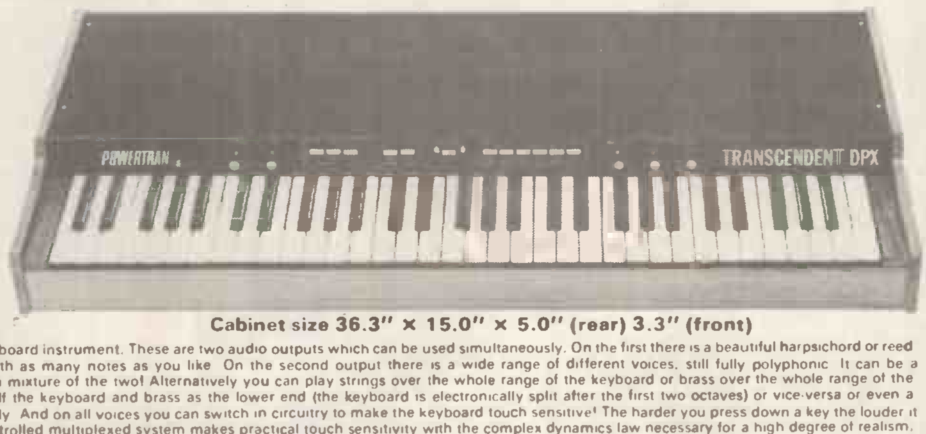
By brilliant design work and the use of high technology components the Polysynth brings to the reach of the home constructor a machine whose versatility and range of sounds is matched only by ready-built equipment costing thousands of pounds. This latest addition to the famous Transcendent family is a 4 octave (transposable over 7 octaves) polyphonic synthesizer with internally up to 4 voices making it possible to play simultaneously up to 4 notes. An add-on unit permits expansion up to 8 voices. Each voice is a complete synthesizer in itself with 2 VCOs, 2 ADSRs, 1VCA and 1 VCF. Being voltage controlled all voices can be adjusted simultaneously by master controls yet their own pitch and gate signals mean each voice can be operated independently from the keyboard.

Although using very advanced electronics the kit is mechanically very simple with minimal wiring, most of which is with ribbon cable connectors. All controls are PCB mounted and the voice boards plug into PCB mounted sockets. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (resistors 2% metal oxide or D 5% and 0.1% metal film), nuts, bolts etc. Complete kit with 1 voice £320, 2 voices £368, 4 voices £464, expansion unit to extend to 8 voices £275 (all prices subject to V.A.T.). A mere fraction of what you would have to pay for a ready-built comparable instrument!

TRANSCENDENT DPX MULTI-VOICE SYNTHESIZER

Another superb design by synthesizer expert Tim Orr published in Electronics Today International

COMPLETE KIT ONLY £299 + VAT!



Cabinet size 36.3" × 15.0" × 5.0" (rear) 3.3" (front)

The Transcendent DPX is a really versatile 5 octave keyboard instrument. These 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 as 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 as 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 touch 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 vibrator comes in only after waiting a short time after the note is struck for even more realistic string sounds.

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 digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing, etc., etc.)

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!

POWERTRAN

MANY MORE KITS ON PAGES 93 and 97. ORDERING INFORMATION ON PAGE 93.

All projects on this page can be purchased as separate packs, e.g. PCBs, components sets, hardware sets etc. See our free catalogue for full details and prices.

Conquer the chip.

Be it a career, hobby or interest, like it or not the Silicon Chip will revolutionise every human activity over the next ten years.

Knowledge of its operation and its use is vital. Knowledge you can attain, through us, in simple, easy to understand stages.

Learn the technology of the future today in your own home.

MASTER ELECTRONICS

LEARN THE PRACTICAL WAY BY SEEING AND DOING

- Building an oscilloscope.
- Recognition of components.
- Understanding circuit diagrams.
- Handling all types Solid State 'Chips'.
- Carry out over 40 experiments on basic circuits and on digital electronics.
- Testing and servicing of Radio, T.V., Hi-Fi and all types of modern computerised equipment.

MASTER COMPUTERS

LEARN HOW TO REALLY UNDERSTAND COMPUTERS, HOW THEY WORK – THEIR 'LANGUAGE' AND HOW TO DO PROGRAMS.

- Complete Home Study library.
- Special educational Mini-Computer supplied ready for use.
- Self Test program exercise.
- Services of skilled tutor available.

MASTER THE REST

- Radio Amateurs Licence.
- Logic/Digital techniques.
- Examination courses (City & Guilds etc.) in electronics.
- Semi-conductor technology.
- Kits for Signal Generators – Digital Meters etc.

FREE

Please send your FREE brochure without obligation to:–

Name ....

Address ....

....

BLOCK CAPS PLEASE

I am interested in:–

PRACTICAL ELECTRONICS ....

COMPUTER TECHNOLOGY ....

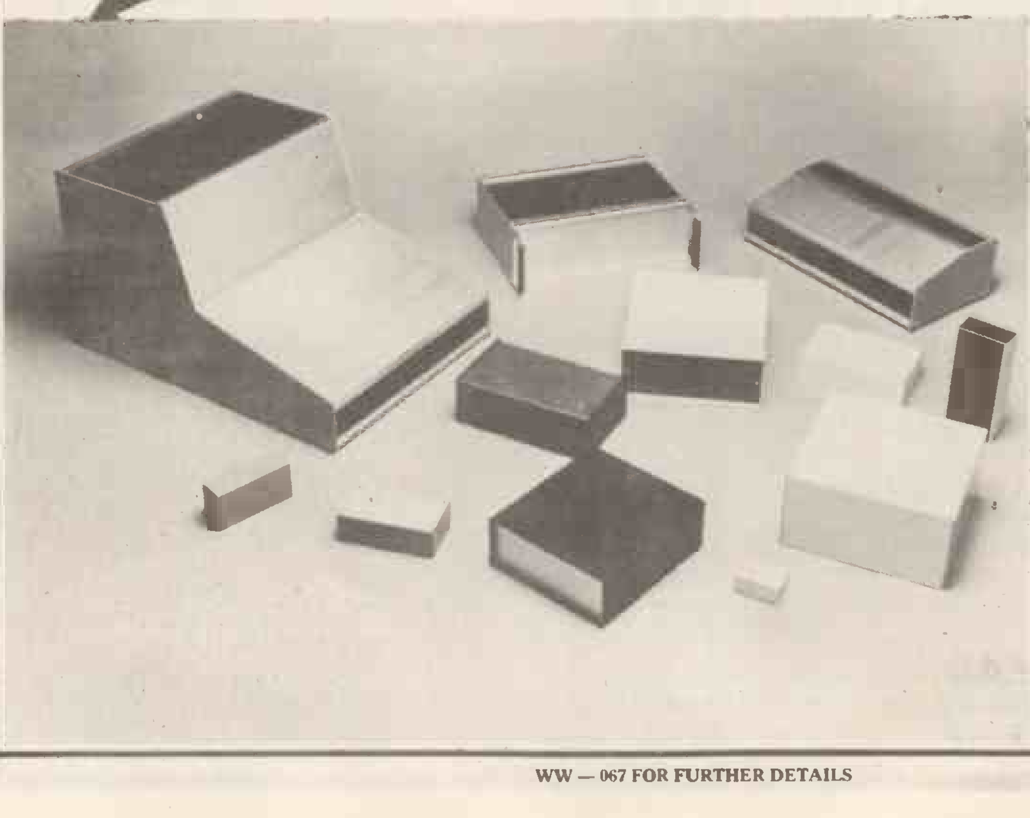
OTHER SUBJECTS ....
(please state your interest)

....

BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL

4 CLEVELAND ROAD, JERSEY, CHANNEL ISLANDS. WW/12/813

INSTRUMENT CASES AND BOXES



Zaerix Electronics Limited

46 Westbourne Grove
London, W2 5SF

PROFESSIONAL QUALITY

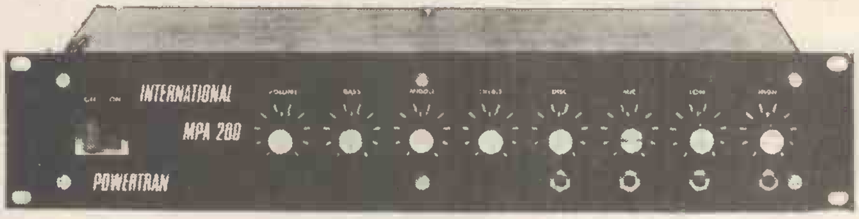
Desk consoles, instrument cases and boxes which feature anodised aluminium extrusions and panels, with integral facilities to mount sub chassis and PCBs.

Telex: 261306
Tel. 01-727 5641

WW — 067 FOR FURTHER DETAILS

MPA 200 100 WATT (rms into 8Ω) MIXER/AMPLIFIER

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features an adaptable input mixer which accepts a wide range of sources such as a microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.



Panel size 19.0" × 3.5". Depth 7.3"

COMPLETE KIT ONLY £49.90 + VAT!

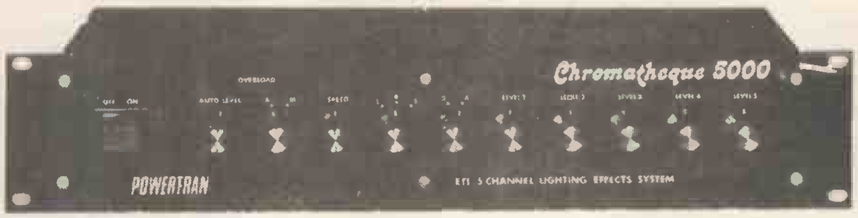
MATCHES THE CHROMATHEQUE 5000 PERFECTLY!

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 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!

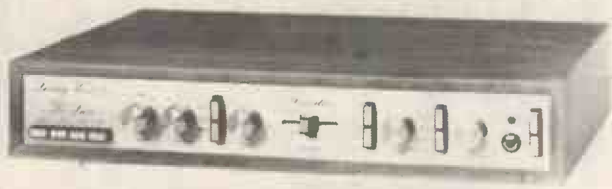


Panel size 19.0" × 3.5". Depth 7.3"

POWERTRAN

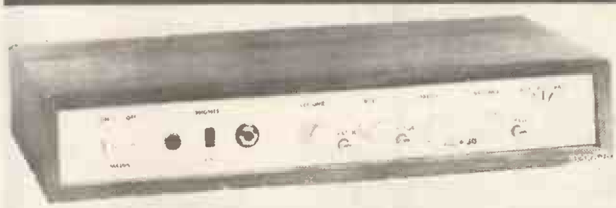
SYNTHESIZER KITS ON PAGE 95; MORE KITS AND ORDERING INFORMATION ON PAGE 93

All kits also available as separate packs (e.g. PCB, component sets, hardware sets, etc). Prices in our FREE CATALOGUE.



DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £85.00 + 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 while distortion is less than 0.01%.



T20 + 20 20W STEREO AMPLIFIER £33.10 + VAT

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30 watt version of this kit (T30 + 30) is also available for £38.40 + VAT.
MATCHING TUNERS — See our FREE CATALOGUE!

Above 2 kits are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cable, nuts, bolts, etc. and full instructions — in fact everything!

BLACK HOLE

MUSIC EFFECTS DEVICE — AS FEATURED IN ELECTRONICS TODAY INTERNATIONAL!

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a "spacey" feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLES), introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity, has high signal/noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure.

COMPLETE KIT ONLY £49.80 + VAT (single delay line system)
De Luxe version (dual delay line system) also available for **£59.80** + VAT

Cabinet size 10.0" x 8.5" x 2.5" (rear) 1.8" (front)

BULK EPROM PROGRAMMING

2-YEAR WARRANTY

P4000 PRODUCTION EPROM PROGRAMMER

This unit provides simple, reliable programming of up to 8 EPROMS simultaneously. It has been designed for ease of operator use — a single 'program' key starts the self check — blank check — program — verify sequence.
Independent blank check & verify controls are provided along with mode, pass/fail indicators for each copy socket and a sounder to signal a correct key command & the end of a programming run. Any of the 2704/2708/2716 (3 rail) & 2508/2758/2516/2716/2532/2732 (single rail) EPROMS may be selected without hardware or personality card changes.
PRICE £545 + VAT. Postage paid

BULK EPROM ERASING

EX-STOCK

MODEL UV141 EPROM ERASER

- 14 EPROM capacity
- Fast erase time
- Built-in 5-50 minute timer
- Convenient slide-tray loading of devices
- Safety interlocked to prevent eye and skin damage
- Rugged construction
- MINS & ERASE indicators
- Price £78 + VAT postage paid.

MODEL UV140 EPROM ERASER
Similar to Model UV141 but without timer. **Price £61.50** + VAT post paid

BULK EPROMS

EX-STOCK

	1-9	10-24	25-49	50-99	100 up
2716 (450ns) (single rail)	**£9.00**	**£8.00**	**£7.35**	**£7.00**	**£6.60**
2708 (450ns)	**£4.80**	**£4.30**	**£3.90**	**£3.60**	**£3.40**

DEDUCT A FURTHER 5% FOR CASH WITH ORDER ON THESE EPROM PRICES.
Postage and Packing is included in all prices. ADD VAT at 15%.
All our EPROMS are manufactured by leading companies and are fully guaranteed, branded and to full specification.

WRITE OR TELEPHONE FOR FURTHER DETAILS OR SEND OFFICIAL COMPANY ORDERS/CHEQUES TO:

PLEASE NOTE NEW ADDRESS & TELEPHONE NUMBER

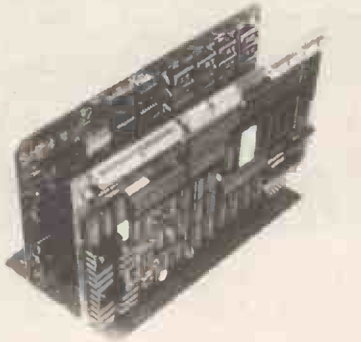
GP INDUSTRIAL ELECTRONICS LTD.

Unit 6, Burke Road, Totnes Industrial Estate, Totnes, Devon
Telephone: Totnes (0803) 863360 sales, 863380 technical
DISTRIBUTORS REQUIRED - EXPORT ENQUIRIES WELCOME

WW — 096 FOR FURTHER DETAILS

S 100

Do You Have All These Facilities On Your S 100 System, With Just Two Boards?



1. Z80A CPU-2 or 4 MHz Operation.
2. Z80A CTC — 4 Channels.
3. Z80A S10 — 2 RS-232.
4. Z80A P10.
5. Disk controller; Takes up to 4 disk drives, single or double density operation.
6. 64k Bytes of memory.
7. EPROM Programmer.
8. Real time clock.
9. Software;
   Standard 2k Monitor.
   CP/M Cold Start Loader.
   CP/M B10S (1.4).

Prices:

FDC-1 Board	**£495.50**
Expandoram	**£327.56**
Mother Board	**£42.00**

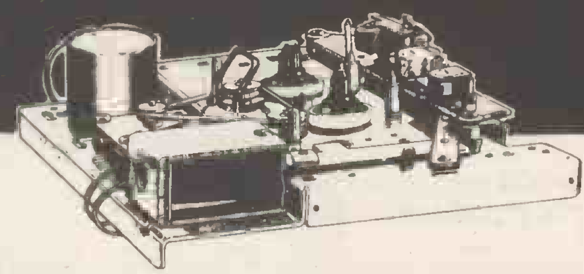
All prices exclude VAT.

SEMEL

MICROCOMPUTER - HARDWARE - SOFTWARE

3c Barley Market Street, Tavistock, Devon PL19 0JF
Tel. Tavistock (0822) 5247. Telex: 45263

SAVINGS ON TAPE TRANSPORTS!



The Monolith C1000 is a new British-made twin-motor tape transport, ideal for a wide range of industrial applications.

- High reliability.
- Solenoid controlled.
- Four remote functions — stop, play, rewind and fast forward.
- Supplied complete with spooling and capstan motors, drive solenoid, and ½-track record/playback and erase heads.

Buy now!
Ex-stock
£36.95
+ VAT (£2.50 p & p).

The C1000 is a major cost reduction development from the successful Monolith C2000 series of remote operation transports, which is widely used in process control, data logging and computer systems.
Ask for details of our control circuit boards, search, position sensors, specialised heads and other products.

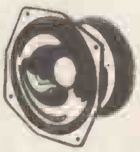
MONOLITH

THE MONOLITH ELECTRONICS CO. LTD.
5/7 Church Street, Crewkerne, Somerset TA18 7HR Tel (0460) 74321 Telex 46306 MONLTH G

WW — 087 FOR FURTHER DETAILS

WILMSLOW AUDIO

The firm for Speakers



HI-FI DRIVE UNITS

Audax HD12.9D25	£8.25
Audax HD11P25EBC	£7.50
Audax HD20B25H4	£14.95
Audax HD13D34H	£12.95
Audax HD24S45C	£21.95
Baker Superb	£25.00
Castle Super 8 RS/DD	£14.95
Chartwell CEA205	pairs only £61.25
Coles 4001	£7.65
Coles 3000	£7.65
Celestion HF1300 II	£10.95
Celestion HF2000	£10.95
Dalesford A8R 10"	£10.25
Dalesford 030/110	£11.25
Dalesford D50/153	£12.25
Dalesford D50/200	£12.25
Dalesford D70/250	£25.50
Dalesford D100/310	£35.75
Dalesford D10 tweeter	£8.45
Decca London Horn	£61.95
Elac 6NC204 6½"	£7.50
Elac 8NC298 8"	£7.95
EMI type 350, 13" × 8", 4 ohm	£9.45
EMI 14A/770, 14" × 9", 8 ohm	£19.50
Isophon KK8/8	£8.15
Isophon KK10/8	£8.45
Jordan Watts Module	£24.95
Jordan Watts HF kit	£10.50
Jordan 50mm unit	£24.50
Jordan CB crossover	£24.50 pair
Jordan Mono crossover	£24.50 pair
Kef T27	£9.45
Kef B110	£12.25
Kef B200	£13.50
Kef B139	£27.75
Kef DN13	£6.75
Kef DN12	£9.40
Kef DN22	pair £42.00
Lowther PM6	£59.00
Lowther PM6 Mk I	£62.00
Lowther PM7	£94.50
Peerless KO10DT	£10.95
Peerless DT10HFC	£10.50
Peerless KO40MRF	£13.60
Radford BD25 Mk III	£36.95
Radford MD9	£14.85
Radford MD6	£25.50
Radford FN8/FN831	£22.50
Richard Allan CG8T	£13.50
Richard Allan CG12T Super	£29.50
Richard Allan HP8B	£20.75
Richard Allan LP8B	£14.50
Richard Allan HP12B	£33.50
Richard Allan DT20	£9.95
Richard Allan DT30	£10.75
SEAS H107	£8.95
Shackman Electrostatic with polar network and crossover	£136.00 pair
Tannoy DC296 10"	£118.00
Tannoy DC316 12"	£159.00
Tannoy DC386 15"	£199.00

PA GROUP & DISCO UNITS

Celestion G12/50TC	£19.50
Celestion G12/80CE	£24.50
Celestion G12/80TC	£23.75
Celestion G12/125CE	£42.00
Celestion G15/100CE	£37.95
Celestion G15/100TC	£38.50
Celestion G18/200	£64.75
Celestion HF1300	£12.50
Celestion HF2000	£12.50
Celestion Powercell 12/150	£66.00
Celestion Powercell 15/250	£88.00
Celestion MH1000	£21.75
Fane Classic 45 12"	£13.95
Fane Classic 55 12"	£15.50
Fane Classic 80 12"	£19.75
Fane Classic 85 15"	£26.00
Fane Classic 150 15"	£37.95
Fane Classic 125 18"	£43.95
Fane Classic 175 18"	£47.95
Fane Guitar 80L 12"	£26.25
Fane Guitar 80B/2 12"	£27.25
Fane Disco 100 12"	£28.75
Fane PA85 12"	£26.25
Fane Bass 100 15"	£39.00
Fane Crescendo 12E	£57.50
Fane Crescendo 15E	£74.50
Fane Crescendo 18E	£94.75
Fane Colossus 15E	£99.95
Fane Colossus 18E	£107.00
Fane J44	£6.90
Fane J104	£15.95
Fane J73	£10.90
Fane HPX1/HPX2	£3.45
Fane HPX3A	£5.60
Fane HPX3B	£4.55
Goodmans 8PA	£5.05
Goodmans PP12	£22.50
Goodmans DI12	£25.50
Goodmans GR12	£24.95
Goodmans 18P	£48.45
Goodmans Hifax 50HX	£21.85
McKenzie C12100GP	£24.45
McKenzie C12100TC	£24.45
McKenzie C12100 bass	£24.45
McKenzie GP15	£35.10
McKenzie TC15	£35.10
McKenzie C15 bass	£59.60
Motorola Piezo horn 3½"	£8.50
Motorola Piezo 2" × 6"	£12.25
Richard Allan HD8T	£20.25
Richard Allan HD10T	£21.75
Richard Allan HD12T	£29.75
Richard Allan HD15	£52.75
Richard Allan HD15P	£52.75
Richard Allan Atlas 15"	£77.00
Richard Allan Atlas 18"	£96.00

WILMSLOW AUDIO

KITS FOR MAGAZINE DESIGNS, etc.
KITS INCLUDE DRIVE UNITS, CROSSOVERS, BAF/LONG FIBRE WOOL, etc. FOR A PAIR OF SPEAKERS
Carriage £3.95
unless otherwise stated

Practical Hi Fi & Audio PRO9-TL (Rogers)	£146.00
As above but including felt panels	£152.75 + £5 carriage
Hi Fi Answers Monitor (Rogers)	£146.00
Hi Fi News State of the Art (Atkinson)	£185.00
Hi Fi News Miniline (Atkinson)	£49.00 + £3 carriage
Hi Fi For Pleasure Compact Monitor (Colloms)	£116.00 + £5 carriage
Popular Hi Fi Mini Monitor (Colloms)	£74.00
Popular Hi Fi Round Sound (Stephens) including complete cabinet kit	£71.00
Popular Hi Fi Jordan System 1	£96.00 + £3 carriage
Practical Hi Fi and Audio BSC3 (Rogers)	£65.00
Practical Hi Fi and Audio Monitor (Giles)	£180.00
Practical Hi Fi and Audio Triangle (Giles)	£120.00
Hi Fi News Tabor (Jones) with J4 bass units	£66.00
Hi Fi News Tabor (Jones) with H4 bass units	£70.00
Wireless World Transmission Line KEF (Bailey)	£125.00
Wireless World Transmission Line RADFORD (Bailey)	£179.00
Everyday Electronics EE70 (Stephens)	£150 + £5 carriage
Everyday Electronics EE20 (Stephens)	£29.50 + £3 carriage

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

REPRINTS/CONSTRUCTION DETAILS OF ABOVE DESIGNS 10p EACH

CARRIAGE & INSURANCE

TWEETERS/CROSSOVERS	60p each
SPEAKERS 4" to 6½"	80p each
8" to 10"	£1 each
12", 13" × 8", 14" × 9"	£1.95 each
15"	£2.95 each
18"	£4.50 each
SPEAKER KITS	£1.95 each / £3.95 pair
MAG DESIGN KITS	£3.95 pair

unless otherwise stated
ALL PRICES CORRECT AT 1/2/80

SPEAKER KITS

Prices per pair
Carriage £3.75 pair

Dalesford System 1	£54.00
Dalesford System 2	£57.00
Dalesford System 3	£104.00
Dalesford System 4	£110.00
Dalesford System 5	£142.00
Dalesford System 6	£95.00
KEF Reference 104aB kit	£133.00 + £5 carriage
KEF Cantata kit	£213.50 + £5 carriage
LS3 Micro Monitor kit	£71.00 + £3.75 carriage
Lowther PM6 kit	£116.00
Lowther PM6 Mk I kit	£122.00
Lowther PM7 kit	£195.00
Peerless 1070	£157.00
Peerless 1120	£169.90
Peerless 2050	£59.95
Peerless 2060	£79.95
Radford Studio 90 kit	£181.00
Radford Studio 270 kit	£309.00
Radford Monitor 180 kit	£243.00
Radford Studio 360 kit	£450.00
RAM 50 kit (makes RAM 100)	£76.25
Richard Allan Tango Twin kit	£55.50
Richard Allan Maramba kit	£77.50
Richard Allan Charisma kit	£111.00
Richard Allan Super Triple kit	£102.50
Richard Allan Super Saraband II	£159.95
Richard Allan RA8 kit	£62.75
Richard Allan RA82 kit	£98.75
Richard Allan RA82L kit	£108.00
SEAS 223	£42.50
SEAS 253	£67.00
SEAS 403	£79.95
SEAS 603	£134.95
Wharfedale Denton XP2 kit	£31.45
Wharfedale Shelton XP2 kit	£40.40
Wharfedale Linton XP2 kit	£56.20
Wharfedale Glendale XP2 kit	£69.00

WILMSLOW AUDIO BA1 sub bass amplifier/crossover kit £37.95 + £1 carriage

EVERYTHING IN STOCK FOR THE SPEAKER CONSTRUCTOR!

BAF, LONG FIBRE WOOL, FOAM, CROSSOVERS, FELT PANELS, COMPONENTS, ETC. LARGE SELECTION OF GRILLE FABRICS.

(Send 22p in stamps for grille fabric samples).

ALL PRICES INCLUDE VAT @ 15%

Send 50p for 1980 56-page catalogue 'Choosing a Speaker'

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

Tel: 0625 529599 FOR MAIL ORDER & EXPORT OF DRIVE UNITS, KITS, ETC.

Tel: 0625 526213 (SWIFT OF WILMSLOW) FOR HI-FI & COMPLETE SPEAKER SYSTEMS.

Lightning service on telephoned credit card orders!

WILMSLOW AUDIO
The firm for Speakers
35/39 Church Street, Wilmslow, Cheshire

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 £2. Ready cut Mounting Board £1 extra

GARRARD AUTOCHANGER CC10A. 3 speed stereo cartridge. Plays all sizes of records, 7", 10", 12". (Turntable 7in) £8.50. post £1.

HEAVY METAL PLINTHS

Cut out for most Garrard decks. Silver grey finish. Size 16 x 14 x 3in. Post £1.50 **£5.00**

BSR DE LUXE TEAK VENEERED MODEL With hinged perspex cover. Size 17½ x 15 x 6 in. **£10.50** Post £2

TINTED PLASTIC COVERS Sizes: 14½ × 12½ × 4in. or 14½ × 12½ × 3in. £3.50. 18 × 13¼ × 4in. £6. 17¼ × 9½ × 3½in. £3. 18 × 12½ × 3in. £6. 18 × 13¾ × 3½in. with standup hinges £7. Post £1.50

BSR SINGLE PLAYER DECKS

BSR P182 3 speeds flared aluminium turntable "S" shape arm, cueing device, ceramic cartridge £26 Post £2.00. Ready cut mounting board. Only £1 extra.

BSR C142 RIM DRIVE QUALITY DECK Manual or automatic play. Two speeds. Precision ultra slim arm. Cueing device. Bargain price With stereo ceramic cartridge **£20** Post £2

BSR P207 BUDGET SINGLE PLAYER ideal for disco or small two-speed Hi-Fi system with stereo cartridge cartridge and cueing device. **£15** Post £2

GARRARD 6-200 SINGLE PLAYER DECK Brushed Aluminium Arm with stereo ceramic cartridge and Diamond Stylus, 3-speeds. Manual and Auto Stop/Start. Large Metal Turntable. Cueing Device and Pause Control Ready cut mounting board only £1 extra. **£22** Post £2

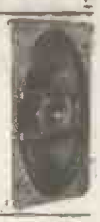
ELAC HI-FI SPEAKER 10in. TWIN CONE

Large ceramic magnet. 50-16,000 c/s. bass resonance 40 c/s. 8 ohm impedance. 10 watts. RMS. **£7.95** Post 99p

POTENTIOMETERS Carbon Track

5kΩ to 2MΩ. LOG or LIN. L/S 50p. DP 90p. Stereo L/S £1.10. DP £1.30. Edge Pot 5K. SP 45p. Sliders Mono 65p. Stereo 85p.

EMI 13½ x 8in. LOUDSPEAKERS



With tweeter and crossover. 10 watt. 3 or 8 ohm. **£9.95** Post 99p

With tweeter and crossover. 8 ohm. 15 watts. **£10.95** Post 99p

SUITABLE BOOKSHELF CABINET £9.50.

Bass woofer, EMI 15 ohm. 20 watt. **£10.95** Post 99p

THE "INSTANT" BULK TAPE ERASER Suitable for cassettes, and all sizes of tape reels. AC mains 200/250V. Hand held size with switch and lead. Will also demagnetise small tools **£7.50** Post 50p
Head Demagnetiser only £5

RELAYS. 12V DC 95p. 6V DC 85p.
BLANK ALUMINIUM CHASSIS. 6 x 4—£1.20; 8 x 6—£1.50; 10 x 7—£1.90; 12 x 8—£2.20; 14 x 9—£2.50; 16 x 6—£2.40; 16 x 10—£2.70.
ANGLE ALI. 6 x ¾ x ¾in—25p.
ALUMINIUM PANELS. 6 x 4—24p; 8 x 6—38p; 14 x 3—40p; 10 x 7—54p; 12 x 8—70p; 12 x 5—44p; 16 x 6—70p; 14 x 9—94p; 12 x 12—£1; 16 x 10—£1.16.
PLASTIC AND ALI BOXES IN STOCK. MANY SIZES
ALUMINIUM BOXES. 4 x 4 x 1½ £1. 4 x 2 x 2 £1. 3 x 2 x 1 80p. 6 x 4 x 2 £1.30. 7 x 5 x 2½ £1.45. 8 x 6 x 3 £2.20. 10 x 7 x 3 £2.50. 12 x 5 x 3 £2.30. 12 x 8 x 3 £3.
BRIDGE RECTIFIER 200V PIV 4 amp £1.50. 8 amp £2.50.
TOGGLE SWITCHES SP 30p. DPST 40p. DPDT 50p.
PICK-UP CARTRIDGES ACOS. GP91 £2. GP94 £2.50.
SONOTONE 9TAHC Diamond £3. V100 Magnetic £6.50.
RESISTORS. 10Ω to 10M. ¼W. ½W. 1W. 1p; 2W 10p.
HIGH STABILITY. ½W 2% 10 ohms to 1 meg. 8p. Ditto 5% Preferred values. 10 ohms to 10 meg. 3p.

MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, jewelled bearings — 2000 o.p.v. Battery included 11 instant ranges measure. DC volts 10, 50, 250, 1000. AC volts 10, 50, 250, 1000. DC amps 0-100 mA. Continuity and resistance 0-1 meg ohms in two ranges. Complete with Test Prods and instruction book showing how to measure capacity and inductance.
£6.50

HIGH QUALITY

JVC DECK £28.50
Post £2

J.V.C. BELT DRIVE STEREO DECK

Detachable head, adjustable counter balance weight, hydraulic damped cueing platform, automatic pick-up arm return, 2 speeds, 33 and 45 rpm, suppression circuit to start stop switch, 240V AC motor, dynamic pendulous bias compensator. Teak veneered base, 19in. x 14½in £9. Plastic cover £6, post £2. Recommended stereo magnetic cartridge £6.50 extra.

RCS SOUND TO LIGHT KIT Mk. 2

Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel. Suitable for home or disco. Easy to build. Full instructions supplied. Cabinet £4.50 extra. Will operate from 200MV to 100 watt signal. **£18** Post 50p
200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights, Edison Screw. 6 for £4, or 12 for £7.50. Post 50p.

"MINOR" 10 watt AMPLIFIER KIT £14.00

This kit is suitable for record players, guitars, tape playback, electronic instruments or small PA systems. Two versions available: Mono, £14.00; 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.

RCS STEREO PRE-AMP KIT. All parts to build this pre-amp. Inputs for high, medium or low imp per channel, with volume control and PC Board **£2.95** Post 35p
Can be ganged to make multi-way stereo mixers

MAINS TRANSFORMERS ALL POST 99p.

250-0-250V 70mA. 6.5V. 2A	£3.45
250-0-250V 80mA. 6.3V 3.5A. 6.3V 1A	£4.60
350-0-350V 250mA. 6.3V 4A CT. 5V 2A	£12.50
300-0-300V 120mA. 2 x 6.3V 2A C.T.: 5V 2A	£10.00
220V 45mA. 6.3V 2A	£2.50

GENERAL PURPOSE LOW VOLTAGE.
Tapped outputs available

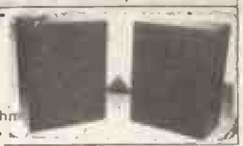
2 amp. 3. 4. 5. 6. 8. 9. 10. 12. 15. 18. 25 and 30V	£6.00
1 amp. 6. 8. 10. 12. 16. 18. 20. 24. 30. 36. 40. 48. 60	£6.00
2 amp. 6. 8. 10. 12. 16. 18. 20. 24. 30. 36. 40. 48. 60	£9.50
3 amp. 6. 8. 10. 12. 16. 18. 20. 24. 30. 36. 40. 48. 60	£12.50
5 amp. 6. 8. 10. 12. 16. 18. 20. 24. 30. 36. 40. 48. 60	£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	2 of 28 volt 1 amp	£5.00
		20V. 1 amp	£3.00
0.5. 8. 10. 16V. ½ amp	£2.50	20V-0-20V. 1 amp	£3.50
9V. 3 amp	£3.50	9-0-9 volt 50ma	£1.50
25-0-25V 2 amp	£4.50	2 of 18V. 6 amp.	£11.00
30V. 1½ amp £3.00 2 amp	£3.50	12-0-12V. 2 amp	£3.50
6V ½ amp	£2.00	9V. ¼ amp	£1.50
15-0-15V. 2 amp	£3.75	32-0-32V. 6½ amp	£11.00

AUTO TRANSFORMERS. 115V to 240V 150W £8.00 500W £10.00.

CHARGER TRANSFORMERS		CHARGER RECTIFIERS	
6-12 volt 3 amp	£4.00	6-12 volt 2 amp	£1.10
6-12 volt 4 amp	£6.50	6-12 volt 4 amp	£2.00

OPUS COMPACT SPEAKERS



FLUTED WOOD FRONTS TEAK VENEERED CABINET
11 x 8½ x 7in
50 to 14,000 cps 15 watts 8 ohm
Post £2 **£20 pair**

LOW VOLTAGE ELECTROLYTICS ALL 10p
1 mfd, 2 mfd, 4 mfd, 8 mfd, 10 mfd, 16 mfd, 25 mfd, 30 mfd, 50 mfd, 100 mfd, 250 mfd. All 15 vgts. 22 mfd/6v/10v; 25 mfd/6v/10v; 47 mfd/10v; 50 mfd/6v; 68 mfd/6v/10v/16v/25v; 100 mfd/10v; 150 mfd/6v/10v; 200 mfd/10v/16v; 220 mfd/4v/10v/16v; 330 mfd/4v/10v; 500 mfd/6v; 680 mfd/6v/10v/16v; 1000 mfd/2.5v/4v/10v; 1500 mfd/6v/10v/16v; 2200 mfd/6v/10v; 3330 mfd/6v; 4700 mfd/4v. ALL 10p.
500mF 12V 15p; 25V 20p; 50V 30p.
1000mF 12V 20p; 25V 35p; 50V 50p; 100V 70p.
2000mF 6V 25p; 25V 42p; 40V 60p; 1200mF 76V 80p.
2500mF 50V 70p; 3000mF 50V 65p; 2000mF 100V £1.
4500mF 64V £2. 4700mF 63V £1.20. 2700mF/76V £1.
5000mF 35V 85p.

HIGH VOLTAGE ELECTROLYTICS

8/350V	35p	8+8/450V	75p	50+50/300V	50p
16/350V	45p	8+16/450V	75p	32+32/450V	90p
32/500V	75p	16+16/450V	75p	100+100/275V	65p
50/500V	£1.20	32+32/350V	50p	150+200/275V	70p
8/800V	£1.20	50+50/500	£1.80	220/450V	95p
16/500V	65p			80+40/500V	£2

TRIMMERS 10pF, 30pF, 50pF, 5p. 100pF, 150pF, 15p.
CERAMIC, 1pF to 0.01mF, 5p. Polystyrene 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, 385pF £1; 500pF £1; 365 + 365 + 25 + 25pF. Slow motion drive £1. 120pF 50p. 3 Gang 365 pF £2.
TRANSISTOR TWIN GANG. Japanese Replacement 50p.
NEON PANEL INDICATORS 250V 30p.
ILLUMINATED ROCKER SWITCH. single pole. Red 65p.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt 15p
CASSETTE MOTOR. 6 volt £1.00
CASSETTE MECHANISM. Mono heads with motor £4.00
U.H.F. COAXIAL CABLE SUPER LOW LOSS. 25p yd.

BAKER LOUDSPEAKERS "SPECIAL PRICES"
Post £1.50 ea.

MODEL	INCHES	OHMS	WATTS	TYPE	PRICE
MAJOR	12	4-8-16	30	HI-FI	£12
DELUXE MK II	12	8-16	15	HI-FI	£14
SUPER8	12	8-16	30	HI-FI	£20
AUDITORIUM	12	8-16	45	HI-FI	£20
AUDITORIUM	15	8-16	60	HI-FI	£35
GROUP 35	12	4-8-16	40	PA	£12
GROUP 45	12	4-8-16	45	PA	£15
GROUP 50	12	4-8-16	60	PA	£20
GROUP 75	12	4-8-16	75	PA	£22
GROUP 100	12	8-16	100	PA	£26
GROUP 100	15	8-16	100	PA	£29
DISCO 100	12	8-16	100	DISCO	£26
DISCO 100	15	8-16	100	DISCO	£29

BAKER 50 WATT AMPLIFIER

£69 Post £2.00
Ideal for Halls/PA systems, Discos and Groups. Two inputs. Mixer, Volume Controls, Master Bass, Treble and Gain Controls. 50 watts r.m.s. Three loudspeaker outlets 4, 8, 16 ohms.

BAKER 150 WATT MIXER/POWER AMPLIFIER

Professional 4 inputs with volume controls. Will mix mics, decks, musical instruments, etc. **£89**
Slave version available £75. 100 Volt Line £14 extra Post £2.00

FAMOUS LOUDSPEAKERS "SPECIAL PRICES"
Post £1.50 ea

MAKE	MODEL	SIZE	WATTS	OHMS	PRICE
SEAS	TWEETER	4in	50	8	£7.50
GOODMANS	TWEETER	3½in	25	8	£4.00
AUDAX	TWEETER	3¾in	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	5½in	15	8	£6.50
GOODMANS	FULL-RANGE	8in	20	8	£5.50
SEAS	WOOFER	8in	30	8	£14.00
RIGONDA	FULL-RANGE	10in	20	8	£8.50
GOODMANS	AUDIOM	12PG	60	8/15	£20.00
GOODMANS	AUDIOM	12PD	60	8/15	£20.00
GOODMANS	AUDIOM	12P	50	8/15	£20.00

BATTERY ELIMINATOR MAINS to 9 VOLT D.C.
Stabilised output, 9 volt 400 m.a. UK made in plastic case with screw terminals. Safety overload cut out. Size 5 x 3¼ x 2½in. Transformer Rectifier Unit. Double insulated. Suitable Radios, Cassettes, models. £4.50

TEAK VENEERED HI-FI SPEAKER CABINETS
For 13x8in. or 8in. speaker £9.50 Post 99p
For 6½in. speaker and tweeter £8.50 Post 99p
Many other cabinets in stock. Phone your requirements.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.
LOUDSPEAKER CABINET WADDING 18in wide 25p ft.

GOODMANS TWIN AXIOM 8 inch dual cone loudspeaker. 8 ohm, 15 watt hi-fi unit £10.50. Ditto 15 ohm £8. Post £1.
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.. £3.00; 8x5in.. £3.00; 8in.. £3.50.
SPECIAL OFFER: 64 ohm, 2¾in., 35 ohm, 3in., 25 ohm, 3in., 5x3in., 7x4in., 8 ohm, 2in., 2¾in., 3in., 3½in., 5in., 15 ohm, 3½in. dia, 6x4in., 7x4in., 5x3in., 3 ohm, 4in., 5in., 7x4in., 120 ohm, 3¼in. dia. £1.50 each.
FAMOUS MAKE TWIN CONE LOUDSPEAKERS 8in. diameter 4W £3.50. 10in. diameter 5W £3.50; 12in. diameter 6W £4.50. 3/8 or 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 RMS 4 ohm imp. Bass resonance = 30 c.p.s. Frequency response 20-8000 c.p.s.
BARGAIN, £8.50. Post £2

ALUMINIUM HEAT SINKS. FINNED TYPE. Sizes 5"x4"x1" 95p. 6½"x2"x2¼" 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.

DRILL SPEED CONTROLLER/LIGHT DIMMER KIT. Easy to build kit. Controls up to 480 watts AC mains £3
DE LUXE MODEL READY BUILT 800 watts plus Photo Electric Sunset "On" feature. Front plate fits standard box £4.

RADIO COMPONENT SPECIALISTS

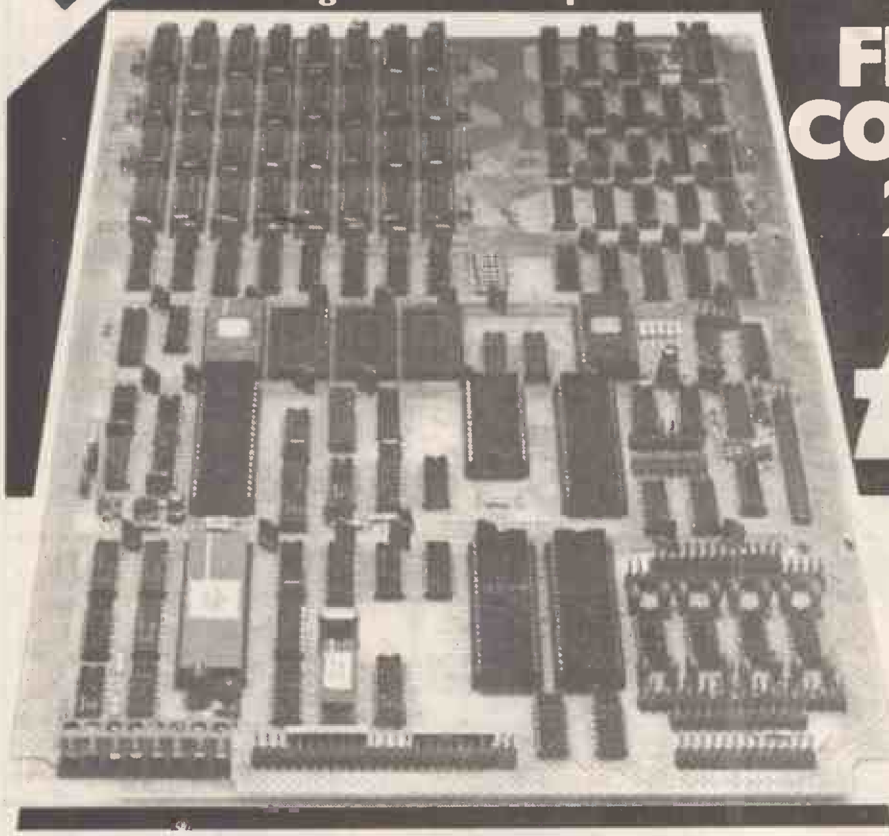
337 WHITEHORSE ROAD, CROYDON
Open 9-6. Closed all day Wed. Open Sat. 9-5.

Radio Books and Components Lists 20p. (Minimum post/packing charge 50p.) Access or Barclaycard Visa. Please Tel: 01-684 1665 for same day despatch. Cash prices include VAT.

NEW

Introducing the incredible BIGBOARD

Single Board Computer Kit



Z-80 CPU! 64K RAM! FLOPPY DISK CONTROLLER! 24x80VDU! AT ONLY £395.00 plus VAT

it packs twice as much on ONE BOARD – at around HALF THE PRICE!

'It's taken three whole years to produce the BigBoard, designed from scratch to run the latest version of CP/M, so just imagine what software you could run WITH NO MODS NEEDED! In fact, add a couple of 8" Disk Drives, a Video Monitor and Keyboard, then an enclosure and connect a suitable Power Supply and you'll have a Total Business System for about ONE THIRD the cost! That's what you call BigBoard flexibility, power – and sheer operating value. Send for your BigBoard today!

Size 8½ x 13¾ inches. Requires + 5V @ 3 Amps +/– 12V @ 0.5 Amps.

YOU GET THESE FEATURES

64K RAM	That's 64K of usable RAM space using industry-standard 4116s. *All* 64K is available to the user, (video and EPROM sections do not make holes in it, for example), and extra special care has been taken to ensure that the RAM array PC layout eliminates potential noise and malfunction.	**80 x 24 Character Video**	Gives a crisp, flicker-free, sharp display even on the smallest monitors. Hardware scroll, full cursor controls, composite or split video and sync. The character set is supplied on a 2716 style ROM (makes customised founts that much easier!), and sync. pulses can be any desired length or polarity. Video can be inverted or true.
Z-80 CPU	Handles *all* 4116 RAM refresh *and* supports all MODE 2 INTERRUPTS. Fully buffered, the Z-80 runs all 8080 software.	**Basic I/O**	A separate parallel port (Z80 PIO) for use with an ASCII encoded keyboard for input. Output on the 80 x 24 character video display.
Floppy Disk Controller	Uses the WD1771 controller chip with TTL Data Separator for reliability, IBM 3740 compatible. It will support up to four 8" drives and is directly compatible with standard Sugart drives such as the SA800 or SA801. Drives can also be configured for remote AC off-on. Runs CP/M 2.2.	**PFM 3.0 2K System Monitor**	The on-board PFM 3.0 is the real power behind the BigBoard. PFM commands include Dump Memory, Boot CP M, Copy, Examine, Fill Memory, Test Memory, Go To, Read and Write I O Ports, Disk Read (Drive, Track, Sector) and Search. But, PFM occupies one of the four 2716 EPROMs, so it doesn't occupy any of the 64K of usable RAM!

PLUS THESE OPTIONS

Serial I/O	Full 2 channels using the Z-80 SIO and the SMC 8116 Baud Rate Generator. You get FULL RS232! For synchronous or asynchronous communication, and clocks can be transmitted or received by a modem in the former. Both channels can be set up for either data communication or data terminals. Supports mode 2 Int. PRICE JUST £60 !
Four Port Parellel I/O	Uses Z-80 PIO to give full 16 bits, fully buffered and bi-directional. User selectable hand-shake polarity, and set of all parts and connectors for parallel I O ONLY £25 !
Real Time Clock	Uses Z-80 CTC and can be configured as a counter on Real Time Clock. Set of all parts ONLY £12 !
CP/M 2.2	The popular CP/M D.O.S. as modified by Micronix Systems to run on the BigBoard is just £99 !

Please send me_____BigBoard/s at £460 (including £60 VAT and £5 INSURED DELIVERY) each.total £______ And

____Serial I/O at £69 (inc. VAT)each, total £______

____Four Port Parellel I/O at £28.75 (inc. VAT) each, total £______

____Real Time Clock/s at £13.80 (inc. VAT) each, total £______

____CP/M 2.2 at £113.85 (inc. VAT)each, total £______

I enclose cheque for £______, or PAY BY ACCESS, giving card number and signature. Cheques payable to Maclin-Zand Electronics Ltd., please. Cash with order.

Name__________

ACCESS NO __________

Address__________

Signature __________

ME

Maclin-Zand

Making state-of-the-art affordable.

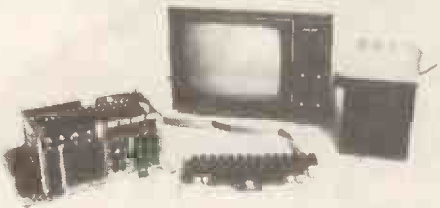
Sole European Distributor.
Maclin-Zand Electronics Limited,
38 Mount Pleasant, London WC1X 0AP.
Tel: 01-278 7369/01-837 1165 Telex 8953084

WWBB

From Newtronics

THE NEW EXPLORER/85 SYSTEM

EXPLORER/85
PROFESSIONAL COMPUTER KIT



An inexpensive 8085, S100 Based Computer System designed for maximum flexibility Now available with 8" Floppies

The EXPLORER/85 offers you real design flexibility — you can build the exact system you require. EXPLORER/85 can be your Beginners System, OEM Controller or IBM formatted 8" Disc System. You don't buy more than you need. Prices start from £85.

Here's the line up:

Intel 8085 microprocessor. 8355 as a really powerful 2K Monitor system. 8155 RAM I/O all on one single Mother board with room for RAM/ROM/PROM/EPROM and two S-100 pads (expands to six), plus plenty of prototype space.

The 8085 is 100% compatible with the 8080 but 50% faster. The 8355 ROM 2K monitor system includes cassette interface with tape control. Two 8-bit programmable I/O ports, automatic baud rate selection, labelling of cassette files, etc. 8155 RAM I/O features ¼K 'scratch pad'. Two programmable 8-bit and One programmable 6-bit I/O ports plus progammable 14-bit binary counter-timer. Plus many other features which cannot be included due to lack of space.

You can purchase the EXPLORER/85 Mother board (level A) at this point for as little as £85 or we'll supply it with address decoding and data drives plus wait state generator and separate regulators (level B), 4K Workspace (level D), 8K Microsoft Basic in ROM for £233 in kit form or £293 assembled and tested.

If you don't possess a VDU you can add our Keyboard Terminal (less monitor) which features a full ASC11 keyboard with upper and lower case with cursor control, Video Display board which is microprocessor controlled giving 64 or 32 (on TV) Characters by 16 lines adding up to a full computer system having 4K workspace at a special price of £299 (less P.S.U. and monitor/TV).

Compare these prices carefully and you'll find you are actually getting more for your money.

4K space not enough? Then it's 'JAWS' for you (see below) and you can go up to 64K in 16K steps. We'll let you have a 16K EXPLORER/85 for only £399.

Like a Floppy Disc system? We now have an 8" Drive system with CP/M. We will quote you for a complete system either in kit form or assembled ready to go.

8" FLOPPY DISC SYSTEM

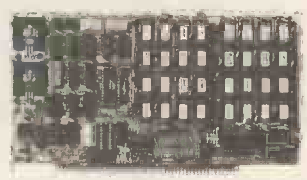
8" Control Data Corp Professional Drive
★ LSI Controller ★ Write protect ★ Single or Double density ★ Capacity 400K Bytes (SD) 800K Bytes (DD) unformatted ★ Access time 25ns. Price £350.

DISC CONTROLLER I/O BOARD
Controls up to 4 Drives ★ 1771 ALSI (SD) floppy disc controller ★ On board data separator (IBM compatible) ★ **2716 PROM socket included for use in custom applications** ★ On board crystal controlled ★ On board I/O baud rate ★ Two serial I/O ports ★ Autoboot to disc system when system reset ★ Generators to 9600 baud ★ Double-sided PC board (glass epoxy). Kit price £150, assembled £170.

DISC DRIVE CABINET WITH POWER SUPPLY
De Luxe steel cabinet to house single drive with power supply unit to ensure maximum reliability and stability. Price £79.

DRIVE CABLE SET-UP FOR TWO DRIVES
Price £19.00.
SAVE £30 by purchasing complete single drive system. One 8" drive, F.D.C. board, cabinet/PS.U. and cables. Regular price £598, Special price £568.
CP/M 1.4 £75. CP/M 2.2 £98. Extended Microsoft MBasic £213 (includes CP/M 2.2). Let us quote you for other Software.

64K 'JAWS' S100 DYNAMIC RAM BOARD



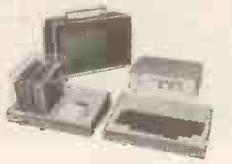
Newtronics solves the problems of Dynamic RAM with a state-of-the-Art chip from Intel that does it all. Intel's 8202 64K dynamic RAM controller eliminates high logic parts . . . delay lines . . . massive heat sinks . . . unreliable trick circuits.

We offer you — Hidden refresh . . . fast performance . . . lower power consumption . . . latched data outputs . . . 200ns 4116 RAM's . . . on board crystal . . . 8K bank selectable . . . fully socketed . . . solder mask on both side of the board.

Designed for 8080, 8085 and Z80 bus signals . . . works in Explorer/85, Tuscan, Horizon, Sol, as well as all other well-designed S100 computers.

16K kits	£149	Wired and tested	£169
32K kits	£194	Wired and tested	£214
48K kits	£239	Wired and tested	£259
64K kits	£284	Wired and tested	£304
16K expansion kits	£45		

ELF II



SPECIFICATION
'RCA 1802 8-bit microprocessor with 256 byte RAM expandable to 64K bytes.
'RCA 1861 video IC to display program on TV screen via the RF Modulator Single Board with Professional hex keyboard — fully decoded to eliminate the waste of memory for keyboard decoding circuits. Load, run and memory protect swiches. 16 Registers, Interrupt, DMA and ALU. Stable crystal clock. Built-in power regulator 5-slot plug-in expansion bus (less connectors).

Christmas Special Offer
~~£59.95~~ **£39.95**

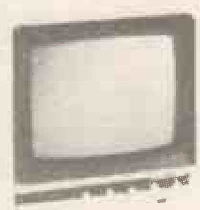
ELF II
BOARD WITH VIDEO OUTPUT

FEATURING THE RCA COSMAC 1802 cpu
STOP reading about computers and get your "hands on" an ELF II and Tom Pitman's short course. ELF II demonstrates all the 91 commands which an RCA 1902 can execute, and the short course speedily instructs you how to use them.

ELF II's VIDEO OUTPUT makes it unique among computers selling at such a modest price. The expanded ELF II is perfect for engineers, business, industry, scientific and educational purposes.

ELF II EXPANSION KITS
Once you've mastered your ELF II you can then expand it to a full 64K microcomputer with our range of ELF II expansion kits. — Hardware — Firmware — Software — Manuals.

NOW AVAILABLE BASIC LEVEL III with R.P.N. Maths package. Both cassette and EPROM versions.



Newtronics
TVM-10 MONITOR

£99.50

IDEAL FOR APPLE NASCOM U.K. 101, ETC.

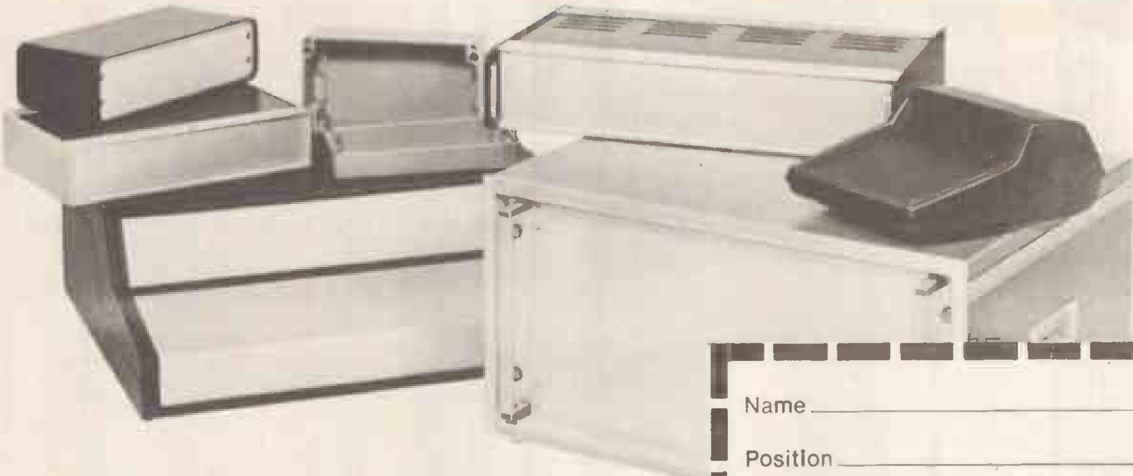
- **Designed for monitoring computers, closed circuit TV and Video Tape Recorders**
- **10" black and white video monitor**
- **10 MHz band width**
- **High-quality metallic cabinet**
- **Dimensions: 9" x 9" x 9½"**

Trade Enquires Welcome

SEND SAE FOR COMPREHENSIVE BROCHURE
Please add VAT to all prices. P&P extra. Please make cheques and postal orders payable to NEWTRONICS or phone your order quoting BARCLAYCARD, ACCESS number.
We are open for demonstrations and Sales. Monday-Saturday, 9.30 a.m.-6.30 p.m. Near Highgate Underground on main A1 into London.

CALL:
Newtronics
255 ARCHWAY ROAD, LONDON, N.6
TEL: 01-348 3325

The facts of the case



West Hyde have one aim in life, to provide a practical solution to the problem of electronic packaging. The fact of the matter is that we have an ideal case for almost every project featured in this magazine. In this advertisement it is impossible to show you our whole range of nearly 1,000 different instrument cases, or our extensive collection of tools and accessories. Please complete the coupon and, in turn, we will send you our free 80-page catalogue and price list.

Name ____________

Position ____________

Company ____________

Address ____________

____

WEST HYDE

West Hyde Developments Limited, Unit 9,
Park Street Industrial Estate, Aylesbury, Bucks., HP20 1ET
Telephone: Aylesbury (0296) 20441/5. Telex: 83570

WW — 107 FOR FURTHER DETAILS

QUICK ACTING & ANTI SURGE CARTRIDGE FUSES

from £2.80 per 100

Wirewound Power Resistors (Ceramic). 5w-17w 0R5-39K from £9.35 100.

Cable Sleeves and Markers from £1.31 1000.

Cf. Resistors. ⅛w-2w from .. .. £4.00 1000.

Crimp Terminals. Elma Knobs and Dials, Audible Warning Devices from £1.14 each.

Catalogue available (state interests)

Cf. Resistors ¼w 5%
£3.00 1000 (per value) + carr. and V.A.T. Following values only.

6E8 33E 100E 120E 360E 470E 560E 2K4 2K7 4K7 5K6 7K5 8K2 100K 120K 150K 220K 300K 390K 820K

PBRA LTD.
Golden Green, Tonbridge
Kent. TN11 0LH
Hopfield (073274) 345
Member Crystalate Group

WW — 060 FOR FURTHER DETAILS

FAST PCB PROTOTYPES

FAST PCB PROTOTYPES

SAME DAY DESPATCH

Prototype epoxy glass printed circuit boards up to 250mm x 200mm from your camera ready artwork.

Up to 125mm x 100mm—**£18+VAT** per side etched only drilling **£5+VAT**
Up to 250mmx200mm — **£24+VAT** per side etched only drilling **£10+VAT**

Send your order with artwork cheque and instructions—orders received by 10 a m guaranteed despatched first class same day etched only (next day etched and drilled) or your money refunded subject to acceptance of artwork

ACR AUSTERFIELD-CLARK RESEARCH. Tel. 0484 48016
42 Blackhouse Road, Huddersfield HD2 1AR (625)

WW — 050 FOR FURTHER DETAILS

COMPUTER APPRECIATION

86 High Street, Bletchingley, Redhill, Surrey RH1 4PA. Tel: Godstone (0883) 843221

PDP 11/23 SYSTEM comprising 11/23 card with memory management chip, MXV 11-A multifunction card with 8K bytes, 2 serial interface channels and 2 x 2716 EPROMs, 64K byte MSV11 card, XYLOGICS Model C510 disc controller with bootstrap, 2 x DIABLO Series 30 removable disc drives compatible with RK05, VT52 VDU (24 lines x 80 ch), DEC BA11-MF box with 4 spare slots. Apart from the terminal and disc drives the components of this system are NEW and dated 1980 .... £7,500.00

TEXAS INSTRUMENTS Model 980A processor. With 16K x 16 MOS memory, battery backup and full console. A generous assortment of interface modules is included. Manufactured 1978 .... £450.00

TEXAS INSTRUMENTS Model 980A processor. As above, but with 8K x 16 memory £300.00

TELETYPE Model KSR 43 matrix terminal. AS NEW £650.00

K & N Model AC3500 acoustic coupler. AS NEW £80.00

KALLE INFOTEC Model 7000 word processing system incorporating IBM Model 82 dual pitch golfball typewriter and single cassette station. With numerous editing facilities etc. £850.00

TELETYPE Model ASR 33 with 20mA current loop or RS232 interface. 110 Baud, remote reader control (which may be disabled by insertion of a jumper), paper tape reader/punch and stand (when available) from £195.00

DATA DYNAMICS Model ASR390. Mechanically identical to ASR 33 but with addition of 240v operation, motor cut out feature, reader single stop, stand and silencing cover. RS232 Interface. Low hours and in immaculate condition £275.00

DI/AN Model 9030. Desk-top terminal similar to DECwriter LA36. Upper/lower case matrix printer, up to 300 BAUD. Features switchable Baud rate, parity, keyboard and duplex options. £190.00

TEXAS SILENT 700 KSR TERMINAL. 30 cps dot matrix terminal using thermal paper. With 20mA current loop interface £275.00

TEXAS SILENT 700 ASR TERMINAL. 110/300 Baud matrix terminal using thermal paper. With twin magnetic tape cassette units £575.00

ITEL Model 1051. IBM SELECTRIC (golfball) typewriter based terminal. With standard RS232/V24 serial interface and optical paper tape reader/punch. EBCDIC coded £295.00

As above, but tested only so far as typewriter operation £195.00

CENTRONICS Model 101A 165 cps matrix printer with parallel and serial interface options £375.00

POTTER Model LP-3000 High Speed (300 lpm) line printer £290.00

DCL MATRIX PRINTER. 120 cps with dual tractors and long platen. Unused £350.00

CDC Model CP CL 892 300 lpm line printer £260.00

ODEC Model 4000 belt printer. 65 lpm. Parallel TTL interface. Manufactured 1980 .... £350.00

DIABLO SERIES 30 DISC DRIVES. These are offered fully refurbished and may be viewed operating on-line at our premises prior to purchase. 2.5 megabyte removable cartridge version is directly compatible with the DEC RK05 drive for PDP/LSI 11. .... £650.00

As above, but with cartridge removable by engineer rather than operator £495.00

WANGCO Model T 1222 disc drives. With one fixed and one top loading platter of 5 megabytes capacity total. 2500 rpm, industry standard interface £450.00

(One only BRAND NEW) £750.00

PERTEC Model D3342-EB-NWX 5 megabyte disc drive with one front loading cartridge and one fixed platter. 100 tpi, 2200 bpi, 2400 rpm £650.00

BURROUGHS disc drives. 2 x 2.5 megabyte front loading cartridge in cabinet. Will interface to most controllers .... £450.00 (Pair)

DEC Model TU 10 9-track NRZ drive in rack cabinet. Manufactured 1975 and DEC maintained £1,100.00

PERTEC Model 6840-9-25 9-track PE and NRZI tape drives usually available from stock £475.00

WANGCO Model 1025 9-track NRZ tape drives. 2 drives mounted in cabinet. (Enquire for one off price) 1,100.00

PERTEC Model 4311 Key to 9-track magtape encoder 800 bpi, portable unit £195.00

DEC Model CR11 card reader £350.00

PLESSEY Paper Tape station. With **TALLY** reader and **TELETYPE BRPE** 110 Punch. Operates either locally or on-line at up to 1200 Baud £285.00

TREND Model PTS incorporating **TREND** Model HSR350 350 cps optical reader and **GNT** Model 34 punch. Compact unit complete with all power supplies suitable for desk top use or rack mounting £285.00

FACIT Model 4070 High Speed paper tape punch with parallel TTL interface £450.00

- ★ VAT and carriage extra all items.
- ★ Visitors welcome, but by appointment please
- ★ We are keen to bid competitively for all good used equipment.

TTLs by TEXAS

7400	11p	74290	150p	4020	100p
74S00	60p	74293	150p	4021	110p
7401	12p	74298	200p	4022	100p
7402	12p	74365	100p	4023	27p
7403	14p	74366	100p	4024	50p
7404	14p	74367	100p	4025	20p
7405	18p	74368	100p	4026	130p
7406	36p	74390	200p	4027	50p
7407	36p	74393	200p	4028	84p
7408	17p	74490	225p	4029	100p
7409	19p	**74LS SERIES**		4030	55p
7410	15p	74LS00	14p	4031	200p
7411	24p	74LS02	16p	4034	200p
7412	20p	74LS03	18p	4035	110p
7413	30p	74LS04	16p	4036	295p
7414	40p	74LS05	25p	4039	295p
74C14	90p	74LS08	22p	4040	100p
7416	27p	74LS09	21p	4041	80p
7417	27p	74LS10	20p	4042	80p
7420	17p	74LS11	40p	4043	90p
7421	40p	74LS13	40p	4044	90p
7422	22p	74LS14	50p	4046	110p
7423	34p	74LS20	20p	4047	100p
7425	30p	74LS21	40p	4048	55p
7426	40p	74LS27	38p	4049	45p
7427	34p	74LS30	20p	4050	45p
7428	36p	74LS32	27p	4051	80p
7430	17p	74LS37	30p	4052	80p
7432	30p	74LS38	38p	4053	80p
7433	40p	74LS42	70p	4054	150p
7437	35p	74LS47	75p	4055	125p
7438	35p	74LS51	24p	4056	135p
7440	17p	74LS55	30p	4059	600p
7441	70p	74LS73	50p	4060	115p
7442A	60p	74LS74	27p	4063	120p
7443	112p	74LS75	36p	4066	50p
7444	112p	74LS76	45p	4067	450p
7445	100p	74LS83	70p	4068	27p
7446A	93p	74LS85	80p	4069	20p
7447A	75p	74LS86	40p	4070	30p
7448	80p	74LS90	40p	4071	25p
7450	17p	74LS92	70p	4072	25p
7451	17p	74LS93	60p	4073	25p
7453	17p	74LS96	110p	4075	25p
7454	17p	74LS107	45p	4076	107p
7460	17p	74LS109	80p	4081	27p
7470	36p	74LS112	40p	4082	27p
7472	30p	74LS113	90p	4086	72p
7473	34p	74LS114	45p	4089	150p
7474	30p	74LS122	80p	4093	70p
7475	38p	74LS123	60p	4094	250p
7476	32p	74LS124	180p	4095	95p
7480	50p	74LS125	50p	4096	95p
7481	100p	74LS126	50p	4097	340p
7482	84p	74LS132	60p	4098	120p
7483a	90p	74LS133	30p	4099	200p
7484	100p	74LS136	55p	40100	220p
7485	110p	74LS138	65p	40101	132p
7486	34p	74LS139	75p	40102	180p
7489	210p	74LS145	120p	40103	180p
7490A	30p	74LS147	220p	40104	99p
7491	80p	74LS148	175p	40105	120p
7492A	46p	74LS151	80p	40106	90p
7493A	36p	74LS153	60p	40107	60p
7494	84p	74LS154	200p	40108	470p
7495A	70p	74LS155	80p	40109	100p
7496	65p	74LS156	90p	40110	300p
7497	180p	74LS157	60p	40114	250p
74100	130p	74LS158	60p	4502	120p
74107	34p	74LS160	90p	4503	70p
74109	55p	74LS161	75p	4507	55p
74116	200p	74LS162	140p	4508	290p
74118	130p	74LS163	100p	4510	99p
74119	210p	74LS164	90p	4511	120p
74120	110p	74LS165	140p	4512	80p
74121	34p	74LS166	180p	4514	250p
74122	48p	74LS173	110p	4515	300p
74123	60p	74LS174	100p	4516	110p
74125	75p	74LS175	100p	4518	100p
74126	60p	74LS181	320p	4520	100p
74128	75p	74LS190	100p	4521	250p
74132	75p	74LS191	100p	4526	108p
74136	75p	74LS192	100p	4527	150p
74137	50p	74LS193	100p	4528	100p
74141	50p	74LS195	140p	4532	140p
74142	200p	74LS196	120p	4534	550p
74145	90p	74LS197	90p	4536	375p
74147	190p	74LS221	120p	4538	120p
74148	150p	74LS240	175p	4543	180p
74150	130p	74LS241	175p	4553	320p
74151A	70p	74LS242	170p	4556	72p
74153	70p	74LS243	170p	4560	200p
74154	120p	74LS244	150p	4569	250p
74155	90p	74LS245	250p	4572	40p
74156	90p	74LS247	140p	4583	110p
74157	70p	74LS251	140p	4584	90p
74159	190p	74LS253	90p	4585	150p
74160	100p	74LS257	90p	4724	250p
74161	100p	74LS258	160p	40097	90p
74162	100p	74LS259	160p	14411	1100p
74163	100p	74LS266	100p	14412	1100p
74164	120p	74LS273	170p	14433	1100p
74165	130p	74LS279	90p	14500	700p
74166	120p	74LS283	90p	14599	290p
74167	200p	74LS298	160p	**INTERFACE ICs**	
74170	240p	74LS323	400p	AD536A	£13
74172	450p	74LS324	200p	AD561J	1400p
74173	120p	74LS348	200p	AD7524	600p
74174	90p	74LS365	48p	DM8123	175p
74175	85p	74LS367	70p	DM8131	375p
74176	90p	74LS368	100p	DP8304	450p
74177	90p	74LS373	150p	DS8835	250p
74178	160p	74LS374	150p	DS8836	150p
74180	93p	74LS375	120p	DS8838	225p
74181	160p	74LS377	160p	MC1488	75p
74182	90p	74LS378	140p	MC1489	75p
74184A	150p	74LS390	120p	25S10	350p
74185	150p	74LS393	120p	75107	160p
74186	500p	74LS399	200p	75110	325p
74188	325p	74LS445	140p	75150	175p
74190	120p	74LS670	400p	75154	175p
74191	120p	**4000 SERIES**		75182	230p
74192	100p	4000	15p	75322	300p
74193	100p	4001	22p	75324	375p
74194	120p	4002	20p	75325	375p
74195	95p	4006	95p	75361	300p
74196	95p	4007	20p	75365	200p
74197	80p	4008	80p	75451/2	72p
74198	150p	4009	40p	75491/2	70p
74199	150p	4010	50p	8T26	160p
74221	160p	4011	20p	8T28	250p
74251	140p	4012	25p	8T95	180p
74259	250p	4013	50p	8T97	160p
74278	290p	4014	84p	81LS95	120p
74279	110p	4015	84p	81LS96	140p
74283	140p	4016	45p	81LS97	120p
74284	360p	4017	70p	81LS98	140p
74285	360p	4018	89p	9602	220p
		4019	45p		

93 SERIES / 74S SERIES

9301	160p	74S00	60p	74S114	120p
9302	175p	74S02	60p	74S124	300p
9308	316p	74S05	75p	74S132	160p
9310	275p	74S08	75p	74S133	75p
9311	275p	74S10	60p	74S138	225p
9312	160p	74S20	60p	74S139	225p
9314	165p	74S30	60p	74S157	250p
9316	225p	74S32	90p	74S174	250p
9321	225p	74S37	90p	74S175	320p
9322	150p	74S64	60p	74S194	350p
9334	360p	74S74	90p	74S241	450p
9368	250p	74S85	300p	74S260	70p
9370	300p	74S86	180p	74S373	500p
9374	200p	74S112	120p	74S374	500p

LINEAR I.Cs

AY1-0212	600p	LM13600	125p
AY1-1313	668p	MB3712	150p
AY1-1320	320p	MC1310P	150p
AY1-5050	140p	MC1458	48p
AY3-1270	840p	MC1495L	350p
AY3-8912	650p	MC1496	70p
AY5-1224A	240p	MC3340P	120p
AY5-1315	600p	MK50398	750p
AY5-1317A	775p	ML920	775p
AY5-4007D	520p	MM57160	620p
CA3019	80p	NE531	150p
CA3046	70p	NE555	20p
CA3048	225p	NE556	70p
CA3080E	72p	NE562B	425p
CA3086	48p	NE564	420p
CA3089E	225p	NE565	130p
CA3090AQ	375p	NE566	155p
CA3130E	90p	NE567	140p
CA3140E	50p	NE571	425p
CA3160E	100p	NE5534A	250p
CA3161E	140p	RC4136	120p
CA3162E	450p	S566B	270p
CA3189E	300p	S566B	270p
CA3280	160p	SAD1024A	1250p
DAC1408-8	200p	SFF96364	1100p
FX209	750p	SL490	400p
HA1388	260p	SN76477	175p
ICL7106	850p	SP8515	750p
ICL8038	300p	TA7205	140p
ICM7555	80p	TAA621	275p
LF13331	310p	TBA641B11	300p
LF351	48p	TBA651	200p
LF356P	95p	TBA800	90p
LM10C	425p	TBA810	100p
LM301A	27p	TBA820	90p
LM311	70p	TBA950	300p
LM318	200p	TCA220	350p
LM319	225p	TCA940	175p
LM324	45p	TDA1004	300p
LM339	75p	TDA1008	320p
LM348	95p	TDA1010	225p
LM358P	50p	TDA1022	570p
LM377	175p	TDA1024	120p
LM380	75p	TDA1034B	250p
LM381AN	180p	TDA1170	300p
LM386	95p	TDA2002V	325p
LM393	100p	TDA2020	320p
LM709	36p	TL071/81	45p
LM710	50p	TL072/82	75p
LM725	350p	TL074	130p
LM733	100p	TL084	110p
LM741	18p	TL170	50p
LM747	70p	UAA170	175p
LM748	35p	UDN6118	320p
LM2917	250p	UDN6184	320p
LM3302	140p	ULN2003	100p
LM3900	70p	XR2206	300p
LM3909	70p	ZN414	90p
LM3911	130p	ZN419C	225p
LM3914	225p	ZN424E	135p
LM3915	225p	ZN425E	400p
		ZN427E	750p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		−ve	
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA		TO-92		
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p	78HGKC	600p
LM317T	200p	78HO5KC	550p
LM323K	500p	78MGT2C	135p
LM723	37p	79HGKC	600p
		TL497	300p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	90p	ORP61	120p
ORP12	120p	TIL78	55p

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL116	90p

LEDS

0.125		0.2"	
TIL32	55p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18p		

		NSB5881	570p
DISPLAYS		TIL311	600p
3015F	200p	TIL312/3	110p
DL704	140p	TIL321/2	130p
DL707 Red	140p	TIL330	140p
FND357	120p	7750/60	200p
FND500	110p	**DRIVERS**	
FND507	110p	9368	250p
MAN3640	175p	9370	300p
MAN4640	200p	UDN6118	320p
		UDN6184	320p

TRANSISTORS

AC126	25p	BFR40	25p	TIP30A	48p	2N3055	48p	3N204	120p
AC127/8	20p	BFR41	25p	TIP30C	60p	2N3442	140p	40290	250p
AC176	25p	BFR79	25p	TIP31A	58p	2N3553	240p	40360	40p
AC187/8	25p	BFR80	25p	TIP31C	62p	2N3565	30p	40361/2	75p
AF116	50p	BFR81	25p	TIP32A	68p	2N3584	250p	40364	120p
AD149	70p	BFX29	40p	TIP32C	82p	2N3643/4	48p	40408	90p
AD161/2	45p	BFX30	34p	TIP33A	90p	2N3702/3	12p	40409	100p
AU107	200p	BFX84/5	40p	TIP33C	114p	2N3704/5	12p	40410	100p
BC107/8	11p	BFX86/7	30p	TIP34A	115p	2N3706/7	14p	40411	300p
BC109	11p	BFX88	30p	TIP34C	160p	2N3708/9	12p	40594	120p
BC117	20p	BFW10	90p	TIP35A	225p	2N3773	300p	40595	120p
BC147/8	9p	BFY50	30p	TIP35C	290p	2N3819	25p	40673	75p
BC149	10p	BFY51/2	30p	TIP36A	270p	2N3820	50p	40841	90p
BC157/8	10p	BFY56	33p	TIP36C	340p	2N3823	70p	40871/2	100p
BC159	11p	BFY90	90p	TIP41A	65p	2N3866	90p		
BC169C	12p	BRY39	45p	TIP41C	78p	2N3902	700p		
BC172	12p	BSX19/20	20p	TIP42A	70p	2N3903/4	18p		
BC177/8	17p	BU104	225p	TIP42C	82p	2N3905/6	20p		
BC179	18p	BU105	190p	TIP54	160p	2N4037	65p		
BC182/3	10p	BU108	250p	TIP120	120p	2N4058/9	12p		
BC184	11p	BU109	225p	TIP122	130p	2N4060	12p		
BC187	30p	BU126	150p	TIP142	130p	2N4061/2	18p		
BC212/3	11p	BU180A	120p	TIP147	130p	2N4123/4	27p		
BC214	12p	BU205	200p	TIP2955	78p	2N4125/6	27p		
BC237	15p	BU208	200p	TIP4055	70p	2N4401/3	27p		
BC327	16p	BU406	145p	TIS43	45p	2N4427	90p		
BC337	16p	E300	50p	TIS93	30p	2N4871	60p		
BC338	16p	E308	50p	ZTX108	12p	2N5087	27p		
BC461	36p	E310	50p	ZTX300	13p	2N5089	27p		
BC477/8	30p	MJ2501	225p	ZTX500	15p	2N5172	27p		
BC516/7	40p	MJ2955	90p	ZTX502	18p	2N5179	90p		
BC547B	16p	MJ3001	225p	ZTX504	30p	2N5191	90p		
BC548C	9p	MJE340	50p	2N457A	250p	2N5194	90p		
BC549C	18p	MJE2955	100p	2N696	35p	2N5245	40p		
BC557B	16p	MJE3055	70p	2N697	25p	2N5296	55p		
BC559C	18p	MPF102	45p	2N698	45p	2N5401	50p		
BCY70	18p	MPF103/4	40p	2N706A	30p	2N5457/8	40p		
BCY71/2	22p	MPF105/6	40p	2N708	30p	2N5459	40p		
BD131/2	50p	MPS6531	50p	2N918	45p	2N5460	60p		
BD135/6	54p	MPS6534	50p	2N930	18p	2N5485	44p		
BD139	56p	MPSA06	30p	2N1131/2	36p	2N5875	250p		
BD140	60p	MPSA12	50p	2N1613	25p	2N6027	48p		
BD189	60p	MPSA13	50p	2N1711	25p	2N6041	160p		
BD232	95p	MPSA20	50p	2N2102	70p	2N6044	160p		
BD233	75p	MPSA42	50p	2N2160	350p	2N6052	300p		
BD235	85p	MPSA43	50p	2N2219A	30p	2N6059	325p		
BD241	70p	MPSA56	32p	2N2222A	30p	2N6107	65p		
BD242	70p	MPSA70	50p	2N2369A	25p	2N6247	190p		
BDY56	200p	MPSU06	60p	2N2484	30p	2N6254	130p		
BF200	32p	MPSU07	60p	2N2646	45p	2N6290	65p		
BF244B	35p	MPSU45	90p	2N2904/5	30p	2N6292	65p		
BF256B	70p	MPSU65	78p	2N2906A	30p	2SC1172	150p		
BF257/8	32p	OC28	130p	2N2907A	30p	3N128	120p		
BF259	36p	OC35	130p	2N2926	9p	3N140	120p		
BFR39	25p	TIP29A	40p	2N3053	30p	3N141	110p		
		TIP29C	55p	2N3054	65p	3N201	110p		

DIODES

BY127	12p
BYX36-300	20p
OA47	9p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

HEAT SINKS

For TO220 Voltage Regs and Transistors 22p
For TO5 12p

BRIDGE RECTIFIERS

1A	50V	19p
1A	100V	20p
1A	400V	25p
1A	600V	30p
2A	50V	30p
2A	100V	35p
2A	400V	45p
3A	200V	60p
3A	600V	72p
4A	100V	95p
4A	400V	100p
6A	50V	80p
6A	100V	100p
6A	400V	120p
10A	400V	200p
25A	400V	400p

ZENERS

2.7V-33V
400mW 9p
1W 15p

TRIACS PLASTIC

3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

1A 50V	70p
1A 400V	90p
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
BT106	110p
C106D	45p
MCR101	36p
TIC44	27p
2N3525	130p
2N4444	140p
2N5060	34p
2N5064	40p

LOUDSPEAKERS

Size		
2½"	64R	80p
2½"	8R	80p
2"	8R	90p
1½"	8R	100p

MODULATORS

6MHz UHF 375p
8MHz UHF 450p

MEMORIES

2101-4L	400p	TMS9918	POA
2102-2L	120p	Z80P10	700p
2107B	500p	Z80AP10	800p
2111-4	400p	Z80CTC	600p
2112-4	300p	Z80ACTC	700p
2114	225p	Z80-S10-1	£24
2114-2L	450p	mc14411	1100p
4027-3	375p	ZN1034E	200p
4044	900p	**UART**	
4116	350p	AY-3-1015P	450p
4118-4	£1200	AY-5-1013A	400p
5101	400p	IM6402	450p
6810	325p	TMS6011NC	400p
74S201	400p	**CHARACTER GENERATORS**	
82S16	325p	3257ADC	990p
ROM/PROMs		RO-3-2513 U C	650p
71301	700p	RO-3-2513 L C	700p
74S188	225p	SN74S262AN	£10
74S387	350p	**KEYBOARD ENCODER**	
74S470	650p	AY-5-2376	700p
74S471	650p	**CRYSTALS**	
74S571	650p	32 768KHz	250p
CPUs		100KHz	300p
1600	1200p	200KHz	370p
1802CE	750p	1.0MHz	320p
2650A	2000p	1.008MHz	350p
6502	650p	1.8432MHz	325p
6800	650p	2.00MHz	325p
6802	950p	2.45760MHz	325p
6809	£20	3.276MHz	300p
8080A	450p	3.579MHz	175p
8085A	1100p	4.00MHz	290p
INS8060	1000p	4.194MHz	POA
TMS9980A	£20	4.43MHz	125p
Z80	700p	5.0MHz	325p
Z80A	900p	6.0MHz	300p
EPROMS		6.144MHz	300p
1702A	500p	7.0MHz	300p
2708	450p	7.168MHz	300p
2716 (+5V)	£7	8.00MHz	300p
2532	£25	8.867MHz	300p
2732	£25	10.00MHz	310p
SUPPORT DEVICES		10.7MHz	300p
3242	800p	12.0MHz	350p
3245	450p	16.00MHz	350p
6522	650p	18.00MHz	300p
6532	825p	18.432	350p
6820	375p	19.968MHz	390p
6821	340p	26.690MHz	350p
6845	£20	27.145MHz	325p
6850	300p	38.6667MHz	350p
6852	370p	48.0MHz	300p
8155	1100p	55.5MHz	400p
8205	320p	116.0MHz	350p
8212	225p		
8216	225p		
8224	275p		
8226	250p		
8228	525p		
8251	475p		
8253	1000p		
8255	450p		
8257	900p		
8259	950p		

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	20p	28 pin	30p
16 pin	11p	22 pin	22p	40 pin	40p

WIRE WRAP SOCKETS BY TEXAS

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

SUBMINIATURE SWITCHES

Toggle	
SPST	60p
SPDT	65p
DPDT	70p
DPDT (centre off)	85p
Push to make	15p
Break	25p
Push latching SPCO	60p
SLIDE DPDT	18p
ROCKER SPST	28p
WAFER	
1P 12W	45p
3P 4W	45p
4P 3W	45p
2P 6W	45p

ANTEX SOLDERING IRONS

C-15W	415p
CX-17W	425p
CCN-15W	425p
X25	440p
SPARE BITS	
C CX CCN	50p
X25	50p
SPARE ELEMENTS	
C CX/X25	180p
CCN	200p
ADCOLA IRONS	
K1000	550p
K2000	550p

DIL SWITCHES

4 way SPST 90p
8 way SPST 120p

VEROBOARDS

DIP Breadboard 4.15 x 6.15 325p
(Suitable for 20 x 14 pin or 16 x 16 pin DIL ICs) DIP Breadboard as above with tracks for 31 way connector 375p
V-Q Boards for ICs (No track cutting) 130p

TRANSFORMERS

(prim 220/240V)

6-0-6 100mA	90p
9-0-9 75mA	95p
9-0-9 1Amp	330p
0-12V 2A	410p
15-0-15 1A	325p

CONNECTOR PLUGS

31 way Plug 120p
31 way Socket 120p
S-100 Busboar 1500p

EDGEBOARD CONNECTORS 0.156" PITCH

2 x 10 way	85p	2 x 22 way	135p
2 x 15 way	100p	2 x 25 way	160p
2 x 18 way	120p		

COUNTERS

74C925	550p	**TTL & ECL**	
74C928	600p	MC4024	325p
ICM7216B	2000p	MC4044	325p
ICM7217A	850p	10116	70p
ZN1040E	700p	10231	350p

★ SPECIAL OFFERS ★

2114L (450ns)	£2.25	7805/7812	£5/10
2708 (450ns)	£4.00	7905/7912	£6/10
2708 (650ns)	£3.00	(Above prices for one value)	
2716 (+5V)	£6.00		
4116 (200ns)	£2.75	P&P and VAT extra	

Programming service for 2716 available by appointment or by mail.

BOOKS by TEXAS INSTRUMENTS

TTL Data Book (700 pages)	£6.80
Power Semiconductor Data Book (600 pages)	£4.50
Linear Control Data Book (368 pages)	£3.00
Software Design for Microprocessors (400 pages)	£11.00
The Great Int'l Maths on Keys (208 pages)	£3.50
Understanding Microprocessors (240 pages)	£3.50
Understanding Solid State Electronics (240 pages)	£3.50
Understanding Digital Electronics (240 pages)	£3.50
Understanding Communications Systems	P.O.A.
Others: TTL Cook Book	£7.25
CMOS Cook Book	£7.75
Microprocessor Interfacing Techniques	£9.95

Please add 70p P&P on each book (NO VAT)

BREADBOARDS

EXP300	£575p
EXP350	315p
EXP600	630p
EXP650	360p
PB6	920p
PB100	1180p
PB102	2295p
PB103	3445p

IC TEST CLIPS

14 pin	£2.60
16 pin	£2.75
24 pin	£4.90
40 pin	£7.90

VEROBOARDS

0.1 (copper clad)

2.5×3.75"	65p	Pkt of 100 pins	50p
2.5×5"	75p	Spot face cutter	120p
3.75×3.75"	75p	Pin insertion tool	118p
3.75×5"	80p	Vero Wiring Pen + 2 wire spools	
3.75×17"	340p	+ combs	370p
4.75×17.9"	450p	Combs	7p

We carry a large stock of 74 and 74LS TTLs, CMOS, Linears, Memories, etc. and can normally offer ex-stock deliveries. We welcome inquiries for volume quantities both from local and overseas buyers.

VAT RATE: Please add VAT at 15% on total order value.
Access and Barclaycard accepted
Please send SAE for list

Please add 30p p&p & VAT
Government, Colleges, etc. Orders accepted.
CALLERS WELCOME
Mon-Fri 9.30-5.30 Saturday 10.30-4.30

TECHNOMATIC LTD.

17 BURNLEY ROAD, LONDON NW10
(2 minutes Dollis Hill tube station) (ample street parking)
Tel: 01-452 1500/01-450 6597 Telex: 922800

ILP Toroidal

TRANSFORMERS IN A RANGE OF 75 TYPES

We use advanced winding technology to make our toroidal transformers. They have only half the weight and height of their laminated equivalents and are appreciably more efficient. Our toroidals cost virtually the same as the older types which they are rapidly replacing. Induced hum is reduced by a factor of ten. *Supplied with rigid mounting kit with centre bolt, steel and neoprene washers.*

30VA *70mm dia. x 30mm Weight 0.45Kg* **£4.71** *(+£1.00 p.p. + 0.86 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
1X010	6+6	2.50
1X011	9+9	1.66
1X012	12+12	1.25
1X013	15+15	1.00
1X014	18+18	0.83
1X015	22+22	0.68
1X016	25+25	0.60
1X017	30+30	0.50

50VA *80mm dia. x 35mm Weight 0.9 Kg* **£5.19** *(+£1.10 p.p. + 0.94 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
2X010	6+6	4.16
2X011	9+9	2.77
2X012	12+12	2.08
2X013	15+15	1.66
2X014	18+18	1.38
2X015	22+22	1.13
2X016	25+25	1.00
2X017	30+30	0.83
2X028	110	0.45
2X029	220	0.22
2X030	240	0.20

80VA *90mm dia. x 30mm Weight 1 Kg* **£5.76** *(+£1.20 p.p. + £1.04 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
3X010	6+6	6.64
3X011	9+9	4.44
3X012	12+12	3.33
3X013	15+15	2.66
3X014	18+18	2.22
3X015	22+22	1.81
3X016	25+25	1.60
3X017	30+30	1.33
3X028	110	0.72
3X029	220	0.36
3X030	240	0.33

120VA *90mm dia. x 40mm Weight 1.2 Kg* **£6.72** *(+£1.30 p.p. + £1.20 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
4X011	9+9	6.66
4X012	12+12	5.00
4X013	15+15	4.00
4X014	18+18	3.33
4X015	22+22	2.72
4X016	25+25	2.40
4X017	30+30	2.00
4X028	110	1.09
4X029	220	0.54
4X030	240	0.50

160VA *110mm dia. x 40mm Weight 1.8 Kg* **£8.88** *(+£1.40 p.p. + £1.54 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
5X012	12+12	6.66
5X013	15+15	5.33
5X014	18+18	4.44
5X015	22+22	3.63
5X016	25+25	3.20
5X017	30+30	2.66
5X018	35+35	2.28
5X028	110	1.45
5X029	220	0.72
5X030	240	0.66

225VA *110mm dia. x 45mm Weight 2.2 Kg* **£10.59** *(+£1.50 p.p. + £1.81 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
6X014	18+18	6.25
6X015	22+22	5.11
6X016	25+25	4.50
6X017	30+30	3.75
6X018	35+35	3.21
6X026	40+40	2.81
6X028	110	2.04
6X029	220	1.02
6X030	240	0.93

300VA *110mm dia. x 50mm Weight 2.6 Kg* **£12.27** *(+£1.60 p.p. + £2.08 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
7X016	25+25	6.00
7X017	30+30	5.00
7X018	35+35	4.28
7X026	40+40	3.75
7X025	45+45	3.33
7X028	110	2.72
7X029	220	1.36
7X030	240	1.25

500VA *140mm dia. x 60mm Weight 4 Kg* **£16.35** *(£1.70 p.p. + £2.71 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
8X017	30+30	8.33
8X018	35+35	7.14
8X026	40+40	6.25
8X025	45+45	5.55
8X033	50+50	5.00
8X028	110	4.54
8X029	220	2.27
8X030	240	2.08

• I.L.P. TOROIDAL TRANSFORMERS ARE GUARANTEED FOR 5 YEARS

CHOICE OF 3 PRIMARY INPUTS

I.L.P. Toroidal Transformers are available in choice of 110V. 220V. 240V. coded as follows: (Secondaries can be connected in series or parallel)

For 110V Primary insert 0 in place of "X" in type number.
For 220V Primary (Europe) insert 1 in place of "X" in type number.
For 240V Primary (U.K.) insert 2 in place of "X" in type number.

Example – 120VA 240V 15+15V. 4A = 42013.

★ CUSTOMER DESIGN ENQUIRIES INVITED. QUANTITY PRICE LIST AVAILABLE.

FREEPOST facility.(U.K. only).

Simply address envelope to **FREEPOST** to address below. NO STAMP REQUIRED.

TO ORDER *Enclose cheque/Postal Order/Money Order payable to I.L.P. Electronics Ltd or quote your ACCESS or BARCLAYCARD account No. To pay C.O.D. add £1 extra to TOTAL value of order.* **Also available from ELECTROVALUE and MARSHALLS.**

ILP TRANSFORMERS
A division of I.L.P. ELECTRONICS LTD.
FREEPOST T5 GRAHAM BELL HOUSE ROPER CLOSE CANTERBURY CT2 7EP
Phone (0227) 54778 Technical (0227) 64723 Telex 965 780

PRINTED CIRCUITS

FOR WIRELESS WORLD PROJECTS

U.h.f. television tuner—Oct. 1975—1 d.s.	£8.50
Stripline r.f. power amp—Sept. 1975—1 d.s.	£5.00
Audio compressor/limiter—Dec. 1975—1 s.s. (stereo)	£4.25
F.m. tuner (advanced)—April 1976—1 s.s.	£5.00
Cassette recorder—May 1976—1 s.s.	£5.00
Audio compander—July 1976—1 s.s.	£4.25
Time code clock—August 1976—2 s.s. 3 d.s.	£15.00
Date, alarm, b.s.t. switch—June 1977—2 d.s. 1 s.s.	£9.50
Audio preamplifier—November 1976—2 s.s.	£8.50
Additional circuits—October 1977—1 s.s.	£4.00
Stereo coder—April 1977—1 d.s. 2 s.s.	£8.50
Morse keyboard and memory—January 1977—2 d.s. (logic board 10¼in. x 5in.) (keyboard and matrix 13in. x 10in.)	£14.00
Low distortion disc amplifier (stereo)—September 1977—1 s.s.	£2.00
Low distortion audio oscillator—September 1977—1 s.s.	£3.50
Synthesized f.m. transceiver—November 1977—2 d.s. 1 s.s.	£12.00
Morsemaker—June 1978—1 d.s.	£4.50
Metal detector—July 1978—1 d.s.	£3.75
Oscilloscope waveform store—October 1978—4 d.s.	£18.00
Regulator for car alternator—August 1978—1 s.s.	£2.00
Wideband noise reducer—November 1978—1 d.s.	£5.00
Versatile noise generator—January 1979—1 s.s.	£5.00
200MHz frequency meter—January 1979—1 d.s.	£7.00
High performance preamplifier—February 1979—1 s.s.	£5.50
Distortion meter and oscillator—July 1979—2 s.s.	£5.50
Moving coil preamplifier—August 1979—1 s.s.	£3.50
Multi-mode transceiver—October 1979—10 d.s.	£35.00
Amplification system—October 1979—3 preamp 1 poweramp (£4.20 each)	£16.00
Digital capacitance meter—April 1980—2 s.s.	£7.50
Colour graphics system—April 1980—1 d.s.	£18.50
Audio spectrum analyser—May 1980—3 s.s.	£10.50
Multi-section equalizer—June 1980—2 s.s.	£8.00
Floating-bridge power amp—Oct. 1980 — 1 s.s. (12V or 40V)	£4.00

Boards are glassfibre, roller-tinned and drilled. Prices include V.A.T. and U.K. postage.
Airmail add 20%, Europe add 10%, Insurance 10%.

Remittance with order to:
M. R. SAGIN, 23 KEYES ROAD, LONDON, N.W.2

WW — 086 FOR FURTHER DETAILS

ONE OF THE MOST USEFUL TOOLS YOU CAN HAVE

Low Distortion (.002% at 1Khz)
AUDIO SIGNAL GENERATOR
Range 10Hz-100kHz
Output 1v rms into 600 ohms.
Sine/Square signals.
Fixed and variable attenuation.
Battery or mains.
Based on a John Linsley Hood design.

Model 146/9

£36 (Batty.) + U.K. Tax £5.40.
Mains version £46 (+ U.K. Tax £6.90).
(Kit of parts £31 + tax £4.65); p.p. £2.

TELERADIO ELECTRONICS

325 Fore Street, Edmonton, London N9 OPE. 01-807 3719
Closed Thursdays. Lists sent on request. Also R.F. & Function Generators. T.H.D. Analyser & Millivoltmeter. SWR and Frequency Meters

WW —.037 FOR FURTHER DETAILS

OHIO SCIENTIFIC Superboard 2. Assembled 50Hz model **£159.00** + 15% VAT. post free. Colourboard 2 (the new colour version of Superboard 2). **£215** + 15% VAT.

★ **Special offer:** If bought with Superboard or Colourboard these items are at the reduced price shown first. Also sold separately at the bracketed prices. Add 15% VAT. Modulator and power supply kit **£21** (£25). 4K extra ram **£20** (£24). Display expansion kit, 30 lines × 54 characters approx., **£18** (£20). Case **£23** (£26). Colour conversion board fully assembled **£55** (£65). Cassette recorder **£13** (£15). Super Print 800MST printer **£350** (£359). 610 expansion board **£160** (£160). ★

SINCLAIR PRODUCTS. New 10MHz scope **£145.** pfm200 **£51.95**, case **£2.07**, adaptor **£4.20.** Connector kit **£13.95.** Microvision tv **£89**, adaptor **£6.88.** pdm35 **£34.23**, adaptor **£4.20**, case **£2.07.** dm350 **£76.70**, dm450 **£102.17**, dm235 **£56.55**, rechargeable batts **£8**, adaptor **£4.20**, case **£9.** Enterprise prog calculator + accessories **£19.95.** TG105 **£87.** Bench frequency counter **£150.**

COMPUTER GAMES. Chess Champion 6 **£49.65.** Chess Challenger 7 **£79.** New Sensory Chess Challenger 8 **£119.** Atari Videocomputer **£129**, cartridges **£14.85.**

COMPONENTS. 1N4148 **0.9p.** 1N4002 **3.7p.** 741 **20p.** bc182, bc184, bc212, bc214, bc548 **6.1p.** Resistors. ¼W 5% E12 10R to 10M **1.5p**, **0.8p** for 50+ of one value 16V electrolytics .5, 1, 2, 5, 10, 22mf **6p**, 100mf **7p**, 1000mf **11p**. 1 lb FeC1 **£1.60.** Dalo pen **90p.** 40 sq ins pcb **50p.** Polystyrene capacitors E12 63V 10 to 1000pf **4p**, 1n2 to 10n **5p**. Ceramic capacitors 50V E6 22pf to 47n **2.5p**. Zeners 400mW E24 2v7 to 33v **7p.**

TV GAMES. AY-3-8550 + kit **£8.26**. AY-3-8600 + kit **£12.98**. Stunt cycle chip + kit **£20.95**. Colour generator kit **£9.95**.

TRANSFORMERS. 6-0-6V 100ma **96p**, 1½a **£3.12.** 9-0-9V 75ma **96p**, 1a **£2.88**, 2a **£4.73.** 12-0-12V 100ma **£1.20**, 1a **£3.50.**

IC AUDIO AMPS with pcb. JC12 6W **£2.60.** JC20 10W **£3.54.**

BATTERY ELIMINATORS. 3-way type 6/7½/9v 300ma **£3.46.** 100ma radio type with press-studs 9v **£4.77.** 9 + 9v **£5.90.** Car convertor 12v input, output 4½/6/7½/9v 800ma **£3.04.**

BATTERY ELIMINATOR KITS. 100ma radio types with press-studs 4½v **£1.64**, 6v **£1.64**, 9v **£1.64**, 4½ + 4½v **£2.30**, 6+6v **£2.30**, 9+9v **£2.30.** Stabilized 8-way types 3/4½/6/7½/9/12/15/18v 100ma **£3.12**, 1Amp **£7.80.** Stabilized power kits 2-18v 100ma **£3.12**, 1-30v 1A **£6.10**, 1-30v 2A **£14.52.** 12v car convertor 6/7½/9v 1A **£1.62.**

T-DEC AND CSC BREADBOARDS. S-dec **£3.79.** T-dec **£4.59**, exp4B **£2.64**, exp300 **£6.61**, exp350 **£3.62**, exp325 **£1.84**.

BI-PAK AUDIO MODULES. s450 **£27.90**, AL60 **£5.62**, pa100 **£18.24**, spm80 **£5.26**, bmt80 **£6.06**, stereo 30 **£23.84**, AL30A **£4.53.**

SWANLEY ELECTRONICS

Dept. WW, 32 Goldsel Rd, Swanley, Kent.
Post 35p extra. Prices include VAT unless stated. Official and overseas orders welcome. Lists 27p post free. Mail order only.

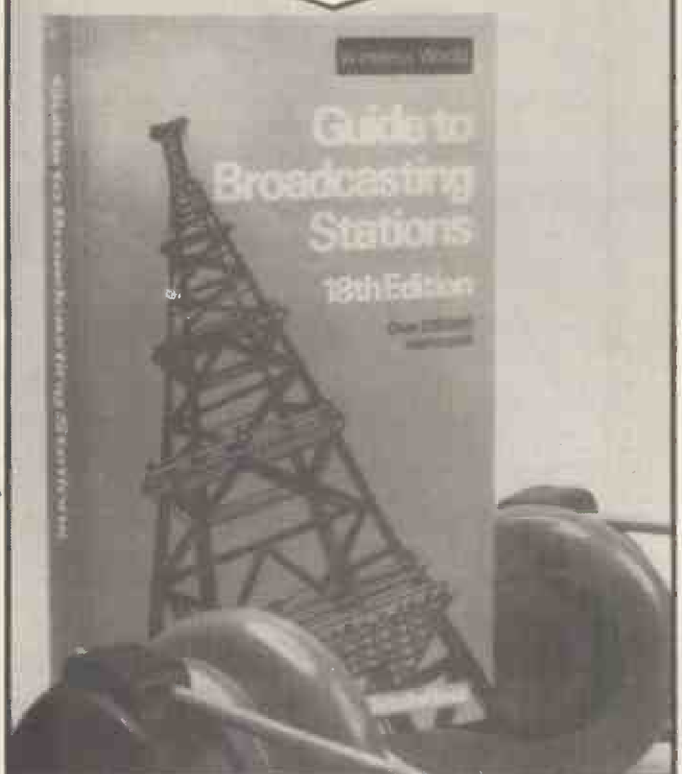
PICK UP... AND CHECK UP!

Around the world some thousands of radio stations are sending signals. If you're receiving, this standard guide will tell you who's where. It lists stations broadcasting in the long, medium, short wave and vhf bands, dealing with them by frequency, geographical location and alphabetical order. Sections are helpfully cross referenced. The Wireless World Guide to Broadcasting Stations is the eighteenth edition of a publication which has sold over 270,000 copies. In addition to the stations data, it includes much useful information on radio receivers, aerials, propagation, signal identification and reception reports.

wireless world

GUIDE TO BROADCASTING STATIONS 18th Edition

£3.25 inc. postage.



To: General Sales Dept., Room 205, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Please send me........copy/ies of the Wireless World Guide to Broadcasting Stations (18th edition) @ £3.25 a copy inclusive (U.K.), $8 overseas, remittance enclosed. Cheque/P.O. payable to IPC Business Press Ltd.,

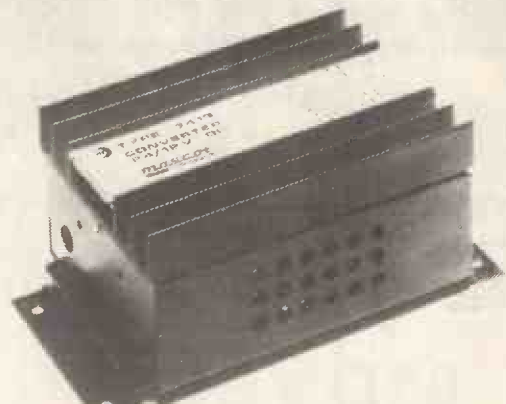
NAME (please print) ....

ADDRESS ....

....

....

DC/DC AND DC/AC CONVERTERS



The table below shows our standard range. Please contact us for your other requirements.

Type	Input	Output Volt DC	Max. current	
692	6	12	2 A	d
707	6	12	3 A	d
712	24	12	2 A	b
744	24	12	5 A	b
7411	24	12	6 A	b
7413/24	24	12	8 A	bd
7413/48	48	12	3 A	bd
7413	48	24	3 A	bd
7508	12/24/48 80/120	12/24	8 A	abd

a = primary/secondary with galvanic separation.
b = stabilized output voltage.
d = switch mode.

DC/AC converter type 7804: Input 12V DC, output 220V AC, 90 VA, 120 Hz

We also supply:

- ★ power supply units from 220 V AC mains operation, with output voltages up to 42V DC and load current from 50 mA DC to 10A DC.
- ★ chargers for nickel cadmium and lead batteries.

Ask for our catalogue

mascot electronic

Tlf. 032/11 200 Telex: 17516
1601 Fredrikstad NORWAY

Happy Memories

4116 200ns	**£2.95**	**2114** 450ns	**£2.95**
2114 200ns	**£3.45**	**2716** 5 volt	**£7.95**
2708 450ns	**£4.75**		

MEMOREX mini discs soft sectored — with FREE library case **£19.95** per ten.

WE'VE MOVED!!

All prices include VAT
30p postage on orders below £10

Access & Barclaycard

All orders to:
Dept. WW
HAPPY MEMORIES
Gladestry
Kington
Herefordshire HR5 3NY
Tel. (054422) 618

TELEPRINTER TYPE 7B: Pageprinter 24v d.c. power supply. Speed 50 bauds per min. S/hand good cond. (no parts broken, £28.75. OR GPO MODEL, as above except motor 110/230V d.c. £34.50. Carriage either type £9.50. Send SAE for list of Teleprinter spares available.
FRIDEN FLEXOWRITER with Perforator. 230V a.c. Excellent cond. £86.25 ea. Carr. £10.
RADAR ECHO BOX TS.488A X-band. £65. Carr. £5.
TS.147 RADAR TEST SET Combination Sig. generator and frequency meter and power meter. Provides C.W. & F.M. signals. 115V a.c. £225. Carr. £7.
HEWLETT PACKARD Signal Generator HP608B. Freq. 10-400MHz C.W. & A.M. Output 1microvolt to 8V, 50... Mod. 400-1000Hz. 230V a.c. £225. Carr. £10.
AUTO TRANSFORMER: 230/115v 50 c/s 1000 watts. Mounted in strong steel case 5" × 6½" × 7". Bitumen impregnated. £17.25 + carriage.
TRANSISTORISED 3cm **RADAR AMPLIFIER SWITCH:** with 24v waveguide switch, 9 × 4cm ins. with crystal CV.2355 and spark gap VX.1046. £17.25 + £1 post.
INSULATION TEST SET 0 to 10KV, negative earth, with Ionisation Amplifier, 100/230 Volts AC. £48.87 + carr.
BC-221 FREQUENCY METER: 125-20,000kc/s complete with original calibration charts £24.15 + carr.
ROTARY INVERTER TYPE PE-218E: Input 24-28v. DC 80 amps, 4,800rpm. Output 110v AC 13 amp 400c/s, 1PH. P.F.9. £23 + carr.
RESONATOR PERFORMANCE CTC 424 8.5 to 9.0 kmc/s 3 cm £80.50 + post £2.
INVERTER 24v. DC input 400 cycles 1pH 6600 r.p.m. 200v. peak. £8.05 + £2 post.
OXYGEN BOTTLE 1800lb. w.p. £11.50 + carr.
NOISE SOURCE UNIT with CV.1881 noise source mount. Produces thermal poise 15.5dB 200/250v. AC £80.50.
HS33 HEADSET. Low imp. £5.35 + 75p post.
MUIRHEAD DECADE OSCILLATOR TYPE 890D: £92 + carr. £5.
SIEMENS POWER METER REL3U/84/Alb: 0-12kmHz 1mw 500mw 6 ranges. 0.17dB 50 ohms. £92 + carr.
CV.1596 CATHODE RAY TUBE: (09D, 09G), 4" screen, green electrostatic base B12B. HT1200 volts, heater 4 volts £11.50.
RADAR RECEIVING ANTENNA TYPE X443 Mk.D: Suitable for detecting signals on X, K, J and Q bands. 9g Hz-60g Hz. Complete with waveguide horns, associated crystals. Transistorised amplifier and geared motor, etc. £143.75.
VACUUM & PRESSURE DEAL TEST EQUIPMENT: complete with 2 × 4" gauges indicating 0.20lbs p.s.i. 0-30lbs vacuum. With stand, hand pump, etc. £34.50 + carr.

BARGAIN MAPS
Large stocks of unused U.S.A.F. surplus maps, weather charts, etc. including:

ONC-E1 — U.K. in full and part N.W. Europe. Scale 1:1,000,000.
JNC-9N — N. Europe. U.K., Scandinavia. Scale 1:2,000,000.
JN-21N — Europe (Mediterranean). Scale 1:2,000,000.
SIZE 58" × 42". colour. Many others. Please send S.A.E. for list.
Price each 75p (inc. P&P)
25 × Maps (either same type OR assorted), £10 + £1.60 P&P.
10 × Maps (either same type OR assorted), £6.50 (in. P&P).

All prices include VAT at 15%
Carriage quotes given are for 50-mile radius of Herts.

W. MILLS — The Maltings, Station Road, SAWBRIDGEWORTH, Herts. Tel: Bishop's Stortford (0279) 725872

Catronics FOR BEST VALUE IN THE FINEST SHORTWAVE RECEIVERS

Trio R1000 — The ultimate H.F. Receiver. 200KHz—30MHz. PLL synthesizer. Digital readout plus analog display for easy accurate tuning. 240 Vac/12Vdc supply. **£285.**

Lowe SRX30. Utilises a drift cancelling loop system to give performance plus. 500KHz — 30MHz coverage. USB/LSB/AM/CW, 240Vac/12Vdc supply. **£158.**

Both the above receivers are currently available from stock. Prices *INCLUDE* VAT but please add £5.50 for Express delivery.

CATRONICS FOR THE FINEST AMATEUR RADIO EQUIPMENT

Trio TR2400 2m FM synthesised hand-held transceiver with 10 memories, plus scanning £198
Trio TR3200 70cm FM handy transceiver, fitted 3 channels .. £164
AR 240 2m synthesised FM hand-held T/ceiver in 5KHz channels £168

USED AMATEUR EQUIPMENT

Catronics always have a good selection of reliable used and second-hand equipment — all with three months' GUARANTEE, including TR2200G: £100-£120 and Yaesu FT7 £290, etc., etc.

JAYBEAM AERIALS

Catronics stock the full range of VHF and UHF amateur aerials — send SAE for list and special prices.

MICROWAVE MODULES

Converters and transverters for 2m and 70cm — send SAE for illustrated leaflet and price list.

ALL ABOVE PRICES INCLUDE VAT.
EASY TERMS available. Written quotations on request.
Access and Barclaycards welcome.

CATRONICS LTD. (Dept. 22), COMMUNICATIONS HOUSE 20 WALLINGTON SQUARE
WALLINGTON, SURREY SM6 8RG
Phone: 01-669 6700. Mon.-Fri. 9 a.m.-5.30 p.m. Sats. 1 p.m.

WW — 049 FOR FURTHER DETAILS

MAINS INTERCOM — NEW IMPROVED

£37.99 + VAT £5.70 per pair

NO BATTERIES, NO WIRES. Made to high Safety and Telecommunications Standard. The modern way of instant 2-way communications. Just plug into power socket. Ready for use. Crystal clear communications from room to room. Range ¼ mile on the same mains phase with call buzzer and light indicator. On-off switch. Volume control. Useful as inter-office Intercom between office and warehouse. In surgery and in homes, between house and garage. Also useful as burglar alarm. 6 months' service guarantee P&P £1.85. Also F.M. 2-channel model £49.95 + VAT £7.50 + P&P £1.95 per pair.

NEW! AMERICAN TYPE CRADLE TELEPHONE AMPLIFIER

ONLY **£18.95** + VAT £2.88

New improved battery operated Telephone Amplifier with detached plug-in speaker. Placing the receiver on to the cradle activates on/off switch for immediate two-way conversation without holding the hand-set. Many people can listen at a time. Increase efficiency in office, shop, workshop. Perfect for conference calls, leaves the user's hands free to make notes, consult files. No "holding on", save money and long-distance calls. Volume control. Model with conversation recording facilities. Price £20.95 + VAT £3.15, post and packing for either model £1.25.

10 days' price refund guarantee. Barclaycard and Access welcome.

WEST LONDON DIRECT SUPPLIES (WW)
169 KENSINGTON HIGH STREET, LONDON W8 6SN

FOTOLAK

POSITIVE LIGHT SENSITIVE AEROSOL LACQUER

Enables YOU to produce perfect printed circuits in minutes!
Method Spray cleaned board with lacquer. When dry, place positive master of required circuit on now sensitized surface. Expose to daylight, develop and etch. Any number of exact copies can of course be made from one master. Widely used in industry for prototype work.

FOTOLAK	£2.00
Developer	30p
Ferric Chloride	50p

Pre-coated 1/16 Fibre-glass board	
204mm x 114mm	£1.50
204mm x 228mm	£3.00
408mm x 228mm	£600
467mm x 305mm	£9.00

Plain Copper-clad Fibre-glass.	Single-sided	Double-sided
Approx. 3.18mm thick sq. ft.		£1.50
Approx. 2.00mm thick sq. ft.	£2.00	
Approx. 1.00mm thick sq. ft.	£1.50	£1.75
Clear Acetate Sheet for making master, 260mm x 260mm		12p

Postage and packing 65p per order. VAT 15% on total
G. F. MILWARD ELECTRONIC COMPONENTS LIMITED
369 Alum Rock Road, Birmingham B8 3DR. Telephone: 021-327 2339

LANGREX SUPPLIES LTD

Climax House, Fallsbrook Rd., Streatham, London SW16 6ED

RST Tel: 01-677 2424 Telex: 946708 RST

SEMICONDUCTORS

AA119	0.12
AAY30	0.31
AAY32	0.48
AAZ13	0.21
AAZ15	0.39
AAZ17	0.31
AC107	0.60
AC125	0.23
AC126	0.23
AC127	0.23
AC128	0.23
AC141	0.29
AC141K	0.40
AC142	0.23
AC142K	0.35
AC176	0.23
AC187	0.23
AC188	0.23
ACY17	0.96
ACY18	0.92
ACY19	0.86
ACY20	0.80
ACY21	0.86
ACY39	1.72
AD149	0.80
AD161	0.52
AD162	0.52
AF106	0.52
AF114	0.86
AF115	0.86
AF116	0.86
AF117	0.86
AF139	0.46
AF186	1.38
AF239	0.52
AFZ11	3.16
AFZ12	3.16
ASY26	1.38
ASY27	1.03

ASZ15	1.44
ASZ16	1.44
ASZ17	1.44
ASZ20	1.72
ASZ21	2.30
AU113	1.86
AUY10	2.30
AU110	1.86
BA145	0.15
BA148	0.15
BA154	0.10
BA155	0.12
BA156	0.10
BAW62	0.06
BAX13	0.07
BAX16	0.10
BC107	0.14
BC108	0.14
BC109	0.15
BC113	0.14
BC114	0.15
BC115	0.16
BC116	0.17
BC117	0.20
BC118	0.12
BC125	0.18
BC126	0.23
BC135	0.16
BC136	0.17
BC137	0.17
BC147	0.10
BC148	0.09
BC149	0.10
BC157	0.10
BC158	0.09
BC159	0.12
BC167	0.14
BC170	0.13
BC171	0.12

BC172	0.12
BC173	0.14
BC177	0.17
BC178	0.16
BC179	0.18
BC182	0.13
BC183	0.12
BC184	0.13
BC212	0.15
BC213	0.14
BC214	0.17
BC237	0.10
BC238	0.14
BC301	0.38
BC303	0.38
BC307	0.12
BC308	0.12
BC327	0.23
BC328	0.21
BC337	0.21
BC338	0.20
BCY30	1.15
BCY31	1.15
BCY32	1.15
BCY33	1.04
BCY34	1.04
BCY39	3.45
BCY40	1.15
BCY42	0.29
BCY43	0.29
BCY58	0.18
BCY70	0.17
BCY71	0.20
BCY72	0.15
BCZ11	1.72
BD115	0.52
BD121	1.50
BD123	1.50
BD124	1.50

BD131	0.40
BD132	0.44
BD135	0.39
BD136	0.39
BD137	0.40
BD138	0.46
BD139	0.40
BD140	0.51
BD144	2.30
BD181	1.26
BD182	1.36
BD237	0.46
BD238	0.63
BDX10	1.05
BDX32	2.30
BDY20	1.44
BDY60	1.72
BF115	0.29
BF152	0.21
BF153	0.23
BF154	0.20
BF159	0.26
BF160	0.18
BF167	0.23
BF173	0.23
BF177	0.28
BF178	0.28
BF179	0.29
BF180	0.35
BF181	0.35
BF182	0.35
BF183	0.2
BF184	0.29
BF185	0.29
BF194	0.10
BF195	0.10
BF196	0.12
BF197	0.14
BF200	0.31
BF224	0.23
BF244	0.32

BF257	0.28
BF258	0.30
BF259	0.37
BF336	0.35
BF337	0.35
BF338	0.36
BFS21	4.55
BFS28	2.56
BFS61	0.23
BFS98	0.23
BFW10	0.74
BFW11	0.74
BFX84	0.25
BFX85	0.26
BFX87	0.24
BFX88	0.24
BFY50	0.30
BFY51	0.30
BFY52	0.30
BFY64	0.30
BFY90	1.44
BSX19	0.24
BSX20	0.23
BSX21	0.23
BT106	1.44
BTY79/400R	3.67
BU205	2.02
BU206	2.50
BU208	2.30
BY100	0.52
BY126	0.16
BY127	0.17
BZX61 Series	0.21
BZY88 Series	0.15
CRS1/40	0.69
CRS3/06	0.52
CRS3/40	0.86

CRS3/60	1.04
GEX66	1.73
GEX541	4.60
GJ3M	0.86
GM0378A	2.02
KS100A	0.52
MJE340	0.92
MJE370	1.35
MJE371	0.71
MJE520	0.60
MJE521	0.63
MJE2955	1.44
MJE3055	0.86
MPF102	0.35
MPF103	0.35
MPF104	0.35
MPF105	0.35
MPSA06	0.28
MPSA56	0.30
MPSU01	0.41
MPSU06	0.53
MPSU56	0.56
NE555	0.52
NKT401	2.30
NKT403	1.99
NKT404	1.99
OA5	1.09
OA7	0.63
OA10	0.74
OA47	0.16
OA70	0.35
OA79	0.35
OA81	0.35
OA85	0.35
OA90	0.09
OA91	0.09
OA95	0.09
OA200	0.10
OA202	0.10
OA211	1.15
OAZ200	1.15

OAZ201	1.15
OAZ206	1.15
OAZ207	1.15
OC16	2.30
OC20	2.30
OC22	2.88
OC23	3.16
OC24	3.45
OC25	1.04
OC26	1.04
OC28	2.30
OC29	2.30
OC35	1.73
OC36	1.73
OC41	0.92
OC42	0.86
OC43	2.59
OC44	0.69
OC45	0.63
OC71	0.63
OC72	0.63
OC73	1.15
OC74	0.74
OC75	0.74
OC76	0.63
OC77	1.38
OC81	0.74
OC81Z	1.38
OC82	0.74
OC83	0.74
OC84	0.74
OC122	1.73
OC123	2.02
OC139	2.59
OC140	3.16
OC141	3.74
OC170	1.15
OC171	1.15
OC200	1.73
OC201	2.02
OC202	2.02

OC203	2.02
OC204	2.88
OC205	2.88
OC206	2.88
OC207	2.02
OCP71	1.44
ORP12	1.15
R2008B	2.02
R2009	2.50
R2010B	2.02
T1C44	0.35
T1C226D	1.38
TIL209	0.23
T1P29A	0.47
T1P30A	0.48
T1P31A	0.51
T1P32A	0.55
T1P33A	0.79
T1P34A	0.84
T1P41A	0.72
T1P42A	0.81
T1P2955	0.77
T1P3055	0.64
T1S43	0.52
ZS140	0.29
ZS170	0.24
ZS178	0.62
ZS271	0.26
ZS278	0.65
ZTX107	0.13
ZTX108	0.12
ZTX109	0.14
ZTX300	0.14
ZTX301	0.15
ZTX302	0.17
ZTX303	0.20
ZTX304	0.22
ZTX311	0.14
ZTX314	0.23
ZTX500	0.15
ZTX501	0.16

ZTX502	0.18
ZTX503	0.20
ZTX504	0.23
ZTX531	0.23
ZTX550	0.18
1N914	0.06
1N916	0.08
1N4001	0.07
1N4002	0.07
1N4003	0.08
1N4004	0.08
1N4005	0.09
1N4006	0.09
1N4007	0.10
1N4009	0.07
1N4148	0.07
1N5400	0.15
1N5401	0.15
1S44	0.05
1S920	0.08
1S921	0.06
2G301	1.15
2G302	1.15
2G306	1.27
2N404	1.15
2N696	0.29
2N697	0.29
2N698	0.35
2N705	1.38
2N706	0.17
2N708	0.23
2N930	0.23
2N1131	0.30
2N1132	0.30
2N1302	1.15
2N1303	0.86
2N1304	1.38
2N1305	1.03
2N1306	1.84
2N1307	1.15
2N1308	2.30

2N1309	1.38
2N1613	0.29
2N1671	1.73
2N1893	0.29
2N2147	4.31
2N2148	1.89
2N2218	0.29
2N2219	0.28
2N2220	0.21
2N2221	0.21
2N2222	0.21
2N2223	3.16
2N2368	0.20
2N2369A	0.24
2N2484	0.23
2N2646	0.63
2N2904	0.29
2N2905	0.29
2N2906	0.24
2N2907	0.24
2N2924	0.24
2N2925	0.25
2N2926	0.16
2N3053	0.20
2N3054	0.58
2N3055	0.81
2N3440	0.69
2N3441	0.92
2N3442	1.26
2N3614	1.73
2N3702	0.13
2N3703	0.15
2N3704	0.15
2N3705	0.15
2N3706	0.15
2N3707	0.15
2N3708	0.12
2N3709	0.15
2N3710	0.12
2N3711	0.12

2N3771	2.02
2N3772	2.30
2N3773	3.45
2N3819	0.41
2N3820	0.52
2N3823	0.63
2N3866	0.83
2N3904	0.15
2N3905	0.15
2N3906	0.15
2N4058	0.16
2N4059	0.12
2N4060	0.14
2N4061	0.14
2N4062	0.15
2N4124	0.17
2N4126	0.17
2N4286	0.23
2N4288	0.25
2N4289	0.28
2N5457	0.40
2N5458	0.40
2N5459	0.40
2S017	7.48
2S019	7.48
2S026	13.80
2S103	1.73
2S302	0.86
2S303	0.86
2S322	0.92
2S324	1.44
2S701	1.73
2S745A	0.40
2S746A	0.40

VALVES

A1834	10.35
A2087	13.58
A2134	10.06
A2293	8.62
A2426	17.63
A2521	24.38
A2900	14.43
A3343	25.56
AZ31	1.26
AZ41	1.32
BK448	110.27
BK484	149.00
BS90	52.27
BS810	35.24
BT5	52.61
BT17	100.71
BT19	34.11
BT29	308.57
BT69	314.07
BT75	102.40
BT95	119.00
CBL31	2.30
CL33	2.30
CY31	1.15
C1K	21.30
C3A	11.50
C3JA	23.23
DA41	21.50
DA42	12.30
DA100	112.62
DAF91	0.46
DAF96	1.15
DET22	32.78
DET24	52.90
DF91	0.46
DF96	1.15
DK91	1.21
DK92	1.44
DK96	1.26
DL92	1.26
DL94	1.38
DL96	1.26
DLS10	9.48
DLS15	12.37
DLS16	12.37
DLS19	12.37
DM70	1.44
DM71	1.44
DM160	3.96
DY86/7	0.73
DY802	0.86
E55L	25.17
E80CC	10.13
E80CF	12.96
E80F	14.19
E80L	13.98
E81CC	6.62
E81L	14.06
E82CC	7.03
E83CC	7.16
E86C	12.48
E88C	7.12
E88CC	3.86
E90CC	9.90
E90F	10.38
E91H	5.34
E92CC	9.40
E99F	10.16

E130L	19.39
E180CC	6.96
E180F	9.66
E182CC	9.90
E186F	12.58
E188CC	9.40
E280F	25.88
E283CC	9.02
E288CC	18.54
EA52	23.69
EA76	2.30
EABC80	1.38
EAC91	0.92
EAF42	1.44
EAF801	2.02
EB41	2.30
EB91	1.01
EBC33	2.02
EBC41	1.44
EBC81	1.26
EBC90	0.97
EBF80	0.58
EBF83	1.44
EBF89	0.97
EBL31	2.88
EC90	1.08
EC91	8.60
EC92	1.44
EC157	310.50
ECC33	4.02
ECC35	4.02
ECC40	2.30
ECC81	1.01
ECC82	0.82
ECC83	1.01
ECC84	1.36
ECC85	1.38
ECC86	2.30
ECC88	2.07
ECC89	1.88
ECC91	10.27
ECC189	1.90
ECC807	2.02
ECC808	2.59
ECF80	1.24
ECF82	1.35
ECF86	1.73
ECH35	2.30
ECH42	1.32
ECH81	1.38
ECH83	1.44
ECH84	1.47
ECL80	1.15
ECL81	1.73
ECL82	1.15
ECL83	1.73
ECL84	1.61
ECL85	1.28
ECL86	1.38
EF37A	4.02
EF39	3.10
EF40	3.45
EF41	2.30
EF42	2.30
EF50	1.73
EF54	5.75
EF55	2.88
EF80	0.92
EF83	2.07
EF85	0.92

EF86	1.74
EF89	1.84
EF91	2.07
EF92	6.68
EF93	1.15
EF94	1.44
EF95	6.27
EF98	1.44
EF183	0.92
EF184	0.96
EF804S	12.65
EF805S	12.65
EH90	1.61
EK90	1.24
EL32	1.73
EL33	4.02
EL34TH	2.53
EL34MUI	3.16
EL36	1.84
EL41	1.44
EL42	2.02
EL81	2.88
EL83	4.03
EL84	1.15
EL86	2.88
EL90	1.10
EL91	8.21
EL95	1.51
EL156	27.00
EL300	0.77
EL500/504	2.16
EL509	3.03
EL821	11.46
EL822	12.55
EM34	5.75
EM80	1.26
EM81	1.15
EM84	1.15
EM85	1.44
EM87	1.73
EN32	16.28
EN91	2.94
EN92	6.18
EY51	2.02
EY81	1.89
EY83	2.02
EY84	10.57
EY86	0.96
EY88	2.02
EY500A	2.23
EY802	94
EZ35	67
EZ40	1.44
EZ41	1.44
EZ80	0.96
EZ81	0.86
EZ90	1.38
FW4-500	2.88
FW4-800	2.88
G1.371K	41.40
G551K	12.65
G180.2M	18.42
G240.2D	12.85
G400.1K	19.28
GN4	8.62
GN4A	8.62
GS16	10.35
GT1C	14.38
GU50	14.31
GU51	13.62

GXU1	16.10
GXU2	28.43
GXU3	30.49
GXU4	32.77
GXU50	17.25
GY501	3.16
GZ32	1.44
GZ33	4.60
GZ34	2.88
GZ37	4.60
KT61	4.02
KT66	11.50
KT88	13.80
KTW61	2.02
KTW62	2.02
KTW63	2.02
M8079	12.29
M8080	9.49
M8081	11.38
M8082	9.87
M8083	8.54
M8091	11.99
M8096	4.31
M8097	4.09
M8098	5.50
M8099	5.96
M8100	8.49
M8136	8.75
M8137	0.73
M8140	5.17
M8141	5.52
M8142	7.77
M8144	4.31
M8149	5.86
M8161	8.11
M8162	10.36
M8163	5.17
M8190	5.29
M8195	4.25
M8196	7.47
M8204	6.57
M8212	12.47
M8223	3.80
M8224	4.66
M8225	2.99
M8248	13.32
MU14	1.73
MX119	58.65
MX123	67.85
MX145	58.65
VX151	17.25
MX152	135.70
MX161	166.75
MX163	23.11
MX164	25.88
MX166	142.60
MX168	48.30
N78	10.35
OA2	2.21
OA3	5.69
OA4	4.02
OB2	1.44
OB3	2.20
OC2	3.04
OC3	2.20
OD3	2.20
OZ4	1.84
PC86	1.61
PC88	1.61
PC95	1.49

PC97	1.38
PC900	1.38
PCC84	1.15
PCC85	1.38
PCC88	1.38
PCC89	1.56
PCC189	1.61
PCC805	1.51
PCC806	2.07
PCE82	2.07
PCF80	1.15
PCF82	1.15
PCF86	1.84
PCF87	1.84
PCF200	3.74
PCF201	2.45
PCF801	1.84
PCF802	2.19
PCF805	1.84
PCF806	1.84
PCF808	1.84
PCL82	1.15
PCL83	2.30
PCL84	1.15
PCL85	1.24
PCL86	1.24
PCL805/85	1.24
PD500	4.14
PE06-40N	31.40
PFL200	2.07
PL36	1.38
PL81	1.38
PL81A	1.38
PL82	1.38
PL83	2.55
PL84	1.24
PL504/5	1.61
PL508	2.07
PL509	3.73
PL519	3.73
PL801	2.07
PL802	3.40
PY33	1.27
PY81	0.97
PY82	0.97
PY83	0.81
PY88	1.01
PY500A	2.07
PY800	0.97
PY801	0.97
QQV02-6	14.44
QQV03-20A	20.13
QQV06-40A	47.15
QQV07-50	60.66
QQZ03-20A	59.80
QQZ06-40A	55.10
QU37	14.38
QV03-12	5.13
QV04-7	2.88
QV08-100	122.26
QY3-65	57.06
QY3-125	61.02
QY4-250	70.16
QY4-400	80.44
QY5-500	168.83

QY5-3000A	333.91
QZ06-20	30.48
R10	5.75
R17	1.89
R18	4.80
R19	1.38
R20	1.66
RG3-250	35.77
RG3-250A	37.40
RG3-1250	36.23
RG4-1250	43.93
RG4-3000	80.64
RR3-250	53.54
RR3-1250	94.83
S11E12	40.25
S130	3.45
S130P	4.03
STV280-40	11.50
STV280-80	24.15
SU41	2.88
SU42	10.35
TD03-10	32.78
TD03-10E	32.78
TD03-29F	33.03
TT15	34.50
TT21	14.16
TT22	18.17
TT100	59.51
TY2-125	60.01
TW4-400	74.07
TY5-500	178.25
TY6-800	181.70
TY6-5000A	337.51
TY6-5000B	264.50
TY6-5000W	290.98
TY7-6000A	357.49
TY7-6000W	286.33
TZ40	17.25
U18-20	2.88
U19	15.81
U25	1.33
U26	1.66
U37	10.35
UABC80	1.44
UAF42	1.44
UB41	1.44
UBC41	1.73
UBF89	1.38
UCC84	1.26
UCC85	1.38
UCF80	1.32
UCH42	1.38
UCH81	2.67
UCL82	1.20
UCL83	1.66
UF41	1.15
UF42	1.44
UF80	1.66
UF85	1.66
UF89	1.66
UL41	2.88
UL84	1.38
UM80	1.15

UY41	1.44
UY85	1.20
VLS631	15.24
XG1-2500	42.04
XG2-6400	113.50
XG5-500	28.52
XG2-6400	106.15
XR1-1600A	38.53
XR1-3200	93.15
XR1-3200A	93.15
XR1-6400	102.01
XR1-6400A	164.23
YD1120	264.50
YD1240	366.62
Z759	19.32
ZM1000	6.03
ZM1001	6.10
ZM1020	10.83
ZM1021	10.17
ZM1022	10.60
ZM1023	8.81
ZM1040	22.26
ZM1041	19.16
ZM1042	20.44
ZM1051	100.05
1B3GT	2.58
1B24	11.50
1B35A	28.75
1B63	57.50
1R5	1.21
1S5	0.46
1T4	0.46
2AS15	11.50
2C39A	21.85
2C43	20.70
2D21	2.94
2E26	15.34
2J42	80.70
2J55	239.97
2J70A	270.25
2J70B	418.34
2K25	40.25
3-400Z	57.50
3-500Z	63.25
3A5	2.70
3B24	9.20
3B28	8.63
3B29	11.50
3B240M	17.25
3B241M	17.25
3C23	18.73
3C45	28.18
3CX100A5	23.00
3E29	29.67
3S4	1.26
3V4	1.38
465A	29.15
4-125A	41.99
4-250A	41.99
4-400A	52.05
4B32	29.16
4C35	46.00
4CX250B	31.63
4CX350A	48.88
4X150A	24.41
4X150D	28.75

5B254M	23.12
5B255M	23.12
5C22	43.00
5J180E	1380.00
5R4GY	2.30
5U4G	3.86
5U4GB	2.99
5V4G	1.75
5Y3GT	0.98
5Z3	1.73
5Z4G	1.75
5Z4GT	1.75
6-30L2	1.79
6AB4	1.44
6AB7	1.73
6AC7	1.61
6AF4A	1.84
6AG7	2.30
6AH6	5.52
6AK5	4.15
6AK6	2.81
6AL5	1.01
6AM4	2.65
6AM5	8.21
6AM6	2.07
6AN5	4.45
6AN8A	3.97
6AQ5	1.10
6AS6	5.73
6AS7G	9.49
6AT6	0.98
6AU5GT	4.97
6AU6	1.24
6AV5GA	4.52
6AV6	0.98
6AX5GT	3.57
6B7	1.73
6B8	2.02
6BA6	1.15
6BA7	5.80
6BA8A	4.31
6BC4	4.27
6BE6	1.24
6BH6	1.75
6BJ6	1.24
6BK4	4.84
6BL6	97.75
6BL7GT	4.44
6BM6	97.75
6BN6	1.89
6BQ7A	4.28
6BR7	4.60
6BR8	2.07
6BS7	4.60
6BW6	4.60
6BW7	1.75
6BX7GT	5.70
6BZ6	2.73
6C4	1.01
6CB6A	2.86
6CD6GA	5.83
6CG7	2.62
6CH6	9.78
6CL6	4.12
6CW4	8.83
6D2	1.01
6DK6	3.00
6DQ6B	4.69
6EA8	3.38

6EB8	2.44
6EW6	1.73
6F6	2.02
6F23	1.84
6F28	1.33
6F33	29.99
6H1	14.38
6H2N	1.21
6H3N	1.21
6H6	1.73
6J4	6.10
6J6	6.21
6J7	8.07
6K4N	1.44
6K6GT	1.50
6K7	1.73
6K8	2.02
6KD6	7.31
6L6G	2.88
6L6GA	1.73
6L6GT	2.24
6L6GC	2.88
6L7	2.30
6N2P	1.21
6N3P	1.21
6N7	1.73
6P25	4.14
6Q7	2.53
6R7	2.07
6SA7	1.67
6SC7	1.73
6SF7	1.84
6SH7	1.73
6SJ7	1.84
6SK7	1.50
6SK7GT	3.08
6SN7GT	1.84
6SQ7	1.50
6SR7	1.73
6SS7	2.07
6U5G	2.30
6U8	0.92
6U8A	3.38
6V6GT	1.84
6X4	1.38
6X5GT	0.97
7B7	1.96
7C5	3.40
7C6	2.00
7H7	2.30
7R7	1.73
7S7	2.98
7Y4	1.84
7Z4	2.13
11E3	60.82
12AT6	1.38
12AT7	1.01
12AU6	2.97
12AU7	0.83
12AV6	2.55
12AV7	4.00
12AX7	1.01
12AY7	4.60
12B4A	3.62
12BA6	2.52
12BE6	2.79
12BH7	1.29
12BY7	3.11
12E1	19.67
12E11TT	10.26

12E14	34.50
13E1	123.05
19H4	28.75
19H5	40.25
24B9	55.20
30C15	1.84
30C17	1.84
30C18	1.84
30F5	1.93
30FL1/2	1.28
30FL12	2.07
30FL14	1.84
30L1	1.15
30L15	2.07
30L17	2.07
30P1	2.88
30P4	1.66
30P13	2.07
30P19	1.38
30PL1	2.83
30PL13	1.93
30PL14	1.93
30PL15	2.07
35W4	0.69
50C5	0.81
75B1	5.38
75C1	2.70
85A1	8.63
85A2	2.75
90AG	14.90
90AV	14.90
90C1	2.81
90CG	16.72
90CV	17.50
92AG	14.90
92AV	14.90
95A1	7.48
150B2	3.47
150B3	6.39
150C2	2.21
150C4	2.75
211	6.90
723AB	40.25
803	11.50
805	23.00
807	4.31
811A	18.32
812A	18.26
813	85.87
833A	128.80
866A	15.23
872A	21.47
922	5.01
931A	16.97
1624	2.50
1625	1.96
2050	8.00
4212E	304.75
4212H	304.75
5544	62.10
5545	67.85
5551A	106.03
5552A	143.35
5553A	259.10
5642	6.45
5654	3.93
5651	2.65
5670	5.18
5675	19.91
5687	6.31
5696	4.35

5718	7.87
5725	5.62
5726	3.62
5727	5.42
5749	5.14
5751	4.80
5763	4.06
5814A	4.28
5840	5.06
5842	13.90
5876A	19.55
5879	5.38
5886	12.08
5963	3.38
5965	4.00
6005	5.62
6021	5.13
6057	4.02
6058	12.47
6059	4.60
6061	4.89
6062	4.31
6063	4.20
6064	8.54
6067	4.02
6072	5.80
6080	7.88
6097A×B×C	46.00
6146A	10.30
6146B	8.12
6159B	17.27
6189	10.03
6201	5.28
6442	17.25
6883B	12.77
6973	4.38
7025	2.73
7551	6.45
7586	11.66
7587	20.11
7609	36.57
7868	5.04
7895	13.25
8005	75.03
8068	6.33
8122	60.11
8136	2.48
8417	6.76
18042	8.63
18045	12.06

Tested Ex-Equipment
4CX250B 5.75

BASES

B7G unskirted	0.17
B7G skirted	0.35
B9A unskirted	0.17
B9A skirted	0.35
Int Octal	0.40
Loctal	0.63
Nuvistor base	0.86
8 pin DIL	0.17
14 pin DIL	0.17
16 pin DIL	0.20
Valve screening cans all sizes	0.35

CRTs

2AP1	9.78
2BP1	10.35
3BP1	11.50
3DP1	5.75
3EG1	8.05
3FP7	6.90
3GP1	6.90
3JP1	9.20
3JP2	9.20
3JP7	11.50
3KP1	17.25
3RP1	40.25
3WP1	23.00

5ADP1	40.25
5BP1	11.50
5CP1	11.50
5CP1A	46.89
5FP15A	17.25
5UP7	16.10
DG7-5	28.75
DG7-32	41.40
DH3-91	35.65
DH7-11	78.20
VCR97	13.80
VCR138	11.50

VCR138A	14.38
VCR139A	9.20
VCR517A	11.50
VCR517B	11.50
VCR517C	11.50

Tube Bases Prices on application

INTEGRATED CIRCUITS

7400	0.18
7401	0.18
7402	0.18
7403	0.18
7404	0.20
7405	0.18
7406	0.46
7407	0.46
7408	0.23
7409	0.23
7410	0.18
7412	0.30
7413	0.37
7416	0.37
7417	0.37
7420	0.20
7422	0.23

7423	0.37
7425	0.35
7427	0.35
7428	0.49
7430	0.20
7432	0.35
7433	0.41
7437	0.37
7438	0.37
7440	0.21
7441	0.97
7442	0.83
7447AN	1.04
7450	0.21
7451	0.21
7453	0.21
7454	0.21

7460	0.21
7470	0.40
7472	0.38
7473	0.41
7474	0.46
7475	0.62
7476	0.46
7480	0.63
7482	0.86
7483	1.04
7484	1.15
7486	0.40
7490	0.60
7491	0.92
7492	0.69
7493	0.69
7494	0.92

7495	0.83
7496	0.92
7497	3.45
74100	1.73
74107	0.52
74109	0.81
74110	0.58
74111	0.81
74116	2.02
74118	1.15
74119	1.73
74120	0.95
74121	0.46
74122	0.69
74123	1.15
74125	0.63
74126	0.63
74128	0.69
74132	0.81

74136	0.63
74141	0.92
74142	2.65
74143	2.88
74144	2.88
74145	1.04
74147	2.30
74148	2.02
74150	1.84
74151	0.97
74154	2.02
74155	0.97
74156	0.97
74157	0.86
74159	2.42
74170	2.65
74172	5.06
74173	1.61
74174	1.73

74175	1.04
74176	1.26
74178	1.44
74179	1.44
74180	1.32
74190	1.73
74191	1.73
74192	1.55
74193	1.55
74194	1.44
74195	1.15
74196	1.38
74197	1.26
74198	2.59
74199	2.59
76013N	2.02
TAA570	2.65
TAA630S	4.02
TAA700	4.50

TBA480Q	2.12
TBA520Q	2.65
TBA530	2.28
TBA540Q	2.65
TBA550Q	3.70
TBA560CQ	3.70
TBA673	2.52
TBA700	1.75
TBA720Q	2.65
TBA750Q	2.38
TBA800	1.38
TBA820	3.34
TBA920Q	3.34
TBA990Q	3.34
TCA270Q	3.34
TCA760A	1.59

Terms of business: CWO. Postage and packing valves and semiconductors 30p per order. CRTs £1. All prices include VAT.
Price ruling at time of despatch.
In some cases prices of Mullard and USA valves will higher than those advertised. Prices correct when going to press.
Account facilities available to approved companies with minimum order charge £10. Carriage and packing £1 on credit orders.
Over 10,000 types of valves, tubes and semiconductors in stock. Quotations for any types not listed. S.A.E.
Open to callers Monday-Friday 9 a.m.-5 p.m.

Telephone 01-677 2424/7
Telex 946708
E. & O.E.

Testing... Testing... Testing...

anywhere!

The New FM/AM 1000s with Spectrum Analyser - we call it the *SUPER-S*

A portable communications service monitor from IFR, light enough to carry anywhere and good enough for most two-way radio system tests. The FM/AM 1000s can do the work of a spectrum analyser, oscilloscope, tone generator, deviation meter, modulation meter, signal generator, wattmeter, voltmeter, frequency error meter - and up to five service engineers who could be doing something else!

For further information contact Mike Taylor

Hunting **FieldTech**

FieldTech Ltd
Heathrow Airport - London Hounslow
TW6 3AF
Tel: 01-759 2811
Telex: 23734
FLDTEC G

IFR precision simulators

WW — 054 FOR FURTHER DETAILS

You could do with a Helper on your test bench.

Helper low cost instruments are specially designed for 'fiddle-free', instant bench testing or mobile servicing of two-way radio equipment.

They'll make life easier for the busy technician whilst giving extremely reliable, lasting service.

The Autopeak Modulation Monitor..

For reading peak modulation and modulation density on any FM receiver whose 2nd I.F. is 400, 450 or 455KHz. Other frequencies may be accommodated on special order,

£280 exc. VAT & P & P

The Sinadder 3 . . .

Ideal for bench or mobile service van use, with 3 functions in one. Automatic SINAD meter with audio monitoring plus a 1000Hz tone generator. Sensitive AC voltmeter, 1M Ω input impedance, with audio monitor for tracking down distortion and locating defective stages.

These are just two of our Helper range.

£220 exc. VAT & P & P

Write now for a product guide and free copy of the mobile radio desk reference.

HELPER

LI **LYONS INSTRUMENTS**

Lyons Instruments Limited, Hoddesdon, Herts, EN11 9DX, England
Telephone 67161 Telex 22724 A Claude Lyons Company

WW — 044 FOR FURTHER DETAILS

B4, 61A moves to F3, 115

. . . or if you haven't got a pocket edition of the current Geographers' A to Z of London with you: Dorset House, Stamford Street, S.E.1. moves to Quadrant House in Sutton, Surrey.

This is the new headquarters of our parent company, IPC Business Press—and our new address as from 1st December.

It's a brand-new, purpose-built tower block of twenty storeys linked to a low-rise block of seven, and it's situated right by Sutton railway station. The environment is nice and the facilities are impressive: our new telephone system is one of the most modern in the country and callers will receive just about the fastest-answering service they've ever had.

This is only one way in which we hope our move will be of benefit, not simply to us, but to everyone who has been used to contacting us at Dorset House, Stamford Street, S.E.1.

We look forward to seeing or hearing from you at our new address, so please make a note in your diary now:

wireless world moves on 10 November 1980 to

Quadrant House, The Quadrant
Sutton, Surrey SM2 5AS
Tel: 01-661 3500 Telex: BisprsG 892084

A member of IPC Business Press Ltd

People in the know, keep in touch.

Call your secretary, factory manager, accountant or even hold a conference – all at the press of a button using the first easy to install 100% British designed and manufactured Duplex Intercom System.

Featuring: Operation on a 6 wire system. • Plug in anywhere on the system. • Retain identity station number. • Up to 56 stations. • Two speech channels. • 24 Volt supply. • All from the smallest central unit available and of course the least expensive.

Barkway keeps you in touch...

Write or phone NOW for further details.

Barkway Electronics Ltd.,
Barkway, Royston,
Herts SG8 8EE, England.
Tel: Barkway (0763 84) 666
Telex: 817651 BARCOM G

Barkway

WW — 108 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

WW — 114 FOR FURTHER DETAILS

EXTENSIVE RANGE OF NEW FLUKE DMM's FROM ELECTRONIC BROKERS

IMMEDIATE DELIVERY

8050A 4½ Digit LCD DMM with true RMS on AC volts and current DC volts 200mV-1KV, 10μV resolution AC volts. 200mV-750V, 10μV resolution. DC/AC current 200μA-2A, 0.01μA resolution resistance 200Ω-20MΩ, 0.01Ω resolution. Also reads dB direct referenced to 16 stored impedances. Conductance ranges 2mS and 200nS.
£199 mains model
£239 mains battery.

8012A 3½ Digit LCD DMM with true RMS on AC volts and current. DC volts 200mV-1KV, 100μV resolution. AC volts 200 mV-750V, 100μV resolution. DC/AC current 200μA-2A, 0.1μA resolution. Resistance 200Ω-20MΩ, 0.1Ω resolution Low resistance 2Ω and 20Ω, 1mΩ resolution Conductance ranges 2mS-20μS-200nS
£199.00 mains model
£219.00 mains battery.

8010A 3½ Digit LCD DMM Same spec as 8012A plus a 10Amp AC/DC current range, but no low resistance range.
£159.00 mains model
£179.00 mains battery.

8024A 3½ Digit hand held LCD DMM with peak hold Level Detector and continuity tester. DC volts 200mV-1KV, 100μV resolution. AC volts 200mV-750V, 100μV resolution. DC/AC current 2mA-2A, 1μA resolution. Resistance 200Ω-20MΩ, 0.1Ω resolution. Conductance 200nS. Peakhold of AC or DC volts and current. Level detector operates around +0.8V reference. Audio tone on level and continuity. **£135.00** carrying case **£7.00** extra.

8020A 3½ Digit hand held LCD DMM. spec as per 8024A with extra conductance range of 2mS but no peak hold, level or continuity ranges. Complete with carrying case. **£112.00**

8022A 3½ Digit hand held LCD DMM. Spec as per 8020A but no conductance ranges and slight reduction on accuracy. Was £89.00 now reduced to **£75.00** carrying case £7.00 extra.

Also available a range of accessories including current shunts, EHT probe, rf probe, Temperature probe and touch and hold probe. Full details on request.

The warranty period on all items shown is 1 year other than the 8020A which is 2 years.

Electronic Brokers

61-65 King's Cross Road
London, WC1X 9LN
Tel: 01-278 3461 - Telex 298694

Prices do not include carriage or VAT.

WW — 099 FOR FURTHER DETAILS

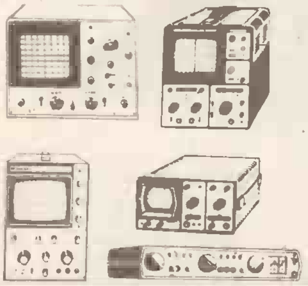
- ORDER BY POST OR TELEPHONE WITH BARCLAYCARD/ACCESS
- ELECTRONIC TEST EQUIPMENT SPECIALISTS
- ALL PRICES INCLUDE VAT

AUDIO ELECTRONICS

- ALL MODELS ON DISPLAY
- RETAIL – MAIL ORDER – EXPORT – INDUSTRIAL
- OPEN SIX DAYS A WEEK
- CALL IN AND SEE FOR YOURSELF

SCOPES

A range of Scopes in stock from 5mHZ Single Trace to 50mHZ Dualtrace. Mains and Battery/Mains portables. Many on demonstration.



SINGLE TRACE (UK c/p etc £2.50)

Hm 307-3 10mHZ, 5mV, 6 × 7cm display plus component test £170.00
CO1303D 5mHZ, 10mHZ, 7 × 7cm display £109.25
SC110 10mHZ Battery portable, 10mV 3.2 × 2.6cm display (Optional case £8.80, Nicads £7.95, Mains unit £4.00) £149.95
LBO512A 10mHZ, 10mV, 5" display (plus FREE probe) £195.50
CS1559A 10mHZ, 10mV, 5" display £198.50
*V151 15mHZ 5" display £241.50

OPTIONAL PROB (ALL MODELS)

X1 £6.50, X10 £8.50, X100 £12.95, X1-X10 £10.95

HAMEG ● TRIO ● SINCLAIR ● LEADER ● HITACHI

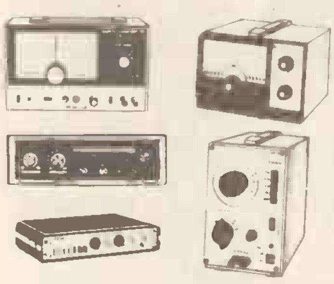
DUAL TRACE (UK c/p etc £3.50)

CS1562A 10mHZ, 10mV, 5" display £244.95
CS1575 5mHZ 1mV 5" display £270.00
Hm312-8 20mHZ, 5mV, 8 × 10cm display £287.50
CS1566A 20mHZ, 5mV, 5" display £323.15
CS1352 15mHZ, 2mV, 7.5cm, display battery/mains portable (Nicads pack £29.90) £346.15
Hm412-4 20mHZ, 5mV, 8 × 10cm display plus Sweep Delay £399.50
CS1577A 30mHZ, 2mV, 5" display £455.40
CS1830 30mHZ, 2mV, 5" display plus sweep delay £507.15
Hm512-8 50mHZ, 5mV, 10× 8cm display, Delay Sweep £667.00
LB0514 10mHZ, 1mV (5mV) 5" display (plus 2 FREE probes) £294.00
*V152 15mHZ 1mV 5" display £326.60
*V302 30mHZ 5" display £447.35
*V550 50mHZ 1mV 10×8 cm Delay sweep + 3 channel display £799.25

* Including free probe(s)

GENERATORS

(UK c/p £1.75)



RF

SG402 100KHZ – 30mHZ with AM modulation £64.40
LSG16 100KHZ (300mHZ on Harmonics) £56.50
LSG231 100m HZ± 1mHZ (adjustable) FM stereo generator and pilot and mod. £195.00

PULSE

2001 1HZ–100KHZ £86.00
TG105 5HZ–5mHZ £92.50
4001 0.5HZ–5mHZ £105.00
200P 0.002H2–5.5mHZ £253.00
200SPC as 200P plus built in freq. display/100mH2 counter £437.00

A range of Signal Generators to cover Audio, RF and Pulsing. Mains operated (TG series Battery).

AUDIO (All sine/square)

AG202A 20HZ–200KHZ £65.55
LAG26 20HZ–200KHZ £69.00
AG203 10HZ–1mHZ sine/square £120.75
LAG120A 10HZ–1mHZ £137.00

LEVELL (Battery Portables) ('M' with Meter)

152 SERIES 3HZ – 300KHZ Sine/Square
200 SERIES 1HZ–1mHZ Sine/Square
TG152D £92.00
TG152DM £113.85
TG200D £124.20
TG200DM £149.50
TG200DMP £155.25

TV GENERATORS

LCG-393V PAL B VHF 6 patts. £137.00
LCG-782U PAL B UHF 15 patts. £217.00

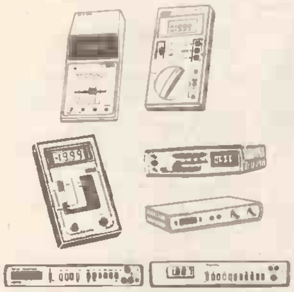
LEADER ● TRIO ● NEWTRONICS ● LEVELL

SWR/FS AND POWER METERS

Range in stock covering up to 150mHZ and up to 1K watt power. PL259 sockets. Also 250 UHZ Grid Dipmeter
SWR9 SWR/S 3-150mHZ £9.50
SWR50 SWR/Power meter. 3½-150mHZ 0-1000 watts £13.95
110 SWR/Power 1½-144mHZ 0/10/100 watts £11.50
171 As 110 Twin meter plus F/S £14.50
Plus large range of BNC/PL259/etc leads plus adaptors/connectors always in stock.
176 SWR/Power/FS 1½-144mHZ 5-50 watt Plus 25-40mHZ ac match £16.60
KDM6 Gnd Dip 1½-250mHZ £38.50

DIGITAL MULTIMETERS

A range of LED and LCD Bench and Hand DMM's battery operated with optional Mains Adaptors – some with optional Nicads. All supplied with batteries and leads.



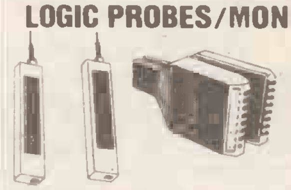
HAND HELD (UK post etc. 85p)

TM352 3½ Digit LCD plus 10 ADC and Hfe checker £54.95
PDM35 3½ Digit 16 range LED (no AC current) £32.95
ME502 3½ Digit LED plus 10A DC and Hfe checker £43.95
LM2001 3½ Digit LCD 2 amp AC/DC 0.1% £51.70
6200 3½ Digit LCD 0.2A AC/DC, Auto range £39.95
6220 As 6200 plus 10A AC/DC £49.95
6100 As 6200 plus Cont. test/range hold £64.95
6110 As 6100 plus 10A AC/DC £74.95

BENCH PORTABLES (UK c/p £1.00)

DM235 3½ Digit LED 21 ranges, 0.5% AC/DC 2A £56.50
DM350 3½ Digit LED 34 ranges AC/DC 10A £78.50
TM353 3½ Digit LCD AC/DC 2 amp £86.50
TM351 3½ Digit LCD AC/DC 10 amp £107.95
LM100 3½ Digit LCD AC/DC 2 amp £86.50
DM450 4½ Digit LED 34 ranges AC/DC 10 amp £107.95
(DM series options. Carry case £8.50, NI-cads £7.95. Mains adaptor £4.00).

LOGIC PROBES/MONITORS

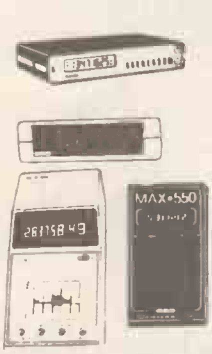


Logic probes indicating high/low etc states that scopes can miss. All circuit powered for all ICs.

LP3 50MHz logic probe £55.95
LP1 10MHz logic probe £35.50
LP2 1½MHz logic probe £19.95
LMI Logic monitor £33.00
Also in stock range of Proto board kits and breadboards.

CHOOSE FROM UK'S LARGEST SELECTION

FREQUENCY COUNTERS



Portable and Bench LCD and LED Counters up to 600mHZ. Prices include batteries and leads.

HAND HELD (UK post etc 85p)

PFM200 20HZ to 200mHZ 8 Digit LED £54.50
MAX50 100HZ to 50mHZ 6 Digit LED £61.00
MAX550 30KHZ to 550mHZ 6 Digit LED £106.00

BENCH PORTABLES (UK c/p £1.00)

MAX100 8 Digit LED 5HZ to 100mHZ £89.00
TF200 8 Digit LCD 10HZ to 200mHZ £158.95
7010A 9 Digit LED 10HZ to 600mHZ £184.00

200D 6 Digit 100MHZ LED built into 0.002HZ to 5.5MHZ Pulse Generator £437.00

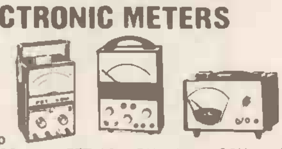
CSC ● SINCLAIR ● OPTOELECTRONICS ● NEWTRONICS

CLAMP METERS/ INSULATION TESTERS

(All multirange except K2303)

K2303 30 AMPS 500 VAC £21.95
3101 300 AMPS 600 VAC 1K OHM £32.95
K2803 300 AMPS 600 VAC 2K OHM £53.95
K2903 900 AMPS 750 VAC 2K OHM £77.95
K3103 Transistorisedinsulation/continuity tester. 100 MEG. 600 VAC. 0/2½K £95.00
M500 Insulation tester 100 MEG. 500 VOLT, 0/200 OHMS continuity £67.50
Also digital and DC types in stock

ELECTRONIC METERS



UK c/p £1.50
K200 38 range FET 10m OHM input 20Hz to 30MHz multimeter £95.00
TM11 120 range multimeter 3Hz to 200KHz £172.50
TM3A Multirange AC micro voltmeter £149.50
TM3B As TM3A larger size meter £166.75

'PRO' MULTIMETERS

UK c/p £1.20
M1200 100K/Volt 30 ranges plus AC/DC 15 amp £67.00
K1400 20K/Volt 23 range large scale £79.95
M1500 20K/Volt 42 range plus AC/DC 10 amp £53.50

Stockists of electronic equipment, speakers/kits, PA equipment plus huge range of accessories ● UK carriage/packing as indicated ● Export – prices on request ● All prices correct at 1.11.80 E & OE ● All prices include VAT

AUDIO ELECTRONICS Cubegate Limited
301 EDGWARE ROAD, LONDON, W2 1BN, ENGLAND. TELEPHONE 01-724 3564

OPEN SIX DAYS A WEEK

BARCLAYCARD VISA AMERICAN EXPRESS

FREE CATALOGUE!
Send large SAE (17½p UK) Schools, Companies, etc. free on request.

TRANSFORMERS
CONTINUOUS RATINGS

Please add VAT after P&P

VAT 15%

MAINS ISOLATORS

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	12.82	1.75
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 (DC)	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	" "	38.31	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	85p
400v	6A	£1.40
500v	12A	£2.85

P&P 17p. VAT 15%

CASED AUTO TRANSFORMERS

240V cable input USA 115V Flat pin outlets

	£	P&P	Ref.
20VA	£6.56	1.03	56W
75VA	£8.50	1.31	64W
150VA	£11.00	1.31	4W
200VA	£12.02	1.67	65W
250VA	£13.38	1.67	69W
500VA	£20.13	1.89	67W
1000VA	£30.87	2.65	84W
1500VA	£42.82	OA	93W
2000VA	£54.97	OA	95W

MINI MULTIMETER

DC1000V, AC-1000V
AC/DC-1000Ω/V
DC-100mA. Res — 150K
Bargain at £7.20
VAT 15% P&P 71p

TEST METERS

AVO8 Mk. 5	£106.40
AVO 71	£43.10
AVO 73	£58.60
AVOMM5 MINOR	£36.90
WEE MEGGER	£87.00
EM272 316KΩ/V	£67.10
DA116 Digital	£108.90
Megger BM7 (Battery)	£58.70
Clamp Meter 300A	£62.50

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 20KΩ/V. Rangers to 1000V 2.5A AC/DC 500KΩ. 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%.

MAINS ADAPTORS

Plugs into 13A socket 3V at 100ma or 6, 9, -12V at 300ma. £4.60 p&p 55p + VAT

SPLIT BOBBIN TYPE

0-12-15-20-24-30V
Ref 009 1 amp.
£2.98 p&p £1.10+VAT.
Ref. 010 2 amp.
£4.62 p&p £1.10 + VAT

ISOLATOR. Ref 30 240V: 240V 200VA £4.62 p&p £1.10.

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 — 112 FOR FURTHER DETAILS

Incredible Quality Incredible Performance Incredible Price!!!

HM312 Dual Trace Oscilloscope.
DC-20MHz. Sensitivity 5mV-20V/cm. Time base range 0.5uS-0.2S/cm with x5 horiz mag to 100nS/cm, with variable control uncalibrated to 40nS/cm. CRT screen 8 x 10cm. Full XY using chII as X input. Bandwidth 2.3MHz. TV trigger.

NOW BETTER VALUE THAN EVER AT

£220

HM512 Dual Trace Oscilloscope with delayed sweep.
DC-50MHz. Sensitivity 5mV-20V/cm Time base range 0.1uS-2.0S/cm with x5 horiz mag to 20nS/cm. Delay ranges 7 decade steps 100ns-1S with fine control CRT screen 8 x 10cm. Full XY using ch II as x input, bandwidth 4 MHz. Z input. Delay line allows viewing of leading edge. Vertical overscan indicated by 2 LED's.

£580

Other models available.
HM307 10MHz plus component tester. £138.00
HM412 20 MHz with sweep delay. £350.00
HM812 50 MHz storage. £1458.00
All scopes can be fitted with a long persistence CRT at extra cost.

World-beating Oscilloscope Offers

FROM

Electronic Brokers

61/65 Kings Cross Road,
London WC1X 9LN.
Tel: 01-278 3461. Telex 298694

Prices do not include carriage or VAT.

WW — 102 FOR FURTHER DETAILS

POPULAR KITS AND PARTS

SAFE BLOCK
Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit £1.95.

LIGHT CHASER
Gives a brilliant display — a psychedelic light show for discos, parties and pop groups. These have three modes of flashing, two chase-patterns and a strobe effect. Total output power 750 watts per channel. Complete kit **Price £16**. Ready made up **£4 extra**.

FISH BITE INDICATOR enables anglers to set up several lines then sit down and read a book. As soon as one has a bite the loudspeaker emits a shrill note. Kit. **Price £4.90.**

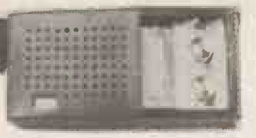
6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit, includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy, if you have an amplifier to connect it to on a pair of high resistance headphones. Price **£11.95.**

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price £2.30. Crystal earpiece **65p**. High resistance headphones (give best results) £3.75. Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy to fault find — start at the aerial and work towards the speaker — when signal stops you have found the fault. **Complete kit £4.95.**

INTERRUPTED BEAM KIT
This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components — relay, photo transistor, resistors and caps, etc. Circuit diagram but no case. Price **£2.30.**

10 POCKET RADIOS for £9



These are brand new but have slight faults. Most, if not all, should be repairable.

2⅓ ROUND PANEL METERS. All flush mounting through 2½in round hole, with flange makes item 3in wide approx. Made to stringent Ministry specifications. We have the following types in stock. All are moving coil unless otherwise stated. **MICRO AMPMETER 500UA**, scaled 0 5. **Price £2.80. MILLIAMP METER** 500 MA, scaled 0 500 mA. **Price £2.30. AMPERE METER.** Hot wire, scaled 0-9 amp. **Price £2.30. DUAL RANGE VOLTMETER.** Scale calibrated 0-10v and 0-250v. **Price £3.45. 0-1 MA METER** IMA f.s.d. centre zero, scaled 100-0-100. **Price £3.45.**

VU METER. Edgewise mounting, through hole size 1⅜in x ⅝in approx. These are 100 micro amp f.s.d. and fitted with internal 6 volt bulb for scale illumination, also have zero reset. The scale is not calibrated but has very modern appearance. **Price £2.88.**

BALANCE METER. Edgewise mounting 100 UA centre zero. **Price £2.30.**

1⅞in SQUARE PANEL METER. Eagle full vision plastic front. 50 UA. **Price £4.60.** 1mA **Price £4.03.**

WATERPROOF HEATING WIRE. 60 ohms per yard. This is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses — around water pipes, under grow boxes, in gloves and socks. **23p metre.**

DIAL INDICATOR. As used in toolmaking and other precision measuring operations, the famous John Bull accurately shows differences of .01mm. A beautifully made precision instrument, price in most toolshops would be £12-£15. We have a fair quantity. **Price £9.20.**

COMPONENT BOARD. Ref. WO998. This is a modern fibreglass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including four 3 amp 400v types (made up in a bridge), 8 transistors, type BC107 and 2 type BFY51, electrolytic condensers, SCR ref. 2N 5062 25 0uf 100v DC and 100uf 25v DC and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at **£1.15.**

PUNCHED TAPE EQUIPMENT for controlling machine tools, etc. motorised 8-bit punch with matching tape recorder. Ex computers believed in working order, any not so would be exchanged. **£15** the pair. Carriage **£3.**

FRUIT MACHINE HEART. 4 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot". **£9.95 + £4** carriage.

DESOLDERING PUMP
Ideal for removing components from computer boards as well as for service work generally. Price **£6.35.**

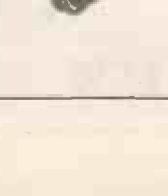
4-CORE FLEX CABLE
White pvc for telephone extensions, disco lights, etc. 10 metres £2, 100 metres £15. Other multicore cable in stock.

MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

HUMIDITY SWITCH
American made by Honeywell. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive microswitch. Very sensitive breathing on it for instance will switch it on. Micro 3 amp at 250V a.c. Only **£1.15.**

V3 MICROSWITCHES
Over 50 000 in stock all 250 AC working, with 3 silver contacts fo c/o circuits — 10 amp **25p** each or **£20** per 100. 15 amp **35p** each or **£30** per 100.

MAINS ADAPTORS
Why use expensive batteries — operate your radios and equipment from the mains with these units.
— **Sinclair** gives 9v-100mA — **£2.95.**
— **Altai** gives 6v 7.5 or 9 v 300 mA **£3.95.**
— **Crown** give 6v 300mA **£2.95.**
— **Nixie** give 12v 750mA **£3.95.**
These are all made up complete with mains lead. We can also supply Mains Transistor Power Pack Kit for Voltage output anything from 3v to 16v up to 300mA — complete kit with double insulated mains transformer and full instructions **£1.95.**



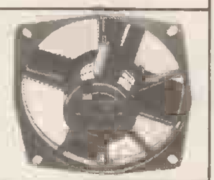
MULLARD UNILEX

A mains-operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy-to-assemble modular form this should sell at about **£30**—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£16** including V.A.T. and postage.
FREE GIFT—Buy this month and you will receive a pair of **Goodman's** elliptical 8" × 5" speakers to match this amplifier.

THIS MONTH'S CONSTRUCTOR'S SNIP

Here's a super bargain for you. 100 twist drills, regular toolshop price over £50, yours for **only £11.50.** With these you will be able to drill metal, wood, plastic, etc, from the tiniest holes in P.C.B. right up to about ¼in. Don't miss this snip — send your order today.

EXTRACTOR FANS

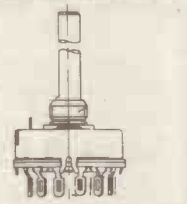


Ex-Computer made by Woods of Colchester. Ideal also as blower, central heating systems, fume extraction, etc. Easy fixing through panel, very powerful 2,500 r.p.m. but quiet running. Choice of 2 sizes, 5" **£5.50**, 6" **£6.50**; post **£1** per fan.

AC CONDENSERS

For motor starters, power factor correction voltage droppers. The voltage quoted is ACRMS, or for DC at 2½ times the AC voltage.

1.5 mfd 440V	**64p**	6.25 mfd 250V	**£1.00**	12 mfd 440V	**£2.78**
2.5 mfd 440V	**87p**	8 mfd 250V	**£1.27**	13 mfd 275V	**£1.65**
3.4 mfd 440V	**£1.00**	8 mfd 440V	**£1.89**	15 mfd 325V	**£1.77**
3.5 mfd 250V	**77p**	11 mfd 275V	**£1.52**	20 mfd 275V	**£1.77**
5 mfd 570V	**£1.52**	12 mfd 250V	**£1.62**	32 mfd 250V	**£2.89**



MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way—1 pole, 12 way. All at **46p** each.

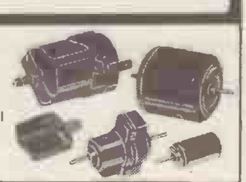
WATERPROOF HEATING ELEMENT
13 yards length 70W. Self-regulating temperature control, **£1.**

PRECISION MAINS OPERATED CLOCK
For only **£1.50** + 22p. Sounds unbelievable but that's what you can have if you send your order right away. The clocks which have large clear dials were made by the famous Smiths Company for use with their domestic cooker switch and are brand new and guaranteed.

THIS MONTH'S SNIP

A 3 wave band radio with stereo amplifier. Made for incorporation in a high-class radiogram, this has a quality of output which can only be described as superb. It is truly hi-fi. The chassis size is approximately 14in. Pushbuttons select long, medium, short and gram. Two dial lights for a scale, the pointer being moved by cord drive. The other controls are balance, volume, treble and bass. The chassis is ready built with its own mains power supply. The output is 6+6 watts. Brand new and in perfect working order, offered at less than value of stereo amp alone, namely **£6.90.** Post £2.

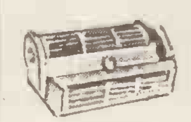
8 POWERFUL BATTERY MOTORS



For models, Meccanos, drills, remote control planes, boats, etc. **£2.**

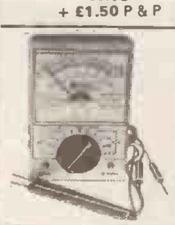
PUNCH TAPE CONSOLES

Complete units, on desks. The 8 bit punch and reader are set in the top, below is the power units and electronics. The keyboard is a standard computer type using reed switches ASCII coded, has 72 encoded keys. Offered complete data, at **£115 each** + carriage at cost. Used but believed in good order — any section not so would be replaced. Please telephone before calling to view.



3KW MODEL
£6.95
+ **£1.50** P & P

TANGENTIAL HEATER UNIT
A most efficient and quiet running blower-heater by Solatron — same type as is fitted to many famous name heaters — comprises mains induction motor, long turbo fan, split 2 kw heating element and thermostatic safety trip. Simply connect to the mains for immediate heat. Mount in a simple wooden or metal case or mount direct onto base of, say, kitchen unit. Price **£6.95**, post £1.50. Control switch to give 2kw, 1kw, cold blow or off available 60p extra.



MINI-MULTI TESTER
Deluxe pocket size precision moving coil instrument, jewelled bearings—2000 o.p.v. mirrored scale.
11 instant ranges measure:
DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0-100 mA.
Continuity and resistance 0-1 meg ohms in two ranges.
Complete with Test Prods and instruction book showing how to measure capacity and inductance as well.
Unbelievable value only **£6.75 + 50p** post and insurance.

FREE Amps ranges kit to enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini-tester and would like one, send **£2.50.**

TERMS: Cash with order—but orders under **£10** must add **50p** to offset packing, etc.
BULK ENQUIRIES INVITED - PHONE HAYWARDS HEATH 54563
ACCESS & BARCLAYCARD ACCEPTED

J. BULL (Electrical) LTD.

(Dept. HE), 34-36 AMERICA LANE
HAYWARDS HEATH, SUSSEX, RH16 3QU

IT'S FREE
Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

SUPER BREAKDOWN PARCEL with free gift of a desoldering pump, perhaps the most useful break-down parcel we have ever offered. Consists of 50 nearly all different computer panels on which you will find: over 300 ICs, over 300 diodes, over 200 transistors and many hundred other parts, resistors, condensors, multi turn pots, rectifiers, SCR etc. etc. for only **£8.50**, which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel. **+£1.27** VAT **+£2** post (it's a big parcel).

THERMOSTAT ASSORTMENT
10 different thermostats, 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits etc, or when fitted, say, in front of the element of a blower heater, the heat would trip the stat if the blower fuses, appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0-100°C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately these thermostats would cost around about £15.00 — however, you can have the parcel for **£2.50.**

12v MOTOR BY CROUZET — a powerful motor virtually impossible to stop by hand, size approx 2¼in long and 2½in dia. this is a permanent magnet field type so is reversible simply by changing polarity and has a relatively constant speed with or without load. Fitted out with a splined shaft which could directly engage a toothed gear wheel or to which a pulley could be attached. Ideal for large models, or small machines etc. **Price £3.95.**

12v MOTOR BY SMITHS INDUSTRIAL made for use in cars, these are series wound and become more powerful as load increases — they will in fact burn themselves out if over-loaded to stopping point — not polarity reversible — but if you are prepared to do a little unsoldering and rewiring then they will reverse at the flick of a switch. Being series wound they will also work off a.c. mains through a step down transformer and if you use a variable voltage type then the motor speed can be varied by the voltage. Size approx 3½in long by 3in dia these have a good length of ¼in dia spindle — **price £3.50.** Ditto out double ended **£4.**

MAINS OPERATED LOW SPEED MOTORS 2 watts type as fitted into time switches, machine controllers etc. We have a good selection and can offer the following final speeds: 1 r 24 hrs, 1 r 8 hrs, 1 r 4 h, 1 r h, 2 r h, 3 r h, 4 r h, 12 r h, 20 r h, 30 r h, 1 rm, 2 rm, 4 rm, 8 rm, 15 rm, 200 rm, all at **£2.85.**

SPIT MOTORS. These are powerful mains operated induction motors with gearbox attached, the final shaft is a ½in rod with square hole, so you have alternative coupling methods — final speed is approx. 5 revs per min. price **£5.25** post 60p — similar motors but with final speed 110 rpm and 80 rpm same price.

WALL MOUNTING THERMOSTAT by Danfoss has a really pretty two tone grey case with circular white scale and dial. Setting temperature from 0-30c — 13 amp 250v contacts. **Price £4.60.**

EXTENSION SPEAKER CABINETS. Teak look black front, size 11in x 8in x 4½in approx. **Price £2.00.** Post £1.00. (We have larger ones). If you can call and collect these these cabinets you can save yourself the quite considerable postage and you only have to buy a few to get a discount as well. The quantity discount for these is a special rate of 25% if you buy ten or more. Note these cabinets are very good quality (made for Rank Audio Systems) the grill material is Dacron.

MERCURY BATTERIES. Bank of 7 mercury cells type 625 which are approximately ⅝in dia. in plastic tube, giving a total voltage of 10.7. Being a plastic tube it is very easy to break up the battery into separate cells which could be used for radio control and similar equipment. Carton of 25 batteries **£1.15 + 85p** post.

HALF-PRICE CABLE OFFERS. We have good stocks of

Size mm	Type	Price 100 metres	Carriage
1.5	Single	£4.00	£1.75
1.5	Flat twin	£6.50	£2.75
1.5	Flat 3-core & E	£9.75	£3.50
4	Single	£7.50	
4	Flat twin	£11.50	£4.00
6	Flat 3-core	£32.50	£5.00
16	Twin & E	£79.00	£10.00

ONCE AGAIN IN STOCK ex-G.P.O. resistance bridge. It is in fact an electronic megger, which tests at a voltage of around 250, thus revealing any leaky points. These must have cost at least £150 each to make. In a portable light weight case, size approx 9in x 9in x 9in with a carrying handle. Has two moving coil panel meters which give clear readings of resistance from fractions of an ohm right up to 100 megs and then to infinity. We have two versions of these instruments 1) is as good as new and checked and tested before despatch price £22.50 + £3 38, post £2 50. 2) Secondhand models complete and believed to be in working order but not checked nor guaranteed, £12.50 + £1.87, post £2 50.

MAKING A CONVECTOR HEATER? We can offer a bank of four 1 KW metal clad elements all mounted on a 3in square iron plate. By comparatively simple switching 8 heat outputs ranging from approximately 250 watts to 4000 watts can be achieved. The elements which have push on tag connectors, extend to a length of approx. 17in from their mounting plate, so a relatively compact simple convector heater could be made using this. **Price £2.37** + post £1 50.

G.P.O HIGH GAIN AMP/SIGNAL TRACER. In case measuring only 5¼in x 3¼in x 1¼in is an extremely high gain (70DB) solid state amplifier designed for use as a signal tracer on GPO cables etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp etc. **An absolute bargain at only £1.85.** Suitable 80 ohm earpiece 69p.

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. **Price £11.50** + £2 50 post.

MOUTH OPERATED SWITCH. Made for washing machines to control water level etc. this is a sensitive low pressure device which operates three 1 pole changeover switches at different levels of pressure but all within a normal persons blowing capacity — blow gently into it and No. 1 switch operates, blow a little stronger and No. 2 operates, blow harder still and No 3 operates. The switch is airtight so the weight of water or other fluid substance could operate it. Undoubtedly a switch with very many applications. Disc type construction, this is approx 3¼in dia x 1⅛in thick — the air entry is a pipe approx 3/16in dia — electrical contacts we estimate a 10 amp c.o a 230 volt — connection by push on tags. Order ref. RS.4. **Price £2.88.**

BE PREPARED. For possible blackouts and interruptions in electricity supply this winter. Have some emergency lighting nearby. We still have the fluorescent outfits for operating 12in or 21in tubes from 12V car battery and the price is **£4.65** 80p post complete with tube, please state which.

BLEEPERS 6 or 12v battery or transformer operated, ideal for using in most alarm circuits but for car and motor cycle alarms. These give a loud shrill note. American made by Delta Alarm. **Price 87p.** Large quantities available.

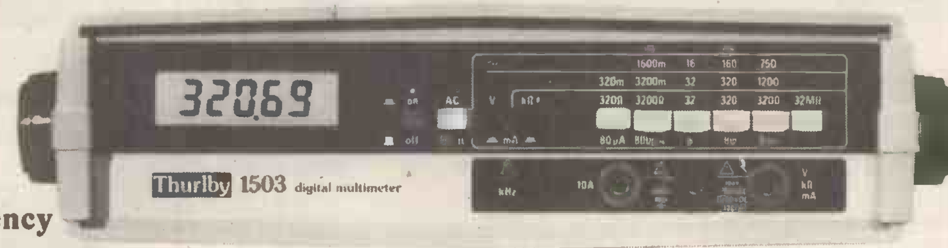
MOTORIZED LIGHT FLASHER. Christmas is coming, so you've got to think about your decorative lighting, to make this flash we can offer two motorized units both capable to 2000 watts of light. One ½ second flasher changes every ½ second and the 2 second flasher changes every 2 seconds. **Either type £6.90.**

TRANSMITTER SURVEILLANCE
Tiny, easily hidden but which will enable conversions to be picked up with FM radio. Can be made in a matchbox — all electronic parts and circuit **£2.00.**

RADIO MIKE
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. **£6.50.**

NEW! Thurlby 1503 high resolution multimeter £139 + VAT

Greater resolution, greater accuracy, and greater versatility



- 4¾ digits (±32,768 counts)
- 10uV, 10mΩ, 1nA resolution
- 0.05% basic DCV accuracy
- LCD, fully field portable
- 7 functions including Frequency
- Outstanding price/performance ratio

Thurlby 1503 designed and built in Britain

Thurlby Electronics Ltd.
Coach Mews, St. Ives, Huntingdon, Cambs.
PE17 4BN. ENGLAND. Tel: (0480) 63570

WW — 111 FOR FURTHER DETAILS

VALVES
All Brand New. Not Ex Equip.

EB91	£0.95	PL504	£.165
ECF82	£.120	PL508	£2.00
EF92	£3.50	PL509	£3.50
PCL82	£1.15	PL519	£3.60
PCL84	£1.15	PY88	£.095
PCL85	£1.24	500A	£2.00
PCL86	£1.24	6V6GT	£.165

HIFI CHASSIS SPEAKERS
3in 8ohm 40w 1300-20KHz £3.00 + 50p P&P
5in 8ohm 15w 50-8KHz £5.25 + £1 P&P
6½in 8ohm 20w 40-2KHz £5.75 + £1. P&P

LOW COST CHASSIS SPEAKERS
6" 8ohm £2.00 + £1 P&P
6"x4" 4ohm £3.25 + £1 P&P
5½"x2¾" 3ohm £1.25 + 60p P&P

B.P.O. APPROVED Nylon cased metallised polyester capacitors.
8017A Series. .01uf, .015uf, .022uf, .033uf, .047uf, .068uf, 0.1uf, 15uf, 22uf, 33uf, 47uf, 68uf, 1 0uf 2.2uf.
8017B Series. .015uf, .022uf, .033uf, .047uf, .068uf, .15uf, .22uf, .33uf.
Price on application

LOW VOLTAGE ELECTROLYTICS

6.3v	22uf	16v	33uf
6.3v	33uf	16v	100uf
6.3v	47uf	16v	1000uf
6.3v	100uf	16v	2200uf
6.3v	330uf	25v	1000uf
10v	33uf	35v	2.2uf
10v	47uf	35v	33uf
10v	100uf	35v	100uf
10v	330uf	50v	0.47uf
10v	1000uf	50v	1'uf
10v	3300uf	50v	3.3uf
16v	10uf	50v	22uf
16v	22uf	50v	33uf.

6.3v, 10v & 16v. ALL AT 10p. 25v 12p, 35v 15p, 50v 15p.
Special prices for quantity. Buyers and Manufacturers.

Protect that expensive equipment with a resetable thermal overload cutout.
Trip current 2.5A, 4A, 8A.
Press to reset £1.25 ea.

We have 1 million resistors, assorted values and wattages. **£1000** will buy the lot.

PHILIPS 10 Button Universal Intercom telephone, attractive two tone grey and brown cradle type, complete with junction box. **£7.50** ea. + £1 P&P. Ideal for small offices.

Super quality 7" Reel to Reel Scotch brand empty spools. **£3** for 10 + 50p P&P.

Terms C.W.O. Add 15% V.A.T. Trade & Export enquiries welcome.

Electronic Equipment Co. Ltd.
SPRINGFIELD HOUSE
TYSSEN ST.
LONDON E8 2ND
PHONE 01-249 5217
TELEX 8953906 EECO G.

We cannot advertise all we sell, for real bargains visit our warehouse and trade counter during the hours of 9 a.m. to 5 p.m. Monday to Friday. You will find us BEHIND DALSTON LANE POLICE STATION. All enquiries treated with prompt attention.

WW — 105 FOR FURTHER DETAILS

reprints

If you are interested in a particular article/special Feature or advertisement published in this issue of

WIRELESS WORLD

why not take advantage of our reprint service.

Reprints can be secured at reasonable cost to your own specifications providing an attractive and valuable addition to your promotional material. *(Minimum order 250.)*

For further details contact
Brian Bannister, IPC Electrical-Electronic Press Ltd. Phone 01-661 8162 or simply complete and return the form below.

To Brain Bannister, Reprints Department
Quadrant House, The Quadrant
Sutton, Surrey SM2 5AS

I am interested in .... copies of the article/advertisement headed .... featured in.

WIRELESS WORLD

on page(s) .... in the issue dated ....

Please send me full details of your reprint service by return of post.

Name ....
Company ....
Address ....
.... Tel. No. ....

DT-400s are designed and manufactured by SAFGAN in UK

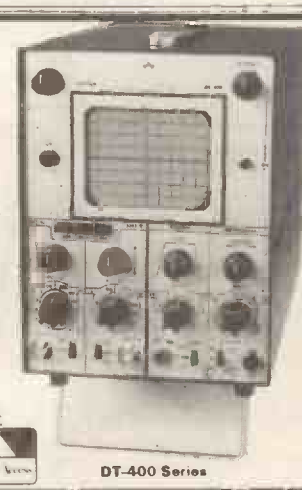
SAFGAN presents DT-400 series from £159 + V.A.T.

HIGH-QUALITY DUAL TRACE OSCILLOSCOPES
A BRITISH PRODUCT EVERYONE CAN AFFORD

Model DT-410 DUAL TRACE 5mv/div 10MHz @ **£159** + VAT
Model DT-412 DUAL TRACE 5mv/div 12MHz @ **£172** + VAT
Model DT-415 DUAL TRACE 5mv/div 15MHz @ **£185** + VAT

SPECIFICATION FOR ALL MODELS

- ★ CH1, CH2; 5mv/div — 20v/div in 12 cal 1-2-5 steps. Input impedance 1MΩ + 22pF
- ★ BANDWIDTH: 10MHz (DT-410), 12MHz (DT-412) 15MHz (DT-415)
- ★ TIME BASE: 0.5μs/div—200ms/div in 18 cal steps X5 Expansion to 100 ns/div X5 Multiplier to 15/div
- ★ XY FACILITY: Matched Inputs X = CHI, Y = CH2
- ★ TRIGGER: Level Control, ± Slope, Bright Line AUTO, NORMAL, TV Triggering CHI, CH2 0.5 div, EXT Trig 100mv
- ★ Z Modulation
- ★ Cal output/probe compensation.
- ★ Graticule blue ruled 8 × 10 div (6.4 × 8cm²)
- ★ SIZE: H215mm W165mm D280mm Weight 4.5 kg. PROBE (XI—REF—X10) **£11.50** + V.A.T.



DT-400 Series

Orders to: **SAFGAN ELECTRONICS LTD.** (Goods + 15% + £3 p. & p.)
56 Bishop's Wood, St. John's, Woking, Surrey, GU21 3QB Tel: Woking 69560 or Woking 66836
Official Government and Educational Orders accepted. Distributors required — please enquire

WW — 082 FOR FURTHER DETAILS

ELECTRONIC GILT-EDGED USED

A.C. VOLTMETERS

BOONTON
True R.M.S. Voltmeter 93A £375
FLUKE
AC/DC Differential Voltmeter 883AB £975
HEWLETT PACKARD
Log Voltmeter/Amplifier 7563A £325
MARCONI INSTRUMENTS
A.C. Voltmeter 400EL £225
Valve Voltmeter TF 2600 £175
Valve Voltmeter TF 2604 £250
R.F. Millivoltmeter TF 2603 £525
PHILIPS
A.C. Millivoltmeter PM2454B £225

ANALYSERS

BIOMATION
Logic Analyser 1650D £3600
GENERAL RADIO
Vibration Analyser 1911A £1750
HEWLETT PACKARD
Distortion Analyser 331A £450
Spectrum Analyser 141T c/w 8552A & 8554L £4350
Network Analyser System 8407A+8412A c/w 8600A+8601A Sweep Marker Generator 100KHz-110MHz range. £3500
Swept Amplitude Analyser 182T+8755A 15MHz-18GHz. £2500
TEKTRONIX
1L5 Spectrum Analyser Plug in £850

BRIDGES

AVO
Electrolytic Capacitance Bridge CB154/4 £500
BOONTON
VHF 'Q' Meter. 280AP. (210-610 MHz) £650
Inductance Bridge 63H £2750
GENERAL RADIO
Immitance Bridge 1607A £750
MARCONI INSTRUMENTS
'Q' meter TF1245 c/w TF1246 and TF1247 £950
RHODE AND SCHWARZ
Inductance Meter LRT £475
Capacitance Meter KRT £475
WAYNE KERR
A.C. Testamatic A60 £900
Universal Bridge B221 (0.1%) £225

D.V.M.s AND D.M.M.s

DATRON
5½ digit D.V.M. 1051 £995
FLUKE
3½ digit D.M.M. 8020A £99
5½ digit D.M.M. 8800A £495
5½ digit D.M.M. 8800A-01 £575
HEWLETT PACKARD
5½ digit D.M.M. 1µV resolution 3490A £515
PHILIPS
Autoranging D.M.M. PM 2514 £125
4 digit D.M.M. PM 2524 £225
Autoranging D.M.M. PM 2527 £400
SCHLUMBERGER
5½ digit D.M.M. A243 £425
Microprocessor D.M.M. 7065 £950
As above with processor option £1250
Microprocessor D.M.M. 7055 £850
As above with processor option £1150

FREQUENCY COUNTERS

ADVANCE
500MHz Counter TC 15 & TC 15 P1 £495
FLUKE
250MHz Multifunction Counter 1911A-01 £325

HEWLETT PACKARD

Generator/Sweeper 8601A c/w Marker Generator 8600A 100KHz-110MHz 5 Marker Freqs

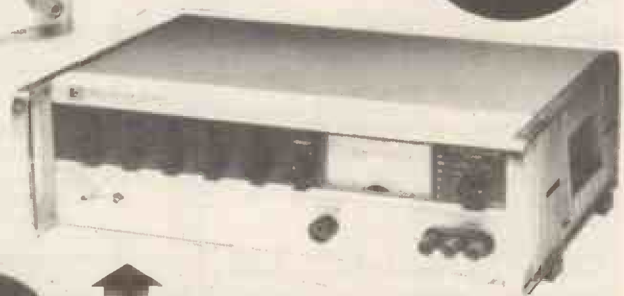
OUR PRICE **£1,500**

MARCONI INSTRUMENTS

M.F. Attenuator TF 2162 DC-1MHz 0-111 dB 600Ω

QUICK DELIVERY— QUANTITIES AVAILABLE FULL WARRANTY

NEW PRICE £300 OUR PRICE **£115**



HEWLETT PACKARD

Digital Oscillator 4204A 10Hz-1MHz 0.2% Freq. accuracy. Accurate 80 db output attenuator Flat freq. response. Provides accurate stable test signals for laboratory or production use

NEW PRICE £1018 OUR PRICE **£715**

AVO

Multimeter Model 8 Mk V superb condition and fully calibrated (Supplied without leads) QUANTITIES AVAILABLE — EX-STOCK DELIVERY

NEW PRICE £104 OUR PRICE **£70**

Electronic Brokers Ltd., 61-65 King's Cross Road, London WC1X 9LN. Tel: 01-278 3461. Telex: 298694

Unless otherwise stated all equipment offered in the Electronic Brokers advertisement is refurbished and in the case of Test Equipment also calibrated. Test equipment is guaranteed for 12 months; computer peripherals for 3 months.

BROKERS EB

TEST EQUIPMENT

500MHz Multifunction Counter 1912A £395
125MHz Multifunction Counter 1925A £350
PHILIPS
520MHz Univ. Counter/Timer PM6614 £395
80MHz. Freq. Counter PM6664 £250

OSCILLOSCOPES

COSSOR
4100 75MHz Portable Dual Trace, Delayed Sweep. 30-day warranty. **Only £450**
HAMEG
HM 312-7 DC — 10MHz Dual Trace (New) £200
HEWLETT PACKARD
75 MHz Dual Trace 1707A £600
High Sensitivity Single Trace 130C £250
1707B 75MHz Portable Dual Trace, Delayed Sweep, 30-day warranty **Only £650**
MARCONI INSTRUMENTS
X-Y Display TF 2213/1 c/w Memory Unit TK 2214 £790
PHILIPS
25MHz Dual Trace PM 3212 £625
PM3260E 120MHz Dual Trace, Delayed Sweep **1 Only £975**
S.E. LABS
6 Channel Monitor SM121 £395
TEKTRONIX
465 100MHz. Spec. similar to 465B but no alternate sweep. £1195
35MHz Dual Trace T932 £550
W. Diff. Plug In £295
1A6 Plug In £199
TELEQUIPMENT
D75 50MHz Portable Dual Trace, Delayed Sweep **2 Only £715**

RECORDERS

BRYANS SOUTHEERNN
40000 12 channel UV Recorder plus 2 Off 40501 galvo amps. 6" chart width. Grid and timing lines. Superb condition £950
PHILIPS
Single Channel Recorder PM 8110 £195
RACAL
Store 4 FM Tape Recorder, 4 tracks DC-20KHz, 7 speeds. £1950
S.E. LABS
3006 12 channel UV Recorder. 6" chart width. Grid and timing lines £550
6012 50 channel UV Recorder 12" chart width. Servo paper drive up to 5 Mtr/Sec. Two event markers. Trace identification **1 Only £1100**
WATANABE
6 Channel Chart Recorder MC 641 £2250
YOKOGAWA
Chart Recorder 3047 £450

SIGNAL SOURCES

HEWLETT PACKARD
H.F. Signal Generator 606B £1500
AM/FM Signal Signal Generator 8640B (Opt. 002) 0.5-1024MHz £3650
Variable Phase, Sine and Signal Generator 203a £495
Oscillator 10Hz-10MHz 651B £415
V.H.F. Oscillator 3200B £400
U.H.F. Signal Generator 612A £850
V.H.F. Signal Generator 608F £450
Phase Lock Synchroniser 8709A £475
RF Sweeper/Marker Generator 8600A + 8601A, 100KHz-110MHz. 5 marker frequencies. £1500
MARCONI INSTRUMENTS
AM/FM Signal Generator TF 995B/2 (0.2 to 220MHz) £675
A.F. Oscillator TF 2000 £325
A.F. Oscillator TF 2100 £150
A.M. Signal Generator. TF801D/8S £550
L.F. Oscillator TF 2102/1M1 £195
U.H.F. Signal Generator TF1060/3 £650
Two Tone Source TF 2005R £295
H.F. Generator TF 144H/4 £750
TF2002B AM/FM Signal Generator. 10KHz-82MHz. **1 Only £1200**
PHILIPS
Function Generator PM 5108 £250
Function Generator PM 5127 £395
Function Generator PM 5167 £500

TELONIC

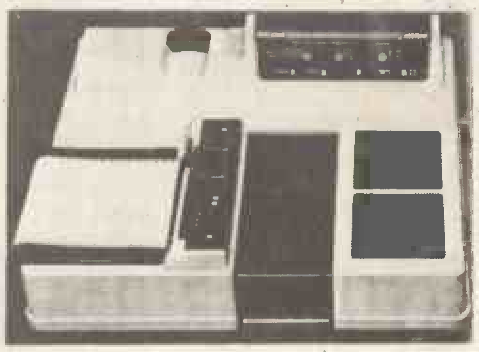
R.F. Sweeper 2003 c/w 3302, 3331, 3341, 3351, 3360, 3370 (1-300MHz) £1150

MISCELLANEOUS

ADVANCE
Constant Voltage Transformer CVN 1000A £65
Off Air Frequency Standard OFS 2B £95
AVO
Valve Tester VCM 163 £475
BRADLEY
AC Calibrator 125B £475
DC Calibrator 126B £250
BRUEL KJAER
Sound Level meter 2203 & Microphone 4145 £395
DATALABS
Power Line Disturbance Monitor DL019 £175
FLUKE
DC Differential Voltmeter 895A £950
332A DC Voltage Calibrator 0.003% Calibration Accuracy 0.1PPm resolution £1750
GENERAL RADIO
Sound Level Meter 1933 £1000
Cassette Recorder 1935
Recording Sound and Vibration Analyser 1911A £1250
HEWLETT PACKARD
DC Microvolt-ammeter 425A £250
AC/DC Differential Voltmeter 741B £695
Vector Impedance Meter 4815A £1950
S Parameter Test Set. 8745A £2750
Insulation Resistance Meter 4329A £500
MARCONI
A.F. Power Meter TF 893A £185
Transmission Test Set TF 2332 £425
Transmission Test Set TF 2333 £600
P.C.M. Regenerator Test Set OA 2805A £2700
P.C.M. Multiplex Tester TF 2807A £1500
RHODE AND SCHWARZ
Stereocoder MSC £850
S.E.I.
Super 50 Selectest £77
SIEMENS
Carrier-Freq. L.M.S. D2021/W2021/G2021 10KHz-25MHz £1700
Level Measuring System. D2074/W2074/G2006 £2600
Carrier Frequency Level Test Set W2007+D2007, 6KHz-18.6MHz. £1750
TEKTRONIX
Pulse Generator 2101 £420
TM515 Main Frame c/w FG504 0.001Hz-40MHz function generator. 2 Off PS503A Triple Power Supplies. £1250
TM515 Main Frame c/w SC502 15MHz Oscilloscope. FG503 1.0Hz-3MHz Function Generator. DM502 3½ digit DMM. DC503 100MHz Counter £1495
WANDEL & GOLTERMAN
Andimat (2MHz system) £9500
Pattern generator PFG-1 £995
Digital Error Detector PFM-1 £1495
WAVETEK
Sweep Generator 135 £275
Programmable Phase Meter 755 £550

POWER SUPPLIES

ADVANCE
PMA47. 0-15V @ 3A (Presetable). £37
PMA 50. 0-15V @ 5A (Presetable). £45
PMA 53. 0-15V @ 10A (Presetable). £65
MG 5-60 5V @ 60A (Switching). £160
MG 5-20 5V @ 20A (Switching). £120
MG 5-10 5V @ 10A (Switching). £95
MG24-12 24V @ 12A (Switching). £130



Only 9 months old SP3 — 200A Infrared Spectrophotometer.

Pye Unicam. Ratio Recording Type. Still under warranty. Current List Price £5150.
ONLY £3950
Also available 15 ton hydraulic Press with Safety Guard S.

ONLY SMALL SELECTION OF OUR VAST STOCKS SHOWN HERE

12-MONTH WARRANTY

All Second User Test Equipment is fully guaranteed for 12 months unless otherwise stated.

Electronic Brokers Ltd., 61-65 King's Cross Road, London WC1X 9LN. Tel: 01-278 3461. Telex: 298694.

Hours of Business: 9 a.m.-5 p.m., Mon.-Fri. Closed lunch 1-2 p.m.
Add 15% VAT to ALL PRICES

A copy of our trading conditions is available on request.
Carriage and Packing charge extra on all items unless otherwise stated.

WW — 041 FOR FURTHER DETAILS

ELECTRONIC

GILT-EDGED USED

DEC EQUIPMENT

DEC MEMORY — BARGAIN OFFER

MM11DP 16KW core (ex DEC-maintained 11 34 systems)ONLY **£395.00**
DD11-CK 4-slot backplane (11/34) . . . **£175.00**
H775-C8 Battery Back-up . . . **£525.00**
KA8E Positive I/O (8E) . . . **£95.00**
KD8E Databreak (8E) . . . **£145.00**
KL8JA Asynchronous I/O (BE) **£275.00**
KL8E Asynchronous I/O (8E) . **£250.00**
KP8E Power Fail (8E) . . . **£95.00**
LAII-PD 180 cps matrix printer **£1250.00**
M7850 Parity Controllers . . . **£185.00**
MF11L 8KW Core including 9-slot system unit . . . **£975.00**
MM11LP 8KW Parity Core . . **£750.00**
MM11YP 32KW Core Memory **£1750.00**
MSV11C 16KW MOS Memory (LSI11) . . . **£495.00**
MS11JP 16KW MOS Memory **£895.00**
PDP11/34 Processor, 10½'' chassis, 128KW MOS, DL11W, KY11B **£6950.00**
PDP11/40 Processor with 32KW parity core, KT11D Memory Management, DL11 Interface 6ft cabinet . . . **£4950.00**
PR11 High speed reader & control . . . **£925.00**
REV11 Bootstrap (LSI11) . . . **£75.00**
RK05F Add-on disk drive . . . **£2250.00**
VT55-FB Graphics Terminal with integral hard copy . . . **£1850.00**
PDP8E Series modules — large stocks of option modules, add-on core, CPU boards etc. all at reduced prices.

PDP11/04 PROCESSOR

10½in chassis. 16KW MOS DL11W. BRAND NEW **£4,500.00** (Can be enhanced to 28KW).

SCOOP BULK PURCHASE OF HAZELTINE VDUs

HAZELTINE H1000 VDU

12 x 80 Display Upper Case ASCII RS232 Interface Choice of Baud Rates
SUPER VALUE

£199 + VAT 30-day warranty

HAZELTINE H2000 VDU

Superb spec including full XY Cursor Addressing and edit facility, 27 x 74 Display.
Upper Case ASCII RS232 Interface Switch-Selectable Baud Rates

£299 + VAT 90-day warranty

HAZELTINE MODULAR ONE VDU

Now with Upper/lower case, XY Cursor Addressing
24 x 80 line display. Upper/Lower Case ASCII. Detachable Keyboard. RS232 Interface. XY Cursor addressing.

£399 + VAT 90-day warranty

Electronic Brokers Ltd., 61-65 King's Cross Road, London WC1X 9LN. Tel.: 01-278 3461. Telex: 298694.

Unless otherwise stated all equipment offered in the Electronic Brokers advertisement is refurbished and in the case of Test Equipment also calibrated. Test equipment is guaranteed for 12 months; computer peripherals for 3 months.

BROKERS
COMPUTER EQUIP

PRINTERS

CENTRONICS 101A

Heavy Duty Matrix Printer with 64 ASCII upper case character set. 165 cps operation. 132 print positions with adjustable tractor feed. 7 x 9 dot matrix, parallel input.
£750.00

ASR 33 TELETYPE

Input/Output terminal incorporating paper tape punch and reader. 64 ASCII upper case character set. 110 baud operation, even parity keyboard choice of RS232 or 20mA interface. **NOW ONLY £595.00.** Options: ICL-type keyboard £50.00. 8th level marking £25.00. Remote reader control £50.00. Reader step £20.00. Auto reader £25.00. Pedestal £30.00.

GE TERMINET 1200 RO Printer, 80 columns, tractor feed, upper/lower case, ASCII, 20mA Interface **£325.00**

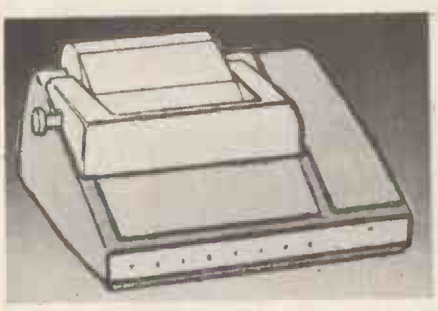
HAZELTINE THERMAL PRINTER, 80 column 30 cps silent RO printer with parallel TTL input **£395.00**

TALLY 1602 MATRIX PRINTER, Parallel Input, Upper/lower case, Tractor feed, as new **£995.00**

TERMIPRINTER 7075 RO Impact Printer, Upper/lower case, pin-feed, RS232 **£275.00**

TEXAS 725 Portable Terminal with acoustic coupler **£625.00**

TEXAS 733 ASR Terminal **£1375.00**



LOW COST PRINTER OFFER

Teletype 33 printer mechanism including case but no keyboard or electronics, 64 upper case ASCII 10 cps Pinfeed platen, ideal for the electronic hobbyist. .... **only £85.00**

MISCELLANEOUS

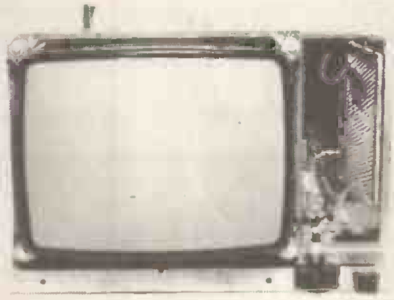
DIGITRONICS P135 paper tape punches. 35 cps. Solenoid device with 27VDC coil **£95.00**

FACIT 4070 Paper Tape Punch **£675.00**

HEWLETT PACKARD PROGRAMMABLE CALCULATOR MODEL 9830A

8K Memory. Extended I/O ROM. String Variables ROM 4. Peripheral interfaces (1 serial, 3 parallel). .... **PRICE £1995.00**

MONITORS



EMI MONITOR

15in Diagonal Tube Integral Power Supplies accepts composite or separate video input. **BRAND NEW SURPLUS.** Price **£100.00.**

BALL MIRATEL TTL15

15in Diagonal green phospher tube. Integral power supply. Requires separate horizontal and vertical video input. **BRAND NEW SURPLUS** **£75.00**

NEW CATALOGUE JUST OUT
Send for FREE COPY

NEW ASCII KEYBOARDS — NEW LOW PRICES

KB 771 Superb 71-station ASCII Keyboard incorporating separate numeric/cursor control pad and installed in custom-built steel enclosure with textured blue enamel finish. Ideal for the VDU builder. Case dimensions 17¼" × 7½" × 3⅝". Total weight 4kg. PRICE **£89.50** (mail order total £108.10).

		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	£49.50	**£58.65**
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	£18.00	**£23.00**
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**
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

90-DAY WARRANTY

SECOND-USER PRINTERS AND TERMINALS ARE COVERED BY FULL 90-DAY PARTS AND LABOUR WARRANTY UNLESS OTHERWISE STATED.

All Prices subject to carriage and VAT

Electronic Brokers Ltd., 61-65 King's Cross Road, London WC1X 9LN. Tel.: 01-278 3461. Telex: 298694

Hours of Business: 9 a.m.-5 p.m., Mon.-Fri. Closed lunch 1-2 p.m.
Add 15% VAT to ALL PRICES

A copy of our trading conditions is available on request.
Carriage and Packing charge extra on all items unless otherwise stated

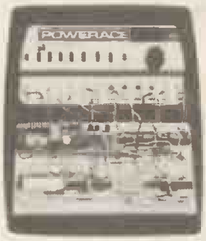
WW — 042 FOR FURTHER DETAILS

WIN THE MOST EXPENSIVE BREADBOARD IN THE WORLD AND OTHER PRIZES

ON AP STAND NOS D10 AND E10 AT BREADBOARD 80

BREADBOARD 1980 NOV 26–Nov 30th ROYAL HORTICULTURAL HALLS ELVERTON ST. LONDON.

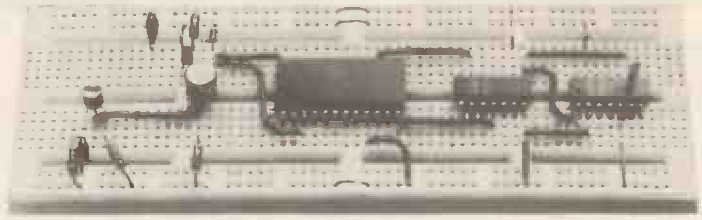
POWERACE THE MOST EXPENSIVE BREADBOARD IN THE WORLD



Three poweraces that give you the ultimate in breadboarding. Built in power supplies and a **FREE** logic probe is built into MODEL 102

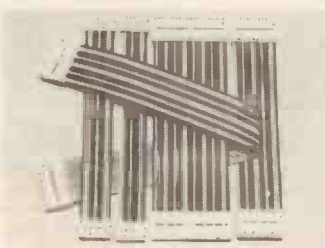
POWERACE 101	923221	**£61.30**
POWERACE 102	923222	**£95.80**
POWERACE 103	923223	**£95.80**

SUPERSTRIP SS2 THE BIGGEST SELLING BREADBOARD IN THE WORLD



When you buy a **SUPERSTRIP BREADBOARD** you buy a breadboard to last you for ever, we give you a LIFETIME guarantee. **SUPERSTRIP** is the most used breadboard by hobbyists, professionals and educationalists because it gives you more for you money ... With 840 contact points **SUPERSTRIP** accepts all DIP's and discrete components and with eight bus bars of 25 contact points each **SUPERSTRIP** will take up to nine 14-pin DIP's at any one time.
You should only buy a breadboard once so buy the biggest seller with a lifetime guarantee.
SUPERSTRIP SS2 923252 PRICE INCL VAT £9.78

DIP-DIP-DIP-DIP-DIP JUMPERS
AP DIP JUMPERS ARE THE LOWEST PRICE IN THE UK



- EX-STOCK DELIVERY
- 5 STANDARD LENGTHS 6, 12, 18, 24, 36"
- WITH 14, 16, 24, 40 CONTACTS
- FULLY ASSEMBLED AND TESTED
- INTEGRAL MOULDED ON STRAIN RELIEF
- LINE BY LINE PROBEABILITY

SINGLE-ENDED

CONTACTS	24"
14	£1.67
16	£1.89
24	£2.74
40	£4.38

DOUBLE-ENDED all prices 1–9 off. Huge discounts for quantity

CONTACTS	6"	12"	18"	24"	36"
14	£2.11	£2.21	£2.31	£2.43	£2.63
16	£2.33	£2.45	£2.58	£2.66	£2.97
24	£3.45	£3.62	£3.78	£3.94	£4.30
40	£5.31	£5.61	£5.91	£6.22	£6.81

We can supply DIP, SOCKET, PCB, CARD-EDGE in any style any quantity ask for free catalogue.

TEST-CLIP TEST-CLIP

Clip an **AP TEST-CLIP** over an IC and you immediately bring up all the leads from the crowded board into an easy working level.
22 NEW AP TEST-CLIPS TO PICK FROM

examples:

TC 14	923695	**£2.76**
TC 16	923700	**£2.91**
TC 24	923714	**£8.50**
TC 40	923722	**£12.88**

NEW The NEW Modular Circuit Building System

EB80

Until now hobbyists had to buy professional solderless breadboards for their projects and pay professional prices. But now there's EBBO a brand new total breadboarding system thats not only economically priced but offers far more advantages to hobbyists and schools. At the core of the system are two starter packs, one for discrete component projects, the other for integrated circuit (IC) projects. Each starter pack comes with a number of EBBO system modules fitted into a tray and an illustrated booklet which guides you step by step in building ten projects. Building a project is simple because the modules are colour-keyed and letter/number indexed and because EBBO is expandable, you can add to your system as many of the available compatible modules. For schools and beginners we have a complete step by step approach to teach yourself electronics consisting of five basic electronics books and the discrete starter pack. So come along to BREADBOARD 80 and build some projects yourself.

BASIC INTEGRATED CIRCUIT STARTER PACK

The IC Starter Pack includes two terminal strips, two distribution strips and a spacer/support strip already in an EBBO tray, ready for use. A free project booklet containing ten IC projects with step-by-step instructions completes the pack.

IC-1 Starter Pack £4.24

BASIC DISCRETE COMPONENT STARTER PACK

This Starter Pack contains a tray, discrete component strip, battery holder and connecter and project booklet with ten projects.

DC-1 Discrete Starter Pack £4.67

All prices shown are recommended retail incl. VAT
In difficulty send direct, plus 50p P & P.
Send S.A.E. for a free copy of colour catalogues detailing our complete range.

AP PRODUCTS, PO BOX 19, SAFFRON WALDEN, ESSEX, (0799) 22036

WW — 118 FOR FURTHER DETAILS

COMPUTER WAREHOUSE

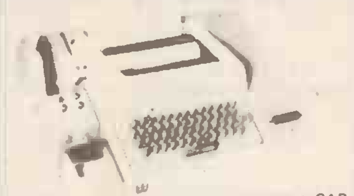
NOW OPEN
MONDAY-SATURDAY
9.30-5.30

In stock now test equipment, microprocessors, teletypes, transformers, power supplies, scopes, sig. gen's, motors, peripheral equipment, I.C.'s, tools, components, variacs, keyboards, transistors, microswitches, V.D.U's sub-assemblies + thousands of other stock lines. Just a mere fraction of our vast range, is displayed below: 100's of bargains for callers.

★ RAM AND EPROM STAR OFFERS ★

2716 Single 5v rail EPROMS	£10.25
2716 Three rail EPROMS	£ 8.50
2708 EPROMS	£ 4.95
4116 16k x 1 200 n s RAMS 8 for	£28.50

TELETYPE ASR33 I/O TERMINALS



£235 + CAR + VAT

Fully fledged industry standard ASR33 data terminal. Many features including: ASCII keyboard and printer for data I/O, auto data detect circuitry, RS232 serial interface, 110 baud, 8 bit paper tape punch and reader for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order. Options: Floor stand £12.50 + VAT Sound proof enclosure £25.00 + VAT

ICL TERMIPRINTER 300 BAUD TERMINALS

£325 + CAR + VAT

Made under licence from the world famous GE Co. The ICL Termiprinter is a small attractive unit with so many features it is impossible to list them in the space available! Brief spec. as follows; RS232 serial interface, switchable baud rates 110, 150, 300, (30 cps), upper and lower case correspondence type face, standard paper, almost silent running, form feed, electronic tab settings, suited for word processor applications plus many more features. Supplied in good condition and in working order. Limited quantity.

SCOOP PURCHASE 9" VIDEO MONITORS

ONLY £57.50 + VAT

Made by the famous MOTOROLA CO. The 9" video monitor type XM226-16 is a self contained unit featuring a quoted bandwidth of 10Hz to 10MHz with 800 lines resolution at the screen centre. The printed circuit board and power transistors are both plug-in for ease of servicing. All controls are easily accessible from the rear. By connection of any 75Ω composite video signal and 12v D.C. you have a professional monitor to do any MPU/CCTV system proud!
Supplied BRAND NEW complete with circuits at only £57.50 + VAT
Specialist carriage and insurance £7.50 + VAT.

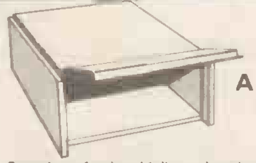
EX STOCK SOFTY

SOFTWARE DEVELOPMENT SYSTEM, INVALUABLE TOOL FOR DESIGNERS, HOBBYISTS ETC.
Enables "open heart surgery" on 2708, 2716, etc, Blows, Copies, Reads EPROMS or emulates EPROM/ROM IN-SITU whilst displaying contents off ROM/RAM on a domestic TV receiver. A host of other features.
Write or phone for more details.

£115 + VAT & CARR
PSU £20 + VAT

You'll never regret buying a SOFTY!

EQUIPMENT CASES

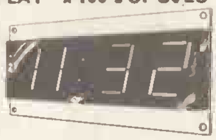


GIVE YOUR M.P.U. A HOME ONLY £9.95 + 1.85 pp

Superb professional fully enclosed, made for the G.P.O. to the highest standard, offered at a fraction of their original cost they feature aluminium slides, hinged removable front panel, which can be secured by 2 screws to prevent prying fingers. All are finished in two tone G.P.O. grey and although believed brand new may have minor scuff marks/scratches due to bad storage. Dimensions 16"D x 6½"H x 14¾"W

LED DIGITAL ALARM CLOCK MODULE

★12 HOUR ★50/60 HZ ★LARGE DISPLAY ★100's OF USES



The same module, NATIONAL MA1012, used in most alarm clock/radios on the market today, the only difference is our price! GIANT ½" LED characters give extremely clear viewing and readability. All electronics are self-contained on a P.C.B. measuring only 3" x 1¼". By addition of a few switches and 5/16 volts A.C. you have a multi-function alarm clock at a mere fraction of cost. Dozens of functions include snooze timer, am-pm, alarm set, power fail indicators, flashing seconds cursor, modulated alarm output, dimmer control, etc, etc, Supplied brand new with full data at only £5.25
suitable transformer for mains operation £1.75

BRAND NEW 8" FLOPPY DISK DRIVES

SHUGART SA800 £225.00 + carr + VAT
SHUGART SA801 £245.00 + carr + VAT

5v D.C. POWER SUPPLIES

Following the recent "SELL OUT" demand for our 5v 3 amp P.S.U. we have managed to secure a large quantity of ex-computer systems P.S.U.'s with the following spec.; 240 or 110v A.C. input. Outputs of 5v @ 3-4 amps, 7.2v @ 3 amps and 6.5v @ 1 amp. The 5v and 7.2v outputs are fully regulated and adjustable with variable current limiting on the 5v supply. Unit is self contained on a P.C.B. measuring only 12" x 5" x 3". The 7.2v output is ideal for feeding "on board" regulators or a further 3 amp LM323K regulator to give an effective 5v @ 7 amp supply.
Supplied complete with circuit at only £10.95 + £1.75pp.
Believed working but untested, unguaranteed.

MAKE YOUR COMPUTER TALK!!!

VIA OUR EX-GPO MODEM UNITS

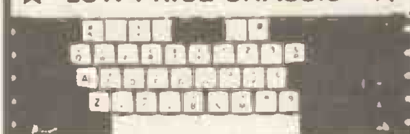
Well, not exactly talk, but communicate over a standard dial-up G.P.O. line with any other modem. The modem unit 2A is housed in an attractive fibre glass case measuring only 15" w x 13" d x 5" h, inside are the electronics and mains power supply which enable serial duplex data communication between terminal-computer etc. at any speed up to and in excess of 250 baud (300 at a push). Made to the most stringent, exacting specification for the G.P.O. These units feature Modular plug in P.C.B.'s, internal test points, Standard tone frequencies, Configureable to terminal or computer end, Auto unattended answer, RS232/V24 interface on standard 25 way 'D' socket, etc. etc., supplied complete with diags., at a fraction of their original cost at only £55.00 + £4.50 CARR.
NOTE: Units believed working, but untested, unguaranteed. Permission may be required for connection to G.P.O. lines

Save Over £1200!! Logabax DZM180 High Speed Matrix Printers

This must be one of our greatest bulk saving deals this year. This fabulous printer is listed at over £1800 and judging by the quality workmanship we are not surprised. The Logabax DZM180 Matrix printer, capable of printing up to 132 characters per line on any size (via variable tractor unit) sprocket fed fanfold paper. A precision matrix head utilising ruby bearings gives exceptionally clear uniform legible characters via standard ribbon. Many other features include internal buffer, for high throughput, in excess of 180 characters per second, software controlable form and tab functions, standard TTL parallel interface, etc. etc.
Supplied brand new and boxed at only
£599.00 plus VAT*
Optional extras
Floor stand (as picture) £30.00 plus VAT Paper handler £18.00 plus VAT
*Carriage — please enquire for specific quote.

KEYBOARDS

★ LOW PRICE CHASSIS ★



A special bulk purchase enables us to offer the above keyboard at a lowest ever price 49 coded keys encoded into a direct TTL compatible 7 bit output. Features such as delayed strobe, 5 volt DC single rail operation and rollover protection make this an absolute must for the MPU constructor! Supplied complete with connection diagram and edge connector, at a secondhand "no time to test" price of only £20.00 + P.P. £1.60

SUPER CASED VERSION Same as above spec but housed in attractive two tone moulded, free standing case. Unit also includes an all TTL parallel to serial convertor (no details) etc. £27.50 + P.P. £1.85

SEMICONDUCTOR 'GRAB BAGS'

Amazing value mixed semiconductors, include transistors, digital, linear I.C.'s, triacs, diodes, bridge recs. etc. etc. All devices guaranteed brand new, full spec. with manufacturers markings, fully guaranteed.
50 + BAG £2.95 100 + BAGS £5.15

MUFFIN FANS

Keep your equipment Cool and Reliable with our tested ex-equipment "Muffin Fans" almost silent running and easily mounted. Available in two voltages. 110 V.A.C. £5.85 + pp 90p OR 240v A.C. £6.15 + pp 90p DIMENSIONS 4½" x 4½" x 1½".

THE "MULTIVOLT" MULTI RAIL P.S.U.

This has got to be the power supply to end all your M.P.U./LAB supply requirements. Recently made by the famous "WIER" Co Ltd to the highest professional specifications. With an original cost of over £200 the supply features every possible form of protection, full regulation, over voltage and current limit and just look at these outputs; it may have been made to your specifications!

+ 5 V at 12 Amps	+ 30 V at 2 Amps	+ 5 V at 4.5 Amps
+ 5V at 4 Amps	− 12 V at 2.5 Amps	+ 12 V at 2.5 Amps
		− 9 V at 1 Amp

you agree! then order now whilst stocks last.
Supplied BRAND NEW at only complete with diagrams. £59·99 CARR. & INSUR. £6·75

TOROIDAL TRANSFORMERS

PR 240v pri sec 15 0 15 @ 2 amps dimensions 3" x 2½" £4.95 + p.p 99p
TM 240v/110v pri sec 15 0 15 8vA dimensions 2½" x 1" £1.95 + p.p 30p.
All voltages measured off load

ELECTRONIC COMPONENTS & EQUIPMENT 66% DISCOUNT

Due to our massive bulk purchasing programme which enables us to bring you the best possible bargains, we have thousands of I.C.'s, Transistors, Relays, Cap's., P.C.B.'s, Sub-assemblies, Switches, etc. etc. surplus to our requirements. Because we don't have sufficient stocks of any one item to include in our ads., we are packing all these items into the "BARGAIN PARCEL OF A LIFETIME" Thousands of components at giveaway prices! Guaranteed to be worth at least *3 times* what you pay plus we always include something from our ads. for unbeatable value!! Sold by weight

2.5kls £ 4.75 + pp £1.25 5kls £ 6.75 + pp £1.80
10kls £11.75 + pp £2.25 20kls £19.99 + pp £4.75

Full range of T.T.L. ex-stock.

DISPLAY ELECTRONICS

Dept. W.W. 64-66 Melfort Rd., Thornton Heath, Croydon, Surrey. Tel: 01-689 7702 or 01-689 6800

MAIL ORDER INFORMATION

Unless otherwise stated all prices inclusive of V.A.T. Cash with order. Minimum order value £2.00. Prices and Postage quoted for UK only. Where post and packing not indicated please add 50p per order. Bona Fida account orders minimum £10.00. Export and trade enquiries welcome. Orders despatched same day where possible. Access and Barclaycard Visa welcome.

Plugs, Sockets & Connectors Cannon 'D' Range

Ways	Plug	Socket
9	£1.03	£1.26
15	£1.17	£2.01
25	£1.72	£2.58
37	£2.35	£4.14
50	£2.90	£5.46

25 way ex-equip. plug or socket £1.25

Edge connectors, gold plated

0.1" DS	40 way	£2.45
0.1" DS	85 way	£3.99
0.15" DS	56 way	£3.25
0.156 DS	36 way	£2.00

All connectors easily cut to size
1000's of other connectors ex stock

NEW FROM REDITRONICS

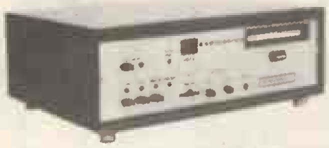
HERE'S HOW TO TALK TO ALL OF THE PEOPLE ALL OF THE TIME

with a communications system built up from the all-embracing, constantly expanding range of

REDITRONICS EQUIPMENT

The latest additions to that range –

A104K AUTOMATIC ANNOUNCER



with **ENCODED SPOT CAPABILITY** for central recording on erasure-proof spots, local recording on blank spots with spot omission switch facility, built-in chime, monitor loudspeaker and/or headphone, direct paging priority via associated mic.

AA115 FOUR-CHANNEL AUDIO POWER AMPLIFIER

with **MAINS-DERIVED OR BATTERY-OPERATION CAPABILITY**
for Versatility, with quad (4 x 40 W), stereo (2 x 80 W), or mono (1 x 160 W)
Mobility, with battery operation on 4 x 12 V battery-pack
Availability, with emergency standby operation (automatic switchover on mains failure by associated Reditronics CU106 standby power control unit incorporating a battery charger).

When it comes to SOUND communications, REDITRONICS EQUIPMENT does MORE FOR LESS. REDITRONICS is the one name that says it all.

Send for details of any item, and our full brochure, of a range of equipment that can provide every integrated link in the chain of a tailor-made sound communications system.

REDITRONICS
... TOTAL SYSTEMS CAPABILITY

REDIFFUSION REDITRONICS LTD.,
La Pouquelaye, St Helier, Jersey, Channels Islands
Tel: Jersey (0534) 30321 Telex: 4192341
U.K. DEPOT: River View Road, Bitterne, Southampton, Hampshire, U.K.
Tel: Southampton (0703) 555566

and to meet growing demand–

Musitune are appointed as Reditronics distributors for Greater London and the Home Counties.

Contact Musitune Ltd., 388 Green Lanes, London N4 1DW (Tel: 01-802 1163) for Reditronics systems-planning to your **exact** requirements.

WW — 110 FOR FURTHER DETAILS

COMMUNICATION TUBES — EX STOCK

4-65A	5763	QQV06-40A
4-125A	6080	QQV07-50
4-250A	6146/A/B	QV08-100
4-400A	6155	QY4-125
4-1000A	6156	QY4-250
4CX250B	7527	QY4-400
4CX350A	8042	QY5-3000A
4CX1500A	QQV03-10	& MORE
4CX1500B	QQV03-20A	

R/F POWER TRANSISTORS — EX STOCK

2N3375	2N5102	BLY33	BLY88
2N3553	2N5590	BLY34	BLY89
2N3632	2N5591	BLY36	BLY91
2N3733	2N5641	BLY53A	BLY92
2N4040	2N5642	BLY55	BLY93
2N4127	2N5643	BLY83	BLX13
2N4128	2N6080	BLY84	BLX14
2N5070	2N6081	BLY85	BLX67
2N5071	2N6082	BLY87	BLX68
2N5090	2N6083		& MORE

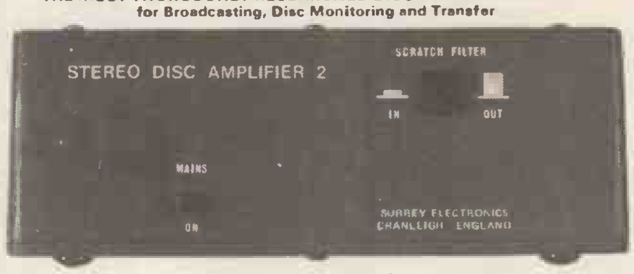
AEL
LEADING EXPORTER

SEND FOR DETAILS TO:
AERO ELECTRONICS (AEL) LTD
GATWICK HOUSE
HORLEY, SURREY, ENGLAND
TEL: (02934) 5353
TELEX 87116 (AERO G)
CABLES AERO G TELEX HORLEY

WW — 095 FOR FURTHER DETAILS

STEREO DISC AMPLIFIER 2

THE MOST THOROUGHLY RESEARCHED DISC AMPLIFIER THERE IS
for Broadcasting, Disc Monitoring and Transfer



Ring or write for full specifications of this or PPM Boxes ★ PPM2 and PPM3 drive circuits ★ *Ernest Turner* movements 640, 642, 643 and TWIN with flush mounting adaptors and illumination kits ★ Peak Deviation Meter ★ Programme and Deviation Chart Recorders ★ Moving Coil Preamplifier ★ 10 Outlet Distribution Amplifier ★ Stabilizer ★ Fixed Shift Circuit Boards.

SURREY ELECTRONICS, The Forge, Lucks Green, Cranleigh, Surrey, GU6 7BG. Tel: 04865 5997

SWITCHCRAFT XLR CONNECTORS

Line Female A3F	£0.99	Chassis Female D3F	£1.25
Line Male A3M	£0.86	Chassis Male D3M	£0.71

4, 5 and 6 pin versions and large selection audio adaptors available

NEUTRIK XLR CONNECTORS

Latchless Chassis Female NC3-FZ	£0.67	Latchless Chassis Male NC3-MZ	£0.59
PCB Mounting Chassis Female NC3-FD	£1.12	PCB Mounting Chassis Male NC3-MD	£0.95

Please specify horizontal or vertical mounting PCB format.

BELCLERE AUDIO TRANSFORMERS

EN6422 Ratio 1 + 1:2 + 2. Freq. 40Hz-35KHz. PCB Mount. PRI 150/600Ω. sec. 600/2.4KΩ £2.90
EN6423 Ratio 1 + 1:6.45 + 6.45. Freq. 40HZ-25KHz. PCB Mount. PRI 150/600Ω, sec. 6.25K/25KΩ £2.90
SKT-723 MuMetal Screening can. 39dB reduction 50Hz ext. field £0.95
Trade enquiries welcome, quality discounts available. All prices subject to VAT. Call, write or phone. Minimum order £10. Please add £1 postage. Access, AmEx, Barclaycard.

KELSEY ACOUSTICS LTD.
28 POWIS TERRACE, LONDON W11 1JH
01-727 1046

WW — 101 FOR FURTHER DETAILS

WW — 029 FOR FURTHER DETAILS

WW—115 FOR FURTHER DETAILS

Appointments

Advertisements accepted up to 12 noon Monday, December 5th, for January issue, subject to space being available.

DISPLAYED APPOINTMENTS VACANT: £12.00 per single col. centimetre (min. 3cm).
LINE advertisements (run on): £2.00 per line, minimum three lines.
BOX NUMBERS: £1 extra. (Replies should be addressed to the Box Number in the advertisement, c/o Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.
PHONE: Eddie Farrell, 01-661 3500, Ext. 8158.
Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.

Increased home and export orders for our broadcast TV products mean that we are looking widely to recruit staff to fill new vacancies and others created by promotion of engineers who have been with us some time.

SYSTEMS ENGINEERS — TELEVISION

Experienced engineers are needed to work on design and project management of Outside Broadcast vehicles and television studios. This is an opportunity for engineers to become involved in projects from their initial design concept, through manufacturing to delivery and installation.

Our custom built systems require a high degree of customer contact at engineering level, from the initial design stage to the necessary training of operational staff on completion of the contract, both within the UK and overseas.

You should have a knowledge of TV studio engineering gained from experience in this type of work or from experience in the operational side of television.

DESIGN AND DEVELOPMENT ENGINEERS — VIDEO

An experienced engineer who will be involved in the design of studio products, including a new range of colour cameras, using the very latest analogue and digital techniques. You will have the opportunity to see your designs made in volume production, fulfilling the high technology requirements of the '80s.

We are looking for engineers who are qualified to degree or HND level and who have at least four years' experience in the design of electronic equipment, with some knowledge of video engineering and microprocessor techniques.

TEST ENGINEERS

We require engineers at intermediate level to assist in the manufacture of our new range of products for the Broadcast studio television market.

You need to have an up-to-date knowledge of digital and linear circuit techniques gained from experience working on broadcast television, or similar sophisticated products, and be capable of faultfinding down to component level.

We are a young, successful Company, well known in international television circles, operating from our modern purpose-built factory in Andover. Salaries offered are very competitive, and supplemented by generous holidays, free life and health insurance, pension scheme, subsidised meals and relocation expenses.

PLEASE WRITE GIVING FULL DETAILS OR PHONE JEAN SMITH AT THE ADDRESS BELOW FOR AN APPLICATION FORM.

LINK
ELECTRONICS

Link Electronics Limited,
North Way, Andover,
Hants, SP10 5AJ.

Telephone: (0264) 61345

(800)

Technicians in Communications

GCHQ We are the Government Communications Headquarters, based at Cheltenham. Our interest is R & D in all types of modern radio communications – HF to satellite – and their security.

THE JOB All aspects of technician support to an unparalleled range of communications equipment, much of it at the forefront of current technology.

LOCATION Sites at Cheltenham in the very attractive Cotswolds and elsewhere in the UK; opportunities for service abroad.

PAY Competitive rates, reviewed regularly. Relevant experience may count towards increased starting pay. Promotion prospects.

TRAINING We encourage you to acquire new skills and experience.

QUALIFICATIONS You should have a TEC Certificate in Telecommunications, or acceptable equivalent, plus practical experience.

HOW TO APPLY For full details on this and information on our special scheme for those lacking practical experience, write now to **Robby Robinson, Recruitment Office, GCHQ, Oakley, Priors Road, Cheltenham, Glos. GL52 5AJ,** or ring 0242-21491 ext 2269.

GCHQ

PIONEER®

require

FIELD SERVICE ENGINEER CAR AUDIO

c. £7,000 + Car

Applicants should hold a C. & G. qualification in Radio and T.V. Electronics or Telecommunications or an H.N.C. in Electronics. It is envisaged that the applicant should have up to 5 years' experience, the specialist knowledge required to analyse and solve car suppression problems and have a wide, general knowledge of car audio equipment, together with a methodical approach to work and the ability to deal in a friendly, polite way with people. You should hold a clean driving licence.

BENCH SERVICE ENGINEERS

Applicants should hold C. & G. Radio and T.V., Electronics Technician or equivalent certificate with a minimum of two years' experience in the Audio field. Alternatively, five years of relevant experience with sound knowledge of electronics is acceptable.

Salary up to £7,500 per annum, according to age and experience.

Luncheon vouchers, four weeks' annual holiday and pension scheme.

For further information, do not hesitate to contact:

Mrs. C. A. Burridge
PIONEER HIGH FIDELITY (GB) LTD.
Pioneer House, The Ridgeway, Iver, Bucks.
Tel. Iver (0753) 652222

(776)

ELECTRONIC TECHNICIANS

FOR PRODUCTION
RESEARCH AND DEVELOPMENT
SERVICING

OXFORD **c. £5,500**

Research Machines is a young, successful company, being the leading U.K. manufacturers of microcomputer systems for research and education.

We are offering the opportunity of varied and satisfying work on technically advanced equipment Applicants should be capable of prototype construction, testing and updating drawings. Experience in working with complex TTL logic boards essential.

You should be educated to A-level or ONC/HNC standard, or have relevant experience. Knowledge of microprocessors is not necessarily required, but applicants must be eager to acquire expertise in this field.

On appointment you will be assigned to either production, servicing or research and development. A starting salary of £5,500 for a 35-hour week is being offered together with good company benefits and the opportunity to acquire a 380Z computer at low cost.

Please write, giving full details of your experience, to: Mrs. Diane Hinton, Research Machines Ltd., P.O. Box 75, Oxford OX2 OBW.

(821)

CAPITAL APPOINTMENTS LTD.

CAPITAL HOUSE
29-30 WINDMILL STREET
LONDON W1P 1HG
TEL: 01-637 5551

THE UK's No. 1 ELECTRONICS AGENCY

Design, Dev. and Test to £9,000
Ask for Brian Cornwell

SALES to £12,000 plus car
Ask for Ken Sykes

FIELD SERVICE to £8,000 plus car
Ask for Maurice Wayne

We have vacancies in ALL AREAS of the UK

Telephone: 01-637 5551 (3 lines)

UNIVERSITY OF PAPUA NEW GUINEA

Applications are invited for the post of

SENIOR TECHNICAL OFFICER IN THE DEPARTMENT OF HUMAN BIOLOGY

Applicants should have a Diploma in Medical Technology or Science Laboratory Techniques or equivalent. Those with experience in the field of physiology will be given preference. A substantial part of the duties will consist of supervision and on-the-job training of junior technical staff, with emphasis on training in handling instrumentation. Salary: K14,050 p.a. (£1 sterling = K1.58). Three year contract; gratuity; rent-free accommodation; family passages; baggage allowance; leave fares after 18 months service; education allowance; salary continuation scheme for extended illness or disability.

Detailed applications (2 copies), including a curriculum vitae, a recent small photograph and naming 3 referees should be sent to the Secretary, Box 4820, University P.O., Papua New Guinea, to arrive no later than 19 December 1980. Applicants resident in U.K. should also send 1 copy to Inter-University Council, 90/91 Tottenham Court Road, London, W1P ODT. Further details are available from either address.

(801)

THE POLYTECHNIC WOLVERHAMPTON

TV SERVICING TECHNICIAN (T3/4)

To maintain and repair video recorders, monitors, TV cameras and control gear. Good environment with potential to further development. Additional training may be available.

Previous applicants still under consideration.

Salary: £4581 to £5784.

Details from:

'Personnel'
The Polytechnic
Wolverhampton
(Tel: Wolverhampton 710654
24-hour ansaphone

(831)

Inner London Education Authority
GARNETT COLLEGE
Downshire House, Roehampton Lane, London, SW15 4HR
01-789 6533

Electrical Engineering Resource Centre Technician (Grade 4)

Technician in the college's Resource Centre and electrical/electronic section; opportunity to develop a wide range of technical skills. Some experience in servicing electrical equipment desirable.

Salary: £4,756-£5,422 including London Weighting.

Applicants should possess an ONC or an Ordinary City and Guilds, or have done a recognised apprenticeship and should have at least 7 years' relevant experience.

Further details and application forms, returnable within 10 days, from the Acting Chief Technician at the college. (Ref. WW)

(825)

TOP JOBS IN ELECTRONICS

Posts in Computers, Medical, Comms, etc. ONC to Ph.D. Free service.

Phone or write: **BUREAUTECH, AGY, 46 SELVAGE LANE, LONDON, NW7. 01-906 0251.**

(8994)

GOVERNMENT OF DUBAI
DUBAI RADIO AND COLOUR TELEVISION
TELEVISION ENGINEERING DEPARTMENT

TRANSMITTER ENGINEER

A vacancy exists for one Television Engineer to augment an existing team which is responsible for the maintenance of VHF and UHF medium and high power transmitters.

Candidates should be experienced in the broadcast field and be familiar with routine testing procedures to ensure the continued good performance of equipments under their control. Extensive use is made of SHF microwave links and candidates should be familiar with the operation, testing and setting up of such equipment. The maintenance of a medium power FM stereo transmitter is also involved.

Only candidates with some years of proven experience in broadcast engineering need apply.

The contract will be for two years and full details of conditions of service may be obtained from Falcon Television, 7a Grafton Street, London W1X 4HB, Telephone 01-629 6203.

The salary scale for this post will be £12000-£14000 Sterling per annum tax free depending on experience.

Applications, which will be treated in strictest confidence should be sent accompanied by C.V. and UK telephone contact to:—

Chief Engineer,
Dubai Radio and Colour Television,
c/o Falcon Television Productions,
7a Grafton Street,
London,
W1X 4HB

It is expected that interviews will be held in London in December.

(787)

St. Bartholomew's Hospital/
St. Leonard's Hospital
Medical Electronics Department

FIELD SERVICE ENGINEER

We have a vacancy for a technician to join a small team maintaining Renal Dialysis equipment. The work involves servicing electronic and mechanical equipment in both the Dialysis Centre and in the patient's homes. Rostered on call duties and overtime working are normally required. A current driving licence is essential. Applicants must hold a recognised technical qualification.

Salary scale (MPT III/IV) in range £4409-£6479 per annum inclusive of London Weighting.

Job description and application form from: **Personnel Department, St Bartholomew's Hospital, London EC1A 7BE. Telephone: 01-600 9000 extension 2271.**

Reference number PTB/100

(775)

UNIVERSITY OF EXETER
DEPARTMENT OF PSYCHOLOGY

TECHNICIAN

Applications are invited for the post of (Audio Visual) Technician (Grade 4) in the Department of Psychology. Candidates should have experience in the use of Video cameras V.T.R. and associated equipment; photographic skills and/or an interest in microprocessor interfacing would be an advantage.

Salary will be on the scale £4431-£5097 p.a., with initial placement according to qualifications and experience.

Letters of application, stating full personal details and the names of two referees, should be sent to **Mrs. Doreen Birch, Northcote House, Queen's Drive, Exeter, EX4 4QJ,** from whom further particulars are available, by 2 December 1980. Please quote reference No. 5153.

(774)

Surrey Education Committee
Brooklands Technical College
Heath Road, Weybridge, Surrey
DEPARTMENT OF TECHNOLOGY

Lecturer I— Telecommunications/ Electronics

to teach TEC Certificate Courses and C & G 224. Industrial experience and qualifications to HNC/FTC preferred. Ability to offer Telephony-based subjects an advantage.

Salary Scale: Lecturer I—£4683-£8055 plus £213 per annum London Fringe Area Allowance

Commencing salary dependent upon qualifications and experience.

General relocation expenses in approved cases.

Further details and application forms from the Principal to be returned within 10 days after publication date.

(819)

Dolby

ELECTRONIC TEST ENGINEERS

We manufacture and market audio noise reduction equipment which is used by major recording companies, recording studios, the film industry and broadcasting authorities throughout the world.

We need experienced Test Engineers to join a dedicated team who are proud to be world leaders in the manufacture of professional noise reduction equipment.

Those with practical knowledge of electronic testing and rapid trouble-shooting ability can enjoy varied and interesting work and high rates of pay.

Telephone TONY HILL 01-720 1111

DOLBY LABORATORIES INC.
346 Clapham Road, London, SW9 9AP

(817)

Experienced T.V. aerial
SYSTEMS ENGINEER
required to work from S.E. London.
Apply to:
Greenwich Cablevision Limited, 307 Plumstead High Street, London SE18 1JX
Tel: 311-3466
(778)

AUDIO ENGINEER. Small company requires Audio Engineer. The applicant should be familiar with construction and servicing of a wide range of audio equipment and should be capable of working without supervision, prototype, R&D work imminent. Applicants should be 21-35 years of age. Salary £3,500-£5,000 per annum according to qualifications. Kelsey Acoustics, 01-727 1046. (829

BROADCAST ENGINEERS, £16,000 neg. Permanent positions overseas. Tax free salaries, first class accommodation and conditions. Apply: SPS EXECUTIVES (Ref 1726), Recruitment Consultants, Delme Court, West Street, Fareham, Hampshire or better still telephone (0392) 235611/236857. (597

ROYAL FREE HOSPITAL, Hampstead, NW3 Medical Physics Technicians II and III. Salary on scale £5,132-£7,445. For well equipped Electronics Laboratory for maintenance of Radiotherapy machines, Physics equipment. CT scanners and Ulstrasound apparatus. Equipment includes Linear accelerator, two Cobalt units, 300 kv and superficial machines. Also development work on computerised Cobalt treatment unit film badge, reader, etc. Qualifications — ONC, HND or equivalent specialising in electronics plus 3 years experience. For details and application form — Personnel Dept, tel. 01-794 0500 ext. 4286. Quote ref: 1487. (821

COMPUTER & DIGITAL FIELD ENGINEERS

A Place on our specialist register ensures wide exposure to the right opportunities with the minimum of time-wasting.

We provide —

- ★ Expertise of ex Field Engineer / Manager
- ★ Continuous update of your circumstances — we don't file and forget!
- ★ Genuine 24-hour service — no answering machines.
- ★ No promises we can't keep.
- ★ Countrywide contacts.

Ring now for a free Registration form—

01-464 7714, ext. 502

LOGEX

ELECTRONICS RECRUITMENT SERVICE
HIGH ROAD, LOUGHTON, ESSEX
01-502 1589/01-464 7714. EXT. 502 (824)

UNIVERSITY OF PAPUA NEW GUINEA

Applications are invited for the post of

SENIOR TECHNICAL OFFICER IN THE DEPARTMENT OF CLINICAL SCIENCES

Faculty of Medicine.

Applicants should have a Diploma in Medical Technology or equivalent with several years' experience, preferably in a teaching institution. Those with experience, in the field of Immunology will be given preference. Appointee will be responsible to the Chairman of the Department (through the Laboratory Manager) for the co-ordination of all technical services. Duties include supervision and on-the-job training of junior technical staff. Salary: K14,050 p.a. (£1 sterling = K1.58). Three-year contract; gratuity; rent-free accommodation; family passages; baggage allowance; leave fares after 18 months' service; education allowance; salary continuation scheme for extended illness or disability.

Detailed applications (2 copies), including a curriculum vitae, a recent small photograph, photo-copy of educational qualifications and naming 3 referees, should be sent to the Secretary, Box 4820, University P.O., Papua New Guinea, to arrive no later than 19 December 1980. Applicants resident in the U.K. should also send 1 copy to Inter-University Council, 90/91 Tottenham Court Road, London W1P 0DT. Further details are available from either address.

(802)

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 **GRANT WILSON**

Technomark
Engineering and Technical Recruitment
11 Westbourne Grove
London W2. 01-229 9239 (9257)

We have the following vacancies in our Network and Service Planning Department based at our Engineering Headquarters near Winchester:-

Engineer

Network Planning

(Ref: WW/524cc)

Under the general supervision of a Senior Engineer you will be required to progress modifications and extensions to the IBA vision, sound and telemetry networks. The work includes the installation and testing of microwave links.

You should have a degree in electronic engineering and at least two years' experience in microwave systems planning and commissioning. Alternatively, experience of Post Office practice or communication methods in either broadcasting or private industry may be acceptable.

Senior Engineer

Network Planning

(Ref: WW/523cc)

You would be required to plan and supervise the implementation of communication facilities for the current and future needs of the Authority. The work will involve the control and provision of Post Office Services and the planning, installation and commissioning of private radio systems within a given budget.

You should be qualified to degree level with several years' experience of transmission systems both line and radio. Familiarity with current video and audio transmission techniques is essential and applicants should have practical experience of microwave link design and operation.

Both posts will involve travelling with periods away from base, therefore, a current driving licence is essential. Applicants (male or female) will be required to climb and work on tall structures.

Depending upon qualification and experience, the commencing salary will be on a range which rises to £9,603 per annum for the Engineer post and to £11,040 per annum for the Senior Engineer post.

Relocation expenses will be paid where appropriate.

IBA INDEPENDENT BROADCASTING AUTHORITY

Please write or telephone for an application form, quoting the appropriate reference number, to Christine Gossling, IBA, Crawley Court, Winchester, Hampshire SO21 2QA. Telephone Winchester 822270.

(772)

Broadcasting Engineers

Saudi Arabia up to £6,000 to £16,000

EDOK-ETER are a major international civil, telecommunications and defence engineering company with rapidly developing worldwide interests. Our headquarters is in Athens.

One of our more important undertakings is the construction, commissioning and long-term operation of the new Saudi Arabian HF and MF broadcasting network based on multi-megawatt MF transmitters and HF or microwave programme and telecommunication links.

We require several grades of Broadcasting Engineers to take full responsibility for the operation and maintenance of all the radio and electronic equipment of a new station.

Successful candidates aged up to 50 must have a relevant Degree and radio engineering experience, preferably in broadcasting, or alternatively in manufacture and installation, or in Armed Services communication.

Salary is up to £16,000 p.a. tax free, depending on qualifications and experience. Benefits are comprehensive covering single furnished accommodation, medical treatment, generous home leave and air fares and accident insurance cover.

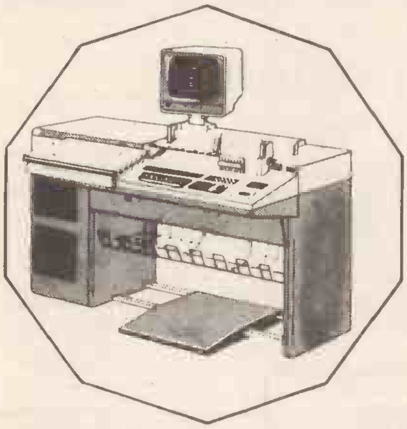
Please write, quoting reference 903, giving full details of previous experience, employment and professional qualifications and enclose a recent photograph to: **The Personnel Manager, EDOK-ETER Group, 83 Buckingham Palace Road, London SW1W 0QJ. Tel: 01-828 6814.**

·EDOK·S.A.-·ETER·S.A.

(789)

ELECTRONIC ENGINEERS

looking for a different image?



Competitive Salary + Car

In the field of Electronics, few areas offer such growth opportunities as that of Computing. Philips Data Systems is a division of Philips Business Systems, the pacesetting group that manufactures and markets one of the widest ranges of advanced business systems and equipment. We are looking throughout the UK for **Customer Engineers, male or female, who wish to be part of that growth.**

If you are experienced in dealing with customers' problems, skilled in electronics/electro-mechanics, then **Philips will provide you with the training necessary to enter this technically exciting and challenging field.**

We offer excellent conditions of employment, a competitive initial salary, which will be reviewed on completion of your first 6 months training period. Naturally, a company vehicle will be provided.

If you believe you have the ability/experience needed to take on this image, then why not telephone Alan Bowden, Senior Personnel Officer, on 0206 5115 or write to him at Philips Data Systems, Elektra House, 2 Bergholt Road, Colchester, Essex CO4 5BE.

PHILIPS Business Systems Simply years ahead **PHILIPS**

(809)

JUNIOR DEVELOPMENT ENGINEERS

ELECTRONICS

John Player and Sons, a leading manufacturer of tobacco products, offer the opportunity to young electronics engineers to gain valuable practical experience in industrial electronics.

Vacancies exist for work in the Machinery Evaluation Section where new generation cigarette making and packing machines are undergoing pre-production trials. These machines are equipped with increasing numbers of modern electronic control circuits using the latest technological advances including microprocessors.

The successful applicants will undergo a period of familiarisation, look after specific machines during the evaluation period, be involved in the development of special features as well as devising evaluation aids and ultimately in the training of others in the maintenance of these machines on the production floor.

We are looking for men or women who are qualified to HNC or equivalent, and who have two years' experience in one or more of the following areas:

a) electronic control and logic circuits
b) process control systems
c) microprocessors

A knowledge of the tobacco industry is not essential.

We offer a starting salary of £6,500 per annum together with other benefits associated with a large progressive company including relocation assistance where applicable.

Application forms cab be obtained by telephoning Nottingham (STD 0602) 787711, Extension 345 or writing to:

Lorna Blayney

JOHN PLAYER & SONS

NOTTINGHAM NG7 5PY

(790)

ELECTRONICS ENGINEER

CENTRAL SCOTLAND

A vacancy exists in our engineering design and development deparment for an Electronics Engineer.
Applicants should be qualified to HNC level or have the depth of industrial experience and ability to work on new designs with the minimum of supervision.

Apply for application form to:

Administration Manager
G R INTERNATIONAL ELECTRONICS LTD.
Inveralmond Industrial Estate, Perth PH1 3NY
Telephone: Perth 34771

(796)

When the ship comes home, why not settle down?

We're British Telecom Maritime Service and we have everything in a job that you'd want: the kind of work you're trained to do, good pay, job security and all the comforts of home where they really count – at home!

Radio Officers

Vacancies exist at several coast stations for qualified Radio Officers to carry out a variety of duties that range from Morse and teleprinter operating to traffic circulation and radio telephone operating. And for those with ambition, the prospects of promotion to senior management are excellent.

You must have a United Kingdom Maritime Radio Communication Operator's General Certificate or First Class Certificate of proficiency in Radio-telegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic. 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:
IE Maritime Radio Services Division (WWA),
IS8.1.1.2, Room 304, Landsec House,
23 New Fetter Lane, London EC4A 1AE.

British TELECOM
PART OF THE POST OFFICE

(524)

Classified

SITUATIONS VACANT

CHIEF ENGINEER
RADIO AVONSIDE LIMITED

Applications are invited for the post of Chief Engineer at the Bristol-based Independent Local Radio station due to come on air in the autumn of 1981. The appointment should be made before the end of this year and the successful applicant will begin his or her duties next spring.

The contract offered to Radio Avonside by the Independent Broadcasting Authority covers Bristol, Bath and surrounding areas with a possible adult audience in excess of 800,000. It will be one of the most exciting and challenging engineering appointments within the ILR network and a high standard of administrative ability and technical experience is required.

The person appointed will be concerned with the planning and setting up of the station and will thereafter be responsible to the Managing Director for all aspects of Radio Avonside's technical operation and maintenance procedures. A salary of around £10,000 p.a. is envisaged, subject to qualifications and experience.

Applicants should write to the Chairman, Professor Glynne Wickham, at Radio Avonside Limited, 4th Floor, Bush House, 72 Prince Street, Bristol BS1 4NU. The closing date is 1st December 1980.

(804)

PICCADILLY RADIO 261

serving a population of four million from the heart of Manchester seeks a

TRAINING and STANDARDS SUPERVISOR

to instruct technical and programming staff in operation of complex station equipment and to organise teaching of editorial, management and related skills.

We want to hear from candidates with an engineering background, with administrative ability and a good knowledge of how a radio station works.

Salary — £8,000-£10,000 according to experience.

Write to:

Colin Walters
Programme Controller
Piccadilly Radio
P.O. Box 261
Manchester M1 4AW

(773)

CHELSEA COLLEGE
University of London
DEPARTMENT O ELECTRONICS

ELECTRONICS TECHNICIAN
GRADE 5

is required for Electronics Workshop serving Electronics and Physics research and teaching. Interesting prototype instrument design, development and construction work using both digital and analogue techniques, and also the servicing of commercial electronic equipment.

Salary (under review) £5556-£6357 p.a. inclusive. Generous holidays.

Further details and application form from: **Mr. M. E. Cane (5EW), Chelsea College, Pulton Place, London SW6 5PR.**

(780)

UNIVERSITY OF GLASGOW
DEPARTMENT OF PSYCHOLOGY

ELECTRONICS TECHNICIAN
GRADE 5

Construction and Development of Specialised Electronic Apparatus for Research and Teaching Purposes. Maintenance and calibration of workshop instruments. Knowledge of, or interest in use of audio and video equipment an advantage. O.N.C. or equivalent, together with minimum of seven years' relevant experience. Opportunities for broadening one's knowledge of microprocessors. Salary scale: £4,776-£5,577.

Applications, giving details of age, qualifications and experience, should be addressed to: The Personnel Officer, University of Glasgow, Glasgow G12 8QQ. In reply please quote Ref. No. 4766.

(813)

QUEEN MARY COLLEGE
(University of London)

ELECTRONICS TECHNICIAN GRADE 5
(Salary £6494-£7559 p.a. including London Weighting)

To work in the Department of Physics Electronic Workshop. The work will involve the design and construction of equipment for research and teaching and the servicing of existing equipment. A good electronic background and qualifications of at least ONC or equivalent is essential. 5-day week, 7½ weeks' annual leave including public holidays. Write with details of age, training, experience and qualifications to Miss K. M. Garner, Personnel Assistant, Queen Mary College, Mile End Road, London, E1 4NS.

(820)

THE MIDDLESEX HOSPITAL MEDICAL SCHOOL

SENIOR ELECTRONICS TECHNICIAN

Applications are invited from suitably qualified and experienced persons for the above post.

The successful candidate will work with a wide range of electronic apparatus. Duties would include the use, maintenance and development of research, practical laboratory, video, sound and CCTV equipment.

Salary, depending on qualifications and experience, within the range £6,657-£7,950 (inc. London Weighting).

Please apply in writing to: **Chief MLSO, Department of Physiology, The Middlesex Hospital Medical School, London, W1P 6DB.**

(777)

UNIVERSITY OF OXFORD

ELECTRONICS TECHNICIAN

Electronics technician required for work on mass spectrometers and other equipment in the Department of Geology and Mineralogy, under the technical direction of the Electronics Group in the Physics Department. Applicants should have wide experience in fault-finding and building of modern electronic equipment.

Appointment is for five years to 31 July, 1986 in the first instance. Salary range £5478 to £6543, under review.

Applications with full personal and professional details as soon as possible, to the **Administrator, Department of Geology, Parks Road, Oxford OX1 3PR.**

(791)

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

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

* Ferrograpn YD 2 track ¼ / EMI RE-301
* Ampex FR1300 7 track ½ UHER 4000 ¼"
* Consolidated 3800 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"
* 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 **aerial equipment is professional MOD quality**

* Option Optical Tuners £80.00
* Ampex Bulk Erasers £95.00
* Eimac 6156 Valves £21.00
* Mullard QQV-06-40A Valves £8.00
* Clare Flash testers £60.00
* Waveguide sets 33/110 GHz £40.00
* Advance Signal Generators H1E-J1 .... £30.00
* Bradley CT 471B VT Multi Meters £60.00
* Westrex Multi Cellular H.F. lens Horns £40.00
* General Electric 200/600 KHz 500 watt transmitters £245.00
* Plessey PR-1556 filter Modulators £45.00
* Marconi HR-23 ISB Receivers £220.00
* K.B. Discomatic Domestic Juke Boxes £90.00
* SCR-625 Mine Detectors in chests £40.00
* Hewlett Packard 400H VTVM Meters £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 £14.00
* Racal MA 1350 synthesisers £125.00
* G.B. Kalee Flutter Meters. Model 1740D £60.00
* Tektronix 551 Scopes £160.00
* Tektronix 555 Scopes £180.00
* Teleonic VR2M Sweeps £150.00
* Hell Schriber RC-28 .... £75.00
* Lenkurt Model 26D Data Sets £90.00
* Aerial Multicouplers from £25.00
* Marconi TF 1168 Disc Oscillators £90.00
* Hughes Memoscopes £120.00
* Nems Clarke 1306 VHF Receivers £260.00
* Telefunken Surveillance Receiver £175.00
* Helix Aerials 11' & 18' and Reflectors £18.00
* Textronix 543A Oscilloscopes £90.00
* Textronix 545A Oscilloscopes £100.00
* Textronix 561A Oscilloscopes £140.00
* 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) £750.00
* Collins KWT 6 Transmitter Receivers SSB .... P.U.R.
* Roband RO 50A Oscilloscopes £145.00
* B & K 2407 Electronic Voltmeters £90.00
* Winston "5" Band Spectrum Analysers .... P.U.R.
* Airmec 352 Sweep Generators D £130.00
* Advance Transistor Testers TT-1S £35.00
* Marconi TF 329 Magnification Meters £140.00
* Marconi TF 801/D/1 AM Signal Generators £180.00
* Ferranti 7.5KVa Auto Voltage Regulators £150.00
* Manson TFM-101 Multipliers £190.00
* Servomex 2kw Auto regulators £100.00
* 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
* Racal 3 & 6 KCS S.S.B. filters £14.00
* AVO CT 471A Electronic Multimeters £60.00
* EMI R301 Tape Recorders £60.00
* Stonorette L Tape Recorders £20.00
* 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 £120.00
* Metal V.D.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)

SITUATIONS VACANT

Inner London Education Authority
LEARNING MATERIALS SERVICE
Television Centre, Thackeray Road
London SW8 3TB

The Television Centre produces a range of educational programmes in the form of video cassettes, sound cassettes and 16mm film for distribution within London and nationally. It has a colour television studio, colour mobile unit and film unit all equipped to professional broadcasting standards.

A vacancy has arisen for:

MAINTENANCE ENGINEER ST3

(£8115-£8709)

The maintenance section has four members and is responsible for all the equipment at the studio centre, both vision and sound.

Applicants must have relevant technical qualifications (a knowledge of digital techniques would be an advantage), and should have good experience in the field, though consideration would be given to experience in allied fields. Limited "on-the-job" training is available, and the Authority will pay for attendance at specialised manufacturer's courses where these are considered necessary.

Further information and application forms available from the Education Officer (EO/Estab. 1C), Room 365, County Hall, London SE1. Telephone: 633-7456/7546.

(779)

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

(141)

ARTICLES FOR SALE

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

P.o. Box 30, London, E.4

ENAMELLED COPPER WIRE

SWG	1lb.	8oz.	4oz.	2oz.
8 to 29	2.76	1.50	.80	.60
30 to 34	3.20	1.80	.90	.70
35 to 40	3.40	2.00	1.10	.80
41 to 43	4.75	2.60	2.00	1.42
47	8.37	5.32	3.19	2.50
48 to 49	15.96	9.58	6.38	3.69

SILVER PLATED COPPER WIRE

14 to 30	6.50	3.75	2.20	1.40

TINNED COPPER WIRE

14 to 30	3.38	2.36	1.34	.90

Prices include P&P, VAT and Wire Data
SAE for list. Dealer enquiries welcome.
Reg Office: 22 Coningsby Gardens. (9063)

EXACT TIME?

MSF CLOCK is ALWAYS CORRECT— never gains or loses, self-setting at switch-on. 8 digits show Date, Hours, Minutes and Seconds, larger digit hours and minutes for easy **QUICK-GLANCE** time, auto. G.M.T./B.S.T. and Leap Year, also parallel BCD output and audio to record and show time on playback, receives Rugby 60KHz atomic time signals, built-in antenna, 1000Km range, ACCURACY, **£54.80.**

V.L.F.? 10-150KHz **Receiver £13.70.**
60KHz RUGBY RECEIVER, as in MSF Clock, serial data output, **£15.70.**

Each fun-to-build kit includes all parts, printed circuit, case, postage, etc. Money-back assurance so GET one NOW.

CAMBRIDGE KITS, 45 (WM) Old School Lane, Milton, Cambridge (803)

PRINTED CIRCUITS. Make your own simply, cheaply and quickly! Golden Fotolak Light Sensitive Lacquer — now greatly improved and very much faster. Aerosol cans with full instructions, £2.25. Developer 35p. Ferric Chloride 55p. Clear Acetate sheet for master 14p. Copper-clad Fibre-glass Board approx. 1mm thick £1.75 sq. ft. Post/Packing 60. — White House Electronics, Castle Drive, Praa Sands, Penzance, Cornwall. (714

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

ASTRO TECHNOLOGY PCB Router 18,000 rpm on stand £450. Solartron CD 1740 oscilloscope 50 MHz DB £300. HP 180 oscilloscope 50 MHz £400. "Q" Services Electronic Camberley Ltd., 29 Lawford Crescent, Camberley, Surrey. Yateley 871048. (805

TELEQUIPMENT. D67 oscilloscope 25 MHz, good order, h/book, £350. Woking 048-62 72695, evenings. (807

PYE SSB170 12v 4 channel 2-9 megs 20w output, ex works, unused QTY 8. Radio alert chargers, new, for 9v battery charges from AC250 mains at 8 m/a. £5.50. Pocketfones PFI, TX and RX with circuits £21. Car adaptor receiver, plug in battery is charged and output taken to 3 watt amplifier into 3 ohm speaker (not supplied) £8.50. Chargers for 12 of each battery £17. OTHER PYE RT EQUIPMENT IN STOCK, phone or write for details. Atalanta ships communications receiver by Marconi special offer £65 each, as removed from ship, complete but untested £115, tested and adapted for AC mains, carriage at cost approx £15. AVO 7 Mk II £32. AVO meter movements 8, 9 and multitest No 1, scaled 0-100„ and 0-30 £15. Heterodyne frequency meter BC 221 £23.50. Pneumatic mast by Scam Clark, 7ft extending to 40ft in unopened maker's pack £345. Delivery by arrangement. We have a constantly changing stock and we are worth a visit. No lists. G.W.M. RADIO LTD., 40/42 PORTLAND ROAD, WORTHING, SUSSEX. Tel. 0903 34897. (806

PAPER TAPE READER, Trend HSR 500, 500 cps with manual and GNT 34 paper tap punch, £100 ono. — Tel. 0273 550664 after 1 pm. (828

AUCTION SALE

on Friday, December 5, 1980, at 10 a.m.

at GLOUCESTER INDUSTRIAL SALES & AUCTIONS LTD., Eastington Trading Estate, Near Stonehouse, Glos.

M5 Motorway — Exit No. 13

100s of Lots of Electronic Components, Test Gear including Oscilloscopes, Signal Generators, Computer Peripherals and Parts, Vacuum Pumps, etc. Many Lots with NO RESERVES.

Catalogues 50p each from G.I.S.A., Eastington Trading Estate, Near Stonehouse, Gloucester. Telephone No. Stonehouse 4118.

Viewing: November 28-December 4 incl., 9 a.m.-4 p.m. (except Saturday and Sunday) and Morning of the SALE.

Light Refreshments on Sale Day

(830)

Classified

ARTICLES FOR SALE

TELETEXT, TV SPARES & TEST EQUIPMENT. TELETEXT. Latest MK2 external unit kit incl. Mullard Decoder 6101VML and infra-red remote control £258, p/p £2.50 (further details on request). Also MK1 external unit kit incl. Texas XM11 decoder, special offer price £168, p/p £2.50. Both kits incl. UHF modulator, and plug into TV set aerial socket. SPECIAL OFFER TEXAS XM11 Decoder, new and tested, limited quantity at ½ price, £65, p/p £1.40. Stab. power supply (5V) for Teletext decoders, £5.80, p/p £1. Thorn design XM11 interface unit, £1.80, p/p 80p. NEW SAW FILTER IF AMP PLUS TUNER (complete & tested for sound & vision), £28.50, p/p £1. COLOUR BAR & CROSS HATCH GENERATOR KIT (MK4) PAL, UHF aerial input type, 8 vertical colour bars, R-Y, B-Y, grey scale, etc. P/B controls £35. Batt holders £1.50 or stab. mains power supply kit £4.80. De-luxe case £5.20 or alum. case £2.90, p/p £1.40. Built & tested in De-luxe case (battery) £58, p/p £1.50. CROSS HATCH KIT UHF aerial input type also gives peak white & black levels, batt. op. £11, p/p 45p. Add-on GREY SCALE KIT £2.90, p/p 35p. De-luxe case £5.20. UHF SIGNAL STRENGTH METER KIT £17.50. Alum. case £1.80. De-luxe case £5.20, p/p £1.40. CRT TEST & REACTIVATOR KIT for colour & mono £22.80, p/p £1.70. THORN 9000 Touch Tune Remote control receiver unit plus transmitter handset £16, p/p £1.40. THORN 9000 Fascia incl. channel select. indicator, set controls, speaker, £5.80, p/p £1.60. TV SOUND IF TRANSTD. Tested, £6.80, p/p 85p. BUSH SURPLUS IF PANELS. A816 £1.80, TV312 (single I.C.) £5, Z718/BC6100 £5, A823 (Exp) £2.80, p/p 85p. BUSH Z718/BC6100 Line Time Base Panel Z904, incl. LOPT, EHT stick. Focus, etc., 18in or 22in, £15, p/p £1.60. BUSH 161 series TB panel A634 £3.80, p/p £1.20. DECCA colour TV Thyristor Power supply £3.80, p/p £1.40. GEC 2010 series TB panel £1, p/p 90p. GEC 2040 CDA panel £4.50, p/p £1.20. PHILIPS. G6 S/S conv. panel £2.50, p/p £1.20. G8 Decoder panels for spares £1.80, p/p £1.20. G9 Signal panels for small spares £3.80, p/p £1.20. THORN 3500 Line TB panel £5, p/p £1. 3000 ex-rental panels IF, VIDEO, DECODER, £5, p/p £1.20. 8000/8500 TB salv/spares £4.80, p/p £1. 9000 Line TB (incl. LOPT) salv/spares £7.50, p/p £1.60. COLOUR SCAN COILS (Mullard or Plessey) £6, p/p £1.80. Yoke £2.50, p/p £1. Blue Lat 75p, p/p 35p. Mono Scan Coils (Thorn, Philips, Pye) £2.80, p/p £1. VARICAP UHF TUNERS. Mullard U321 £7.80, ELC1043/05 £5.50. G.I. £3.50. Salv. (asstd) £1.50, p/p 45p. Varicap UHF/VHF ELC2000S £8.50, Bush (dual) £7.50, p/p 70p. TOUCH TUNE CONTROL units, Bush (6 pos) £4.50, p/p 80p. VARICAP CONTROL UNITS 3 pos. £1.20, 4 pos. £1.50, 5 pos. £1.80, 6 pos. £1.80, 6 pos. special offer £1, p/p 45p. UHF transtd. Tuners (rotary) incl. s/m drive £2.50, 4 pos. P/B £2.50, 6 pos. P/B £4.20, p/p £1.20. (Special types available, details on request). DL50 Delay Line £2.50, p/p 50p. Large selection of LOPTS, Triplers, Mains Droppers, and other spares for popular makes of colour & mono receivers. PLEASE ADD 15% VAT TO ALL PRICES. — MANOR SUPPLIES, 172 WEST END LANE, WEST HAMPSTEAD, LONDON, N.W.6. SHOP PREMISES. Tel. 01-794 8751. Easily accessible W. Hampstead Jubilee Tube & Brit Rail N. London (Richmond-Broad St.) and St. Pancras-Bedford. Buses 28, 159, 2, 13. Callers welcome. Thousands of additional items not normally advertised available at shop premises. Open daily all week incl. Saturday (Thursday half day). MAIL ORDER: 64 GOLDERS MANOR DRIVE, LONDON NW11 9HT. PLEASE ADD 15% VAT to all prices. (60

FOR SALE

Almost unused Tektronix TM506 mainframe with:—
DM502 Autoranging DMM
DC503 Universal Counter
PG501 Pulse Generator
PS503A Dual Power Supply
COST NEW £1,550. OFFERS IN EXCESS OF £800 REQUIRED
PHONE: Day — 01-242 6939
(781)

TOWERS' INTERNATIONAL MICROPROCESSOR SELECTOR

by T. D. Towers Price: **£15.70**
THE CP/M H/B WITH MP/M by R. Zaks Price: **£9.50**
YOUR FIRST COMPUTER by R. Zaks Price: **£6.40**
OPTICAL FIBRE COMMUNICATION SYSTEMS by C. P. Sandbank Price: **£18.60**
THE ACTIVE FILTER H/B by F. P. Tedeschi Price: **£4.85**
INFORMATION TRANSMISSION MODULATION, & NOISE by M. Schwartz Price: **£8.00**
OPERATIONAL AMPLIFIERS by B. G. Clayton Price: **£11.70**
DESIGN OF TRANSISTOR CIRCUITS WITH EXPERIMENTS by Dr. K. A. Pullen Jr. Price: **£9.15**
DIGITAL ELECTRONICS FUNDAMENTAL CONCEPTS & APPL. by C. E. Strangio Price: **£17.30**
RADIO & TELEVISION SERVICING 1979/80 MODELS by R. N. Wainwright Price: **£16.50**

★ 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)

WANTED

SURPLUS TEST EQUIPMENT
Electronics Components
Prompt Settlement
Cooke International Services
Ramalla House, Ancton Lane, Middleton-on-Sea, Bognor Regis, Sussex
Tel. 024-369 2849
(783)

WIRELESS WORLD 1969 to 1979 inclusive. Good condition. Offers. Phone Egham (Sy) 32234. (793

POTENTIOMETERS

Rotary carbon track pots. Standard A.B. type 45. Spindles ¼in. dia. × 1⅝in. long 0.25W log/0.5W linear.
SINGLE GANG. Values 1K to 1M.
£14.50 per 100 of 1 value/**£16.50** per 100 mixed.
SINGLE GANG WITH D.P. SWITCH
Values 2K5 to 500K.
£25 per 100 of 1 value/**£27** per 100 mixed.
DUAL GANG. Values 1K to 1M.
£33 per 100 of 1 value/**£35** per 100 mixed.
2 Watt WIREWOUND. Type ABW2 Spindles ¼in. dia. × 1½in. long. Values: 25R, 50R, 100R, 1K, 2K5, 5K. **£25** per 100 of 1 value/**£27** per 100 mixed.
All above supplied with nuts & washers
J.P.R. DISTRIBUTORS
49 Wadeson Street, London, E2 9DP
Tel: 01-980 1028/1029 (827)

THINKING OF RENTING A TELEPHONE ANSWERING MACHINE?

THEN STOP!

Did you know that for the equivalent of just one year's rental you could actually buy one outright?

For details write to:
Javal Supplies Ltd. (Dept. 2C), 120 Alexandra Road, Burton-on-Trent, Staffs DE16 0JB or telephone (0283) 47427 any time.
(337)

CRYSTAL for Scanner and Receiver

10.7 MHz IF HC25/u
£3.50/pcs. from stock or special order.
We stock over 10,000 pieces.

[illegible] ag
Dubendorfstr. 335
CH-8051 Zürich

Write for free documentation.
(795)

AERIAL BOOSTERS, improve weak V.H.F. radio and TV reception. price £6.70. S.a.e for leaflets. Electronic Mailorder. Ramsbottom. Lancs. BL0 9AGE. (978

COMP-80 computer 3K ROM, 5K RAM. Graphics and UHE modulator fitted, £190. — Tel. Thurso 3652. (690

U.K. AIRPORT frequencies list £1. UK coast station frequencies list £1. — PLH Electronics, 20 Vallis Road, Frome, Somerset. (792

TEST EQUIPMENT. Well-established trading company seeks new customers, particularly from overseas. We are bulk suppliers of used electronic test equipment to the trade, ie: signal sources, analysers, bridges, scopes, sweepers, counters, PSUs, Polyscops, DVMs, etc. Whole or part parcels available. Carriage and shipping can be arranged. State your requirements. Terms negotiable: Also interested in purchasing parcels of anything electronic, radio, etc, speedy quotations, and immediate cash settlement. COOKE INTERNATIONAL SERVICES, Ramalla House, Ancton Lane, Middleton-on-Sea, Bognor Regis, Sussex PO22 6NJ. Tel: 024-369 2849. (654

CLEARANCE PARCELS: Transistors, resistors, boards, hardware, 10lbs only £5.80! 1,000 Resistors £4.25, 500 Capacitors £3.75. BC 108, BC 171, BC 204, BC 230, 2N 5061, CV7497 Transistors, 10-70p, 100-£5.80. 2N 3055, 10 for £3.50. S.a.e. lists: W.V.E. (3), 15 High Street, Lydney, Glos. (444

BUILD YOUR OWN LASERS. Full plans and instructions on how to construct three fully working lasers: Pulsed dye, Argon and Helium — neon, at a fraction of the cost of a commercially produced device. All parts available. Send £4.95 plus 25p P&P to A. V. Services, 10 Agecroft Road West, Prestwich, Manchester M25 8RL. Also Laser Scanning Systems. Send for literature. (647

RACAL MA-259-G secondary frequency standard. New with test certificate. £595. — Nottingham 0602-397446 evenings. (703

SOLARTRON DISPLAY UNIT type 2100, freq 100 Khz 40 GHz, price £495. Tektronix storage scope split bin type 564B with sampling plug in units, £395. 585A scope with 82 plug in units, £195. Please phone 01-404 5011. (811

TWO RECORDING oscillographs Bell & Howell 5-137, 5-124, with manuals, excellent condition, little used. Offers to Box WW 810. (810

S/H ELECTRONIC TEST EQUIPMENT in bulk or singly. Cooke International Services. Ramalla House, Ancton Lane, Middleton-on-Sea. Bognor Regis, Sussex. Tel. 024-369-2849. (782

TEKTRONIX 85 MHz Scopes, Type 585A + 82. Plug-in £290. Type 581A + 86 Plug-in £220. GR Oscillator 60-500 MHz £30. HP VV's £15 ea. — Phone evenings 02514-6483 (Fleet). (785

SERVICES

SAVE TIME!

PRINTED CIRCUIT BOARD
INTERNATIONAL FAST TURNAROUND TOTAL MANUFACTURING SERVICE

- PTH boards in 3 days.
- Conventional boards in 24 hours.
- Soldermask, component legends etc.
- Artwork service.
- Prototype assembly.
- Volume assembly in our plants in the Far East.

AEC Microtechnology
Tanners Drive, Blakelands, Milton Keynes, Bucks.
Telex: 837879 AECLTD G
TEL: 0908 611086 (624)

AEC MICROTECHNOLOGY

DESIGN, DRAUGHTING and DEVELOPMENT

- Services of experienced Engineers & Draughtsmen
- Tracing and Illustrating
- PCB design & manufacture
- Precision photography
- Dyeline prints, Photocopies (818)

3D ENGINEERING LTD
READING (0734) 582579

CIRCOLEC

THE COMPLETE ELECTRONIC MANUFACTURING SERVICE

Let us realise all or any part of your project from prototypes to production, from artwork design and component sourcing, through assembly and test to final quality assurance, packing and delivery.

We also provide a test, repair and modification service to suit your individual requirement.

For competitive prices and fast turnaround contact:

CIRCOLEC, 1 Franciscan Road, Tooting, S.W.17
Telephone: 01-767 1233 (544)

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! (9630)
EURO CIRCUITS TD.
Highfield House
West Kingsdown
Nr. Sevenoaks, Kent. WK2344

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

MICROPROCESSOR SYSTEMS

Original hardware and software design, prototype build and development, batch production and testing.
May we help you with your new project?
DEACON INSTRUMENTS LTD.
Knowl House, Hibbert Road
Maidenhead, Berks.
Tel: (0628) 29701
(816)

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

SERVICES

P.C.B. PROTOTYPE and small batch production. Design layout, assembly and testing. Fast, relible service. Wye Valley Electronics, 15 High St, Lydney, Glos. Tel: Dean (0594) 41267. (365)

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

TUBE REBUILDING PLANTS PROCESS, all TV tubes can be seen in operation. They can be installed internationally at the best price: 554 Stafford Road, Birmingham B11 AAL. (592

DESIGN AND DEVELOPMENT. ANALOGUE, DIGITAL, RF AND MICROWAVE CIRCUIT AND SYSTEM DESIGN. Also PCB design, mechanical design and prototype/small batch production. — Adenmore Limited, Unit 103 Liscombe, Bracknell, Berks. Tel: Bracknell 52023. (656

ALTRONIC SYSTEMS LTD. Alarm systems designed and manufactured to your requirements. Free estimates under no obligation. — Tel Ansafone 07073 30514. (715

ELECTRONIC DESIGN SERVICES. MICROPROCESSOR HARDWARE and SOFTWARE design facilities have now been added to our established expertise and comprehensive test facilities previously available to you for ANALOGUE and COMMUNICATIONS designs. — For fastest results please phone Mr. Anderson, Andertronics Ltd, Ridgeway, Hog's Back, Seale (nr. Farnham), Surrey. 02518-2639. (275)

SHEET METAL WORK, fine or general front panels chassis, covers, boxes, prototypes. 1 off or batch work, fast turnround. 01-449 2695. M. Gear Ltd., 179A Victoria Road, New Barnet, Herts. (812

MICRO-ELECTRONIC design and development work undertaken by professional engineers. — Contact Box No. WW 784. (784

ARTICLES WANTED

WANTED!

all types of scrap and

REDUNDANT ELECTRONIC & COMPUTER MATERIALS

with precious metal content

TRANSISTORS & PRINTED CIRCUIT BOARDS TO COMPLETE COMPUTERS

THE COMMERCIAL SMELTING & REFINING Co. Ltd.
171 FARRINGDON ROAD
LONDON EC1R 3AL
Tel: 01-837 1475
Cables: COMSMELT, EC1
Works: FLECKNEY, Nr. LEICESTER
(205)

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

SPOT CASH

paid for all forms of electronics equipment and components.

F.R.G. General Supplies
550 Kingston Road, London
Tel: 01-404 5011
Telex: 24224 Quote Ref 3165
(8742)

WANTED

ANGLIAN INDUSTRIAL AUCTIONS

We sell by auction, all radio and electronic components and equipment. Why not let us sell your surplus and end of production materials. All entries must be received at least 21 days prior to sale.

For entry forms or catalogue of next auction contact:

B. BAMBER ELECTRONICS
5 STATION ROAD
LITTLEPORT
CAMBS. CB6 1QE
TEL: (0353) 860185
(263)

DEAD OR ALIVE

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)

CAPACITY AVAILABLE

PCB ASSEMBLY CAPACITY AVAILABLE

Low or high volume, single or double sided, we specialise in flow line assembly.

Using the Zevatron flow soldering system and on line cutting, we are able to deliver high quality assemblies on time, and competitively priced.

Find out how we can help you with your production. Phone or write. We will be pleased to call on you and discuss your requirements.

TW ELECTRONICS LTD.
120 NEWMARKET ROAD
BURY ST. EDMUNDS, SUFFOLK
TEL: 0284 3931

Sub-contract assemblers and wirers to the Electronics Industry
(9068)

SMALL BATCH productions wiring assembly to sample or drawings. Specialist in printed circuits assembly, Rock Electronics, 42 Bishopsfield, Harlow, Essex 0279 33018. (9094

BATCH PRODUCTION wiring and assembly to sample or drawings. McDeane Electricals, 19b Station Parade, Ealing Common, London, W5. Tel. 01-992 8976. (169

ELECTRONIC DESIGN SERVICE. Immediate capacity available for circuit design and development work, PC artwork, etc. Small batch and prototype production welcome. — E.P.D.S. Ltd., 93b King Street, MAIDSTONE, Kent. 0622-677916. (9667

PCB ARTWORK DESIGN SERVICE with component notation masters and assembly drawings. PADS Electrical Ltd, 01-850 6516, 45 Southwood Road, New Eltham SE9. (7905

The AIRAMCO Mikro 1000 —The Scottish Solution.

The Mikro 1000 is a Scottish built micro-computer which combines State of Art technology with simplicity and durability to give a powerful small business system at a very competitive price.

Driven by a 2.5 MHz or 4 MHz Z80 processing unit constructed around Industry Standard S100 Bus, the Mikro 1000 is designed to provide the ease of expansion necessary in a modern growing business or industry - memory is expandable from 32K to 256K, with up to 4 Megabytes of on-line disk storage.

The integral VDU has an 80 cols. x 24 lines screen, and incorporates a green phosphor CRT, while the 117 key keyboard can be used remotely from the main body of the machine, and may be programmed for user functions such as word processing commands.

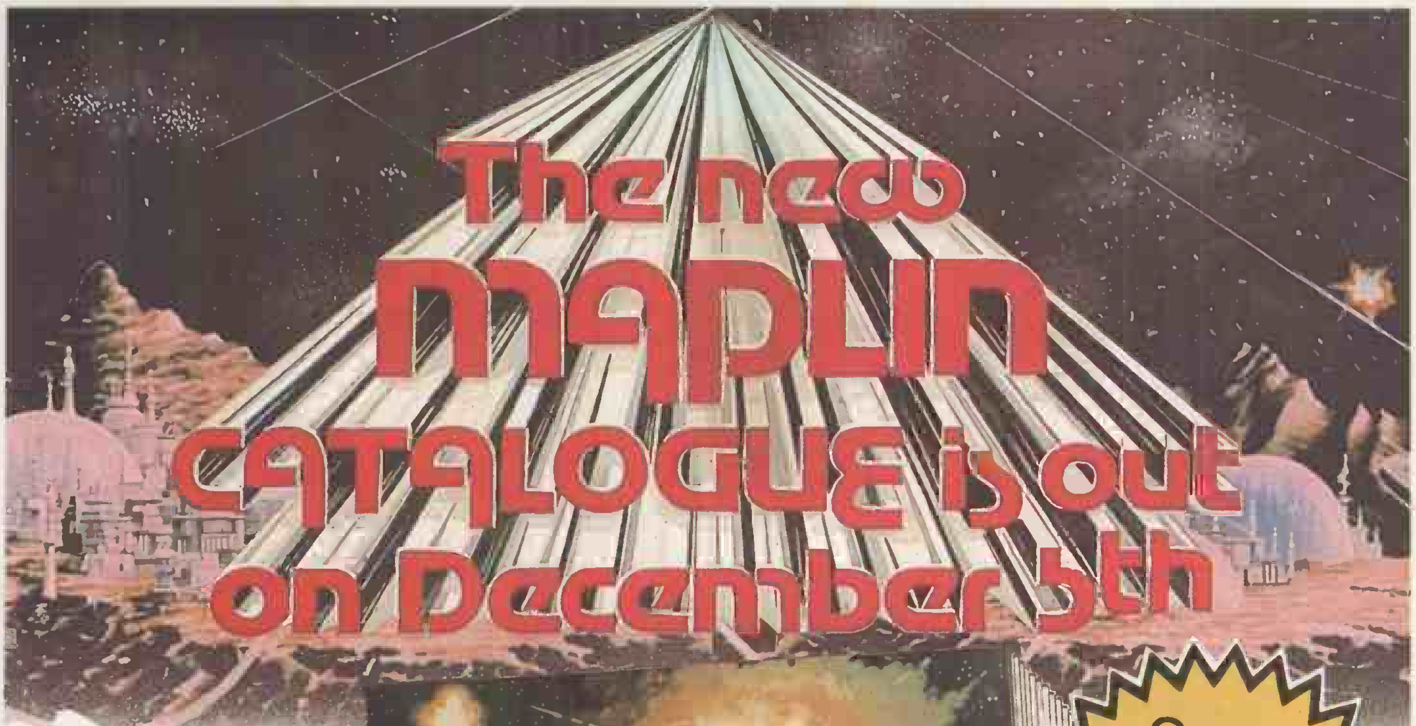
As well as supporting all CP/M based languages, the Mikro 1000 has a full range of business software, including Sales, Purchase and Nominal Ledger, Inventory Control, and Payroll, as well as Word Processing (which is available at even lower cost as a separate system on the Mikro 1000 WP).

For further information on either Mikro 1000 system, please contact:

airamco
AIRAMCO LIMITED

Unit A2, Longford Avenue, Kilwinning Ind. Est., Kilwinning, Ayrshire, KA22 8NP.
Tel: 0294 57755 Telex: 779808

WW—113 FOR FURTHER DETAILS



On sale in all branches of W H Smith from Dec 5th price £1

A massive new catalogue from Maplin that's bigger and better than ever before. If you ever buy electronic components this is the one catalogue you must not be without. Over 300 pages, it's a comprehensive guide to electronic components with thousands of photographs and illustrations and page after page of invaluable data. We stock just about every useful component you can think of. In fact, well over 5000 different lines, many of them hard to get from anywhere else. Hundreds and hundreds of fascinating new lines, more data, more pictures and a new layout to help you find things more quickly.

Breadboard 1980
26th to 30th November
Open 10 a.m. till 6 p.m. (and till 8 p.m. Thursday, 4 p.m. Sunday)
Royal Horticultural Halls, Elverton Street, London
(Nr. St. James's Park Underground)
Visit our huge stand and see our new 'single-chip' organ, a new sequencer/composer, and lots more.
Don't miss it!!

MAPLIN

Maplin Electronic Supplies Ltd.
All mail to: P.O. Box 3, Rayleigh, Essex SS6 8LR.
Telephone: Southend (0702) 554155. Sales (0702) 552911.
Shops:
159-161 King Street, Hammersmith, London W6. Telephone: (01) 748 0926.
284 London Road, Westcliff-on-Sea, Essex. Telephone: Southend (0702) 554000.
Both shops closed Mondays.

Post this coupon now for your copy of our 1981 catalogue price £1.
Please send me a copy of your 320 page catalogue. I enclose £1 (Plus 25p 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 UK send £1.68 or 12 International Reply Coupons.

I enclose £1.25

Name ____________________

Address ____________________

W 1280

Multicore™

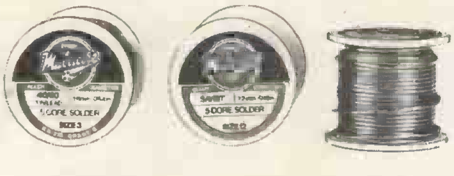
The biggest name in solder worldwide

Products that help you make a better job of it.

Arax Multicore Solder.
Economy pack for general non-electrical use.
Replaces solid wire and stick solder. (B.S. 219 Grade L).
Econopak 200g reel of 3mm dia. Size 16A.
£4.14 per reel.

Handy Dispensers		Per pack
PC115	for printed circuits.	£1.15
SV130	for radio and TV. repairs.	£1.61
AR140	for non-electrical applications, except aluminium	£1.38
SS160	for stainless steel and silver jewellery.	£2.53
19A	for printed circuit boards – non-corrosive.	96p
AL150	for aluminium.	£1.93
BCA16	solder cream for stainless steel, jewellery and household products (non-electrical).	£3.22
BCR10	solder cream for electronic and electrical use.	£1.38
BCA14	all purpose solder cream, non-electrical jointing and repairing.	£1.38

Econopak.
Ersin Multicore 5-core solder. Contains non-corrosive flux for electrical applications.
1.2mm dia. 200g Econopak. Size 13A. **£4.14 per reel.**



Toolbox Reels.
Multicore 5-core solder for general use. Suitable for electrical joints (B.S. 219 Grade C).
40/60 tin/lead. 1.6mm dia. Size 3. **£3.91 per reel.**

Savbit.
Multicore 5-core solder for radio, T.V. and similar work. Reduces copper erosion. Suitable for service engineers and manufacturers using small quantities of solder.
1.2mm dia. Size 12. **£3.91 per reel.**

Metal Soldering.
Arax Multicore 4-acid-core solder for metal fabrication (not aluminium) and repairs.
40/60 tin/lead. 1.6mm dia. Size 11. **£3.91 per reel.**

Multicore Wick.
Multicore solder-wick for removing solder from virtually any joint.
1.7mm dia. Size AB10. **£1.38** per reel.

Tip Kleen.
Multicore Tip Kleen.
Soldering-iron tip wiping pad.
Replaces wet sponges. (Should not be used above 350°C).
81p per pack.

T.V. and Radio Soldering.
Savbit Multicore for radio, T.V. and similar work. Reduces copper erosion.
1.2mm dia. Size 5.
90p per handy dispenser.

Econopak.
General purpose solder suitable for all electrical joints.
40/60 alloy. 1.2mm dia. Size 6. **58p per handy plastic dispenser.**

Aluminium Soldering.
Alu-Sol Multicore 4-core solder for soldering most types of aluminium. No extra flux needed.
1.6mm dia. Size 4. **£11.50 per reel.**

Soldering Flux Pastes.
Multicore soldering flux paste. Extra fast, non-corrosive, rosin-flux for electrical and general purpose soldering.
Rosin R.F.10. 35g net. **69p per pack.**
Multicore soldering flux paste for soft metals (except aluminium) and stainless steel. Non-electrical.
Arax A.F.14. 35g. **69p per pack.**

Wire Stripper and cutter.
Wire stripper and cutter with precision ground and hardened steel jaws. Adjustable to most wire sizes. With handle locking-catch and easy-grip plastic covered handles.
Ref: 9. **£2.69** per pair.

Bib Hi-Fi Accessories Ltd., (Solder Division),
Kelsey House, Wood Lane End,
Hemel Hempstead, Hertfordshire HP2 4RQ.
Telephone: (0442) 61291.

All recommended retail prices shown are inclusive of VAT. If you have difficulty in obtaining any of these products send direct with 40p for postage and packing. For free colour brochure send S.A.E.

WW—022 FOR FURTHER DETAILS