

Reels

Three solders that cover all your electrical 40/60 Tin/Lead

£2 16 each Size 3 £2.29 each Saybit Alloy/ Size 12

Soldering Flux Paste A fast non-corrosive, rosin flux for general and electrical soldering.

Use in conjunction with 'Ersin' Multicore solders. Size RF10 48p inc. VAT 'Arax' Use in conjunction with 'Arax' Multicore solder for general metal fabrication. Size AF14 48p inc. VAT

Multicore Desoldering Wick

For desoldering component leads from PCB's or noving solder from virtually any joints. Size AB10 97p inc. VAT



Easily adjustable for most sizes of flex and cable. Fitted with extra strong spring for automatic opening. Easy grip handles

locking device.



Savbit Dispenser

For radio, TV and similar work Reduces copper erosion.

Size 5 58p inc. VAT

Emergency Solder

Self fluxing, tin/lead solder tape that melts with a match. For electrical and non-electrical pplications. Size ES36 39p inc. VAT



A reel of 1.2mm 'Ersin' Multicore solder for general electrical use. | Size 13A £2.59 inc. VAT A reel of 3mm 'Arax' Multicore solder for general non-electrical use.

Size 16A £2.59 inc. VAT

Solder Cream

Tacky mixture of solder powder, and correct percentage of flux for difficult to reach areas. Flectrical/Electronic ('Ersin' Flux) Size BCR10 £1.08

Size 19A All electrical work Size PC115 For small components Size SV130 Use with copper bits and wires 69p £1.08 Metal joining ('Arax' flux) Size BCA14 £1.08 Size AR140 Metal repairs Stainless Steel & Jewellery ('Arax Flux) Size BCA16 £1.38 Size AL150 Aluminium Size SS160 Stainless Steel (All prices inc. V.A.T.) Bib keepsit playing



Make editing simple with the Bib splicer, tape cutter and splicing tape. Standard pack with 6.3mm adaptor.

> In permanent storage case with tape piercer and winder remover.
> Ref 98 £2.70 inc. VAT

USA Pat. No. 4067563 (splicer) Brit, Pat. No. 1507583 (splicer) No. 1258280 (method of splicing)



Groov-Kleen

Handy Dispensers (All prices inc. V.A.T.)

Parallel tracking, it cleans whilst disc plays. Engineered in chromed steel and with two bases to suit all decks. Pat. Pending Ref 101A Brit. Reg. Des. No. 982790 U.S.A. Reg. Des. No. 247622



Groov-Stat Electronic 3000

This improved static reducer, powered by one small battery, neutralises record surface static in seconds. Comes in permanent storage box with FREE

Ref 3000 F9.98 inc. VAT

static tester.

______ nended retail, inc. VAT.



In difficulty send direct, plus 20p P & P. Send S.A.E. for free copy of colour catalogue detailing complete range. Bib Hi-Fi Accessories Limited, Kelsey House, Wood Lane End, Hemel Hempstead, Herts., HP2 4RQ.

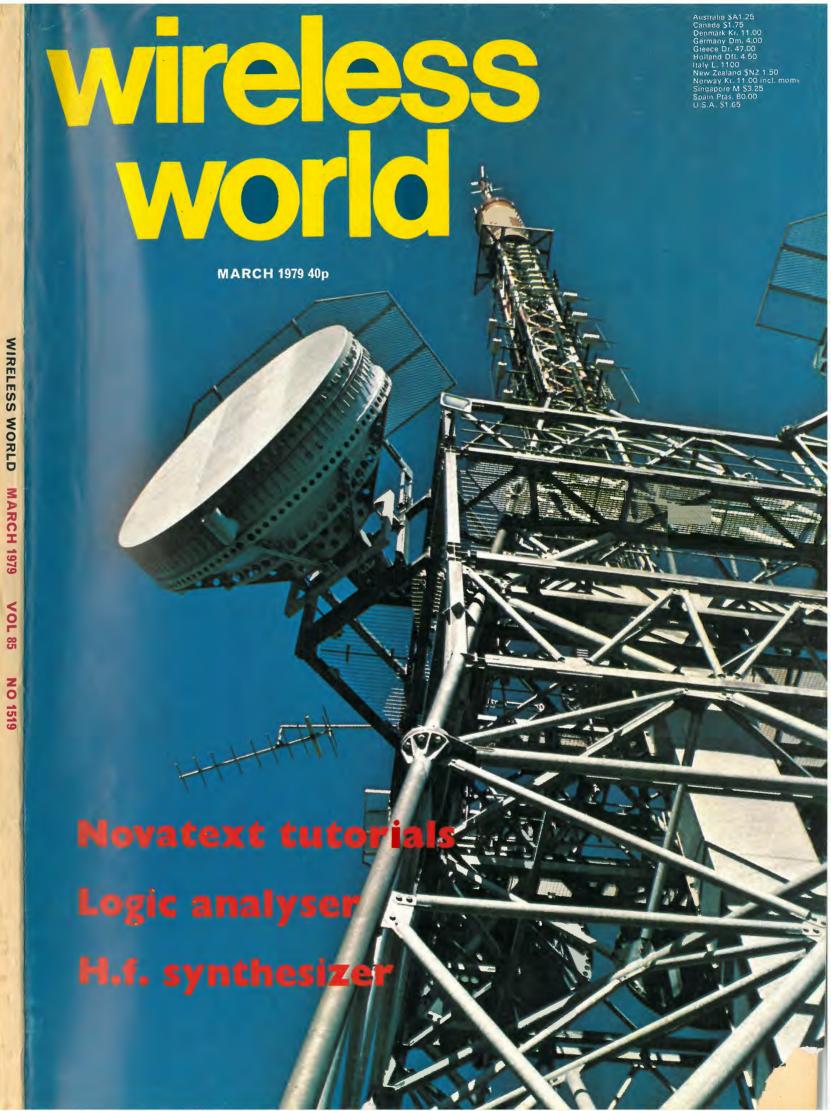


Soft bristles on leading edge remove dust and humid velvet pad collects particles. This advanced cleaner is engineered in chromed steel and is supplied with dust



Everything necessary for cleaning heads, capstan and pinch wheel on all types of

Cleaning and polishing pads, cleaning liquid and brush inspection mirror included.
Standard Pack Ref 25 £1.99 inc. VAT Permanent Storage Box with cleaning cloth Brit. Pat. No. 1485069 Ref 99 £2.70 inc. VAT





A Synthesized Signal Generator from mi \$8,000? £6,000? £4,000? under £2,000?

Somehow some of our customers have been persuaded that our prices are as big as we are. Sometimes the biggest brains are the most cost-conscious brains. For example, our illustration shows a synthesized signal generator which costs £1,900*: the new 520MHz TF2015/1 Signal Generator with its associated Synchronizer. With this combination, synthesizer operation is obtainable without any degradation of generator signal purity, performance and versatility.

Leakage specification is lower than any other available VHF/UHF source and output accuracy at low levels beats all others in the price range.

Building on the enviable reputation of the TF2015 for performance, reliability and value, we have now introduced two new a.m./f.m. versions: the TF2015/1 for narrow band mobile radio testing and TF2015/2 for telemetry and other wideband applications. The U.K. price for TF2015/2 with Synchronizer is £2,150*. All have a frequency coverage of 10 to 520MHz with calibrated a.m. and f.m.

Tuning in 100Hz steps whilst under locked conditions provides a valuable facility for bandwidth measurements and channel stepping. Digital setting of frequency with direct readout means no waiting for counter gate times when you want high resolution, and no r.f. leakage from display holes.

*Special U.K. price

One in four

Only one in four of our customers tells us he needs the stability of a synthesizer. So the other three can save almost half the cost of the synthesizer combination by buying the analogue part alone. So, whether you require a synthesizer or a signal generator you can now obtain quality at ordinary prices.

Optional accessories include Pulse Modulator TF2169, i.f. probes for 'squelch killing', multiple calibration plates for units of output level, matching pads, attenuators, reverse power protection and carrying case.

Write or 'phone for full details:

mi MARCONI INSTRUMENTS

Marconi Instruments Limited · Longacres · St. Albans · Hertfordshire · England AL4 0JN · Tel: (0727) 59292 · Telex: 23350

Marconi Electronics Inc · 100 Stonehurst Court · Northvale · New Jersey 07647 USA · Tel: (201) 767-7250 · Twx: 710-991-9752

Marconi Instruments · 32 avenue des Ecoles · 91600 Savigny-Sur-Orge · France · Tel: 996.03.86. · Telex: 600541.F

Marconi Messtechnik GmbH · 8000 München 21 Jörgstrasse 74 · West Germany · Tel: (089) 582 04 · Telex: 5 212642



Front cover shows aerial of Niederhorn television transmitter operated by Swiss PTT on v.h.f. and u.h.f. colour. Photp: The Hamer-Smith Swiss collection

IN OUR NEXT ISSUE

Home computer. The start of a series on the construction and use of a microcomputer, which uses a novel language and which is designed for mathematical problem solving.

Teletext remote control is a further unit designed to extend the usefulness of the Wireless World teletext decoder.

Digital data recording without f.s.k. A simple interface for audio recorders using differentiation.

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

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

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

Telephones: Editorial 01-261 8620. Advertising 01-261 8339. Telegrams/Telex: Wiworld Bisnespres 25137 BISPRS G Cables: Ethaworld, London SE1. Subscription rates: 1 year: £7.00

UK and \$23.40 overseas (\$24 USA and Canada).

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

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

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

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

IPC Business Press Ltd, 1979 ISSN 0043 6062



and Canada)



wireless

ELECTRONICS/TELEVISION/RADIO/AUDIO

MARCH 1979 Vol 85 No 1519

43 Performing blights

44 Low-cost logic analyser — 1 by B. C. Adams

> 49 Novatexts by P. Williams

53 Electronic organ tone system — 5 by A. D. Ryder

58 **Circuit ideas**Thyristor touch tuning Audio switching unit

Continuous d-to-a converter

60 Computer buses — 2 by I. Witten

65 Antennas and propagation — 2° by R. Ashmore

67 The history of displacement current by I. Catt, M. F. Davidson, D. S. Walton

69 H.f amateur band frequency synthesizer → 1 by M. Small

73 **News of the month**Audience response to wavelength changes GEC and Hitachi join forces

77 Communications in tunnels

52 World of amateur radio / 78 Books received / 85 Sixty years ago 91 Literature received

79 Letters to the editor
Mobile c.b. dangers Displacement current Military electronics

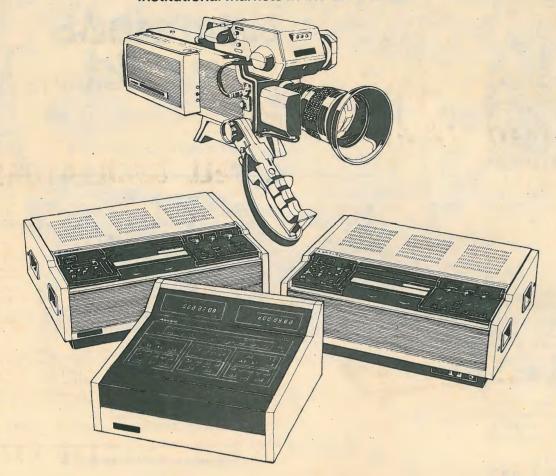
83 Frequency synthesizers — 4 by R. Thompson

86 Magnetic gyration

89 Antenna aiming calculations by R. M. Stephenson

92 New Products

94 Sidebands



JVC. BELL& HOWELL. SUPERSHIELD.

Choose video equipment with all these names in mind.

Above: a new, complete and outstanding video system from JVC. One three-tube colour camera, of studio quality but portable. Two editing U-format video cassette recorders. One automatic editing control unit. Designed to meet broadcast requirements, and therefore excellent in any other application, they should be seen in action before deciding how to re-equip a video production centre which aims at the highest standards (though by no means at the highest current price)

At the other end of the comprehensive JVC range is low-cost equipment for surveillance and similar tasks. Between the extremes: a wide choice of b/w and colour cameras and recorders (reel-to-reel and U-format). And now, of course, VHS-VHS made by the people who invented and developed it, JVC.

For leaflets about JVC video products or, still better, a demonstration, use the coupon. We'll also send you a leaflet on Fuji video tapes, worth reading about because their exclusive Beridox coating is so good for the picture.

We'll also tell you about the third name in our headline, Supershield. This is a new and, we believe, unique guarantee, covering all video and audio-visual products made or distributed by Bell & Howell (excluding only camera tubes, tapes and projector lamps). For two years after purchase, Supershield gives free

technical advice, free parts with no labour charges, and (in mainland Great Britain) free collection from your premises to one of our Supershield workshops and free delivery back to you when the job is done. JVC plus Bell & Howell was already a strong combination. JVC plus Bell & Howell plus Supershield, plus a national network of first-class dealers, should be unbeatable.

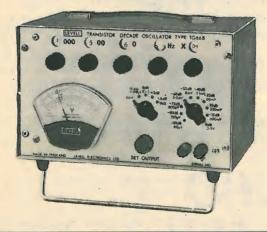
Please tick squares, fill in your nam letterhead and mail in an unstampe Bell & Howell A-V Ltd, Freepost, W Leaflets, please, on:	ed envelope to
JVC video products generally	C VHS Demonstration arrangements
Name	3.
BELLET Information systems. For work.	

WIRELESS WORLD, MARCH 1979









DON'T GAMBLE WITH PERFORMANCE BUY LEVELL OSCILLATORS

FREQUENCY

ACCURACY

SINE OUTPUT

DISTORTION

SQUARE OUTPUT

SYNC OUTPUT SYNC INPUT METER SCALES

SIZE & WEIGHT

1Hz to 1MHz in 12 ranges. 0 to 1% fine control on TG200DMP. $\pm 1.5\% \pm 0.01$ Hz up to 100kHz. ± 2% up to 1 MHz. $7V \text{ r.m.s. down to} < 200 \mu V \text{ with Rs} =$

 600Ω . <0.05% from 50Hz to 15kHz, <0.1% from 10Hz to 50kHz, <0.2% from 5Hz to 150kHz, <1% at 1Hz and

TG200D, DM & DMP only, 7V peak down to <200 µV. Rise time <150nS.

< IV r.m.s. sine in phase with output ± 1% freq. lock range per volt r.m.s. TG200M, DM & DMP only. 0/2V' 0/7V & -14/ + 6dBm260 × 130 × 180mm. 4.3kg with

batteries.

TG200M TG200 TG200D TG200DM TG200DMP

FREQUENCY ACCURACY

SINE OUTPUT DISTORTION

SQUARE OUTPUT SYNC. OUTPUT METER SCALES

SIZE & WEIGHT

3Hz to 300kHz in 5 decade ranges. ± 2% ± 0.1Hz to 100kHz. Increasing to ± 3% at 300kHz 2.5V r.m.s. down to < 200 µV <0.2% from 50Hz to 50kHz.

<1% from 10Hz to 200kHz. 2.5V peak down to < 200 µV. 2 5V r.m.s. sine 0/2.5V & -10/ + 10dB on

TG152DM 260 × 130 × 180mm. 3.4kg with batteries

TG152D

TG152DM

Without

FREQUENCY **ACCURACY**

SINE OUTPUT

DISTORTION

TG66B

0.2Hz to 1.22MHz on four decade controls

± 0.02Hz below 6Hz.

± 0.3% from 6Hz to 100kHz. ± 1% from 100kHz to 300kHz.

- 3% above, 300kHz.

5V r.m.s. down to $30\mu V$ with Rs = 600Ω. <0.15% from 15Hz to 15kHz.

< 0.5% at 1.5Hz and 150kHz.

METER SCALES 2 Expanded voltage and -2/+4dBm 260 × 180 × 180mm. 5.4kg. SIZE & WEIGHT

TG66A

Prices are ex works with batteries. Carriage, packing and VAT Ontional extras are leather cases and mains power units.

Send for data covering our range of portable instruments

ELECTRONICS LTD.

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



Artistic licence?

We at QUAD go to a very great deal of trouble to ensure that with a QUAD 33 in the Cancel position, the voltage delivered to your loudspeakers is a virtually exact RIAA transfer of the voltage the pickup will produce into a stated passive load. Nothing added - nothing taken away.

A visiting journalist recently suggested that we should not do this. Final adjustment should be done by ear, he said.

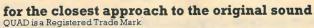
What an opportunity!

After all we know that if we add a little warmth with a subtle boost in the lower middle and balance this with an ever so gentle hump in the quack region (2-3kHz), we can make most programmes sound superficially more impressive. Come to that, why not change the 3180µS to 5000µS adding a little more 'heft' that most people will fall for. We could even make a special model for the boom and tizz brigade.

Been to any live concerts recently?

For further details on the full range of OUAD products write to: The Acoustical Manufacturing Co. Ltd., Huntingdon, Cambs. PE18 7DB Telephone: (0480) 52561





The Ultimate Multi-mate

It's easy to see why Philips new PM 2517 digital multimeter is called The Ultimate Multi-mate. No other DMM comes anywhere near its

combination of laboratory performance and handy form - for such a handy price. Take a look at some of the features it packs in.

Full 4-digit display giving higher resolution than 31/2 digits for 80% of measurements. Parameter readout, too.

Choice of LED or LCD display - choose the one that suits you,

the price is the same. Mains unit supplied free with LED version.

Small and sturdy construction makes this DMM ideal for bench or field work.

Autoranging with manual override. Average auto response time less than two seconds.

High accuracy -necessary to make full use of those four digits. An impressive 0.2% of reading ±0.05% of scale on d.c. volts.

Current to 10A via a separate input is standard, not optional, on the PM 2517

Overload protection that is so comprehensive you have to try very hard to do any damage, even with mains and TV booster voltages.

The Ultimate Multi-mate is available from Wessex Electronics Ltd., 114 - 116 North Street, Downend, Bristol BS16 5SE. Tel: (0272) 571404; Rank Radio International, Watton Road, Ware, Herts. (Tel: Ware 3966); and Philips Service Centres ('phone 01-686-0505 for the address of your nearest branch).

Test & Measuring Instruments

Ergonomic design allows it to work in any position without fuss or fumble.

> from --60 to +200°C.

Data hold option neans that in tricky situations you can "freeze" measurements for increased operator safety and convenience.

Built to international standards - you name them and the PM 2517 meets them. But what else would you expect from an international company like Philips?

It can also be purchased from the U.K. marketing organisation



Pye Unicam Ltd

THINK OF A SHAPE



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

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

S 500D

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

S 250D

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

A complete range of matching transformers and peripheral equipment for closed loop, constant current and voltage use are available.

Alternative input and output termination to order. Rack case for bench use built to specifications. For complete data write or call.



Kirkham Electronics

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

FRANCHISED COMMERCIAL AND INDUSTRIAL AGENTS FOR HIH ELECTRONIC

WW - 065 FOR FURTHER DETAILS







h — build the first working section for just

A range of highly attractive knobs is described to our
catalogue Our prices are very attractive tool



Mobile amateur radio. TV and FM aerials plus lots of accessories are described in our catalogue



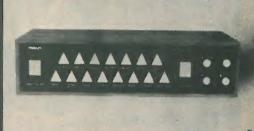
A wide range of disco accessories at marvellous prices. Co catalogue has all the details



Add on have pedil unit for organs. Has excellent bass guiter stull for guitarists accompanion. Specification in our catalogue.



The 3900 synthesiser — build it yourself at a fraction of the cost of one ready made with this specification. Full details in our critalingue.



Touch operated rhythm generator the Drumsette Construction details 25p (Leaflet MES49) Specification in our

MARPLIN

ELECTRONIC SUPPLIES LTD

All mail to:-

P.O. Box 3, Rayleigh, Essex SS6 8LR. Telephone: Southend (0702) 554155.

Shop: 284 London Road, Westcliff-on-Sea, Essex. (Closed on Monday). Telephone: Southend (0702) 554155.



our catalogue Post the coupon novy



PRINTED SOLD WATERS MODINE DUBITS AS THE AND



A massive new catalogue from Maplin that's even bigger and better than before if you ever buy electronic components, this is the one catalogue you must not be without Over 280 pages - some in full colour - it's a comprehensive guide to electronic components with hundreds of photographs and illustrations and page after page of invaluable data

Our bi-monthly newsletter contains guaranteed prices special offers and all the latest news from Maplin



A 53-key ASCII keyboard with 625 line TV interface 4-page

Post this coupon now for your copy of our 1979-80 catalogue price 75p.

Please send me a copy of your 280 page catalogue as soon as it is published (8th Jan. 1979). Lenclose 75p but understand that if I am not completely satisfied I may return the catalogue to you within 14 days and have my 75p refunded immediately. If you live outside U.K. send £1 or ten International Reply Coupons.

IAVIAIC	
ADDRESS	

Our early involvement can save a good idea from becoming a flash in the pan.



In the development of a project, the design engineer cannot afford to become involved too deeply in every associated technology.

He often needs the help of specialists in solving particular problems. Especially where electrical connection is concerned.

AMP Sales Engineers offer such a specialist service. Working in close co-operation with the design team while the ideas are still very flexible can often prove invaluable.

And the results of involving AMP at the earliest stage of design can be dramatic to say the least—more reliable circuitry, improved performance with greater output and economy in production.

In fact, when the capabilities of AMP are coupled to the design team's engineer's flair and inventiveness you have a unique combination. A combination for success.

Call in AMP on your next design job, telephone 01-954 2356.

You'll certainly find our early involvement a great help.

Our connections fit in with your ideas.

AMP OF GREAT BRITAIN LTD., TERMINAL HOUSE, STANMORE, MIDDX,

KGM TV MONITORS thebig

Type 224 - the ruggedized monitor for those really demanding situations - extremes of weather, temperature, vibration and frequent change of site.

Standard KGM monitors range from 12" - 24". Our long experience of CCTV enables us to meet almost any special requirement.

VDU's - visual display units have also been supplied in large numbers to suit customers' requirements. Tell us your needs and we will gladly quote.

Send for your data sheets on the full range of CCTV monitors and cameras designed and manufactured by KGM. KGM also supply an extensive range of ancillaries and distribution units.



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

WW - 043 FOR FURTHER DETAILS



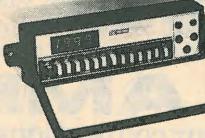
2810 3-1/2 Digit Portable DMM with.5% Accuracy



FEATURES: 31/2 digit easy to read LED display . 0.5% typical DC accuracy Autozeroing · 100μV, .01Ω, mA resolution 10 ohm range and control to zero lead resistance Selectable High-/Low-power

ohms on four ranges · Fully overload protected.

2830 New 3-1/2 Digit Lab DMM



FEATURES: Bright 3½ digit LED display · 0.5% DC accuracy · 100μV, 100nA, .01Ω resolution · 100mV AC and DC ranges · Selectable high-/low-power ohms Autozeroing · Autopolarity · Completely overload protected · AC operation standard, DC power pack optional · Protected against RF interference · Built-in 10 amp current range

Three Of The **Best From**

DYNASCANCORPORATION

For details of the full range of Electronic Test Equipment:including Capacitance Meters DMM'S Frequency Counters Scopes Power Supplies and Semi-Conductor

Contact - Sole UK Distributors

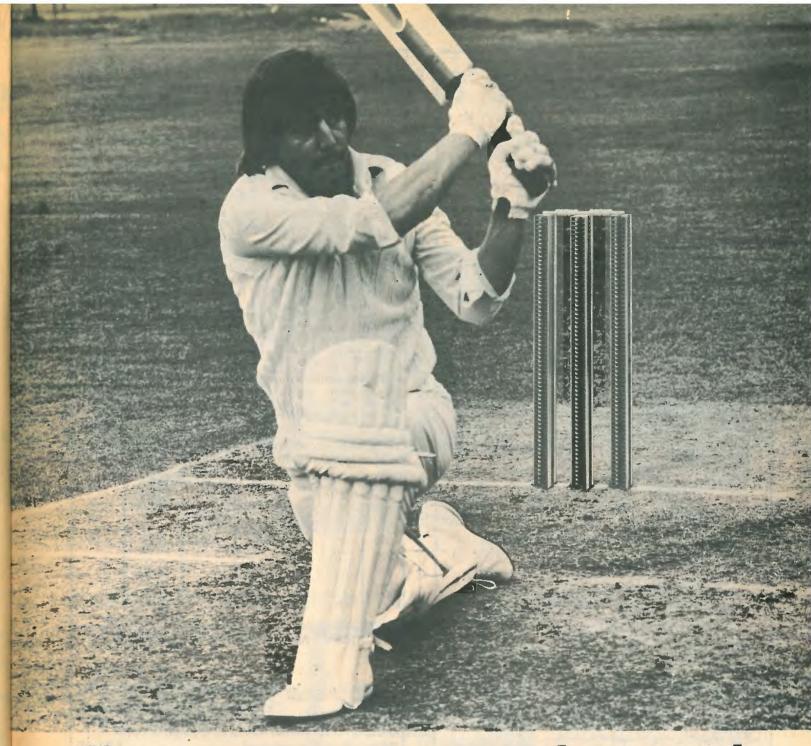
RADIO SUPPLIES (Components) LTD. **P.O.BOX 27** 39 WHITBY STREET, HARTLEPOOL CLEVELAND. TELEPHONE: 0429~75750

820 **New Portable Digital** Capacitance Meter

FEATURES: Measures capacitance to 1 Farad in 10 ranges Resolves to 0.1pF on lowest range · 4 digit easy-to-ready LED display · 0.5% accuracy · Special lead insertion jacks and banana jacks · Fuse protected · Uses either



rechargeable or disposable batteries · Overrange indication.



If you want your connectors to have a good innings specify Ferranti.

Ferranti circuit board edge connectors are known for their staying power. They're designed for a far higher number of insertions and withdrawals than you're likely to make. They need to be, so that you can rely on them throughout their

You'll like our other design features too. Low force spring contacts. Gold flash or full gold plating on the contacts as you wish. Terminals for wire wrapping or soldering. Many options; pitches of .100" (2.54mm)—modular connector, .150" (3.81mm), .156" (3.96mm) and .200" (5.08mm).

Contact: Connector Sales, Ferranti Limited, Professional Components Department, Dunsinane Avenue, Dundee DD2 3PN, Scotland. Telephone: 0382 89321 Telex: 76166 Distributors: Giltech Components Ltd., 22 Portman Road, Battle Farm Industrial Estate, Reading, Berks RG3 1ES Telephone: 0734 582131

Connector Capability

WW - 012 FOR FURTHER DETAILS

New from AMCRON Real Time Analyser RTA2



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

- ★ 5° CRT Display ★ Internal Pink Noise Source
- ★ //₃ or 1 octave Display
 ★ Frequency range 20 20kHz
 ★ Outputs for X-Y Recorders
 ★ Compatible with any microphone

- ★ Price £1,960 ex. VAT

POWER AMPLIFIER D75



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

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

Other AMCRON products include:

DC300A amplifier 500 watts/chan.	2550
D150A amplifier 200 watts/chan	2350
VFX2A Electronic Variable Filter	2270
EQ2 Equaliser	
IC150A Pre-amplifier	
IMA Intermodulation Distortion Analyser unit	610

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

Туре	Width	Height	Depth	no vents	with vents	leg
21 22 23 24 25A 25B 26A 26B 27A 27B 28A 28B 29A 30A 30B 31A 31B 61 62 63 64 65 66	6½" 8½" 10½" 12½" 6½" 6½" 8¾" 12¼" 12¼" 14" 10" 10" 12" 14" 15½" 15½" 17½" 16½" 17½"	4½" 5½" 6½" 7½" 4½" 5¾" 5¾" 10½" 10½" 4" 5" 6" 6" 7½" 8½" 9½"	4½" 5½" 6½" 7½" 6¼" 6¼" 8¼" 5½" 6½" 8½" 6½" 1½" 1½" 1½"		5.88 6.50 7.70 8.45 6.60 8.50 8.85 9.35 10.05 10.90 11.85 7.75 8.13 8.50 8.85 9.63 13.00 15.00 15.00 17.15 17.15	1.15 1.30 1.30 1.30 1.30 1.30 1.30 1.30 1.30

INSTANT TRUNKING SYSTEM!



Ready to use. Internal wiring suitable for 30 amp

	TR6 — 6 sockets switched	 £21.5
-1	TR9 — 9 sockets switched	 £25.5
	P&P £1.85	+VA

PORTABLE POWER DISTRIBUTION **FOR INSTANT MAINS!**

NEW! 10 sockets switched in sloping box



Type 13A/10SW £27.50. P&P £1.85 + VAT



COMPLETE WITH 6FT. CABLE AND 13



£14.30 6 sockets 13A switched

ALL DISTRIBUTION PANELS ARE FITTED WITH MK SOCKETS & PLUG Send for details of complete range + postage 85p each + 8% V.A.T.

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

WW-017 FOR FURTHER DETAILS

The professionals' colour pattern generator

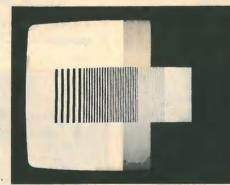


Over 20 patterns to CCIR or RTMA standards

- Full RF coverage: TV IF, Band I-III- IV and V.

WIRELESS WORLD, MARCH 1979

- Electronic tuning and choice of six preset channels.
- Synchronisation according to TV standard, also obtainable as composite and frame sync.
- Adjustable Video, calibrated chroma/burst and variable RF amplitude,
- Internal/external video and sound modulation.



Linearstaircase signal with 8 identical steps combined with definition pattern of 5 vertical bars at 0.8 - 1.8 - 2.8 - 3.8

compact but very versatile pattern generator. More than 20 patterns are available on six channels frequencies using instant touch-button selection. The RF, video and trigger outputs are superior to many other portable generators and closely resemble those

Pye Unicam Ltd Find out more about the PM 5519 and the rest of the Philips audio and video service Philips Electronic Instruments Dept York Street, Cambridge, England CB1 2PX Tel: Cambridge (0223) 58866 Telex: 817331

This pattern generator is the finest

including domestic TV receivers.

cable TV installations.

Service technicians, video

available for precise measurement and alignment work on video equipment

VCR's, VTR's, VLP's, closed circuit and

development engineers, TV broadcast

transmitted from your local TV station.

staff and lecturers will all appreciate the quality and ease of use of this

Test & Measuring. Instruments

equipment range by requesting our new Service Brochure.

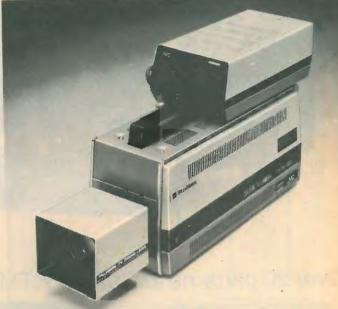
OSCILLOSCOPES 10 – 150 MHz
DIGITAL & ANALOGUE MULTIMETERS
CONVERSATIONAL DATA LOGGERS
RECORDERS CHART & X - Y
LF & RF OSCILLATORS
MICROWAVE EQUIPMENT
DC POWER SUPPLIES & AC STABILIZERS
FREQUENCY COUNTERS & TIMERS
TV STUDIO & TRANSMISSION INSTRUMENTATION
PULSE GENERATORS
AUDIO & VIDEO SERVICE EQUIPMENT

Buying video equipment?

Then talk to someone who picks horses for courses better than most.



The JVC VHS recorder and GC3300 camera form an economical colour system for duties like rôle playing and product demonstrations.



A three-tube colour camera with a wide range of applications: JVC's NUI800.



Fuji video tapes-among the world's finest-are a comprehensive range extending from VHS to broadcasting.



The outstanding new JVC CY8800, truly portable but with a 'studio' standard of performance.

WIRELESS WORLD, MARCH 1979

Before making a purchasing decision, talk to one of Bell & Howell's specialist video dealers. You'll find he's a specialist with some special qualities. He knows everything worth knowing about the IVC and other video products distributed by Bell & Howell, as you'd expect. He also knows which of these products, or which combination of them, is likely to be best for whatever video job you have in mind.

Indeed, he'll even resist the temptation to sell you any kind of video equipment if your message can be conveyed just as well by a tray of slides plus a cassette of audio tape. Conversely, he'll have the courage to start talking in four figures, or maybe five, if a substantial investment is what you've got to make.

And, when the decision has been made and the order placed, you have a guarantee of highly skilled free advice on anything to do with the equipment you buy. That's part of the exclusive new Bell & Howell Supershield warranty, which also guarantees free replacements or repairs, with no labour charges, for two years from the date of purchase.*

First-class video equipment, First-class advice. The support of a first-class (and, we believe, unique) guarantee. For all of these, just contact one of the Bell & Howell specialist video dealers whose names and addresses you can obtain by using the inquiry service or writing in an unstamped envelope to Bell & Howell A-V Ltd, Freepost, Wembley, Middlesex, HA0 IBR (01-903 5411).

*This two-year warranty even includes video heads and excludes only video tapes and camera tubes. In mainland Britain, too, we collect and deliver free when guarantee service is required.





CR8500LE, JVC's new U-format recorder, designed for assemble and insert editing and with important special features.



One of the current IVC range of 3/4 in. U-format video cassette recorders, with full remote control.



A JVC configuration for U-format recording on location, based on the CR4400 portable recorder and two-tube GC4800 colour camera.



The JVC accessory range extends from simple vision switches to effects and mixing units—and beyond.

100,000,000,000,000 Ohms



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

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

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

You'll never meet a better meter



AVOLimited, Archeliffe Road, Dover, Kent, CT17 9EN Tel: 0304 202620 Telex: 96283

Thorn Measurement & Components Division

WW - 039 FOR FURTHER DETAILS



Only Valves are good enough for this customer.

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

Valves, and only valves, can provide the level of performance many listeners now demand. M-OV Beam Tetrode KT77 and KT88 valves meet

all audio market requirements from 30-200 watts. KT77 is especially rugged and

ultra linear

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

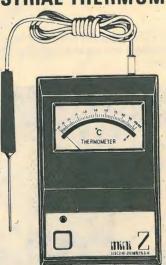
Get in touch with us now for technical data and details of worldwide distribution.



88C THE M-O VALVE CO LTD, HAMMERSMITH, LONDON, ENGLAND W6 7PE TELEPHONE 01-603 3431. TELEX 23435. GRAMS THERMIONIC LONDON

WW - 028 FOR FURTHER DETAILS

ELECTRONIC INDUSTRIAL THERMOMETER



THE MODERN WAY TO MEASURE TEMPERATURE

A Thermometer designed to operate as an Electronic Test Meter. Will measure temperature of Air, Metals, Liquids, Machinery, etc., etc. Just plug-in the Probe, and read the temperature on the large oper scale meter. Supplied with carrying case, Probe and internal 11/21 volt standard size battery.

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

Write for further details to

HARRIS ELECTRONICS (LONDON)

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

WW-015 FOR FURTHER DETAILS

15-240 Watts!

Preamplifier

The HYS is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.); are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HYS is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack — Multi-function equalization — Low noise — Low distortion — High overload — two simply combined for stereo.

APPLICATIONS: Hi-Fi — Mixers — Disco — Guitar and Organ — Public address.

SPECIFICATIONS:

SPECIFICATIONS:
INPUTS Magnetic Pick-up,3mV Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3.100mV; input impedance 47kQ at 1kHz.
OUTPUTS Tape 100mV; Main output 500mV R.M.S.

ACTIVÉ TONE CONTROLS Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION 0.1% at 1kHz; Signal/Noise Ratio 68dB.

OVERLOAD 38dB on Magnetic Pick-up; SUPPLY VOLTAGE ± 16.50V

Price £6.27 + 78p VAT. P&P free. HY5 mounting board B1 48p + 6p VAT P&P free.

HY30

15 Watts into 80

The HY30 is an exciting New kit from I.L.P., it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available. **FEATURES**: Complete kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build. **APPLICATIONS**: Updating audio equipment — Guitar practice amplifier — Test amplifier — Audio

OUTPUT POWER 15W R.M.S. into 8Q. DISTORTION 0.1% at 15W. INPUT SENSITIVITY 500mV, FREQUENCY RESPONSE 10Hz-16kHz -- 3dB. SUPPLY VOLTAGE ±18V.

Price £6.27 + 78p VAT. P&P free.

HY50

25 Watts into 80

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High

the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components.

APPLICATIONS: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier.

SPECIFICATIONS: INPUT SENSITIVITY 500mV.

OUTPUT POWER 25W RMS in 80 LOAD IMPEDANCE 4-160. DISTORTION 0.04% at 25W at

SIGNAL/NOISE RATIO 75dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE ± 25V. SIZE 105.50.25mm.

Price £8.18 + £1.02 VAT. P&P free.

HY120

60 Watts into 8Ω

The HY120 is the baby of I.L.P's new high power range, designed to meet the most exacting requirements including load line and thermal protection, this amplifier sets a new standard in modular FEATURES: Very low distortion - Integral Heatsink - Load line protection -- Thermal protection --

Five connections — No external components. **APPLICATIONS:** Hi-F, — High quality disco — Public address — Monitor amplifier — Guitar and

SPECIFICATIONS:

INPUT SENSITIVITY 500mV
OUTPUT POWER 60W RMS into 8\(\Omega\) LOAD IMPEDANCE 4-16\(\Omega\), DISTORTION 0.04\% at 60W at: SIGNAL/NOISE RATIO 90dB. FREQUENCY RESPONSE 10Hz-45kHz —3dB. SUPPLY VOLTAGE

Size: 114 x 50 x 85mm.

Price £19.01 + £1.52 VAT. P&P free.

HY200

HY400

120 Watts into 8Ω

The HY200, now improved to give an output of 120 Watts, has been designed to stand the most rugged conditions, such as disco or group while still retaining 'true Hi-Fi performance.'

FEATURES: Thermal shytdown — Very low distortion — Load line protection — Integral Heaisink.

No. external components:

APPLICATIONS: Hi-Fi — Disco. — Monitor — Power Slave — Industrial — Public address

INPUT SENSITIVITY 500mV.
OUTPUT POWER 120W RMS into 8Q. LOAD IMPEDANCE 4-16Q.DISTORTION 0.05% at 100W at

SIGNAL/NOISE RATIO 96dB. FREQUENCY RESPONSE 10Hz-45kHz - 3dB. SUPPLY VOLTAGE 1

SIZE 114 x 100 x 85mm

Price £27.99 + £2.24 VAT. P&P free.

240 Watts into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ωl It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown — Very low distortion — Load line protection — No external

APPLICATIONS: Public address — Disco — Power slave — Industrial

SPECIFICATIONS:

OUTPUT POWER 240W RMS into 4Q. LOAD IMPEDANCE 4-16Q. DISTORTION 0.1% at 240W at 1 kHz. SIGNAL/NOISE RATIO 94dB. FREQUENCY RESPONSE 10Hz-45kHz -- 3dB. SUPPLY VOLTAGE

INPUT SENSITIVITY 500mV. SIZE 114 x 100 x 85mm.

Price £38.61 + £3.09 VAT. P&P free.

POWER SUPPLIES

PSU36 suitable for two HY30's £6.44 + 81n VAT PSU50 suitable for two HYS0's £8.48 + £1.02 VAT
PSU70 suitable for two HY120's £14.58 + £1.17 VAT
PSU90 suitable for two HY200 £15.19 + £1.21 VAT
PSU90 suitable for two HY200 £15.19 + £1.21 VAT
PSU9180 suitable for two HY2000's or one HY400 £25.42 + £2.03 VAT

TWO YEARS' GUARANTEE ON ALL OF OUR PRODUCTS

I.L.P. Electronics Ltd. **Graham Bell House**

Roper Close Canterbury **Kent CT2 7EP** Tel (0227) 54778 Please Supply_

Total Purchase Price_

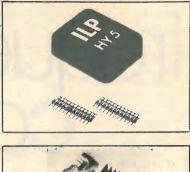
I Enclose Cheque ☐ Postal Orders ☐ Money Order ☐

Please debit my Access account

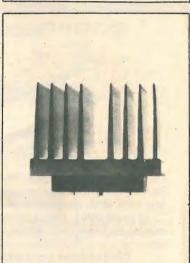
Barclaycard account

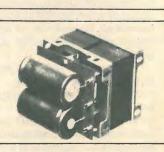
Account number Name & Address

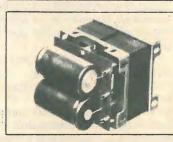
Signature_











For value in frequency counters, count on us.



You won't be disappointed. Because CSC offers more range, more accuracy, more versatility than anyone else ... at lower prices. Choose from three portable, easyreading counters and a compact, range-extending prescaler!

Our calculator-sized MAX-550 is the top of the line, with continuous readings from 1000 Hz up to a guaranteed 550 MHz and above. Measures AM, FM digital or video signals with this 6-digit, audio-to-UHF know-it-all. No switching or adjusting of polarity, slope, trigger or input level, either. Just turn it on and feed in signal. Only £102.06*

Our MAX-100 looks and performs like an expensive instrument. But it's not ... even though it measures continuously from 20 Hz past a guaranteed 100 MHz, with 8-digit accuracy and 1 Hz resolution. With its high sensitivity, and big .6" LED display, MAX-100 is ideal for a wide range of audio, ultrasonic, RF, video and digital applications. Especially at a modest £85.37* Prices, specifications subject to change without notice. *Manufacturer's suggested list.

Price includes Post, Packing and VAT for 1-off, Prices are for UK only. For Europe and 10%. Outside Europe add 121/2%.

HOW TO ORDER: Tel: 0799 21682 and give us your Access, American Express or Barclaycard number, : and your order will be in the post that night. Or send your order, enclosing cheque, postal order, or credit card number and expiry date. OR send to our latest FREE catalogue.

can afford.

CONTINENTAL SPECIALTIES CORPORATION

Europe, Africa, Mid-East: CSC UK LTD. Shire Hill Industrial Estate, Units 1 and 2 Saffron Walden, Essex CB 11 3AQ Telephone Number: SAFFRON WALDEN 21682 TLX 817477 DEPT 15/L

Our MAX-50 may be mini in size, but it offers

maximum value. Bringing down measurement costs for

signals from 100 Hz to above a guaranteed 50 MHz. An

pabilities of any 50/100 MHz counter from 50 to 500 MHz

MAX-100, it has a 400 mV output, to drive less sensitive

got you covered. In range. Accuracy. And versatility - with

We are manufacturers of breadboarding and

a broad family of accessories from antennas and input

testing devices, function generators, digital logical analysis and testing instruments, test clips and power

Our compact PS-500 Prescaler extends the ca-

When it comes to frequency measurement, we've

CSC. Capability you can count on . . . at a price you

Completely automatic, MAX-50 accurately measures

and beyond. The perfect companion to MAX-50 and

hams, computer enthusiasts and audiophiles.

outstanding value at only £59.94*

counters. Modestly priced at £39.42*

boards. Send for a free catalogue.

connectors to AC and car-battery adaptors.

AGENTS REQUIRED AT HOME AND ABROAD. PLEASE CONTACT MRS TINA KNIGHT DIRECT.

WW - 101 FOR FURTHER DETAILS

YOUR COMPLETE RANGE OF ELECTRONIC HARDWARE...

BIMENCLOSURES



ALL METAL BIMCASES Red, Grey or Orange 14swg Aluminium removable top and bottom covers. 18 swg black mild steel chassis with fixing support brackets.

BIM 3000 (250x 167.5x68.5mm) MINI DESK BIMCONSOLES

Orange, Blue, Black or Grey ABS body incorporates 1.8mm pcb guides, stand-off bosses in base with 4 BIMFEET supplied 1mm Grey Aluminium panel sits recessed with fixing screws

into integral brass bushes. BIM 1005 (161 x 96 x 58mm) £2.18 BIM 1006 (215 x 130 x 75mm) £3.05

ALL METAL BIMCONSOLES

All aluminium, 2 piece desk consoles with colour Code either 15° or 30° sloping fronts, sit on A Top Panel Off White Blue 4 self-adhesive non-slip rubber feet Sand Green Satin Black Gold Ventilation slots in base and rear panel for excellent cooling. See latest catalogue for new styles and sizes

15° Sloping Panel 30° Sloping Panel BIM7151 (102x140x51[28] mm) BIM7301 (102x140x76[28] mm) BIM7152 (165x140x51[28] mm) BIM7302 (165x140x76[28] mm) BIM7153 (165x216x51[28] mm) BIM7303 (165x183x102[28] mm) £12.61 BIM7154 (165x211x76[33] mm) BIM7304 (254x140x76[28] mm) f13.82 BIM7155 (254x211x76[33] mm) BIM7305 (254x183x102[28] mm) f15.36 BIM7156 (254x287x76[33] mm) BIM7306 (254x259x102[28] mm) £16.67 BIM7157 (356x211x76[33] mm) BIM7307 (356x183x102[28] mm) £17.58 BIM7158 (356x287x76[33] mm) BIM7308 (356x259x102[28] mm) £18.55

ABS & DIECAST BIMBOXES

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

	17 200				
	ABS	•	Diecast	Hammertone	Natural
(50x50x31mm)	N/A		BIM5001/11	TBA	£1.02
(100x50x25mm)	BIM2002/12	£0.96	BIM5002/12	£1.46	£1.19
(112x62x31mm)	BIM2003/13	£1.13	BIM5003/13	£1.78	£1.46
(120x65x40mm)	BIM2004/14	£1.35	BIM5004/14	£2.24	£1,82
(150x80x50mm)	BIM2005/15	£1.52	BIM5005/15	£2.84	£2.28
(190x110x60mm)	BIM2006/16	£2.37	BIM5006/16	£3.94	£3.33

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

MULTI PURPOSE BIMBOXES

Orange, Blue, Black or Grey ABS with 1mm Grev Aluminium recessed front cover held by screws into integral brass bushes.

1.8mm pcb guides incorporated and 4 BIMFEET supplied.

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

LOW PROFILE BIMCONSOLES



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

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

EUROCARD BIMCONSOLES

Orange, Blue, Black or Grey ABS body accepts full or 1/2 size Eurocards, with bosses in the base for direct fixing. 1.8mm wide pcb guides incorporated and 4 BIMFEET supplied, 1mm Grey aluminium lid sits flush with body

top and held by 4 screws into integral brass bushes.

BIM 8005 (169×127×70[45] mm) £4.12 BIM 8007 (243×187×103[66] mm) £6.10

BIMTOOLS + BIMACCESSORIES



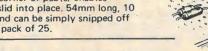
MAINS BIMDRILLS

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

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

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

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





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

12 VOLT BIMDRILLS



2 small, powerful drills easily hand held or used with lathe/stand adaptor. Integral on/off switch and 1 metre cable.

Mini BIMDRILL with 3 collets up to 2.4mm dia. £ 8.10 Major BIMDRILL with 4 collets up to 3mm dia. £13.60

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

BIMPUMPS



...FROM

2 all metal desoldering tools provide high suction power and have easily replaceable screw in Teflon tips, Primed and released by thumb operation with in-built safety guard and anti-recoil system.

BIMPUMP Major (180mm long)£7.99 BIMPUMP Minor (150mm long) £6.80



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

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

BIMBOARDS



DIL COMPATIBLE BIMBOARDS



Accept all sizes (4-50 pin) of DILIC packages as well as resistors, diodes. capacitors and LEDs. Integral Bus Strips up each side for power lines and Component Support Bracket for holding lamps switches and fuses etc. Available as single or multiple

units, the latter mounted on 1.5mm thick black aluminium back plate which stand on non slip rubber feet and have 4 screw terminals for incoming power.

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

BIMBOARD 1 f 883

BIMBOARD 2 £21.01

BIMBOARD 3 £29.84 BIMBOARD 4 £38,79

DESIGNER PROTOTYPING SYSTEM

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

> **DESIGNER 1 £55 62** DESIGNER 2 £61.02 DESIGNER 3 £66.42

All quoted prices are 1 off and include Postage, Packing and VAT. Terms are strictly cash with order unless, you have authorised BOSS account. For individual data sheets or short form catalogue on all BOSS products send stamped, self addressed $4\% \times 8\%$ " envelope.

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

AMATEUR COMMUNICATION EQUIPMENT

CQ-P-2200E 2 meter FM 12 channel portable/mobile 1/3 watt transceiver



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

CQ-R-700 6 band general coverage receiver with ultra high sensitivity (0.1 uV for 170 Khz-30.0 Mhz 15 db S/N on 30 Mhz)



Features: vFO patent allows perfect frequency read- off and tune in with ease. Selectivity selectable wide/narrow. Modes: SSB (USB/LSB), CW or AM.

Noise-blanker incorporated, large, illuminated two colour S-meter, 500 Khz and 50 Hz calibration facility. Modern electronical layout. A true solution for all searching a reliable mean for short range or continuous long haule receiption.

300 - 3000 watts HF-LINE. Modes: USB/LSB. CW, AM, RTTY (FSK), FAX in 1.6 - 30.0 Mhz



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

UK: please contact our distributor Messrs. William Munro, Invergordon, High Street 100,

SOLE DISTRIBUTOR EUROPE OF NEC RADIO AMATEUR AND CB EQUIPMENT VIA VALDANI, 1, CH 6830 CHIASSO/SWITZERLAND, TELEF. 091/446464, TELEX 64077 CEC CH WW-046 FOR FURTHER DETAILS



IN THE P.A. CHAIN ... M 260 NS

DYNAMIC RIBBON MICROPHONE

Specifications:

Frequency Response Polar Pattern Output Level

50 - 18 000 Hz Hypercardioid 0.9mV/PA \ = -60 dbm - 153 dbm

EIA Sensitivity Rating: 200 ohms Electrical Impedance >1000 ohms Load Impedance:

Excellent anti-feedback characteristic over the whole frequency range.

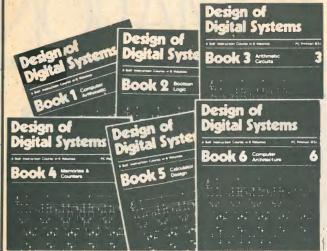
Send now for Brochure to:

BEYER DYNAMIC (GB) LTD. 1 Clair Rd., Haywards Heath, Sussex

NAIVIE	 	 	 ٠.		 ٠.	 		
ADDRESS	 ٠	 	 	. :	 	 		

WW-048 FOR FURTHER DETAILS

Understanding Digital Electronics New teach-yourself courses



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

The contents of Design of Digital Systems include:

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

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

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

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

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

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









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

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

CAMBRIDGE LEARNING ENTERPRISES, UNIT 35, RIVERMILL SITE, FREEPOST, ST. IVES, HUNTINGDON, CAMBS. PE17 4BR, ENGLAND TELEPHONE: ST. IVES (0480) 67446

PROPRIETORS: DAYRIDGE LTD. REG. OFFICE: RIVERMILL LODGE. ST. IVES REGD. IN ENGLAND No. 1328762

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

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

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

The six volumes of Design of Digital Systems cost only: And the four volumes of Digital Computer Logic and Electronics cost only: But if you buy both courses,

the total cost is only:

+ 90p post & packing

+ £1 post & packing

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

Flow Charts & Algorithms

HELP YOU PRESENT

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

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

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

Please allow 21 days for delivery

Cambridge Learning Enterprises, Unit 36, Rivermill Site Freepost, St. Ives, Huntingdon, Cambs. PE17 4BR

Please send me the following books sets Digital Computer Logic & Electronics @ £5.50, p&p

sets Design of Digital Systems @ £9.00, p&p included Combined sets @ £13.00, p&p included .The Algorithm Writer's Guide @ £3.40, p&p included

I enclose a cheque PO payable to Cambridge Learning Enter-

Please charge my 'Access/ Barclaycard, Visa, Eurocard, Mastercharge / Interbank account number

deleted as appropriate Telephone orders from credit card holders accepted on 0480-

67446 (ansafone). Overseas customers should send a bank draft in sterling drawn on a London Bank.

Immediately available. In case of difficulty write to Dept 0650, SME Limited Steyning, Sussex, BN4 3GY

programme, plug in and switch on to BUIGIN AUTOMATION

Building an industrial control system has never been simpler. Wherever there is a need to automate production machinery or process plant the new Bulgin System is the answer.

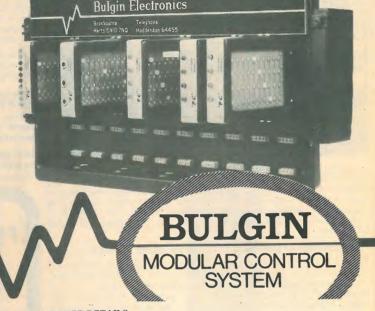
Sequences, times and other quantities required for a programme are simply set up on each module with a screwdriver. Then each module is plugged into the mother board and switched on. It's as easy as that!

Result - a great deal of time and money saved, plus a really reliable and robust control system that you have matched precisely to your machine or process.

Send for our brochure today.

Bulgin Electronics One of the Bulgin Group of Companies Soundex Ltd

Park Lane, Broxbourne, Herts. Tel: Hoddesdon 64455



WW - 086 FOR FURTHER DETAILS





arm in the world

he best pick-up

The Series III precision pick-up arm and Shure V15 Type IV cartridge. Designed and built by the rules for faithful, uncoloured musical

"Stereo Sound is Japan's principal hi-fi magazine. The Summer '78 issue carries an article compiled by seven leading critics. Of forty-three arms they recommend the SME Series III as the best and the Series II Improved as good".

WW - 059 FOR FURTHER DETAILS

A NEW INSTRUMENT FOR WIDENING INDUSTRIAL APPLICATIONS

The FOR-4 Mark 2

The new Medelec FOR-4-2 fibre optic recording oscilloscope is the result of a constant research and development policy. It incorporates many refinements which have been made to customers' special requirements.

The FOR-4-2 provides industrial and research users with high quality recording facilities at really low cost. X-Y Plot, Transient and Raster mode are all available in a single instrument.

Special features of the Medelec FOR-4-2 include:

- •10 times gain X and Y (1mV/cm on 4 Y channels)
- •Fully automatic triggering (with higher sensitivity)
- Improved recording facilities (for greater flexibility)
- Light control filter (for excellent contrast)
- Wide speed range (from 0.1 to 1000 mm/sec –in 3 models)
- Internal loudspeaker (for audio monitoring)

For further information on the new FOR-4-2 or instruments in the range, contact:

MEDELEC LIMITED
Manor Way, Woking
Tel: Woking (048 62) 70331
Telegrams: Medelec, Woking



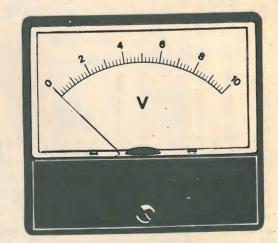
Leaders in Fibre Optic Recording



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

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

METER PROBLEMS?



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

Full Information from:

HARRIS ELECTRONICS (London)

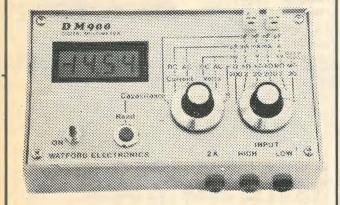
138 GRAYS INN ROAD, W.C.1 Phone: 01/837/7937

WW - 077 FOR FURTHER DETAILS

WATFORD ELECTRONICS

33 CARDIFF ROAD. WATFORD, HERTS, ENGLAND
Tel. Watford 40588/9.

DM 900



THERE ARE 900 REASONS FOR BUYING THIS MULTIMETER (with direct reading capacitance range)

Its 900 cubic centimetres are packed with up to the minute technology offering a low cost yet accurate method of measuring voltage, current, resistance and capacitance too, on a total of 30 RANGES. The WATFORD ELECTRONICS DM900 uses latest MOS Integrated Circuits which drive a 3½ digit Liquid Crystal Display for extremely low power consumption.

Specifications

- DC VOLTS 5 ranges 200mV to 1KV
 AC VOLTS 5 ranges 200mV to 1KV
- DC CURRENT 5 ranges 200 µA to 2A

 AC CURRENT 5 ranges 200 µA
- to 2A

 RESISTANCE 6 ranges 200Ω
 to 20M0
- DIODE Voltage Drop 100nA to 10mA
- CAPACITANCE 4 ranges 2nF to 2 µ F
 Accuracy on all ranges better
- than 1%

 0.5" 3½ digit LCD Display
- Single 9V (PP3) Power
 Supply
 Sampling Rate
- Sampling Rate
 > 2 per second
- Display Test Facility
- Battery Test FacilityMovable Decimal Point
- Isolated Floating Ground
- Dual Slope A / D Conversion
 Critical Input Protection
- Overrange IndicationPolarity Indication
- True Auto Zero
- 30 Ranges
- Overall size: 160 x 95 x 60mm
- Colour: Grey (standard)
 Black Orange (optional)

The DM900 incorporates dual slope A/D conversion; true auto zero; polarity and overrange indication; battery and display test facilities. Its input impedance of over $10M\Omega$ allows voltage measurements in high impedance circuits without distorting circuit operation.

The DM900 is small and robust. It measures only 160 x 95 x 60mm and is housed in an ABS case which will fit in your coat pocket or briefcase.

The DM900 has been specially designed for Watford Electronics and is available in kit form or ready built.

Special Offer: £78.50 plus VAT (p&p insured add 80p)

Also available in Kit form for the Enthusiast at £54.50 plus VAT plus 80p (probes and carrying case £3.00 extra).

WW-026 FOR FURTHER DETAILS

New from GREENWOOD



PANAVISE[®]

a precision vice that rotates a full 360 degrees-tilts 180 degrees from vertical to horizontal, and offers a choice of 3 bases, 3 heads, a bench clamp and a PCB holder.

We think it's like no other vice you've ever used. Its head rotates a full 360 degrees – and tilts 180 degrees from vertical to horizontal.

One conventional knob locks work in any desired position, firmly yet gently. You can choose a standard, low profile or vacuum base – a standard, low profile or wide opening head – a bench clamp mounting base – a printed circuit board holder and of course replacement jaws and pads if ever you need them.

Panavise is more than just a vice – it's a system.

Greenwood Electronics

Greenwood Electronics, Portman Road, Reading, RGS INE Telephone, 97,54-595844, Telephone, 1997

Obtainable also from our distributors: Electroplan Ltd P.O. Box 19, Orchard Road,

Royston, Herts SG8 5HH.

West Hyde Developments Ltd
Unit 9, Park Street Industrial Estate,
Aylesbury, Bucks HP20 1ET.

Toolrange Ltd
Upton Road, Reading RG3 4JA.
Special Products Distributors Ltd
81, Piccadilly, London, W1.
ITT Electronic Services
Edinburgh Way, Harlow,
Essex CM20 2DF.

WW - 071 FOR FURTHER DETAILS











Prices per pair. Carriage £2.50.

£52.90 £55.75

Dalesford System 1

	· G
400	
WATER BEING	cc 00
HD12 9D25 HD13 D34H	£12.00
HD13 D34H	£9.45
HD20 B25H4	£11.98
HD11 P25EBC	£5.56
Paker Superh	£22.50
Castle 8RS/DD Chartwell CE205 8 bass, m	£12.35
Chartwell CE205 8" bass, m	atched
pairs only pairs	33.30
Coles 4001	£6.25
Coles 3000 Celestion HF1300 II Celestion HF2000	£8.25
Celestion HF2000	£9.95
Dalesford D10 tweeter Dalesford D20/105 4 Dalesford D30/110 5 Dalesford D50/153 6½	£8.25
Dalesford D20/105 4"	£10.95
Dalesford D30/110 5	£10.95
Dalesford D50/153 6/2	£11.95
Dalesford D50/200 8 Dalesford D70/250 10	£24.95
Dalesford D100/310 12	£34.95
Decca London	
Decca London	£8.95
Decca DK30	£27.50
E & A I tumo 350 / ohm	£9.25
E.M.I. 14A/770 14 x 9	£16.95
I FM 1.8 x 5 d/c IU wall	£3.95
Isophon KK10/8	£8.25
Isophon KK8/8	£17.95
Jordan Watts Module Jordan 50mm Unit	£22.50
Jordan CB Crossover	£22.50
KEF T27	£8.50
KEF B110	£10.95
KEF B200	£11.95
KEF B139	£24.95
KEF DN13	£4.95
KEF DN12	£7.25
KEF DN22 pair Lowther PM6	£49.95
Lowther PM6 MKI	£52.00
	€86.50
Peerless DT10HFC	£9.75
Peerless KO10DT	. £8.95
Peerless KO40MRF	£11.75
Radford MD9 Radford MD6	£20.95
Radford MD9	£14.50
Radford MUD	£19.95
Radford FN8/FN831 Richard Allan CG8T	£9.95

Richard Allan CG12T Super £22.45
Richard Allan HP8B £15.50

Shackman Electrostatic C/W polar

network & X/O . pair £112.00

Wilmslow, Cheshire.

£10.35 £25.25

£7.25 £7.45

£8.75

£78.00

Richard Allan HP8B Richard Allan LP8B

Richard Allan DT20

Richard Allan DT30

annoy HPD 295A

Seas HO86

Richard Allan HP12B

Tannoy HPD 315A Tannoy HPD 385A Baker Group 25 Baker Group 50/12 Baker Group 50/15 Celestion G12M Celestion G12H Celestion G18C Celestion G12/75 (alum. dome) Celestion G12/75 (d/cone)	
Celestion G12M / 50	£16.95
Fane Pop 40 Fane Pop 50H Fane Pop 75 Fane Pop 65 Fane Pop 80 Fane Pop 100	£10.95 £12.50 £16.95 £19.95 £21.95 £35.95
Fane J44 horn Fane J104 horn Fane J73 horn Fane Guitar 80L Fane Guitar 80B Fane Disco 80 Fane PA80 Fane Bass 85 Fane Crescendo 12A Fane Crescendo 12B	£13.75 £9.75 £19.75 £19.95 £21.50 £19.50 £29.95 £42.95
Fane Crescendo 12B Fane Crescendo 15/100 Fane Crescendo 15/125 Fane Crescendo 18 Fane 920 II Horn Fane HPX1/HPX2 Goodmans 8PA	£44.95 £54.95 £64.95 £75.95 £45.95
Goodmans 12PD Goodmans 12PG Goodmans 12PG Goodmans 18P Goodmans 50HX	£19.75 £22.50 £21.25 £45.50 £20.50
McKenzie GP15 McKenzie GP15 McKenzie TC15 McKenzie CG15 Bass Motorola Piezo Horn Richard Allan HD8T Richard Allan HD10T Richard Allan HD12T	£32.9! £32.9! £55.9! £8.5

Kits include drive units, crossovers, BAF/Long fibre wool, etc. for pair of speakers.
Carriage £3.50
Practical Hifi & Audio PRO9-TL
(Rogers) £118.00
Felt panels for PRO9-TL £5.50 + £1.50 p&p
Hifi Answers Monitor (Rogers)
£129.00
Hifi News State of the Art
(Atkinson) £161.00.
(Atkinson)
Popular Hifi Mini Monitor
(Colloms) £63.00
Popular Hifi Round Sound (Stephens)
including complete cabinet kit
£68.00
Popular Hifi (Jordan) £91.00
Practical Hifi & Audio Monitor
(Giles) £119.00
Practical Hifi & Audio Triangle
(Giles) £86.00
Practical Hifi & Audio BSC3
(Rogers) £60.00
Practical Hifi Mini Triangle
(Giles) £99.00
Hifi News Tabor (Jones) . £59.75
Hifi News Tabor (with H4
bass units) £65.00
Mindon Market II (MEE
Wireless World T.L. / KEF
(Bailey) £112.00 Wireless World T.L./Radford
vvireless vvorid 1.L./ Radford

(Bailey)

SPEAKERS!

Speakers up to 10 Speakers 12"

Speakers 15" Speakers 18"

Speaker Kits

Mag. design kits

HiFi News Minilink (Atkinson) SMART RADGES FREE WITH ALL AROVE KITS ITO GIVE THAT PROFESSIONAL TOUCH TO DIY

Send 3 x 7p stamps for repr

CARRIAGE & INSURANCE

75p e

£2.50 each

£2.50 pair

Tweeters / Crossovers 40p e

	Dalesiola System 2	
-	Dalesford System 3 £101.75	
	Dalesford System 4 £108.00	
"	Dalesford System 5 £139.00	
8.00	Dalesford System 3 £101.75 Dalesford System 4 £108.00 Dalesford System 5 £139.00 Dalesford System 6 £93.00	
	Fagle SK 210 £15.00	
p&p	Fagle SK 215 £29.00	
	Eagle SK320 £37.00	
9.00	Engle SK325	
,	Fagle SK335 F91.00	
1.00	Candrage DINIO	ı
	Coodmans DINZU E51.30	ı
	Dalesford System 6 £93.00 Eagle SK210 £15.00 Eagle SK215 £29.00 Eagle SK320 £37.00 Eagle SK325 £67.00 Eagle SK335 £91.00 Goodmans DIN20 £31.50 Goodmans Mezzo Twinkit £51.95	ı
3.00	Kef Kit 1	ı
nens)	Kef Kit I £59.50 Kef Kit III £119.95	ı
	(carr. £5) Lowther PM6 Kit £103.00 Lowther PM6 MKI Kit £108.00	ı
8.00	Lowther PM6 Kit £103.00	ı
1.00	Lowther PM6 MKI Kit . £108.00	ı
	Peerless 1060 £71.95 Peerless 1070 £122.00 Peerless 1120 £139.00	ı
9.00	Peerless 1070 £122.00	ı
3.00	Peerless 1120 £139.00	ı
6.00	Peerless 2050 £49.95	ı
0.00	Peerless 2060 £65.95	ı
0.00	Peerless 2050 £49.95 Peerless 2060 £65.95 Radford Studio 90 £154.00	ı
0.00	Radford Monitor 270 £208.00	ı
9.00	Radford Monitor 270 £208.00 Radford Studio 270 £275.00 Radford Studio 360 £390.00	ı
9.00	Radford Studio 360 £390.00	ı
9.75	Ramkit 50 (makes ham 100) £03.33	ı
3.75	Richard Allan Tango Twin Assembly	ı
5.00	£43.50	ı
3.00	Richard Allan Maramba T.R.8	l
	£61.50	ı
2.00		ı
2.00	### ##################################	ı
4.00	Richard Allan Super Triple £73.00	ı
4.00	Richard Allan RA8 £46.50	ı
	Richard Allan RA82 £74.00	ı
3.00	Richard Allan RA82L £79.95	ı
	Seas Mini £17.90	İ
	Seas 203 £35.50	ı
	Seas 302 £43.90	ı
	Seas 302 £43.90 Seas 303 £73.90	ı
	Seas 503 £119.90	ı
rints/	Wharfedale Denton 2XP . £26.95	ı
above	Wharfedale Linton 3XP £41.95	١
DOVE	Wharfedale Denton 2XP £26.95 Wharfedale Linton 3XP £41.95 Wharfedale Glendale 3XP £56.95	ı
-		i
3.0	Everything in stock for the	i
	speaker constructor!	١
ach	BAF, long fibre wool, foam,	ı
ach	crossovers, felt panels, com-	١
ach	annute etc	١

Send 15p stamp for free 38 page catalogue Choosing a Speaker OF WILMSLOW Telephone: Speakers, Mail Order and Export: The firm for Hi-Fi 0625 529599. Hi-Fi: 0625 526213 5 Swan Street,

Richard Allan HD15

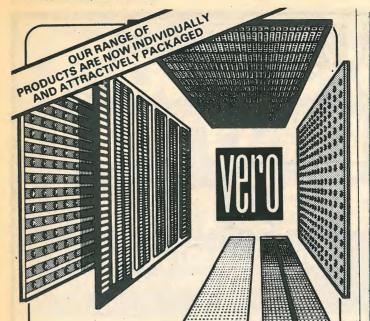
Richard Allan HD15T



Prices correct at 1/1/79).

Large selection of grille fabrics. (Send 15p in stamps for fabric





WIRELESS WORLD, MARCH 1979

Our new catalogue lists circuit boards for all your projects, from good old Veroboard through to specialised boards for ICs. And we've got accessories, module systems, cases and boxes everything you need to give your equipment the quality you demand. Send 25p to cover post and packing, and the catalogue's yours.

VERO ELECTRONICS LTD. RETAIL DEPT. Industrial Estate, Chandlers Ford, Hants. SO5 3ZR Telephone Chandlers Ford (04215) 2956

WW - 009 FOR FURTHER DETAILS

745 COUNTER TIMER DC-32 MHz

FREQUENCY, PERIOD, TIME & TOTALISE

±5ppm STABILITY @ 25°C



745 COUNTER TIMER £97 + £2.50 P&P

WW 094

Other products include:

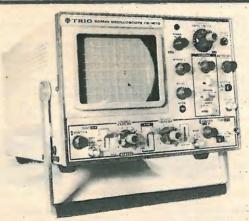
643 Function Generator £105 643A Function Generator £89 631 Filter Oscillator £112 746 Autoranging Frequency Meter £75 615 Off Air Standard £81 35 Series Digital Panel Meters from £26 WW 097

Delivery is normally ex-stock -- telephone for confirmation Prices correct at time of going to press, subject to change without notice

OMB electronics, Riverside, Eynsford, Kent. Tel: 0322 863567

LOWE ELECTRONICS LTD.

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





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

TRIO OSCILLOSCOPES

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

CS-1570 130mm DUAL TRACE TRIGGERED SWEEP OSCILLOSCOPE

£512 +8% VAT

£352
And many more items of Trio Equipmen
55p for full catalogue and price list

Phosphor: P31
Power: AC100/120/220/240V
50/60Hz, 25W
Dimensions: W260 x H190 x D375 (mm)

SPECIFICATION
Bandwidth: DC to 30MHz (-3dB)

5mV/div to 5V/div 1MΩ. 24pF 11.7nsec Better then 3% 160nsec CH2 can be inverted 0.2 μs/div to 0.5s/div

x 5
Better than 3%
0.5Vpp (1kHz square

wave) ulation. More than 5Vpp

CS 1575
Unique 4 function audio
analysis scope.
Shows not only two channels but also phase relationship bety

DC-5MHz 1mV/CM

£288

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

Lightning service on telephoned credit card orders!

			electr	ouic	5		
2111 WEST	CAMELBACK	SUITE B	PHOENIX	, ARIZONA	USA		(602) 242-3037
R F Transi	istors				ندنوس		
Туре	Pric	P	Type	Price		Туре	Price
2N1561	\$15.0		2N5637	\$20.70		HEPS3006	\$19.90
2N1562	15.0		2N5641	4.60		HEPS3007	24.95
2N1502 2N1692	15.0		2N5643	20.70		HEPS3010	11.34
2N1693	15.0		2N5764	27.00		HEPS5026	2.56
2N2857JAN	2.4		2N5862	50.00		MMCM918	1.00
2N2876	. 12.3		2N5913	3.25		MMT72	.61
2N2880	25.0		2N5922	10.00		MMT74	.94
2N2927	7.0		2N5942	49.50		MMT2857	1.43
2N2947	17.2	25	2N5943	1.75		MMT3960A	6.25
2N2948	1.5 . 5		2N5944	7.50		PT4186B	3.00
2N2949	3.9	90	2N5945	10.90		PT4571A	1.50
2N2950	5.0	00	2N5946	13.20		PT8659	10.72
2N3287	4.3	30	2N6080	5.45		PT9784	24.30
2N3300	1.0	05	2N6081	8.60		PT9790	41.70
2N3302	1.0	05	2N6082	9.90		PT9847	26.40
2N3307	10.5		2N6083	11.80		J04030	15.60
2N3309	3.9	90	2N6084	13.20		40281	10.90
2N3375	7.0	00 -	2N6094	5.75		40282	11.90
2N3553	1.	80	2N6095	10.35		40290	2.48
2N3818	6.	00	2N6096	19.35		TA7994	50.00
2N3824	3.:	20	2N6097	28.00			
2N3866	1.0	09	2N6136	18.70		FET,s	
2N3866JAN			2N6166	36.80		40673	1.39 or 10/10.00
2N3866JAN			2N6439	43.45		3N128	1.35 or 10/10.00
2N3924	4.		MM1500	32.20		2N5248	.60 or 10/ 4.50
2N3925	6.		MM1550	. 10.00		MPF102	.45 or 10/ 3.50
2N3927	11.		MM1552	50.00		MEM631	.63 or 10/ 5.30
2N3950	26.	25	MM1553	56.50			~~~~~~~~~~~~~~~~~
2N3961	6.	60	MM1601	5.50		TERMS :	
2N4072	1.	70	MM1602	7.50			S and MONEY ORDERS ARE
2N4073	2.	00	MM1607	8.65		IN US FUN	IDS !!!
2N4135		00	MM1620	17.50		ALL ORDER	RS SENT AIRMAIL DAY
2N4427	1.	24	MM1661 -	15.00			nclude \$2.50 Minimum for
2N4430	20.	00	MM1669	17.50		postage.	
2N4440	8.	60	MM1943	3.00			ES IN US DOLLARS.
2N4957	6.	30	MM2605	3.00			PRIME/GUARANTEED.
2N4958	4.	35	MM2608	5.00			
2N4959	2.	12	MM8002	2.05			RICARD/VISA/MASTERCHARGE
2N4976	19'.	.00	MM8006	2,12		Your Numb	ber;
2N5070	13.	.80	MRF245	31.05			
2N5090	6.	.90	MRF304	43.45		Exp. Date	
2N5108	3.	.90	MRF501	.49			
2N5109	1.	. 55	MRF504	6.95		Your Sign	nature
2N5160		. 34	MRF509	4.90			
2N5177	20.	.00	MRF511	8.60			
2N5179		. 68	MRF646	20.70		IC,s	
2N5184		.00	MRF5177	20.70		MC1550G	1.50
2N5216	47.	. 50	MRF8004	1.90		MC1590G	
2N5589	4.	.60	HEP76/S301			MC4024P	3.27
2N5590	6.	. 30	HEPS 3002	11.30		TMS4024	10.00
2N5591		. 35	HEPS3003	29.88			
21,5551			HEPS 3005	9.55			

MHZ Electronics Kits 2N5179 Transistor UG-88/U BNC Connectors And all other parts for assembly. Now Only \$19.95 Kit # 3 Fairchild 11C9ODC Prescaler 650MHZ. Fairchild 11C9ODC Prescaler divides by 10/100 to 650 MHZ. This counter will take any 65 MHZ Counter to 650MHZ. Or with a 82590 it will take a 6.5 MHZ Counter to 650MHZ. Kit includes the following: Fairchild 11C90DC Chip 2N5179 Transistor UC-88/U BNC Connectors LM/MC7805 Voltage Regulator 50volt lAmp Bridge LED Indicator PC Board Now Only \$29.95 And all other parts for assembly FAIRCHILD WHF and UHF Prescaler Chips 350MHZ Prescaler Divide by 10/11
350MHZ Prescaler Divide by 5/6
650MHZ Prescaler Divide by 5/6
650MHZ Prescaler Divide by 10/11
650MHZ Prescaler Divide by 5/6
IGHZ Divide by 248/256 Prescaler
600MHZ Pilp/Flop with reset
ECL VCM
Phase Frequency Detector (MC4044F/L)
UNF Prescaler 750MHZ D Type Flip/Flop
IGHZ COUNTER DIVIDE by 4
High Speed Dual 5-4 Input NO/NOR Cate

WW - 030 FOR FURTHER DETAILS

TOTAL AMPLIFICATION FROM CRIMSON ELEKTRIK

WE NOW OFFER THE WIDEST RANGE OF SOUND PRODUCTS -

STEREO PRE-AMPLIFIERS





CPR 1

CPR 1— THE ADVANCED PRE-AMPLIFIER. The best pre-amplifier in the U.K. The superiority of the CPR 1 is probebly the disc stage. The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.I.A.A. is accurate to 1dB; signal to noise ratio is 70dB relative to 3.5mV; distortion < .005% at 30dB overload 20kHz.

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

F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is $138 \times 80 \times 20 \text{mm}$. Supply to be \pm 15 volts.

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

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

POWER AMPLIFIERS. It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc. who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification. T.H.D. typically, 0.1% any power 1kHz 8 ohms; T.I.D. insignificant: slew rate limit 25V/uS; signal to noise ratio 110dB; frequency response 10Hz 35kHz, —3dB; stability unconditional; protection drives any load safely; sensitivity 775mV (250mV or 100mV on 100mV). request), size 120x80-25mm.

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

Crystal Filters. Tyco 001-19880 same as 2194F 10.7MHZ Narrow Band Crystal Filter 3 db bandwidth 15khz minimum 20 db bandwidth 60khz minimum 40 db bandwidth 150khz minimum

Ultimate 50 db : Insertion loss 1.0db Max. Ripple 1.0db Max. Ct. 0+ - 5pf. Rt. Now Only \$ 5.95

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





£32 40

POWER AMPLIFIER MODULES		POWER AMP KII
CF 608 60W / 8 ohms 35-0-35v	£16.30	
CF 1004 100W / 4 ohms 35-0-35v	£19.22	PRE-AMPS:
CE 1008 100W / 8 ohms 45-0-45v	£23.22	These are available in two versions -
CE 1704 170W / 4 ohms 45-0-45v	£29.12	one uses standard components, and
CE 1708 170W / 8 ohms 60-0-60v	£31.90	the other (the S) uses MO resistors
CE 1708 170447 8 011113 00 0 00		where necessary and tantalum capaci-
TOROIDAL POWER SUPPLIES		tors.
CPS 1 for 2xCE 608 or 1xCE 1004	£14.47	* ** ***
CPS 2 for 2xCE 1004 or 2/4xCE 608	£16.82	CPR1 £29.49
CPS3 for 2xCE 1008 or 1xCE 1704	£17.66	MC1£18.50
CPS4 for 1xCE 1008	£15.31	CPRIS £39.98
CPS5 1 for 1xCE 1708	£22.68	MC1S £29.49
CPS6 for 2xCE 1704 or 2xCE 1708	£23.98	
CPS6 for 2xCE 1704 or 2xCE 1700		
		and the second of the second o
HEATSINKS		
Light duty, 50mm, 2 C/W	. £1.30	POWER SUPPLY:
Modium power 100mm, 1-4 C/W	. £2.20	REGI . £6.75 TR6 £1.75
Diago (group 150mm 1-1 C/W	. £2.85	
Fan, 80mm, state 120 or 240v	£18.50	
Fan mounted on two drilled 100mm heatsinks	,	The same of the same
2x.4 C/W, 65 C max. with two 170W		BRIDGE DRIVER, BDI
modules	£29.16	Obtain up to 340W using 2x170W
modules		amps and this module.
THERMAL CUT-OUT, 70 C	£1.90	BD1 £5.40
THERMAL COI-OUT, TO C		

CRIMSON ELEKTRIK

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

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

Top Quality Test Equipment at the keenest of prices

				-	
Ī		Prices	Modulation Meters	Prices	Pulse Generators
	Acoustic	from £	MADIOWILILING	from £	E. H. RESEARCH
	BRUEL & KJAER		AFM1 AM/FM modulation meter	205	G7105 V/50 Ω 30 Hz-50 MHz
	2203 Precision sound level meter	400	Oscilloscopes		132AL 50 V/50 Ω 5 Hz-3 MHz 6
	2204 Precision sound level meter	475	ADVANCE		LYONS INSTRUMENTS
	1613 Octave filter set couples directly	250	OS1000 DC-15 MHz dual trace	265	PG2E 10 V/50 Ω 1 Hz-16 MHz
	to 2203 & 2204	250	HEWLETT PACKARD		PG23 10 V/50 Ω 1 Hz-10 MHz SYSTRON DONNER
	CEL	575	184A + 1801A + 1822A DC-50 MHz		101 10 V/50 Ω 10 Hz-10 MHz F
	112 LEQ meter-digital readout	3/3	system, T.B. and amplifier included,		110B 10 V/50 Ω 5 Hz-50 MHz
	Bridges		storage facility (storage de-rated	650	Recorders & Signal
	CAMBRIDGE	75	please ask for details)	030	Conditioning Equipm
	43379 Decade resistance bridge	/5	LANSCOPE	200	
	MUIRHEAD	175	419A Display oscilloscope 4 trace PHILIPS	200	BRUNO WOELKE ME102B Wow and flutter meter
	D30A Wheatstone bridge test set	1/5	PM3232 DC-10 MHz dual trace	375	ME102C Wow and flutter meter
	SULLIVAN	190	TEKTRONIX	370	BRUSH
	T1098 Decade resistance bridge	130	3A74 4 channel amplifier for 560 series	285	260 Six channel 80 Hz response
	WAYNE KERR B221 Universal bridge	180	453A DC-60 MHz dual trace	750	writing
	B601Z RF bridge to 5 MHz \		545B + CA DC-24 MHz dual trace		BRUEL & KJAER
	SR268 Source for B601Z	475	system	350	2305B Stylus Recorder include
	Cable Test Equipment		5103/D11 + 5A18 + 5L4 Spectrum		50 db pot
	MARCONI		analyser and storage system	4050	HEWLETT PACKARD
	TF2091A/TF2092A White noise		20 Hz-100 kHz	1950	7035B 83" × 11" 0.4 mV-4 V/c
	generator/receiver 300 channel		5103N/D13 +5A18N +5B12N	675	7035B 8½" ×11" 0.4 mV-4 V/c 17502A Plug-in for 7100 series
	system complete	550	Storage system 20 div/ms DC-2 MHz 5103N/D15 + 5A18N + 5B12N	0,0	recorder temperature module
	SIEMENS		Storage system 800 div/ms DC-2 MHz	595	METRAWATT
	3W518/3D335 Cable test oscillator		5A21N DC-1 MHz differential	95	RA66 channel UV with condition
	and voltmeter 10 kHz-17 MHz	310	7A13 DC-100 MHz differential		amplifiers
	STC		comparator	350	NAGRA
	74226B Telephone cable test set	350	7870 Dual time base with 7871	275	IVD Portable tape recorder
,	WANDEL AND GOLTERMAN	1	delayed sweep (for 7000 series)		SE LABS
	TFPM43 Cable test voltmeter		TELEQUIPMENT		3006DLT 12 channels UV 6 inc
	10 kHz-14 MHz	90	D54 DC-10 MHz dual trace	275	A1000 Galvo 600 Hz 0.34 mA/
	Counter Timers		Oscilloscope Probes -		MICROMOVEMENTS
	HEWLETT PACKARD		Current		M100 Galvo 60 Hz 2.5 μA/cm M400 Galvo 300 Hz 50 μA/cm
	5253B Converter plug-in to 512 MHz	380	TEKTRONIX		M1000 Galvo 600 Hz 0.34 mA
	5263A Time interval plug-in	60	P6021 AC current probe to 20 MHz	220	M1600 Galvo 1000 Hz 0.4 ma
	MARCONI		P6022 AC current probe to 150 MHz	240	M8000 Galvo 5 kHz 15.5 mA/c
	TF2414A DC-40 MHz 7 digits	170 50	Oscilloscope Probes -		SMITHS
	TF2422 Frequency divider to 300 MHz	50	Voltage		RE520.20 2 pen potentiometric
	RACAL	225	HEWLETT PACKARD		chart
	9024 10 Hz-600 MHz 7 + 1 digits	325 300	1121 A 500 MHz	90	RE551.20 X-Y1 Y2 plotter A3 to
	9059 DC-560 MHz with battery pack 9835 DC-15 MHz 6 digits	175	TEKTRONIX		base fitted
	9837 DC-80 MHz 6 digits	245	P6032 Sampling probe kit	15	SIEMENS
	Function Generators		P6046 Differential probe DC-100 MHz	250	Oscillostore 4 channel digital st
	HEWLETT PACKARD		Oscilloscope Cameras		system with UV recorder KOMP III 2 pen potentiometric
	3300A 0.01 Hz-100 kHz sine,		HEWLETT PACKARD		chart
	square triangular	150	195A Pack film polaroid	285	Signal Sources &
	3301 Auxiliary plug-in		198A Pack film polaroid	145	
	Insulation Testers		TEKTRONIX		Generators
	EDGCUMBE		C30AR Roll film polaroid	130	HEWLETT PACKARD
	Metrohm Hi resistance test set	50	C31A Roll film polaroid	135	200CD 5 Hz-600 kHz O/P 10 \ 608E 10 MHz-480 MHz AM
	Logic Analysers		Power Meters		0.1 μV-1 V O/P
	HEWLETT PACKARD		HEWLETT PACKARD		8693/100 3.7-8.3 GHz 5 mW,
	1601L Logic state analyser 12		432A/478A 10 MHz-1.2 GHz	350	sweeper plug-in
	channel display	1050	wideband with bolometer	350	LEVELL
	SPECTRUM DYNAMICS		Power Supplies		TG150DM 1.5 Hz-150 kHz 2.5
	550 Universal programmer/verifier	4550	DANA	5.	MARCONI
	for ROMs	1550	Battery Pack for use with 3800 series	3.	TF1370A 10 Hz-10 MHz 3 mV
	Mains Monitors		FARNELL	140	TEXSCAN
	AMPROBE		TSV70 DC stab. variable 70 V/5 A	140	VS401-300 MHz sweeper
	LAV2X Mains voltage recorder	45	HEWLETT PACKARD	195	VS80A 1-1000 MHz sweeper
	LAV3X Mains voltage recorder	45 50	6265B DC stab. variable 40 V/3 A 6267B DC stab. variable 40 V/10 A	215	*************
	LAV4X As LAV3X with supressed zero	50	6269B DC stab. variable 40 V/50 A	350	
	GEC		SYSTRON DONNER		
	FB31A Surge monitor records mains spikes + filter	85	LNG 16-10 16 V/10 A variable	95	
	RUSTRAK		Pressure & Displacement		
	288 + CT Clamp-on AC recording		Transducers		
	ammeter	110	ELECTRO MECHANISMS		
	Microwave		LVDT DC linear variable ± 0.50 inches	25	
	HEWLETT PACKARD		SCHAEVITZ	-	
	423A Crystal detector	65	P700 Pressure sensor 250 psi	30	
		220			

X382A Attenuator 'X' band

P. In Consenters	Prices
Pulse Generators	from £
E. H. RESEARCH G710 5 V/50 Ω 30 Hz-50 MHz RT 5 ns	100
132AL 50 V/50 Ω 5 Hz-3 MHz RT 12 ns	175
LYONS INSTRUMENTS	
PG2E 10 V/50 Ω 1 Hz-16 MHz RT 10 ns	130
PG2E 10 V/50 Ω 1 Hz-16 MHz RT 10 ns PG23 10 V/50 Ω 1 Hz-10 MHz RT 5 ns	135
SYSTRON DONNER	
101 10 V/50 Ω 10 Hz-10 MHz RT 5 ns	95 195
110B 10 V/50 Ω 5 Hz-50 MHz RT 4 ns	133
Recorders & Signal	
Conditioning Equipment	
BRUNO WOELKE	120
ME102B Wow and flutter meter ME102C Wow and flutter meter	150
BRUSH	
260 Six channel 80 Hz response, ink	Land .
writing	2400
BRUEL & KJAER	
2305B Stylus Recorder includes	650
50 db pot	030
HEWLETT PACKARD 7035B 8½" × 11" 0.4 mV-4 V/cm	500
17502A Plug-in for 7100 series	000
recorder temperature module	75
METRAWATT	
RA66 channel UV with conditioning	005
amplifiers	695
NAGRA	950
IVD Portable tape recorder	330
SE LABS 3006DLT 12 channels UV 6 inch chart	450
A1000 Galvo 600 Hz 0.34 mA/cm	30
MICROMOVEMENTS	
M100 Galvo 60 Hz 2.5 µA/cm	25
M400 Galvo 300 Hz 50 µA/cm	25 25
M1000 Galvo 600 Hz 0.34 mA/cm M1600 Galvo 1000 Hz 0.4 maA/cm	25
M8000 Galvo 5 kHz 15.5 mA/cm	25
SMITHS	
RE520.20 2 pen potentiometric roll	205
chart	385
RE551.20 X-Y1 Y2 plotter A3 time base fitted	575
SIEMENS	
Oscillostore 4 channel digital storage	
system with UV recorder	3300
KOMP III 2 pen potentiometric roll	575
chart	0.0
Signal Sources &	
Generators	
HEWLETT PACKARD 200CD 5 Hz-600 kHz O/P 10 V RMS	75
608E 10 MHz-480 MHz AM	,,
0.1 μV-1 V O/P	410
8693/100 3.7-8.3 GHz 5 mW,	F2F
sweeper plug-in	525
TG150DM 1.5 Hz-150 kHz 2.5 V	45
MARCONI	45
TF1370A 10 Hz-10 MHz 3 mV-3 V O/P	160
TEXSCAN	
VS401-300 MHz sweeper	450

Temperature & Humidity
AMPROBE 50 12"/hr chart speed 1604BLU Analogue thermomete 55 DARTRON 45 LEE-DICKENS HP5 Humidity probe HUMIGUN Temp/humidity probe 215 RAYTEK T1000 Infra-red thermoprobe 275 Voltmeters - Analogue AVO 9AC/DC/Ω 50 BRADLEY CT471C AC/DC/Ω/current 350 HEWLETT PACKARD 427A AC/DC/Ω multime 3406A 10 kHz-1.2 GHz KEITHLEY 610B Electrometer recorder O/P LINSTEAD 330 M2B DC/AC 10 Hz-500 kHz 50 MARCONI 375 NORMA U-Function Dual channel peak/RMS meter PHILIPS PM2454B AC voltmeter to 12 MHz 11320 Scalamp galvo 10 mV-300 V Voltmeters - Digital ADVANCE DMM3 1999 FSD AC/DC/Ω/current DANA 5230 119999 FSD AC/DC 175 BOONTON 93A 20 Hz-20 MHz true RMS 285 FLUKE 8300A 119999 FSD DC only 150 185 8300A OP1 119999 AC/DC HEWLETT PACKARD 215 3474/29999 FSD AC/DC/Ω SOLARTRON A200 19999 FSD DC only A205 19999 FSD AC/DC/Ω A215 19999 FSD AC/DC/Ω LM1867 101999 FSD DC only 300 475 175 **Wave Analysers** HEWLETT PACKARD 550 302A 20 Hz-50 kHz 75 db range **Redundant Test Equipment**

T.V. Test Equipment MARCONI TF2909 Gray scale generator

29

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





4D-10A

£180.00



BRIDGES	£85 00
Wayne Kerr B.521 Universal Bridge 1%	£195.00
Wayne Kerr B.221 Universal Bridge 0.1% Plus Adaptor	£225.00
COUNTERS	
TC4 TCD100 4 digit 10Hz-100MHz	£135.00
	2300.00
Systron Donner 1033 7 Digit 2012/3012 Systron Donner 1037 8 Digit DC-500MHz	£300.00
H-P 3439A 4 digit AC/DC 10V-1000V 100KHz	£200.00
METERS . ALL ANUE 1 m/ 2001/	£60.00
Advance VM.78 Millivoltmeter 1Hz-1MHz 1mV-300V	£160.00
Avo Precision Avometer DC 0.3%: A.C. 0.75%	£115.00
H-P 430C + 477B Power Meter 0.01-10mW: 10MHz-10GHz	
What Edd Edd Magaba Mater Hattery operated	L00.00
Marconi TF. 2604 Electronic Voltmeter	£225.00
MARTIN ASSOCIATES	

You'll do better at Martin Associates we guarantee it!

A COORD Di A-ale Voltmeter	£120.00
North Atlantic 202BR Phase Angle Voltmeter	£400.00
North Atlantic 202BH Phase Angle Volumeter Telonic 9011A Frequency Meter 1-18GHz	
OSCILLOSCOPES Tektronix 567 Sampling 1 GHz. Digital Readout	£215.00
Telford Type A Oscilloscope Camera. Polaroid Roll	£250.00
SIGNAL SOURCES General-Radio 1362 UHF Oscillator + 1267 P.S.U.	£600.00
General Radio 1209C 250MHz-960MHz Oscillator	£150.00
General Radio 1209C 250MHz-960WHz Oscillator	£150.00
General Radio 1215C 50MHz-250MHz Oscillator General Radio 1215C 50MHz-250MHz Oscillator	£350 00
Marconi 1099 Sweep Generator up to 24MHz 0.3-3V NEW	£200.00
Marconi 1099 Sweep Generator up to 24 Mil 20.3-34 MEV	
	444

RECORDERS		
Advance HR-100 X-Y Recorder	£125.00	1
Bryans 1806 X-Y Recorder	£225.00	2
Bryans 22020 Auto Plotter X-Y	£450.00	
Howlett-Packard 7700 Recorder Syste	em 6 Pen	9
Thermal + Amplifier & Transducers	£700.004	
Oxford 3000 Potentiometric Flat Bed 2 P	en 4	à
Oxioid Soco i cionasinome	£450.00	7
Dall & Hawell 5 124 17 Channel LI/V Re		9

uthern Inst. M. 1300 10 Channel U/V Re



WW-024 FOR FURTHER DETAILS

MPU XTALS

OVER SEVENTY STANDARD FREQUENCIES

TENS OF THOUSANDS STOCKED

> **DELIVERY FREE** WORLD-WIDE



INTERFACE QUARTZ DEVICES LTD

29 Market Street, Crewkerne, Somerset TA18 7JU Crewkerne (0460) 74433 Telex 46283 inface g WW - 057 FOR FURTHER DETAILS

1/2 watt ATTENUATORS
TERMINATIONS **IMPEDANCE TRANSFORMERS FAST DELIVERIES** LOW COST **Aspen Electronics Limited**

Communications Equipment and Components
2 KILDARE CLOSE, EASTCOTE, RUISLIP, MIDDLESEX HA4 9UR
Telephone: 01-868 1188. Telex: 8812727

Scopex vital statistics: 2% more in accuracy, around 20% less in price. Greater accuracy, lower cost plus something more - a wide range covering dual trace, 10 and 25MHz, long persistance, rack mounted - single trace 6MHz, long persistance and battery portable models, plus a wide variety of accessories and probes. The figure of 3% accuracy compares very favourably with the 5% claimed by our competitors. As does the Scopex reputation for producing reliable, easy to use oscilloscopes for just about every application.





Take the 4D - 10A dual trace model. Guaranteed 3%

accuracy achieved by a stabilised power supply including the EHT. 10mV - 50V/cm sensitivity, TV field trigger and trace locate, £180.00*

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

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

*U.K. list price excluding VAT. (Correct at time of going to press)



	Scopex Sales Pixmore Avenue, Letchworth, Herts. SG6 1JJ. Tel: (04626) 72771	
	Please send me full details of the Scopex range of oscilloscopes.	
	Name	
1	Company	
۱	Address	
İ	Tel.:	
L		WW3/79

Scopex GmbH Hasselfelder Weg36 1000 Berlin 45

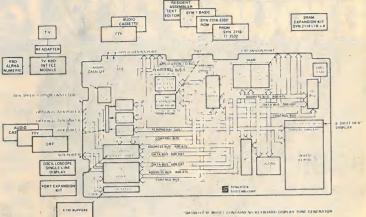
WW-052 FOR FURTHER DETAILS

Features Include:

- Ready to use because it's fully assembled, tested and completely integrated as soon as you open the shipping container.
- The powerful SY6502 8-bit microprocessor with advanced architectural features which make it one of the largest selling "micros" on the market
- Five on-board programmable interval timers available to the user for timing loops, watchdog functions, and real-time communications protocols.
- 4K-byte ROM SUPER-MON resident monitor and user expandable.
- Single 5-volt power capability is all that is required.
- 1K-bytes of static RAM on-board with sockets provided for immediate expansion to 4K bytes on-board, with total memory addressability to 65,536
- User PROM/ROM the system is equipped with 4 PROM/ROM expansion sockets for SY2316/SY2332 ROMs or 2716/2732 EPROMs, up to 28K bytes.
- Standard interfaces: digital audio cassette recorder interface with remote control; full duplex 20mA teletype interface; system expansion bus interface; TV/KB controller board interface; RS 232 compatible interface; four strappable relay drivers or input buffers; and a 32-character single line oscilloscope display interface.
- Application port 15 bidirectional TTL lines for user applications with on capability for added lines.
- Expansion port for add-on modules (51 I/O lines in basic system).
- Separate power supply connector for easy disconnect of the DC power.
- Uses same hardware interface busses as KIM-1 (MOS Technology).

*Synertek Inc. is a Honeywell Company





Sym-1 Microcomputer Board Sym-1 Reference Manual

.....£192 (+8% VAT)

Distortion Measuring Unit-low cost distortion measurement down

£56.00

£70.00

CITADEL PRODUCTS LTD.

50 High Street, Edgware, Middx. HA8 7EP. Tel: 01-951 1848

AFI CRYSTALS LIMITED atwick House, Horley, Surrey, England RH6 9SU elephone: Horley (02934) 5353 Telex: 87116 (Aerocon Horley)

JES AUDIO INSTRUMENTATION Illustrated the Si452



£70.00 Si453 Comprehensive Millivoltmeter Low distortion Oscillator 20 ranges sine - square - RIAA 350µ Volts

prices plus VAT

J. E. SUGDEN & CO. LTD. Tel. Cleckheaton (0274) 872501 CARR STREET, CLECKHEATON, W. YORKSHIRE B19 5LA

WW - 053 FOR FURTHER DETAILS

Design, manufacture & installation

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

Tel: Saffron Walden



Sound & Communications systems

Please send me details

Sound reinforcement/ public address equipment

Theatre sound equipment

Hospital distribution and nurse call systems

Intercom systems, commercial & industrial

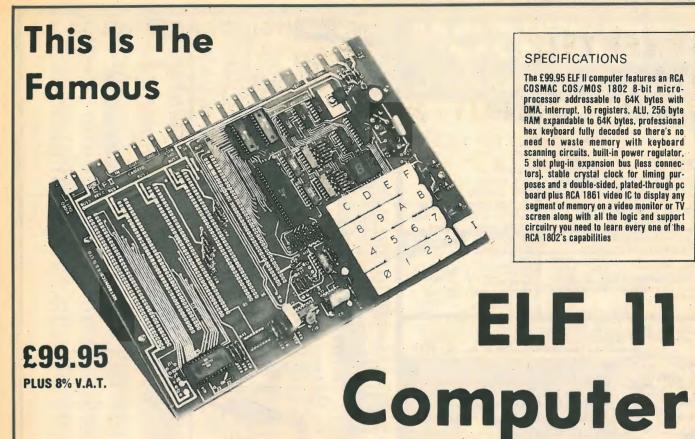
Hotel entertainment systems

Simultaneous interpretation and conference systems

Name

Address

WIRELESS WORLD, MARCH 1979



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

capabilities.

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

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

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

power than a college degree. Without a knowledge of computers, you are always as the mercy of others when it comes to solving highly complex business, engineering, industrial and scientific problems. People who understand computers can command MONEY and to get in on the action, you must learn computers. Otherwise you libe left behind.

ELF II is The F-A-S-T Way to Learn

Regardless of how minimal your computer background is now, you can-learn to programme a computer in almost no time at all. That's because Netronics has developed a special Short Course on Microprocessor And Computer Programming in non-technical language that leads you through every one of the RCA COSMAC 1802's capabilities so you'll understand everything ELFI II and on ... and how to get ELFI II to do ... and how to get ELFI II to do ... witten for Netronics by Tom Pittman, is a tremendous advance over every other programming book in print.

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

for you.

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

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

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

With ELF II, you learn to use machine language — the fundamental language of all computers. Higher level languages such as FORTRAN and BASIC must be translated into machine language before a computer can understand them. With ELF II you build a solid foundation in computers so you'll really know what you're doing, no matter how complicated things get. Video output also makes ELF II unque among computers selling such a low price. Attached to your TV set. ELF II becomes a fabulous home entertainment centre. It's capable of providing endless hours of fun for both adults and children all all ages! ELF II can create graphics, alphanumeric Only a low cost RF modulator is required to connect ELF II to your TV's aerial sockel (To order see below.)

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

ELF II Explodes into A Giant!

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

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

anywhere near ELF II's low price is backed by such an extensive research and development programme.

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

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

Now BASIC Makes Programming ELF II Even Easier!

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

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

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

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

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

H. L. AUDIO, 138 KINGSLAND ROAD, LONDON E2 8BY

Tom Pittman's Short Course On Microprocessor & Computer Program-ng teaches you just about everything there is to know about ELF II or any A 1802 computer. Written in non-technical language, it's a learning sakthrough for engineers and laymen alike, £5.0° post paid! Deluxe metal cabinet with plexiglas dust cover for ELF II. £29,95° plus 50.0% no

1.50 p8p.

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

GIANT BOARD kit with cassette I/O. RS 232-C/TTY I/O. 8-bit P. I/O secoders for 14 separate I/O instructions and a system monitor/editor. 239.95° plus £1.00 p8p.

Kluge (Prototype) Board accepts up to 36 IC's. £17.00 plus 50p, p8p. 4k Static RAM kit. Addressable to any 4k page to 64k. £89.95° plus

70° post paid. rofessional ASCII Keyboard kit with 128 ASCII upper/lower case set, printable characters, on board regulator, parity, logic selection and ce of 4 handshaking signals to mate with almost any computer £64.95°

i paid. Deluxe meial cabinet for ASCII Keyboard. £19.98° plus £1.50 p&p. LEFII THIN BASIC on cassette tape. Commands include SAVE, LOAD. ÷ . 26 variables A-Z, LET IF/THEN, INPUT PRINT, GO TO. GO SUB, URN, END, REM, CLEAR, LIST, RUN PLOT, PEEK, POLE, Comes fully

alphanumeric characters directly on your TV screen without additional hardware. Also plays tick-tack-toe plus a drawing game that uses ELF II's hex keyboard as a joystick, 4k memory required. £14.95° post paid.

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

Daid.

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

ELF-BUD Deluxe System Monitor on cassette tape. Allows displaying the contents of all registers on your TV at any point in your programme. Also displays £4 bytes of memory with full addresses, blinking cursor and auto scrolling. A must for the serious programmer! £14.95* post paid.

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

Call or write for wired prices!

H. L. AUDIO LTD., Dept. W.W. 138 Kingsland Road, London E2 8BY Tel: 01-739 1582

SEND TODAY FOR DETAILS OR ORDER

Sole European Distributors for Netronics R & D Ltd., U.S.A. Yee! I want to run programmes at home and have enclosed: ☐ £109.56 including postage and V.A.T. for RCA COSMAC ELF II kit, ☐ £5.94 including postage and V.A.T. for power supply (required) ☐ £5.95 in RCA, 1802 User's Manual. ☐ £5.95 including postage and V.A.T. for Short Course on Microprocessor Computer Programmino.

USE YOUR T ACCESS T BARCLAYCARD

PHONE ORDERS ACCEPTED 01-739 1582

45p 45p 45p 45p

50p 56p 90p 70p 50p 52p 70p 125p 68p 72p 72p 72p 64p 55p 55p

STEVENSON

Electronic Components

RESISTONO
ors. High stability
Low noise 5%.
E12 series. 4.7ohms to 10M. Any mix: 1000+ 100+ 0.8p 0.9p 1.2p

Special development packs consisting of 10 of each value from 4.7ohms to 1 Megohm (650 res.) 0.5W £7.50. 0.25W £5.70

METAL FILM RESISTORS A range of high precision, very high stability, low noise resistors. Rated at ¼1 1% tolerance. Available from 51 ohms to 330K in E24 series. Any mix:

100+ each 1% 4p 3.5p 3.2p

Special development pack consisting of 10 of every value from 51 ohms to 330K in E24 series. Any mix:
(a total of 930 resistors) £23.75 We now have an express telephone order service. We guarantee that

INCLUDING: BOOKS, HARD-WARE AND AN EXTENSIVE SELECTION Electronic Components OF PASSIVE Send Jarge S.A.E all orders received before 5pm. are shipped first class on that day. Contact our Sales Office now! Tel: 01-464 2951/5770.

ORDERS DESPATCHED BY RETURN

74LS & Linear circuits. 25+ 10%. 100+ 15%.. Prices VAT inc. Please add 30p for carriage. All prices valid to 30th April. Official orders

DL704 0.3 in CC DL707 0.3 in CA FND500 0.5 in CC

& ACCESS WELCOME. | Newchame have

BARCLAYCARD (VISA

Mail orders to: STEVENSON (Dept WW)

TRANSISTORS 0.125in. 0.2in. TiL209 TiL220 TiL211 TiL221 TiL213 TiL223 3p 3p OUR NEW ILLUSTRATED 40 PAGE CATALOGUE CONTAINS A WIDE RANGE OF COMPONENTS

LS73 29p LS74 29p LS75 44p LS76 35p LS83 60p LS85 70p LS85 70p LS85 33p LS90 45p LS95 65p LS123 56p LS125 40p LS126 40p LS126 40p LS126 40p LS126 50p LS128 36p LS138 54p LS155 50p LS155 50p LS157 LS164 LS175 LS190 LS192 LS193 LS196 LS251 LS251 LS258 LS266 2N697 12p
3N1302 38p
2N2905 22p
2N2907 22p
2N3905 50p
2N3055 50p
2N3442 135p
2N3706 9p
2N3706 9p
2N3706 9p
2N3706 9p
2N3708 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p
2N3906 8p BCY71 14p BCY72 14p BD131 35p BD132 35p BD135 38p BD139 35p BD140 35p BF244B 36p BFY50 15p BFY51 15p MJ2955 98p MPSA06 20p MPSA06 20p MPSA56 20p TIP30C 70p TIP31C 65p TIP32C 80p ZTX107 14p ZTX108 14p BC182L BC184 BC184L DIODES BC214L BC214L BC477 BC478 BC479 7400 7401 7402 7404 7408 7410 7413 7414 7420 7427 7430 7442 7447 7448 1N914 4p 1N4148 3p 1N4001 4p 1N5401 13p 1N4002 4p 1N5402 15p 1N4004 5p 1N5404 16p 1N4006 6p 1N5406 18p BZY88series 2V7 to 33V 8p ea. BC548 BCY70 NE555 25p NE556 60p NE565 120p NE567 170p SN76003 200p SN76013 140p SN76033 200p TBA800 70p TDA1022 650p ZN414 75p LM301AN 28p LM318N 125p LM324 50p LM339 50p LM339 75p LM380 75p LM382 120p LM1830 150p LM3900 50p LINEAR 120p 150p 50p 60p 60p 35p 4018 4023 4024 4026 4027 4028 4029 4040 4042 4046 4049 LM3909 MC1496 MC1458 4001 4002 4007 4011

8 pin 10p 24 pin 24p 14 pin 12p 28 pin 28p 16 pin 13p 40 pin 40p

236 High St, Bromley, Kent, BR1 1PQ, England



tool kits and cases Send now for details of the superb Jensen range of tools,

meters and accessory equipment, all in the most handy and robust cases - also available separately. Jensen products are specifically designed for industrial use, perfect for all engineers, technicians, electricians, instrument repairmen etc. Choice of more than twenty kits and cases.

Write for free Jensen catalogue to: SPECIAL PRODUCTS DISTRIBUTORS LTD, 81 Piccadilly, London W1V OHL. Tel: 01-629 9556. Cables: Speciprod London W1

WW-090 FOR FURTHER DETAILS

POWER SUPPLIES foldback, overload, thermal and short ircuit protected. Fully fused. 2-YEAR GUARANTEE Type AD12 - AD24 (Illustrated) TYPES AVAILABLE ADVO30 AD2412 AD24 5 amp 16 amp 8 amo OUTPUT CURRENT 8 amp 0 to 30 12 NOMINAL OUTPUT Fully variable and metered 115-230-250 24 DC INPUT VOLTS 115-230-250 115-230-250 50 cycles a/ 50 cycles a / TOLERATED 15% MAINS VARIATION 15% 15% PRICES 1 off — ADV030 £118.00 1 off — AD 12-AD24 1 off — AD 2412 All subject to VAT @ 8% SOUTHERN ELECTRONICS

6 WESTCLIFF ARCADE, RAMSGATE, KENT

TEL. THANET (0843) 57888

WW - 056 FOR FURTHER DETAILS

REGULATED

carbon film RESISTORS ON BANDOLIERS OR PREFORMED 12.5mm AT NO EXTRA COST -BILL -3784 -BEEF -AUSE ANX HELD **AERO SERVICES LTD.** 42-44A-46 Westbourne Grove London W2 5SF Tel. 01-727 5641 Telex 261306

WW-066 FOR FURTHER DETAILS

RECHARGEABLE BATTERIES

TRADE ENQUIRIES WELCOME

Full range available to replace 1.5 volt dry cells and 9 volt PP type batteries, SAE for lists and prices. £1.25 for booklet. "Nickel Cadium Power," plus catalogue.

Write or call at:

SANDWELL PLANT LTD. 2 Union Drive, Boldmere Sutton Coldfield, West Midlands 021-354 9764

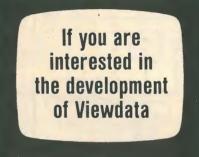
See full range at TLC, 32 Craven street, Charing Cross, London

WW-010 FOR FOR FURTHER DETAILS

VIEWDATA ... TELETEXT ... VIDEO RECORDERS ... TV GAMES ...

The new world of TV using is expanding at the speed of light. To help you get the maximum profits from it IPC Flectrical Electronic Press has launched a brand-new quarterly: Viewdata and TV User.

Issue No. 1 explained in clear, non-technical terms how Viewdata works and how it differs from Teletext. It covered Prestel (the Post Office Viewdata System) in detail. It also reviewed a wide range of news and products. Subsequent issues are



developing story of Viewdata, Teletext, home video cassette recording, TV screen games, home computers and every other aspect of TV using, and how it can benefit you. Each issue of Viewdata and TV

covering the

User will contain the current Prestel directory, and will be available to all Prestel users free of charge. To others, the annual subscription is £2.00. Not much for a journal which could be your passport to a whole new world of interest. Post this coupon, with your cheque, today!

...you could use a new journal!



Editorial enquiries: Owen Ascroft (editor) Advertisement enquiries: Stewart Goodwin at Dorset House, Stamford Street, London SE1 9LU, Tel. 01-261 8000

TO TAKE IT REGULARLY, POST THIS COUPON NOW.

To: Subscriptions Dept. IPC Business Press (S. & D.) Ltd. Oakfield House, Perrymount Rd. Haywards Heath, Sussex

Please send me Viewdata and TV User quarterly for a year. I enclose cheque/P.O. for £2.00 (inc. post and package) made payable to IPC Business Press Limited.

Name		
Address		
		· · · · · · · · · · · · · · · ·
	,	

Larsholt &	88-108MHz in : AF out	UH
		in
Ma Hart		
	المالية فياليا	Spe
		use,
Tank 3	7757 1-9: £26	

this superbly engineered VHF Band II varicap FM inermodule. (As used in the Signalmaster Mk8),

The four stage frontend employs dual gate MOSFET transistors for both RF and Mixer stages, providing the 7252 with a 1uV sensitivity for 30dB S/N (m). The IF uses a dual ceramic IF filter, and provides all usual HiFi functions, of tuning meter drives. muting, AFC and AGC. THD is only 0.1% cial frequency options are available for OEM

where the high standard of Larsholt construction frequently employed in sound distribution systems 2.5% VAT (£29.81) PP 25p

of this and other Larsholt products in Catalogue (40p) ex-stock, from: Ambit international, 2 Gresham Road, Brentwood, Essex. tel(0277) 216029

WW-022 FOR FURTHER DETAILS



MODEL 756 LOW COST! **FULL ASCII** Fully KEYBOARD Assembled

NUMERIC KEYPAD

756 KEYBOARD

- Intended for professional microprocessor applications.
- This one Keyboard will meet most present and future requirements.
- Full 128-character ASCII 8-bit code
- Tri-mode MOS encoding.
- Applications notes for auto repeat, numeric pad, serial output.
- Upper and lower case characters generated by keyboard with latching shift-lock
- Selectable polarity. Size 305 X 140 X 32mm (121/4 X 51/2 X 11/4 in)
- MOS/DTL/TTL compatible outputs. New guaranteed OEM grade com-
- Needs +5 and -12V supply
- Board has space for small low cost DC/DC converter so that entire unit operates off single 5V rail.

Carter Associates

P.O. Box 11262 VLAEBERG South Africa postal code 8018 £49 90 + VAT

	273.30
	Also available
	Numeric keypad — interfaces with 756 £7.50
1	DC to DC converter to give — 12V
١	(Afairmed dispost on 756 PC)
	Plastic enclosure type 701
П	Gold plated edge connector type 756/con £1.95
1	Generous Quantity Discounts Available
	U.K. orders add 8% VAT on order total.

All U.K. enquiries to CITADEL PRODUCTS LTD. 50 High St., Edgware, Middx. HA8 7EP Tel.: 01-951 1848

Alpha lock

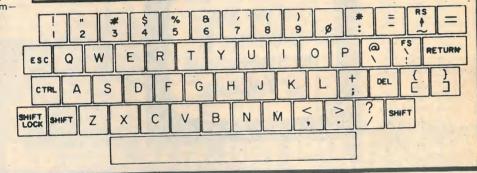
Extra loose keys available. Supplied complete with full

technical data. Rugged mil. spec. G-10 PCB

with plated through holes. 2-key roll-over

DC level and pulse strobe signal for easy interface to any 8-bit input port microprocessor system video display or terminal board. Strobe pulse width 1 ms.

User selection of positive or negative logic data and strobe output.



WW-008 FOR FURTHER DETAILS



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

The Winners These two products are our

best sellers! The two products shown above from Sabtronics are our best selling products. Both these products compare with similar equipment selling for atleast

£ 150,00. Is there more to these products than

The Frequency Counter Model 8100

value? Let's take a closer look.

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

Brief specifications:

Frequency Range: 20 Hz to 100 MHz guaranteed, (10 Hz to 130 MHz typical) – Sensitivity: 10 mV RMS, accuracy of 0.1% \pm 1 digit. sabtronics 2 Model 2000 31/2 Digit DMM

Kit £ 49.95 assembled: £ 69.95 (plus p.p. £ 3.00 and VAT at 8%)



20 Hz to 50 MHz (5 mV typical); 15 mV RMS, 50 MHz

DC volts in 5 ranges: 100 µV to 1 kV - AC volts in 5 ranges: 100 μV to 1 kV - DC current in 6 ranges: 100 nA to 2A - AC current in 6 ranges: 100 nA to 2A -Resistance: 0.10 to 20 MO in 6 ranges -

AC frequency response: 40 Hz to 50 kHz - Display: 0.36" (9,1 mm) 7-segment LED - Input impedance: 10 MΩ-Size: 8" W×6.5" D×3" H (203×165×76 mm) Power requirement: 4 "C" cells (not included).

The DMM Model 2000

March 1979.

Requirement: 9-15 VDC.

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

to 100 MHz (10 mV typical) - Selectable impedance:

1 MΩ/25 pF or 50Ω - Attenuation: X1, X10 or X100 -

Accuracy: ± 1 Hz plus time base accuracy - Aging

Rate: ±5 ppm/yr-Temperature Stability: ±10 ppm,

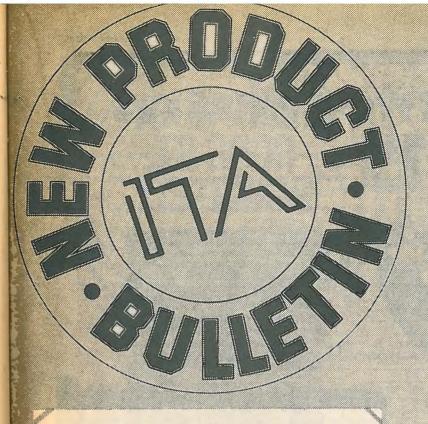
0° to 50° C - Resolution: 0.1 Hz, 1 Hz, 10 Hz selectable

- Display: 8-digit LED, floating DP, overflow

Optional prescaler will be available from around

indicator - Overload Protection - Power

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





ITAM Graphic Equalizer

A fully professional graphic equalizer at a reasonable price. Stereo, with 10 bands per channel, 19 inch rack mounting

OTARI DP4050 0CF IN CASSETTE DUPLICATOR

Now with 3% + 71/2 master capability and Ferrite heads. Duplicates 6 cassettes each run at 8 times speed. Over 80 stereo C60 per hour. Unquestionably the finest in cassette copier avail-able from the world's largest duplicator manufacturer.





Dual channel multispring reverb unit. Each channel features four springs - far smoother than single spring systems. "Twang" and 'boing" are virtually eliminated by incorporating a floating threshold limiter. Bass, mid-range EQ and bandwidth controls. The best compact reverb unit available.

ITAM 882

New Stereo Mixer, built to a specification not a price! Ultra low noise, —128dB. 8 inputs+8 direct outputs, 2 outputs with VU meters. 2 limiters. XLR mic inputs (balanced), 3 band EQ + mid sweep.



AMPEX ATR-700

Now every studio can afford legendary Ampex performance and reliability. Fully professional specification including balanced inputs/outputs, Cannon connectors, variable tape speed, sel sync. The price will fit this year's budget, not next year's! Sole distribution by ITA.





QUAD

The new 405 power amplifier is now in stock. 100 watts per channel simply the best, for £££'s less! Immediate Delivery!



1-7 Harewood Avenue, Marylebone Road, London NW1. Tel: 01-724 2497 Telex: 21879

FRANCE Son Professionnel, 2 Rue des Tennerolles, 92210 Saint Cloud (Paris), Tel 602 6815

WW-089 FOR FURTHER DETAILS.

The Teleprinter Plus. The Transtel 315 word processing communications terminal includes all the best developments and refinements that have been introduced in a decade of teleprinter technology.

This high performance teleprinter has many plus features, including: -

- Microprocessor control
- High quality dot matrix printout KSR or ASR with up to 8k memory
- Speeds of up to 30 cps
- Telex or private wire operation
- Full word editing capability

The Transtel 315 gives you high performance at a moderate price, and with thousands of machines installed worldwide, you need not worry about reliability and after sales service.

Contact us today for further information or to arrange a convincing demonstration.

TRANSTEL

Transtel Communications Limited

Mill Street, Slough, Berkshire SL2 5DD, England Telephone: Slough (0753) 26955 Telex: 849384 WW - 084 FOR FURTHER DETAILS



WW-033 FOR FURTHER DETAILS



HIFIYEAR BOOK



Hi-Fi Year Book is firmly established as the annual reference to just about everything the quality hi-fi market has to offer. The 1979 edition is better than ever: over 450 pages of products and photographs - separated into the major categories of equipment — giving you descriptions, prices, specifications, who makes it, where to buy it ... everything you need to know. And this information is backed by authoritative articles on the latest hi-fi developments and their application. So if you want a reliable guide to the latest and best hi-fi products available, order your copy today because it sells out pretty quickly.

HI-FI YEAR BOOK

Available direct from the publishers@£3.50 inclusive or from leading booksellers and newsagents price £3.00.

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

Please send me___copy/copies of Hi-Fi Year Book 1979 @ £3.50 a copy inclusive, remittance enclosed. Cheque/p.o. should be made payable to IPC Rusiness Press I td.

NAME. ADDRESS

> Registered in England No. 677128. Registered Office: Dorset House, Stamford Street, London SE1 9LU.

D PANSISHER TESTER E NPN READY

NEW TESTER

Designed for fast in-circuit testing, new DATEST 2 tests transistors, FETs, SCRs and Triacs even whe shunted by resistors as low as 20 ohms. It will usually test every device in even a DC coupled AF power amp. or in a colour TV (except line o/p)

while still in circuit Automatic NPN/PNP indication, foolproof three-LED display, and unique test-probes allow a very high rate

of testing even by unskilled users. Other features include long battery life, low battery warning, rugged die-cast case, reliable six-IC circuit. Best news of all DATEST 2 is affordable and available

Full data sheet free on request.

ONLY £39.50

J.P.S. ASSOCIATES

(ASTONKILN LTD.)

BELMONT HOUSE

LONDON NW10 7AR

STEELE BOAD

PARK ROYAL

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

WW-044 FOR FURTHER DETAILS.



FUTURE FILM DEVELOPMENTS

36/38 Lexington Street, London W1R 3HR Telephone 01-437 1892/3 • Telex 21624 ALOFFD G

N/A

WW-036 FOR FURTHER DETAILS

we wondered why

This B.B.C., British Rail, B.A.C., Decca Acoustics, Institute of Sound and Vibration Research, I.C.L., Post Office

Maybe they liked the competitive prices of our modules, or the fact that all modules have a frequency nse from 20Hz to 22kHz 0.2dB, a slewing rate of 8 volts per microsecond, input sensitivity of 0dB (0.775V). a damping factor greater than 400 to 1kHz and a total harmonic distortion less than 0.055% at 1kHz.

Or could it be that they went for the reliability and the comprehensive protection bircuitry. Then

OR PERHAPS THEY JUST LIKED THE SOUND OF US!

J.P.S. 100: 100 Watt. J.P.S. 150: 150 Watt. Power supplies available to suit all modules. Send for further information on our range of pre-amplifier modules. JPS products are now stocked at the dist

J.P.S. 60 : 60 Watt.

ributors shown below. Further information on products available direct from JPS Associates of All modules are made in the United Kingdo



ENGLAND Midlands

CROXFORD CUSTOM EQUIP. SEVERNSIDE AUDIO & LTG

ENGLAND West

W.C.2. Tel. 01 836 2372 Mr. John Cowan.

ATMOSPHERE LTG, & SOUND 7 Nelson Street. Scotland, Tel. 0224 572905 Mr. Keith Main.

WW-035 FOR FURTHER DETAILS

andbanks Metal Locator: a kit based on this recently published design for The PW Sandbanks Metal Locator: a kit based on this recently published design for this uniquely effective type of metal locator is available for only £35.00 + 8% VAT. The kit closely resembles the appearance as published, except that a close fitting injection molded housing replaces the vacuum molded electronics box to improve the environmental suitability of the construction. Carriage for complete kits £1.

The New Catalogue: "Tecknowledgey Part 2"
Part 2 of the catalogue: by the time this advert reaches the press, part 2 should be on sale. Sorry it's late, but it contains so many new and interesting things that we felt we had to hold up production to include them. Part three by the autumn and already there are many new items to go in! Part one 45p, part 2 50p. (inc PP etc). The New Catalogue - "Tecknowledgey Part 2"

here are m	any new items to go in:	1 41 0			- un Abon	ovor.	
Radio ICs			Discrete de	vices: n	nore trian	ever.	1 60#
TDA1062		1.95	BF960	800MH	z/2.8dB nf	moster	0.80*
TDA1083	One chin AM/FM rx	1.95	BF961		z/2.0dB nf	**	0.43*
	One chip HiFi am/fm	3.35	40822	FM RF			0.43*
TDA1090	One chip am/fm rx	1.75	40823	FM mix	er .		
TDA1220	HiFi AM tuner IC	1.40	40673	Famous	MOSFET		0,55*
HA1197W	AM tuner IC	1.40	2SJ49/2sK13	33 120v	/100W MO	SPOWE	H
CA3123E	AM tuner IC	1.81		output	devices		10.50*
TBA651	Famous FM IF system	1.94	LEDS:	the best	value toda	y	
CA3089E	As 3089+ deviation mute		LLDO.	3mm	5mm,	2.5x5	mm
CA3189E	AF preamp, adj, agc	2.75	Red	0.14	0.14	0.17	
	Improved S/N 3089	2.20	Green	0.18	0.16	0.20	
HA1137W	limiting amp+detector	0.75	Yellow	0.18	0.15	0.20	
TBA120		1.00	Orange	0.22	0.29	0.24	
TBA120S	high gain	1.20	100 off mix,	0.22	IIA teues	are AF	G first
MC1350P	agc'd IF preamp synch AM/video detector	1.35	grade types	, 25% un	ely no junk	5mm	clips
MC1330P	synch AM/video detector	0.65	for panel mo	apsolut	013 each		
KB4406	Cascode IF preamp	1.95					
uA753	limiting FM preamp	1.50	Misc. ICs f	or radio	o/audio ap	plicati	ons
Communic	cations circuits		U237B	5 LED	bargraph d	LIAGL	0.00
SD6000	DMOS RF/Mixer pair	3.75	SAS6610	4 static	n touch tu	ne IC	1.48*
KB4412	Bal mixers, 1F+agc	2.55	SAS6710	adds 4	stations to	6610	1.48
	AM/SSB det. squelch,agc	2.75	MSM5523/4	LW,MY	V,SW and F	M digit	al
KB4413 KB4417	mic processor	2.55		frequer	ncy readout	plus	
	best thing in NBFM yet	3.12		clock.	timers, stop	watch	£14 *
MC3357	popular double bal mixer	1.25	MSM5526	LW/M	N/FM DFM	with	
MC1496P	popular dy noise blanke	r		direct	drive for L	CD	£11*
Multiplex	decoders + noise blanke	2.20	TCA730	DC vo	ume contre	ol	3.50
MC1310P	popular PLL decoder	2.20	TCA740	DC to	ne control		3.50
uA758	buffered 1310	3.25	TDA1028	DC in	out switch		3.50
CA3090AC	RCA PLL decoder	3.23	TDA1029		de switch		3.50
HA1196	improved PLL decoder	3.95		T	madulas		
	with stereo preamps	3.55	Radio and	Luner	modules		mould
HA11223	19kHz pilot cancel, low	4.35	We cannot	really lis	t all the de	tails we	Monio
	distortion, high S/N		like to here	- but w	ith advent	of the i	tohing
KB4437	as HA11223 with remote	4.55					
-	VCO kill facility						
KB4438	stereo MUTING preamp	2.22	-lue bardus	are and	stvling tha	t materi	102 (110
	for post decoder mute	2.53	high standa	ards we h	nave set in	this nev	v range.
KB4423	impulse noise blanker						
			me is constall	v 121/4%	except wh	ere mai	Ked (

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

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

- Exceptionally high performance exceptionally straightforward assembly
 Baseboard and plug-in construction. Future circuit developments will readily
 plug in, to keep the MkIII at the forefront of technical schlevement
 Various options and module line-ups possible to enable an installment approato the system
- and now previewing the matching 60W/channel VMOS amplifier:
- ★ Matching both the style and design concepts of the MkIII HiFi FM tuner
 ★ Hitachi VMOS power fets characterized especially for HiFi applications
 ★ Power output readily multiplied by the addition of further MOSFETs
 ★ VU meters on the preamp not simply dancing according to vol level
 ★ Backed with the usual Ambit expertise and technical capacity in audio

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

THE DIGITAL DORCHESTER ALL BAND TUNER



in with the rest of AMBIT's new range of tuner & audio equipment

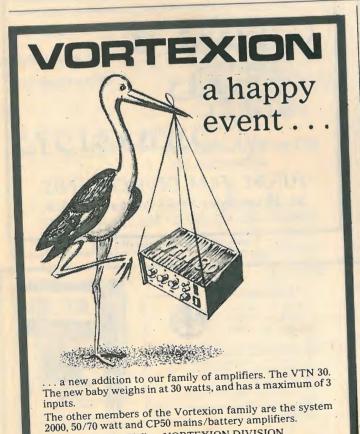
When the new range of OKI digital frequency display ICs was announced, the original prototype of the Dorchester had been made - but since so many of you wanted to use the OKI frequency counterdisplay system with the Dorchester, we quickly designed a unit to incorporate the necessary facilities. The Digital Dorchester is designed in 19 inch form, and forms a perfect match for the other units in the range. If you don't want to go to the expense of the full Ambit DFM1 module, with AM/FM/Time/Timers, then the MA1023 lake module are be used instead. clock module can be used instead

The Dorchester has been described in PW Dec., Jan. and Feb. issues - but for those of you who may have missed it - it is an All Band broadcast tuner, covering LW/MW/SW and FM stereo in 6 switched ranges. Construction is very straightforward, with all the switching being PCB mounted - and the revolutionary TDA1090 IC used for AM/FM.

The electronics for the radio section of the Dorchester remain unchanged at £33.00, with 12.5% VAT. The hardware package, of case, meter, PSU now costs £33.00 + 8% with the ALOSS with 12.5% VA1. The naroware package, of case, fileter, F50 flow costs £55.00 with the MA1023 available for an extra £5 only. For the fully digital version, with Ambit DFM1, the price is £56.50 + 8% VAT.

2 Gresham Road, Brentwood, Essex.

WW-050 FOR FURTHER DETAILS





WIRELESS WORLD, MARCH 1979

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

Micromarket SLASHED TTL : Standard AND LP Schottk #ET SLASh.

1.95
2.88
4.78
2.51
2.255
5.40

| MEMORIES | 2102 E1.70
2112 E3.40
2513 E7.54
257
E5.78 'LSN' 13 13 14 14 14 18 38 38 17 17 15 20 17 30 51 6800P 66 50 8251 8251 8252 8080 series 8080 6.30 8212 2.30 8251 8252 8080 6.30 8212 2.30 74378 74379 74386 74390 74395 74396 74398 74399 74445 74447 74490 74668 74670 28 28 32 27 38 37 **Voltage Regs** 74148 74150 74151 74153 74154 74155 74156 74157 74158 74159 74670 249

WISCELLENY
NE555 30p
NE556 78p
NE558 180p
ICM7217 950p
ICM7208 1495p
ICL7106CP LCD DVM IC
955p 97 104 NEW LOW PRICES
7800 series UC TO220 package 1A all 95p
7900 series UC TO220 package 1A all £1
78MUC series TO220 package %A all 90p
78LCP series TO92 100mA all 35p 7489 24 7490 24 7491 24 7492 7493 27 7495 29 7495 32 7497 24 74104 32 74105 24 74106 24 74107 24 74109 24 74110 74111 99 74112 74113 74116 74118 99 74121 99 74121 74122 24 74123 L200 up to 3A/adjustable V&A 195p 78MGT2C ½amp adjustable volts 79MGT2C ½amp adjustable volts LCD DVM KIT 175p 120 90 3½ digit LCD display 1150p MAINS FILTERS FOR NOISE/RFI etc 1 amp in IEC connector £4.83 display 1150p ICL7107 LED DVM kit 2065p ICM7216 - 8 digit 10MHz DFM/ timer £19.82 (for LED C.Cath) 5 amp in 'wire in' case NE550A 73p £3.87 230 625 170 87 87 75 78 85 165 160 OPTO 7 seg displays 7442 7443 7444 7445 7446 7447 7448 7449 7450 7451 7453 7454 SCALAR ICS 100 SCALAR ICs 105 8629 150MHz 107 49 108 49 109 95H90DC 780p 11 1C90DC 1400p 17 by 100 or 10 109 100 or 10 109 100 10 100 100 10 100 100 10 100 100 10 100 100 100 10 10 LM339N 66p LM348N 186p LM3900N 609 709HC to5 64p 709PC dil 36p 710PC dil 59p 723CN 65p 741CN 8dil 27p 747CN 70p 748CN 36p NES31N 105p 0.43" High Efficiency HP: 5082- 7650 red CA 5082- 7653 red CC 5082- 7663 yellow CA 5082- 7660 yellow CC 5082- 7670 green CA 5082- 7673 green CC CA3140E CA3140T CA3160E CA3160T 99 74121 25 74181 165 74182 160 74182 160 74183 17 24 74123 38 44 74184 135 74184 135 0.3" Standard HP 5082- 7730 red CA 5082- 7740 red CC

7454 17 | 24 | 74125 38 | 44 | 74184 135 | 1 | The ICL7216BIPI is still the cheapest way to make a full 8 digit/ 10MHz frequency counter/timer, and with 10 external components + display - it is also one of the simplest. For £19.82, it takes a lot of beating. The mains filters have been extended now to include a 6amp IEC version at £5.10, and with the amount of electronic noise on the average supply (next door's fridge, for instance) it is a really worthwhile addition to any sensitive equipment. LPSN TTL now includes many more of latest types, all - of course - are absolutely prime first quality types. And don't forget our range of OPTD displays includes Hewlett Package high efficiency 0.43" types in all colours - renowned as the finest quality in the market. For other types of component - discrete LEDs, radio and audio devices, tuner modules, kits etc., see our other advertisement for more details - or send for the AMBIT catalogue system. Part one (45p) includes details of our background 'standard' tems, and the new part two includes all the latest introductions and developments, plus a rundown on OSTS. 0.5" Fairchild VAT to be added at 8% (inland), pp 25p per order. When ordering from the 2 Gresham Road, Brentwood, Essex.

WW-049 FOR FURTHER DETAILS

PRECISION POLYCARBONATE CAPACITORS

All High stability out of the search								
440V ac range (+-		63V DC RANGE (É)						
μF	L (mm)	D	£1each	μF (Tol	.+-1%	+2%	6 +-5%	
	27	12.7	1.34	0.01-0.2	1.80	1.22	0.88	
0.1	33	16	1.66	0.22-0.47	1.82	1.24	0.90	
0.25	33	16	1.78	1.0	2.26	1.52	1.08	
0.47	33	19	2.08	2.2	2.80	1.94	1.42	
0.5	33	19	2.24	4.7 .	4.00	2.72	2.24	
0.68	50.8	19	2.48	6.8	4.88	3.36	2.66	
1.0	50.8	19	2.64	10.0	6.94	4.68	3.56	
2.0	50.8	25.4	3.74	22.0	13.32	9.98	6.80	
				0 10				

TRANSISTORS, DIODES, I.C.s, Bridge, Rectitiers, Capacitors, Plugs & Sockets, Vero, etc. TRANSISTORS, DIODES, I.C.s, Bridge, Rectitiers, Capacitors, Plugs & Sockets, Vero, etc.

RESISTORS: High stability, low noise, carbon fillr—15% foll 1/W @40 C 1/2070 C. E12 series

only — from 2.2 ohm to 4.7M. All 2p* each 15p*/10 of any one value 95p*/100 of any one

value £4.35*/500 (may be mixed in 100's) £8*/1000 (may be mixed in 100's).

SPECIAL DEVELOPMENT PACK; 10 off each value 2.2 ohm to 2.2M (730 resistors) —

£6.50 each. (1W c/f 5%-5p* ea: 2w c/f 5%-8p* ea.).

PRESETS: 0.1W submin. skeletion presets — vertical or horizontal. 100 ohm to 1M 7p* each.

£3*/50 £5*/100 £2.50*/500, £40*/1000. Values may be mixed.

ZENER DIODES: 400mW ± 5% 3V-33V - 10p; 1W 3V3-200V - 18p.

TANT. BEAD CAPS: μF/V 0.1, 0.22, 0.33, 0.47, 1/35 - 10p*; 2.2/25 - 11p*; 2.2/35 - 12p*; 4.7/35 - 15p*; 6.8/35, 10/25 - 17p*; 10/35, 15/20, 22/15, 33/10, 47/6.3 - 21p*; 68/3-17p*; 100/3 - 21p*. Please add 25p P&P and 8% VAT to all items except those marked * which are 121/2%

MARCO TRADING (Dept. W12) The Old School, Edstaston, WEM, Shorpe Tel: WHIXALL 464 (STD 094872) (Props Minicast Trading Ltd.)

Semicomps Ltd.,

Tel: 0926 59411

Kenilworth

WW - 029 FOR FURTHER DETAILS



Model 146 **VERY LOW DISTORTION** (.0015%) **AUDIO SIG: GENERATOR**

Based on J. Linsley Hood Design (W.W.)

£36 (Kit. £31) + tax 8%

Low cost version, A0113 (02% dist), £27.50 (Kit £23). Other instruments include: Millivoltmeter, Tachometer, Noise level meter, Distortion Analyser, F.M. Sig. Gen. Crystal Frequency Standard. KEF Speaker Units. Send S.A.E. for lists. VAT extra 8%.

TELERADIO ELECTRONICS

325 Fore Street, Edmonton, N.9. 01-807 3719 Closed all day Thursday

WW - 069 FOR FURTHER DETAILS

Ferranti Semiconductor Distributors Nationwide.



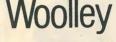
Semicomps Northern Ltd.,

Kelso Tel: 05732 2366

Semicomps Ltd.,

Tel: 0727 24522

St. Albans



Tel: 061-941 1911

Altrincham



Henlow Tel: 0462812505



Comway Electronics, Bracknell Tel: 0344 24765





S.D.S. Components Ltd., Portsmouth Tel: 0705 65311

Harlow

Tel: 0279 26777

ITT Electronic Services, Swift Hardman, Rochdale

FERRANTI Semiconductors Tel: 0706 47411

WW-038 FOR FURTHER DETAILS

Clarke & Smith Manufacturing Co. Ltd., Melbourne Works,

Melbourne Road, Wallington, Surrey. Tel. 01-669 4411 Ext.

Telex Casint G 22574; Telegrams: Electronic Wallington.

Contact Jennifer Hall — VORTEXION DIVISION.

At the end of the test session the communications engineer sang the praises of our filters.

"What performance" he said, referring to the capability of the Barr & Stroud EF3 Filter System in satisfying his signal conditioning needs. He and other engineers in many fields are equally complimentary about our supporting range of Active Filter Modules and our Custom-Built Filter Service. We have fully descriptive literature which will generate similar enthusiasm in yourself. Use the journal reply system or call us, Barr & Stroud Limited, (Detp. WW6). Melrose House, 4-6 Savile Row, London WIX IAF. Telephone: 01-437 9652. Telex: 261877. EF3 Variable Filter System Designed on a modular basis to give flexibility in use and to match your budget. A plug-in system developed for use in labs., test departments, anywhere where signal conditioning is required. Filter units can be used separately or combined to give a wide variety of functions from low-pass to band-separate. The current pass-band capacity is from d.c. to 10 MHz. **Active Filter Modules** The ready-to-use convenience of small, encapsulated filter units, each with a basic function. No filter knowledge required to set up for specific characteristic or cut-off frequency. These filters are equally suited to the one-off lab. application and the large quantity production requirement. Available in low-pass, high-pass, universal and notch designs with a range of cut-off frequencies and attenuation rates. **Custom-Built Filters** The basis of our filter activity, this service has for 20 years provided solutions to customers specific requirements. Based on in-house computer facilities and an extensive programme library we can design and manufacture the filters not provided in our standard range. Designs can be passive or active with cut-off rates up to several hundred dB per octave in a frequency range up to around 70 MHz. **Barr & Stroud** adds to your resources wireless

Performing blights

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

Deputy Editor: PHILIP DARRINGTON Phone 01-261 8435

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

Projects Editor: MIKE SAGIN Phone: 01-261 8429

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

Drawing Office Manager: ROGER GOODMAN

Production: ALAN KERR

Advertisement Controller: G. BENTON ROWELL

Advertisement Manager: BOB NIBBS Phone 01-261 8622

DAVID DISLEY Phone 01-261 8037

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

BARRY LEARY (Classified Advertisements) Phone 01-261 8508

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

Publishing Director: GORDON HENDERSON It is not open to question that goods sold by retailers should be capable of fulfilling the purpose for which they are meant — they should be of "merchantable quality". Most people need no urging to insist that this law should be observed; a faulty pair of shoes or a watch that gains or a tape recorder that doesn't are quickly returned whence they came and instant action demanded.

Usually, the fault is obvious: if a pair of shoes lets the water in, one can be reasonably sure there is a hole in them; a book with pages missing is an affront to the eye and a bag of crisps containing nothing but little blue packets brooks no argument.

Times are changing rapidly, more so than ever before, and the words "high technology" are bandied about and taken to mean, in our own industry, "clever electronics". Domestic tape recorders, amplifiers and tuners are not in the same class as industrial equipment, computers and the like when judged by the height of their technology, but on the domestic scene they are clever enough to be the least-understood kind of hardware ever found in the average person's home.

Of course, radios and record players have been around for many years, but all they have been expected to do (by this mythical "average person") is to produce a large enough amount of "mellow" music, Now, the possession of an array of satin chrome and teak, high-quality equipment comes a good second to the bed and dining table when setting up house.

The choice of the equipment, when not made on appearance alone, is often prompted by the scanning of reviews in the magazines devoted to high-fidelity. sound — and very thorough some of them are. But an ominous note is sounded in many reviews seen in these magazines to the effect that

adjustments have not been properly carried out by the makers, drastically reducing the quality of reproduction and this is on equipment lent by makers, not bought in shops. On tape recorders, for example, head alignment is frequently a cause for complaint, as are the amount of bias current and Dolby level adjustment.

It does not seem possible for most users to investigate the finer points of performance themselves, which means they are totally in the hands of the maker/retailer organization. Since it would be unrealistic to suppose that, when sold, every single piece of equipment is at the peak of its potential, it must be assumed that there are instruments in service which are not performing as well as they might, the reasons for which the user is at a loss to explain, even supposing he can detect the shortcomings.

It would probably increase the price of equipment to an unacceptable level to expect that each instrument be subjected to a stringent examination of every facet of its specification, and since it seems probable that many purchasers would not be greatly upset by a signal-to-noise ratio of 57dB instead of 58dB, it would be unwarranted. But is there, perhaps, scope for specialist organizations to "breathe on" equipment, at a price, to make sure it is performing up to its capabilities? In an ideal world, this sort of thing would not be needed, but it seems to be an increasingly rare experience to buy a complicated object - a car, music-centre, house - and be completely happy with its performance. Exhortations from public to manufacturers appear to have negligible effect. It might be better and cheaper, of course, for the maker to do no testing at all, the specialist taking over completely: the maker couldn't then charge for work which hasn't been done

ELECTRONIC FILTERS, OPTICAL FILTERS, FIBRE OPTICS. LASERS, SCIENTIFIC AND MEDICAL INSTRUMENTATION.

Low-cost logic analyser

Simple, yet flexible design with discrete I.e.d. display

by B. C. Adams

As digital i.cs and systems get larger and more complex, so the problems of testing and de-bugging also become more difficult. To keep pace with these problems, costly commercial analysers have been designed to maintain the systems. This design offers several useful features and enables the constructor to build a versatile, yet economical logic analyser.

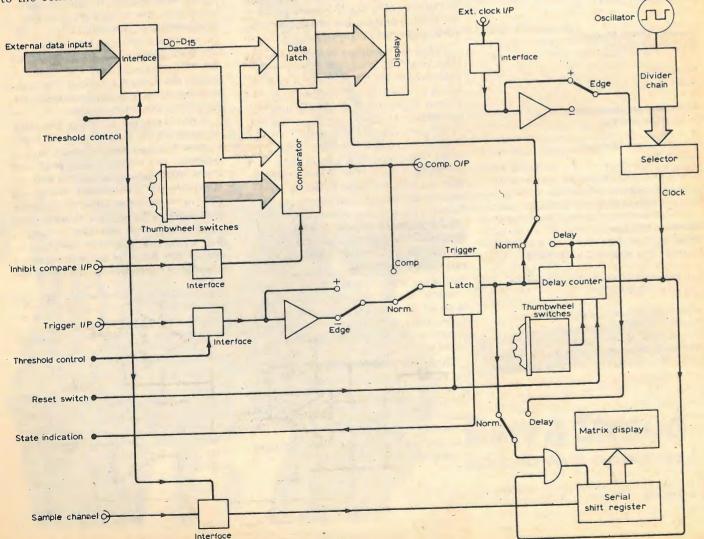
THE PROBLEMS INVOLVED in testing and function checking digital equipment are exactly the same for the amateur constructor as they are for industry except that the cost of a commercial logic analyser is prohibitive to the constructor. Faced with this problem, I designed a reasonably simple analyser which can provide almost any information that may be required from a logic system. With a little experience and ingenuity the user can overcome most diagnostic problems.

Introduction

A block diagram of the analyser is shown in Fig. 1. The instrument is a self-contained unit which comprises four main sections, a 16-bit parallel data input latch, a sample channel and display matrix, a hexadecimal comparator, and a trigger input with control logic.

In operation, the analyser monitors a number of different signal points and displays their state. If a particular section is triggered, the data is stored. All inputs are interfaced to the internal logic via comparators which provide a high input impedance, compatability with high level or t.t.l. logic, and permit the threshold transition level to be controlled. The 16-bit parallel latch outputs are taken to a row of l.e.d.s which indicate the 0 to 1 state of each input. The latch can be used, for example, to sample a data bus at a predetermined time or in the event of a fault, which can be especially useful when debugging

Fig. 1. Block diagram of the analyser which comprises four basic sections. All external inputs are interfaced to the logic by comparators.



WIRELESS WORLD, MARCH 1979

microprocessor machine-code pru-

The sample channel can be used to store and display any sequential input signal by loading it into a 32-bit serial shift register at a preselected clock rate. The contents of the register can then be continuously displayed on an l.e.d. matrix. When a trigger signal occurs, the sample clock is inhibited and the display matrix indicates the states of the 32 previous input pulses. By using the external sample clock input, a datadomain rather than time-domain display can be generated which is necessary when monitoring synchronous logic.

A 16-bit hexadecimal comparator continuously compares the data-latch inputs with a hexadecimal code set on thumbwheel switches. A true output is generated when the latch input code equals the hexadecimal code, and this can be used either as an external control signal, or switched internally to the trigger input. Many microprocessors use hexadecimal coding for their machine code instructions, so the analyser can be triggered by a particular machine instruction and store data from, for example, a peripheral at a time related to that instruction. An input is provided which can inhibit the compare output, during a change in state of the parallel data inputs, until they have settled.

The data latch and sample channel can be individually controlled by the external trigger input which has a separate logic threshold control, and provision for positive or negative-edge triggering. The trigger signal is detected by a latch, and the state of the latch is displayed by an l.e.d. which flashes when a correct trigger signal has been received. In addition to signals from the trigger latch, control may also be derived from a delay counter which generates a signal a preselected time after the trigger latch has changed state. This delay mode is useful because it allows any combination of pre-trigger and post-trigger information to be stored by the data latch and sample channel. The delay is set by a 0 to 99 thumbwheel switch, and is the thumbwheel setting multiplied by the sample rate selection.

Circuit description

The main requirements for the input interface are that it should be high impedance, fast, and should allow control of the 0 to 1 to 0 transition threshold. The external sample-clock input is similar, but with a preset transition threshold. It is also necessary for the interface to accept both t.t.l. and high level logic inputs. The circuit in Fig. 2 shows the SN2710 comparator which was chosen for its speed and its ability to drive t.t.l. This device does, however, have a relatively high input current requirement which restricts the input impedance. To overcome the inSpecification Data inputs, sample channel and compare / inhibit input

Propagation delay for low to high 70ns Propagation delay for high to low 95ns Input resistance 90κΩ Transition threshold 1.5 to 10V Transition hysteresis 0.175V + 1.2V Maximum input Minimum input -2V

Trigger input as above except for

Propagation delay from trigger signal to disable signal Transition threshold Delay mode

1.5 to 10V Selectable from 0 to 99 times the selected clock period or

external input period

70ns

Clock

Source Clock period selection External input

20ns to 20ms

The same as data input except for threshold which is fixed at 2.2V.

Internal oscillator or external input

herently low hysteresis of the comparator, about 175mV of feedback hysteresis is added by R3.

A combination of input resistance and intrinsic shunt capacitance of the comparator tends to increase the propagation delay, but this has been partly overcome by the addition of a speed-up capacitor C₁, which provides some input overdrive for each edge of the input waveform. The reference voltage for each comparator is derived from a common op-amp via separate source-impedance matching resistors. It is essential that a well-stabilized voltage is used for the variable threshold levels, because power supply ripple can cause incorrect transition

Low power Schottky t.t.l. is used to limit the load on each comparator, and

Fig. 2. Interface comparator and threshold level controls. Resistor R3 provides about 175mV of feedback to increase the hysteresis.

to keep the total propagation delay to a minimum.

Trigger and delay

The trigger and delay circuit is shown in Fig. 3. The trigger channel is interfaced with its own threshold control, and the signal is used to clock a D type flip-flop connected as a latch. The output of the latch is used to gate a low-frequency oscillator which drives the trigger indicator lamp and delay counter. As shown, the latch can be reset using the clear input, and positive or negativeedge triggering is achieved via two inverters. Once the latch has been triggered, the CTL output goes high and enables the two synchronous decade counters. The count is compared with the thumbwheel switch setting by exclusive-OR gates, and the gated outputs are decoded when the counter value reaches the required number. The counters are then disabled by taking their inputs low. The delay and the CTL signals can both be used for switch selection to the sample channel and the

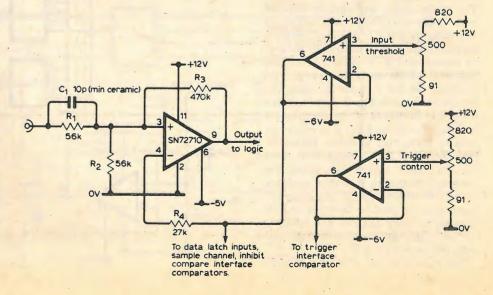


Fig. 3. Trigger and delay circuit. The counter clock may be fed from the clock and divider chain in Fig. 4, or from the external input.

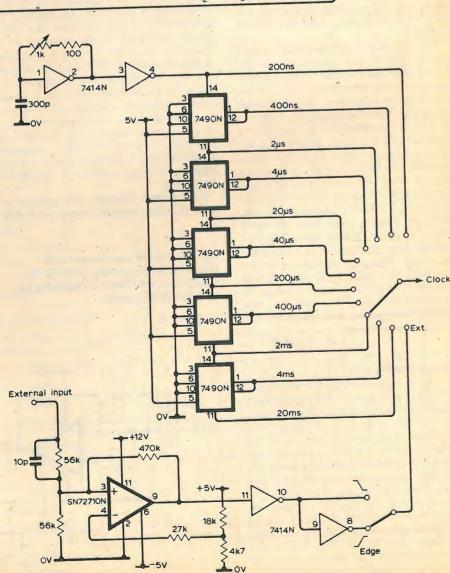
Fig. 4. Clock generator and external input.

data latch disable inputs. The counter clock period may either be derived from the internally generated clock and divider chain in Fig. 4, or from the external input, in which case the delay counter can be used to trigger a data section after a pre-determined number of pulses at the trigger input.

Internal clock generator and external input

The trigger-delay and sample-channel both require a clock train which is supplied by a t.t.l. Schmitt trigger oscillator and a chain of decade dividers as shown in Fig. 4. Alternatively an external clock may be used, and provision for this is made by using the interface circuit in Fig. 2. Although the transition threshold of the comparator is shown preset at 2.2V, it is relatively easy to make this variable. However, this should be kept independent from the data-input threshold control for maximum flexibility. It is often useful to determine which edge of the externalinput signal is used to drive the sample channel or delay counter, and a switch for selecting the positive or negativeedge has been included.

The total number of clock outputs



WIRELESS WORLD, MARCH 1979

available, including the external source, is twelve and on the prototype these are selected by a 1-pole 12-way rotary switch connected to the clock inputs of the sample-channel and delay-counter which are linked. It is just as easy, however, to allow both clock inputs to independently select a clock line by using two rotary switches.

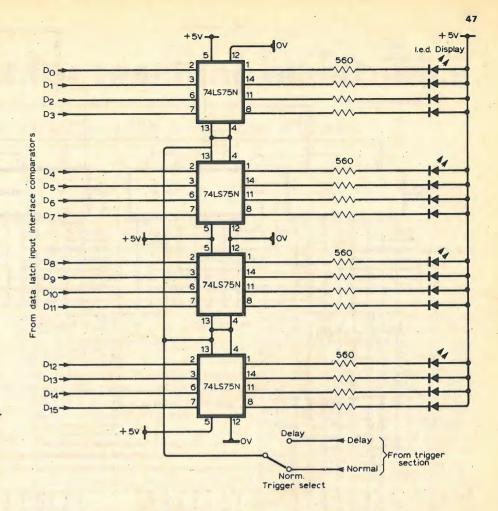
Data latch inputs and hexadecimal comparator

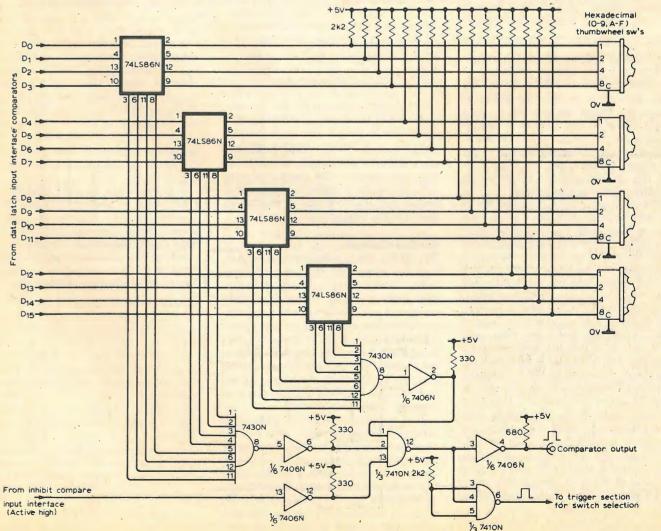
The data-latch and l.e.d. display circuitry is shown in Fig. 5. The interface comparator outputs in Fig. 1 directly drive the hexadecimal comparator and the bistable latches. The latch outputs each control an individual l.e.d. which is positioned on the front panel directly above the corresponding data input socket.

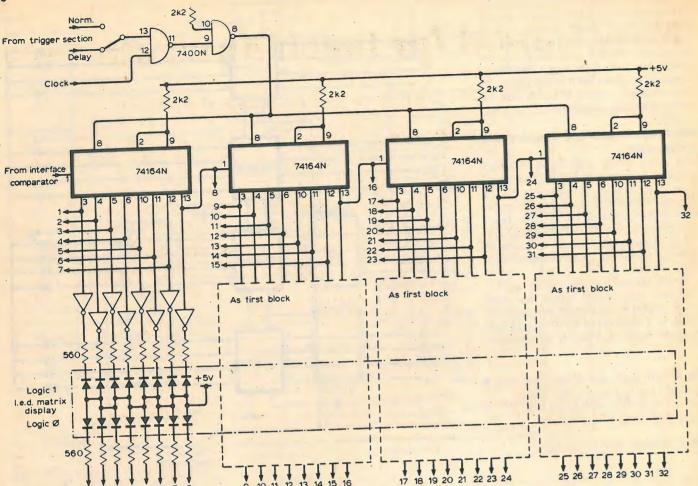
While the enable input is at logic 1, the latch output will follow the data input condition, and when the enable is taken to a logic 0, the latch output will hold the logic state which was present

Fig. 5. Data latch and display. Because ▶ the 74LS latches have a low output current capability, a reduced l.e.d. current of about 5.5mA is used.

Fig. 6. Hexadecimal comparator.







at the time of the transition. The latchenable signal is derived from the trigger section and a switch is provided to select either normal or delay mode. The data-latch therefore has the ability to sample and freeze the state of the data inputs either at the time of a trigger signal occurring, or at a pre-determined time or operational point after the trigger signal. By disabling the trigger input, the l.e.d. display can be used as a 16-bit real time logic indicator.

The low output current capability of the 74LS series necessitates a lower l.e.d. current than would normally be used, and in this case it is about 5.5mA. However, this has proved to be quite acceptable. By using the Q latch output, an l.e.d. that is illuminated indicates a logic 1 and vice versa. The circuit has been designed to show 16 bits of data, although this can easily be expanded or reduced in blocks of four bits depending on the user's requirements. It should be noted that extra control signal buffering will be required if further bits are added.

The hexadecimal comparator section is shown in Fig. 6. The comparator continuously compares the logic state of the data inputs with a hexadecimal-coded binary value set on the thumb-wheel switches. This signal can be used as a control for either external use or as a trigger command, and also as a signal to be displayed on the sample channel. The compare/inhibit input, which uses the standard interface, disables the

Fig. 7. Sample channel and display matrix. In the prototype, two spare NAND gates were used as inverters. All other inverters are 7400N types.

compare-output when taken high, and thus inhibits unwanted comparisons from the exclusive-OR gates. An open collector output is taken to a front panel socket and also to a switch which can feed it to the trigger input.

Sample channel

The 32-bit sample-channel store uses four 8-bit series shift-registers as shown in Fig. 7. Input data is presented to the shift register via an interface comparator, and clocked through the register on the positive edge of each clock cycle. Therefore, the register contains the input logic states that appeared during the previous 32 clock periods. By disabling the clock when a trigger signal occurs, the register will store the previous 32 bits of input data.

The register contents are continuously displayed on an l.e.d. matrix as shown. The top row of the matrix represents logic 1 register bits, and the bottom row represents logic 0. By using the external clock input, the combination of shift register and display forms a time or data domain storage channel which can be used for displaying one-

shot pulses or pulse trains. Use of the trigger-delay mode enables the channel to store and display events occurring after the trigger signal. By delaying 16 sample clock periods, the first half of the display will show the state of the sample channel input for the 16 clock periods before the trigger signal, and the second half of the display will show the state of the input for the 16 periods after the trigger signal.

It is important to note that for an input pulse or change of state to be clocked into the register, it must be present for at least one positive clock edge. For this reason, it is always advisable to have a clock sampling frequency of at least five times the expected frequency of the input waveform.

to be continued

New format for teaching electronics

"Novatexts" are a breakaway from conventional textbooks

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

TEXTBOOKS HAVE NOT CHANGED their format in our generation — nor in the last. There are good reasons for this: the format has been successful for so long that there have to be. Conventionally the work is divided into chapters of roughly equal length, each chapter dealing with a single subject. Within each chapter there is a variety of information. In engineering and science at least four types are distinguishable: diagrams, figures and graphs; text, often describing the diagrams and linking them to the analysis; mathematical material developing the theoretical background; examples either practical or numerical. The last category can be extended to include data on particular devices or systems, references to related topics and so on. It is possible without diminishing its importance to describe this section as "house-keeping", a collection of useful functions that vary from occasion to occasion, e.g. some chapters lend themselves to worked examples, while others benefit from reference to manufacturers' data.

On each subject the reader is presented with this range of information, that, fully absorbed, leads to a balanced judgement. It is at this point that the approach can be challenged. It assumes implicitly that each reader is in need of all the information all the time. In some cases certain sections are indicated as being of advanced level, or of being subsidiary to the main theme, but that all the types of information are necessary does not appear to be questioned.

Consider the order in which the material is presented: the text introduces a topic, followed by a circuit diagram, a graph or a scale drawing. Some aspect of the material is then analysed, perhaps with a worked example and the text resumes. The pattern, or sometimes the lack of it, is repeated throughout each chapter, the aim being to provide a logical and coherent development of the whole subject at a level appropriate to the readers. The material is presented sequentially, and the reader is constrained to follow that sequence if he or she is to benefit most from the efforts of

The proposition underlying the new approach is simple: that at any given

time the information needed by a reader is less than that presented by the author. (This does not conflict with the truism that the need is always more than any author can provide.) The proposition is that different types of information are appropriate to different users, and to the same users at various times. The following illustrations may help to make the case:

- —a technician asked to produce a piece of test equipment would find a diagram of a circuit or a scale-drawing helpful, particularly if backed up by a worked example.
- —a student meeting a subject for the first time would need a description of the principles well before the rigours of the mathematical analysis became important.
- —during a second-level course the general principles should have been absorbed leaving the analysis as the key section though with reference to explanatory material to fill gaps in the memory.
- —a working engineer coming on an unfamiliar topic would welcome a visual summary of the subject in diagrammatic or graphical form; this would show the degree of relevance of the material and whether the text and analysis merited further study.

This is the case for the separation of a

subject into separate types of information. It is not argued that this should always be done, but that it is an alternative of say diagrams, text analysis, examples. The weakness is that the physical separation onto different pages makes it almost as difficult to find the explanation of a diagram or the equations referred to in the text. There appears to be no way of juggling the information in a book to meet these requirements. This is because there is the hidden and apparently reasonable assumption that each sub-division of the book needs a number of pages. To a reader of this journal it will be clear that the format allows a far greater amount of material on the page. As a rough guide a WW page of text has 1200 to 1600 words depending on the type-size. By comparison, a novel has about 220 to 300 words per page with comparable figures for many text books. This shows the intensive nature of the information available in an A4 journal format - a 300-page text book can be accommodated in less than 60 pages, which is comparable to the editorial matter in a single issue of the journal.

The importance lies not in the valuefor-money aspect but in the fact that a double-page spread is equivalent to perhaps a dozen pages of conventional text books. This represents a short chapter, and readily encompasses single topics within a longer chapter. The topic can now be presented at one sitting as it were and the format chosen is shown on page 50. The presentation is series-parallel rather than purely serial in that each of the four types of information appears sequentially but with the four streams of information in parallel. The first, time reader can scan the left-hand column and perceive the nature and scope of the topic at a glance. Even before the details are gleaned from the text, the development of the ideas should be clear and the

"Different types of information are appropriate to different users, and to the same users at various times."

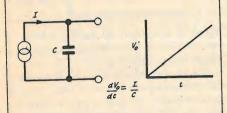
reader should know whether the text analysis or examples are most likely to meet his needs. Thus students, engineers, teachers and technicians can select the types of information they need in the most convenient order.

Because the data streams are parallel, it is easy to cross-refer from diagram to text, to relate the analysis to the diagrams and so on without having to turn pages. To facilitate this a further constraint has been accepted: the text has generally been broken down into paragraphs of 150 to 250 words, with each paragraph related to the adjacent diagram. The diagrams, figures and graphs have been selected to assist this division. It is not thereby implied that all diagrams are of equal importance but the attempt has been made to partition the left-hand page into units of comparable length. This is neither possible nor desirable for the analysis, since certain equations apply to more than one diagram, while some diagrams may require several equations.

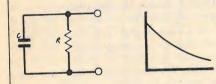
continued on page 88

Capacitor charging and discharging

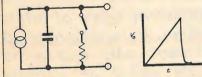
Linear Ramp: Constant Current



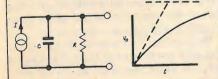
Capacitor Discharge



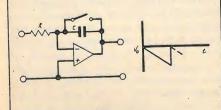
Sawtooth Generation



Ramp Non-Linearities



Op Amp Sawtooth Generator



Ramp, sawtooth and triangular wave generators, astables, monostables and pulse generators all depend on one simple fact: when a capacitor accumulates charge from some source of current its voltage changes. Further, the rate at which the voltage changes is directly proportional to the magnitude of the current. The variety of these circuits and their applications tends to obliterate this common property. It is very helpful to return to the behaviour of a single capacitor connected to a current source, a resistor, or both. In this way both the ideal behaviour and the departures from the ideal can be identified before considering the many versions that have been proposed for the above functions. A perfect current generator sustains a defined current into any load including that of a capacitor regardless of the terminal voltage. (Because most practical generators approximate to voltage sources, the behaviour, of current sources may appear less obvious, and a formal restatement of this basic property helps to avoid confusion.) The capacitor has the property that charge and voltage are proportional, Q = CV, provided that the capacitance C remains constant. Observing that current is the rate of flow of charge then the relationship between current and rate-of-change of voltage follows.

If a capacitor is charged to a given voltage and then has a resistor placed in parallel with it, that charge is dissipated. The higher the terminal voltage the greater the initial current flow and hence the rate at which the charge is lost. Hence the slope of the voltage waveform is steep at first, progressively diminishing as the voltage falls. The voltage is asymptotic to zero and the point at which the capacitor is said to be 'discharged' is thus arbitrary — for practical purposes, a final voltage of 1-10% of the initial value might be used. (In some cases the presence of a constant-current term in the model of the active devices used results in the capacitor voltage genuinely passing through zero). The property that the rate-of-change of voltage is proportional to the voltage itself leads to an exponential relationship between voltage and time. In this the resistor and capacitor always appear in the relationship as a product and it is convenient to write $\tau = CR$ where τ is referred to as the time constant of that portion of the circuit. A complex circuit has many time constants but it is often possible to evaluate the effects of each separately.

The two previous voltage waveforms can now be joined together to provide a pattern that if repeated continuously is described as a saw tooth waveform. It consists of a linear slope or ramp followed by a rapid, but not necessarily linear, return to zero or some very low value. A single cycle of this waveform can be obtained by switching the capacitor from the current generator to the resistor. This would leave the current generator open-circuit for part of the time, and by analogy with a short-circuited voltage generator this state of afairs can be seen as undesirable. As the discharge is required to be very rapid the current flow in the resistor is much greater than that from the source and it is more usual to leave the current generator connected. This raises the minimum value of the final output to IR, but provided IR V OLIMBAY this is no great disadvantage. The switching is simple in this form, consisting only of a single-pole switch. If the switch is operated at pre-determined instants the generator is said to be triggered and such a ramp-generator is the basis of oscilliscope time-bases. Alternatively, a level-sensing circuit can be used to activate the switch when the ramp reaches some particular voltage (free-running mode).

No perfect current generator exists, and the imperfection is most often that of a constant parallel resistance. This includes any leakage resistance of the capacitor and the input resistance of the following stage, as well as the finite output resistance of the generator. The current in the resistor is still much less than that from the generator if the circuit is to have any pretence of being a ramp generator, but the gap progresively closes as the output voltage increases. Hence the output departs from the ideal linear ramp. The error can be calculated either in terms of the difference between the actual and ideal voltages at any instant or in terms of the difference in the slopes. As the purpose of such a calculation is often to compare the relative merits of different arrangements it matters little which is used; the slope error is easier to calculate and is used in the following section. The actual error is usually obtained by expanding the exponential equation and taking account of the low-order terms in the expansion. In circuits involving active devices, the effect of finite voltage and current gains are shown to be equivalent to additional resistive losses:

A practical and widely-used form of sawtooth generator uses an operational amplifier. The configuration is that of an inverting integrator, and with a constant input voltage, the current in R is constant, assuming a true virtual earth corresponding to infinite voltage gain. Departures from this assumed condition are discussed later. The input current of an operational amplifier is finite, small and almost independent of the signal condition. It may be either positive or negative depending on whether npn or pnp transistors form the input stages. This current either increases or decreases the capacitor current by a small but constant fraction, leaving the ramp linear but with a slightly modified slope. Any voltage offset of the input devices modifies the voltage across R, providing a similar slope error. The inverting nature of the stage results in a negative-going output ramp for a positive input voltage. It is the virtual earth behaviour resulting from the very large voltage gain that allows the constant input voltage to produce a proportional and constant charging current. It also allows the output voltage to be nearly equal to the capacitor voltage while the output can be loaded without any significant change in the capacitor current.

Capacitor charging: constant-current

THEORY

The voltage built up across a capacitor when charged from a

Q=CV

$$I = dQ/dt$$

$$\frac{dV}{dt} = \frac{1}{C} \frac{dQ}{dt} = \frac{I}{C}$$
and V=
$$\int_{t_1}^{t_2} \frac{I}{C} dt$$

For I constant, and V₁ the initial value of V

$$V = \frac{1}{C}(t_2 - t_1) + V_1$$

In many practical circuits the initial voltage across the capacitor is zero

The discharge cycle would be similar, with a constant current discharge; in most cases the discharge is through a resistor. Let the initial voltage be V_1 , with the current flowing *into* the capacitor still I

$$\frac{dV}{dt} = \frac{I}{C} = \frac{V}{CR}$$

For convenience write CR = T the time-constant of the CR network

$$\frac{dv}{dt} = -\frac{v}{\tau}$$

Hence $V = V_1 \exp -t/\tau$

with $V \rightarrow V_1$ for $t \rightarrow 0$

and $V\rightarrow 0$ for $t\rightarrow \infty$

There are two conditions of interest in which both resistive and constant current terms are present. In the first, the resistor switched into the circuit to discharge the capacitor is normally so low that the constant current has a negligible effect on the duration of the discharge. It limits the absolute lowest output to IR.

The second condition considers the effect of stray leakage or load resistances that disturb the linearity of the charging cycle.

Then
$$\frac{dV}{dt} = -\frac{V}{\tau} + \frac{I}{C} = \frac{1}{C} (I - V/R)$$

The slope departs from the original value of I/C more and more as V increases, with a fractional error of (V/R)/I corresponding to V/V_{max} where V_{max} is the theoretical maximum voltage output if all the current were flowing in the leakage resistance R. The analysis can also be carried out by converting into the corresponding voltage generator form and treating it as a standard RC timing circuit with a corresponding large drive voltage (IR), with the output as only a small portion at the bottom of the experimental charging cycle.

The information can be applied to the op.amp sawtooth generator shown. To a first order for high-gain op.amps, the capacitor current depends on V/R and the input bias current. The latter is independent of the output voltage to a first order i.e. modifies the output slope to be proportional to $(V/R-I_{bias})$ without disturbing the linearity.

EXAMPLES

1. An operational amplifier has a compensating capacitor of 30pF into which its first stage can deliver a maximum current of $\pm\,20\,\mu\text{A}$. Calculate the slew rate i.e. the maximum rate-of-change of voltage across the capacitor

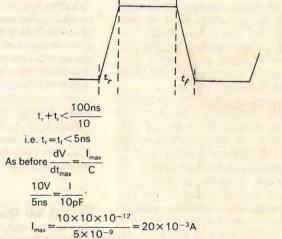
$$\frac{dV_{C}}{dt} = \frac{d(Q/C)}{dt} = \frac{1}{C} \frac{dQ}{dt} = \frac{I}{C}$$

$$\frac{dV_{C}}{dt_{max}} = \frac{I_{max}}{C} = \frac{20.10^{-6}}{30.10^{-12}} \text{V/s}$$

$$= 0.67 \times 10^{-6} \text{V/s}$$

$$= 0.67 \text{V/} \mu \text{s}$$

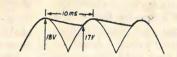
2. An amplifier is loaded by a stray capacitance of 10pF and is to reproduce 10V peak-peak square-waves at a 10MHz clock-rate. What should the peak current-capability of the amplifier be, if the rising and falling edges are to occupy less than 10% of the total time?



Hence the amplifier output current must be at least 20mA.

3. A 1mF capacitor in a full-wave rectifier power supply is charged to a peak voltage of 18V. If the voltage is to decay by <1V between successive peaks, estimate the minimum value of load resistance that can be used (i) using the exponential decay equations; (ii) by the approximate method of assuming the discharge current is constant at its peak value. Assume mains frequency 50Hz.

(a) Capacitor discharges almost for a half cycle i.e. ≈ 10ms



 $17 = 18 \exp(-10^{-2}/R \times 10^{-3})$

$$\frac{10}{R} = \ln\left(\frac{18}{17}\right)$$

 $R = 175\Omega$

(b) For linear decay 1≈18/R

$$\Delta V = 1V$$

$$\Delta t = 10 ms$$

$$\frac{7t}{7A} = \frac{C}{I}$$

$$\frac{1}{10^{-2}} = \frac{18}{R.10^{-3}}$$

R≈1800.

Sun-spots, sweepers and buried clocks

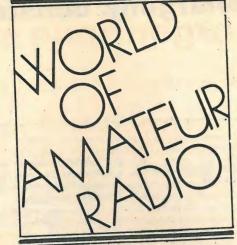
Although the approaching sun-spot peak is clearly going to be a high one, it now seems that it may not reach the bumper figures (over 200) predicted a few months ago: the sudden "recession" last summer seems to have had a lasting effect. Nevertheless, prospects for 50MHz and similarly high frequencies producing long-distance contacts are good. A series of s.s.b./c.w. contacts between KH6EQI in Hawaii and a number of Australian stations took place last Autumn, for the first time in 20 years.

Martin Harrison, G3USF, recently appealed for co-operation from British amateurs in collating more information on "sweepers and creepers," the unexplained natural emissions that sweep across finite bands of frequencies (often in the region 20 to 30MHz but sometimes much lower). Ted Cook, ZS6BT in Johannesburg, South Africa has recently forwarded to me a tape cassette providing many excellent examples of these curious and distinctive signals. So far, although a number of theories have been tentatively put forward, there is no entirely satisfactory explanation of these phenomena, first observed by Gerson and Gossard in 1958 (see WoAR, February 1978).

R. H. Dicke of Princeton University has recently put forward the idea that despite the apparently large and random variations in the periodicity of the sunspot cycles (cycles varying from 7.3 to 17.1 years have been recorded) the Sun appears to have the ability to "remember" and re-adjust to the correct spacing between maxima — almost as though there were an accurate chronometer buried deep in the Sun. His explanation for the apparent variations is that the transport of the magnetic field from the deep interior to the surface requires a long time and is subject to irregularities.

Band plan problems

The system of voluntary band-planning, introduced into Europe by the RSGB some 30 years ago and subsequently endorsed by the International Amateur Radio Union, has long been recognised as a highly desirable, if not essential, means of separating non-compatible transmission modes. However the increasing number of modes and specialised communication techniques (virtually unknown when the system was set up) is making it difficult to modify and extend band planning so that it satisfies everybody. One finds, for example, grumbles with the present situation on the popular 144MHz band. Some users are seeking specifically a.m. as well as n.b.f.m. "channels" and there have been problems with overlapping "satellite" and "emergency" alloca-



tions. A major problem is that frequent modifications to a v.h.f. band-plan can prove costly for stations not using frequency-synthesizer techniques, owing to the cost of new crystals.

Then again, on h.f. most r.t.t.y. operation is within the "telegraphy" sections of the various bands, though this does not seem to have been recognised by the writers (G3VYV, G8IAT and G4GQO) of the "Letter to the Editor" in the January issue who were apparently "stunned" by my suggestion that this mode can (and does) have high interference-potential. They did not seem to grasp that this referred to those using manual telegraphy, where one would find it extremely difficult to "notch out" an r.t.t.y. transmission, whatever may be the case with 'phone transmissions.

From all quarters

One of the less desirable aspects of amateur radio is that it seems to make its adherents more likely to receive unwanted "chain letters" promising to bring in thousands of dollars to those foolish enough to send money to the name at the top of the list and then forward copies of the letter to about 20 other people. A reader sent me (for inspection I hasten to say) a recent copy of one of these pests with their appeals or warnings against "breaking the chain." Pulling the chain on them is more appropriate.

Special event callsigns in the series GB2, GB3 or GB8 plus two or three letters are available through the RSGB provided that application is made at least one month before the event. However, once a particular callsign has been alotted to a group, the same call will not be issued to another group for a different event. The special prefix "GT" is being authorised during the Isle of Man Millenium for use between June 30 and July 8 (inclusive). Normal prefix for the Isle of Man is "GD."

The Japanese scientists - M. Morimoto, H. Hirabayashi and J. Jugaku - have pointed out that if in-

telligent civilisations are common throughout the Galaxy, they must have formed a community using communication and must be sending radio beacon signals. They suggest it is possible to specify not only the most likely frequency on which to listen (4829.659MHz, the spectral line of formaldehyde) but also the directions to be searched.

The Swedish farmer-amateur Lars-Erik Johansson, SM4AQL keeps his station on the air (and his farm running) from an ambitious cow-powered methane digester cum electric generator. The reactor, at any one time, contains some 22,000 gallons of slurry formed from the output of 50 cows and 40 heifers, providing 4,000 litres of fresh slurry daily and producing some 70 cubic metres of methane gas each day.

While a number of amateurs have been puzzled at why some Japanesemade amateur radio equipment seems to sell at relatively much lower prices in the U.S.A. than in the UK, rather fewer (Rev G. C. Dobbs, G3RJV of the G-QRP-Club is an exception) have remarked on the extraordinary difference between what the Post Office now charges for International Reply Coupons (25p each) and what it is prepared to give for them.

The BARTG newsletter has pointed out that amateurs using s.s.b. rigs for r.t.t.y. often have power amplifiers working at well under 50 per cent efficiency and that even the old and often discarded a.m./c.w. rigs have uses, other than as boat anchors: their Class C power amplifiers and large power units designed for high duty cycles can provide potent r.t.t.y. signals.

In brief

Application has been made for the operation of the first two 24GHz beacon stations on the Isle of Wight and Alderney ... National events announced for 1979 include: March 10, National VHF Convention at The Winning Post, Twickenham, Middlx; May 11-12, RSGB Amateur Radio Exhibition, Alexandra Palace, London; August 5, National Mobile Rally, Woburn Park; September 15, RSGB H.F. Convention, Birmingham; and September 22, Scottish V.H.F. Convention, Dundee . . . Bert Mathews, G6QM of Cheltenham has died - he was a sub-manager of the RSGB QSL Bureau for over 30 years .:. Denis Campbell, G13TAC, a radio and electronics officer aboard the cable ship "Mercury" has been keeping a daily schedule from the Bermuda area with his father, G130LJ ... North Midlands Mobile Rally, organised jointly by The Midland Amateur Radio Society and Stoke-on-Trent Amateur Radio Society will take place on Sunday, April 29 at Drayton Manor Park, near Tamworth.

PAT HAWKER, G3VA

Electronic organ tone system — 5

Vibrato, noise, expression pedals and stop control

by A. D. Ryder, M.A., Ph.D., F.I.E.E.

This article completes the section on tonal variations, and concludes the electronic organ tone system by describing further optional additions together with some general notes.

MODIFIED FILTERING may also be useful with cross-keved ranks (see below), otherwise only octave harmonics are available.

For use with modified filtering, the harmonic content of the SQB signal may be increased by combining octavely-related divider outputs to produce an unequal mark-to-space ratio signal for gating. It is preferably to use OR or NAND functions rather than their inversions to minimise the d.c. component. For example, the NAND of 65.4, 131 and 262Hz provides a 1:7 pulse with a fundamental of 65.4Hz for which the first 16 harmonics are listed in table 12 with a saw-tooth for comparison.

Because the third harmonic of F1, for

example, is nearly equal in frequency to C with accurate equal temperament, an out-of-tune rank may be built up using 34F1, for C1, 34F'1 for C'1 and so on, which contrasts usefully with intune stops. This requires keying signals KB in Fig. 14 to be cross-linked (or separately generated). For example, the KB signal from manual C1, normally at 65.40Hz, must drive a gate on the F card supplied from the $1.5f_0$ divider output at 65.48Hz, and so on with these gates feeding a separate set of buses. A similar scheme is possible using the fifth harmonic where the much larger frequency difference produces noticeable beats similar to a celeste. The lowest note of a celeste rank is usually tenor C, and the appropriate frequency is available at $2.5f_0$ on the G' card. Table 13 shows the linking pattern for both arrangements. The same principle could be applied using the 7th and 9th harmonics to create larger frequencydifferences. To provide the necessary frequencies, the reference input in Fig. 47 would be 12f or 24f with p.l.l. circuit components modified accordingly.

As the ear is insensitive to pitch at

Table 13 Third and fifth harmonic cross-keying. The table shows manual frequencies for the first octave of each cross-keyed rank.

Played Keyed Hz	F1.5	F' 1.5	G1.5	G' 1.5	A1.5	A' 1.5	B1.5	C03	G'K1 C'03 103.9	D08	D'03	E03	
Played Keyed Hz	G'2.5	A2.5	A'2.5	B2.5	C05	C'05	D05	D'05	G'K2 E05 206.0	F05	F'05	G05	

high frequencies, the 8th harmonic signal may be extended beyond EK5 by using 6th harmonic frequencies and so on. This is equivalent to the breaking back of a mixture. The transistor gate in Fig. 13 can function as a mixer because of the low input resistance at the base. but its usefulness is limited to octave combinations due to transient effects during keying. To build up a mixture rank, separate gates are preferable although they may use a common SOB set and filter. For comprehensive mixtures, it is necessary to expand to two sets of cards,

Fig. 48. Low impedance sinewaye source for vibrato. The potentiometer may be remotely mounted and connected with twisted wire.

The term vibrato is used here for frequency modulation at 4 to 8Hz with a pk-to-pk amplitude of up to one semitone, 100 cents, though much smaller amplitudes, down to five cents or less, are useful. Sinusoidal modulation is preferable for large amplitudes. As noted in part 2, f.m. may be applied directly to the gate-card generators and, if a common signal is used, normal vibrato is produced. A 100 cent swing requires about 0.7V r.m.s. at the vibrato inputs. The use of independent signals is considered in the next section. Fig. 48 shows a low impedance sinewave source suitable for normal vibrato. In the trigger circuit, R₁ or R₂ may be trimmed for an equal mark-to-space ratio at A, i.e., for minimum second harmonic. Resistor R₃ or C₁ sets the

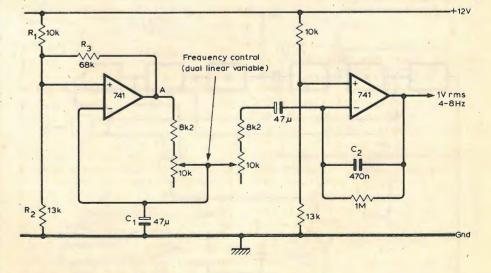


Table 12 Harmonic components as a percentage of the fundamental.

Harmonic No	1	2	- 3	4	5	6	7	8/	- ġ	10	11	12	13	14	15	16	
1:7 pulse	100	92	81	65	48	31	14	0	11	19	22	22	19	13	7	0	
Sawtooth	100	50	33	25	20	17	15	13	11	10	9	8	7	7	7.	6	
-		-		-								-					

WIRELESS WORLD, MARCH 1979

frequency range of the control, which may be remotely mounted using twisted wire. The output level may be increased up to about 2.5V r.m.s. by reducing C₂.

Vibrato applied at the generators will affect all three departments and all frequencies. Vibrato to an individual department offers more flexibility, and helps a solo stop, for example, to stand out distinctively. It is sufficient to consider the h.f. channels only, because a pipe organ vibrato or tremulant has little effect on the bass pipes. Frequency modulation can be achieved by passing the signal through a bucket-brigade delay device, such as the Mullard TDA 1022 or Reticon SAD 1024, and modulating the clock frequency. The phase Ø of the output, relative to the input, depends on the line delay D, and because the frequency corresponds to dØ/dt, the output frequency varies as dD/dt. For sinusoidal modulation, the peak frequency deviations occur at the zeros of the modulating signal, where its slope is a maximum, and so have an amplitude proportional to both the frequency and amplitude of the modulation. Also, because D is a number of clock periods, e.g. 256 periods, it is the clock period rather than its frequency which should be linearly related to the modulating signal.

The circuit in Fig. 49 shows a periodmodulated oscillator based on Circard 15-16, with a current mirror for constant-current charging of the 470p timing capacitor. The modulation amplifier provides the necessary lowimpedance drive to pin 5, and has a gain inversely proportional to frequency so that the peak dD/dt, and thus the signal frequency deviation, is independent of the modulation input frequency. The clock excursions are greatest at low modulating frequencies, and the working point of pin 5 is set by the 7k5/8k2 divider to maximise the linear range. The adjustment can be trimmed by using a p.l.l. with a suitably short loop

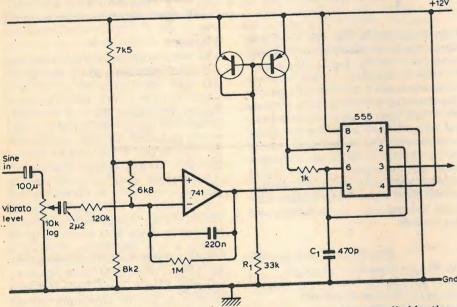


Fig. 49. Period-modulated oscillator. The oscillator frequency is controlled by the voltage at pin 5 and R $_{\rm f}$

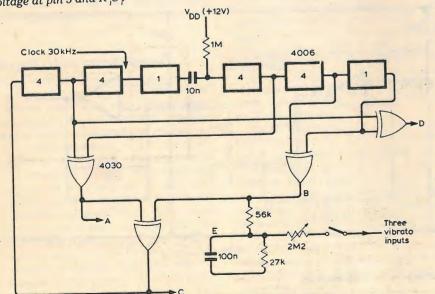


Fig. 50. P.r.b.s. generator with additional output. The capacitance coupling avoids persistence of the all-zeros condition. The output network shown at B is repeated for outputs A, C and D.

time-constant to derive the effective modulation waveform, and with a signal of say 8kHz as a carrier. The oscillator frequency is controlled by the voltage at pin 5 and R₁, C₁. The 6k8 resistor reduces the charging time of the input blocking capacitor at switch-on.

Bucket-brigade devices need twophase clock signals, and manufacturers' data sheets show suitable circuits for deriving these from an input of twice the required clock frequency. The circuit values in Fig. 49 are for a 100 kHz clock, which requires the oscillator to run, unmodulated, at 200 kHz. Using a delay of 256 clock periods, the required modulation input is then about 1 V r.m.s. for 50 cents pk-to-pk f.m. Deeper modulation up to about 100 cents can be used, but the low-frequency limit is 4 to 5 Hz at this level. Although it entails correspondingly wide excursions, a relatively high clock frequency minimises a.f. noise from the device, and raises the frequencies of spurious output signals, so that a second-order output filter with a corner frequency of 12kHz is satisfactory. Care should be taken to set the signal input bias to the centre of the linear range, and r.f. bypassing at the input may also help to reduce noise.

In general, organ pipe harmonics fluctuate in phase with respect to the fundamental, and this effect can be simulated using a modulated and an un-modulated channel with a passive 6 dB/octave crossover at say 1 kHz, so that the modulated channel predominates at h.f. Separate speakers allow reflected sound to smooth out the comb-like frequency response which is produced if a delayed and undelayed channel are mixed electronically. Various other effects are possible by cyclic variation of channel gain, etc.

Noise: quasi-chorus

A pseudo-random binary sequence (p.r.b.s.) noise generator with a cycle length of 218-1, approximately 262,000 is shown in Fig. 50. Using a clock frequency of about 30 kHz, the signal at any output is substantially uniform over the a.f. range, and the periodicity of about 81/2s is unnoticeable. The clock' may be derived from the 1 MHz crystal by using a division of 32, or from pin 3 of the 240 divider in Fig. 37, about 29 kHz. A noise-jitter chorus effect can be produced by applying band-limited noise signals to the gate-card vibrato inputs, and the circuit in Fig. 50 provides four time-shifted versions of the p.r.b.s., each of which may be used to modulate three adjacent semitones. The network shown at D has a 3 dB frequency of about 100 Hz, and also sets the mean level at E to +2V, which avoids transient frequency shifts when the switch is operated.

For use as a noise bus for mixing into stop combinations, the p.r.b.s. signal needs to be gated, by key operation, with an amplitude following roughly an

r.m.s. characteristic. Fig. 51 shows a basic circuit where Tr₂ corresponds to the p-n-p transistor in Fig. 33, and the noise gate is an inverted form of those in Fig. 13. Again, the time-shifted outputs of Fig. 50 can provide substantially uncorrelated signals for different stops or departments.

Expression pedals and amplitude modulation

The usual pipe organ expression pedal, which controls the swell department only, allows a greater variety of effects than if the whole organ were enclosed in a swell-box, and this arrangement can be adopted with the present design, with pedals for the other departments if required. A wide-range pedal is hard to control musically, and 15 or 20 dB is about right. The MC3340P electronic attenuator can provide a simple noisefree control, and although it introduces some low-order distortion at higher attenuations, this is not a serious drawback. The main difficulty is in the scaling, and each device needs individual calibration. Fig. 52 shows the basic connections. The gain depends on the pin 2 voltage, and is controllable by an external resistance R.. The gain reaches a maximum of about ×4 when Rc is zero. If this is defined as 0 dB, the gain varies more or less linearly with R. between about -6 dB, $(R_c = R_6)$ and -26 $dB_1(R_c = R_{26})$. These two values must be found by trial, and also the open-circuit voltage E at pin 2, and Re, the value of Re which pulls down the pin 2 voltage to E/2. Typical values are $R_6 = 7k\Omega$, $R_{26} = 12k\Omega$, E = 5.3 V, $R_e = 4.7k\Omega$. Resistance R can consist of a fixed 7kΩ resistor in series with a $5k\Omega$ variable which is controlled by the pedal. In practice, however, the choice of pedal resistor is restricted. Fig. 53 shows a simple pedal linkage with an approximately linear action over an arc of 90°. This operates a wire-wound variable resistor which gives, for example, a swing R_{ν} of $3.3k\Omega$ with a 10kΩ variable resistor. In general, it is necessary to scale down the effective value of R, and hence R, and R, to suit the available R, by a factor s, which in this case is 3.3/5.0 or 0.66. Fig. 54 shows two additional resistors R, and R, which are used for this purpose. Assuming a 12V supply, the values are

$$s = \frac{R_{\rm v}}{R_6 - R_{26}}, R_{\rm f} = s \cdot R_6$$

$$R_a = \frac{12 \cdot s \cdot R_e}{E(1-s)}, R_b = \frac{E \cdot R_a}{(12-E)}$$

For a 15dB range, R₂₁ is measured and used in place of R₂₆.

The MC3340P may also be used for amplitude modulation tremulant by applying the modulation to pin 2. However, if an expression pedal is used as well, the modulation sensitivity necessarily varies with the pedal setting. To compensate for this, C₁ is increased to say 47µF to have a dominatingly low reactance. The modulation is applied to

Fig. 51. Basic noise gating. The current i_k is proportional to the number of keys operated, and the noise output amplitude is required to vary as $\sqrt{i_k}$.

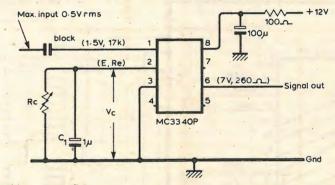


Fig. 52. Basic electronic attenuator. The figures in brackets show open-circuit d.c. voltages and internal resistances.

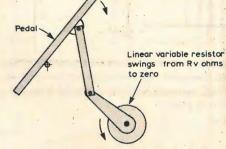
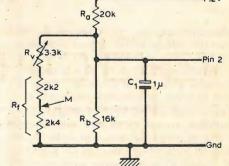


Fig. 54. Modified control network.

Fig. 53. Expression-pedal linkage. This arrangement provides an approximately linear action over an arc of 90°.



Shown in de-operated position

Spring

Light extension for finger operation and labelling

Buffer Pallet-mounting Fixed buffer

Fig. 55. Pallet-magnet with tab extension.

Fig. 56. Stop tab circuit and swell department cancelling.

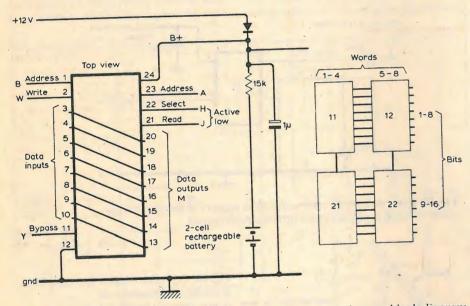


Fig. 57. Pin connections for the 4036 and battery. The insert shows a block diagram of the four packages for one department, and these are wired as follows, B+, gnd, A, B, J, W and Y - common to all four. 11-12, 21-22, outputs and inputs, (pins 13 to 20) common in pairs. 11-21, 12-22, H, - common in pairs.

approximately the mid-point of R_f, so that the voltage swing at pin 2 increases as the gain increases. At 6 Hz, a modulation of 2 dB pk-to-pk will require an input at M of 100 to 150 mV r.m.s. If two or three independent channels are to be controlled by one pedal, the simplest course is to link additional variable resistors, because individual devices vary widely in gain for a given V_c value. The calibration process will then allow reasonable tracking.

Stop control

The use of 4016 devices, as previously mentioned, allows switching of stops and couplers via unscreened leads from the console stop-tabs. Each 4016 controlinput should have a pull-down resistor, to ground, of $150k\Omega$. The form of stoptab described is an adaptation of the widely used pipe-organ pallet-magnet, shown in Fig. 55, which requires about 0.11 A at 12V. Although inefficient magnetically, it is designed for silent operation, and the shape allows parts to be attached, in particular a finger tab and light wire contacts to close in the operated position. Also, the fixed buffer may be replaced by one mounted on a stiff spring which can be depressed by extra finger pressure to operate further contacts for second-touch cancelling, s.t.c. This is only necessary for speaking stops, not couplers, and all s.t.c. contacts for one department are in parallel.

In the circuit of Fig. 56 the switching action causes the tab to remain up or down as moved by the finger. The voltage at T with the tab on is 9 to 10V, the negative rail of the tab supply being nominally 4.7V positive to ground. For s.t.c. purposes, the cancel signal is differentiated, and t.c. only interrupts the C line for about 40 ms. The t.c. circuit is repeated for the other departments, and

the general-cancel piston activates all three

The main purpose of magnetically operated or motorised tabs is to permit them to be controlled in combination by pistons (buttons) arranged for thumb or foot operation, and the automatic movement of the tabs keeps the player informed. The circuit in Fig. 56 permits the same T line to be used for both stop and tab control because a momentary connection of T to + 12V will operate the tab, and a momentary ground will release it.

The 4036 memory can be used in a simple parallel configuration to store and execute combinations, and a small battery allows them to be retained with the mains power off. The 4036 stores four words of 8-bits, and this description assumes that 16-bits (stops, couplers, etc.) are used per department, and that it is required to store eight combinations or words. Four are selectable by departmental pistons, c.p., and four by general pistons, g.p., which control all departments at once, using 12 packages in all. Couplers are included because of their tonal importance in the present design, although this is not

universal practice.

Each combination is stored, or changed, by capture. It is set up manually on the tabs, and then allocated to a particular c.p. or g.p. by holding in that piston while simultaneously operating a separate capture button. This results in a write operation at the corresponding memory address. Fig. 57 shows one 4036 package, and the interconnection of four to produce 16 output lines. These are connected to the T lines of the department tabs, and two select lines, H1-4 (packages 11, 21) and H5-8 (packages 12, 22) which are in effect address lines together with the common address lines A and B. As Fig. 58 shows, the addresses are allocated to the c.p., B high, and g.p., B low, in two groups of four.

The memory control is shown in Fig. 59. With no piston operated, lines J, high, W and Y, low, are inactive and the M outputs take the potential of their T lines. Operation of a piston generates a memory address/select, and simultaneously a low at J via the two left-hand 4093 sections, which cause the address contents to be read onto the T lines, and drive them high or low to set the tabs accordingly. Holding in a capture button sets Y high, and prevents a subsequent J low from causing a read-out. Instead, operation of a piston then switches all four 4093 sections, and the high or low states of the T lines are written into the address from the inputs because the outputs remain floating. The c.r. couplings and trigger action delay the write pulse until the address lines are stable, and ensure that it terminates before the piston is released. The 4093 devices are supplied from the battery so that the memory outputs float, J high, with power off, and the T lines do not draw current. Battery drain WIRELESS WORLD MARCH 1979

Fig. 58. Addressing for swell department. The other departments are similar, with common connections to the general pistons.

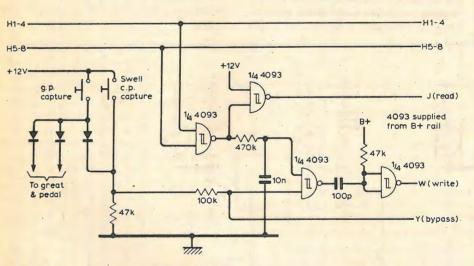
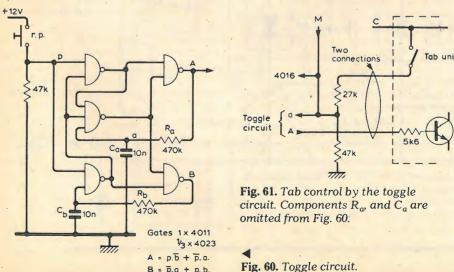


Fig. 59. Memory control for the swell department.



is only nanoamps, and the smallest cell size is suitable.

The two or three most used couplers. such as great-to-pedal, are often made available also from reversible pistons, r.p., push-on, push-off. This function requires some form of toggle or divideby-two circuit. For example, a flip-flop preceded by a trigger circuit to produce a clean signal from the piston contacts. The circuit in Fig. 60, however, is more economical. A counter cell must have four distinct states, which requires two memories, A and B, and if p is the signal to be counted, the basic logic is,

 $A = p.\overline{B} + p.A$ $B = \overline{p}.A + p.B$ In package counters, switching races are controlled by additional gates. In Fig. 60, which is a manipulation of the basic logic to minimise the package count, they are avoided by the RC delays. These delays also permit the latching action to be slowed sufficiently. to immunise the toggle from contact bounce and interference. This allows direct connection to the r.p.

To use this circuit with a tab, the feedback path from A to a is arranged via the tab itself, which provides a delay, as shown in Fig. 61, and two connections are brought back from the tab unit. Manual tab operation, or a pulse from the memory, leaves the toggle appropriately set so that a subsequent r.p. actuation produces the expected result.

Acknowledgement

The advice on tonal variations given by Mr E. L. Jones of Hiykon Ltd is gratefully acknowledged, and the p.r.b.s configuration of Fig. 50 is also due to

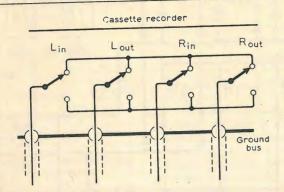
A 30 min cassette recording of the prototype is available for £2.00 c.w.o. A set of 15 special printed circuit boards (12×E01, 3×E02) is also available for £117.32 c.w.o. Both items are post free in the UK, and delivery is about 2 weeks and 4 weeks respectively.

Purchasers of these will also receive supplementary component and procurement details. Hiykon Ltd, Woodside Croft; Ladybridge Lane, Heaton, Bolton, BL1 5ED.

Thyristor touch tuning

The use of thyristors as the switching elements in a touch-tune unit simplifies the circuit and gives improved reliability over conventional designs. Initially the s.c.r. in channel 1 is on due to the 10nF capacitor, and tuning potentiometer R₁ is activated. If the s.c.r. in channel 2 is triggered, 30V is dropped across R2 and R1 momentarily has a voltage drop of $VC_1C_2 + VR_2$, i.e. 60V. As the cathode of SCR₁ is now more positive than the anode, the holding current is zero and the thyristor is therefore turned off, which leaves R₂ as the active potentiometer. Triggering any other s.c.r. will repeat this process. The circuit includes neon channel indicators which were chosen for their low current consumption. The high voltage supply was obtained by tripling the 30V supply. Alternatively, l.e.d. indicators can be used as shown.

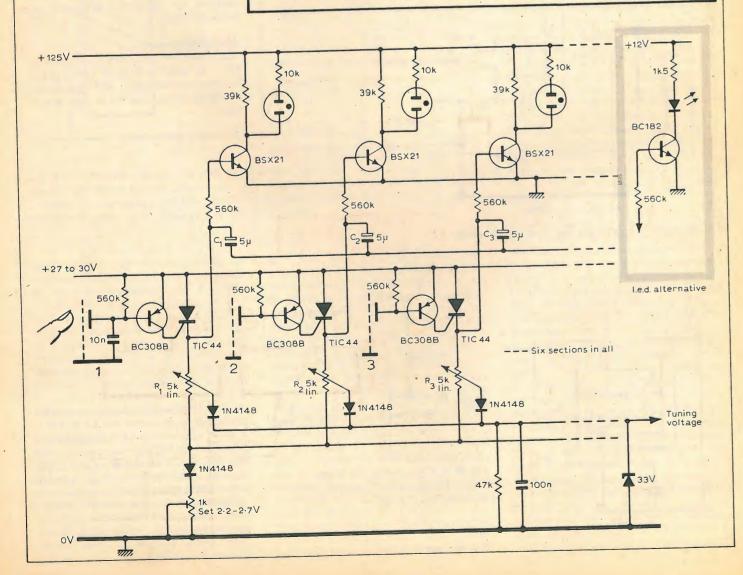
R. P. Beales Kempsey Worcester



Audio switching unit

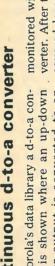
A simple switching unit suitable for hi-fi systems can be constructed using the bus system shown. Each input or output, such as the cassette recorder connections in the diagram, requires a 1-pole 2-way centre off switch. Switches for the inputs and outputs of each piece of equipment should be grouped together and labelled. Any switches in the up position are connected together, similarly, switches in the down position are also connected together. With this system any input or output can be connected to any other input or output. Obviously, some connections should not be attempted, such as tape-in to tape-out. For some applications it may be useful to label the two switch buses left and right, or input and output. It is also useful to supplement the buses with jack sockets so that temporary leads can be patched into the unit.

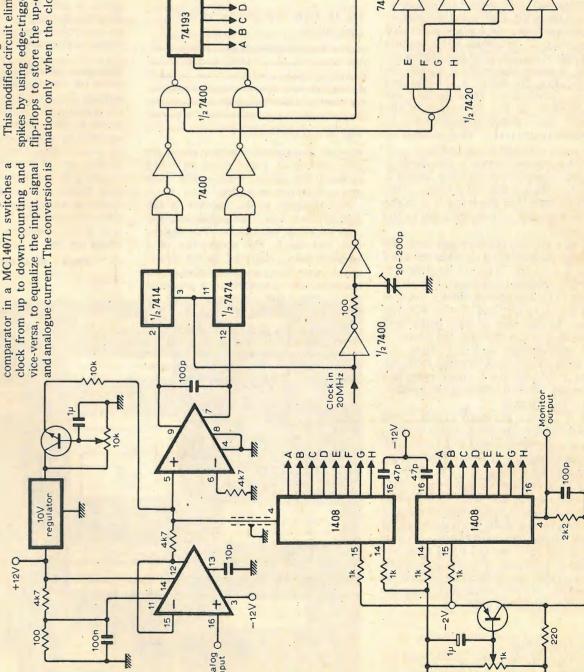
F. A. B. Smith Washington D.C. U.S.A.



WIRELESS WORLD, MARCH 1979

D





Computer buses — 2

Read/write control and contention for possession of the bus

by Ian H. Witten, M.A., M.Sc., Ph.D., M.I.E.E.

Department of Electrical Engineering Science, University of Essex.

IN THE EXAMPLES quoted, device 1 has sent data to device 2. Suppose that device 2 is the processor and device 1 is a store. Since the store will usually hold more than one word of data, it will respond to several different combinations of address lines, each of which combinations addresses a certain location of the store. Typically, there will be 16 address lines, and a single store unit may have 212 locations, each holding one byte of data. So 12 of the 16 lines are used to select the location within the store, and the other 4 address the storage device itself. Thus, device 2 will respond to all the addresses in the < 0010111111111111>. This presents no problems with address decoding.

The processor, device 1, also needs to be able to read from the store, device 2. In this case, it is still the initiator of the data transfer, but the transfer is in the other direction - from the store to the processor.

There are two relationships here: the master/slave relation between devices 1 and 2; and the receiver/transmitter relation. Device 1 is the master in all the cases so far considered, since it initiates the bus activity; and device 2 is the slave. In the case of data being sent from device 1 to device 2, the former is the transmitter and the latter the receiver, whereas in reading from device 2 into device 1 these roles are reversed, without affecting the master/ slave relationship.

The choice between reading and writing is accomplished simply by adding a read/write control line to the bus, which is held low by device 1 for reading and high for writing, as in Fig. 19.

If only one device can ever initiate transfers along the bus - in the sense that a processor can initiate reading or writing from a store, but a store cannot itself initiate these operations - we now have all the control lines that are needed. However, if there are several devices that can initiate bus activity, for example, several processors, some interesting problems arise.

Bus contention

At any time, only one device must be capable of initiating transfers on the bus. This device is called the bus master. If several devices are potential bus

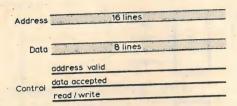


Fig. 19. Asynchronous bus, without

Bus request-

Fig. 20. Bus control lines.

masters (imagine several processors on the same bus), there must be some protocol for passing mastership from one to the other as needed.

For example, in the absence of the dashed line in Fig. 1, the processor is the only potential bus master. The dashed line introduces the possibility of a transfer being initiated by an input/ output interface, and the interface in question will therefore be a potential bus master. Table 1 summarizes which devices are potential masters.

The ideal bus structure is one where every potential master uses the same protocol to communicate with other devices, and none is in overall charge. This increases the reliability of the sys-

tem, since any device can fail without disrupting bus activity that does not involve it. If, on the other hand, just one of the devices had responsibility for the organisation of the bus, its failure could be catastrophic. We will stray from this ideal in the following two sections in order to see how existing computer systems operate their buses, but return to it later to examine more unconventional "distributed" bus protocols.

Bus controller. "Bus contention" occurs when two devices both desire bus mastership. The best cure for contention is prevention! A "bus busy" control line is added to show when the bus is active, asserted by the bus master throughout its mastership. There is normally no mechanism to prevent a device from hogging the bus for ever: it is assumed that device designers understand the importance of leaving the bus free whenever possible.

A device requests mastership only when the bus is not busy. Suppose it

Table 1. Potential bus masters

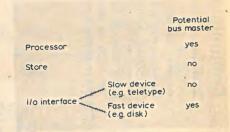
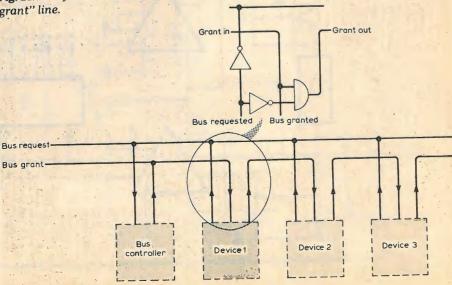


Fig. 21. Daisy-chaining of the "bus



WIRELESS WORLD MARCH 1979

does so by asserting "bus busy". This by itself may seem an adequate protocol for transferring mastership but, unfortunately, it is not. If two devices simultaneously assert "bus busy", they will each think they have the bus to themselves, resulting in collisions. Hence there must be a protocol for requesting bus mastership, and having it granted by a central authority - the bus controller. A "bus request" and a "bus grant" line are introduced for this purpose. The controller monitors "bus busy" and "bus request", and issues grants when appropriate. Fig. 20 shows the control lines so far.

However, the "bus grant" line as described does not completely solve the problem. Each device requesting the bus will see the grant line being asserted, and each will think that it is now bus master. One way out is to "daisychain" the "bus grant" line through the devices, as in Fig. 21. A device, seeing "bus grant", will only pass the signal on to the next device if it itself does not want the bus. Hence a device has priority over all other devices which are further away from the controller than it, when contention occurs.

Fig. 21 also shows the circuitry which controls the daisy-chaining. When a device wants mastership, it takes the "bus requested" signal high, signalling a request on the "bus request" line. Note that this line cannot be tri-state, since there is no way of preventing simultaneous bus requests, and more than one tri-state gate cannot actively drive the same line at the same time. It is the only bus line we have introduced that must be wired-AND, and an opencollector gate is shown driving at low to signal a request. If the "grant in" line is

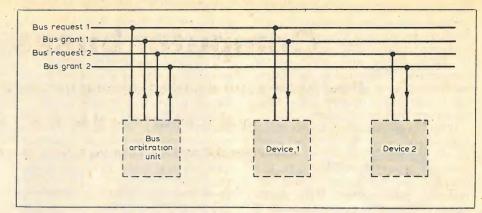


Fig. 23. Bus control with an arbitration

asserted, it is routed through the "grant out" line provided the bus has not been requested. If it has, the grant chain is broken and the device achieves master-

A summary of the protocol necessary for a device to gain and relinquish bus mastership is given in Fig. 22, in which the bus is used for a single "send" operation during mastership. Although the protocol is quite complicated, we have seen how each step is necessary if the bus is to perform its job correctly.

Bus arbitration. An alternative to daisy-chaining the "bus grant" signal is to have separate "bus request" and "bus grant" lines for each device, as shown in Fig. 23. When contention occurs, the bus controller can select one of the

Fig. 22. Protocol for gaining bus mastership and sending data.

Master device Slave device Asserts "bus request." Checks "bus busy." Receives "bus grant" Does not pass it on. Asserts "bus busy." Puts address and data Asserts "write" Asserts "address valid." Recognises address. Asserts "data accepted." Takes address and data off the bus. De-asserts 'address valid! De-asserts 'data accepted: De-asserts ssues "bus grant" equested again.

contending devices and give it alone mastership by asserting its grant line. In this case, the controller is in a position to impose a priority structure on devices using programmed priority levels, and is often called a bus arbitration unit.

The disadvantage of bus arbitration is that the number of lines increases by two for each device added. However, the delays inevitably associated with a long daisy-chain are avoided. In practice a compromise solution is sometimes adopted, with say 8 priority levels, 8 "bus request" and "bus grant" lines, and several devices daisy-chained within each priority level.

Distributed buses. In general, if several identical autonomous devices are connected to a single bus, in a system with no protocol, bus controller or arbitration unit, there is no way of guaranteeing that two or more of them do not try to use it at the same time. However, if such "collisions" can be detected, it is possible to devise protocols for retransmission which ensure that the information gets through eventually.

Although it should be possible to detect collisions by looking for the neither-high-nor-low logic level that occurs when two tri-state gates, both enabled, are fighting for the bus, in practice distributed buses usually use serial transmission. So far, the bus has been considered as a parallel collection of wires, where the address, data and control information is presented in parallel, one wire for each bit of the information. However, if the bus wires are expensive, it is more attractive to use one line only for the information, and transmit the bits one after another on this one wire. This is the case, for example, when radio is used as the bus medium: to transmit 32 bits in parallel requires 32 different radio frequencies to be reserved for the bus, and radio. bandwidth is a scarce resource. (The cost of duplicating the radio receiver and transmitter 32 times for each device connected to the bus is not negligible either!)

To detect collisions using serial transmission, some error-checking information is sent with the data. For example, one might send each transmission twice, and the receiver could check that they were the same. It is extremely unlikely that in the event of a collision when two transmitters are driving the bus simultaneously, the duplicate versions will check correctly. In fact, there are much more collision-detection economical mechanisms than double transmission, but we need not be concerned with them here: the principle is enough.

When a receiver sees a transmission addressed to it, it sends a "data accepted" or "acknowledgement" message. However, if a collision has occurred and the transmission is corrupted, it remains silent. If the sender has not received acknowledgement of his transmission after a reasonable time, he should assume that it has collided, and re-transmit it. However, if two senders collide on a transmission, it is important that they should not time out after exactly the same interval and collide when sending again, and so on



The author

lan H. Witten graduated with a B.A. in mathematics from the University of Cambridge, England, an M.Sc. in computing science from the University of Calgary, Canada, and a Ph.D. in electrical engineering science from the University of Essex, England. He was a Commonwealth Scholar at Calgary during 1969-1970 and has been a lecturer in the Department of Electrical Engineering Science at Essex University since then.

His research interests span the field of man-machine systems; he has specialized in the fundamental problems of machine learning, and in computational phonetics - the science of speech synthesis by computer. He is the author and co-author of about 35 technical publications, including several on speech synthesis.

During a sabbatical year in 1977, he worked at the University of Canterbury, New Zealand, on learning machines, at the University of Calgary on speech synthesis by computer, and at Bell-Northern Research, Montreal, on speech analysis.

Dr. Witten is on the Editorial Board of the International Journal of Man-Machine Studies, and recently, as a consultant to the Open University, participated in the development of a new course entitled "The Digital Computer."

ad infinitum! This situation is avoided by the simple expedient of making the time-out internal random (within suitable bounds).

If an acknowledgement is corrupted by colliding with another transmission, it will simply fail to be received. The device which was expecting the acknowledgement will then time-out and transmit again. This means that the receiver will see the same message twice, and care should be taken to ensure that this does not have any harmful effects. For example, each message could be numbered, so that the receiver can simply discard the second message after acknowledging it.

The scheme described is used in the Aloha network of computers in the Hawaiian islands. Note that no attempt is made to detect if the bus is busy before sending: this means that collisions can be expected fairly often and much of the bus's bandwidth will be used for re-transmissions. (One way of calculating just how much - under very simple assumptions - is given as an Appendix.) A more sophisticated mechanism is for the sender to listen to the bus before transmitting, to see if it will cause a collision by interfering with another transmission. This is analogous to the "bus busy" information described earlier. While this can be expected to reduce substantially the frequency of collisions, it will not eliminate them altogether since two devices may still decide to send at exactly the same time. A further refinement is for the sender to monitor its transmission itself and check that the bits it "hears" are trhe same as those it sends. If there is a discrepancy, this indicates a collision and it should cease transmitting at once. However, this is not feasible in the case of radio, since locally transmitted signals tend to swamp the local receiver and so collisions are not detected locally.

Appendix

Suppose d devices are attached to a distributed bus, each of which sends m messages (excluding re-transmissions) per second. All messages take T seconds to transmit. A synchronous or interlocked bus could handle the traffic provided the total time for dm messages was less than 1 second, i.e. provided dmT<1.

Now let the re-transmission rate be r re-transmissions/sec. In 100 seconds, there will be 100d(m+r) messages sent (including, re-transmissions). These will occupy a total of 100d(m+r)T seconds which must, of course, be less than 100, and during the remaining 100-100d(m+r)T seconds the bust will be unused. Hence the probability of a message requiring re-transmission is 100d(m+r)T/100. Now since there are r retransmission for m real messages, the retransmission rate can also be expressed as

Hence r/m = 100d(m+r)T/100, from which

$$r = \frac{dm^2T}{1 - dmT}$$

We observed above that 100d(m+r)T must be less than 100 seconds, since the bus cannot be used more than full-time. Hence

WIRELESS WORLD, MARCH 1979

$$d\left(m + \frac{dm^{2}T}{1 - dmT}\right) < 1,$$

$$dmT$$
or
$$\frac{dmT}{1 - dmT} < 1,$$

$$dmT < 1/2$$

This shows that the maximum number of messages that can be originated under the distributed bus organization is only half that which the bus could handle if control were centralized.

Actually, these calculations are rather simplified. In real life, even a bus with centralized control cannot necessarily handle the traffic if dmT is close to 1, because this is the average load - the peak load will be higher. If messages are generated stochastically, then the performance of a centralized bus will depend on whether messages can be queued by the devices that originate them. For example, suppose a device wants to send a message, but the (centralized) bus is busy. It must wait for the bus to become free. If, while it is waiting, another message appears which must be sent as well, the device needs to be able to queue the two messages. If it can't, then a message will be lost and so the bus must be overloaded. If it can, how many message can be queued? Two? Two hundred? This is one of the parameters that will affect the performance of a bus with centralized control. In the most optimistic case, where an unlimited number of messages can be queued by each device if necessary, the centralized bus will be able to operate provided dmT < 1. Statistical calculations show that the Aloha distributed bus becomes saturated if dmT grows as big as 1/2e (Abramson, 1970). Thus the distributed bus can handle about 20% of the traffic that a centralized bus can.

Further reading

Abramson, N. (1970) "The ALOHA system another alternative for computer communications," AFIPS Conference Proceedings 37: 281-285; November.

Davies, D. W. and Barber, D. L. A. (1973) Communication networks for computers.

Metcalfe, R. M. and Boggs, D. R. (1976) "Ethernet: distributed packet switching for local computer networks," Communications of the ACM 19: 395-404; July.

Peatman, J. B. (1977) Microcomputer-based design, McGraw Hill.

Williams, G. E. (1977) Digital technology: principles and practices. Chicago: Science Research Associates.



You can now combine fingertip accuracy with strict temperature control (within 2%) at the 0.6mm tip of a miniature soldering iron, by using the soldering station shown with one of the 24 volt irons.

The exceptionally fast recovery time of a miniature iron of 40 watts at the chosen temperature ensures a short exposure or dwell time. If your requirements are less demanding, one of our ordinary miniature or general purpose soldering irons or kits may suit better.

All our soldering equipment is made in England to strict local and international standards of safety. Our name for reliability is spreading from all over Europe to the U.S.A., to Japan and to most other countries.



Mayflower House, Armada Way, Plymouth, Devon Tel: 0752 67377/8 Telex: 45296





the stand ST3 Priced at £6.21 inclusive of VAT and P.&P It makes an excellent present for the radio amateur. modelmaker or hobbyist.

model X25 240 genera



Model SK1 Kit

This kit contains a 15 watt min and a booklet. How to solder. Price at £6.48 inclusive of VAT and P.&F



The soldering iron in this kit can be operated from any ordinary car battery tries litted with 15 feet flexible cable and battery clips Packed in a strong plastic envelope it can be left in a car a boat or a caravan ready los oldering in the field Price £4.83 inclusive of VAT and P. & P.



Please send the following
Please send me the Antex
colour brochure
I enclose cheque/P.O./Giro No. 258 1000
Name
Address
70
Antex Ltd. Freepost, Plymouth PL1 1BR Tel. 0752 67377

WW - 064 FOR FURTHER DETAILS



never meet a better meter

Nobody makes a more impressive range of analogue meters for the professional than Avo.

And within this impressive range is a series of smaller meters which can be picked up with a thumb and forefinger and slipped into a pocket for those applications where simple portability is a crucial factor.

These are the Models 71 and 73 Multimeters, the electronic EM272, the electrician's "Multiminor" MM5, the 300 and 1200 Clampmeters and the LM4 Lightmeter.

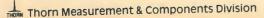
These instruments may be smaller than the rest, but they're equally big in quality, accuracy and reliability.

Otherwise we'd never call them Avo.

Get in touch today and we'll let you have the full facts.



AVO LIMITED Archcliffe Road, Dover, Kent, CT17 9EN. Telephone: 0304 202620 Telex: 96283



Antennas and propagation — 2

Further developments in antenna technology

by R. Ashmore

Part one gave extracts based on some of the papers presented at the Antennas and Propagation Conference, held at the Institution of Electrical Engineers in London recently. Topics covered included a systems engineering approach to antenna design, satellite communications and the amateur radio service. This second part continues where Part one left off, with the discussion on amateur antennas, based on the paper⁴ by Les Moxon, G6XN.

A RECENT analysis showed that at least 80% of the h.f. stations contacted used relatively small antennas on rotary beams. These had closely-spaced halfwave elements providing about 6dB gain (relative to a dipole). This kind of antenna, on the popular DX bands. gives considerable directivity because of the narrow bandwidths. Even smaller beams are needed, but methods of size reduction so far employed have used lossy devices such as loading coils of resonant feed lines. Les Moxon therefore gives consideration to design optimization on the smaller antennas with a view to achieving increased efficiency

Large beam antennas commonly used in commercial installations operate on an additive principle in that the gain and the volume of space occupied by the array are proportional to the number of elements. In contrast, the smaller amateur beams use a subtractive process where energy is concentrated in the wanted direction by arranging that cancellation is less complete in that direction than in the unwanted directions

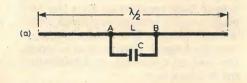
Mr Moxon gives an example of a beam antenna comprising two parallel, closed-spaced dipoles fed in antiphase to give a figure-of-eight directional pattern. This pattern is readily converted into a cardioid by introducing a phase shift corresponding to the spacing. Provided all the available power is radiated, the gain, 4.2dB for both of the above cases, will be independent of size. The practical realization of obtaining higher gains using more than two elements is extremely difficult because of the low radiation resistances, narrow bandwidths and close tolerances inherent in the subtractive method of beam formation, but the two-element design above allows

considerable reduction in size without loss of effective gain.

The useful bandwidth of the smallest beam tried was found to be less than 100kHz but the required coverage of 350kHz was achieved by separately feeding each element through appropriate networks located at the transmitter.

In developing the small antenna it was found that to tune shortened elements to resonance without introducing losses, it was necessary to use as much capacitive loading as possible. The resulting concentrations of metal at the ends of the elements produced very severe capacitance overcoupling of the elements, effectively preventing the beam from operating. This difficulty was overcome by neutralizing the excess coupling using two additional wires to provide antiphase capacitance coupling between the ends of the elements.

Restricted space often goes hand-inhand with height limitations, so it may not be enough just to reduce the size of the antenna. Where ranges are short the need can usually be met by vertical polarization for ground-wave communication or horizontal polarization for high-angle, sky-wave working. However, where longer ranges are required the use of steep ground slopes, if available, is the simplest solution, otherwise vertical polarization may provide the



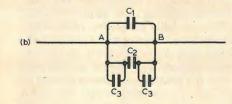


Fig. 2. (a) A linear resonator for a \/2 dipole. This will enable simultaneous operation at the design frequency and also at a higher frequency. (B) A linear resonator arrangement showing additional capacitors for three-frequency operation.

only answer. In the latter case, cancellation of the direct wave by the ground-reflected wave is incomplete so that a modest DX communication capability, almost independent of height, can be achieved.

The paper then discusses the use of beam antennas for multiband DX operation. Beam antennas for amateur DX communications are normally required to cover bands about 3% in width centred near 14, 21 and 28MHz. To achieve this, beam antennas used by amateurs have traps to effectively shorten the elements at the higher frequencies. This, says Mr Moxon, is a wasteful process because the half-wave element for 14MHz can be used as two half-waves in phase at 28MHz to obtain 2dB of extra gain by the additive process

The traps, which are liable to deteriorate, also add losses, restrict bandwidth and increase top weight. Alternatives include resonant feeders and tuning and matching networks located in the centre of the elements. However, the author of the paper recently adapted a linear resonator, as shown in Fig. 2 (a), to provide operation with full aperture at the higher frequencies, without significant effect on operation at the lowest frequency. The inductance L of the conductor AB is tuned by C to act as an insulator at 28MHz. For 21MHz the capacitor is increased to achieve resonance with the inductance of the outer portions of the dipole. (Further, analysis is given in Ref. 4)..

The capacitance may be switched, or resonance may be achieved simultaneously at 21 and 28MHz by providing two capacitors as shown in Fig. 2 (b). This works on the principle that higher frequency resonances have little effect on the lower frequencies, while the high value of k (k being the coupling factor between the current paths and X₁/X₂) brings the parallel and series resonances so close together that the 21MHz path via C₁ is inductive at 28MHz. The main effect of the extra capacitances in Fig. 2 (b) is that the effective value of L is modified. The two capacitors, C, are added to increase the shunt inductance of 28MHz (having little effect at 21MHz) to avoid narrowing of the bandwidth.

Mr Moxon points out that this type of resonator may also be used to tune a

conductor to or away from any specific resonant frequency, or, for example, to allow masts or rigging to be used as antennas at a small number of discrete frequencies. It may also be used to overcome nulls in the polar diagram of an antenna caused by the near presence of resonant metal structures.

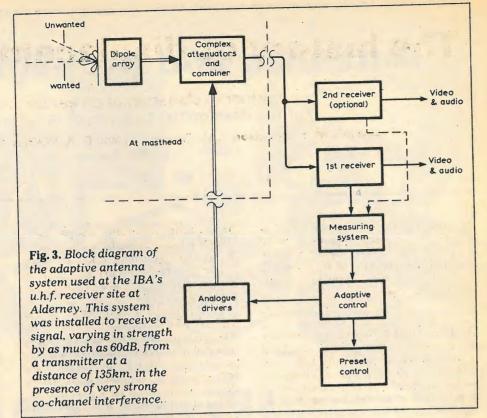
Broadcasting

The Independent Broadcasting Authority (IBA) expect that by completion of the u.h.f. transmitter network they will be operating about 650 transmitters in Bands IV and V. This means that when the fourth channel comes into operation, the total number of transmitters will be about 2600 within the 44 channels of the u.h.f. band. While careful planning avoids serious interferences arising within the appropriate service areas, broadcasters who need to receive signals outside these areas, for rebroadcast, find that irregular propagation can cause them considerable interference problems. Consider for example the u.h.f. link across the English Channel from Stockland Hill to Alderney, part of the colour-tv feed to the Channel Islands. This is an overthe-horizon sea path of 135km length and, characteristically, the received signal is very variable in strength with a range of about 60dB and generally very weak. For this reason, the signal is very susceptable to co-channel interference (c.c.i.) from several sources both within and outside the UK. Crystal Palace in London, Wrekin in Shropshire and Kippure in Ireland (the latter being at an angle of only 7° off the wanted signal) are particularly powerful sources of c.c.i. at the receiving end of

To obtain a broadcast quality signal the reception pattern of an antenna needs on occasions to have null depths of the order of 45dB in the directions of interfering sources. Since this was not possible with conventional arrays, the IBA decided to investigate the properties of adaptive arrays. Details of this investigation are given in a paper⁵ by M. D. Windram from the Authority's Winchester establishment.

The paper lists the main advantages of the adaptive array. When operating the adaptive array automatically adjusts the antenna pattern to give minimum interference, and it will handle these interferences whether they are from single or multiple sources. The antenna can also track the changing apparent direction of interference resulting from propagation effects, and because of its adaptability does not present a severe mounting and tolerance problem, as does a fixed array.

After considerable theoretical study and investigations into the behaviour of a simple four-element adaptive array, the IBA built a prototype half-size (eight element) array. The results of tests on this array confirmed the theory and an operational antenna was instal-



led at Alderney in March 1977. The final operational antenna system used at Alderney is shown in Fig. 3. This is a 16×4 dipole array constructed as a 2×2 array of 8×2 dipoles.

A similar system, having a linear array of 16 elements, is described in the IEE paper. The output of each element is connected to a network which effectively controls the amplitude and phase of that output. These output signals are then combined to create a voltagecontrolled antenna, the pattern of which is a function of the control voltages. This combined output is fed to the system's receiver or receivers which provide the video and audio outputs and also the signals required for the system's measuring circuitry. Up to four receivers may be used within the control loop. The output from the measuring system is then passed to the adaptor control unit which provides the control logic required to alter the antenna control voltages to modify the antenna pattern. The control logic is converted into analogue form to drive the element combiner, so completing the feedback loop.

Initial analysis showed that the ideal element spacing was approximately 2/3\(\lambda\) since this combined reasonable directivity with easy null control. Cartesian (X+jY) type control of the antenna outputs was chosen as this provided the continuous control needed in the adaptive process, where for small changes in control, discontinuities could cause instability. Pure phase shifters have finite phase ranges and would therefore present serious pro-

For u.h.f. arrays of a size similar to that used at Alderney, it is necessary because of the expense, stability and maintainability to use control algorithms which take measurements by making step changes in the control voltages to the array, thus stepping the antenna pattern and measuring the result in terms of c.c.i. on the output signal. The use of correlation methods or similar techniques are too expensive, although in principle capable of giving more accurate measurements of error. The theory of the adaptive array and the theoretical conclusions made by the IBA are described in much greater detail in Mr Windram's paper.

The operational system used at Alderney has helped the IBA to maintain a virtually continuous colour service without drop-out due to excessive co-channel interference. Based on results so far Mr Windram says, "we can now state with confidence that propagatic mechanisms such as sea scatter and tropospheric scatter do not degrade the performance of the adaptive aerial, and in fact the adaptive aerial has considerable advantages over a fixed array in that it can track the changes in apparent c.c.i. direction caused by scattering processes".

The IBA is now investigating the design of a simpler four-element system for use on links having perhaps two or at the most three sources of interference requiring rejection of about 45 to 50dB. This system will use the same principles but the amount of equipment will be considerably reduced, and this combined with rapidly improving technology makes possible the use of a microprocessor to control the array. In conclusion Mr Windram says that it has been shown from theory and confirmed in practice that an adaptive array pre-

continued on page 76

WIRELESS WORLD, MARCH 1979

The history of displacement current

Further explanation of an earlier article

by I. Catt and M. F. Davidson (CAM Consultants) and D. S. Walton (Icthus Instruments Ltd)

As a result of correspondence following their article "Displacement current" in the December 1978 issue, the authors feel that further explanation of their views is required. They offer it in the form of this brief historical survey.

IN THE EARLY nineteenth century electromagnetic theory made advances, a cornerstone of the theory being the doctrine of conservation of charge q, which developed into the doctrine of continuity of electric current flow, dq/dt = i.

In the middle of that century Maxwell struggled with the paradox of the capacitor, where charge entered one plate and then flowed out of the other plate apparently without traversing the space between the plates (Fig. 1). It seemed that electric charge was being destroyed on the upper plate and being re-created when it reappeared on the lower plate. Maxwell "cut the Gordian knot" as Heaviside put it (Heaviside 1893) by postulating a new type of current, called "displacement current", as flowing across the gap BC in Fig. 1 so as to save the principle of continuity of electric current.

"Displacement current" was a result of his postulation of "electric displacement". Maxwell said that the total outward displacement across any closed surface is equal to the total charge inside the closed surface (Maxwell

It is not surprising that objections were raised. Notice, in Fig. 2, that if in any circuit there should be a break, BC, in the current path, we are bound by the principle of conservation of charge to say that the current i, that is the flow of charge, entering B from A accumulates as charge fidt at B, and the current reappearing at C "accumulates" as equal negative charge - fidt. By definition, electric displacement outward from B equals the total charge trapped at B; $D = \int i dt$ and i = dD/dt. It is not a coincidence that "displacement current" saves the idea of continuity of electric current; it does so by definition. With the postulation of displacement current, it would never in future be possible to devise an experiment which might refute the principle of continuity of electric current. Popper would therefore say that "displacement current" is

an unscientific concept (Popper 1963). Whenever charge seems to disappear at a point, displacement takes its place. Whenever electric current seems to disappear at a point, displacement current takes its place.

It is important that Maxwell and Heaviside believed that the current entering a capacitor plate became trapped and had nowhere to go. Writers on the subject must be glad that some route between B and C for real current did not declare itself, since they say that the brilliant postulation of displacement current led to the postulation by Maxwell of waves in space.

Meanwhile, even as Maxwell was contemplating the ethereal displacement current, practical electricians were inventing and building wired telegraph systems. The distortion of signals travelling long distances was bad, and was thought to be due to the fact that the capacitance of the telegraph wires had to be charged up through the resistance of the wires, resulting in an RC time constant which attenuated different frequencies dif-

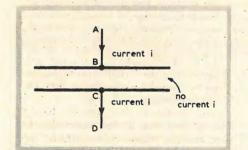


Fig. 1. Charge flowing into one plate of a capacitor, as current i, and flowing out of the other plate.

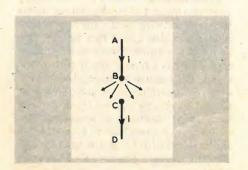


Fig. 2. Electrical circuit AD with a break in the current path at BC. Charges accumulate at B and C.

ferently. As late as 1910 virtually all electricians (including Lord Kelvin) did not accept Oliver Heaviside's claim that a telegraph wire had distributed inductance as well as capacitance, and that if only this inductance were increased by the addition of periodic loading coils, distortion-free transmission over long distances could be achieved (Heaviside 1893).

It was important for Heaviside to encourage a sensible approach to the characteristic impedance of telegraph lines, because the practical pay-off in telegraphy and telephony would be immense. (This misunderstanding delayed the introduction of telephones for twenty years.) This practical pay-off would be best achieved by arguing that signals travelling down (between) telegraph lines were undistorted TEM and similar to the waves in space discovered by Hertz in 1887, twenty years before, and previously postulated by Maxwell as one implication of his proposed displacement current.

It was important for Heaviside not to criticise the theory he was trying to argue from, Maxwell's electromagnetic theory. So it would have been injudicious for Heaviside to question the concept of displacement current, and he never did.

The essence of the concept of a transverse electromagnetic wave, TEM, is that nothing - field, flux, or current flows laterally across the surface of the wave front. The analogy is the Severn Bore, where we see a single step of water rushing up the River Severn. Everything ahead of the step is steady, and everything behind the step is steady. There is no lateral, sideways flow. In the electromagnetic case (Fig. 3), the idea of a lateral flow of current across the face of a TEM step is absurd, and would result in a longitudinal magnetic field; the step would "get ahead of itself". Further, since the step travels forward at the speed of light, 1/ \/ \/ \mu \epsilon any lateral flow would cause embarrassment by travelling even faster, in the same way that when you walk across inside a moving train by Pythagoras' Theorem you are travelling faster than the train.

Now although in the case of a capacitor, displacement current needed to be regarded as just like a real current. for instance causing a magnetic field; in

the case of the D flux at the front of a step of TEM $(E \times H)$ energy current travelling down a telegraph line, the displacement clearly must not behave like a real current - for instance by creating a magnetic field which would reach out ahead of the wave front and ruin its TEM nature.

Maxwell and later Heaviside did not notice the discrepancy in the requirements of displacement current; that in a capacitor it must act like a real current but in a transmission line it must not; because neither of them knew that a capacitor is no more nor less than a transmission line (Wireless World, Dec. 1978, p. 51). This is even today known by very few scientists. Maxwell, along with today's text-book writers (e.g. Fewkes 1956, Bleaney 1957), believed that the displacement current dD/dt travelling across between the plates of a capacitor. BC was uniformly distributed, and it is only very recently that it has been pointed out that the flow of current and field in a capacitor is identical with that in a transmission line; that the field moves out from the capacitor's leads as if they were links to one end of a transmission line. So the discrepancy could not become apparent.

A serious difficulty for displacement current arises when we realize that the two plates, BB', CC' in Fig. 4, are a transmission line. We know that the current i travelling down to B from A then flows out sideways from B along the capacitor plate BB'. This route, along the capacitor plates, failed to declare itself to Maxwell, and everyone has followed his lead.

In a transmission line (Fig. 4), everyone agrees that the current i entering the line at B leaves B by flowing along the line BB'. No displacement current dD/dt between the lines is needed for us to retain the doctrine of conservation of charge and conservation of current. In fact, if this dD/dt were regarded as a current, far from saving the doctrine, it would destroy it, because now more current (i+dD/dt) would be leaving the first section of the plate BB' than was entering it. The last sentence is difficult to grasp; no matter, because it is easy to see, and sufficient to see, that if i enters B from A and i leaves B along BB', continuity of current is preserved without our having to postulate displacement current.

"But surely we cannot just drop displacement current when for a century every expert (e.g. Solymar 1976, Winch 1963) has been protesting that it is the foundation of our craft; that 'Maxwell's leap of genius' in proposing displacement current was what got the subject going - leading to Hertz's discovery of waves in space, for instance?"

The answer lies hidden in Heaviside's magnificent, regal statement, "We reverse this." In his "Electrical Papers", Vol. 1, 1892, page 438, Heaviside wrote;

Now, in Maxwell's theory there is the potential energy of the displacement

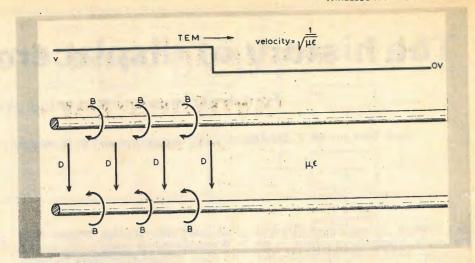


Fig. 3. A TEM step (top) travelling at the speed of light and guided by two wires (below). The B arrows represent magnetic flux lines and the D arrows electric strain between the wires.

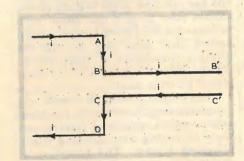


Fig. 4. Current flowing into and out of capacitor plates BB' and CC'. These two plates together constitute a transmission line.

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 discrediting of displacement current merely makes Heaviside's "We reverse this" mandatory. It means that the field must be the cause and electric current an effect, rather than (as Maxwell thought) the other way round.

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. Under "Theory H", Maxwell's 'leap of genius' (in postulating displacement current and thence waves in space) becomes tautological; "Because a wave in space if it existed would have

to have a front face (displacement current), then I propose such a front face and therefore I propose waves in space."

Maxwell would have saved us a century of confusion if he had had enough insight to say, "Since circuits containing capacitors, that is, open circuits, work, it follows that the essence of electromagnetics cannot be electric current in closed circuits of conductors; it must be something else. What about waves in space?" Heaviside, seventy years ago, missed the key point by a whisker. He failed, but he failed gloriously. He never discovered the flaw in the structure, displacement current.

References

Bleaney, B. I. and Bleaney 1965, Electricity and Magnetism, 2nd Edn (Oxford: Clarendon) p. 258.

Fewkes, J. H., and Yarwood 1956, Electricity and Magnetism, Vol. 1 (London: University Tutorial Press) p. 505.

Heaviside, O., 1893, Electromagnetic Theory, (London, Reprinted New York: Chelsea Publishing, 1971) p. 28 section 30; p. 441

Maxwell, J. C., 1873, A Treatise on Electricity and Magnetism, (Oxford: Clarendon) p. 253. Popper, K. R., 1963, Conjectures and Refutations, (London: RKP) p. 37. Solymar, L., 1976, Lectures on Electromag-

netic Theory, (Oxford: OUP) p. 6.

Winch, R. P., 1963, Electricity and Magnetism, (Englewood Cliffs: Prentice-Hall) p. 387.

Further reading

Catt, I., Walton and Davidson 1979, Electromagnetic Theory, (St. Albans: CAM Publishing, 17 King Harry Lane). Catt, I., Walton and Davidson 1979, Digital Hardware Design (London: Macmillan). Catt, I., "The rise and fall of bodies of knowledge". The Information Scientist, 12 (4), December 1978, pp. 137-144.

The next seminar by the authors on digital electronics design will be held at St Albans on May 3-4. For information, contact C.A.M. Publishing, 17 King Harry Lane, St Albans, Herts.

H.f. amateur band frequency synthesizer — 1

by M. Small, B. Tech. (G4DVI)

This article describes a frequency synthesizer which is capable of covering most of the h.f. band, and which has been used as the local oscillator of an h.f. amateurband transceiver by the author for five months. The synthesizer contains three basic components: a digital phase-locked loop, a variable frequency interpolation oscillator and a heterodyne mixer.

WISHING to build a transceiver to cover the amateur bands from 10-160m, and to avoid the expense of buying a large number of crystals, the author was prompted to investigate synthesizers using phase-locked loops. A costing showed that, with the availability of cheap t.t.l. m.s.i., a phase-lock loop which would provide the equivalent of 32 crystals could be built for the component cost of between 5 and 8 crystals.

There are many different ways of making frequency synthesizers. (a survey of synthesizers appeared in the Sept., Oct. and Nov., 1978 issues and on p.83 of this issue - Ed.)

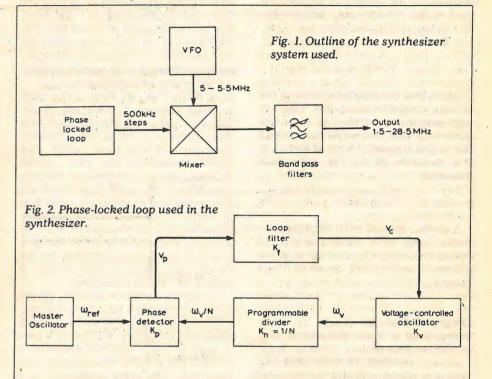
The system sketched in Fig. 1 comprises a phase-locked loop which provides frequencies, in 500kHz steps, between 7 and 23MHz. The output of this is combined with a variable frequency from 5 to 5.5MHz, the products of mixing covering a band from 1.5 to 28.5MHz.

Performance

range

1.5 to 28.5MHz, in

	500kHz bands.
output	70mV r.m.s. into 500
+ -	ohms.
stability	Digital phase-locked
1 1 1 1 1 1	loop: 10 ppm/degree
	Centigrade
	Interpolation oscillator
	50Hz per 15 minutes
	after 10 minute warm
	up.
purity of	In-band spurious out-
output	puts typically 90dE
output	below carrier.
	Out-of-band products
	from mixer more than
	30dB below carrier.
lock up	Small signal: 5ms to
time of	within 10% of change.
	,
phase-	Large change: approx
locked	8ms per MHz change.
loop	TO THE MENTINE



Coverage Required locked provided local MHz oscillator loop frequency frequency MHz MHz 160 1.5-2.0 10.5-11.0 16.0 80 3.5-4.0 12.5-13.0 .40 7.0-7.5 16.0-16.5 11.0 20 14.0-14.5 23.0-23.5 18.0 15 21.0-21.5 12.0-12.5 28.0-28.5 19.0-19.5 14.0 28.5-29.0 19.5-20.0 14.5 29.0-29.5 150 20.0-20.5 29.5-30.0 20.5-21.0 15.5

Table 1 showing local oscillator and p.l.l. frequencies.

Two sets of local oscillator frequencies would give coverage of the amateur bands for a given intermediate frequency. For a given v.f.o. frequency, there are also two sets of frequencies from the phase-locked loop which could be used to obtain the required localoscillator frequencies. Tables of all these possibilities were drawn up but only the final one used, Table 1, is shown. This was chosen because direct coverage of the normal h.f. band is also obtained, extending the potential use of the device.

Principle of phase-locked loop

The operation of a phase-locked loop system can be seen from Fig. 2. The loop contains a voltage-controlled oscillator whose output frequency (ω_{ν}) is a function (K_{V}) of the control voltage V_{c} .

$$\omega_{\rm v} = K_{\rm v} \cdot V_{\rm c} \, {\rm rads/sec}$$

The output from this oscillator is buffered and fed into the programmable divider which divides the input frequency by some integer N, so that its output has a frequency equal ω_v/N and its transfer function $K_n = 1/N$.

The output from the divider is taken to a phase detector where it is compared with a reference frequency ω_{ref} , derived from a master oscillator. The phase detector produces an error voltage V_n, whose magnitude is a function K, of the phase error between the two signals.

$$V_p = K_p \cdot \phi_e$$

This error voltage is smoothed by the loop filter, to remove residual traces of the reference frequency and to tailor the response of the system. It is then fed back to the voltage-controlled oscillator. The loop filter has a transfer function K_f

$$V_c = K_f \cdot V_e$$

Given that the characteristics of the various components in the loop are appropriately matched, the loop will settle with time to a stable state where the output frequency from the v.c.o. is the multiple N of the reference frequency.

$$\omega_{\rm v} = N\omega_{\rm ref}$$

Clearly, since N may be programmable within some range, a number of output frequencies may be selected, the minimum separation between them being wref.

Design of the loop

Design aims of a p.l.l. will specify such factors as settling time, stability, spectral purity and drift. More detailed analysis is required to enable the designer to predict how these aims can be achieved, and the primary approach to this problem is through the use of servo mechanism theory and Laplace transform analysis.

The Laplace transform allows the analysis of both the transient and steady state conditions in feedback control systems. It is valid for positive real time, linear parameters. An introduction to its use for p.l.l.s can be found in reference 1.

In this method the feedforward and feedback transfer functions of the control loop are defined in terms of the complex variable s. The resulting equations may be tested using largely algebraic techniques to determine the stability of the system. In addition, their type and order can be used to indicate the transient response characteristics to be expected under various conditions of

In the p.l.l. system of Fig. 1, the feedforward transfer characteristic of the

 $G(s) = K_p \cdot K_f \cdot K_v \cdot \dots \cdot (1)$ and the feedback transfer function,

 $H(s) = K_n = 1/N.$ (2) The characteristic equation of the loop CE is defined to be

 $1+G(s)\cdot H(s)=\phi$

which, in the case of this loop, is

$$1 + K_p \cdot K_f \cdot K_v \cdot K_n = \phi$$
.

When the loop is closed its transfer function is

$$\frac{1}{1+G(s) \cdot H(s)}$$

Substituting from (1) and (2), this becomes for our system

$$\frac{1}{1+K_{\rm p}.K_{\rm f}.K_{\rm v}/N} \qquad (3)$$

Now some of the functions K_{p}, K_{v}, K_{f} have a complex nature; that is they are functions of s. Equation (3) will therefore be a polynomial of s, and the characteristics of the polynomial define the type and order of the system. The practical consequence of its type in particular will be discussed shortly.

Loop filter. The loop filter is the main variable component which can be designed to tailor the fundamental loop characteristics - lock up time, transient response and loop band width. The other components, the v.c.o., phase detector and programmable divider, usually have characteristics which are fixed or defined by the application. It is generally accepted that the optimum characteristics are obtained from a type 2 system, practical differences between type 1, 2 and 3 being indicated by the steady-state phase errors, shown in Table 2 for various conditions.

A type 2 system maintains phase coherence between reference and controlled oscillators for steps in both phase and frequency, whereas in a type 1 system there always remains a residual phase error which varies with frequency. The extra advantage of a type 3 system being able to follow a changing frequency with phase coherence is not usually worth the extra design complexity. A loop filter of the form shown in Fig. 3(a) will produce a type 2 system.2

The transfer function of such a filter is (if A is large)

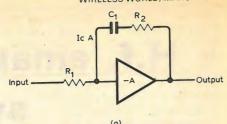
$$K_{\rm f} = \frac{1+T}{T_1}$$

where $T_1 = R_1 \cdot C_1$ and $T_2 = R_2 \cdot C_1$

These time constants can further be expressed in terms of the loop natural frequency (ω_n) and damping factors (ζ)

$$T_1 = \frac{K_p \cdot K_v}{N\omega_n^2} \qquad T_2 = \frac{2\zeta}{\omega_n}.$$

$$R_1 = \frac{K_p \cdot K_v}{N\omega_n^2 C_1}$$
 $R_2 = \frac{2\zeta}{\omega_n C_1}$



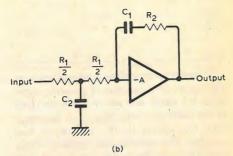


Fig. 3. Loop filter to obtain a Type 2 form of phase characteristic is at (a), modified as at (b) to contain additional filter R₁C₂ for the reduction of error pulses.

The values required for ωn and ζ must be chosen by the designer to obtain the required settling characteristics (transient response) or frequency response (peaking and roll off). The values for ω_n and ζ can be chosen using the normalized transient response curves shown in Fig. 4, which plot the response to a step in frequency. The effect of varying the damping factor is shown and the normalized time axis is a function of ω_n . From these it can be seen that for reasonable values of damping factor 2>5>0.5 a system will lock to within 10% of the step within the time, $t = 5/\omega_n$. Thus, the required settling time can be used to determine ωn and the shape of the response.

Limiting conditions

For the phase-lock loop system to possess the characteristics predicted by the solution of these equations, it is necessary that none of the components are driven beyond the range over which their transfer functions are as described, that is to say, into limiting. This is normally avoided by allowing sufficient tolerance between the boundary design conditions and the known physical limits on the components.

The limits on components to be con-

-maximum and minimum output voltages obtainable from the operational

-limit of the linear voltage/frequency characteristic of the varicap diode.

-maximum output from the phase de-

STEADY STATE PHASE ERROR

step rate of change of frequency step frequency Type step phase continuously increasing constant zero constant zero zero zero

WIRELESS WORLD, MARCH 1979 These limits must be allowed for under the worst case design value of overshoot as found from the normalized

time-domain response curves. This is the case most likely to drive the operational amplifier or the varicap diode out of the linear region. The combined effect of maximum overshoot at the edge of the band covered together with error pulses from the phase detector should also be catered for. The problem of error pulses is most readily reduced by inserting a simple, low-pass filter between the phase detector and the integrator. This can be obtained by

dividing the resistor R₁ in the integrator circuit into two parts and inserting a capacitor C2, as in Fig. 3(b).

The turnover frequency of this filter should be chosen to be 10 times the natural frequency of the loop, ω_n , so as not to reduce the phase margin of the system. The filter has the additional advantage that it reduces the feed through of the reference frequency and so contributes to the spectral purity, which may be expected from the output of the voltage-controlled oscillator.

The turnover frequency can be shown to be

$$f_{c} = \frac{4}{2\pi \cdot R_{\perp} \cdot C}$$

Response to large changes in N

The response of the system to a large change in the division ratio N can be much slower than that predicted by the Laplace method. This occurs when the maximum cumulative phase error that the phase detector can handle is exceeded during lock up. However, it is possible to estimate the maximum frequency step which will remain within this limit and the response time when it is exceeded.

The maximum phase error that the phase detector used here can handle is $\pm 2\pi$ radians. If this is exceeded, the output remains of the correct polarity, because the device contains a frequency detector, but its magnitude is a sawtooth function of increasing phase error, as in Fig. 5. This sawtooth has a repetition frequency equal to the instantaneous difference between the two input frequencies. The sawtooth modulates the control voltage, causing the system to settle in what appears to be an oscillatory manner. Since the loop contains what is effectively a low-pass filter, the oscillations appear to increase in amplitude as the v.c.o. approaches its target frequency.

It is possible to predict the maximum frequency step which can be achieved with a phase error of less than $\pm 2\pi$ radians. If the loop is initially in a locked condition, both the reference frequency and the output from the programmable divider have the same frequency and phase, illustrated in Fig. 6 by the portion of the graph A-B. At point B, the modulus of the divider is instantaneously changed by some step. The

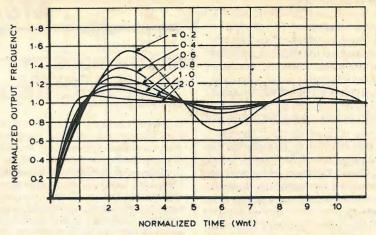


Fig. 4. Normalized response curves in the time domain of Type 2 system to a step in frequency.

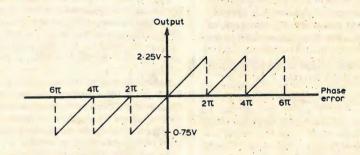


Fig. 5. Sawtooth output of phase detector for wide capture band.

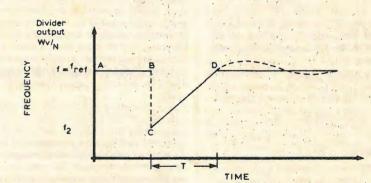


Fig. 6. Effect of changing division ratio of programmable divider.

v.c.o. frequency is initially unchanged and the result is that the output from the divider changes to a new frequency f_2 , shown by B C in Fig. 6. The loop now starts to respond to correct the increasing phase and frequency coherence will again be achieved after

The magnitude of the phase error is $\phi_{CD} = \pi (f_{ref} \pm f_2) T \text{ rads.}$

If the original division ratio was N₁ and the new ratio is N2 then

$$f_2 = \frac{N_1}{N_2} \cdot f_{\text{ref.}}$$

So the original equation can be re-

$$\phi_{\rm CD} = \pi \cdot f_{\rm ref} \cdot \left(1 \pm \frac{N_1}{N_2}\right) \cdot T.$$

Given that the maximum phase error is

$$-2\pi < \phi_{\text{max}} < 2\pi,$$

$$-2\pi < \pi \cdot f_{\text{ref}} \cdot \left(1 \pm \frac{N_1}{N_2}\right) \cdot T < +2\pi$$

$$= \left(1 - \frac{2}{f_{\text{ref}} \cdot T}\right) < \pm \frac{N_1}{N_2} < \left(1 + \frac{2}{f_{\text{ref}} \cdot T}\right)$$

For example, if the term f_{ref} . T has a value of 50, which is reasonable to ensure minimum feed through of f_{ref} , then N_1/N_2 must be within the range.

$$\frac{48}{50} < \frac{N_1}{N_2} < \frac{52}{50}$$

So the maximum step in N corresponds to about -4%, if phase coherence is to be maintained.

The most significant problem with a digital phase detector is reference frequency feed through. This occurs when the loop is locked because of leakage in the phase detector, integrator or any other similar small unbalancing conditions. The feedthrough frequency modulates the v.c.o. and this modulation can be detected as sidebands on the wanted signal. The magnitude of this effect may be reduced by the loop integrator which acts as a low-pass filter. Further suppression may be obtained by including further low-pass filters or by balancing the

leakage effects. The MC4044 phase detector contains a charge pump with a small reverse leakage current, which may, at extremes of temperature, be 5µA, but is typically less than 0.1 µA. If it is assumed that the reference frequency is greater than the time constant T2, the gain of the filter at this frequency tends to

R₂/R₁.
The apparent phase detector output due to the leakage current IL is

$$V_{p \text{ (leakage)}} = R_1 I_L.$$

Thus the error voltage due to this

$$V_{E \text{ (leakage)}} = \frac{R_1 \cdot I_L \cdot R_2}{R_1} = R_2 \cdot I_L$$

It is possible to compute the magnitude of the sidebands produced for small leakage effects using normal f.m. theory. For f.m. signals with a small modulation index the magnitude of the first sideband is

 $J_1 = \frac{1}{2}$ (modulation index). In the case here this is

$$J_{1 \text{ (leakage)}} = \frac{1}{2} \cdot \frac{V_{e \cdot \text{ (leakage)}} \cdot K_{v}}{\omega_{ref}}$$

i.e.
$$\frac{\text{sidebands}}{\text{carrier}} = \frac{1}{2} \frac{R_2 \cdot I_L \cdot K_v}{\omega_{\text{ref}}}$$

$$= 20 \log_{10} \frac{1}{2} \cdot \left(\frac{R_2 \cdot I_L \cdot K_v}{\omega_{ref}} \right) dB$$

To be continued

References

1. Garth Nash. Phase-locked loop design fundamentals. Motorola application note

2. P. Atkinson and A. J. Allen. Design of Type 2 digital phase-locked loops. Radio and Electronic Engineer, Nov. 1975, p.657.

More letters

BRITISH INDUSTRY WASTES WORKERS' SKILLS

Mr Pepper's advice (January letters) to those with engineering skills to emigrate to a seller's market is economically sound and his example testifies to the reality of our social freedom, i.e. to the existence of international free-trade. Intra-nationally of course, constraints other than those of commodity market-value are recognised by executives and other workers, e.g. Der Spiegel recently reported that British workers are "treated like dirt" (classwise) and of course they too sometimes find their skills better paid else-

The recovery of "British" industry has long been sought in the same direction. Most large firms find it more profitable not to export but to manufacture within their market region, i.e. not the produce but the production is exported. The "British" problem is therefore

1. Dependence upon supra-national firms.

2. The working structure chosen by most firms wherein personnel placement in "division of labour" categories is made a class attribute with rigidly controlled contributions to and rewards from society.

As a socially constructive approach to the problem I recently suggested to my employer (a major international industry) via the suggestions box that an "innovators' workshop" be incorporated as a subsidiary of the group, administered by the innovators with spare time access to the group's employed expertise, and to some capital plant during normal unused periods, in order to develop to prototype stage potentially commercial products for separate exploitation with joint

Being socially revolutionary the idea was rejected (cf. the Lucas Combine plan). To demonstrate the scope of the project I described in outline to the management a novel 3D system enabling transmission and recording of "look around" 3D motion colour images, with "zoom" and projection facil-

It is not, therefore, the technocrat's current differentials alone, but the hierarchy's increasing failure to employ creatively skills of all kinds which defines our socio-economic problem.

C. H. Dierks Nether Stowey

3D TELEVISION

Being away at the time your November issue was published I only recently saw the article "What future for television?" with its discussion on three-dimensional viewing. It certainly revived memories of a quarter of a century ago for we could have had such then, compatible and in colour.

My father, the late Granville Bradshaw. whose inventions spanned many fields but who was better known for his advanced designs of automobile, motorcycle and aero engines, some of which are to be found in the Science and other museums worldwide, developed in the 1930s a system for the threedimensional display of pictures where an

object in the foreground, say, was angularly displaced in relation to the background as the viewer moved across the screen of the display, thus giving a very realistic 3-D impression. In fact it was as if one could 'look around the back' of the object as in real life.

With this in mind when, in the early 1950s television concerns were becoming somewhat apprehensive of losing their new-found audiences which flocked back to the cinemas with their wide screen and sterescopic systems now all the rage, he conceived the idea that the principle of his 3-D picture display, which was wholly mechanical, could be adapted for television viewing and asked me to design an appropriate electronic 3-D system based on this, which I did.

Both the BBC and the then ITA were approached and were greatly interested but had to admit they had no mandate to move into this field, let alone any finance with which to carry out experiments, so, as it has so often been said, yet another British invention being too far ahead of its time was stifled at hirth

Readers of that eminent journal of the day Picture Post may remember the publication of an article headed "We can have 3-D Television" on this very project. The date, July 1953.

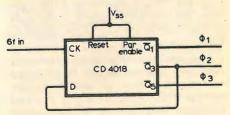
Geoffrey Bradshaw Leatherhead Surrey

May I correct Professor Bell for a minor inaccuracy in his article "What future for television" (November issue)? I remember as a boy seeing in London the feature/musical film "Kiss Me Kate" at the Empire Leicester Square and "House of Wax" at the Warner Leicester Square in 3D using 45°/45° polarised glasses. I also refer him to the British Kinematograph Society Journal for reports on 3D films, especially in the USSR. His comment "... but does not appear to have produced any normal film in 3D, neither feature or documentary" is consequently in serious error.

H I. Yentis Edgware Middlesex

GENERATING THREE PHASES

Three phases may be generated more simply than the method suggested in "Circuit Ideas" in the August 1978 issue p.60, by substituting



a CD4018 variable divider for the CD4017, since this gives square wave outputs, displaced in phase from one another (see the accompanying diagram).

D. Austin Birmingham WIRELESS WORLD, MARCH 1979

NEWS OF THE MON

White paper on broadcasting strongly criticized

The Government's White Paper on broadcasting was likened to a haystack stuffed with weapons in the November 78 issue of Independent Broadcasting, the IBA's quarterly journal. This was a personal reaction by the IBA's director of television, Mr Colin Shaw, a former chief secretary to the BBC.

In the article, Mr Shaw said that the White Paper proposed Government intervention on a scale previously unknown in Britain. This, he said, far exceeded anything that would be considered tolerable if it were applied to the press or book publishing. He recalled that the broadcasters had always acknowledged that the Government's responsibility for the allocation of frequencies secured by international agreement gave politicians a greater right and opportunity to intervene in the conduct of broadcasting, and that, until now, they had exercised this right with caution. Very early in the history of broadcasting in Britain, ministers had evolved the formula, in dealing with parliamentary questions, that the day-to-day responsibility for the broadcasting services rested with the broadcasting authorities. By these means, British broadcasting had enjoyed a degree of independence in editorial

control as great as any to be found in the world and out of them had grown a reputation for the range and quality of programming which was widely envied. However, according to Mr Shaw, there were indications that both of these might be in danger. "Well intentioned as it may be, and innocent-seeming, in some of the proposals it contains, the White Paper stands like a havstack stuffed with weapons against some future need," he said.

Mr Shaw also discussed the threats posed to the independence of broadcasting by some of the proposals for ministerial appointments to the IBA and BBC advisory bodies and to service management boards in the BBC. He asked whether the members of the OBA would have the trustee role traditionally given to the Governors of the BBC and members of the IBA, who act both as trustees' of the national interest and as a buffer between the Government and programme makers. "In a television interview not long ago after the White Paper appeared, the Home Secretary seemed to be saying that they would not", he said, " . . . The OBA would be highly vulnerable to Government pressure in the absence of such a buffer".

GEC and Hitachi join forces to make tv sets

Following the example set by Rank and. Toshiba, who in August last year said that they were to operate jointly, two more companies, GEC and the Japanese company Hitachi, have announced that they are to work together in the manufacture of television sets at Hirwaun in South Wales. This union has been welcomed by Alan Williams. Minister of State for Industry, whose own policy is to encourage co-operative ventures between Japanese and British companies.

Mr Williams said when the announcement was made that this venture, like the one taken by Rank and Toshiba, would make it clear in Japan that we (the British) really do want Japanese companies in our country. He welcomed the project for a number of reasons. Apart from saving a large number of jobs which were very seriously threatened in an area of high unemployment, it would enable Japanese technology to be applied to British industry. It would also increase efficiency and exports and save time on imports, and it would show that yet another major country had chosen the UK as a base for its manufacture for the whole of Western Europe. GEC already sourced over half of their non-tube components and materials from within the UK, and the new joint venture would make the maximum use of UK tubes, components and materials, subject to commercial considerations. There would also be extra investments to improve the quality of the components and this in turn would add to the capability of the British component industry and help to improve the quality and reliability of British-made consumer elec-

Mr Williams suggested that the venture would be a great encouragement to Japanese and other foreign investors. Repeatedly these investors had shown that small and medium-sized, well-managed enterprises in this country could operate well, could be highly efficient and have high productivity, resulting in the country having the bestprofitability in Europe.

Discussions between Hitachi and the Department of Industry, about Hitachi's proposal to establish a colour-tv manufacturing facility in the UK, initially took place during 1977 and early 1978, but as a result of opposition from certain sections of the British tv industry the company eventually withdrew its proposals. However, during his visit to Japan in April 1978, Mr Williams stressed his, and the British Government's, disappointment at Hitachi's decision, and he indicated that it was in sensitive sections such as ty manufacture that co-operation between Japanese and British companies would bring mutual benefits, and might prove the best way forward

RCA to enter videodisc market

Following the lead of Philips and MCA (see News, p.39, Feb. 79 issue) RCA has decided to launch its "Selecta Vision" videodisc system in the United States of America. RCA's president, E. H. Griffiths, said that they would proceed with "maximum speed" to get the product ready for introduction in the US, and a schedule for the product's introduction, and marketing concept aimed ultimately at full national distribution, would be announced later this year.

The company is giving the videodisc system top priority because their market research indicates that it will become a multi-million-dollar business in the 1980's. Before RCA would consider going ahead with the project two years ago the company's chief executive set certain goals which had to be met. They planned to develop a videodisc player that could be sold at a retail price of \$400 (about £200) or less, and an uncoated disc that would contain one hour of programming per side, or a total of two hours per disc. There also had to be available adequate software, or programming, to support the introduction of the system and to sustain it in the market. RCA say that they have now met these goals.

The RCA system is very different to the Philips/MCA system in that it uses a grooved disc that is played with a diamond stylus (the latter uses an optical system so that no stylus or needle ever touches the disc). RCA's disc revolves at 450 rev/min, contains one hour of programming on each side, and is expected to sell for about \$10 to \$17 (about £5 to £8.50).

The disc comes in a plastic sleeve, similar to a record album cover, which, when inserted into a slot on the front of the videodisc player, deposits the disc on the turntable. To remove the disc, the empty sleeve is simply re-inserted into the slot.

RCA's initial catalogue of programmes will contain 250 titles including feature motion pictures, musical sports, cultural, education and children's programmes.

New electronics teaching programmes available in UK

A series of electronic training systems for subjects ranging from elementary principles to modern communications and computers. is now available in the UK. These systems, which are supplied by Dagem Systems Ltd, are modular programmes containing all the equipment and manuals needed to perform a series of laboratory experiments in the subjects they cover. The elementary, basic and intermediate laboratory systems, for example, consist of a set of experimental circuit boards and plug-in components. Each circuit is permanently wired underneath its board and the plug-in components, which complete the circuit, are used only for the parameters which are changed during the experiment. Each electronic training system is supplied with its appropriate theoretical and experimental manuals

First transatlantic video link using optical fibres

On December 12 a two-way sound and video system, originated and terminated with optical fibre equipment, linked the Post Office's Contravision studio in London with a Bell Canada studio in Toronto, Canada. This was the first ever transatlantic link of its kind and also the first time that colour television had been used for Contravision, which is the Post Office's conference-by-tv system. The two-way link enabled the participants to hold 'across the table' discussions with their colleagues on the other side of the Atlantic.

The transatlantic discussions demonstrated the capabilities of optical fibre transmission systems in sending sound and vision signals over long distances and also marked the start of a two-year household trial of an optical fibre system - initially serving 35 residential telephone customers in Yorkville, Toronto - which Bell Canada is carrying

The main link in the communications chain was the Intelsat satellite positioned 22,300 miles above the Atlantic Ocean. This carried the signals between Britain and Canada, Underground optical fibre cable systems in London and Toronto were used to carry the signals to and from the two studios. In London, outgoing signals were transmitted over a 1.7km optical fibre link, supplied by British Insulated Callenders Cables Ltd (BICC) and Plessey Telecommunications Ltd. to the Post Office Tower. This system has been in public service for the past two years as part of the Post Office's public Contravision network.

According to the Post Office, together with British industry they have developed optical fibre systems to the extent that they could be installed and working in the UK telephone network by 1980. Their aim initially is to introduce optical fibres into key inter-city networks and between telephone exchanges within main city centres. Already telephone calls are being carried by two experimental optical fibre links in the UK - a 13km link in Suffolk and a 9km link in Hertfordshire. Two further trial links are nearing completion. These are between Maidenhead and Slough, supplied by Plessey and BICC, and between Uxbridge and Ruislip, supplied by GEC and TCL. On the Suffolk link, at Martlesham, Post Office researchers are studying more advanced systems for inter-city and undersea operations, as well as cost-reduced systems.

The optical fibre cables at the Canadian end of the transatlantic link were made by Northern Telecom Ltd and were linked to a laboratory where research for the two-year trial is being carried out. Bell Canada's research company, Bell Northern Research Ltd, started work on practical fibre-optic transmission systems in 1972. Then, in 1977, following work for the Department of National Defence, they installed a 1.42km optical fibre link between two switching centres in Montreal to test optical fibres under field conditions. Each pair of fibres in this trial are used to transmit and receive 96 simultaneous telephone conversations.

News in brief

Post Office trials on an inductive coupler to help people using hearing aids fitted with pick-up coils to make better use of the telephone have been completed. The coupler replaces the standard telephone inset. Eighty per cent of the trial 'guinea pigs' reported a substantial improvement in reception when using the new device. Some minor modifications were made as a result of this trial, and a first contract for 100,000 units has now been placed. First deliveries of these devices are expected early this year.

The University of Essex will be holding its annual electronics summer school for teachers during the week July 9-13, 1979. This year, as well as courses in linear circuit design and digital circuit design, a third course in electronic systems is available which is closely related to the A.E.B. electronics systems A-level course. The linear design course covers the use of transistors and operational amplifiers in analogue applications, particular emphasis being placed upon design philosophy related to the basic circuits in a hi-fi amplifier. The digital design course concentrates on the use of the transistor as a switch and develops design using integrated logic circuits. A programme of laboratory experiments is included on each course so that the lecture material is fully supported. Further information on the summer school may be obtained from Dr M. J. Hawksford or Mrs J. L. Mead at the Department of Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester CO4 3SO (Tel. 0206 862286, ext. 2262/2299).

Third Marisat shore station commissioned

Japan's maritime-communications shore station, for use with the Marisat (Maritime satellite Communications) satellite above the Indian Ocean, was officially commissioned on November 18. The station, which is located at Yamaguchi in the western-most part of the main island, was completed in September by the Nippon Electric Co. Ltd (NEC) for Kokusai Denshin Denwa Co. Ltd (KDD), Japan's international communications company. KDD's Intelsat standard A earth station is also located on the same site.

The new station can provide, via the Marisat satellite, 22 high-grade telegraph lines and two telephone lines between land subscribers and ships in the Indian Ocean and the water off Japan and Southeast Asian countries. It is the third station of its kind in the world and the first to be capable of accessing the Marisat satellite over the Indian Ocean. The other two stations, which have access to Marisat above the Pacific and the Atlantic oceans, are located in the USA, one at Santa Paula in California, and the other at Southbury in Connecticut. Since the Marisat system can now cover almost all the waters of the world it not only ensures a high standard of world-wide maritime communications services and efficient operation of ships, but also provides better safety and distress services.

The Marisat station has a duplex configuration and a 13m-diameter Cassegrain antenna, which is commonly used for the C and L bands. A network control processor assigns the channel and controls the line connection between ships (both at sea and in ports) and

land subscribers or shore stations, performs telegraph and telephone signal conversion, and supervises the status of lines.

In addition, the Marisat system, which is jointly owned and operated by several US communications companies, also provides services for facsimile and data transmission. All of these services are, of course, only available to ships equipped with a Marisat ship terminal. A typical ship terminal consists of an r.f. and antenna assembly mounted in a water-proof radome above deck and a communications console installed below deck. NEC, together with Anritsu Electric Co. Ltd of Tokyo also manufacture such a terminal.

Picture shows a Jetstream T. Mk 2 aircraft, the first of sixteen being delivered to the Royal Navy. On-board equipment includes a static invertor, Model 060-05, made by Brandenburg Ltd. The Model 060-05 is a three-phase unit delivering 115V at 400Hz for the aircraft's electronic equipment. It operates from 28V d.c. and can provide a total output power of 1500VA. Output frequency and voltage are maintained constant over a wide range of input voltages and load variations.

The sixteen aircraft, which will replace Sea Princes currently in service in an observer training role, are manufactured by the Scottish Division of British Aerospace's Aircraft Group.



Post Office meets Government's financial targets

According to a statement by Sir William Barlow, the Chairman of the Post Office, continued stable prices and a vigorous drive for increased business has enabled the Post Office to achieve results which show that the Corporation is still meeting the financial targets set by the Government.

Interim unaudited results show that in Telecommunications, the Post Office had an income of £1549.1 million and a profit after interest of £144.7 million over the half year to September 29, 1978. Figures for the full year to March 31, 1978, show a £2924 million income and £326,6 million profit. In Posts, results for the full year showed an income of £1325.1 million and profit of £40.4 million and for Girobank and Remittance Services, £77.9 million and £0.7 million respectively. Corporation figures, again for the full year, give an income of £4183.2 million with a profit before dividend and taxation of £367.7 million.

The financial results for the current half year, for each of the three main businesses, are consistent with their full year targets set by the Government. For Telecommunications this represents 6% return on mean net assets at replacement costs. Mr Barlow suggested that the half year results reflected the increased use which was being made of the Post Office services. This, he said, was partly due to the fact that telephone rentals and call charges had not increased for more than three years and postal charges had been frozen for 18 months. Telephone traffic had continued to increase and determined efforts were being made to improve the quality of the international telephone operator service, which Mr Barlow considered had fallen short of the standard required.

Product liability conference

A special one-day conference on product liability is to be held at the Europa Hotel, London, on Friday, March 2. It is hoped that the conference will enable delegates to study in-depth not only the UK's liability law today, and its likely changes tomorrow, but also its practical effects through insurance

and through hazard reduction. Greville Janner, Q.C., Member of Parliament for Leicester West, said when the conference was announced that every executive and manager concerned with the manufacture or marketing of products should have been following developments in our law with grave concern and in preparation for change. He referred to the Law Commissions, the Royal Commission on Civil Liability (the Pearson Commission) and to the EEC Draft Directive, as well as to changes which have already been made in the USA and in many of the EEC countries (see News, p.47, Jan 79 issue).

Speakers at the conference will present the

practical aspects of product liability law, as it affects all those concerned with the manufacture, distribution, purchase or sale of industrial products. Mr Janner will also explain how to use documentation in order to cope with produce liability problems actual and likely - with special regard to the new anxieties created by "The Supply of Goods (Implied Terms) Act" and "The Unfair Contract Terms Act". The other speakers will be: Lord Pearson, who was chairman of the Royal Commission on Civil Liability and Compensation for Personal Injuries (the Pearson Committee Report, 1978); Professor Anthony Jolowicz of Trinity College, Cambridge, an expert in EEC and USA product liability law; Oliver Prior, a product liability insurance specialist and Brian Mair, who is the MD of Plessey Assessment Services Ltd, a

The conference is to be held by Industrial & Commercial Technical Ltd (In Com Tec), Park House, Park Street, Camberley, Surrey.

product liability consultancy.

Government enters mobile radio business

The British Government has now gone into mobile radio after its acquisitions a few years ago with Ferranti and the more recent investment in Inmos Ltd. The National Enterprise Board (NEB) and Berec Group Ltd (formerly Ever Ready Company (Holdings) Ltd) have reached agreement in principle to form a joint company to acquire the business of Burndept Electronics (ER) Ltd, a whollyowned subsidiary of the Berec Group. It is planned that the NEB will invest £510,000 in Burndept in exchange for 51% of the equity, with Berec retaining a 49% holding. This investment will enable the company to expand in existing markets and also to develop additional products.

Burndept Electronics, who manufacture a wide range of two-way radio communications equipment, employ about 400 people and are located in Erith, Kent, and Biggleswade, Bedfordshire. They supply personal radios to the majority of UK police forces and also to a variety of industries. The company also manufactures a full range of vehiclemounted radio equipment, base stations, complex radio control schemes and emergency rescue systems.

In the last six years Burndept has made

about a £1 million loss, mainly due to the cutbacks in police spending and to inflation eating away the profit on their fixed price contracts. Berec, who were unable to give the financial and technical support needed, plan to concentrate on their portable power busi-

News in brief

The Post Office is anxious to do the right thing in relation to microwave radiation exposure and are, within their own powers, seeking to allay the fears currently being expressed by the media. They are providing attenuators for new inland microwave radio contracts to reduce the power fed to antennas by an order of 20dB, when necessary, thus reducing the radiation from the antenna. Instructions are also being given to people working in front of antennas to ensure that the power inputs to the antennas are either removed, reduced sufficiently or measured to confirm that the radiation level is permissible.

Audience response to wavelength changes

A document issued by BBC Radio says that, on balance, reception for all four BBC radio channels on their new wavelengths, is better than it was before the introduction on the 23rd November, 1978. The majority of listeners questioned four days after the changes said that reception had improved or remained the same and only a small proportion reported that their reception had deteriorated. The BBC is examining those areas where it is known that people are experiencing poor reception.

Figures from the normal BBC Daily Audience Research Survey were as follows: percentage of listeners reporting that reception was now better on Radios 1, 2, 3 and 4 was 45%, 35%, 24% and 35% respectively; those reporting that reception had deteriorated were 6%, 10%, 14% and 12% respectively. Listeners reporting that reception was about the same on Radios 1, 2, 3 and 4 were 49%, 55%, 62% and 53% respectively.

A preliminary examination of listening figures for the first three days on the new wavelengths show a slight increase in audiences for Radios 1 and 2 and no change in the size of audiences for Radios 2 and 4.

Maritime radar to be fitted to Nimrod

Searchwater, perhaps the world's most advanced maritime radar, will soon be fitted in the RAF's Nimrod aircraft. The radar and equipment division of EMI Electronics at Haves, Middlesex, delivered the first production model of Searchwater to the Ministry of Defence on November 7 last year.

Searchwater is the result of more than six years of research and development work by the staff of EMI Electronics and engineers from the Royal Signals and Radar Establishment at Malvern, Worcestershire. The radar uses its own computer to detect, measure, track and classify its targets and its power and versatility have already been demonstrated during extensive flight trials. At very long ranges Searchwater can even detect targets as small as the periscope of a submerged submarine, say EMI. During the six years of its development, designers continually modified Searchwater to accommodate the latest electronic technology despite the rapid changes taking place.

Tandberg ends Norwegian operations

At a special meeting in Oslo, the Norwegian Government recommended to the management of Tandberg Radiofabrikk A/S that the company close down their trading operations with effect from the next day (Dec. 14). Despite this, the government has pledged to continue to support the company with a view to restructuring the special product divisions of the Group that have a continuing commercial future. In addition, a sum of 50 million NKr which had been offered to the company two days before would still stand and would be employed for an orderly winddown of the operations in Norway and to investigate the remaining operations.

Tandberg have eleven overseas subsidiary companies and other representatives worldwide, including the Leeds company Tandberg (UK) Ltd, the most successful of the daughter companies with a turnover of over £61/2 million

TASS, The Technical, Administrative and Supervisory Section of the Amalgamated Union of Engineering Workers, is warning its committees of representatives of the potential health hazards associated with the use of. visual display units. This warning comes in a document, from the general secretary of TASS, Ken Gill, which says a sizeable body of evidence shows that unless a v.d.u. or terminal is used correctly there can be potential health hazards to the operator. The document is concerned specifically with the introduction of these units in areas of clerical work and gives, as a guidance to the representatives, the conditions in which v.d.u.s should be used.

According to the document, clerical work ideally requires brightly lit work areas, preferably near daylight, whereas v.d.u.s are best used in shady conditions. This contradiction means that the v.d.u.s are seldom used under the correct lighting and, in some cases, reflections on the screen can be brighter than the projected image. The document suggests that offices in which v.d.us are used should be kept gloomy and local lighting provided where necessary for work areas.

The health hazards associated with v.d.us include visual fatigue, stress, posture ailments and radiation exposure. TASS attempts to give the causes of these afflic-

tions and describes in quite considerable detail the symptoms experienced by the sufferers. Visual fatigue they say is caused by glare, reflections and lack of contrast on the screen. Stress results among other things from slow computer response times, poor environmental conditions and 'the information load'. Posture ailments such as backache, headache and aching muscles are blamed on the bad standard v.d.u. layout, the fact that the screen is usually above the keyboard. This, says TASS, imposes an immobility which leads to the aches/pains described.

Radiation exposure is the cause of major concern to TASS because they say that the health hazard has not yet been determined. However, to minimise risk they suggest that v.d.u.s should be frequently serviced by qualified engineers and the front of the tube covered by a glass panel. They also suggest that the set be enclosed in a metal case to give maximum protection in case of explosion.

As a guide to office committees who may negotiate agreements on the introduction of v.d.u.s, TASS gives a total of 14 recommendations. In addition to regular maintenance of the units, they suggest that the screens be tested for glare and reflections and that ambient lighting be reduced to below 300 lux,

with additional local lights being fitted where necessary for ordinary clerical work. One recommendation suggests that each piece of v.d.u. equipment should have a plaque attached stating how it should be operated and specifying the health hazards which can occur if the safeguards are not followed.

News in brief

Strathearn Audio Limited, the Belfast highfidelity equipment manufacturer, established by the Government five years ago, is to close. The reason for the closure is that the Treasury is unwilling to consider providing additional funding until the autumn of 1979, by which time their proposed association with Aiwa would have been in effect and the company's viability would have been assured, because of heavy debts. Despite the company chairman's faith in the company those on the inside claim to be able to see the light at the end of the tunnel and a very real future ahead - the Treasury feels unable to provide them with the necessary funds to pay for the development of new products and to pay off the debtors.

continued from page 66

sents a successful solution to the problems of c.c.i in the u.h.f. band. With advancing technology, he says, costs may be expected to fall to the point at which adaptive antennas will be used increasingly by the broadcasters, especially when the fourth channel is brought into use.

Antenna work in ESA

Three years ago at the last IEE antenna conference, the European Space Agency's activities, mainly concerning their then new payload antennas, were described. Since then, several of these activities have been completed and new developments have started. A paper by J. Aasted from ESA reviews the present antenna and propagation activities at ESA.

A major part of ESA's work in payload antennas has been in the development of dual-polarized reflector antennas. This has led to a better understanding of the depolarization mechanism and has also resulted in the development of new antenna types having much improved cross-polarization performance. One example is the off-set reflector antenna which, though previously rejected for dual polarized systems due to its assymetry, is now a prime contender because of improved feed designs.

In the lower-frequency S and L bands,

reflector antennas become impractical for small beamwidths and array antennas may be preferred. These also allow the use of multiple simultaneous beams. ESA have developed and are now testing an L-band 19-beam antenna system which is to be used for earth coverage from a geostationary satellite. As one moves to the higher frequency bands (11/14 and 20/30GHz) and narrow beam widths (1/2° to 3/4°) the need arises for improved test ranges because the standard ranges are likely to be increasingly affected by multipath effects. ESA is therefore investigating the near-field measurement technique. Of the three scanning methods the Agency has chosen to develop the spherical technique and an experimental facility is now being set up at the Technical University of Denmark.

ESA is presently developing a standard cardioid type radiator for S-band and are anticipating moving all telemetry and telecommand into this band, or even higher. The antenna is designed to be boom-mounted on top of a payload. They are also planning to develop reflector-type, multiple beam antennas with contoured coverage for the higher 20 and 30GHz bands. The realisation of these antennas will require tight tolerance reflectors and a new class of feed systems. Work on this has already been started and that will be

intensified in the next two years.

So far, ESA's work in propagation has concentrated on the 11/14GHz bands. Data from ten radiometers stationed across Europe have been analysed and have formed the basis for the European propagation model which will be verified with direct measurements from OTS. The Agency is also developing radiometers for the 20 and 30GHz bands. At the higher frequencies, however, says the ESA paper, deep fades may occur which radiometers are unable to record. Because of this a propagation experiment is planned using H-SAT, which will carry a beacon for the purpose. In addition, ESA will be carrying out diversity experiments to try to solve the fading problem.

To be continued

References

'4. Moxon, L. A., Radio Society of Great Britain, High-frequency antennae and propagation modes in relation to the amateur service, pp 83-86, Part 1.

5. Windram, M. D., Independent Broadcasting Authority, Crawley Court, Winchester, Adaptive antennas for u.h.f. broadcast reception, pp 30-35, Part 1.

6. Aasted, J., European Space Agency, Netherlands, Antenna and propagation work in ESA, pp 230-231, Part 1.

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

Radio communication in tunnels

A note on the "split-path" paradox.

by K. F. Treen

From time to time, suggestions are made that radio propagation, (particularly with reference to the private mobile radio-frequency spectrum) throughout the length of tunnels in which bends introduce excessive losses, could be achieved by receiving the signal with a suitable antenna at the end of a straight portion and then connecting this antenna to a second antenna which would re-radiate the signal in the required direction. In terms of propagation losses, conventional available powers and antenna gains, this is not a very practicable arrangement.

PASSIVE COMMUNICATION in tunnels is not comparable to the passive reflector systems used in some microwave links, either as the main reflectors in a line of sight link, where they are used as means of avoiding feeder losses, or en route to avoid obstacles present in the shortest path. In these cases the wavelengths are small and reflector sizes are very large in terms of wavelength.

For the purposes of this note, propagation loss is calculated as a free-space attenuation which, between isotropic antennas, is $(4\pi r)^2/\lambda$ where r is the range and λ the wavelength in the same units.

This expression is optimistic for most tunnel conditions and available wavelenths; in practice, signal strengths would be much less than calculated.

Consider a tunnel of length r with a transmitter at one end and a receiver at the other. If the transmitter effective radiated power (e.r.p.) into the tunnel is W_t watts and the receiver antenna gain is G_r , the tunnel end to end attenuation considered as free space, is given by $(4\pi r)^2/\lambda$. With a transmitter e.r.p. of W_t watts and a receiver antenna gain of G_r , the r.f. power fed to the receiver is given by

$$W_{\rm t} \times \left(\frac{\lambda}{4\pi r}\right)^2 \times G_{\rm r} \text{ watts} \dots$$
 (1)

Assume a bend in the tunnel at a point distant *l* from the source and around which significant propagation will not take place. At this point insert two auxiliary antennas, one directed normally to the transmitter and the other to

the receiver. Let the two antennas be connected together with a lossless feeder cable and let their respective gains by G_1 and G_2

The r.f. power at the output of the auxiliary receiving antenna is

$$W_t \times \left(\frac{\lambda}{4\pi l}\right)^2 \times G_1$$
 watts.

This power is fed without loss to the auxiliary re-transmitting antenna, giving an effective re-radiated power of

$$W_t \times \left(\frac{\lambda}{4\pi l}\right)^2 \times G_1 \cdot G_2$$
 watts.

The distance to the final receiver is (r-1), and the power fed to the input of the receiver is given by:

$$W_{t} \times \left(\frac{\lambda}{4\pi l \iota}\right)^{2} \times G_{1} \cdot G_{2} \times \left(\frac{\lambda}{4\pi (r-l)}\right)^{2} \times G_{r} \text{ watts } \dots \dots (2)$$

Equations (1) and (2) represent the 'direct' (i.e. directly through a straight tunnel) and the 'indirect' signal strengths respectively. It is clear that equation (1) represents a power greater than equation (2). Dividing (1) by (2) we get:

$$\frac{16\pi^2 l^2 (r-l)^2}{G_1 G_2 \lambda^2 r^2} \dots (3)$$

Applying practical values to a system in which the receiver is mobile and is situated at the end of the tunnel distant r from the transmitter.

Let frequency = 450 MHz; hence wavelength (λ) = 0.67m. Let length of tunnel (r) = 2000m.

Let length of tunnel (r) = 2000 m. Let bend be at 1000 m (l = r/2).

Let transmitter e.r.p. = 7dBW. (5W) Let receiver antenna gain (G_r) = 3dB. (2:1)

Let back to back antenna gains each equal 8dB. (6.31:1)

Then from equation (1), for the direct case, the r.f. power input to the receiver is equal to:

$$5 \times \left(\frac{0.67}{4\pi \times 2000}\right)^2 \times 2 \text{ watts.}$$

= 7.1×10^{-9} watts, or -81.5dBW, a very adequate signal strength. Equation (2) gives the result for the

indirect case as:

$$5 + \left(\frac{0.67}{4\pi \times 1000}\right)^2 \times 6.31 \times 6.31 \times$$

$$\left(\frac{0.67}{4\pi \times 1000}\right)^2 \times 2 \text{ watts.}$$

 $=3.21\times10^{-15}$ watts or -145dBW, too weak for reliable operation.

The difference of 63.5 dB is given directly by equation (3). It is also apparent, by inspection of that equation that the difference value is maximum when l = r/2. As the point at which the intermediate antennas move from the centre (l = r/2) point in either direction, the r.f. input power to 2 receiver increases, at first fairly slowly but as either end is approached the increase is asymptotic to 6dB as the distance to the ends is halved. In order to restore the 'direct' condition it would be necessary to interpose an amplifier with a gain given by equation (3) between the pick-up and re-radiating antennas (and of course, effectively decouple them from each other), or alternatively increase the gain of these antennas such that the total sum gain is:

$$2 \times \left(\frac{G_1 G_2}{2} \times \frac{16 \pi^2 l^2 (r-l)^2}{G_1 G_2 \lambda^2 r^2} \right),$$

which reduces to:

$$\frac{16\pi^2 l^2 (r-l)^2}{\lambda^2 r^2} \qquad (4)$$

Applying the values for r, l and λ given above, we get the sum again as

$$\frac{16\pi^2 \times 1000^2 \times 1000^2}{0.67^2 \times 2000^2}$$
$$= 8.79 \times 10^7$$

=79.4dB.

Thus each antenna would need to have a gain of approximately 40 dB, generally an impracticably difficult task in most tunnels. As the frequency is raised (hence generally falling outside the band allocated for private mobile radio purposes) the production of high gain antennas becomes easier; on the other hand, the free space attentuation increases. In some rare cases losses may be decreased by the generation of waveguide modes of propagation but these could not normally be relied upon.

If we consider raising the frequency by ten times to 4500 MHz. ($\lambda = 0.067$ m) and maintaining the same received power as in the direct case, (7.1×10^{-9}) watts or -81.5 dBW) with the same transmitter e.r.p. of 5W (7dBW) we would need a receiver antenna gain of 23dB instead of 3dB, an almost impossible value to achieve for an omnidirectional mobile antenna. Alternatively, the e.r.p. of the transmitter could be increased by 20 dB to 27dBW (500W) by using say, a 1 watt transmitter and a parabolic antenna of 0.67 metres diameter which, at 50% efficiency, would provide a gain of 27 dB. For the indirect case at 4500 MHz, we can again apply equation (4) to ascertain the sum gain of the intermediate antennas. Sub-

 $\frac{16\pi^2 \times 1000^2 \times 1000^2}{0.067^2 \times 2000^2}$ = 8.79 × 10⁹
= 99.4dB.

stituting the values as before we get

Thus each of the two antennas would need a gain of about 50dB which at 50% efficiency would entail a paraboloid of 9.54 metres diameter, a somewhat impracticable value.

In conclusion, what is shown above is not that radio communication through tunnels is impossible, (adequate systems either as separate entities or in association with external mobile radio schemes have been achieved) but that sufficient illumination by the radio wave cannot be provided simply by passive means. In many cases, radiating cables would provide the most satisfactory solution with a minimum of design problems and, when used with repeaters, would cater for almost any configuration.

A short curriculum vitae of Mr Treen appeared in the issue for August, 1978, in which he was the author of an article on a proposed radiating cable system.

Wireless World — a decade of growth

More and more people are reading Wireless World. This is clear from our latest circulation figure, which has just topped the 70,000 mark. According to the Audit Bureau of Circulations the average number of copies distributed in the twelve months ending 31st December, 1978 was 70,125 per issue. This was an increase of 1,608 copies per month on the corresponding 1977 circulation of 68.517.

And here we are not merely noting an isolated increase for one particular year. If you look back over the past decade, this increase proves to be in fact one more step in a continuing process of growth. In 1968 we had a circulation of 48,401 copies per month. The graph then shows a steady overall climb with fluctuations of only about a thousand from the ideal smooth curve — giving an average increase over the whole decade of 2,172 copies per month each year. And remember the journal is paid for by its readers, it's not a "give-away" as many are. People who buy it really need it.

These figures can only mean that Wireless World, now in its 68th year of publication but unwithered by age, is still doing its job. It is not only keeping

its long-standing professional and general readers, some of whom have taken the journal for thirty years or more, but continuously attracting new readers in the highly competitive and increasingly specialized field of electronics publishing. On average more than one person reads each copy, and the total readership now amounts to 215 000

An important aspect of this growth is the continuing increase in Wireless World's overseas circulation, which is now over 23,000 per month - a figure greater than the total circulation of some of our contemporaries in professional electronics publishing. Apart from the major groups of readers - in all countries of Western and Eastern Europe, all states of the USA, in the USSR and China, in most countries of the African and South American continents, not forgetting Australasia, Scandinavia, the Indian sub-continent and South-East Asia - you will find them in unexpected places from Afghanistan to Haiti, from Ethiopia to Iceland, from Alaska to Sri Lanka and on small islands like the Faroes, the Azores and those in the Pacific and Indian Oceans. The "World" in our title really does mean what it says!

BOOKS RECEIVED

BSO Directory '79, edited by Linda Holland,' is compiled by the people who produce the journal Broadcasting Systems and Operation, and is a comprehensive guide to broadcasters, equipment and services. The book is in four parts; the first being a list of the world's radio and television authorities and stations, with addresses. Part 2 contains the names, company executives, agents and activities of companies supplying equipment and services. The third part is a listing of equipment and services, classified by type, with the names of relevant companies in each field, and the final section contains brief descriptions of the equipment produced by the world's manufacturers. Each section is

The 208-page book is extremely comprehensive, being the first such compilation to appear, according to the publisher, whe expresses the intention to expand the listings in forthcoming editions. The publishers are B.S.O. Publications Ltd, P.O. Box 1, 41 High Street, Wivenhoe, Colchester CO7 9EA, and the price is £25.

Elements of Computer Science, by Glyn Emery, with assistance from David Bale, is designed to accompany a first-year course in computer science. The treatment is such that no knowledge of computing is necessary to take full advantage of the text: the very basics of logic and a logical view of problem solving are treated in three chapters, as are the various number systems. Programming is built up from a discussion of the structure of data and its control, through programming. and operating systems, to a section on the structure of languages. Although the main part ov the book is concerned with digital computing, a section on the analogue variety takes up the final chapter. Exercises are

provided after each chapter. Glyn Emery is Professor of Computer Science at the University College of Wales, Aberystwyth. The book is published in paperback by Pitman Publishing Ltd, 39 Parker Street, London WC2B 5PB, at £2.95.

Man-made Radio Noise, by Edward N. Skomal, analyses and characterises virtually all the sources of man-made interference, found in industrial society. Each type of noise source is given a chapter (automotive, power lines, etc) and is then related to other sources in an analysis of composite noise in metropolitan areas, at the surface. This exercise is then repeated to give a picture of composite noise at specific altitudes over large cities. The book is extremely comprehensive in coverage and the treatment is thorough and mathematical. Copious references are provided. Costing £16.15 in hard back, this 342-page book is published by Van Nostrand Reinhold Company Ltd, Molly Millars Lane, Wokingham, Berks.

MOBILE CB DANGERS

If Mr Riley is trying to argue a case against mobile c.b. based on danger to human life (January letters), he should produce more convincing evidence than the results of artificial tests conducted by a university research group. I have no statistics to prove it, but I doubt if radio-controlled mini-cabs, which have both inexperienced drivers as well as mobile radio operators, show an excessively high accident rate due to use of the radio in heavy traffic.

Surely only the silliest driver will attempt to operate a radio while negotiating a hazard, which requires both hands to be on the steering wheel? The tests referred to by Mr Riley, would, I am sure, produce even more alarming results if the drivers concerned were told to light a cigarette or change a tape cassette, while negotiating the obstacle course set for them by the university.

The point which should be made about mobile c.b. radio is how many lives could be saved by intelligent use of it on the roads. I am at present in correspondence with the Home Minister over this aspect of c.b. radio, in connection with the recent tragic pile-ups on the M1 and M5. I firmly believe that prior warning could have been given in time to those drivers involved if some had been equipped with mobile c.b. The time factor is vital in fog and, under these circumstances, any driver, especially truck drivers, would have the c.b. open all the time; therefore, they would be prepared for advance warning of an accident from any c.b. equipped vehicle a mile or so ahead. This would allow time to take evasive action and also warn other drivers in the vicinity, visually and on the radio, of the situation.

Mr Riley states that police "frown on" the use of mobile c.b. If this is the case, what then is their reaction to the carnage of a motorway pile-up, which often includes their own men and vehicles? Police patrol cars on the motorway are just as vulnerable as other vehicles in fog, and are equally helpless in either warning or being warned by other drivers, or of summoning assistance if their vehicles are immobilised in the accident area.

In my opinion, the time has now come for Chief Constables to stop frowning on c.b. and to start listening instead to the conclusions of their own motorway patrolmen; and then make public their views of the benefits that mobile c.b. radio could bring to motorway safety and the saving of human life.

Tanlaw House of Lords Westminster

Whilst Mr Riley makes some valid points with the help of the OU (January letters) he also makes some presumptions, e.g. that a driver using a "c.b." would continue to discuss the evening's menu with his wife, etc., and simultaneously attempt almost impossible trials of judgement on the road. Also Mr Riley feels that accident statistics would suddenly rise "if dozens of inexperienced c.b. users suddenly [took] to the road." This assumes that inexperienced c.b. users would also be inexperienced drivers. Tell that to new taxi drivers.

May I state that, notwithstanding my name, I am English, white and a road user, also I value my life and others. Furthermore, I have had several years' experience on US roads, notably, with about a "dozen" truck drivers who drive the road crew and p.a. equipment belonging to the rock-and-roll group that I work for between every major



USA city (many, many thousands of miles). Invariably, if they suspected danger ahead (or behind) they immediately dropped the 'mic' in their laps and coped with the situation, if any, then recontacted. Most importantly the same reaction was seen by myself in the many 17-21-year-olds that I have as friends in Los Angeles and Miami. Incidentally my own (hired) car had everything but c.b. and I didn't miss it.

Mike Januszkiewicz Ipswich Suffolk

TELETEXT CHARACTER ROUNDING

My November 1978 article on the character rounding board IV for the Wireless World decoder mentioned that the power unit originally supplied with decoder kits could not provide the additional 530mA needed for the new board. (Current and very recent kits have an uprated power supply which can provide the extra, as long as the regulator heat sinking is sufficient.)

Since the board was originally designed, low power Schottky t.t.l has become available at prices only marginally higher than the standard type. With the same or only slightly lower speeds, and a fanout of five into standard t.t.l., the low power Schottky (L.S.) can in most cases replace it directly with an appreciable saving in current consumption.

Board IV built with L.S. i.cs apart from IC $_{208}$ (74121), draws 230mA against 530mA for the standard (the r.o.m. accounting for 50mA in both cases), the only change necessary being an increase in C $_{202}$ from 1n to 1n5.

On board III the current fell from 570 to 270mA with four i.cs having to stay as standard — IC_{104} (74150) not available as L.S., IC_{125} (7473) where the L.S. version has different logic, and IC_{105} (74157) and IC_{125} (7408) which drive the television set and video interface.

This means that the two L.S. boards together draw less than the standard board III, and can therefore be fed from the original power unit, saving the cost and inconvenience of renewing or adding to it, while with the new larger one 600mA at least is left available for possible future extensions, such as ultrasonic remote control. It is understood that the kit supplier intends to offer L.S. i.c. sets as an option for these two boards.

On board IV the timing component values for the odd/even field detector monostable IC $_{208}$ were derived from T.I. data for the

74121 and it has been found that with other manufacturers' products the value of R_{202} may have to be changed if the character rounding jitters or does not work.

Owing to a typographical error the reference "Broadcast Teletext Specification — BBC, IBA, BREMA — September 1976" was omitted from the list of references at the end of the article, and some of the reference numbers in the text are therefore wrong. Also the source resistance of a t.t.l. output in the high state is printed as 190 ohms instead of 130, and the phrase "two r.a.ms in parallel" in the centre of p.49, should read "two r.o.ms"

J. H. Hinton Cambridge

DISPLACEMENT CURRENT

I am slightly alarmed by some of the statements in the article "Displacement current — and how to get rid of it" (December 1978). I suggest that there would justifiably be an outcry if the authors were to have written paragraph 5 as follows . . .

Since the inductance has now become a transmission line, it is no more necessary to postulate 'magnetic flux' in an inductor than it is necessary to do so for a transmission line. The excision of 'magnetic flux' from electromagnetic theory has been based on arguments independent of the classical dispute... (an apparent negation of Faraday's law of Induction).

Displacement current (without the inverted commas) is as real and justifiable a concept as conduction, or convection, current in charge transport — it is directly analogous to the time differential of magnetic flux in magnetic theory ($\partial \overline{D}/\partial t$ instead of $\partial \overline{B}/\partial t$ if you want to be precise). Displacement current is neither a mathematical convenience nor an artefact of a faulty model for a capacitor, it is a fundamental part of Maxwell's equations.

To those who have designed high frequency networks, interchanging between a capacitor or inductor and a transmission line is common practice: the inductors and capacitors used actually look like short transmission lines. Such circuits can be analysed using either of two methods; the discrete approach in which case each line has an equivalent inductance and capacitance or the distributed approach in which case characteristic and terminating impedances are important. Paragraph 4 could be misleading because it confuses the lumped and distributed techniques: a transmission line used as a capacitor, or a capacitor appearing as a transmission line, must have some inductance which is inherent in the component construction. This will become clear in the next paragraph.

Consider an ideal transmission line. For analysis this has a few useful parameters; L- the series inductance per unit length, C- the shunt capacitance per unit length, C- the characteristic impedance (= $\sqrt{L/C}$), and v- the characteristic velocity (1/ \sqrt{LC}). (And where do we get these parameters from? Why, of course, from electromagnetic theory using B,H,E,J, and naturally enough \overline{D} the electric flux or displacement vector.) The impedance measured at the end of an open circuited transmission line of length d is simply $Z_{in}=Z_o/j$ tan ($\omega d/v$). But if ($\omega d/v$) is small, a condition of lumped circuit analysis, we can expand the tan term to obtain

 $= Z_o/(j\omega d/v) + \frac{1}{3}Z_o(j\omega d/v).$ Using the transmission line parameters this gives $Z_{ir} = 1/j\omega(dC) + j\omega(dL/3)$ which can be interpreted quite easily as a capacitor and inductor in series. To me that would seem a very plausible mechanism for an internal series inductor in a capacitor.

At 'low frequencies' a capacitor may well be a good equivalent circuit for a particular form of transmission line, but at increased frequencies the series inductance must be considered: eventually we must switch to a distributed analysis, otherwise we are going to be barking up the wrong tree in the wrong hall park. For digital systems where harmonics extend into the GHz region very careful consideration must be given to distributed effects in what are nominally lumped components.

P. I. Day Maidstone Kent

The authors reply:

We would like to make three points which we hope will clear up any misunderstanding that Mr Day has over the statements we made.

- 1. He wrongly assumes that we say inductance does not exist. Series inductance does not exist as a separate entity, but distributed inductance does, linked to distributed capacitance as a measured property of a transmission line defined as characteristic impedance.
- 2. We are considering an ideal step response of a component and the inclusion of frequency in the discussion is making an unnecessary complication.1.
- 3. If Mr Day believes that you can swap "magnetic flux" with the displacement vector (current) then where does this exist when a step is propagating down a transmission
- I. Catt, M. F. Davidson and D. S. Walton

Reference

1. Interconnection of logic elements, Wireless World June 1978, p. 61.

FERRITE ROD AERIALS

In his article in the December 1978 issue Professor Sutcliffe refers to the ferrite rod as .. collecting and concentrating the radiated magnetic field and channelling it through a coil wound round the middle of the rod". He states that this approach is strangely unrewarding although it has provided a challenging exercise in field theory and mathematics.

I am still looking for a lucid explanation as to the manner in which ferrite rod receiving aerials and, for that matter, dielectric receiving aerials can achieve gain. It is easy to get a physical picture of say a parabolic dish several wavelengths in diameter and placed normal to the direction of the transmitter acting as a collector whose aperture is effectively that derived from its geometry and concentrating the field at the focus. Nothing utterly complicated is done to the electromagnetic wave except possibly some shadowing for a distance behind the dish. Even a half-wave dipole or a Yagi array have a physical aperture of which one can conceive reasonably easily but when one considers the ferrite rod aerial used in many receivers today it is difficult to grasp the means by which an oncoming wave becomes aware that it is to be intercepted by something that is physically small in relation to its alleged effective aperture.

Does the wave, once it finds itself in the presence of permeable or dielectric material, somehow signal back to those adjacent portions of the oncoming wave that they have to 'concentrate' and, should this take a finite time, could one consider that a signal comprising a series of very short pulses with complete gaps in between the pulses would be received by the ferrite rod aerial with no aerial gain being achieved?

Perhaps I have got it all wrong and the answer is associated with the ratio of wavelength to the comparatively small physical size of the ferrite rod aerials.

The concept of a ferrite rod or dielectric aerial as a transmitter conjures up a somewhat different picture; the 'concentration' is: there at the beginning. Perhaps the reciprocity theorem is not quite right after all.

K. F. Treen Totteridge London N20

MILITARY **ELECTRONICS**

Your admirable editorial in the January issue glosses over the real dilemmas which face the practitioner of electronic engineering. The first is that military and civil developments are tightly enmeshed — or optimistically, there has been a good deal of beating of swords into plough-shares. An obvious example is radar: this was originally a military development but now forms the essence of air traffic control, maritime navigation and checking the speed of road traffic. The Loran navigation system grew out of devices to aid bombing missions and Omega has obvious military potential for the USA. There is little difference between a 'spy-in-the-sky satellite' and a 'weather satellite'. The initial war-time urge to develop powerful electronic computers was based on various military needs; but the EMI brain (or body) scanner would not be possible without computer technology. The progressive miniaturisation of computers has made it easier to put adequate navigational computers in aircraft, rockets and space vessels, whether civil or military; and at the present time microprocessors are finding industrial use so that our government says that the future of British industry depends on its learning to use microprocessors.

So long as all the large electronics firms are substantially involved in military work, the ordinary citizen is expected to acquiesce in it. Society has always tolerated a very small minority of drop-outs, whether monks in the mediaeval past or hippies in the present day, but it cannot continue to function unless most of its members accept its norms. (Of course it may be argued that it should not continue to function.) A few can take refuge in university work, but even here one suspects that the funding of research may sometimes be influenced by anticipation of military advantage. Very few of those who have developed expertise in electronics will be prepared to scrap the lot because they regard some of the applications as evil. As the physicist Max Born wrote*: "Science has undoubtedly two aspects: it can be regarded from the social standpoint as a practical collective endeavour for the improvement of human conditions, but it can also be regarded from the individualistic standpoint, as a pursuit of mental desires, the hunger for

knowledge and understanding, a sister of art, philosophy, and religion."

So should electronic engineers feel a special responsibility about armaments, in the same way that some eminent American physicists felt that the original development of the atom bomb had placed a special responsibility upon them, or should moral and political arguments be left to moral and political organisations? If the latter, is it reasonable for electronic engineers who are probably depending on the armaments trade for half their income (on average) to support organisations such as International Voluntary Service whose long-term aim is to eliminate the need for armaments? What about the short-term effect on employment of any significant reduction in the armaments business? There are no easy answers, but we all need to arrive at some sort of answer.

D. A. Bell (Professor) Walkington, Beverley,

Yorks

*Natural Philosophy of Cause and Chance, reprinted by Dover Publications, 1964

Your leader "The death delivery business" in the January issue is most timely. How can one pretend that the world expenditure on armaments is necessary for the defence of democracy when the records of the two super-powers are of expansionism, cruelty and corruption, and when armaments are used in so many countries not for defence but for internal suppression?

When hundreds of millions of people exist on such incomes as £50 per annum can one justify such squandering of the earth's resources?

The military-industrial complexes of the two super-powers have more in common with each other than they have with their respective populations, and one of today's greatest dangers is that if the populations object to these unnecessary expenditures, these complexes may be tempted to indulge in offensive acts in order to justify their own existence and continuation in being.

The left and right wings of society are equally to blame. It is unfortunate that many people delude themselves that they have no responsibilities in this matter because they do not see the results of their handiwork. Responsibility lies not only with those who pull triggers but also with those who drive lorries, type letters and clean offices. Can they not be made to realise that those who would live by the sword must expect to die by the sword? Unfortunately the rest of us also are likely to die by it.

Roy C. Whitehead Sutton

INTELLIGENT MACHINERY

Recently I have been likening a micro2 processor to a paralysed person in a wheelchair, because it cannot itself perform any actions. I now realise that I should have said "a deaf and blind person in a wheel-chair" because a microprocessor cannot itself gather information: it can only manipulate information which is fed to it in machinereadable form. In other words, intelligent machinery (November 1978 editorial) requires sensors and actuators as well as the information processor. It is for this reason that the Electronic Engineering Department of the University of Hull, for example, offers a

degree course in "Instrumentation and Control" as well as the course in Electronic Engineering (which includes a computer option). There is more to automation than silicon chips!

D. A. Bell (Professor)

Walkington, Beverley, Yorks.

Until his retirement in 1978, Professor D. A. Bell was Professor of Electronic Engineering at the University of Hull. - Ed.

'DID YOU KNOW?''

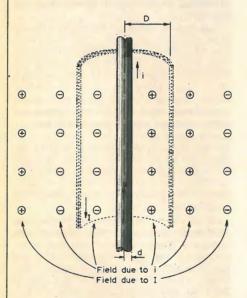
Epsilon spoils his otherwise interesting article in the December 1978 issue by incorporating several errors.

The inductance formula used to derive his expression for X (p. 67) is the well known formula for a length of straight wire,

 $L = 10.2\log_{2}(2l/r)\mu H$ from which $X = 2\pi f 10.2 \log_{10} (2l/r-1) \Omega$

(f in MHz, all other dimensions in metres. I have used r here for radius - I think D for a radius is highly confusing!)

Fig. 5 contained several important errors. I think the diagram should look like this:



Because of the incorrect drawing, the sentence including "... (but note that this expression is not applicable when x is less than d) ..." became misleading. It is true, however, for the drawing as shown above.

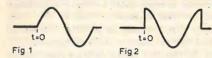
The reason is, of course, that for high frequency currents, skin effect keeps the current to the surface of the centre conductor and hence both i and H are zero within. Likewise, in the outer conductor, skin effect keeps the currents to the inside surface of it.

The author explains the zero ground plane current in terms of magnetic effect and mutual inductances. However, a valuable alternative approach is to regard it in terms of field boundaries. The outer conductor forms one boundary (and the inner conductor the other) for both the electric and magnetic fields as in a waveguide. Thus the current on both the conductors forms the field boundary and all of the current flows in these boundaries. Since skin effect keeps the current to a thin inside layer of the outer conductor there can be no field and no current elsewhere. Thus at very low frequencies where the skin depth is thick compared with the outer conductor wall thickness a resistive volt drop will occur along it and current will flow in parallel paths like the "infinite" ground plane.

In the high frequency case, perhaps Epsilon would like to comment on the current route if one end of the braid is open circuit?

One final point concerning ground planes. Even an infinite ground plane has resistance and inductance. The "spreading" resistance around the two connecting points gives it resistance and the flux produced by a current between connecting points gives it induct-

Regarding the discussion on audibility of phase errors (Letters, December issue and earlier), a sine wave chopped into short bursts with varied start and stop times cannot be used for audibility tests. If we consider the two extreme cases of Figs. 1 and 2 where the sinewaye is switched at zero or at peak,



the spectra of these two pulses is totally different. Fig. 1 has a fall-off as 1/ω² at high frequencies, whereas Fig. 2 has a fall-off as 1/ω at high frequencies. These are equivalent to 12dB/octave and 6dB/octave.

Any distinction the ear makes between them will probably be the result of the energy rich h.f. spectrum associated with the abrupt level change in Fig. 2 at t = 0 + 1 think this point is the same as Mr Coleman's.

B. J. C. Burrows Ewelme Oxford

Epsilon replies:

As expected from previous discussions with colleagues, my article "Did you know?" in the December 1978 issue aroused many comments. Some readers wrote to me concerning the capacitor problem (I shall deal with their comments at a later point in this reply) and others, while not disagreeing with my explanation concerning the screening of the coaxial cable, had clearly had many unfortunate experiences to the contrary.

Regrettably, one or two minor errors did appear as follows. In the second equation on page 67 the r.h.s. should be divided by two, and a 2π should appear in the third equation. d in Fig.3 refers to the inner conductor rather than the outer as originally shown, and on balance I find Mr Burrows's version of Fig.5 more satisfactory. It is hoped that the minor errors did not interfere with readers' enjoy-

Mr Burrows's letter is concerned mainly with the explanation of coaxial cable screening in terms of field boundaries and skin effects. I have no objection to treating a cable as a TEM waveguide (except that this leaves the original question unanswered), but do raise a protest at the invoking of skin effect as the reason that screening exists. To begin with, skin effect does not cause all the current to flow in the inside of the cable, and for many of the frequency ranges of commercial interest appreciable currents flow on the outside of the braiding. Furthermore, even if currents were limited to the inside of the braiding, the problem as formulated in the article would remain unchanged.

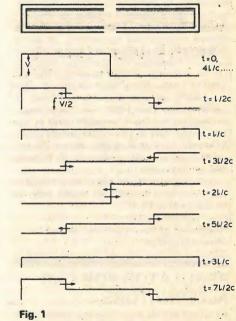
If the outer braid of the cable is broken, the solution to the current flow is clearly geometry and frequency dependent. However, certain observations can be made. The cable is no longer screened, a forward current will flow in the braiding, which will have a potential above ground, and return currents will flow in the earth plane. Their path (or rather, that of the elementary current filaments) will follow a route which gives the lowest loop inductance, i.e. the current will be concentrated under the projection of the cable onto the ground plane.

Turning now to the capacitor problem, some readers expressed doubt about the given solution, preferring instead to seek comfort in their own explanations. These mainly relied on the presence of losses, caused by resistance or arcing (solutions which I excluded by the reasoning given in the article), or by radiation, which some claimed was always present. Other readers ignored the statement that inductance was intrinsic.

One reader raised the interesting problem of what happens when the capacitance is altered slowly by separation of the plates or by changing the dielectric constant. In such cases the same inconsistency between the answers obtained by the conservation of charge or of energy appears. The explanation lies in the mechanical strain between the plates, which is caused by electrostatic attraction and which changes to account for the energy difference.

Further insight into the original problem can be obtained by allowing the capacitors to have distributed constants and using a configuration which precludes the escape of radiative energy. Consider the circuit shown in Fig.1, which consists of two capacitors made in the form of coaxial cylinders. The cylinders are really coaxial lines, closed at one end but open circuited, and are a good substitution for the familiar tubular capacitors.

One capacitor is charged to a voltage V and is connected to the other to form a completely closed system from which energy cannot escape. The capacitors can operate at superconducting temperatures, so that there are no resistance losses. Sketch the voltage along the capacitors as a function of time.



The answer is given in Fig.1, and to forestall further questions, note that:

(a) Energy and charge are conserved.

(b) The current flow also has the form shown in the figure, with a peak amplitude given by V/Z_o, (Z_o is the characteristic impedance of the coaxial structure).

(c) Since current is finite, and in any case can

be made small by making V small, it can always be below the critical level at which superconductivity is suppressed.

(d) By a similar reasoning, arcing need not occur.

(e) There is no escape of radiation.

(f) There is no such thing as a perfect open circuit, and end effects will modify the square wave shown. However, this does not invalidate the above arguments.

(g) No matter how short the capacitor length, the oscillating nature of the discharge remains.

Point (g) is really the whole crux of the matter, since it guarantees an oscillation which can temporarily store the "missing" energy in inductive fields.

I hope that the more refined model will assist readers in their further understanding of the subject.

FOUR YEAR DEGREE COURSE

I have noted your article entitled "New four year degree course in electronics" which was published in the December issue of Wireless World. As you well know, there is considerable interest in the establishment of a variety of four year courses in this country prompted by the UGC's initiative in 'management enriched' courses. Many other universities in the United Kingdom are following a similar route on a free-lance basis and, as you correctly report, Southampton is one of these establishments.

It is, of course, appropriate that any initiative of this kind should be given its place in the technical and academic press but it should not escape the notice of editors of these journals that courses of four years duration have been operated for many years in the United Kingdom. I am not thinking of four year sandwich courses but of genuine four year academic courses such as the one which Hull has made available since the mid-1960s. This is a special degree course in electronic engineering which not only qualifies the successful student for the degree of Bachelor of Science but also a diploma in electronic engineering for those students who have achieved a high academic standard. Consequently, graduates from the four year course in Hull have had the experience of the extra year which we now recognise as an enhanced degree course. It was Professor David Bell, my predecessor, who established the four year course in the Department here and he must take the credit for his remarkable foresight. Relatively minor changes are taking place in the Department at the present time to incorporate in the course structure those component subjects which now find favour with bodies such as the IEE and the UGC.

Alan Pugh (Professor), Department of Electronic Engineering, University of Hull.

REGULATOR FOR CAR ALTERNATORS

We would like to draw your attention to the article "Regulator circuit for car alternators" in your August 1978 edition. As electronic design engineers we would like to express our dissatisfaction with the article, and feel very displeased that such a poor design should appear in Wireless World. An example of the design deficiencies involves Tr₃, whose maximum base drive is 140mA,

assuming a 14.4V line. This device (MJE3055) has a specified minimum $h_{\rm FE}$ of 20 at $I_{\rm c}=4A$ and $V_{\rm CE}=4V$, which would produce a collector current of 2.8A minimum. Assuming a nominal 3.5R rotor resistance the device would then try to dissipate 13W. If the machine has a nominal 30A output, the regulator may limit this to about 20A due to the lack of available field current. Neither of these are desirable features although the former will assist R_1 in driving out moisture from the unit!

The maximum collector current of Tr_1 will be 6.3mA, of which 2.7mA will flow in R_2 leaving a base current of 3.6mA in Tr_2 when it is desired to turn off Tr_3 . The device specified for Tr_2 (2N3053) has a minimum gain of 25 with I_C = 150mA and V_{CE} = 2.5V so the collector current could be 90mA with 50mA still flowing as base current in Tr_3 . This means that a minimum collector current of 1.0A could still flow, with Tr_3 dissipating 11W and the machine output being a minimum of 7A. Assuming a higher gain for Tr_3 to help saturation merely worsens the minimum output figure. This cannot be regarded as satisfactory.

It should be noted also that the worst case specified saturation voltage of a 2N3053 is 1.4V with $I_c=150 \mathrm{mA}, I_b=15 \mathrm{mA}$, so increasing the available base drive to Tr_2 could not guarantee to turn Tr_3 off even with its existing inadequate base drive.

The selection of a nominal zero temperature coefficient is not satisfactory in view of the negative temperature coefficient of the terminal voltage of a lead acid battery. If a part charged battery is being charged from a relatively high output machine, the battery temperature will rise, terminal voltage fall and charging current increase.

The battery temperature will then rise further and so on. This can rapidly damage a battery and possibly cause it to explode, yielding hot concentrated sulphuric acid. This tendency may be exacerbated by the high value of the recommended setting voltage.

Other perhaps more minor problems are also apparent. It is unlikely that the range of setting provided by R9 will cope with reasonable variations in R4, R5, R9, D1, Tr1 and Tr2. The wiper of R9 may possibly lift off due to vibration and put the machine on to nearly full field and maximum output. Sensing the machine voltage on the ignition switch is prone to trouble arising mainly from voltage drops across the switch, connections wiring and fuses if fitted. No useful indication of the method of selection of C, is given. A better design would include circuitry to induce switching. The circuitry to drive the warning light would be unnecessary if a nine-diode machine was used. The extra three diodes provide an additional isolated positive supply, and can be easily fitted to older

We feel that a design which has so many major and minor faults in philosophy, design and component selection should not be published in any magazine, and particularly not in a semi-professional magazine such as Wireless World. We wonder how many other designs would prove to have similar shortcomings, if subjected to a similar analysis. M. J. Newsome and S. A. White, London, NW10.

Mr Watkinson replies:

The gain of transistors follows a distribution curve where the peak is at the typical gain. The percentage of units having worst case gain is very small, as these units are at the tail

of the distribution. When dealing with the alleged inability of Tr₂ to turn off Tr₃ statistics tells us that the chances of having two devices which are simultaneously worst case are negligible, being the product of the two probabilities.

On my own unit Tr₃ saturates at 0.3 volts. I have not wasted my time measuring the minimum collector current.

I am aware of the temperature coefficient of accumulator voltage, but I cannot see why it is valid to assume that the temperature of the regulator tracks the temperature of the battery as the two are usually found in different places on the vehicle. In my own vehicle the battery is not in the engine compartment, but the regulator is. Having accepted that the two components differ in temperature, adopting a zero coefficient is simple good design practice.

No figures accompany the allegation about the range of adjustment of the pot, but the fail-safe mode is deliberate. The inductive current limiting of the alternator prevents damage on full field. This is better than having no generator at all, particularly at night. A friend drove his van around with full field current for several weeks until he tired of topping up the battery and replaced the regulator.

It is no easy matter to install extra diodes in an alternator. Not only would this render the unit a one-off; impossible to replace away from home, but the extra parts, wiring and connections required would consume more effort than making the trivial but effective circuit I have offered. I had nine-diode machines in mind when I wrote about the tortuous means used to drive a light bulb.

The article clearly shows how to avoid trouble with voltage drops and if the instructions are followed no trouble will result.

The prototype unit was constructed in 1973 and has given no trouble. The battery dates from before this and only requires occasional topping up.

Whilst heralding Wireless World as a semi-professional publication Messrs Newsome and White descend to the sensational verbiage of the crusading tabloid in their attack, which does nothing to support their shaky technical criticisms. In closing I should point out that the acid in batteries is dilute only; perhaps this will save me when mine explodes!

J. R. Watkinson.

MICROCOMPUTER BUSES

I would like to take up Mr Aylward's points about the amateur bus standard E-78 (December letters).

I am endeavouring, with the support of the microprocessor manufacturers and a great many professional microprocessor users, to define a microprocessor bus standard for use with the new generation of 16-bit microprocessors. I do not believe that E78 is suitable as a professional standard, for it suffers too many deficiencies to support the devices Mr Aylward mentions. I would like to invite anyone who is interested in this topic to write to me for further information.

Paul L. Borrill
Mullard Space Science Laboratory
University College London
Holmbury St Mary
Dorking
Surrey

Frequency synthesizer — 4

Examples of design using techniques already described

by R. Thompson, M.I.E.E.

Single frequency

Having looked generally at types of synthesizing circuit, three applications have been chosen to illustrate specific designs. The first example is a synthesizer for an atomic standard. The problem is simplified here by approximating the hydrogen maser frequency to 1420.405 MHz, ignoring the last five significant digits. The requirement is to produce a reference frequency at 5 MHz, locked to the accuracy of the maser. This represents the type of synthesizer required for special purpose, single-frequency use, Figure 21 shows a possible arrangement.

Because of the high frequency of the maser the synthesis is organised in two loops. One loop generates 1400 MHz and subtracts this from the maser signal; the other loop synthesizes the residue, or intermediate frequency. An i.f. of 20.405 MHz is suitable to provide the high gain necessary to amplify the maser signal. The 1400 MHz is generated by a 140 × p.l.l. multiplier, followed by a 2 × harmonic multiplier. A single-stage p.l.l. multiplication by 240 is not used because the output frequency would be too high for the divider. The synthesis of 20.405 MHz can be carried out with a simple divider and p.l.l. multiplier.

Variable frequency

The next example has a very different requirement, the provision of a frequency which can be easily varied over a range of many decades, while retaining reference frequency stability. This requirement cannot be met simply by putting several decades of variable dividers in a p.l.l. Apart from the problem of designing a v.c.o. capable of overating over several decades of frequency, there could be severe tuning time problems. The reference frequency would equal the lowest frequency increment, which may be required to be a fraction of one Hertz. The loop bandwidth would have to be at least an order narrower than this so that the tuning time could be very long. There would be wide changes in loop gain as the frequency was changed which would have to be compensated for if a reasonably constant damping factor is to be maintained.

Because of these difficulties the normal design approach to this type of synthesizer is to cascade synthesizing stages, each stage providing one decade of frequency control. Figure 22(a) shows the basic arrangement.

Selector switch D selects a harmonic of Δf between 0 and $9\Delta f$. This is divided by 10 and added to the harmonic selected by switch C. This combined frequency is divided by 10 and added to the Δf harmonic selected by B; and so on. The final output frequency is therefore a decimal number of times Δf , the digits being readily and independently variable.

The disadvantage of this simple scheme is that the interface between stages is at widely varying frequency. This can be avoided by the arrangement shown in Fig. 22(b). The cascading of stages incorporating 10 times dividers and mixers is similar to the previous scheme. However the frequency added in each stage is the sum of the selected harmonic plus $0.9 \, f_1$. This means that the output of each stage consists of the variable frequency plus a fixed offset. This offset can be removed at the output of the final stage.

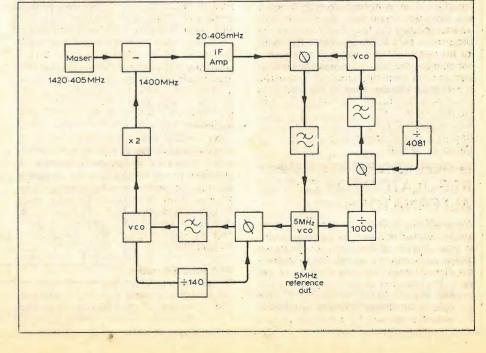
Figure 23 illustrates a typical decade module suitable for cascading in a

Fig. 21. Arrangement of synthesis to obtain a 5MHz signal locked to an atomic standard of 1420-405 MHz.

manner similar to that shown in Fig. 22(b). The harmonic multiplier and 0.9f₁ mixer/generator are combined in the one p.l.l. The fixed portion of the divider ensures that f_1 is generated by the v.c.o. when the selected value of C and D are zero. With the example frequencies shown N_0 is 180. Stepping switch C by one increases the p.l.l. multiplication by one, therefore adding 10 kHz to the output frequency. The output frequency never varies by more than 1/2% and modules can be cascaded at will allowing smaller increments of frequency. An advantage of the divide and cascade system is that loops can all be operated at high comparison frequencies giving low noise and fast tuning time, but the tuning time increment can be made arbitrarily small by cascading more stages and/or increasing the division ratio.

V.h.f. variable

As a final example; a typical v.h.f. communications synthesizer has been chosen. The requirement is for a carrier frequency selectable in 25kHz channels over the range 150-170 MHz. Here the frequency range to be covered is comparatively restricted, allowing the use of a single p.l.l. with a variable divider. Figure 24 (a) illustrates a suitable arrangement



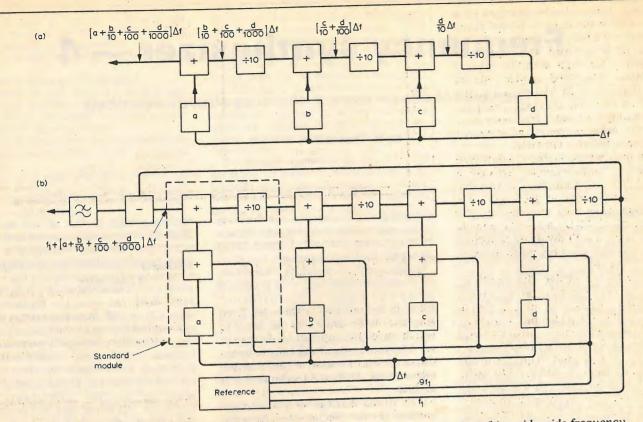
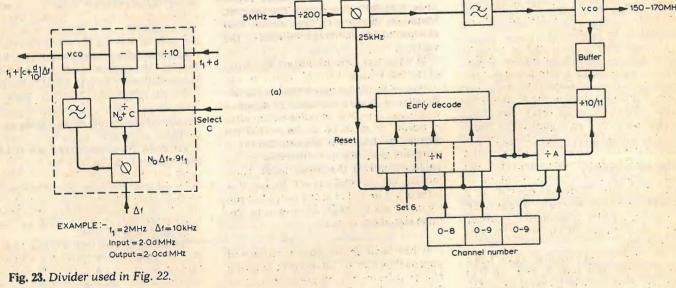
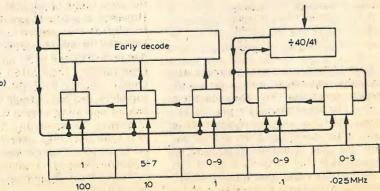


Fig. 22. Cascade of synthesizers to provide a variable-frequency output at (a). Circuit at (b) avoids wide frequency difference between stages.





for v.h.f. communications. Divider is shown at (b).

Fig. 24. Variable-frequency synthesizer



This is a two-stage synthesizer consisting of a fixed divider followed by a p.l.l. variable multiplier. The reference frequency of 5 MHz is a common choice since it is around the optimum frequency for high stability crystal oscillators. The fixed divider reduces the reference to 25 kHz which is the required channel spacing. The p.l.l. must multiply its input frequency by a factor of 6000 to obtain 150 MHz, increasing to 6800 for 170 MHz.

The multiplying factor is controlled by the p.l.l. variable divider. Because of the high v.c.o. frequency a variable modulus prescaler is used, giving a maximum frequency into the variable divider of 17 MHz. An early decode circuit is used with divide by N portion of the counter, allowing medium-speed logic to be used.

As explained earlier, the divide by 10/11 variable-modulus arrangement allows the output to be incremented in steps equal to the p.l.l. input frequency. The three synthesizer control switches are marked in channel numbers starting with 000 for an output frequency of 150 MHz and rising to 800 for 170 MHz. Each switch programmes a presettable decade divider to the number indicated on the switch, the final decade stage having a fixed programming of 6. All zeros on the switches therefore gives the required division of 6000 for 150 MHz, while 800 will give a division of 6800 for 170 MHz. If the setting switches are required to indicate frequency directly a modified counter design can be used. Figure 24(b) shows the divider portion of such a circuit.

The variable modulus prescaler divides by 40/41 and the higher scaling ratio may possibly allow the early decode circuit to be dispensed with. The least significant digit of the N counter is now 1 MHz (40 \times 25 kHz). The N decades are therefore organised to relate their settings to the output frequency in decimal form. The 'A' counter must count off the 25 kHz increments below 1 MHz; that is a maximum count of 40. The A counter therefore consists of a programmable modulo 4 counter, counting 25 kHz increments, followed by a decade counter counting 100 kHz increments.

The final decade counter again has a fixed preset, this time 1, and the four setting switches will be marked as follows:

switch	markings	scaling
1 .	5, 6 or 7	x 10 MHz
2	0 to 9	x 1 MHz
3	0 to 9	x 0.1 MHz
4	25, 50 or 75	x 0.001 MHz

Communications synthesizers are normally required to give a very pure output spectrum. For this reason a buffer circuit is normally placed between the v.c.o. and the dividers. This buffer must have high reverse attenuation so that spurious frequencies generated in the dividers are not fed back into the v.c.o. In practice a buffer would also be placed at the output of the

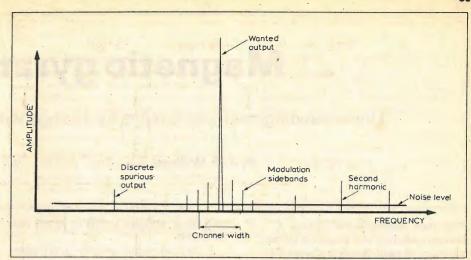


Fig. 25. Synthesizer in Fig. 24 provides this general type of spectrum.

v.c.o. to isolate the synthesizer from spurious noise generated in the load which could effect operation of the loop. Another factor which will help maintain a clean output signal is the comparatively high 'comparison' frequency of 25 kHz. This allows a fairly fast loop which means that the loop will cancel much of the low frequency phase noise generated in the v.c.o.

The loop design will probably be a high-gain, second-order type with a lead lag filter. The high gain will minimise the comparison frequency component at the output of the phase detector. This, supplemented by additional high frequency filtering, will reduce the level of spurious frequencies produced by the V.C.O.

The general form of output spectrum obtained with a typical communications synthesiser is illustrated in Fig. 25. Wideband noise measured in a bandwidth equal to the channel bandwidth, is normally required to be 80-100 dB down on the main signal. Discrete spurious outputs are normally to be 10-20 dB above the noise level. Harmonics are normally much higher if a filter is not included at the output of the v.c.o. Levels of 20-30 dB down on the main signal are typical.

It has been shown that a variety of approaches can be adopted in meeting the requirements of generating one frequency from another. The choice of design approach will vary depending on the wide range of possible applications. However, it is true to say that advances in digital integrated circuits have resulted in synthesizers now being dominated by the p.l.l./variable divider type design. Integrated circuits are cheap, readily available from many suppliers, flexible in their use und capable of operating over a wide range of frequency. These factors have resulted in a radical change over the past five years in the accuracy, size and cast of frequency sources available for application in field equipments and in the laboratory.

References

- 1. Frequency Synthesis
- V. F. Kropua (Griffin 1972) 2. Phaselock Techniques
- F. M. Gardner (Wiley 1966)
- 3. Phase-locked Loop Systems
 - Data Book. Motorola Semiconductor Products Inc.

SIXTY YEARS AGO

The March 1919 issue was much concerned with getting the amateurs back on the air after their enforced silence during the 1914-18 war. We feared that the government, having taken complete control of wireless communication, would "relinquish their hold very reluctantly, and in their future activities may totally prohibit the erection and the maintenance of a wireless installation by the amateur." A campaigning article in support of the amateurs contained backing up statements by Guglielmo Marconi himself, Professor J. A. ("diode") Fleming and Professor W. H. Eccles, and ended with a call for readers' views. Obviously the amateurs did get back.

But apart from the immediate and the practical, the magazine still had time for the more esoteric and speculative aspects of radio science. Marconi, for example, was asked in an interview for his views on what we now call SETI (search for extra-terrestrial, intelligence) but then described as "communication with the stars".

"Senatore Marconi then went on to state that he hoped for communication with intelligence on other stars. Dealing with the question of the language difficulty, he said that although it was an obstacle he did not think it was insurmountable. 'You see, one might get through some such message as 2 plus 2 equals 4, and go on repeating it until an answer came back signifying yes - which would be one word. Mathematics must be the same throughout the physical universe. By sticking to mathematics over a number of years, one might come to speech; it's certainly possible.

"Certainly communication with the stars, if at all possible, must be effected by wireless telegraphy, and the more recent discovery of a means of magnifying signals to almost any degree places within our hands an instrument of almost infinite delicacy. When so great a scientist as Senatore Marconi talks seriously of these possibilities it behoves the sceptic to consider his position.'

Magnetic gyration

Understanding magnetic circuits by analogy with electrical circuits

by J. B. Williams B.Sc.(Eng), A.C.G.I., M.I.E.E.

This article introduces the analogy between electrical and magnetic circuits, covering the basic theory and workings. The analogy is a consistent one and does not fail the modern test of energy which has changed many concepts in recent years. The difference can perhaps best be imagined as if we had for years been treating all our electriccircuits in terms of charge, not current, and often electric field strength and charge densities. We abandoned these concepts for circuit work many years ago.

A LARGE PROPORTION of practising electrical and electronic engineers have only a hazy understanding of magnetic circuit theory while being quite familiar with electric circuit theory. So widespread is this among many with very different backgrounds that one is forced to ask whether the fault lies in the presentation of the subject rather than in the people concerned.

Many engineers are used to tackling problems outside their own field, such as those in heat transfer, by analogy with electrical circuits. The subject of magnetism, closely related to the familiar electrical area, has however not been very satisfactorily treated by this method. A confusing system of units has for many years disguised the fact that electrical and magnetic quantities are dimensionally amenable to manipulation by the same mathematics. As explained by "Cathode Ray" in the January 1973 issue, the introduction of SI has removed this first barrier by making the electrical and magnetic quantities relate directly without the use of strange conversion factors.

Most electrical circuit theory is based on the concept of impedances, both resistive and reactive, i.e. those capable of energy dissipation and energy storage. An attempt was made to overcome the lack of a suitable magnetic "impedance" by using the concept of reluctance, which was supposed to be analogous to resistance in an electrical circuit. However resistance is a dissipative component and reluctance, which is related to inductance, is a storage component. This makes for a very poor analogy.

Perhaps the biggest blockage to understanding was the link between the electrical and magnetic circuits. The electrical current links directly into the magnetic circuit but the more useful

parameter, voltage, seems to be left out

A method which largely overcomes these problems and opens the way to an easier understanding is due to work by Buntenbach* and others in the U.S.A. but does not appear to have had a wide circulation in this country. It is the aim of this article to introduce this system to a wider readership.

It is necessary to go back to the basic formulae of electromagnetism to see the dimensional similarities.

The first relationship is between magnetomotive force F, the magnetic "voltage", and electrical current

$$F = NI$$
 (1)

where N is the number of times I that is producing F, or more normally the number of turns. The second relationship is between voltage and rate of cutting of flux \(\phi \). This is the rate of flux change o multiplied by the number of times it is linked, i.e.

$$V = N\dot{\phi} \tag{2}$$

The important magnetic property permeability µ is linked to inductance that the magnetic circuit produces

$$L = N^2 \mu A/l \tag{3}$$

The term µA/l could be called the specific permeability as it is the modified value for that particular shape of magnetic circuit, it is known as permance, P i.e.

$$L = N^2 P. (4)$$

As N is a dimensionless number F has the dimension of amps, o the dimension volts, and P the dimension inductance. The previous reluctance-resistance ana-

logy was based on the similarity of the equations

$$V = IR$$
and $F = \phi S = \frac{\phi}{P}$ (5)

where S is reluctance. However there is another electrical equation of similar

$$V = \frac{Q}{C}.$$
 (6)

Inductance is a storage not a dissipative parameter and hence so is permanence (equation 4). Thus attempting to use resistance as the analogous property for reluctance, S (the reciprocal of permanence) is not a happy state of affairs. There is a much better analogy in equations 5 & 6, capacitance also being a storage parameter.

Thus the "current" in the magnetic circuit is not φ but rate of change of flux o. This means that we now have a looking-glass circuit in which the "vol-'tage" has the dimension amps and the "current" the dimension volts. The main component in this circuit P behaves like a capacitor but has the dimension of inductance. Flux o is seen to be analogous to charge Q.

Another way of checking this is to consider the energy stored in a magnetic circuit.

$$E = \frac{1}{2}LI^{2} = \frac{1}{2}PN^{2}I^{2}$$

$$E = \frac{1}{2}PF^{2}$$
(7

This can be seen to be analogous to the capacitive energy equation

$$E = \frac{1}{2}CV^2$$

Magnetic-electric circuit link

Having explored the magnetic circuit and found it to behave in an analogous fashion to the electric circuit, although it is a looking-glass similarity, now look at the link or mirror itself. The basic equations 1 & 2 link the "voltages" and "currents" on the two circuits. In addition, the magnetic circuit should have a magnetic impedance Z_m (= F/ϕ) and this should be related to the electrical impedance Z

$$Z = V/I = \frac{N\dot{\phi} N^2 \dot{\phi}}{F/N} = \frac{F}{F}$$

$$Z = \frac{N^2}{T}.$$

Equations 1 & 2 can be seen to be the defining relations of a Tellegen gyrator with a gyration constant N. This gyrator gyrates a voltage to a current times N, which is the required relationship. An impedance in one circuit gyrates to admittance times N2 in the other circuit as in equation 8. The gyrator thus fulfils the requirements of the electricalmagnetic circuit link.

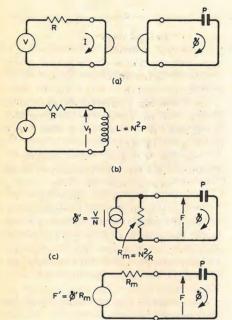
WIRELESS WORLD, MARCH 1979

It is worth investigating the simplest magnetic arrangement to gain some understanding of the working of the analogy.

Air-cored inductor

In Fig. 1 if V is a step function, the classic result is obtained in the electrical circuit:

$$V_1 = V \exp(-tR/L) \tag{8}$$



In the magnetic circuit \(\phi \) is also a step function, from equation 2, and hence a similar equation can be derived. This can be calculated directedly but a short cut can be used by using the currentto-voltage source transformation in Fig. 1 (c) and (d). The voltage source and its resistor have the same properties as the current source and its resistor. This can be checked by considering the opena dn short-circuit conditions for the two sources

The circuit in Fig. 1 (d) is now familiar and we can write down the expression for when F is a step function:

$$F = F'(1 - \exp(-t/PR_m))$$

by analogy to the standard capacitor charging equation. Hence

$$\phi = \frac{F - F}{R_{m}}$$

$$\phi = F' \exp(-t/PR_{m})$$

$$\phi = \phi \exp(-t/PR_{m})$$

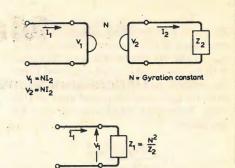
Converting each term in this equation to its electrical counterpart yields equation 8.

It can also be seen that if a fixed voltage is applied to the inductor (i.e. R is small and R large) & is constant and hence the F across P increases linearly.

If V is an alternating source the electrical impedance is juL and hence the

Tellegen gyrator

The gyrator is a theoretical circuit component like a resistor, capacitor or perfect transformer, but unlike these others a simple practical realisation does not exist. It is similar to a transformer in that it links two circuits, but the link is between the voltage in one circuit and the current in the other. For this reason it is useful as the theoretical link between the electrical and magnetic circuits. It is denoted with two semicircles facing each other.



Rules of gyrator behaviour in either direction:

- Voltages gyrate to current sources multipled by N
- Resistances gyrate to conductances multiplied by N²
- Inductances gyrate to capacitances multipled by N²
- Short circuits gyrate to open circuits
- Components in series gyrate to components in parallel

magnetic impedance is 1/jωP. F and & are seen to be at 90° to each other as are V and I in the electrical circuit.

Nowhere in this discussion of the inductor have we mentioned the flux ϕ . This is the integral of \circ and is given by $\phi = PF$

which is analogous to equation 5. In the a.c. case this becomes sinusoidal like the other quantities and is apparently in phase, thus leading to much traditional

Magnetic cores

At first sight substituting a core of a magnetic material merely gives a much larger value to P (large u hence large P from equation 3) but iron and ferrite cores are also conductive. Much ingenuity has gone into minimizing the conductive paths, but they still exist, producing as it were small single-turn secondaries distributed a round the core. These can be approximated by one limped component as in Fig. 2.

The conductive path, being an electric circuit, is linked into the magnetic circuit via another gyrator where $N_2 = 1$. This reflects into the magnetic circuit as a series resistance and hence into the electrical circuit as a resistance in parallel with the inductance.

Transformers

A transformer has another electrical circuit gyrated into the magnetic circuit with constant N2 as in Fig. 2. More secondaries can easily be added by putting in more gyrators in series in the magnetic circuit. The primary voltage V, causes N, & in the magnetic circuit which in turn causes V_2 .

$$V_2 = \phi/N_2$$

$$\therefore V_2 = V_1 N_1/N_2$$

which is the normal transformer voltage equation.

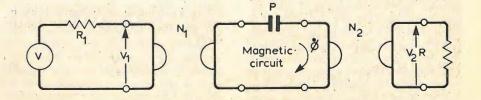
If V_1 is a fixed alternating voltage then & is a fixed sinusoid and there will be a drop of F_p i.e. $V_1 = N\phi$. But at this frequency P has an impedance Z=1/2πfP i.e.

i.e.
$$\phi = 2\pi f P F_{p}$$

$$\therefore V_{1} = N2\pi f P F_{p}$$
(10)

But $\phi = PF$

 $...V_1 = N2\pi f \phi$



^{*}Analogs between magnetic and electrical circuits, by Rudolph Buntenbach. Electronic Products, October 1969.

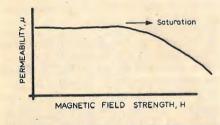
This is the transformer equation and is important in the design of transformers. ϕ_{max} is the maximum working flux that is to be used and can be obtained form the usually-quoted flux density B, multiplied by the cross-sectional area of the core. However equation 10 can be rewritten

$$V_1 = \frac{2\pi N f P F_{\text{pmax}}}{\sqrt{2}}$$

$$V_1 = 4.44Nf\mu A \hat{H} l = 4.44Nf\mu A \hat{H}$$

 \widehat{H} being mmf per unit length. This would be the useful form if the basic magnetic information on the material was presented as a graph of μ against H, or a value of μ was given up to a certain value of H where it starts to fall as saturation begins. This is more in line with standard capacitor practice where the maximum voltage, not charge, is stated.

Presenting the information in this form means that *P* can be calculated directly



and hence so can the open-circuit primary current, as $F_p = NI_1$.

Consider now the effect of a load on the secondary.

The load on the secondary can be reflected back into the magnetic circuit, a heavy load being a small resistor. This becomes a large "resistor" in the magnetic circuit. As φ is fixed the "drop" F_L must become large and hence F_{total} . The current in the primary must rise in the same way as F_{total} . Thus F is the variable in the magnetic circuit.

The amount of energy stored in a core is an important factor in d.c. to d.c. converters and in some forms of filter design. It is also important to understand the effect of air gaps introduced into the core.

When a voltage is connected to the terminals of an inductor \$\overline{\sigma}\$ flows in the magnetic core. The mmf F developed across P can be determined from

$$cot = PF$$

where t is time, which is a restatement of equation 9 for a fixed ϕ . In other words, F (and hence I) rises linearly with time. The energy stored is $\frac{1}{2}PF^2$ from equation 7. If the primary is suddenly open circuited, the energy is left stored in the form of mmf F on a "capacitance" P. An open circuit of the primary converts to a short circuit on the other side of the gyrator. A very large ϕ will thus flow causing a very large primary voltage. This can be coupled to some arrangement that only removes the energy at a high voltage, such as a

breakdown device, and a voltage converter such as the ignition coil of a car has been produced. A high \$, corresponding to the high voltage, will flow until the energy stored in the core has been dissipated.

If an air gap is added in the magnetic path it would appear that another component should be added in series in a magnetic circuit is normally shown as total reluctance

$$= \frac{l_1}{u_1 a_1} + \frac{l_2}{u_2 a_2}$$

i.e
$$\frac{1}{P_{\text{total}}} = \frac{1}{P_1} + \frac{1}{P_2}$$

which is two "capacitors" P₁ and P₂ in series.

As magnetic materials have a very much larger μ than air it can be seen from equation 3 that only a very short length of air gap is required to make P_1 and P_2 equal. For example a gap of around 0.025mm (1 thou) is required in small commercial ferrite cores.

If we now have two "capacitors" of value P with a flowing through them, twice the energy can be stored in them in the same time. In practice a piece of magnetic material can only be worked to a certain value of F before saturating and hence more energy can be stored in the system.

The value of F across each P will be the same and hence the total F will be twice as large. The current ramp will thus be twice as fast. The two "capacitors" can be gyrated out into the electrical circuit as two inductors in parallel.

continued from page 51

The central feature of the approach is partitioning: the material is partitioned into topics that fit within a page-pair with successive pairs grouped together into themes as appropriate; each page is partitioned into smaller units based on the diagram or graph. This feature has been found to be particularly helpful when the work has to be edited or up-dated. It also allows particular pages or sections to be included in other courses, e.g. an appropriate section of one course can be simply transferred to another as revision material.

There remain objections to this new format: it is artificial and constrains the material to fit a particular pattern; it is inappropriate to some topics; the balance between the types of information is wrong. They are not difficult to rebut. The work has to be put into some pattern and the tighter the organisation the more the mind of the author is concentrated. Where a topic cannot be comfortably fitted into a single pagepair it can be extended to two or more. The structure is formalized, as an aid to clarity in writing and understanding,

not as a rigid set of rules. These can be bent as required, to make more room for analysis at the expense of examples or vice versa. After such changes it is important to return to the original structure as the starting point for the next section, so that the benefits of a formal and systematic approach are retained.

Finally, no matter how enticing ideas may be, they must be shown to be practical. The subject area chosen is that of oscillation in the broadest sense, encompassing ramp sawtooth, and triangular wave generators; astables, monostables and diode-pump circuits; RC and LC sinusoidal oscillators; the techniques of frequency and amplitude control. Wherever possible the opportunity has been taken to find unifying concepts, simple equations to cover the largest range of applications and novel and useful applications of the ideas. The merits or otherwise of the new format and of the material presented in it should perhaps be considered separately. There are cases where consciously and unconsciously the writing has been shaped by the format, but on re-reading this series of articles in their draft form I have no doubt that the format is much more widely applicable. Conversely, the particular viewpoint embodied in these articles could have been expressed in a conventional layout with little change in the detailed material.

No new format is going to replace the standard text book, nor is this one intended to. What it does is to present the reader with an alternative. In writing this series the organization of the work has been a considerable stimulus to new ideas and to the re-arrangement of the old. I hope you will find the results as helpful.

I would like to record my thanks to many colleagues who have helped through discussion and argument to evolve this approach; to those students who have patiently suffered earlier experimental versions of this format; to the editor and staff of Wireless World for their willingness to consider new ideas and their skill in making them work in print.

Antenna aiming calculations

Method using a pocket programmable calculator

by Andrew M. Stephenson

TERRESTRIALLY BASED antennas may be aimed by reference to any of several co-ordinate systems, but the one chosen will have to accommodate local operational constraints. If we forget for the moment those fixed and special-purpose antennas such as in permanent microwave relays and large satellite ground stations, which can be established in a relatively leisurely fashion or have the advantage of convenient reference points, the only co-ordinate system that is of real use is that known as the horizon system, whose two coordinates are azimuth (a) and altitude (h).

WIRELESS WORLD, MARCH 1979

Azimuth, often colloquially referred to as "compass bearing", is taken here as the eastward angle from due north, to the target antenna (0^{0} to 360^{0} , or 0^{0} to \pm 180°.). Altitude is the angle between the horizontal and the target (0° to \pm 90°). See Figs 1 and 2, in which station A is aiming for station B.

The purpose of this article is to describe a set of mathematical formulae with which it is possible to derive a and h, given the latitude (L) and longitude (\(\lambda\)) of stations A and B. The prevalence of excellent scientific calculators now makes their evaluation straightforward. Indeed, the advent of the pocket programmable machine has almost rendered this task trivial, and has permitted additional calculations to be made which formerly were best performed graphically or by means of approximations. An appendix includes a pair of programmes for the Hewlett-Packard HP-25. Owners of the HP-65 and other calculators may also find them useful as inspiration.

The shortest path between two points on a sphere lies along a "great circle", as shown in Fig. 1. The azimuth of B from A is the angle between their great circle and the one that passes through A and the poles.

To avoid wrestling with the generalised mathematics of solid elliptical geometry, it is usual to regard the Earth as a sphere. This is a good enough approximation since the practical discrepancies will usually be swamped by other (e.g., atmospheric) effects. Even so, the derivation of useful formulae for the azimuth is not to be undertaken lightly. There are many versions, all descending by one tortuous route or another from standard spherical geometry formulae, and the ones given

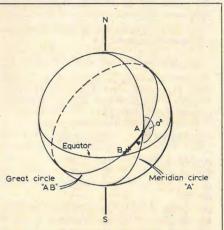


Fig. 1. Illustrating the azimuth part of the horizon system of co-ordinates. The azimuth of point B from point A is the angle a° between their great circle and the great circle that passes through A and the poles.

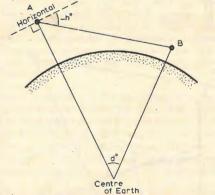


Fig. 2. Illustrating altitude, h (actually angle h°), and the angular distance, d°, between points A and B.

here therefore should not be regarded as definitive. It may be that the reader's calculator possesses a special function that renders them obsolescent; he is encouraged to discover refinements of his own.

The usual approach is first to determine the angular distance between A and B, which is shown as angle d° at the centre of the Earth in Fig. 2, then use it to find a, while saving it for the evaluation of h.

$$d = \cos^{-1} \left\{ \sin(L_A) \cdot \sin(L_B) + \cos(L_A) \cdot \cos(L_B) \cdot \cos(\lambda_B - \lambda_A) \right\}$$

Thus:

From this, without further ado or preliminary explanations:

a = Argument (X,Y) where $Y = \sin(\lambda_B - \lambda_A) \cdot \cos(L_A) \cdot \cos(L_B)$ $X = \sin(L_B) - \cos(d) \cdot \sin(L_A)$

Stop a moment. Many calculators now have polar/rectangular coordinate conversion keys. These can save many programming headaches, such as when X becomes very small compared with Y. Use the function if it is there; otherwise, take care.

One should also beware of two special cases that can arise. The commoner of them is when A is at either of the poles. As a general rule it is safer not to attempt the derivation of meaningless figures, so if this condition arises, reconsider what the "compass bearing" would be. Likewise, if A and B are directly opposite each other on the Earth, one great circle is as good as another, and d can only be 180° . Of these two cases, it is only worth testing for $L_A = \pm 90^{\circ}$ (or $\cos{(L_A)} = 0$), when d will probably still be needed and will still mean something.

Having set the azimuth, we still have the altitude to find. This much simpler problem masks a whole set of dependent ones. B may be below the horizon for one reason or another, either because the sea is in the way, or because some mountain happens to be taller than was thought before arrival at the station site. Such details can be checked as follows.

Fig. 3 summarises the situation. Each station has its antenna situated at some height (H_A and H_B) above the nominal surface of the Earth, taken as sea level here. The Earth's radius is R. The altitude of B may easily be shown to be:

$$-h = \tan^{-1} \frac{Y}{X} \text{ where}$$

$$Y = \frac{(H_A + R)}{(H_B + R)} - \cos(d)$$

$$X = \sin(d)$$

Again, use should be made of the rectangular-to-polar function if it is available, lest the calculator be confronted with the awkward problem of one antenna directly above the other (which can happen).

Next, it may be useful to know if B lies below the horizon. As shown earlier, "horizon" can mean two things, either of which can be acutely embarrassing to those users who had not intended to rely on atmospheric refraction to complete the signal path for them.

In the case of the sea level horizon:

$$-h_{\rm H} = \cos^{-1} \left[\frac{R}{({\rm H_A} + R)} \right]$$

(Note that the angular surface distance of the horizon is also $h_{\rm H}$.)

In the case of spurious obstructions, we are (or should be) more interested in what clearance (ΔH) exists between them and the line-of-sight signal path. Since these obstructions are usually close enough to appear on the same medium-scale map as A (and possibly B, too), the input values are conveniently. expressed as plane measures: surface distance (Ds) and height (Hs).

$$\Delta H = \left[\frac{(H_A + R)}{\tan(h) \cdot \sin(\sigma) + \cos(\sigma)} - (H_S + R) \right]$$
where $\sigma = \frac{180 \cdot D_S}{\pi R}$

If stations A and B are close enough, it may be better to use as d in the altitude formula a value derived from the map surface distance, Ds:

$$d = \frac{180 \cdot D_{\rm S}}{\pi R}$$

This reduces the effects of errors arising from the original measurement of λ and L, and may obviate the need for azimuth calculations if the bearing can be taken from the map too. The course adopted will depend on local circumstances, naturally.

Appendix A contains two HP-25 programmes: Azimuth, which generates a and d; and Altitude, which covers the calculations relating to h, h_H , and ΔH . Appendix B gives some examples of the use of these programmes, and suggests a use for the formulae that may not at first be obvious.

Appendix A: HP-25 antenna aiming programmes

All angles are in decimal degrees unless otherwise shown (D.MS). "(w)" means "write as a value"; other symbols have their keyboard meanings.

Accepts: own long. (λ_A) ; own lat. (L_A) ; other long. (λ_B) ; other lat. (L_B) - all in D.MS. Computes: azimuth (a); angular separation of stations A and B (d).

STEP KEYS			ST	EP KEYS
00	(R/S)		16	fSIN
01	g→H		17	RCL 1
02	STO 3		18	fSIN
03	·R/↓		19	×
04	g→H		20	+
05	RCL 0		21	g COS-1
06			22	STO 7
07	STO 2		23	RCL 2
08	fCOS		24	fSIN
09	RCL 3		25	RCL 3
10	fCOS		26	f COS
11	X		27	×
12	RCL 1		28	RCL 1
13	fCOS		29	f COS
14	X		30	g x = 0
15	RCL 3		31	f FIX 0
10	RCL	- 1	7	

or raine 2, and may obvious the need for	
Harizontal plane Harizontal plane HA Ds	AH H _S Sea level horizon
get enter	R R
	o° h _H
Fig. 3. Factors in altitude and height	d° Centre of Earth

32 41 g→P RCL 3 33 42 x↔y f SIN 43 g x≥0 35 RCL 7 GTO 47 44 f COS 36 45 RCL 4 37 RCL 1 38 f SIN 47 RCL 7 ×

USE OF PROGRAMME

48 x⇔v

GTO 00

#1 (w) 360 STO 4 #2 (w) \ \ \ g→H

40

STO 0 (w)L g→H STO 1 f PRGM

 $\sharp 3 (w) \lambda_B$ **ENTER** (w)L_B R/S

display shows a; y-register and R2 contain d. If $L_A = \pm 90^{\circ}$, display switches to integer format.

#4 For new 'other station', repeat from #3. #5 For new 'own station', repeat from #2. Notes: 1. If $L_A = 90^\circ$, a is returned as 0° . 2. If A and B diametrically opposite each other, an error condition may arise owing to calculator imprecision. 3. Stores R₅ and R₆ are unused.

Altitude

Accepts: angular separation of A and B (d); radius of Earth (R); height of own antenna (HA); height of other antenna (HB); obstruction height (H_s) and surface distance (D_s). Computes: altitude of other antenna (-h)and of the sea level horizon (-hH); clearance between obstruction and signal line-of-sight path (ΔH) .

STE	EP KEYS	ST	EP KEYS
00	(R/S)	25	R/S
01	RCL 4	26	STO 1
02	STO 2	27	R/
03	+ *	28	RCL 4
04	STO÷2	29	STO+1
05	STO 0	30	÷
06	х⇔у	31	gπ
07	RCL 4	32	÷
08	+	33	1
09	÷	34	8
10	RCL 7	35	0
11	f COS	36	×
12	_	37	f COS
13	RCL 7	38	f LASTx
14	fSIN	39	fSIN
15	g→P	40	RCL 3
16	x⇔y -	41	f TAN
.17	STO 3	42	×
18	RCL 2	43	+
19	g COS ⁻¹	44	
20		45	х⇔у
21	f x <y< td=""><td>46</td><td></td></y<>	46	
22	GTO 25	47	RCL 1
23	f PAUSE	48	/
24	GTO 23	49	GTO 25

USE OF PROGRAMME

#1 (w) radius of Earth STO 4

#2 (w) angular sep., d STO 7

#3 f PRGM $(w)H_B$ ENTER 1 (w)H_A

displays altitude of other antenna, -h. If this is below the sea level horizon it will blink; this may be halted by pressing any key. In any case, the "horizon value, $-h_H$,

will be in the y-register.

5 For clearances, continue:

WIRELESS WORLD, MARCH 1979

#4 If -h displayed is acceptable, GTO 26 (if not blinking, ignore this GTO operation); if not, then restart at #3 with new heights.

(w)D. ENTER 1 (w)H_s

displays clearance, ΔH , in same units as H

#6 To repeat for other obstructions, go to #5.

#7 For new station heights, go to #3.

#8 For new d, go to #2.

Notes: 1. R, HA, HB, HS (and AH) must all be in the same linear units. 2. Altitudes computed are negative if above the horizontal. 3. Heights are all a.s.l. if positive; negative are below sea level. 4. Radius of Earth used may be local value. 5. Stores R₅ and R₆ are unused.

Appendix B: Examples

An ambitious radio amateur plans to establish a station (at $\lambda_A = -4^{\circ}18'30''$; $L_A = 50^{\circ}31'05''$; and 333.5m above sea level) from which he hopes to contact three other stations as follows:

1. By h.f. to a friend in Melbourne, Australia $(\lambda_B = \text{approx } 145^\circ; L_B = \text{approx } -37^\circ 50'). 2. \text{ By}$ u.h.f. to another friend on a nearby hill $(\lambda_{\rm p} = -3^{\circ}59'08''; L_{\rm p} = 50^{\circ}31'13.7''; \text{ and}$ $H_{\rm p} = 12$ m mast + 445m a.s.l.).

3. By S-band microwave link to a geostation- $(\lambda_B = -30^\circ; L_B = 0^\circ; \text{ and } H_B = 35796660.91\text{m}$ a.s.l.). ary satellite over the Atlantic Ocean

The radius of the Earth he takes as 6367467.5m, this being the arithmetic mean of the equatorial and polar values. Note that H_p for the satellite is its orbital radius minus this value

Procedure

(a) He determines the various bearings and d values using the Azimuth programme.

 $a_1 = 71.588^{\circ}$ true $d_1 = 154.8570868^\circ$ $a_2 = 89.201^{\circ}$ $d_2 = 0.2052409307$ $a_3 = 211.936^\circ$ $d_3 = 55.04195678^\circ$

(b) Retaining the d values for those applications in which obstructions could be a hazard or where he will want an altitude figure, he uses the Altitude programme to determine -h, assuming the extra height provided by his masts as 5m (i.e., $H_A = 5 + 333.5 = 338.5$ m

 $-h_1 = 77.429^{\circ}$ blinking. (i.e.: approx 77° below the horizontal.) $-h_2 = -0.195^{\circ}$. (i.e.: approx 0.2° above the horizontal.) $-h_3 = -27.241^\circ$.

(c) He estimates that only the u.h.f. link is liable to be obstructed, so he checks the map and sees two possibly troublesome hills. Re-use of Altitude programme checks the

 $D_{S1} = 3442 \text{m H}_{S1} = 250 \text{m}$ $\Delta H_1 = 101.15 \text{m}$ $D_{S2} = 18741 \text{m H}_{S2} = 381 \text{m}$ $\Delta H_2 = 48.88 \text{m}$

Theoretically, therefore, he has a clear view of Station 2, and knows this before reaching the site. Unhappily, no amount of programming will ensure that the owners will allow him to camp there (at Kit Hill, Cornwall, west of Dartmoor).

LITERATURE RECEIVED

Advantages of automatic testing equipment are set out in a booklet from Teradyne, who feel that fables and cartoons are a help in disseminating their message. Teradyne Ltd, Clive House, 12 Queens Road, Weybridge, Surrey WW 401

Replacement guide for semiconductors of all types, using Philips devices, is now available. Salient performance data is provided for transistors, thyristors and triacs, but replacements only for other devices. Mullard Ltd, Mullard House, Torrington Place, London W.C.I.

To provide a basic insight into the preparation and production of printed circuits, Isola of Duren have published a 32-page booklet, in which the Isola material is described and manufacturing methods illustrated. Information is offered on recommended ways of preparing artwork, Isola Werke A.G., D-5160 Duren, Postfach 236, West Germany

WW 402 Analytical instruments for chemists is briefly described in a short catalogue from Hewlett-Packard. Instruments listed include gas chromatographs and accessories, liquid chromatographs, mass spectrometer systems and ancillary equipment. Hewlett-Packard. Winnersh, Wokingham, Berks RG11 5AR

Assistance with the design of radar circuitry is provided by Plessey's Radar Applications Handbook. Design details, with p.c. layouts, are given for preamplifiers, a 120MHz log. strip and swept-gain i.f. strip and detector. Analogue-to-digital converters are also covered. Copies can be had from Plessey Dis-

120W, 300W and 600W amplifiers are the subject of a leaflet from Derritron. The units are intended as drivers for vibrators or p.a. amplifiers, giving 1% t.h.d., from 5Hz to 20kHz, at rated output. Derritron Electronics Ltd, Sedlescombe Road North, Hastings, East Sussex TN34 1XB WW 404

Electronic timer Series E is described by Tempatron in a new leaflet. This is a c.m.o.s. timer offering a variety of operational modes. Timing ranges between 0-100ms and 0-30h are available. Tempatron Ltd, 6 Portman Road, Reading, Berks WW 405

Components catalogue from Rank lists a variety of general electronic parts and spares for Rank Radio equipment. There is also a section on servicing instruments, tools and materials. Rank Radio International Ltd, RSVP Service, Walton Road, Ware, Herts SG12 0DY WW406

Development, design and use of KEF Calinda and Cantata loudspeakers is subject of Keftopics, Vol.3, No.2. Eight-page paper, covering background and performance details of speakers. Accompanying note points out that lower curve in Fig.8 (b) should be reactance, not resistance. KEF Electronics Ltd, Tovil, Maidstone, ME15 6OP. WW407

Linear circuit applications is a 20 page booklet containing over 40 applications of RCA i.c.s. Obtainable from Distronic Ltd, 50-51 Burnt Mill, Elizabeth Way, Harlow, Essex WW 408

Phase Angle Voltmeters is title of note from North Atlantic, Techn. Bulletin 120, describing theory of these instruments. It can be obtained from Bill Cullum, Applications Engineer, North Atlantic Industries Inc., 60 Plant Avenue, Hauppage, N.Y. 11787, USA

Magnetic Perception Heads: Principles and Practice, describes heads used for detection of moving objects. Application note is produced by Orbit Controls Ltd, Lansdown Industrial Estate, Gloucester Road, Cheltenham, Glos GL51 8PL WW 410

Dry reed relays fully described in 32 page catalogue from Associated Automation. General background information followed by specific data on devices made by AA. Catalogue is available from 70 Dudden Hill Lane, London NW10 1DJ WW 411

GaAs power oscillators, described in Application Note TE-213 from Microwave Semiconductor Corporation. Devices used cover frequency range 3-18GHz. Useful list of references. Can be had from Pascall Electronics Ltd, Hawke House, Green Street, Sunbury-on-Thames, Middx TW16 6RA

Voltage regulators for microprocessors listed and characterized in 15 page booklet from Lambda Electronics Co., Abbey Barn Road, High Wycombe, Bucks WW 413

Multiplying d-a converters in c.m.o.s. is subject of 40 page guide published by Analog Devices. Section on theory is followed by 25 applications, including gain adjustment, panners, function generator, phase shifter and power series generator. Analog Devices, Central Avenue, East Molesey, Surrey

WW 414

Optoelectronic devices from Monsanto described in new short-form catalogue, available from Swift Hardman, P.O. Box 23, Baillie Street, Rochdale, OL16 1JE WW 415

Portable Data terminal and v.d.u., Tele-ZIP, allowing communication between telephone and computer, using television set as v.d.u., and ZIP-64 low-cost v.d.u. both described in leaflets from Data Dynamics, Data House, Springfield Road, Hayes, Middx . WW 416

High-voltage and r.f. connectors from Suhner described in two catalogues, available from Suhner Electronics Ltd, Telford Road, Bicester, Oxfordshire OX6 OLA

WW 417

NEW PRODUCTS

Professional readers are invited to enter codes on the reply-paid card bound in at pages 112/3

Measuring systems

A range of modules (amplifiers, signal conditioners, etc.) enable a complete industrial measuring system to be assembled to individual requirements. A typical system for a weighing application is shown in the photograph and is built up using a power supply, amplifier, peak value store, auto-tare and limit switch, all contained in a cast metal housing which is secure against dirt and the direct jet from a hose. Reference-signal generators are included, providing 225Hz, 5kHz or direct-voltage outputs. The equipment is made by Hottinger Baldwin Messtechnik and is marketed here by Carl Schenck (UK) Ltd, Stonefield Way, Ruislip, Middx HA4 0JT.

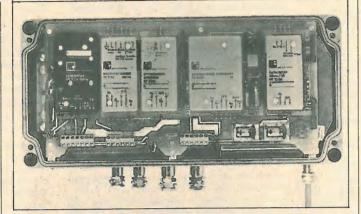
WW301

Digital multimeters

Two new meters by Sinclair, the DM350 and DM450, are 31/2 and 41/2-digit instruments respectively, offering a similar set of ranges and facilities, the DM450 at greater accuracy and resolution. Basic accuracy is 0.1% ±1 digit and 0.05% ± 1 digit and each type will measure from 100µV d.c. and a.c., InA d.c., IuA a.c. and from $100 \text{m}\Omega$ to $20 \text{M}\Omega$. Each has a diode test facility. The instruments are in very slim plastic cases with tilt stands, similar in form to that of the older DM235, and can be provided with a carrying case and neck strap for 'hands-off' use. Four C cells provide the power, or an a.c. adaptor can be used. Rechargeable batteries and a high-voltage probe are accessories. Sinclair Radionics, London Road, St. Ives, Huntingdon, Cambs PE17 4HJ. WW302

Temperature probe

Effectively a temperature-tovoltage transducer, the Model TP-28 from B and K Precision enables temperature in the range -50° to +150°Celsius to be measured by means of an ordinary analogue or digital voltmeter. Liquids, gases or solids can be examined and in the case of a liquid the short settling time after a 100° change of 10s is achieved. A suggested way of using the probe is to examine small elec-



WW301



WW302

tronic components for overheating.

The meter used with the probe must have an impedance of over $10k\Omega$ on the 0-3V range. Maximum error of the combination is quoted as $\pm 1.7^{\circ}$ C \pm the error of the meter. Power to the probe unit is 9V, a small radio battery lasting around 120 hours of continuous use, and the end of battery life is indicated. B and K Precision, 6460 W. Cartland Street, Chicago, Illinois 60635,



Power resistors

The Erg range of miniature, wirewound power resistors, with new closer tolerance, are said to fill the gap left by metal oxide power resistors in the lower values of resistance. The range is from 30 milliohms up to $18k\Omega$ in the higher voltage applications, at an initial tolerance of 1% to 5% - any value in the range. Instability is claimed to be reduced by the use of crimped leadouts, and temperature variations are normally specified as +60 p.p.m./°C. Alternative specifications for specialized work are available. Erg Components, Luton Road, Dunstable, Beds LU5

WW304

Television sound i.c.

The TDA2190 integrated circuit. contains an i.f. limiter amplifier with output low pass filter, f.m. detector, d.c. volume control,

audio input/output point for tone controls and v.c.r. audio preamplifier and power amplifier. The power amplifier can operate in either a class B or a constant current consumption mode. The power output at $V_s = 24V$ is up to 4.5W into 16 ohms (class B) or 3.5 W into 16 ohms (c.c.c. mode). The device is mounted in a power d.i.l. package incorporating a copper slug for up to 15W power dissipation. SGS-ATES (UK) Ltd, Planar House, Walton Street, Aylesbury, Bucks. WW305

Remote controlled transmitters

A range of 1.0kW trequency synthesized h.f. solid-state transmitters, designated the T1005 series, offers full remote control over any distance. Up to 10 transmitters can be controlled from a single unit. The makers say a country's complete h.f. transmitting network could be controlled from one point in this way. Frequency, type of service and other operational facilities, including optional antenna selection, are all under the control of the remote operator. Frequency and service information can be stored on up to 15 channels for recall purposes. Commands are made on a 20-button keyboard, and a digital readout is provided of transmitter, channel and frequency selected. The series of transmitters covers a frequency range of 1 to 29.9999 MHz, with 290,000 channels in 100Hz steps. Transmission modes are s.s.b., c.w., m.c.w., d.s.b. and optional i.s.b. A control system gives protection from mismatch of an antenna circuit ranging from shortcircuit to open-circuit output. Redifon Telecommunication Ltd, Broomhill Road, Wandsworth, London SW18 4JO.

WW306

Buzzers

Small buzzers, for use in portable, battery-operated equipment, are now available in a new range, Type GA100/K, from Highland. The 400Hz tone is produced electronically, at between 70 and 83dBA at 22cm. Supplies of 2.5, 6,

12 or 24V d.c. are needed, dependding on the version ordered, each type being contained in 22 x 15 x 10mm plastic case, which is colour coded to indicate voltage. The units can be mounted by a clip, by double-sided adhesive strip or by adhesive. Weight is 7g. Highland Electronics Ltd, Highland House, 8 Old Steine, Brighton, East Sussex BN1 1EJ. WW307

Printer interface

A driver for the Roxburgh SF-30 print mechanism accepts ASCII, bit-parallel character-serial inputs from c.m.o.s. voltage levels. The type 3001 operates the seven-electrode head of the SF-30 to print 64 alphanumeric characters on a 7 x 5 matrix of dots, accommodating 18 characters per line at two lines per second. Voltage supplies needed by the driver board are 12V, -12V, 24V and 35V, provided by a separate power supply, also obtainable from Roxburgh, who are at 22 Winchelsea Road, Rye, East Sussex TN31 7BR.

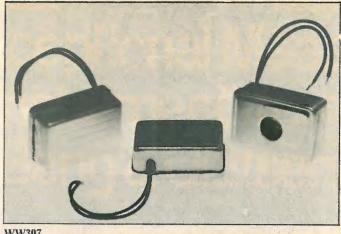
WW308

Interchangeablescale meters

A range of analogue panel meters, comprising ammeters, voltmeters (both moving-coil and moving-iron), varmeters and frequency meters, have removable, interchangeable scale plates. These can be put in or taken out without opening or tampering with the rest of the instrument, so the user can add his own markings. Available in three DIN sizes, 72, 96 and 144 mm square with quadratic scales. all the meters are to specifications CEI 13.6, IEC Publication 51, BS89, VDE 0410, DIN 43700, 43701 and 43802. The total range of scales available goes from mA to MV. The meters have 90° sweep, compressed scales for overload and employ damped, jewelled movements. Long scale instruments (240°) are also available, IMO Precision Controls Ltd, 349 Edgware Road, London W2 1BS.

WW309



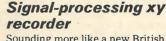




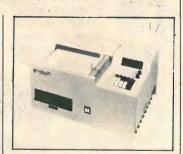
WW308

Taut-band VU meters

Sifam's new volume level meter has a performance "virtually indistinguishable from that of a true VU meter under most conditions" according to their marketing director. The new meters meet the requirements of the American Standard C16.5 1954, the company say, except the clause relating to dynamics. They are more heavily damped and have a rise time of about 0.1 second greater than traditional VU meters. They quote time from 0 to -3VU as 0.21 to 0.26 seconds, which compares with 0.13 to 0.15 for their conventional meters. Makers say the price is less than £5. Sifam Ltd, Woodland Road, Torquay TQ2 7AY. WW310



Sounding more like a new British Standard, BS8000 is a microprocessor-based xy plotter than can digitize, record and process up to eight channels of analogue information. Either raw or processed data are plotted in real time or stored on a flexible disc, equivalent to about 100 metres of chart paper. You can record on pre-set triggering or on event triggering modes at up to 20,000 points per second, or at regular intervals with as few as 86 points per day. Information can be pro-



cessed before plotting, of course, in a variety of ways that includes averaging, smoothing, differentiation, integration.

Last year the same company introduced the first chart recorder with built-in memory enabling the Transcribe 10 to perform as a transient recorder. Bryans Southern Instruments Ltd, Willow Lane, Mitcham, Surrey CR4 4UL. WW311

Large-numeral multimeter

We first saw the Metrix digital multimeter at the recent opening of Precision Instrument Laboratories new showroom. It is notable in that two PP3 batteries will give 1000 hours operation. And the number of hours service left in the battery can be displayed once the expected life drops below 200 hours. What's more, manganese alkaline batteries double this time to give three years "autonomy" at eight

hours a day. This long battery life for a digital multimeter, and its 18mm numerals, single-function switch and price of £109 make it unique among such meters. The c.m.o.s. microprocessor and liquid crystal display consume 250μA. Accuracy on most range is $\pm 1\%$ reading $\pm 0.25\%$ f.s.d. (better on direct voltage) and best resolution 1mV, 10A and 1Ω. Many other performance details of the instrument, made by Metrix of Chemin de la Croix Rouge, Annecy are available from their U.K. agents Precision Instrument Laboratories Ltd, 727. Old Kent Road, London SE15, WW312

Power regulator

The Domino power regulator has a group of parallel slave units. controlled by a voltage or current master amplifier. By connecting an appropriate number of 20A. slaves in parallel, any required current can be regulated. The units are encapsulated circuits enclosed in a metal case, which has an electrically isolated flat aluminium surface for mounting on convection or force-cooled heat sinks. Each slave can dissipate up to 250W at 20A, and the voltage master provides voltages between 0 and 55V. The constant current system can provide accuracies and linearities claimed to be better than 0.01%. A redundancy system enables full output to be maintained if one of the slaves becomes faulty. Roband Electronics Ltd, Charlwood Works, Charlwood, Surrey WW313

Router for p.c.bs

'A router has been designed

specifically for development of prototype p.c. boards. The removable guide pin, adjustable fence and end/depth stop, fitted as standard, allow a variety of work to be done. Profiles can be cut from a master using the guide pin; cut-outs for edge connector keys, relays and other components can be made using the fence and end stop, and unwanted tracks removed using the cutter heights adjustment. Also, boards can also be chamfered to remove rough edges. Construction is of steel and aluminium and the key type chuck has a 4mm maximum capacity. The work area is lit by a lamp and the 100-watt motor drives the cutter at 16000 to 18000 r.p.m. A vacuum cleaner adaptor is available for removing swarf. Price is £245 plus v.a.t. Circuitape Ltd, 33 New Street, Aylesbury, Bucks.

WW314

Silicone geraniums

In the interval between the fall of the despotic valve and the beginning of integration, the majority of semiconductor devices were carved out of germanium. It wasn't a name commonly used by non-technical people and, as often as not when they did come across it, it came out as *geranium*. It even crept into *Wireless World* on one or two occasions, but we kept quiet about it and everyone was too kind to refer to the mistake. The BBC, of course, maintained such a high standard that they never, ever committed such a gaffe.

It's all changed now, though. We don't have much geranium now, but we do seem to have much the same trouble with silicone. I recently had a letter from F. L. Devereux who, as most readers will know, was Editor of W.W. for many years. He writes a very entertaining letter, does Dev., and although he appears cheerful on the surface, one can sense the raw, naked aggression under the surface. His bête noir is the now widespread use of the word silicone, when silicon is meant, as in silicon chip. And the surprising thing is that the BBC are as much to blame as anyone, this time. He has this fantasy, he says, of microprocessors being made of a kind of elastomer and moulded into the form required by the designer.

It's a bit sad about the Beeb, I feel. The Pronunciation Unit used to be concerned mainly with words like Brno, Szechwan and axolotl, but must now be kept fairly busy explaining how to speak plain English. Since the gabblers, mutterers and mid-Atlantic snarlers took over, one can't depend on broadcasters for a lead any more. It's as though the Coldstream Guards had started to slop around like a bunch of old lags in the exercise yard.

Production wine

It's been a good year for apples. We have two trees, both a bit peculiar but laden down to the ground with the rummest-looking fruit I've ever come across. One is a crab-apple, which is fair enough, I suppose, although a bit limited in application, and the other produces gigantic red apples. Not just red skins, you understand, but red all the way through. The first year we moved into the house, I kept waiting for them to turn into ordinary apples, but they never did.

Well, anyway, in our family, we draw the line at red apple pie and after a while we got fed up with apple jelly, so I thought I'd get into wine making. Two years ago, I made a tentative gallon of wine in a most unscientific way and it was beautiful. It went through the malo-lactic fermentation (pure luck,



nothing to do with intent) and it tasted like nectar. So, this last October, I went gently mad and made seven gallons, only this time I got hold of all the technical-looking glassware and yeast, and tablets and stuff and did the job properly and it's awful. Actually, it's only just now clearing, but I've been having a furtive taste every now and then and the effect is grotesque. It feels as though it's making hair grow on the inside of your head.

As I've mentioned before, electronics is into practically everything now, so there has to be a way of testing the brew before it goes beyond recall. You can't tell by looking at it that it's going to be either poisonous or liquid gold, and there is definitely a need for some kind of gizmo or dip into it, with a meter scaled from, say, 'Uk' to 'Wow', or 'sink' to 'cellar'. Warned in time, my seven gallons could possibly have been upgraded from Uk to So-So, but now there are going to be lots of very drunk sewer-rats stumbling around. Maybe a pH meter would help, if I knew what to look for, but I haven't come across, anything, so far, which will warn me to take remedial action. It could be I've identified a hole in the market here.

Freudian chip

I always seem to be going on about computers. It isn't that I have anything against them - not much, anyway but I do become noticeably agitated when someone suggests that computers could take over from the Almighty in their spare time and spend the rest of the week playing each other at threedimensional chess. In a recent communication from a firm of program (see? I haven't forgotten!) suppliers for a home computer, the spectacular suggestion is made that if one is experiencing a pain in the brain, all one has to do is post a floppy disc into the machine, which promptly turns into a psychiatrist. Honestly! Cross my heart, that's what it says. The sample of operator/

seems to be concerned with this chap who can't stand the sight of his mother and I would dearly like to know how it finishes. Also, what effect a fault in programming would have. The first case of matricide committed on advice from a computer would definitely be in the 'man bites dog' class of news item, and could conceivably cause a good deal of head scratching in the legal profession. The program is actually very relevant since anyone who thinks a computer is going to help in circumstances of that kind is almost certainly in need of a psychiatrist.

Sight and sound

A letter from John Corner, of Whiteley Electrical Radio, informs me that the public address system at London Bridge was not, when I wrote the piece in the October issue, new. It was the old equipment I heard, the new one still being in their factory. So much for British Rail's accuracy in replying to a request for information. I've heard the new system now, and the concourse coverage is much improved, but there does seem to be a certain amount of trouble in the station itself. I'm now convinced that the problem lies more in the way it is used than in the system some announcements are clear as a bell, others convey no information at all. Not to me, at any rate. The ones I can make out are spoken slowly, with expression; the others are read in a flat monotone. at a speed which allows the main echo to coincide with the next syllable, rendering both useless.

The recommended drill now adopted by experienced commuters is to hang about unconcernedly in the concourse until the train one wants is signalled on the big new visual-display board and then to race like a stag to get to the train before all the fierce ladies with their enormous bags beat you to it. The p.a. is of great help here, because as soon as you see the destination come up, you can start running and listen for the platform number on the wing, so to speak. I've gained nearly five seconds, several times, in this way. If you stop to pick up the people you've knocked down there is, of course, a danger of losing the advantage.

I still think v.d.us on the platforms would be a good idea, since those whose business it is to make life difficult sometimes change the destination of a train when everyone is comfortably settled with the crossword, and if you can't hear the platform p.a. you are left wandering about asking complete strangers what in the world is happening. I am usually reduced to chasing after the mob, and I am certain I shall finish up in Eastbourne one of these days. Not that I have anything against Eastbourne, but I happen to live near Croydon.

An Exceptional Measuring Instrument from Bang & Olufsen

B&O Voltmeter RV11 is the result of 11 years research.

B&O has been working on the construction and development of test instruments since 1959. The expertise gained during these two decades has resulted in a range of measuring instruments with a particular relevance to design/development and service fields.

B&O Voltmeter RV11 is a multimeter for the measurement of AC and DC volts and ohms. The pushbutton function and range selectors are quick and easy to use and are positioned to form an instant read-out of settings during use.

Ranges:

Volts 3mV - 1000 V AC/DCResistance $0.2\Omega - 50 \text{ M}\Omega$ Frequency range 10 Hz - 1 MHzInput impedence $10 \text{ M}\Omega \text{DC/1 M}\Omega \text{AC}$

Options:

Probes are available at extra cost allowing direct measurement of temperature, frequency, high voltage DC and R.F. signal voltage.

Send in reply card for our brochure giving detailed information about RV11 and other instruments in the B&O range.

Bang&Olufsen A solid investment



NRDC-AMBISONIC UHJ



SURROUND SOUND DECODER

The **first ever** kit specialy produced by Integrex for 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:

The decoder is linear throughout and does not rely on listener fatiguing logic enhancement techniques. Both 2 or 3 input signals and 4 or 6 output signals are provided in this most versatile unit. Complete with mains power supply, wooden cabinet, panel, knobs, etc.

> Complete kit, including licence fee £49.50 + VAT or ready built and tested £67.50 + VAT

NEW S5050A STEREO AMP

50 watts rms-channel, 0.015% THD, S/N 90 dB, Mags/n 80 dB

Tone cancel switch. 2 tape monitor switches.

Complete kit only £63.90 + VAT.

Wireless World Dolby noise reducer



- switching for both encoding (low-level h.f. compression) and decoding
- a switchable f.m. stereo multiplex and bias filter.
- provision for decoding Dolby f.m. radio transmissions (as in USA)
- no equipment needed for alignment.
- suitability for both open-reel and cassette tape machines. check tape switch for encoded monitoring in three-head machines

Complete Kit PRICE: £43.90 + VAT

at Dolby level) at Monitor output

Dynamic Range >90db

30mV sensitivity

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

Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal

Price £59.40 + VAT

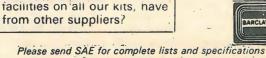
Calibration tapes are available for open-reel use and for cassette (specify which) Price £2.40 VAT

Single channel plug-in Dolby PROCESSOR BOARDS (92 x 87mm) with gold plated contacts are available with

Selected FETs 65p each + VAT, 110p + VAT for two, £2.10 + VAT for four.

Please add VAT @ 121/2 % unless marked thus*, when 8% applies (or current rates)

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



INTEGREX LTD.

Portwood Industrial Estate, Church Gresley, **Burton-on-Trent, Staffs DE11 9PT** Burton-on-Trent (0283) 215432 Telex 377106

S-2020TA STEREO TUNER/AMPLIFIER

SOLID MAHOGANY CABINET

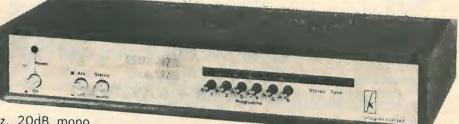
A high-quality push-button FM Varicap Stereo Tuner combined with a 24W r.m.s. per channel Stereo Amplifier.



Brief Spec. Amplifier Low field Toroidal transformer, Mag, input, Tape In/Out facility (for noise reduction unit, etc.), THD less than 0.1% at 20W into 8 ohms. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section uses 3302 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88-104MHz. 30dB mono S/N @ 1.2 LV. THD 0.3%. Pre-decoder 'birdy' filter. PRICE: £59.95 + VAT Nelson-Jones Mk. 2 Stereo FM Tuner Kit. Price: £69.95 + VAT.

NELSON-JONES MK. I STEREO FM TUNER KIT

A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter / dual IC IF amp.



Brief Spec. Tuning range 88-104MHz. 20dB mono quieting @ 0.75 µV. Image rejection - 70dB. IF rejection - 85dB. THD typically 0.4%

IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

Compare this spec, with tuners costing twice the price.

Mono £36.40 + VAT With ICPL Decoder £40.67 + VAT With Portus-Haywood Decoder £44.20 + VAT



Sens. 30dB S/N mono @ 1.2 µV THD typically 0.3% Tuning range 88-104MHz LED sig. strength and stereo indicator

STEREO MODULE TUNER KIT

A low-cost Stereo Tuner based on the 3302 FET RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC. Pre-decoder 'birdy' filter Push-button tuning

PRICE: Stereo £33.95 + VAT



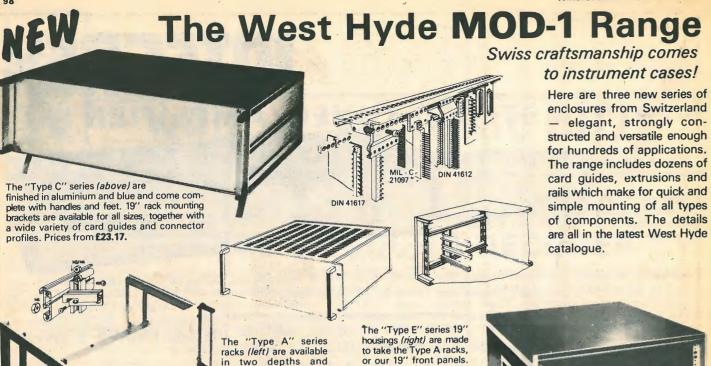
S-2020A AMPLIFIER KIT

Developed in our laboratories from the highly successful "TEXAN" design. PC mounting potentiometers, switches, sockets and fuses are used for ease of assembly and to minimize wiring Power 'on off' FET transient protection.

Typ Spec. 24+24W r.m.s. into 8-ohm load at less than 0.1% THD. Mag. PU input S/N 60dB. Radio input S/N 72dB. Headphone output. Tape In/Out facility (for noise reduction unit, etc.). Toroidal mains transformer.

PRICE: £35.95 + VAT

BASIC NELSON-JONES TUNER KIT £15.70 + VAT BASIC MODULE TUNER KIT (stereo) £18.50 + VAT PHASE-LOCKED IC DECODER KIT ... £4.47+VAT PUSH-BUTTON UNIT£6.00 + VAT



racks (left) are available in two depths and heights of 2 to 6 U. The

front panel is 4mm thick natural anodised aluminium,

and the sturdy framework will carry

up to 50 kg. Accessories include chassis plates, blue cover plates and mounting

extrusions. Prices from £14.96.

Send for our catalogue and price list!

All West Hyde cases are available with substantial discounts for quantities. The Mod-1 Range have price breaks at 5, 10, 25, 50 and 100 off. (20% discount at 100 off). Prices include post and packing and are correct at press date. 10% discount is given on first two price breaks if cases are collected.

WEST HYDE DEVELOPMENTS LIMITED, Unit 9, Park Street Industrial Estate, AYLESBURY, BUCKS. HP20 1ET. Phone: Aylesbury (0296) 20441. Telex: 83570 WW - 070 FOR FURTHER DETAILS

10 OUTLET DISTRIBUTION

AMPLIFIER 2

otal Harmonic Distortion, all outputs loaded, at

00Hz-20kHz -76dB, 0.015%

Static Intermodulation Distortion, 50Hz + 7 kHz Output +12dBV 7 ...86dB. 0 005% The unit meets the IBA "signal path" specifications and is available as a complete unit or as a set of all parts excluding the case and XLR connectors.

STEREO DISC AMPLIFIER 2

SUPERLATIVE PERFORMANCE FOR BROADCAST-NG DISC MONITORING AND TRANSFER Magnetic cartridge to balanced lines with HF and LF litering Mains powered. Meets IBA specification. Specifications December advertisement.

PEAK PROGRAMME Meet IEC268-10A, BS5428.
PPM2 Standard performance drive circuit under licence from the BBC Reviewed Studio Sound.
September 1976 Ernest Turner meter movements STABILIZER
R HOWL REDUCTION, BALANCED AND
UNBALANCED VERSIONS BOXED
OR RACK MOUNTING

PUBLIC ADDRESS : SOUND REINFORCEMENT

+5Hz Fixed Shift Circuit Boards as WW July 1973 article but improved noise Small enough to be built inside the cabinets of

Complete kit and warre £30 including PSU & mains APPROVED

Bourf bull and enjared E38 transformer APPROV
SURREY ELECTRONICS
The Forge, Lucks Green, Cranleigh
Surrey GUB 78G Tel: 04866 5997
CASH WITH ORDER INSS 5%
UK POST FREE ADD VAT at 8%

Attractively finished in blue and light grey, the

cabinets may be supplied in two depths and seven

heights. Slide rails, mounting

rails and many other accessories

are kept in stock. Price from £47.55

SINCLAIR PRODUCTS
Microwsion TV UK model £89.95. PDM35 £27.25.
Mans adaptor £3.24. Case £3.25. DM350 £67.80.
DM450 £96.50, DM255 £69.45. Rechargeable batts.
£7.50. Mains adaptor £3.70. Enterprise prog calculator
£21.95. Cambridge prog calculator £13.13. Prog library £3.45. Mains adaptor £3.20.

COMPONENTS
Send sae for full list. 1 lb FeC1 £1.05. Dalo pen 73p. 60 sq ins pcb 55p. Laminate cutter 75p. Small drill 20p. 141.4 £1.05, pcb and extra parts for radio £3.85. Case £1. 1N4148 14 lp. 1N4002 2.9p. 723 29p. 741 15p. NE555 23p. bc128b. bc13b. bc18b. bc184b. bc12b. bc213b. bc214c 4.5p. Plestic equivs bc107. bc109 4.8p \text{ W 5% E1.2 resistors 10R to 10M 1p. 0.8p for 50+ of one value. Electrolytics 16v. 5/1/2/5 10 2/mt 15p, 1000mf £p, 1000mf 1p. 100mm (Pc) 3.4p. 100 2/mt 1.p. 1000mf 51.p. 200mf 6p. Polyesters 250v. 015. 068 .1 mt1 Vsp. Ceramics 50v E6 22ptro 47n 2p. Polysytenes 53v E12 10pt to 10n 3p. Zeners 400mW E24 2v7 to 33v 7p.

TV GAMES

Send sae for data. AY-3-8500 + kit £8.95. Rifle kit £4.95. AY-3-8600 + kit £12.50. Stunt cycle chip + kit £10.90. Racing cars chip + kit £17.90.

TRANSFORMERS

6-0-6v 100ma 74p, 1½a, £2.35, 6.3v 1½a £1.89, 9-0-9v 75ma 74p, 1a £2, 2a £2.60, 12-0-12v 100ma 90p, 1a £2.49.

IC AUDIO AMPS
With pcb J12 6w £1.60. JC20 10W £2.95. Send sac for data.

BATTERY ELIMINATORS

DATIENT ELIMINATURS
3-way tupe 6-7½-/9 x 300 mg £2.95. 100ma radio
type with press-studs 9ν £3.35, 9+9ν £4.50.
Stabilized type 3/6/7½/9ν 400ma £5.30. 12ν car
convertors 3/4½/6/7½/9ν 800ma £2.50.

WIRELESS WORLD, MARCH 1979

BI-PAK AUDIO MODULES S450 £23.51. AL60 £4.86, pa100 £15.58, spm80 £4.47. bmt80 £5.95, stereo 30 £20.12.

SWANLEY ELECTRONICS

(Dept. WW) 32 Goldsel Road, Swanley, Kent post 30p extra. Prices include VA

THE MOST COST EFFECTIVE FREQUENCY COUNTERS



OFF/AIR FREQUENCY STANDARD TYPE 103 10MHz, 1MHz Stability 1 part 108

TYPE 102 CRYSTAL **FREQUENCY** Standard 10MHz, 1 MHz, 100KHz Stability 5 parts 1010



50MHz 8 Digit £192 801B/M 250MHz 8 Digit £280 Memory versions available if not suffixed M

£30 extra

TYPE 801B 401A 50MHz 6 Digit £150 80MHz 8 Digit £210 701A 520MHz 8 Digit £395 901M 1001M 1.2GHz 8 Digit £670 Start/Stop versions Plus £18 SUPPLIERS TO: Ministry of Defence, G.P.O., B.B.C., Government Depts., Crystal Manufacturers and Electronic Laboratories world-wide for 18 years.



LED COUNTERS 302 50MHz. 5 digit £108 All standard counters in centre column now available as the 02 Series with LEDs.

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

WW - 076 FOR FURTHER DETAILS

WIRELESS WORLD, MARCH 1979

MAINS TRANSFORMERS (TM) All these have 230/240v 50hz Primary						
Voltage	4UV JUNZ Pr	unary	0.15			
ly	2 amp	Our Ref	Price £1.94	Post 40p		
2.44	5 amp	TM 2	£1.62p	45p		
44	7 amp	TM 32	£2.70	60a		
6v	% amp	TM 3	85p	40p		
6.5v	% amp	TM 37	85p	40p		
6.5v 6.5v-0-6.5v	200 mA	TM 21	£1.62	40p		
6.5v-0-6.5v	100 mA	TM 21	£1.62	40p		
6.3v-0-6.3v	750 mA 100 mA	TM 7 TM 33	£2.16 £1.62	45p		
6.3v	2 amp	TM 4	£1.02 £1.89	40p 50p		
8.5v	1 amp	TM 12	£1.62	40p		
8.5v + 8.5v sep. winding	12 amp	TM 12	£1.62	40p		
97	1 amp	TM 5	£1.62	45p		
	1 amp c core	TM 6	£1.89	.40		
9v	31/2 amp	TM 11	£2.70	50p		
10v	5 amp	TM 38	£3.24	60p		
10v-0-10v	25 amp	TM 15	£4.86	£1.25		
10v-0-10v	4 amp 12½ amp	TM 50	£3.78	£1.25		
12v	12% amp % amp	TM 15 TM 9	£4.86 £1.05	£1.25		
13v	100 mA	TM 21	£1.05 £1.52	50p 40p		
13v	36 ama	TM 7	£2.16	50p		
12v	1 amp	TM 10	£1.89	50p		
12v-0-12v	50 mA	TM 19	£1.62	40p		
12y-0-12y	1 amp.	TM 41	£3.24	50 p		
15v tapped 9v 17v	2 amp	TM 11	£2.70	50p		
18v	½ amp ¾ amp	TM 12	£1.62	50p		
20v	1/2 amp	TM 13 TM 14	£1.90 £1.62	50p 50p		
20v (with 6v 1/2 amp)	2 amp	TM 50	£3.78	£1.25		
20v	6 amp	TM 46	€4.32	£1.25		
20v	12½ amp	TM 15	£4.86	£1.25		
20v-0-20v	6 amp	TM 15	£4.86	£1.25		
244	1½ amp	TM 16	£2.12	60p		
24v + 2v 7 amp	2 amp	TM 17	£2,17	. 60p		
24v + Ev r amp	2 amp 4 amp	TM 39	£2.97	70p		
254	1½ amp	TM 40 TM 18	£3.78 £2.43	80p		
26v	2 amp	TM 39	£2.98	60p		
30v	8 amp	TM 35	£4.86	£1.25		
37v	37 amp	TM 34	£31.86	enquire		
40v	3 amp	TM 46	£4.32	£1.25		
40v	5 amp	TM 48	£5.02	£1.25		
40v tapped 30v, 20v & 10v 40v-0-40v	6 amp	TM 15	£4.86	£1.25		
50v-2 amp with 6.3v shrouded	2½ amp 2 amp	TM 48	£5.02	£1.25		
50v	S sump	TM 22 TM 29	£4.86 £11.65	£1.25 £1.75		
60v tapped 40v & 20v	2 amp	TM 46	£4.32	£1.75		
70v	4½ arip	TM 24	£7.02	£2.50		
75v-3 amp with 6.3v shrouded		TM 23	10.10	£2.00		
75v	4½ amp	TM 24	£7.02	£2.50		
80v tapped 70v & 75v	4 амр	TM 24	£7.02	€2.50		
80v centre tapped 100v	2½ amp	TM 48	£5.02	£1.25		
100v-0-100v	1 amp	TM 25	£7.02	£1.75		
200v	½ amp ½ amp	TM 25 TM 25	£7.02 £7.02	£1.75		
250v-0-250v & 6.3v 2a	50 mA	TM 36	£3.78	£1.75 £1.00		
250v	100 mA	TM 36	£3.78	£1.00		
500v	50 mA	TM 36	£3.78 ·	£1.00		
260v	60 mA	TM 26	£3.24	£1.00		
1000v (and over secs)	60 mA	TM 43	€6.50	£2.00		
4 Kv	5 mA	TM 49	£4.05	70p		
,5 Kv	5 mA	TM 30	£7.02	£1.00		
8 Kv 8.5 Kv	5 mA 10 mA	TM 45	£4.05	£1.00		
Full RAANGE OF Mains to 120v A	to MA	TM 31	£10.26	€2.00		
TOTAL OF THE REAL PROPERTY.	o of amount mal 2	Tellegic.		-		

Car Starter Charger Kit. New version, two 10 amp rectifiers, 250W transformer and the start charge switch with instructions. Price £9.75. This is probably one of the most useful pieces of equipment you can have in your garage. Sooner or later you or someone will leave something on and you will have a flat battery. This starter will get you away usually in less than five minutes.

garage. Sooner or later you or someone will leave something on and you will leave a flat battery. This starter will get you away usually in less than five minutes.

Interested in Tape Control. American made tape punches, really beautiful units full of sophisticated parts, designed we believe to automatically operate typewriters, and they can of course be used to operate other punch tape controlled machines. Reference number is NCR Class 461-2 reference 205 H8 R56. We believe these are 8 bit paper tape punches powered from 115v 50Hz in very good condition with tape. £16.00. Carriage is £3.20.

Digital Panel made for the GPO for incorporation, we understand, in push-button dialling units, this has the usual 10 digits, each of which when depressed operates at wo pole switch. Really beautifully made, size approx. 4" square. Price £2.95.

25 Wart Audio Systems in Cabinets. Comparing 8 woofer and 3 tweeter with crossover and terminal connection panel mounted in simulated teak finish cabinet with fabric front. These are extremely good quality units comparable with tose selling at twice the price. Cabinet size approx. 20" high. 10 ½" wide and 8½" deep, heavy cabinet made of thick blockboard. Price £25.00 the pair, well worth you coming to collect them but if you cannot collect them then still worth adding £5.00 the pair for carriage. This swhich 15 amp. Meant to swhich is only when it is in the upright position. It could be incorporated in burglar alarm, car alarms etc. Contacts look quite able to cope with 15 amp loads at mains voltage. Price \$4p. Heating Pads. These measure 11" long × 8½" wide and are flat. Look rather like pieces of thick blotting paper. Wire ended 250 watt or joined in series they would be approx. 60 watt each. Dozens of uses. Price 80p or two for £1.50.



DELAY SWITCH

Mains operated — delay can be accurately set with pointers knob for periods of up to 2½ hrs. 2 contacts suitable to switch 10 amps — second contact opens few minutes after 1st contact 3

SOUND TO LIGHT KIT, Based on the Everyday Electronics circuit, this is a very efficient little unit and when made up is in every way equal to professional models costing many times the price. This unit is not tuned to any particular frequency, it is simply dependent upon volume. This is no disadvantage, in fact the effect is very pleasing. It will control up to 750w of lighting and it works well with amplifiers with outputs of 1.50 wats. The kit complete with leads and plastic case is £4.00 only, or 10 for £36.00, post and VAT paid.

MULLARD UNILEX

A mains operated 4+4 stereo system Rated one of the finest performers in the stereo field this would make wonderful gift for almost anyone, in easy to assemble modular form an easy to assemble modular form and complete with a pair of Plessey speakers 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 £15 including VAT and postage.



UNISELECTORS

ouv coil is standard. 24v operation extra at £2 per swi 3 pole 4 pole 5 pole 6 pole 6 pole 5 8 pole £1 10 pole £1



INDUCTION MOTORS



NELAYS

12 volt wo 10 amp changeover plug in 95p. 12v three 10 amp changeover plug in £1.28. 12v two changover miniature wire ended 95p. 12 volt open single screw fixing wo 10 amp changeovers 85p. 12v open three 10 amp changeovers £1.25. Latching relay mains operated 2 c/o contacts £2.11. Mains operated three 10 amp changeovers open type one screw fixing £1.25. Many other types with different coil voltages and contact arrangements are in stock, enquiries invited.



EXTRACTOR FAN

FLUORESCENT INVERTOR



This Month's Snip

Hartley CT 436 double beam oscilloscope DC6M hz Beautiful condition may have slight faults. Manuals available. Snip price £75.00, carriage £5.00. Tek tronix, Marconi, Philips and other make scopes in

PP3/PP9 REPLACEMENT MAINS UNIT

WIAITS UNIT Japenese made in plastic container with leads size 2 1½ x 1½ this is ideal to power a calculator or radio. has a full wave rectified and smoothed output of 9 volt suitable for a loading of up to 100mA £2.53.



TANGENTIAL HEATER UNIT



mmediate heat — mount in a simple wooder or metal case or mount direct onto base or say kitchen unit — price £4.95 post £1.50 control switch to give 2kw. 1kw cold,blower or off available 60p extra

MOTORISED DISCO SWITCH

with 10 amp changeover switches, mutit adjustable. Switches are rated at 10 amps each so a total of 200w can be controlled and this would provide a magnificent display. The motors are 50V but they are of such a low wattage only 2 watts that they can be driven by a resistor or condenser, voltage dropper. 8 switch model £5.25. 10 Switch model £5.75.



TERMS
Prices include Post & VAT but orders under £6.00 please add 50p to offset packing etc. Bulk enquiries please phone for generous discount 01-688 1833 Access and Barclaycard accepted.

J. BULL (ELECTRICAL) LTD (Dept. WW) 103 TAMWORTH ROAD **CROYDON CR9 1SG**

IT'S FREE!

Our monthly Advance Advertising Bargains List gives details bargains arriving or just arrived — often bargains which sell obefore our advertisement can appear — It's an intersting list and if ree — just send S.A.E. Below are a few of the Bargains still availably more review, lists.

Telephone Ringing Mains Unit. Rather novel unit as it not only reduces mains to 50 volts but also reduces the mains frequency to 25hz. This frequency gives correct ringing note for 6P Ob ells. These units were made for the GPO so obviously are first-class. Completely enclosed and safe to mount on the wall or stand on a shelf. Price £3.20.

Telephone Extension Bells in bakelite wall box. These will save y missing calls when you are out in the garden or shed, etc. Price £3.16.

Variable Mains Supply. A bench mounting unit which contains an isolation transformer for safety and a 2 amp variac for adaptability. With this you will be able to get continuously variable mains supply from zero to full voltage at 2 amps. A real time saving device. Only price £20.75.

of these. A very large purchase this month enables us to offer a range of radio items. You will find the prices well below average.

Cassette Recorder / Player. Japanese or Hong Kong made, these have all the normal facilities record. playback, fast rewind etc., also sockets for stop/satr, microphone, earphone and lead for mains as these operate from mains or HP 1 batteries. £12.50.

Six Transistor Pocket Radios. Medium wave only but with Radio 2 and Radio 4 changing places. Medium wave is all the average listener will want in the future. These little radies would make a lovely gift for a child. Modern design and irr popular colours. Please state preferred colour and give an alternative price only £1.50.

AM /FM Radios. There's no doubt that FM does give better reproduction in good areas so a more adult member of the family will be pleased with one of these. The ones we have are in leatherette cases and are battery/mains radios having the mains unit built in and are complete with mains plug. These cover medium wave and VHF with optional AFC. Price £6.75.

8 Track to Cassette Adaptors. Cartridges are going out of popularity Cassettes on the other hand are being made in increasing numbers an cover practically every field of sound entertainment. Cassettes can be player in 8 tracks if you have an adaptor. We offer these adaptors complete in carrying case and the price is only £8.50.

Soft Toy Radios. Not necessarily only for the younger members of the family as these are soft and cute and have universal appeal. Dolls, Poodles, elephents and rabbits each with zip compartment at the bottom where the radio fits. Medium wave only, working from PP3 batteries. When ordering please state preference and if possible give an alternative. £4.50

5 Band Portable. A very impressive radio in black imitation crocodile case. Size approx. 12 ins. wide, 7 ins. high and 4 ins. deep. This has metal embellished carrying handle and a pullout chrome plated FM aerial, covers the following bands AM 535 to 1605 Khz FM 88 to 108 Mhz weather band 162 5Mhz and it has a logging scale. This battery/mains radio has the build in mains unit also serves as a charger if you use rechargeable batteries. The mains lead with plug tucks away in its own compartment, another feature is a dial indicator which shows state of batteries. A real snip at £10.50.

Upright Multi Band Redio. 5 Bands and again a most desirable radio, all other details similar to the one above. Only real difference being slightly small case, again in imitation crocodile, but with soft handle and shoulder strap. Interesting point about both receivers is that if used with rechargeable batteries the built in mains unit serves as a charger. Price £11.50.

Extension Speaker Cabinets. A new delivery of these enables us to bring down the price quite a lot. We can now supply the smaller ones (11 k 8 k 4 ½) approx) at £1.95. Post £1.00 and we have a larger one with a silver finish size approximately 12½½ x 9½ x 55½. Price of this is £1.69, post £1.50. If you can call and collect 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 four or more. Note these cabinets are very good quality (made for Rail Audio Systems) the grill material is Dacron.

Motor Start Relay. The current through the motor start winding is passed through a coil which gives a slight time delay before connecting the motor winding. This has heavy duty contacts and can be used for many other projects. Price 54p.

Six Digit Counter. Mains operated: 1 pulse moves counter throughout digit, not resettable but all you have to do is to make note of the number before the start of each count. Real bargain at 80p.

Be Propered for possible blackouts and interruptions in electricity supplies this winter! Have some emergency lighting nearby. We still have the fluorescent outfits for operating 12" tubes from 12 v.c. and the price is still the same £3.95, plus 50p post complete with a 21" tube.

Sleepers. 6/12 volt battery or transformer operated, ideal for using in many alarm circuits but particularly for car and motor-cycle alarms. These give a loud shrill note. American made by Delte Alarms. Price £1.08 + 8p. Large quantities available.

Most Uesful Timer. Up to 12 on/offs per 24 hours is what you can get from the Venner time switch if you fit our adaptor. The shortest on/or off time is one hour but you can use any combinications of on/off to make up the 24 hours An obvious use for this is to control immersion heaters. These are real current consumers and even though the thermostats are working properly, economies can be quite considerable if a time switch is used. Our Venners are all capable of 20 amp switching. There is of course many other applications for the time switch, which you will remember in its basic form follows the sun switching on at dusk and off at dawn. Price £3.24 plus 50p post for switch with adaptor, extra for plastic case £1.08 or metal case £2.16 + 16p.

Sefe Soilstat. For growers who use soil heating on benches, economies can be made by using a thermostat but if mains voltage equipment is used then the thermostat must be enclosed in a waterproof and earthable container. We can now supply this price £3.78 + 28p. This container will accept the normal immersion heater type thermostat but for soil heating you want one which covers 50 deg Farenheit and upwards, we can supply these at £3.20.

Motorised Light Flasher. We can offer two motorised units both capable of 2,000 watts of light. Our ½ second flasher changes every ½ second an the 2 second flasher changes every 2 seconds. Either type £8.40.

Frightenip Fuel Bills could loose some of their stip if you fit double glazing but even if the fuel bill does not come down much you will have a more comfortable home less draughts etc. Double glazing frames movable in the Spring, can be quite easily made using rigid PVC sheetings. We have this, it is as clear as glass and virtually as everlasting. It is easy to fit as you can cut it bend it, nail it, etc. A recent purchase enables us to offer this at well below current price. It is 600 mm (23½" wide) and available in any length (trolls up like lino). Price 5p per sq th. Minimum order 20 sq t for £1.06 post 50p. Orders over £6.00 post free. Longer lengths price negotiable.

Car Battlary Power Unit made for Rank Radio. This unit has been designed to operate 6 volt battery powered equipment from a 12v. car battery it provides a reliable source of stabilized voltage and gives protection to your equipment in case of accidental reversal connections also again excessive car battery voltage should this occur. The unit is very robust and virtually everlasting if used sensibly. It uses a negative earth circuit but it will operate in a positive earth car providing the instrument being played is not connected to the car chasses. A real bargain at £2.20.

Project Boxes. All those offered in a recent newsletter are still available have now had a much larger one size 8½ x 5½ x 3½. Price £1.85.

Z&IAERO SERVICES LTD

Head Office: 44a WESTBOURNE GROVE, LONDON W2 5SF Tel. 727 5641

RETAIL SHOP 85 TOTTENHAM COURT ROAD, W.1 Tel. 580-8403

SPECIAL OFFER OF BRAND NEW USSR MADE MULTIMETERS



Sensitivity D.C. Sensitivity A.C. D.C. Current D.C. Volts

Price complete with pressed steel

carrying case and test leads

Packing and postage

Resistance Capacity Accuracy

20,000 o.p.v 2,000 o.p.v. 20,000 o.p.v. 2,000 o.p.v. 60µ A-1.5A 0.5mA-2.5A 0.6mA-1.5A 75mV-1000V 1V-1000V 75m V-600V 15V-600V 1K-1M 300Ω-500kΩ 2.5% D.C.

£10.50 £10.50 £1.50

0.06-0.6-60-600mA-3A A.C. Current D.C. Voltage A.C. Voltage

0.3-3-30-300mA-3A 0.6-1.2-3-12-30-60-120-600-1200V 3-6-15-60-150-300-600-900V 500Ω-5-50-500kΩ D.C. 2.5% A.C. 4% (of F.S.D.)

PRICE complete with test leads and fibreboard storage Packing and postage £1.20 case £9.50

TYPE U4324

TYPE U4323 COMBINED WITH SPOT FREQUENCY OSCILLATOR



Voltage ranges Current ranges Resistance Accuracy Oscillator output

2.5-1000V A.C./D.C. 0.05-500mA D.C. only 5Ω-1MΩ 5% F.S.D 1kHz 50 / 50 squarewave 465KHz sinewave modulated by 1KHz squarewave

PRICE, in carrying case, complete with leads and manual £8.00

Packing and postage £1.00

THIS OFFER IS VALID ONLY FOR ORDERS ACCOMPANIED BY REMITTANCE WHICH SHOULD INCLUDE DELIVERY CHARGES AS INDICATED AND 8% V.A.T. ON THE TOTAL

TYPE U4341

COMBINED MULTIMETER AND TRANSISTOR TESTER



Sensitivity

Resistance

16,700Ω/V D.C., 3,300Ω/V A.C. 0.06-0.6-6-60-600mA D.C., 0.3-3.0-30-0.3-1.5-6-30-60-150-300-900V D.C. 1.5-7.5-30-150-300-750V A.C. 2-20-200kΩ-2ΜΩ Collector cut-off current 60µ A max D.C. current gain 10.350 in two ranges

PRICE, complete with steel carrying case, test lead, battery and instruction manual £9.50 Packing and Postage £1.50

OUR 1978 CATALOGUE/PRICE LIST OF VALVES, SEMICONDUCTORS, PASSIVE COMPONENTS AND TEST EQUIPMENT IS AVAILABLE. PLEASE-SEND P.O. for £0.30 FOR YOUR COPY



pletely automatic with detachable in speaker. Placing the receiver on to oradle activates a switch for immediate the crade activates a switch of infinited in two-way conversation without holding the hand-set. Many people can listen at a time. Increase efficiency in office, shop, workthop. Perfect for "conference" calls: leaves shop. Perfect for conference cans. leaves the user's hands free to make notes, consult files. No long waiting. On/Off switch, volume control. Model with tape-recording facility £19.95 + VAT £1.60. P.8P. 89p. C.W.O. 10-day price refund guarantee. NEW IMPROVED

tions Standards. The modern way of instar 2-way communications. Supplied with 3 intercom, surgery and homes, between office and warehouse. Full price refund if

WEST LONDON DIRECT SUPPLIES (W/W) 169 Kensington High Street, London W.8

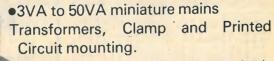


Sanua from: Quality Electronics Limited

 Large Standard Range stocked in depth.

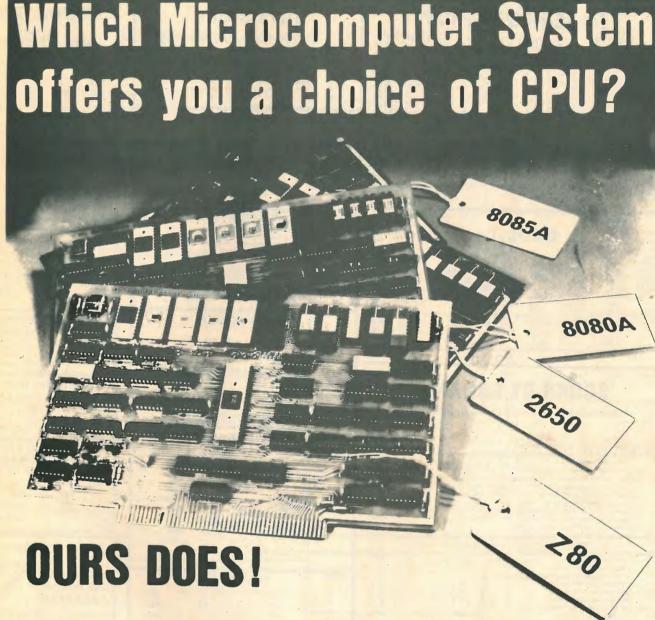
delivery on custom wound transformers.

quality transformers customwound at really competitive prices (from 89p at 500 up).



• 'Blue Riband' service gives 7-14 day

• 'Blue Star' service for OEM's, top



It has long been established that for a particular application there is an optimum microprocessor, but the purchase of a new Microprocessor Development System for each application is prohibitively expensive. With the Quarndon Microcomputer System only the cpu board has to be changed. Each high-performance microcomputer board, using an 8080A, Z80, 2650, or 8085A as cpu can be used with an extensive common range of memory and interface boards, including our new high-performance fixed/floating point Arithmetic Processing Board.

The Quarndon QMS System provides true economy, allowing a change of cpu with a minimum of expenditure on new hardware.

QUARNDON ELECTRONICS LTD

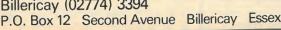
SLACK LANE—DERBY DE3 3ED

Telephone: DERBY 32651 Telex: 37163 (Quarntron Derby) WW - 105 FOR FURTHER DETAILS



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

Lascar Components Billericay (02774) 3394





3 Momomon

74 SERIES TTL ICS

					_				
Type	Price	Type	Price	Туре	Price	Туре	Price	Type	Price
7400	±0.07	7427	£0.21	7472	£0.19	74105	£0.35	74163	£0.60
7401	£0.09	7428	±0.25	7473	£0.22	74107	£0.22	74164	£0.65
7402	£0.09	7430	£0.08	7474	£0.22	74110	£0.35	74165	£0.65
7403	£0.09	7432	£0.20	7475	£0.27	74111	£0.55	74166	£0.75
7404	£0.09	7433	£0.28	7476	£0.22	74118	£0.75	74167	£2.00
7405	£0.09	7437	£0.20	7480	£0.40	74119	£1.10	74174	£0.60
7406	£0.22	7438	£0.20	7481	£0.80	74121	£0.22	74175	£0.60
7407	£0.22	7440	£0.10	7482	£0.65	74122	£0.35	74176	£0.55
7408	£0.12	7441	£0.45	7483	£0.55	74123	£0.38	74177	£0.55
7409	£0.12	7442	£0.38	7484	±0.82	74136	£0.50	74180	£0.80
7410	£0.09	7443	£0.68	7485	£0.65	74141	£0.50	74181	£1.25
7411	£0.15	7444	£0.68	7486	£0.22	74145	£0.54	74182	£0.55
7412	€0.14	7445	£0.64	7489	£1.60	74150	£0.65	74184	£1.00
7413	£0.22	7446	£0.60	7490	£0.30	74151	±0.45	74190	£0.68
7414	£0.45	7447	£0.45	7491	±0.60	74153	£0.45	.74191	£0.68
7416	£0.22	7448	£0.52	7492	£0.32	74154	€0.80	74192	£0.65
7417	£0.22	7450	£0.09	7493	£0.28	74155	£0.48	74193	£0.60
7420	£0.09	7451	£0.09	7494	£0.70	74156	£0.48	74194	£0.55
7421	£0.19	7452	£0.09	7495	£0.45	74157	£0.48	74195	£0.55
7422	£0.15	7453	±0.09	7496	£0.48	74160	£0.55	74196	£0.60
7423	£0.20	7454	£0.09	74100	£0.80	74161	£0.60	74197	£0.58
7425	±0.18	7460	£0.09	74104	£0.35	74162	£0.60	74198	£1.00
7426	£0.21	7470	£0.24	-				74199	£1.00
				-				.74279	£1.00

CMOS ICs

Туре	Price	Type	Price	Туре	Price	Туре	Price	
CD4000	£0.12	CD4017	£0.65	CD4031	£1.60	CD4055	£1.00	
CD4001	£0.13	CD4018	£0.70	. CD4035	£0.90	CC4056	£1.15	
CD4002	£0.13	CD4019	£0.35	CD4037	£0.78	CD4069	±0.15	
CD4006	£0.80	CD4020	£0.80	CD4040	£0.78	CD4070	£0.15	
CD4007	£0.14	CD4021	£0.75	CD4041	£0.68	CD4Q71	£0.15	
CD4008	£0.80	CD4022	£0.75	CD4042	£0.68	CD4072	£0.15	
CD4009	£0.40	CD4023	£0.13	CD4043	£0.78	CD4081	£0.15	
CD4010	£0.42	CD4024	£0.55	CD4044	£0.78	CD4082	£0.16	
· CD4011	£0.13	CD4025	£0.13	CD4045	£1.15	CD4510	£0.80	
CD4012	£0.14	CD4026	£1.00	CD4046	£0.95	CD4511	£0.80	
CD4013	£0.35	·CD4027	£0.45	CD4047	£0.75	CD4516	£0.85	
CD4014	£0.70	CD4028	£0.60	CD4049	£0.35	CD4518	£0.85	
CD4015	£0.70	CD4029	£0.75	CD4050	£0.35	CD4520	£0.85	
CD4016	£0.35	CD4030	£0.40	CD4054	£0.95			

BOOKS BY BABANI

The following books are offered at 10% off their normal price

ı			Normal	Sale
ı			Price	Price
ı	BP6	Engineers & Machinists Reference Tables	0 40	£0.36
ı	8P14	Second Book of Transistor Equivalents & Substitutes	-110	£0.99
ı	BP22	79 Electronic Novelty Circuits .	: 0.75	£0.68
ı	BP24	52 Projects Using IC741 for equivalents	. 40 75	£0.68
ı	BP26	Radio Antenna Handbook for Long Distance Reception & Transmission	10 85	£0.77
ı	BP27	Giant Chart of Radio Electronic Semi-conductor and Logic Symbols	-0 60	£0.54
ı	BP32	How to Build Your Own Metal & Treasure Locators	+0 85	£0.77
ı	BP34	Practical Repair & Renovation of Colour TV s	-0 95	£0.86
ı	BP35	Handbook of IC Audio Preamplifier & Power amplifier construction	.0 95	£0.86
ı	BP36	50 Circuits Using Germanium Silicon & Zener Diodes	-075	£0.68
ı	BP37	50 Projects Using Relays SCR's and Triacs	-110	£0.99
ł	BP39	50(FET) Field Effect Transistor Projects	1.25	£1.13
ı	BP40	Digital IC Equivalents & Pin Connections .	· 2 50	£2.25
ı	BP41	Linear IC Equivalents & Pin Connections .	12.75	£2.48
ı	BP42	50 Simple LED Circuits	0.75	£0.68
ı	BP43.	How to make Walkie-Talkie	1.25	£1.13
ı	BP44	IC 555 Timer Projects	. 145	£1.31
ı	8P45	Projects on Opto-Electronics .	• 1 25	£1.13
ı	BP46	Radio Circuits using IC s	- 1 35	£1.22
ı	BP47	Mobile Discotheque Handbook .	· 1 35	£1.22
ı	BP48	Electronic Projects for Beginners	-135	£1.22
ı	BP49	Popular Electronic Projects	+1.45	£1.31
ı	BP50	IC LM3900 Projects	. 1 35	£1.22
ı	BP55		., 1 45	£1.31
ı	BP160	Coil Design & Construction Manual	-0 75	£0.68
ı	BP202	Handbook of Integrated Circuits (ICs) Equivalents & Substitutes	·0 75	£0.68
ı	BP205	First Book of Hi-Fi Loudspeaker Enclosures	0 75	£0.68
ı	BP213	Electronic Circuits for Model Railways	· 0 85	£0.77
ı	BP215	Shortwave Circuits & Gear for Experimenters and Radio Hams	0.85	£0.77
ı	BP216	Electronic Gardgets & Games	• 0 85	£0.77
ı	BP217	Solid State Power Supply Handbook	· () 85 · () 95	£0.77
ı	BP221	28 Tested Transistor Projects	0 95	£0.86
ı	BP222	Solid State Short Wave Receivers for Beginners		
1	BP223	50 Projects Using IC CA3130	· 0 95	£0.86
ı	BP224	50 CMOS IC Projects	-0 95	£0.86
Į.	BP225	A Practical Introduction to Digital ICs	1 20	£1.08
ı	BP226	How to Build Advanced Short Wave Receivers	1 20	£1.13
ı	BP227	Beginners Guide to Building Electronic Projects	1 25	£1.13
ı	BP228	Essential Theory for the Electronics Hobbyist	1 25	21.13
п				

VPS30 Variable Regulated Stabilised Power Supply Module

Incorporating a short circu	nit protection and current limiting:	-
Voltage Regulation	2-30v	
	0-2A 25v	
	eries and thus saves +s - can be used time	an

BRAND NEW ITT 923 Silicon

Diodes 200mA 200v. 100 off 500 off £2.00 £9.00 £15.00 £130.00 P.C. BOARD

Single-sided Fibre-glass Board 12" × 3 1/2" approx 2 pcs \$143 t0.60

THYRISTORS

	MIS	0113	
No. THY1A/50	1 Amp.	50 volt TO5	18p
No. THY1A/400	1 Amp. 4	00 volt TO5	32p
No. THY3A/50	3 amp.	50 volt T064	25p
No. THY3A/200	3 Amp. 2	00 volt T064	32p
No. THY3A/400	3 Amp. 4	00 volt T064	40p
No. THY5A/50	5 Amp.	50 volt T066	25p
No. THY5A/400	5 amp. 4	00 volt T066	40p
No. THY5A/600	5 Amp. 6	00 volt T066	50p
No. C106/4	6 Amp. 4	00 volt T022	0 42p

TR	AC	
8 Amp. 400 volt	T0220	80p

	DIACS	
ITT	V413 equt	12p
BR100	D32 each	12p

	CAPACITO	RPAKS
16201	18 Electrolytics	4.7µF — 10µF
16202	18 Electrolytics	10µF - 100µF
16203	18 Electrolytics	100µF — 680µF
All	3 at SPECIAL PI	RICE of £1.20°
16160	24 Ceramic Caps	22pF — 82pF

All	3 at SPECIAL PRI	CE DI E1.20	
16160	24 Ceramic Caps	22pF — 82pF	
16161	24 Ceramic Caps	100pF — 390pF	
16162	24 Ceramic Caps	470pF - 3300	
16168	21 Ceramic Caps	4700pF - 0.047µ	
All 4 at SPECIAL PRICE of £1.60			

RESISTOR PAKS 100 ohm - 820 ohm 601/4 W. 60¼W. 1K - 8.2K

16215	00 74 VV.	10K - 02K
16216	601/4W.	
All	4 at SPECIAL	PRICE of £1.60°
16217	401/2W.	100 ohm - 820 ohm
16218	401/2W.	1W - 8.2K
16219	401/2W.	1K - 8.2K
16220	401/2 W.	100K — 820K
All	4 at SPECIA	L PRICE of £1.60'

VOLTAGE REGULATORS

	Positive			
	No. MVR7805	μA/805	T0220	55p
	No. MVR7812	μA7812	T0220	55p
	No. MVR7815	μA7815	T0220	55p
	No. MVR7818	µA7818	TO220	55p
	No. MVR7824	µA7824	T0220	55p
	Manager 1			
	Negative			
	No. MVR7905	μA7905	T0220	75p
	No. MVR7912	μA7912	TO220	75p
	No. MVR7915	µA7915	T0220	75p
	No. MVR7918	µA7918	T0220	75p
	No. MVR7924	μA7924	TO220	75p
	µА723С ТО99	38n	72723 14	pin Dil 38p
		1309K TO3		
_				

SWITCHES	
5 x Mains Slide Switches 5 x Miniature Slide Switches	40p
4 x Standard Slide Switches 4 x Miniature Push to Make	40p

	Mileston 17 N. J. St.	
No 16178	5 x Mains Slide Switches	40p
No. 517	5 x Miniature Skde Switches	40p
No S18	4 x Standard Slide Switches	40p
No S19	4 x Miniature Push to Make	
	single hole mounting	40p
No S20	3 x Miniature Push to Break	
	single hole mounting /	40p
No 'S21	Push button Switch Pak	
	4 x Assorted types multi bank	
	and singles Latching	
,	and non-Latching	£1.00

AUDIO LEADS

Order No.	
127 Audio lead 5 pin DIN plug to 4 phono	
pluas	90
129 - Audio lead 5 pin plug to 5 pin DIN plug-	
Mirror Image	70
130 - 5-metre lead 2 pin DIN plug to 2 pin DIN	
· inline socket	45

AUDIO PLUG AND

Order	No.	
S1	5 x 3 5 mm Plastic Jack Plugs	40p
52	5 x 2 5 mm Plastic Jack Plugs	40p
S3	4 x Std Plastic Jack Plugs	50p
S4	2 x Stereo Jack Plugs	30p
S5	5 x 5 Pin 180 DIN Plugs	50p
S6	8 x 2 Pin Loudspeaker Plugs	50p
S7	6 x Phono Plugs Plastic	50p
SR	5 x 3 5 mm Chassis Sockets (Switched)	25p
S9	5 x 2 5 mm Chassis Sockets (Switched)	25p
S11	2 x Stereo Jack Sockets with instruction	
	leaflet for H / Phone connection	50p
S12	5 x 5 Pin 180 DIN Chassis Sockets	40p
S13	8 x 2 Pin DIN Chassis Sockets	50p
S14	6 x Single Phono Sockets	40p

P.C. BOARD

S110 Mixed Bundle P.C.B. Fibre-glass paper single and double-sided. Fantastic value. 75p

SPECIAL OFFER! SPECIAL OFFER!

UNTESTED	
SEMICONDUCTOR PAKS	
Code Nos shown below are given as a gui type of device. The devices themselves are unmarked.	de te
No. 16130 100 Germ. Gold bonded did like OA47	
No. 16131 150 Germ, Point contact did	odes

ч	No. 16131	150 Germ. Point contact diod
ı		like 0A70/81
4	No. 16132	100 200mA Sil. diodes like
١		0A200
9	No. 16133	150 75mA Sil. Fast switching
1	The state of the s	diodes like IN4148
9	No. 16134	50 750mA Sil. top hat Rects.
1	No. 16135.	20 3 amp Sil. stud Rect.
ı	No. 16136	50 400mw Zeners D.O.7 case
ı	No. 16137	30 NPN Plastic trans. like
1		BC107/8
1	No. 16138	30 PNP Plastic trans. like
1		BC177/8
1	No. 16139	25 NPN trans. like 2N697/
		2N1711 TO39

-	No. 16140	25 PNP trans. like 2N2905 TO39
	No. 16141	30 NPN trans. like 2N706 TO18
2	No. 16143	30 NPN Plastic trans. like 2N390
	No. 16144	30 PNP plastic trans. like 2N390
-	No. 16145 No. 16147	30 PNP Germ, trans, like OC71 4
	110. 10147	2N3055

I.C. SOCKET PAKS No. S66 11 x 8 pin DIL Sockets

_	
No. S70	3 x 28 pin DIL Sockets
No. S69	4 x 24 pin DIL Sockets
No. S68	9 x 16 pin DIL Sockets
No. S67	10 x 14 pin DIL Sockets

MAMMOTH I.C. PAK Approx. 200 Pieces. Assorted fall-out integrity including: Logic, 74 series, Linear

	D.T.L.				ices.	but	som
mark	ked - y	ou to ic	dentify	-			
		-Order	No. 1	6223	£1.0	00	

	PNI	GE	D PAIR RMANI OWER T	UM
2	amp		7	50mW
	VCE	VCB	HFE	-
NKT301	40	60	30-100	35p p
NKT302	40	60	50-100	35p p
NKT303	20	30	30-100	25p p

NKT304 20 30 50-150 25p pe From U.S.A. by (CONCE)

DINDY SCREW CASED LOW NOISE CASSETTES

Order No. S53 10 for £3.50*

HEAD-CLEANING CASSETTE 45p each

AUDIO AMPLIFIER
RETURN OF THE AL204
popular demand - this useful 5 wa
ower Amplifier is offered at the re-intro
ing of C2 7E* Hook up data supplied

EI	CH KESIS	PENS
Order No.	1609	50p eac
UNIJUN	CTION TR	ANSISTOR
UT46	TIS43	20p

FETs 2N5458 2N3819 15p

		•
	Metal Stud Mounting	
No. S45	50V (KBS 005)	
No. S46	100V (KBS 01)	
No. S47	200V (KBS 02)	
_		
_		_

SILICON BRIDGE RECTS. DRDERING

SILICON RECTS. SIMILAR IN 4000 SERIES		
25 Like IN4001 (1A/50V) 20 Like IN4002 (1A/100V) 18 Like IN4003 (1A/200V)	V.	

OMPONENT DAKE

-	,UI	WIPUNEIN I PA	12
th	sec No	Quantity	
al	1168	5 pieces Assorted Ferrite rods	40p
	169	2 pieces Tuning gangs MW/ LW/	40p
	170	50 metres Single strand wire	
		assorted wire	40p
P	171	10 Reed switches	40p
	172	3 Micro switches	40p
16	176	20 Assorted electrolytics	
		Trans types	40p
	177	1 nack Assorted Hardware	
h		nuts bolts etc	40p
Ņ	179	20 Assorted tag strips and panels	40p
U	180	15 Assorted control knobs	40p
	184	15 Assorted Fuses 100mA 5 amp	40p
0	188	601: W resistors mixed values	40p
ø	187	30 metres stranded wire	
		assorted colours	40p
۸	00	120 1/4 watt resistors Pre-formed	
ų		1978 Prod Our mix	60p
	01	120 ½ watt resistors Pre-formed	
0		1978 Prod. Mixed values 250 1/2 watt resistors	60p
ı	02	Range 100 ohms-1 8 meg	
c	03	220 1/2 watt resistors	£2.00°
١	03	Range 100 ohms10 meg.	
ı	04	60 Low ohms 1/8 watt resistors	£2.00°
i	O.C.	10-100 ohms	60-1
ı	0.5	40 Low ohms 1/2 watt resistors	60p
ğ	05	10-100 ohms	CO
d	06	25 Mixed wirewound resistors	60b.
άĺ	07	20 Tantalum bead caps	oup
3	0)	0 22-100mF Our mix	£1.00°
1	08	High-quality electrolytics 10mF-500	DmE
	44	voltage range 15 50V	,,,,,
q		Our mix 40 for	£1.00°
k	204	C280 Pak Contains 50 metal	21.00
N	100	foil caps	£1.00
1			21.00

POTENTIOMETERS er 40mm TRAVEL

6 x 470 Ohm	LIN Single	40p
6 x 1 K	LIN Single	40p
	LIN Single	40p
	LIN Single	40p
	LOG Single	40p
	LIN Single	40p
	LIN Single	40p
6 x 100 K		40p
6 x 500 K	LOG Single	40p
6 x 50 K	LIN Single	40p
	6 x 5 K 6 x 22 K 6 x 47 K 6 x 47 K 6 £ 100 K 6 x 100 K	6 x 5 K LIN Single 6 x 22 K LIN Single 6 x 47 K LOG Single 6 x 47 K LIN Single 6 x 100 K LIN Single 6 x 100 K LOG Single 6 x 500 K LOG Single 6 x 500 K LOG Single

ider	60mm TRA	VEL	
18	6 x 2 5 K 4 x 100 K 4 x 1 3 MEG	LOG Dual	40p° 40p° 40p°
5	6 x 220 K 6 x 100 K	LIN Single	40p

N	6 x 500 K	LIN Single	2
per	Mixed slider pots—va	rious values	
p per	and sizes. Off wix	only £1.00).
p per	186 x Chrome slider kn	ohs 40	
nar			

WIREWOUND Rwound Pots Linear 1 Watt Mixed—useful values: 5 for £1.00* CARBON TYPES

0 K Lin switched	Dual Switched Pot
25 K Lin	each 60p°
UAL POT	S P.C. MOUNTING

ZENER PAKS	
20 mixed values 400mW Zener	
diodes 3-10V	£1.00
20 mixed values 400mW Zener	
diodes 11-33V	. £1.00
10 mixed values 1W Zener	
diodes 3-10V	£1.00
10 mixed values 1W Zener	
diodes 11-33V	£1.00

2 AMP. BRIDGE RECTIFIERS CON POWER TRANS. N.P.N.

2N5293 P C A 36w 4 Amps 75Vceo Hfe 30-120 5 for +1	.00
with heat tab 5 for	60p
Hfe 40-400 Case T092	
BD371 2 Amp 1 2w 60Vceo	

Mixed Pak 2 – 5 Amp. 50-600v. All coded. 4 for £1 Minimum postage and packing for Sale Orders £0.50 PLUS any urther postage as stated as per this Sale Advertisement. erseas Orders - ADD extra for Air-mail.

ase ADD V.A.T. as follows: 121/2% to items marked *. 8% to 18 Like IN4003 (14/200V)
15 Like IN4004 (1A/400V)

15 Like IN4004 (1A/400V)

15 Like IN4004 (1A/400V)

Crystal EAR Preces S126 Less plug	±0.20°
Plugs for above No 16106 2 5 plastic No 1697 3 5 plastic	£0.09°
Mono Crystal Cartridge S127 GP91 1SC Special Offer	£1.00°
Nickel Cadmium Rechargeable Batteri S128 3500D Cell size = U2 S129 900C Cell size = %U11	es 1 25v £2.50 £0.90
S130 Complete kit of parts to huild nickel cadnium charger	£3.50
Super Save Pak S124 6×741P S125 5×555	£1.00 £1.00
S138 Surplus End of Manufacturers with Bass Treble Volume Contre gram supplied ONCE ONLY	ol & circuit dia-

S137 20 Assorted Slider Knobs — Chrome Black	£1.00°

S131	2×12v Relays plastic case £0.7	0.
\$132	2 × 24 v Relays, plastic case £0.6	
	1 Switch bank 5-way incl silver knob £0.7	
\$134	Magnets suitable for reed switches £0.*	10
S135	1 Veroboard pak 2 pcs 45sq. ins. approx	
	£0.1	80
S136	15 Verohnard nak 2 pcs 60sq ins approx	

16199	1 Verohoard pak pcs 30sq ins approx
16200	15 Vernboard pak pcs 30sq ins approx £0.50

TOOLS	
No 2011 5" wire cutters	£1.55
No 2012 5" long wire plier	£1.45

SUPER DUPER COMPONENT ROX

* This is a large box and is sent separate to your

S140. £2.50 including p&p.

TRANSFORMERS SALE OFFER
0235 240v primary 0-55v at 2 Amp seco £4.50'+£1.00 p&p.

COMPLETE AUDIO

AMPLIFIER KITS

STA15. 15 watts per channel amplifier kit.

CONSISTS: 2×AL60 — 1×PA100 —
1×SPM80 — 1×2034 transformer —
2×coupling capacitors. £37.70 inc.

V.A.T.+86p p&p.

V.A.1.+86p pep.

STA25. 25 watts per channel amplifier kit.

CONSISTS: 2×AL60 — 1×PA100 —
1×SPM120/45 — 1×2040 transformer
— 1×reservoir capacitor — 2×coupling
capacitors. £41.45 inc. V.A.T.+£1.16

STA35. 35 watts per channel am CONSISTS: 2×AL80 — 1×F 1×SPM120 — 1×2041 transfor reservoir capacitor — 2×couplii tors. £48.45 inc. V.A.T.+£1.16

STA50. 50 watts per channel amplifier kit. CONSISTS: 2×AL120 — 1×PA200 — 1×SPM120/65 — 1×2041 transformer — 1 reservoir capacitor — 2×coupling capacitors. £58.20 inc. V.A.T.+£1.10 - p&p.

STA125. 125 watts per channel amplifier kit. CONSISTS: 2×AL250 — 1×PA200 — 2×SPM120/65 — 2×2041 transformers capacitors. £72.85 inc. V.A.T.+£1.25

4		BKA	NDN	EW	- FUI	LLY	GUAF	RAN7	TEED	
ı	Type	Price	Туре	Price	Туре	Price	Type	Price	Туре	Price
1	AC107	25p	BC177	12p	BF194	'9p	TIP32A	34p	2N1613	15p
1	AC126	14p	BC178	12p	BF195	'9p	TIP32B	35p	2N1711	15p
1	AC127	16p	BC179	12p	BF196	'12p	TIP32C	36p	2N1893	28p
٦	AC128	16p	BC182	.9b	BF197	'12p	TIP41A	34p	2N2218	15p
ı	AC128K	24p	BC182L	'9p	BF200	25p	TIP41B	35p	2N2218	
ı	AC176	16p	BC183	*9p	BFX29	22p	TIP41C	36p	2N2219	15p
4	AC176K	24p	BC183L	.9b	BFX84	18p	TIP42A	36p	2N2219	A 18p
1	AC187	16p	BC184	'9p	BFY50	12p	TIP42B	37p	2N2221	15p
J	AC187K	26p	BC184L	*9p	BFY51	12p	TIP42C	38p	2N2221.	A 16p
ŀ	AC188	16p	BC212.	10p	BFY52	12p	TIP2955	65p	2N2222	15p
4	AC188K	26p	BC212L	'10p			TIP3055	42p	2N2222	
ı	AD161/	7	BC213	'10p	MPSA05	'22p	ZTX107	'6p	2N2369	
ı	162 MP	80p	BC213L	'10p	MPSA06	'22p	ZTX108	'6p	2N2904	14p
1	AF139	30p	BC214	110p	MPSA55	.55b	ZTX109	'7p	2N2904	A 15p
ı	AF239	30p	BC214L	'10p	MPSA56	'22p	ZTX300	.17p	2N2905	14p
ı	BC107	6р	BC251	10p			ZTX301	'7p	2N2905	
ı	BC108	6р	BCY70	12p	OC44	12p	ZTX302	.6b	2N2906	12p
ı	BC109	6р	BCY71	12p	OC45	12p	ZTX500	.8b	2N2906	
ı	BC118	'10p	BCY72	12p	OC71	9p	ZTX501	10p	2N2907	12p
ı	BC147	8b	BD115	'40p	OC72	12p	ZTX502	12p	2N2907	
ı	BC148	.8b	BD131	'35p	OC75	10p	2N696	10p	2N2926	
ı	BC149	.8b	BD132	'37p	OC81	14p	2N697	10p	2N2926	
ı	BC154 BC157	'16p	BF115	17p	TIROGO		2N706	7p	2N3053	12p
ſ	BC157	'9p	BF167 BF173	19p	TIP29A	35p	2N706A	8p	2N3055	35p
ı	BC158	.9b	BF173	20p	TIP29B	36p	2N708	8p	2N3702	
ı	BC169	'9p	BF180	25p	TIP29C	38p	2N1302		2N3703	
ı	BC170	10p	BF181	25p	TIP30A	36p	2N1303	15p	2N3704	
1	BC170	.eb	BF182 BF183	25p	TIP30B	37p	2N1304	15p	2N3903	111p
ı	BC1-72	.eb		25p 25p	TIP30C TIP31A	38p	2N1307	18p	2N3904	111p
ı	BC173	.2b	BF185	25p	TIP31A	32p	2N1308 2N1309	22p	2N3905	'11p
ı	50175	/ p	Di 105	23p	TIP316	33p	2111309	22p	.2N3906	11p
L					111316	34p				

RESISTORS
40 MIXED VALUES. 1 watt & 2 v
RESISTORS. No. S143 *£0.60

PROGRAMMABLE UNIJUNCTIONS

DIODES									
Type AA119 AAZ13 BA100 BA115 BA144 BA148 BA173 BAX13/ OA200	Price 5p 4p 6p 5p 5p 10p	Type BAX16/ OA202 BY100 BY127 BYZ10 BYZ11 BYZ12	5p 15p 10p 32p 32p 32p	Type BYZ16 BYZ17 BYZ18 BYZ19 OA47 OA70 OA79 OA81	Price 30p 28p 28p 28p 5p 5p 7p	Type OA85 OA90 OA91 OA95 IN34 IN60 IN914	Price 7p 6p 7p 7p 7p 5p 6p 4p	Type - IS44 IN5400 IN5401 IN5402 IN5404 IN5406 IN5407	Price 3p 10p 11p 12p 13p 16p 17p
0A200	5p	BYZ13	30p			IN148	4p	IN5408	19p

DIODEC

LINFARICA

		PHALM	1.6.5		
TBA800	'£0.75	UA709	£0.20	748P	'£0.28
TBA810	'£0.85	UA711	'£0.25	UA748	'£0.28
TBA820	'£0.65	UA703	'£0.20	72558	'£0.45
LM380	.£0.80	, 741P	'£0.18	MC1310P	'£1.25
LM381	'£1.25	72741	'£0.20	76115	'£1.25
72709	£0.20	UA741C	£0.20	NE555	£0.22
,		72747	'£0.55	SL414A	'£1.80

ZN414 RADIO CHIP 75'

OPTOELECTRONICS

£0.10

40p

DISPLAYS	
No. 1510. 707 LED Display	£0.70
No. 1511. 747 LED Display	£1.50
No. 1512. 727 Dual LED Display	£1.55

LEDs	
No. S120125 Bright Red	£O.
No. S1212 Bright Red	£O
No. 1502125 Green	£0.
No. 15052 Green	£O.
No. 1503. 125 Yellow	£0.
No. 15062 Yellow	£O.

mplifier kit.	No. 15062 Yellow No. S82. Clear. 2 Illuminating
former — 1	P.O. RELAYS
ling capaci-	S85 — 2 Off Post Office relays

BATTERY HOLDERS to take 6 x HP7s Order No. 202 10p each

EX-G.P.O. MICROSWITCHES

CABLE CLIPS S65-50 2.5mm round single pin fixin 2nd QUALITY LED PAKS
No. 1507. 10 Assorted Colours & Sizes

No. S122. 10×.125 Red

No. S123. 10 x .2 Red

£0.75

POWER SUPPLY STABILIZER BOARD

Unused ex-equipment stabilizer board. Input 30V. D.C. Output 20V. Complete with Order No S81 £1.25

INSERTION EXTRACTION TOOLS O/N 2015

30p each



DEPT. W.W.3, P.O. Box 6, Ware, Herts. **COMPONENTS SHOP: 18 BALDOCK STREET**

DIL SKTS

Marshall's Electronics



Retail Sales London: 40-42 Cricklewood Broadway, NW2 3ET. Tel: 01-452 0161/2. Telex: 21492. London: 325 Edgware Road, W2. Tel: 01-723 4242 Glasgow: 85 West Regent Street, G2 20D. Tel: 041-332 4133. Bristol: 1 Straits Parade, Fishponds Road, B516 2LX. Tel: 0272 654201

POPULAR INTEGRATED CIRCUITS. (A very small selection from our vast stocks, please enquire about devices not

listed)			1			
listed.)					i market	
CA3018 0.75	LM341P5 0.80	LM1303N 1.15	SAS570 2.70	TBA550Q 3.80	7405N	0.22
CA3018A 1.10	LM341P12	LM1304N 1.52	SAJ110 2.10	TBA5600Q	7406N	0.56
CA3020 2.20	0.80	LM1305N 1.52	SO41P 1.35	3.00	7407N 7408N	0.55
CA3020A 2.50	LM341P15	LM1307N 1,22	SO42P 1.35	TBA570 2,10		0.22
CA3028A 0.90	0.80	LM1310N 2.10	SN76001N	TBA570Q 2.20	7409N	
CA3028B 1.25	LM341P24	LM1351N 1.30	1.30	TBA7000 2.20	7410N	0.20
CA3030 1.50	0.80	LM1458N 0.45	\$N76003N	TBA720AQ	7411N	0.26
CA3030A 2.20	LM348N 0.95	LM1496N 0.97	2,38	2.06	7412N 7413N	0.20
CA3038 2.90	LM358N 0.60	LM1808N 2.10	SN76013N	TBA750 2.36	7414N	0.80
CA3038A 4.10	LM360N 3.00	LM1812N 6.20	1.50	TBA750Q 2.45	7414N	0.36
CA3045 1.55	LM370N 3.30	LM1820N 1.16	SN76023N	TBA800 1.30	7417N	0.36
CA3046 0.77	LM371H 2.35	LM1828N 1.90	1.50	TBAB10S 1.30 TBAB20 0.80	7420N	0.22
CA3048 2.45	LM350K 6.45	LM1830N 1.90	SN76033N		7423N	0.32
CA3052 1.78 CA3080 0.85	LM373N 3.35	LM1841N 1.90	7AA263 1.35	TBA920 2.99 TCA160C 2.36	7425N	0.32
	LM374N 3.36	LM1845N 1.50	TAA300 3.70	TCA160B 2.55	7427N	0.32
CA3080A 2.10 CA3086 0.50	LM377N 1.80	LM1848N 1.98	TAA320A 1.15	TCA270 2,99	7430N	0.22
CA3088B 1.87	LM378N 2.40	LM1850N 1.90	TAA350A 3.00	TCA730 4.50	7432N	0.30
CA3089B 2.90	LM379S 4.25	LM1889N 4.90	TAA521 1.10	TCA740 4.50	7437N	0.35
CA30900 4.40	LM380N8 0.96	LM3301N 0.60	TAA522 2.10	TCA750 3.00	7438N	0.32
CA3130 1.06	LM380N14	LM3302N 0.55	TAA550 0.48	TCA760 2.00	.7440N	0.20
CA3140 1.04	1.08 LM381AN 2.70	LM3401N 0.55	TAA560 2.10	TCA105 1.49	7441AN	0.84
LM301 0.30	LM381N 1.89	LM3900N 0.68	TAA570 2.20	TCA440 1.65	7442N	0.76
LM307N 0.50	LM382N 1.32	LM3909N 0.78	TAA370A 5.45	TDA1022 7.50	7445N	1.40
LM308N 0.95	LM384N 1.55	LM3911N 1.10	TAA630 2.40	TDA1024 1.24	7446AN	0.90
LM309KC 1.95	LM386N 0.88	LM7805K 1.75	TAA960 3.90	TDA1034 4.75	7447AN	0.80
LM317K 3.35	LM387N 1.10	LM7812K 1.75	TAA970 4.20	TDA2020AD	7448N	0.80
LM318N 2.45	LM388N 1.00	LM7824K 1.75	TAA611B 2.50	4.50	7450N	0.22
LM320TS 2.15	LM389N 1.00	LM78L05CZ	TAA621 2.50	UAA170 2,15	7451N	0.22
LM320T122.15	LM702C 0.81	0.30	TAA661A 1.65	UAA180 2.15	7.453N	0.22
LM320T15	LM709 0.70	LM78L12CZ	TAA661B 1.45	TL080CP 1.25	7454N	0.22
2.15	LM7098 0.50	0.30	TAA700 4.50	TLOB1CP 0.90	7460N	0.22
LM320T24	LM70914 0.49	LM78L15CZ	TAA930A 1.45	TL082CP 1.10	7470N	0.46
2.15	LM710 0.67	0.30	TAA930B 1.45	TL083CN 1.40	7472N	0.30
LM320P5 1.15	LM71014 0.64	MM5314 4.60	TAD100 2.00	TL084CN 1.45	7473N	0.44
LM320P12	LM711CN 0.72	MM5316 4.60	TBA120 0.80	LF355N 0.80	7474N	0.32
1,15	LM723C 0.75	NE555 0.33	TBA500 '2.24	LF356N 0.80	7475N	0.80
LM320P15	LM723C14.	NE556 0.85	TBA500Q 2.34	LF357N 0.80	7.476N	0.45
. 1.15	0.45	NE558N 1.98	TBA510 2:35	LF13201N 3.00	7480N 7481N	0.60
LM320P24	LM741C 0.70	NE560 4.50	TBA510Q 2.48 TBA520 2.60	LF13331N 3.00 LF13741H 0.80	7482N	0.90
1.15	LM741C8 0.30	NE561 4.50			7483N	1.05
LM323K 6.95	LM741C14	NE562 4.50	TBA520Q 2.70 TBA530 2.35	LF13741N 0.55	7484N	1.20
LM339N 0.60	0.30	NE565 1.39	TBA5300 2.35		7485N	1.36
LM340T5 0.88 LM340T15	LM747CN 0.99	NE566 1.75	TBA540 2.60	7401N 0.17 7402N 0.17	7486N	0.36
0.88	LM7488 0.50	NE567 1.90	TBA540Q 2.70	7402N 0.17	7489N	2.45
LM340T24	LM7814 0.90	NE571N 4.95 SAS560 2.70	TBA550 3.60	7404N 0.17	7490AN	0.45
0.88	ALL PRICES		VAT CORRECT		7491AN	0.85
0.00	MLL PRICES P	IOAA IMCTODE	VALCORRECT	AT 12.11.78	-	
Name and Address of the Owner, where the Owner, which is		The second secon	AND DESCRIPTION OF THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUM			_

Our range covers over 8,000 items. The largest selection in Britain. Top 200 ICs, TTL, CMOS & LINEARS



TRIACS plastic pack 400v TO220

1384 Convert your TV set into an excellence in set of the set of a basic VDU sible as chip or full display card. VEV oursor control, 5 volts TIL complete, line erase, full card includes CHIP £17.2 T. Modem, Char, gen, etc. Comp FULL CARD cout from encoded keybd. in.



CATALOGUE

MARCONI TEST EQUIPMENT TF791D Deviation meter

TF455E Wave analyser. New. £135 TF1101 RC oscillators. £65 TF1099 20MHz Sweep generators TF1041 B & C. VT Voltmeters TF1102 Amplitude modulator. 500MHz
TF1020A Power meter. 100W. 250MHz. £85 TF1020A Power meter. 100W. 250MHz. £85 TF1152A/1 Power meter. 25W. 500MHz. £75 TF890A/1 RF test set. £425 TF801B/3S Signal generator. £175 TF1064B/5 VHF. FM Signal generator TF1400 Pulse generator

TF675F Pulse generator
TF1370 Wide-range RC oscillator. £125

TF2162. MF Attenuator
TF1058 UHF/SHF signal generator TF995A/4. AM/FM signal generator TF1066 AM / FM signal generator

TF340 Power meters

220 Volts. 250W. £25 (£2 carriage)

ADVANCE CONSTANT VOLTAGE TRANS-FORMERS
Input 190-260V AC. Output constant

POLARAD TYPE TSA. SPECTRUM ANA-LYSER. C/w type STU/2M plug-in unit covering from 950 to 4500 MHz.

NICKEL CADMIUM BATTERIES Size 'D' (HP2) 4 A.H. £2 (pp. 20p) Size 'F' 6.00 A.H. £2.75 (pp. 25p)

POWER SUPPLIES

ADVANCE PMA47, 0-15V @ 3 Amps. ADVANCE RMA20, 0-7V @ 20 Amps. Both brand new, boxed, with book. APT10459/11. 10-15V @ 7.5A APT10459/13. 24V (var) 5A

BECKMAN TURNS COUNTER DIALS Miniature type (22mm diam.). Counting up to 15 turn "Helipots". Brand new with mounting

nstructions. Only £2.50 each. Wandel & Gotterman Equipment Level Meter 0.2-1600KHz Level Oscillator 0.2-1600KHz Level Transmitter 0.3-1350KHz

P. F. RALFE ELECTRONICS

10 CHAPEL STREET, LONDON, NW1

TEST EQUIPMENT
LEADER TV FM Sweep and marker generator

AIRMEC 210 Deviation meter
HEWLETT-PACKARD 302A Wave-Analyser RACAL type 801R. 100MHz digital frequency meter TEXSCAN X-Y oscilloscope. 9-inch CRT TELETYPE ASR33 now in stock SOLARTRON 1420. 2 digital voltmeter. 6 ranges to 1KV BOONTON 80 Signal generator. 2-400MHz BOONTON 230A RF Power Amplifier £325 3PL Capacitance decade (5) CD133. 100pF-1uF GERTSCH Frequency meter and deviation meter 20-1000MHz HEWLETT-PACKARD 695A Sweep oscillator £350 HEW/LETT-PACKARD Sweep oscillator DERRITRON. Digital Wheatstone Bridge
MUIRHEAD K-134-A Battery op. wave analyser
WEINSHEL Power Supply Modulator MO3

BRUEL & KJOER Vibration equipment 1018
BRUEL & KJOER Frequency analyser 2105

BRUEL & KJOER Microphone amplifier 2603
BRUEL & KJOER Type 3301 Automatic frequency response recorder 200Hz-20KHz
MUIRHEAD-PAMETRADA D489EM Wave Analyser

TEKTRONIX 555 scope with plug-ins types CA (2 off), 21, 22 TEKTRONIX 515A Oscilloscope

TEKTRONIX 545 main frames. £210. Choice of plug-in units

TEKTRONIX 585A oscilloscope with '82' P.I. DC-80MH; TEKTRONIX type 180A Time-mark generator TELEQUIPMENT DM53A Storage oscilloscope EKTRONIX 556, 50MHz oscilloscope

NOTICE. All the pre-owned equipment shown has been carefully tested in our workshop and reconditioned where necessary. It is sold in first-class operational condition and most items carry our three months' guarantee. Calibration and certificates can be arranged at cost. Overseas enquiries welcome. Prices quoted are subject to an additional 8% VAT.

ROHDE & SCHWARZ EQUIPMENT

NEW 1979

HUZ Field Strength Meter. 47-225MHz. AMF TV. Demodulator 55-90MHz. Selective UHF v/meter, bands 4&5 USVF Selectomat. RF Voltmeter. USWV. BN 15221

Standard attenuator. .0-100dB, 0-300MHz. DPR. UHF Sig. gen. type SDR 0.3-1 GHz £750 UHF Signal generator type SCH. £17 £750 UHF Test receiver type USVD £325

PYE-LING VIBRATORS 3 ohm coil. Overall dimensions 9 x 6½ x 6½ x 6½ cms. Each £5,25 (25p P&P).

SOLARTRON Type CD1400
OSCILLOSCOPES
Double-beam, DC-15MHz (--3dB). Complete

with types CX1441 (2 off) plug-in Y-Amp units, 100mV/cm (10mV to 750KHz) and type CX1444 Sweep delay time-base unit. Sold in first class operational condition with guarantee. £175 + 8% VAT.

'CENTAUR' INSTRUMENT COOLING FANS

Made by Rotron Holland. These are very high quality, quiet running fans, specially designed for the cooling of all types of electronic equipment Measures 4.5 x 4.5 x 1.5in. 115V AC. 11 Watts The list price of these is over £10 each.

Also 230V. AC available. Either voltage £4.50 each

TEKTRONIX TYPE 556 OSCILLOSCOPE WITH TYPES 1A1 and 1A2 PLUG-IN UNITS. First class condition through

TELEVISION MONITORS

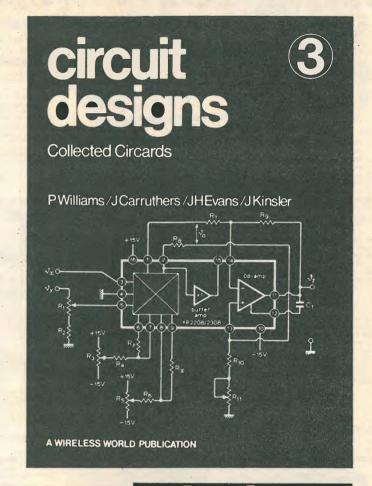
Philips studio quality precision colour monitors and Pye monochrome 405/525/625 lines. PACE ELECTRONICS VARIPLOTTER

MUIRHEAD DECADE OSCILLATORS Type

1Hz-110KHz in four decade ranges. Scope monitored output for high accuracy of frequency. Excellent generator.

This third book in Wireless World's popular series will be welcomed by all concerned with designing, using and understanding electronic circuits. It comprises information previously included in the third ten sets of Wireless World's highly successful Circards—regularly published cards giving selected and tested circuits, descriptions of circuit operation, component values and ranges, circuit limitations, modifications, performance data and graphs. The book follows on from Circuit Designs Nos. 1 and 2. It is magazine size in hard cover and contains ten sets of Circards plus additional information and an explanatory introduction. Like its predecessors, it may soon be difficult to obtain, so you are advised to order your copy without delay.

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



General Sales Department, IPC Business Press Ltd., Room CP34, Dorset House, Stamford Street, London SE19LU.

ORDER FORM

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

Please send me.....copy s of Circuit Designs - Number 3 at £14.50 each inclusive. I enclose remittance value £.. (cheques payable to IPC Business Press Ltd.)

NAME.

Company registered in England and a subsidiary of Reed International Ltd. Registered No. 677128. Regd. office: Dorset House, Stamford Street, London SEL 911

DE LUXE EASY TO BUILD LINSLEY-HOOD 75W AMPLIFIER



1. Fibreglass printed circuit board for power

4. Pair of 2 drilled, finned heat sinks
5. Fibreglass printed-circuit board for

7. Set of low noise, high gain semiconductors for . £2.40 8. Set of potentiometers (including mains

Price Pack
11. Fibreglass printed-circuit board for power supply
12. £0.85

. £1.15
power
£2.50
13. Set of resistors, capacitors, secondary fuses, semiconductors for power supply £5.40
13. Set of miscellaneous parts including DIN skts., mains input skt. fuse holder, interconnecting

table, control knows

14. Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.

15. Handbook £8.20 16. High Quality Teak Veneer cabinet 18.3" x 12,7" x 3.1" £10.70

2 each of packs 1-7, 1 each of packs 8-16 inclusive are required for complete stereo amplifier. Total cost of individually purchased packs £92.80

Designed in response to demand for a tuner to complement the world-wide acclaimed Linsley-Hood 75W Amplifier, this kit provides the perfect match. The Wireless World (Skingley and Thompson) published original circuit has been developed further for inclusion into this outstanding slimline unit and features a pre-aligned front end module, excellent a.m. rejection and temperature compensated varicap tuning, which may be controlled either continuously or by push-button pre-selection. Frequencies are indicated by a frequency meter and sliding LED indicators, attached to each channel selector pre-set. The PLL stereo decoder incorporates active filters for "birdy" suppression and power is supplied via a toroidal transformer and integrated regulator. For long term stability metal oxide resistors are used throughout.

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

LINSLEY-HOOD CASSETTE DECK



SPECIAL PRICE FOR COMPLETE KIT

£79,60

AVAILABLE AS SEPARATE PACKS PRICES IN OUR FREE CATALOGUE

SPECIAL PRICE FOR COMPLETE KIT £99.30

The standard model of our kit for Mr. Linsley-Hood's 75 watt design has for a long time offered exceptional performance at a very modest cost with high quality high power ready-built units of comparable quality generally being over three times the price.

Features of the amplifier include very low distortion (icss than 0.01%), 75W rms per channel power output, rumble

ARABI Our new De Luxe model uses 14 boards which interconnect with gold plated contacts and are designed to have the potentiometers and switches mounted upon them. This system almost eliminates internal wiring, making installation, after their assembly, delightfully straightforward, and as each board can be easily removed in seconds from the chassis, checking and maintenance is so simple that even newcomers to electronics will be able to cope competently with the kit. Additional features of our new model are inclusion of the latest circuit improvements, generously sized heat sinks for heavy duty use, even in tropical climates, and metal oxide resistors throughout for long-term stability and

STANDARD LINSLEY-HOOD 75W AMPLIFIER



SPECIAL PRICE FOR COMPLETE KIT

£79.80

WIRELESS WORLD FM TUNER



SPECIAL PRICE FOR COMPLETE KIT

£70.20

Pack
Price
1. Stereo PCB (accommodates 2 rep. amps. 2 meter, amps, bias/erase osc. relay| £3.35 2. Stereo set of capacitors. M.D. resistors, potentiometers for above £7.95 3. Stereo set of semiconductors for above £8.50 Miniature relay with socket £2.90 5. PCB., all components for solenoid, speed control

7. Function switch, knobs £1.90
8. Dual YU meter with illuminating lamp ... £6.95
9. Toroidal transformer with E.S. screen prim £1.90 £6.95 0-117V, 234V, Sec. 15V

Pack
10 Set of capacitors, rectifiers, I.C. voltage regulator
P.C.B. for power supply (Powertran design) E2.80
11. Set of miscellaneous parts, including sockets, fuse
holder, fuses, interconnecting wire, etc. £3.40

holder, luses, interconnecting wire, etc. £3.40
12. Set of metalwork including silk screened fascia panel, internal screen, fixing parts, etc. £7.10
13. Construction notes £0.25
14. High Quality Teak Veneer cabinet 18.3" x 12.7" £10.70

One each of packs 1-14 inclusive are required for complete stereo cassette deck. Total cost of individually purchased packs £83.00

Matsushita WY 436 AZ head (optional extra) . £4.50

Published in Wireless World (May, June, August 1976) by Mr. Linsley-Hood, this design, although straightforward and relatively low cost, nevertheless provides a very high standard of performance. To permit circuit optimization separate record and replay amplifiers are used, the latter using a discrete component front-end designed such that the noise level is below that of the tape background. Pushbutton switches are used to provide a choice of equalization time constants, a choice of bias levels and also an option of using an additional pre-amplifier for microphone use. The mechanism used is the Goldring-Lenco CRV, a unit distinguished in its robustness and ease of operation. Speed control and automatic cassette ejection are both implemented by electronic circuitry. This unit which is powered by a toroidal transformer and uses metal oxide resistors throughout offers an excellent match for the Wireless World Tuner and the Linsley-Hood 75 Watt Amplifier. Circuit changes as published in February, 1978, follow-up article are included in the kit X NO EXTRA COSTI A higher performance head (Matsushita WY 436 AZ head as recommended in the follow-up article) is offered as an optional extra but this will be automatically supplied FREE OF CHARGE with all orders for complete

T20+20 AND T30+30 20W, 30W AMPLIFIERS



WWII TUNER



SPECIAL PRICE FOR COMPLETE KIT £47.70

AVAILABLE AS SEPARATE PACKS - PRICES IN OUR FREE CATALOGUE

Following the success of our **Wireless World FM Tuner Kit** this cost reduced model was designed to complement the **T20+20** and **T30+30** amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either.

Designed by Texas engineers and described in Practical Wireless, the Texan was an immediate success. Now developed further in our laboratories to include a Toroidal transformer and additional improvements, the sliming T20+20 delivers 20W rms per channel of true Hi-Fiet exceptionally flow cost. The **easy to build** design is based on a single F/Glass PCB and features all the normal facilities found on quality amplifiers including scratch and ramble filters, adaptable input selector and headphones socket. In a follow-up article in Practical Wirelss further modifications were suggested and these have been incorporated into the T30+30. These include RF interference filters and a tape monitor facility. Power output of this model is 30W ms per channel.

SPECIAL PRICES FOR COMPLETE KITS T20+20 KIT PRICE £33.10

T30+30 KIT PRICE £38.40

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

POWERTRAN SFMT TUNER



PRICE FOR COMPLETE KIT £35.90

AVAILABLE AS COMPLETE KIT ONLY

This is a simple, low cost design which can be constructed easily without special alignment equipment but which still gives a first-class output suitable for feeding any of our very popular amplifiers or any other high quality audio equipment. A phase-locked-loop is used for stereo decoding and controls include switchable afc, switchable muting and push-button channel selection (adjustable by controls on the front panel). This unit matches well with the T20+20

200 + 200 watt Amplifier

WIRELESS WORLD MARCH 1979

400W rms continuous —— 800W peak! 0.03% THD at FULL power! PLUS all the following features too!

- ★ Inherent reliability monster heat sinks for cool running at the hottest venues electronic open and short circuit protection!
- ★ Ultra low feedback (an incredible low 14dB overall!), super high slewing rate (20V/μs), 200W rms continuous to 4 ohm from EACH channel, input sensitivity 0.775V (0dB).
- Professional quality components, sturdy 19 rack mounting chassis complete with sleeve and feet for free standing work too.
- * Easy to build plenty of working space with ready access to all components, 'minimal wiring, extensive instruction suitable for both experienced constructors and newcomers to electronics.
- * Value for money quality and performance comparable with ready-built amplifiers costing over

PSI 4002 STUDIO MODEL



Cabinet size 17.2" x 6.7"

COMPLETE KIT ONLY £196.90 + VAT

READ THE REVIEW

IN SOUND INTERNATIONAL DEC 78!

SINGLE BOARD SYNTHESIZER TRANSCENDENT 2000 As featured in Electronics Today International



The kit includes fully finished metalwork, fully assembled solid The kit includes tully finished metalwork, fully assembled soline teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibre glass PCB printed with component locations. All the controls mount directly on the main board, all connections to the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!

> COMPLETE KIT ONLY £172.00 + VAT!

Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more than a multi-meter and a pair of

CHROMATHEQUE 5000 5-CHANNEL LIGHTING EFFECTS SYSTEM

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound to light or have it strobe all the lights at a speed dependent upon music level or front panel control setting or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is ing 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 the last nut and bolt!

COMPLETE KIT ONLY £49.50 + VAT

MPA200 100W MIXER/ **AMPLIFIER**

> **COMPLETE KIT** £49.90 + VAT



. .

Wireless World Designs: Full kits are not available for the projects below but PCBs and component sets are stocked. Further details of these and other packs are in our Free Catalogue.

Linsley-Hood Low Distortion Oscillator.
LDO Pk. 1 Fibreglass PCB
LDO Pk. 2 MO Resistors, capacitors
LDO Pk. 3 Semiconductors

Details of Stuart Tape Recorder and SQ Quadraphonic Decorders are in FREE CATALOGUE

£1.65 £2.60 £3.90

All kits also available as separate packs (eg PCB component sets, hardware sets, etc). Prices in our FREE CATALOGUE.

EXPORT A SPECIALITY! Our Export Department can readily despatch orders of any size to any country in the world. Some of the countries to which we sent kits last year are shown in this advertisement. To assist in estimating postal costs our catalogue gives the weights of all packs and kits. This will be sent free on request, by airmail, together with our "Export Postal Guide" which gives current postage prices. There is no minimum order charge. Prices same as for U.K. customers but no Value Added Tax charged. Postage charged at a ctual cost plus 50p documentation and handling. Please send payment with order by Bank Draft. Postal Order, International Money Order or cheque drawn on an account in the U.K. Alternatively for orders over £500 we will accept Irrevocable Letter of Credit payable at sight in London.

Value Added Tax not included in prices **UK Carriage FREE**

PRICE STABILITY. Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until March 31st, 1979, if this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.

U.K. ORDERS: Subject to 121/2% surcharge for VAT (i.e. add 1/8 to the

No charge is made for carriage. 'Or current rate if charged SECURICOR DELIVERY: For this optional service (U.K. mainland only)

add £2.50 (VAT inclusive) per kit.

SALES COUNTER: If you prefer to collect your kit from the factory, call at Sales Counter (at rear of factory). Open 9 a.m. 4.30 p.m. Monday-Thursday.

QUALITY: All components are brand new first grade full specification guaranteed devices. All resistors (except where stated as metal oxide) are low noise carbon film types. All printed circuit boards are fibreglass, drilled roller tinned and supplied with circuit diagrams and construction layouts.

FOR FURTHER INFORMATION PLEASE WRITE OR TELEPHONE FOR OUR FREE CATALOGUE

PORTWAY INDUSTRIAL ESTATE ANDOVER HANTS SP10 3NN

(0264) 64455

6

J. L. Linsley-Hood High Quality **Cassette Recorder**



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 £81.50 plus VAT.

REPRINTS of the 3 articles describing this design 45p No VAT.

REPRINT of Postscript article 30p No VAT.

TEST CASSETTE TC1

Special Hart Copyright test tape makes it easy to set up VU level, head azimuth and tape speed, without test instruments. Suitable for any cassette recorder. Complete with instructions £2.50 inc VAT



SCOOP PURCHASE

Everybody thought they had all gone but we found them! Brand New Garrard CT4 cassette mechanisms as used by J. L. Linsley-Hood in the prototype cas-sette recorder. These come complete with the motor and solenoid boards fitted, wired and tested. Record/play head is a Matsushita WY435z. Equivalent Lenco value £22. Our price only £11.99 plus £1.50 VAT.

PLASTIC ESCUTCHEON

Suitable for CRV and CT4 mechanisms. As used on our cassette recorder, complete with mounting screws £1.99 plus VAT.

CASSETTE HEADS

A large range of cassette heads for domestic, industrial and audio visual purposes is available from us. The very best stereo head that we can find is our HS15 Sendust Alloy Super Head. This has an even better high frequency response than our HS14 which it replaces. Unlike cheaper and ferrite types this excellent high frequency performance is combined with a high output, thus maintaining the best possible signal to noise ratio. **Price £7.60** plus VAT.

4-TRACK Record / play head. Scans all 4 tracks on cassette tape. Suitable for auto-reverse mechanisms, film sync, quadrophonics and many other purposes. Standard impedance £7.40 plus VAT

Full details of these and other heads are in our lists.

LENCO CASSETTE MECHANISMS

We hold stocks of a range of Lenco tape transports for all uses, we can also supply spare parts. For example

CRV Motors complete £4.00 plus VAT.
CRV Drive Belts 90p plus VAT.

CASSETTES

Our laboratory tests on recorders made us realise how important the choice of cassette is. Wow and flutter is obviously affected by the quality of the housing but the performance differences caused by the tape are enormous. It is possible to record a signal at the same level on two different cassettes one of which will replay at a VU level 10db higher than the other. Poor tape can also lose all signals above 8KHz! These tests enable us to offer what we think is the best value available. The tape is a Super Ferric High Energy Low Noise formulation

C60 60p

Complete with library case and index card

Complete in library case. Suitable for Micro Programming. C10 35p

ALL UK ORDERS ARE POST FREE Please send 9x4 SAE for lists giving fuller details and price breakdowns.

Penylan Mill, Oswestry, Salop

Personal callers are always welcome but please note we are closed all day Saturday

AY38500 450p LM381N 90p CA30039 70p LM382 90p SN76023ND TBA7500 205p TBA7500 205p CA3046 60p LM391 180p SN76023ND TBA8800 80p CA3060 225p LM750C 40p SN76023ND TBA8800 80p CA3065 200p LM709C 40p SN76023ND TBA880 100p CA3076 250p LM710DIL 65p SN76023ND TBA880 100p CA3080 75p LM710DIL 65p SN76227N 160p TBA8200 280p CA3084 250p LM723DL 40p SN76227N 160p TCA270S 220p CA3084 250p LM723DL 40p TAA300 100p TCA270S 220p CA3088 85p LM723DL 40p TAA300 100p TCA270S 220p CA3088 190p LM743 120p TAA350 190p TCA4500 A450p CA3088 190p LM748 40p TAA550 35p TDA1008 350p CA3089 160p LM748 40p TAA550 35p TDA1008 350p CA31089 160p LM1458 100p TAA661B 140p TDA2002 300p CA3123E 130p LM1458 100p TAA700 350p TDA1034 450p CA3123E 130p LM1458 100p TAA700 350p TDA2020 300p TAA700 350p TL084 120p CA3140 60p LM3080 75p TAA700 350p TL084 120p CA3140 60p LM3090 55p TAD110 150p XR320 250p LM311H 250p MC1312P 150p TBA120T 350p XR2206 450p LM301AN 30p MC1314P 190p MK50398 650p TBA5200 200p XR2207 450p LM301AN 30p MK50398 650p TBA5200 200p XR2207 450p LM301AN 30p MK50398 650p TBA5200 200p XR2216 650p LM309N 100p MK50398 650p TBA5200 200p XR4202 150p LM308N 100p MK50398 650p TBA5200 200p XR4202 150p LM308N 100p MK50398 650p TBA5200 250p XR4202 150p LM308N 100p MK5514 480p TBA560C 250p XR4202 150p LM308N 100p MK5514 480p TBA560C 250p XR4202 150p LM308N 100p MK5514 480p TBA560C 250p XR4202 150p LM308N 100p MK5514 480p TBA560C 250p XR4202 150p LM308N 100p ME555 25p MK5224 1500p MK514 150p MK55039 A00p MK55039 650p TBA560C 250p XR4202 150p MM531170S 150p MS556 400p MS514 480p MC1314P 150p MK55039 650p TBA560C 250p XR4202 150p MM531170S 150p MS556 400p MS514 450p MS504 450p M	LINEA	R	LM380	60p	SN76013N	ND	TBA700	180p
CA3039 70p LM382 90p SN76023N 110p TBA7500 200p CA3060 205p LM391 180p SN76023ND TBA800 80p CA3065 200p LM709C 40p SN76023ND 125p TBA810 100p CA3076 250p LM710DL 65p SN76023N 150p TBA820 100p CA3080 75p LM710DL 65p SN76228N 180p TCA2700 220p CA3085 85p LM723T05 40p SN76228N 180p TCA2700 220p CA3086 60p LM723DL 40p TAA300 100p TCA760 300p CA3088 190p LM741 20p TAA350 190p TCA4500A 450p CA3089 160p LM748 40p TAA570 220p TDA1008 350p CA3123E 130p LM1458 100p TAA661B 140p TDA2002 300p CA3123E 130p LM3080 75p TAA700 350p TDA2020 300p CA3130 100p LM3080 75p TAA700 350p TDA2020 300p CA3140 60p LM3080 75p TAA700 350p TL084 120p CA3140 60p LM3090 55p TAA700 350p TL084 120p CA3140 60p LM3090 FSp TAA700 350p TL084 120p CA3140 60p LM3090 FSp TAA700 350p TL084 650p LM300TRS 170p MC1312P 150p TBA1202 60p XR2207 450p LM301AN 30p LM301AN 30p MC1312P 150p TBA120T 85p XR2208 600p LM301AN 30p LM301AN 30p MC1314P 190p TBA4800 200p XR2216 650p LM309N 65p LM300TRS 170p MK50398 650p TBA5200 200p XR2216 650p LM308T 100p MK50398 650p TBA5200 200p XR2216 650p LM308N 100p LM308N 100p MK50398 650p TBA5500 250p XR4136 150p LM308N 100p LM308N 100p NE559K 150p TBA560C 250p XR4121 150p LM308N 150p NE5528 400p LM311T0S 150p NE5528 400p LM311T0S 150p NE5528 400p LM311T0S 150p NE5528 400p LM311T0S 150p NE5528 AD01024 1500p	AY38500	450p	LM381N	90p		125p		
CA3046 60p LM391 180p SN76023ND TBA800 80p CA3065 200p LM709C 40p SN76033N 150p TBA820 100p CA3076 250p LM710T05 80p SN76227N 160p TBA820Q 280p CA3084 250p LM710T05 80p SN76227N 160p TBA820Q 220p CA3085 85p LM723D14 40p SN76660N 75p TCA270S 220p CA3085 85p LM723D14 40p TAA300 100p TCA760 300p CA3086 80p LM733 120p TAA300 100p TCA760 300p CA3088 190p LM741 20p TAA350 190p TCA4500A 450p CA3089 160p LM748 40p TAA570 220p TDA1034 450p CA3089 160p LM748 40p TAA570 220p TDA1034 450p CA3090AQ 360p LM1303N 100p TAA661B 140p TDA2002 300p CA3123E 130p LM1458 100p TAA700 350p TDA2020 300p CA3140 60p LM3900 55p TAA700 350p TDA2020 300p CA3140 60p LM3909 65p TAA700 350p TL084 120p CA3140 60p LM3909 65p TAA700 350p TL084 120p CA3140 60p LM3909 65p TAA700 350p TL084 120p CA3140 60p LM3909 65p TAA700 350p TL084 450p CA3140 60p LM3909 FSp TAA790 350p TL084 120p CA3140 60p LM3909 65p TAA700 350p TL084 120p CA3140 60p LM3909 65p TAA700 350p TL084 650p LM314P 190p MC1314P 190p TBA120T 85p X8220 450p LM301AN 30p MC1314P 190p TBA120T 85p X82206 650p LM301AN 30p MC1314P 190p TBA520Q 200p XR2216 650p LM307N 65p LM307N 65p LM307N 65p LM307N 65p LM307N 65p MK50398 650p TBA520Q 200p XR2216 650p LM308N 100p M5514 480p TBA560C 250p XR413 150p LM308N 100p M5516 480p TBA560C 250p XR4202 150p LM308N 100p M5516 480p TBA560C 250p XR4202 150p LM308N 100p NE529K 150p TBA560C 250p XR4202 150p LM308N 100p NE556 90p NE5628 400p LM311705 150p NE556 90p LM311705 150p NE5628 400p NE5628 400p LM311705 150p NE5628 400p NE5628 400p LM311705 150p NE5628 400p NE5628 400p M54116 450p M54116 45	CA3039	70p	LM382	90p	SN76023N	110p		
CA3065 200p LM709C 40p SN76033N 150p TBA810 100p CA3076 250p LM709C 40p SN76023N 150p TBA820 100p CA3076 250p LM710DL 65p SN7622N 160p TBA8200 280p CA3084 250p LM723105 40p SN7622N 180p TCA270Q 220p CA3085 85p LM723105 40p SN76628N 180p TCA270Q 220p CA3086 60p LM733 120p TAA350 190p TCA4500 450p CA3088 190p LM741 20p TAA350 190p TCA4500 450p CA3089 160p LM748 40p TAA550 35p TDA1008 350p CA3090AQ 360p LM148 40p TAA570 220p TDA1008 350p CA3123E 130p LM1458 100p TAA5661 140p TDA2002 300p CA3123E 130p LM3080 75p TAA700 350p TDA2020 300p CA3130 100p LM3080 75p TAA700 350p TDA2020 300p CA3140 60p LM3900 55p TAA700 350p TDA2020 300p CA3140 60p LM3900 55p TAA1010 150p XR320 450p LM3141 250p LM3909 NG5p TAA1010 150p XR320 450p LM3111 250p MC1312P 150p TBA120S 60p XR2207 450p LM301AN 30p MC1312P 150p TBA120S 60p XR2207 450p LM301AN 30p MC1312P 150p TBA480Q 200p XR22667 250p LM301AN 30p MK50398 650p TBA530Q 200p XR2266 650p LM309N M5514 880p MK50398 650p TBA550Q 200p XR2266 7250p LM308T05 100p MM5514 880p TBA540Q 200p XR4202 150p LM308DIL 100p M5505 25p TBA560C 250p XR4202 150p LM309K 100p LM308DIL 100p NE529K 150p TBA560C 250p XR4212 150p LM301TNO 150p NE556 90p TBA550Q 250p SH90 700p LM311TNO 150p NE556 90p LM311TNO 150p LM311TNO 150p LM311TNO 150p LM311TNO 150p XAD1024 1500p	CA3046	60p	LM391	180p	SN76023N	ID		
CA3065 250p LM710705 60p SN76033N 150p TBA8200 200p CA3080 75p LM710705 60p SN76227N 160p TBA8200 220p CA3084 250p LM723105 40p SN76227N 160p TBA8200 220p CA3086 85p LM723D1L 40p TAA300 100p TCA750 300p CA3086 60p LM733 120p TAA350 190p TCA4500A 450p CA3089 160p LM741 20p TAA550 35p TDA1008 350p CA3080 810p LM748 40p TAA570 220p TDA1034 450p CA3090A0 360p LM748 100p TAA661B 140p TDA2002 300p CA3123E 130p LM1458 100p TAA661B 140p TDA2002 300p CA3130 100p LM3080 75p TAA700 350p TDA2020 300p CA3140 60p LM3909N 65p TAA700 350p TDA2020 300p CA3140 60p LM3909N 65p TAA700 350p TDA2020 300p CA3140 60p LM3909N 65p TAA700 350p TDA2020 450p LM311H 250p MC1312P 150p TAA100 150p XR320 450p LM300TRS 170p MC1314P 190p TBA120T 85p XR2206 450p LM301AN 30p MC1315P 230p TBA5200 200p XR2207 450p LM301AN 30p MC1315P 230p TBA5200 200p XR2216 650p LM307N 65p	CA3060	225p	LM555	25p		125p		
CA3076 250p LM710T05 60p SN76227N 160p TBA9200 280p CA3084 250p LM710DIL 65p SN76628N 180p TCA270S 220p TCA270S 220p CA3084 250p LM723T05 40p SN76660N 75p TCA270S 220p TCA270S 220p TCA3085 85p LM723DIL 40p TAA300 100p TCA760 300p CA3088 190p LM743 120p TAA350 190p TCA4500A 450p TCA3090A 450p LM748 40p TAA550 35p TDA1008 350p CA3090AQ 360p LM1303N 100p TAA550 35p TDA1008 350p CA3123E 130p LM1458 100p TAA5661B 140p TDA2002 300p CA3130 100p LM3080 75p TAA700 350p TDA2020 300p TAA350 80p LM3900 S5p TAA700 350p TDA2020 300p TAA556 80p LM3909N 65p TAA700 350p TDA2020 300p TAA557 80p LM3909N 65p TAA790 350p TL084 120p CA3140 60p LM3900 S5p TAA100 150p XR320 450p LM314D 140p TAA570 350p TL084 120p TAA700 350p TDA2020 300p TAA700 350p TL084 120p TAA700 350p TDA2020 300p TAA700 TDA2020 300p TAA700 350p TDA2020 300p TDA2020 300p TAA700 350p TDA2020 300p TDA2020 300p TAA700 350p TDA2020 300p TDA2020 3	CA3065	200p	LM709C	40p	SN76033N			
CA3080 75p LM710DIL 65p SN 76628N 180p TCA2700 220p CA3085 85p LM723DIL 40p TAA300 100p TCA760 300p CA3086 60p LM733 120p TAA350 190p TCA4500A 450p TAA3089 160p LM741 20p TAA550 35p TDA1008 350p CA3089 160p LM741 20p TAA550 35p TDA1008 350p CA3090AQ 360p LM1303N 100p TAA650 35p TDA1008 350p CA3123E 130p LM1458 100p TAA670 220p TDA1034 450p TAA510 100p CA3140 60p LM3080 75p TAA700 350p TDA2020 300p CA3140 60p LM3909 65p TAA700 350p TDA2020 300p LM3140 60p LM3909 65p TAD100 150p XR320 250p LM3111 250p MC1312P 150p TBA120T 85p XR2208 600p LM301AN 30p MC1315P 230p TBA120T 85p XR2208 600p LM301AN 30p MC1315P 230p TBA5202 200p XR2567 250p LM301AN 30p MC1315P 230p TBA5202 200p XR2567 250p LM301AN 30p MS50398 650p TBA5202 200p XR2567 250p LM301AN 30p MS514 380p LM3037N 65p LM301AN 30p MS514 380p LM3037N 65p LM301AN 30p MS514 380p LM308T0S 100p MS516 480p TBA500 250p XR4202 150p LM308DIL 100p LM308N 100p NE529K 150p TBA560C 250p XR4123 150p LM308N 100p NE529K 150p TBA560C 250p XR4212 150p LM308N 100p NE556 90p NE5662B 400p LM31170S 150p NE566 90p NE5662B 400p LM31170S 150p NE566 90p MS31170S 150p NE566 90p LM31170S 150p NE566 90p NE5662B 400p LM31170S 150p NE5662B 400p LM31170S 150p NE5662B 400p LM31170S 150p NE5660B A00p NE5650B A00p MS116B A00p	CA3076	250p	LM710T05	60p				
CA3084 250p LM723T05 40p SN76660N 75p TCA270S 220p CA3085 85p LM723DIL 40p TAA300 100p TCA760 A50p CA3088 190p LM733 120p TAA350 190p TCA7600 A50p CA3088 190p LM741 20p TAA350 190p TCA7600 A50p CA3089 160p LM748 40p TAA550 35p TDA1008 350p CA3090AQ 360p LM148 100p TAA570 220p TDA1034 450p CA3123E 130p LM1458 100p TAA700 350p TDA2002 300p CA3130 100p LM3080 75p TAA700 350p TDA2020 300p CA3130 100p LM3080 75p TAA700 350p TDA2020 300p CA3140 60p LM3900 55p TAA700 350p TL084 120p CA3140 60p LM3909 65p TAA700 350p TL084 120p CA3140 60p LM3909 N65p TAA700 350p TL084 120p CA3140 60p LM3909 N65p TAD110 130p XR3200 450p LM311H 250p MC13110P 140p TBA120T 60p XR2207 450p LM300TRS 170p MC1314P 190p TBA120T 85p XR2208 600p LM301AN 30p MC1314P 190p TBA480Q 200p XR2216 650p LM301AN 30p MC1315P 230p TBA520Q 200p XR2266 650p LM307N 65p LM307N 65p LM307N 65p LM308T05 100p MM5314 380p LM308T05 100p MM5314 480p TBA550Q 250p XR4202 150p LM308DIL 100p NE529K 150p TBA560C 250p XR4202 150p LM308DIL 100p NE529K 150p TBA560C 250p XR4213 150p TBA560C 250p SR4212 150p LM308T15 150p NE556 90p LM311T05 150p NE562B 400p LM311T05 150p NE562B 400p LM311T05 150p NE562B A00p LM3	CA3080	75p	LM710DIL	65p	SN /6228N	180p		
CA3085 60p LM723DIL 40p TAA300 100p TCA760 300p CA3088 190p LM733 120p TAA350 190p TCA4500A 450p TCA4500A 450p CA3088 190p LM741 20p TAA550 35p TDA1008 350p TDA1008 360p TAA500 350p TDA1008 360p TAA501 350p TAA501 35	CA3084	250p	LM723T05	40p	SN76660N	75p	TCA270S	
CA3086 60p LM733 120p TAA350 190p TCA4500A 450p CA3089 160p LM741 20p TAA550 35p TDA1008 350p CA3089 160p LM748 40p TAA550 35p TDA1034 450p CA3090AQ 360p LM1303N 100p TAA5661B 140p TDA2002 300p CA3123E 130p LM1458 100p TAA700 350p TDA2002 300p CA3130 100p LM3080 75p TAA700 350p TDA2002 300p CA3140 60p LM3900 55p TAA700 350p TDA2002 300p LF356 80p LM3909N 65p TAA700 350p TDA2002 300p LF357 80p LM3909N 65p TAD1100 150p XR320 250p LM311H 250p MC1312P 140p TBA120S 60p XR2207 450p LM301AN 30p MC1315P 230p TBA120T 85p XR2208 600p LM301AN 30p MC1315P 230p TBA520Q 200p XR2216 650p LM301AN 30p MK50398 650p TBA520Q 200p XR2216 650p LM301AN 30p MK50398 650p TBA520Q 200p XR2166 650p LM301AN 30p MK50398 650p TBA530Q 200p XR4202 150p LM308DIL 100p M5514 480p TBA560C 250p XR4202 150p LM308DIL 100p M5516 480p TBA560C 250p XR4202 150p LM308DIL 100p NE529K 150p TBA560C 250p XR4212 150p LM309K 100p NE555 25p TBA641A12 TAV141 100p LM311TOS 150p NE556 90p NE562B 400p LM311TOS 150p NE562B 400p LM311TOS 150p SAD1024 1500p	CA3085	85p		40p	TAA300			
CA3088 190p LM741 20p TAA550 35p TDA1008 350p CA3090 AQ 360p LM748 40p TAA570 220p TDA1034 450p TDA2020 300p TAA570 350p TAA570 35	CA3086	60p	LM733	120p	TAA350	190p	TCA4500A	
CA3089 160p LM748 40p TAA570 220p TDA1034 450p TA3090AQ 360p LM1303N 100p TAA661B 140p TDA2002 300p TA30130 100p LM3080 75p TAA6700 350p TDA2020 300p TA30130 100p LM3080 75p TAA6700 350p TDA2020 300p TA30130 100p LM3080 75p TA50100 150p XR320 250p LF357 80p LM3909N 65p TA50100 150p XR320 250p LF357 80p MC1310P 140p TBA120S 60p XR3207 450p LM301AN 30p MC1312P 150p TBA120T 85p XR2206 600p LM301AN 30p MC1314P 190p LM301AN 30p MC1315P 230p TBA520Q 200p XR2567 250p LM307N 65p LM307N 65p LM307N 65p LM30816 480p TBA500 200p XR2567 250p LM308T05 100p M5316 480p TBA500 250p XR4202 150p LM308DIL 100p LM308DIL 100p LM308DIL 100p NE529K 150p TBA560C 250p XR4739 150p LM308DIL 150p NE556 90p LM311T05 150p NE556 90p LM311T05 150p NE562B 400p LM3117K 325p SAD1024 1500p	CA3088	190p		20p	TAA550	35p	TDA1008	
CA3123E 130p LM1458 100p TAA7700 350p TDA2020 300p CA3130 100p LM3080 75p TAA790 350p TDA2020 300p TAA790 TAA790 350p TDA2020 300p TAA790 150p TAA790 350p TDA2020 300p TAA790 350p TAA790 350p TAA790 350p TAA790 150p TAA790 350p TAA790 350p TAA790 350p TAA790 150p TAA790 350p TAA790 150p					TAA570	220p	TDA1034	
CA3130 100p LM3080 75p TAA790 350p TL084 120p CA3140 60p LM3909 55p TAD110 150p XR320 250p XR3206 450p LF356 80p LM3909N 65p TAD110 130p XR3206 450p LM311H 250p MC1312P 150p TBA120T 85p XR2207 450p LM300TRS 170p MC1314P 190p TBA120T 85p XR2208 600p LM301AN 30p MC1314P 190p TBA4800 200p XR2216 650p LM301AN 30p MC1314P 190p TBA5200 200p XR2216 650p LM307N 65p LM3087 85p LM3087 85p LM308T05 100p MM5314 380p LM308T05 100p M5516 480p TBA5500 250p XR4202 150p LM308DIL 100p NE529K 150p TBA560C 250p XR4202 150p LM309K 100p NE555 25p TBA560C 250p XR4739 150p LM311705 150p NE556 90p NE562B 400p LM311705 150p NE562B 400p LM311705 325p XAD1024 1500p Im4148 idiodate by ILTL/faxis 100 for £1.50					TAA661B	140p	TDA2002	300p
CA3140 60p LM3900 55p TAD100 150p XR320 250p LF356 80p LM3909N 65p TAD110 130p XR2206 450p LF357 80p MC1310P 140p TBA120S 60p XR2207 450p LM211H 250p MC1312P 150p TBA120T 85p XR2208 600p LM301AN 30p MC1315P 230p TBA5200 200p XR2267 250p LM301AN 30p MC1315P 230p TBA5200 200p XR2567 250p LM307N 65p MK50398 650p LM307N 65p MK50398 650p LM307N 65p MM5314 380p LM308T05 100p MM5316 480p TBA5500 200p XR4202 150p LM308DIL 100p M5529K 150p TBA5500 250p XR4212 150p LM308DIL 100p NE555 25p TBA560C 250p XR4212 150p LM309X 100p NE556 90p LM311T05 150p NE556 90p NE562B 400p LM311T05 150p NE562B 400p LM311T05 150p NE562B 400p LM311T05 150p NE566B 400p LM311T05 150p NE562B 400p LM311T05 150p LM311T05 150p NE562B 400p LM311T05 150p NE562B 400p LM311T05 150p NE562B 400p LM311T05 150p LM3					TAA700	350p	TDA2020	300p
LF356 80p LM3909N 65p TAD110 130p XR2206 450p LM3014N 30p MC1312P 150p TBA120T 85p XR2208 600p LM3014N 30p MC1315P 230p TBA202 200p XR2216 650p LM3014N 30p MC1315P 230p TBA5200 200p XR2567 250p LM307N 65p LM307N 65p LM308T05 100p M55314 380p LM308T05 100p M55314 480p TBA500 250p XR4136 150p LM308DIL 100p LM308DIL 100p LM308DIL 100p NE529K 150p TBA560C 250p XR4739 150p LM309K 100p NE556 25p LM30175 150p NE562B 400p LM311705 150p NE562B 5AD1024 1500p Im4148 idealeu by LT.T./faxis 100 for £1.50					TAA790	350p	TL084	120p
F357 80p MC1310P 140p TBA120S 60p XR2207 450p MC1311P 150p TBA120T 85p XR2208 600p MC1314P 190p TBA480Q 200p XR2216 655p MC1314P 230p MC1315P 230p TBA520Q 200p XR2267 250p MC1307N 65p MC13147 380p					TAD100	150p	XR320	250p
LM211H 250p MC1312P 150p MC3312P 150p MC3314P 190p TBA450Q 200p XR2216 650p TBA50Q 200p XR2567 250p MK50398 650p TBA520Q 200p XR2567 250p MK50398 650p TBA520Q 200p XR4136 150p MM5316 480p TBA550Q 200p XR4136 150p MM5316 480p TBA550Q 250p XR4202 150p LM308DIL 100p M529K 150p TBA550Q 250p XR4212 150p LM308DIL 100p NE529K 150p TBA560C 250p XR4212 150p LM309K 100p NE555 25p TBA641A12 ZN414 100p LM311705 150p NE562B 400p M5311705 150p N5311705 150p N5					TAD110	130p	XR2206	450p
LM300TRS 170p MC1314P 190p M54800 200p XR2216 650p M54801 A 30p M54800 200p XR2216 650p M54801 A 30p M54800 200p XR2567 250p M54136 150p M54800 200p XR4136 150p M54800 200p XR4136 150p M54800 200p XR4136 150p M54800 200p XR4136 150p M54800 200p XR4202 150p M54800 200p XR4202 150p M54800 200p XR4202 150p M54800 250p XR4212 150p M54800 250p XR4212 150p M54800 250p XR4212 150p M54800 250p XR4212 150p M54800 250p XR4739 150p M54800 250p XR4212 2000 XR4739 150p M54800 250p XR4739 150p M54800 250p XR4739 150p M54800 250p XR4739 150p M54800 250p XR4739 150p M54800 250p XR4739 150p M54800 250p XR4739 150p M54800 250p XR4739 150p M54800 250p XR4739 150p M54800 250p XR4739 150p M54800 250p XR4739 150p M54800 200p XR4739 150p X					TBA120S	60p	XR2207	450p
LM301AN 30p MC1315P 230p TBA520Q 200p XR2567 250p LM307N 65p MM5514 380p LM308T05 100p MM5316 480p LM308DIL 100p LM308DIL 100p LM308K 100p LM308K 100p LM308K 100p LM308K 100p LM308K 100p LM308K 100p LM3016K 100p LM3016K 100p LM3016K 100p LM3016K 100p LM3016K 100p LM3016K 100p LM3017K 325p XAD1024 1500p LM3117K 325p XAD1024 1500p LM317K 325p XAD1024 1500p X					TBA120T	85p	XR2208	600p
LM304 200p MK50398 650p TBA5300 200p XR4136 150p MS314 380p TBA540 200p XR4202 150p LM308T05 100p M5316 480p TBA5500 250p XR4202 150p LM308DIL 100p NE529K 150p TBA560C 250p XR4213 150p LM310T05 150p NE556 90p LM311T05 150p NE562B 400p LM311T05 150p NE562B 400p LM311T05 150p NE562B 400p LM311TX 325p SAD1074 1500p Im4148 diedeu by LT.T./fexas 100 for £1.50					TBA480Q	200p	XR2216	650p
LM307N 65p MM5314 380p TBA540 200p XR4202 150p LM308T05 100p M5316 480p TBA550Q 250p XR4212 150p LM309K 100p NE555 25p TBA560C 250p XR4739 150p LM310T05 150p NE556 90p M311T05 150p NE562B 400p LM311T05 150p NE562B 400p LM317K 325p SAD1024 1500p M4148 fieldes by LT.T./faxas 100 for £1.50					TBA520Q	200p	XR2567	250p
LM308T05 100p MM5316 480p TBA550Q 250p XR4212 150p LM308DIL 100p NE559K 150p LH310T05 150p NE556 90p LM311T05 150p NE562B 400p NE562B 400p LM311T05 150p NE562B 400p NE562					TBA530Q	200p	XR4136	150p
LM308DIL 100p NE529K 150p TBA560C 250p XR4739 150p NE555 25p TBA641A12 ZN414 100p LM311705 150p NE556 90p NE562B 400p LM3117K 325p SAD1074 1500p M317K 325p SAD1074 1500p M317K 325p SAD1074 1500p M317K 325p SAD1074 1500p					TBA540	200p	XR4202	150p
LM309K 100p NE555 25p TBA641A12 ZN414 100p LM311T05 150p NE5656 90p LM311T05 150p NE562B 400p LM317K 325p SAD1024 1500p M4148 fieldes by I.T.T./fexas 100 for £1.50					TBA550Q	250p	XR4212	150p
LH310T05 150p NE556 90p NE562B 400p LM317K 325p SAD1024 1500p In 4148 diedes by I.T.T./fexas 100 for E1.50					TBA560C	250p	XR4739	
LM311T05 150p NE562B 400p LM317K 325p SAD1024 1500p In 4148 diedes by I.T.T./Texas 100 for £1.50					TBA641A1	2	ZN414	
LM317K 325p SAD1024 1500n In 4148 diodes by I.T.I./Texas 100 for £1.50						250p	95H90	700p
LIVI 324 /Up 5L91/B 65Up 2112 255 v A bit A50 sans can 52 E0								Catil
LM339 60p SN /6003N 150p Murata ultrasonic transducers 40kHz £2.00 each or £3.50 pair								E3.50 pair
LM348N 90p SN76013N 110p ALL PRICES INCLUDE POST AND VAT	LM348N	90p	SN76013N	110p	AL	L PRICES INC	LUDE POST AND VAT	-

7400	10p	7432	20p	7482	75p	74126	35p	74155	45p	74181 130 p
7401	10p	7433	28p	7483	75p	74128	60p	74156	45p	74182 50p
7402	10p	7437	20p	7484	70p		120p	74157	45p	74184 120p
7403	10p	7438	20p	7485	60p	74131	90p	74160	55p	74185 100p
7404	12p	7440	12p	7486	25p	74132	45p	74161	55p	74188 320p
7405	12p	7441	45p	7489	130p	74135	90p	74162	55p	74190 70p
7406	25p	7442	40p	7490	25p	74136	80p	74163	55p	74191 70p
7407	25p	7443	60p	7490	40p	74137	90p	74164	60p	74192 60p
7408	12p	7444	60p	7492	35p		100p	74165	60p	74193 60p
7409	12p	7445	65p	7493	30p	74141	50p	74166	75p	74194 55p
7410	12p	7446	50p	7494	70p	74142		74167	160p	74195 50p
7411	15p	7447	50p	7495	45p	74143		74170		74196 50p
7412	15p	7448	50p	7496	45p	74144		74173	80p	74197 50p
7413	25p	7450	12p	7497	120p	74145	55p	74174	60p	74198 100p
7414	45p	7451	12p	74100			100p	74175	60p	74199 100p
7416	25p	7453	12p	74104	40p	74148	90p	74176	50p	74293 90p
7417	25p	7454	12p	74105	40p	74150	65p	74177	50p	741500 18p
7420	12p	7460	12p	74103	25p	74151	45p	74178	75p	745112 80p
7421	20p	7470	25p	74108	100p	74153	45p	74179	120p	7-10112 000
7422	15p	7472	20p	74109	25p	74154	70p	74180	90p	
7423	20p	7473	25p	74118		74134		200		
7425	20p	7474	25p	74120	75p 80p			20	W	ELL
7426	22p	7475	25p	74121	25p					
7427	22p	7476	25p	74122	. 35p	3				London N1
7428	25p	7480		74123				ephone		
7430	12p	7481		74125	40p	I di la	Barclay	/ Access cr	edit card	is accepted
		7-01	osp	74123	35p	Shop	closed f	rom 21st [Decembe	r to 2nd January

RADFORD

AUDIO MEASURING INSTRUMENTS

Oscill	ators
--------	-------

LDO3. Low Distortion Oscillator £300.00	
LDO3B. Low Distortion Oscillator, balanced output	
£400.00	

Distortion Measuring Sets

DMS3. Distortion Measuring Set, manual nulling£250.00 DMS4. Distortion Measuring Set, auto-nulling £350.00

Voltmeters

HSV1. Audio Microvoltmeter, average responding

HSV2. Audio Microvoltmeter, true r.m.s. reading£225.00

Noisemeters (psophometers)

ANM1. Audio Noisemeter and Microvoltmeter,		
average responding	£200.00	
ANM2. Audio Noisemeter and Microvoltmeter,		
true r.m.s. reading	£250.00	
ANM3. Audio Noisemeter and Microvoltmeter,		
true r.m.s. and quasi-peak responding	£300.00	

Descriptive leaflets available on request.

RADFORD LABORATORY INSTRUMENTS LTD. 4 High Street, Nailsea, Bristol BS19 1BW Tel. 02755-6637

WIRELESS WORLD, MARCH 1979

MODEL 500 MHz CTR-2A & 1 GHz 1 us to 10 my @ 1 sec. 150 MHz

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

- Built-in Pre-Amc 10 mv @ 150 MHz 8 Digit .3 LED Display High Stability TCXO Time Base Built-in VHF-UHF Prescaler

Counter

£145 + 8% VAT

600.10983 MELIN.

7208 COUNTER

General Purpose Low Cost Counter Without the Sacrifice of Basic Performance "Check the features we have that some other low-cost counters don't

- have"

All Metal Cabinet
8 Digit 4 LED Display
Input Cable Included
12V Input Jack
Prices

All Metal Cabinet
Sensitivity 10 MV at 60
MHz
240V or 12V Operation
Push Button Controls
Gate Light
CTR-2A-500 £280 & VAT 8%

CTR-2A-1000 £420 & VAT 8%

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

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

WW - 027 FOR FURTHER DETAILS

RADIO SHACK LTD for DRAKE



Ham Bands with 1,5-30 MHz receive with built-in 150 MHz frequency counter plus option of 0-1.5 MHz receive and / or any transceiving application 1.8-30 MHz.

For Communications equipment including Trio products and Trio testgear.

We are situated just around the corner from West Hampstead Underground Station (Bakerloo line). A few minutes' walk away is West Hampstead Midland Region station and West End Lane on the Broad Street Line. We are on the following Bus routes: 28, 59, 159. Hours of opening are 9-5 Monday to Friday. Closed for Lunch 1-2. Saturday we are open 9-12:30 only. World wide exports.

DRAKE * SALES * SERVICE

188 BROADHURST GARDENS, LONDON NW6 3AY

Giro Account No. 588 7151. Telephone: 01-624 7174 Cables: Radio Shack, London, NW6, Telex: 23718

thing to match our Sales Service is our **After-Sales Service**

When you get your test equipment serviced or maintained by the London instrument Repair Centre, you get the same top quality work that made the instrument in the first place-and backed by a full year's warranty too.

Contact the address below for your nearest centre.



The service organisation of





Archcliffe Road, Dover, Kent. Telephone: 0304-202620

Thorn Measurement & Components Division

WW - 062 FOR FURTHER DETAILS

electronic

FIX-PRINT JIG for printed circuits



Drill Stand with ample throat Adjustable height

£18 50

cantilever with lever actuated feed.

Spring return. Will

accept both drills

P2 Mk. 2 Drill £19.50 inc. VAT P&P 86p

TEL: 01-977 0878

and ensure a high degree of accuracy n all types of lectrical precision work £6 50

Drill Stand

1 Drill £10.00

119a HIGH STREET TEDDINGTON MIDDLESEX TW11 8HG

C. VAT. P&P 38r

HAVE YOU TRIED SPADE DRILLS for printed circuit boards and other soft materials? No clogging — cooler — cleaner holes — there's a range of sizes, 0.1 to 2.5mm.

WW - 073 FOR FURTHER DETAILS

1.00 1.00	110								WIRE	LESS WORLD,	MARCH 1979
74174 93p 74LS374 195p 9603 60p CALLERS WELCOME Saturdey 10.30-4.30 Tel: 01-452 1500 Telex: 922800	711. by 7400 7400 7400 7401 7402 7403 7404 74504 7405 7406 7407 7408 7410 7411 7412 7413 7414 7412 7422 7423 7428 7432 7433 7434 7440 7441 7442 7443 7446 7447 7448 7150 7457 7480 7480 7481 7481 7481 7485 7486 7489 7490 7490 7491 7491 7492 7493 7493 7496 7480 7491 7492 7493 7496 7480 7491 7491 7491 7491 74110 74110 74111 74116 74118 74117 74116	13p	19	9301 160p 9302 175p 9308 316p 9310 275p 9311 275p 9311 160p 9311 160p 9311 160p 9311 160p 9312 160p 9314 165p 9312 160p 9314 225p 9322 150p 9322 150p 9322 225p 9324 220p 9374 200p 11000 200p 9370 200p 9374 200p 9374 200p 9374 200p 9374 200p 9374 200p 9374 200p 9374 200p 111000 200p 121000 211p AY5-1315 680p AY5-1315 AY5-13	Carbon film 5% High. Stab Min To BS9110 Ww 1007-1MQ E12 Typ per pack of 5 (one value) E1.20 per 100 (one value) E2.20 per 100 (one value) E2.20 per 200 (one value) E2.20 per 200 (one value) MC33u0P MC4000B MC53u0P MC5039B MC503B AC1276 25p AC12778 20p AC12778 25p AC12778 25p AF11677 25p AF11677 25p AF11677 370p AD1149 70p AD161 /2 45p BC109 11p BC1107 8 10p BC1157 8 10p BC157 8	BFX84 5 30p BFX86 7 30p BFX86 7 30p BFX86 7 30p BFX87 30p BFV10 90p BFV10 90p BFV10 22p BFV50 22p BFV56 90p BFV83 70p BFX83 70p BFX83 45p BFX90 22pp BFX90 64pp MFX90	TIP35C 200p TIP36C 200	2N3823 70p 2N3823 70p 2N3903 4 89 2N3903 6 20p 2N3903 6 20p 2N3903 6 20p 2N3903 6 20p 2N3903 6 20p 2N3903 6 20p 2N4058 9 12p 2N4060 12p 2N4060 2 2p 2N4123 6 22p 2N4123 6 22p 2N4123 7 20p 2N5179 27p 2N5179 10p 2N5296 55p 2N5460 40p 2N5295 105p 2N540 100p 3N128 100p 3N128 100p 3N128 100p 40290 250p 40360 40p 40594 100p 550p 550p 400p 550p 50p 100p 550p 100p 100p 100p 10	BY127 12p OA47 9p OA47 9p OA41 15p OA49 15p OA90 15p OA90 9p OA95 15p OA90 9p OA90 9p OA200 10p OA200 10p IN914 4p IN914 4p IN914 4p IN914 4p IN914 4p IN914 4p IN914 7 1p IN914	PLAST SA 400V 60p A 500V 63p A 400V 60p A 500V A	
SEMICONOUCTORS "TIP29/30 1 39p 7404 11p BARGAIN PAKS A29 5x2M300 60p AC176/187 18p TIP3/4 39p 7405 11p PAK NO. ALL FULL SPEC "A30 10z/R3702. 3. 4 or 5	74174					SEMICONOUCTOR	RS *TIP29/30 /	39p 7404	11p BARG	UN PAKS A29 5	x2N930 60m

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. Pre-coated 1/16 Fibre-glass board

FOTOLAK £1.50 Developer	204mm x 114mm £1.50 204mm x 228mm £3.00 408mm x 228mm £600 467mm x 305mm £9.00
Plain Copper-clad Fibre-glass. Approx. 3.18mm thick sq. ft. Approx. 2.00mm thick sq. ft. Approx. 1.00mm thick sq. ft. Single sided Copper-clad Paxolin, 10 shee Clear Acetate Sheet for making master, 2:	£2.00 £2.25 £1.50 £1.75 ets 245mm x 150mm £2.50

G. F. MILWARD ELECTRONIC COMPONENTS LIMITED 369 Alum Rock Road, Birmingham B8 3DR. Telephone: 021-327 2339

	SEMILUMUUC	IUNG	111729/30	39p	1404	11p	BARGAIN PAKS		A29 5x2N930 60p
	AC176/187	18p	TIP31A	39p	7405	11p	PAK NO. ALL FULL S	SPEC	"A30 10x2N3702, 3, 4 or 5
	BC107/8/9	8p	TIP32A	46p	7408	13p	A1 5x741 8 pin	90a	65g
	°BC147/8/9	8p	TIP41A	61p	7409	13p	A2 4x555 8 pin	100p	*A31 10x1 megehm preset
	°BC157/B/9	9p	TIP42A	62n	7420	12p	*A3 25xAA119	750	0.25w 60n
	BCY70/1/2	140	°ZTX301/2	12p	7427	23p	A4 5xAC128	75a	*A32 50xmixed w/w resistors
	B0131/2	34p	*ZTX502/3	16n	7430	11p	A5 3xAD161 or 162	90p	2.5w, 5w, 10w, etc 150a
	80135/6/7	35p	184001/2	5p	7440	110	°A6 25x8AX13	70p	*A33 50x2.5w w/w resistors
- 4	80138/9/40	36p	184004/5	6p	7445	62p	°A7 5xBB105A or B	70p	150
	8F115	18p	1N4008/7	7p	7453	140	*A8 5x8C117 or 118	60p	*A34 50x5w w/w resistors
-	°BF167	23p	2N706	12p	7472	22p	*A9 10x8C132	90p	
	BF180/1/4	28p	2N1304/8	40n	-7473	24p	*A10 10x8C147, 8 or 9	70p	150p
	*BF194/5	9p	2N1305	30p	7474	24p	°A11 10xBC172		A35 50x74 series with
-	*8F197		2H3053		7480		*A12 10x8C182, 3 or 4	65p	
-		10p	2N3054	20p	7482	42p	A12 10x86182, 3 0F 4	70p	*A36 10x0.1/600v dubilier
-	BF200	28p		46p		66p	°A13 10x8C2048	50p	capaciter 60p
3	BF257/8/9	26p	2N3055	48p	7483	68p	Cropped Leads	. 50p	ANTEX IRON
	*BF336	32p	°ZN3819	21p	7490	32p	*A14 10xBC121, 3 or 4	70p	15w 240v with 3/32" bit
	*BF337	28p	204443	80p	7491	45p	A15 5x8C301 or 303	110p	200-
	*BT106	110p		1	7495	49p	*A16 10x8C547, 8 or 9	80p	W/W RESISTORS 360p
	°BU205	150p	LINEAR I.C.'s		7496	50p	A17 10x8CY70	110p	W/W IILOIG I UNG
	*BU208	160p	741 8 pin	19p	74100	86p	A18 3x80115	110p	2.3W. 13W 1UD
-	*8U208A	175p	555 8 pin	27p	74107	23p	A19 2xBC695A or 6A	110p	'5w 10w 9p
-	MJE340	43n	LM3900N	60o	74121	23p	A20 3x8F180, 1 or 5	70p	"GARBON FILM RESIS-
	MJE520	43p	°T8A750	160p	74123	39p	°A21 5x8F198	55p	TORS
	°0A200	7p	*TBA800	80p	74128	74p	A22 4xBF324	80p	E12 series 487 to 8MZ ohms
	OC28	880	*TBA8105	100p	74151	48p	°A23 4xBFR80		1.5p
-	OC35	78p		·oop	74155	50p	A24 5x8FY50 or 52	75p	any mix 100+ 1p
	00140/202	82p	TTL		74157	50p	A25 5x8SX19 or 20	75p	ZENER DIODES 400m W
	0C200	70p	7400	110	74164	700	*A26 10x8Y127	65p	TYPE
	0C201	72p	7401	· 110	74190	95p		80p	*2.7. 3. 3.6, 4.7, 8.2, 8.2,
	*R2008B/10B		7402	12n	74193	95p		120p	*10, 18, 20, 0r 27 volts 8p
1	TIZUUOD/1UD	170p					°A28 25xiS44 or 941	70p	TANTALUM BEADS
	6 . Mar.	-4 50 0	DECOU	HES 72+	10% [of any	one type)	of our sales		*2.2/16, 6,8/10, 10/10, 15/
	Min. 0	suer £2.0	u rar Jup VAI -	- Linase a	100 8% 8XC	ept those mark	ed " which are 12.5%.		
			S.a.e. for lists. W	moresale	ano industri	al enquiries w	elcome		16.3v 11p
	R & A DISTRIB	UTORS,	52 BARKBY RO	DAD. SY	STON. LEI	CESTER, LET	8AF. TEL: 0533 609	391	°6.8/35, 10/20, 22/10v 14p

SERVICE TRADING CO

WHY PAY MORE?!

MULTI RANGE METERS Type MF15A.
A.C./D.C. volts 10, 50, 250, 500, 1000. Ma.
0-5, 0-10, 0-100. Sensitivity 2000V. 24 ranges,
Dimensions 133 × 93 × 46mm. Price £7.00
plus 50p P&P (£8.10 inc. VAT & P).



RYAC.

Raytheon tag symmetrical Triac. Type Tag 250/500v. 10 amp 500 piv. Glass passivated plastic triac. Swiss precision product for long term reliability £1.25 P&P 10p (£1.46 inc. VAT & P) (inclusive of date and application sheet). Suitable Diac 22p.

O to 60 MINUTES CLOCKWORK TIMER.

Double pole 15 amp 230AC. Contacts (no dial). £1,50. P&P 30p (£1.94 inc. VAT & P). N.M.S.

MERCURY SWITCH Size 27m x 5mm, 10 for £5.00, P&P 30p. total including VAT £5.72. Min. quantity 10. N.M.S.

230 VOLT AC FAN

ASSEMBLY with 5 blade 6½" aluminium fan. New reduced price £3.00 P&P 65p (£3.94 inc. VAT & P). N.M.S.

21-WAY SELECTOR

SWITCH with reset coil The ingenious electro mechanical device can switched up to 21 positions and can be reset fro any position by energising the reset co 230/240v. A.C. operation. Unit is mounted strong chassis. Complete with cover. Price £5.50 P&P 75p (£6.75 inc. VAT & P). N.M.S.

VORTEX BLOWER AND

VORTEX BLOWER AND
VACUUM UNIT
Dynamically balanced totally enclosed 9"
rotor with max. air delivery of 1.5 cubic
matres per min. Max. static pressure
600mm W. G. Suction or blow from 2
side-by-side 37mm I.D. circular apertures
fitted to base of unit. Powerful continuously
rated 115va.c. motor mounted on alloy base
with fixing facilities. Dimensions: Length
22cm x width 25cm x height 25cm minimum use. Fully tested
prior to despatch. Price £12 + £1.50 P&P (£14.58 inc. VAT & P).
Suitable transformer for 230/240va.c. £6 + £1 P&P (£7.56 inc. VAT & P).

CENTRIFUGAL BLOWER Smith type FFB 1606 022 220/240v A.C. Aperture 10x41/cm overall size 16x14cm. Price 53.75 P8P 75p (incl VAT £4.85). Other types available. S.A.E. for details N.M.S.

24V DC BLOWER UNIT USA made. 24v D.C. 8 amp blower that operates well on 12v. 4 amp D.C. producing 30 cu. ft. min. at normal air pressure. Maximum housing dia. 110mm. Depth inc. motor 75mm. Nozzle length 19mm. dia. 22mm. ideal for cooling mobile equipment, car, caravan, etc. £4.50 P&P.75p. (£5.67 inc. VAT & P). N.M.?

MINIATURE UNISELECTOR 12V. 11 way 4 bank (3 non-bridging, 1 homing). £2.50 P&P 35p (£3.08 inc. VAT & P).

MICRO SWITCHES

Sub min lever m/switch type MML46, 10 for £2.50.
Type 3 115M 906T 10 for £2.50 post paid (£2.70 inc. VAT (& P).

1& P).

BF lever operated 20a. c/o. mf. Unimax USA. 10 for £4.00 plus 50p P&P (min. order 10) (£4.86 inc. VAT & P).

D.P. C/O lever m/switch, mfg. by Cherry Co., USA. Precious metal, low resistance contacts. 10 for £2.50. P&P 30p. Total inc. VAT £3.02 (min 10). N.M.S.

NEW HEAVY DUTY

SOLENOID
Mg. by Magnetic Devices. 240v A.C.
Operation approx. 10lb. pull at %th in.
Rating intermitant. Price £4.00 P&P 60p
i£4.95 ing. VATD N M S
PYE EYTHER

PYE EYTHER
240v A.C. Solenoid. Approx. 1 lb pull, ¼in travel, intermitant rating. Price £1.00 P&P
20p (£1.30 inc. VAT & P). N.M.S.

WESTOOL TYPE MM8 MODEL 2
240V AC. Approx. 1¾ lb pull at ½ inch. Rating 1. Price £1.50 P&P 20
(£1.84 inc. VAT & P). N.M.S.

240 A.C. SOLENOID OPERATED FLUID VALVE
Rated 1 p.s.i. will handle up to 7 p.s.i. Forged brass:
body, stainless steel core and spring ½ in. b.s.p. inlet
outlet. Precision made. British mfg.
PRICE £3.50 Post 50p (£4.32 inc. VAT & P). N.M.S.

INSULATION TESTERS

(NEW)
Test to I.E.E. spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8 in., W. 4 in. H. 6 in., weight 6 lb. 500 VOLTS 500 megohms
£49.00 Past 80p (£53.78 inc. VAT & P)
1000 VOLTS 1000 megohms
£55.00 Post 80p (£60.26 inc. VAT & P)
S&E for leaflet.

YET ANOTHER OUTSTANDING OFFER (£2.16 inc. VAT + P&P). (Min 10).

ALL MAIL ORDERS, ALSO CALLERS AT

57 BRIDGMAN ROAD, CHISWICK, LONDON, W4 5BB. Phone: 01-995 1560 **VARIABLE VOLTAGE TRANSFORMERS** INPUT 230 v. A.C. 50/60

OUTPUT VARIABLE 0/260v A.C. BRAND NEW. All types. 200W (1 Amp) fitted A/C

volt meter 0.5 KVA (Max. 21/2 Amp) £17.00 £22.50 £37.00 1 KVA (Max. 5 Amp) 2 KVA (Max. 10 Amp) 3 KVA (Max. 15 Amp) 5 KVA (Max. 25 Amp) 10 KVA (Max. 50 Amp) 17 KVA (Max. 75 Amp) £260.00

LT TRANSFORMERS

Carriage extra

C-10-15v at 3 amp. (ex new equip) £2.50 P&P 50p. (£3.24 inc. VAT) 13-0-13v at 1 amp £2.50 P&P 50p. (£3.24 inc. VAT) 13-0-13v at 1 amp £2.50 P&P 50p. (£3.24 inc. VAT) 25-0-25v at 25v amp. £4.50 P&P 75p. (£5.67 inc. VAT & P) 0-4v /6v /24v /32v at 12 amp. £18.50 P&P £1.90 (£22.03 inc. VAT & P) 0-6v /12v at 20 amp £18.70 P&P £1.50 (inc. VAT £1.50 P&P £1.50 PP £1.50 (inc. VAT £1.50 PP £1.50 PP £1.50 (inc. VAT £1.50 PP £1.50 (inc. VAT £1.50 PP £1.50 PP £1.50 (inc. VAT £1.50 PP £1.

VAT & P)

0-6v/12v at 10 amp. £8.25 P&P £1.25 (inc. VAT £10.26)

0-6v/12v/17v/18v/20v at 20 amp. £18.00 P&P £1.50 (£22.10 inc. VAT & P)

0.10v/17v/18v at 10 amp. £10.50 p&p £1.50 (inc. VAT £12.96)

Other types in stock; phone for enquiries or send sae for leaflet.

ROTARY VACUUM AIR COMPRESSOR

& PUMP
Carbon vane oil-less. 100/115V a.c. 1/12-h.p.
motor 50/60 cycle 2875/3450 rpm. 20"
vacuum 1.25 c.f.m. 10 p.s.i. (approx. figures).
Mfr. by Gast Co. Fraction of maker's price £14.00
P&P £1.00 (Total: £16.20 inc. VAT). Suitable
transforme £3.50 P&P 50p. (Total: £3.78 inc.
VAT). N.M.S.

BLOWER/VACUUM PUMP
3 phase A.C. motor 220/250v or 380/440v, 1,425 rpm ½ hp cont.
Direct coupled to William Alday Alcoss carbon vane blower/vacuum
pump, 0.9 cfm 8 hg. Price £22.00 P&P £2.00. (£25.92 inc. va. + p).

STROBE! STROBE! STROBE!

HY-LIGHT STROBE KIT Mk. IV

Latest type Xenon white light tube. Solid state timing and triggering circuit. 230 / 240 volt A.C. operation. Speed adjustable 1-20 1.p.s. Designed for large rooms, halls, etc. Light output greater than many (so called 4 Joule) strobes. Price £19.00 post £1 (£21.60 inc. VAT & P). Specially designed case and reflector for Hy-Light £8.80 Post £1.00 (£10.58 inc. VAT & P).

ULTRA VIOLET BLACK LIGHT
FLUORESCENT TUBES
4ft. 40 wett 68.70 (callers only). 2ft. 20 wett 68.20. Post 75p. (£7.51 inc. VAT & P). (For use in stan bi-pin fittings). Mini 12in. 8 wett £2.25 post 35p (£2.81 inc. VAT & P). 6in. 4 wett £2.25 post 35p (£2.81 inc. VAT & P). 6in. 4 wett £2.25 post 35p (£2.81 inc. VAT & P).
Complete ballast unit. Either 6". 9" or 12" tube 230V. A.C. op. £3.50 plus P&P 45p (£4.27 inc. VAT & P). Also avaitable for 12V. D.C. op. £3.50 plus P&P 45p (£4.27 inc. VAT & P). Also avaitable for 12V.

400w UV lamp and ballest complete £31.50. Post £3. (£37.26 inc. VAT & P.) 400w UV lamp only £11.25 Post £1.20 (£13.45 inc. VAT & P.) ***********

A new conception in light control. Four channels each capable of handling 750 wats of spotlights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation, effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free. Price only £80.00 (£65 61 in. val + p).

S.A.E. (Foolscap) for further details. Post 75p

WIDE RANGE OF DISCO LIGHTING EQUIPMENT

XENON FLASH

GUN TUBES
Range of Xenon tubes available from stock. S.A.E. for full details.

RELAYS Wide range of AC and DC relays available from stock. Phone or write in your equiries. 230/240V A.C. Relays: Arrow, 2 c/o. 15 amp £1.50 (£1.84 inc. VAT

& P).

T.E.C. open type 3 c/o. 10 amp £1.10 (£1.40 inc. VAT & P). Omoron or Keyswitch 1 c/o, 7 amp £1.00 (£1.30 inc. VAT & P).

D.C. Relays: Open type 9/12V 3 c/o 7 amp £1.00 (£1.30 inc. VAT & P). Sealed 12V 1 c/o 7 amp octal base, £1.00 (£1.30 inc. VAT & P). Sealed 12V 2 c/o 7 amp octal base, £1.25 (£1.56 inc. VAT & P). Sealed 12V 3 c/o 7 amp 11-pin £1.35 (£1.67 inc. VAT & P). 24V. Sealed 3 c/o 7 amp 11-pin £1.35 (£1.67 inc. VAT & P) (amps = contact rating). P&Po namy Relay 20p.
Other types available — phone for details. N.M.S.

Diamond H heavy duty A.C. relay 230/240V a.c., two c/o contacts 25 amps res at 250V a.c. £2.50 P&P 50p. (£3.24 inc. VAT + P&P). Special base 50p.

AT CURRENT RATE TO ALL ORDERS FOR THE TOTAL VALUE OF GOODS INCLUDING

POSTAGE UNLESS OTHERWISE STATED

SERVICE TRADING CO.

SHOWROOMS NOW OPEN AMPLE PARKING

GEARED MOTORS

GEARED MOTORS

100 R.P.M. 115 lbs. ins.!!

115 lb. ins. 110 volt. 50Hz, 2.8 amp. single phase, split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled. In-line gearbox. Length 250mm. Die. 135mm. Splinde Dia. 15.5 mm Length 115mm, ex-equipment tested £12.00 Post 1.50 (£14.58 inc. VAT & P). Rat GEARED MOTORS

28 r.p.m., 20lb. inch 115v a.c. Reversible motor. Both types similar to above drawing. Price either type £4.75 + 75p P&P. (£5.94 inc. VAT + P&P). Supplied with transformer for 240v a.c. operation £7.25 + P&P £1. (£8.91 inc. VAT + P&P). N.M.S.

FRACMO MOTOR

versible, 0.7 amp. plength 35mm, dia. 16mm, weight 6 kilos grams. Price £15.00 P&P £1.50 (£17.82).



PARVALUX MOTOR TYPE S.D.2 £10.00 P&P 75p (£11.61 inc. VAT & P). N.M.S.

PARVALUX 230/250V a.c.

MOTOR
Type SD18 240V AC reversible 30 rpm 50lbs inch.
Price £15.00 P&P £1.50 (£17.82 inc. VAT). N.M.S

CITENCO
FHP motor type C 7333/15 220/240v A.C. 19 rpm reversible motor, torque 14.5 kg. Gear ratio 144:1. Brand new incl. capacitor, our price E14.25 + £1.25 P&P (£18.74 inc. VAT & P).

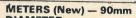
CROUZET — 230 / 240 V ÅC 2 rpm synchronous geared motor £2.90 P&P 30p (Total: £3.46 inc. VAT). N.M.S. HAYDON — 230 / 240 V &C 1 rpm synchronous geared motor £2.90 P&P 30p (Total: £3.46 inc. VAT). N.M.S.

REVERSIBLE MOTOR 230V A.C.

anti-vibration mounting bracket and capacitor. O/A size 110mm × 90mm. Spindle 5/16 dia. reversing. Ex-equipment tested £3.00. Post 50p (£3.78 inc. VAT & P).

RODENE UNISET

TYPE 71 TIMER
0-60 sec. 230V AC operation. Incorporating a lapsed time indicator and repeat facilities. A precision motorised timer indeal for process timing, photography, welding mixing etc. Price £6 P &P 60p
VAT & P) NM S



DIAMETER

AC Amp., Type 62T2. 0-1A, 0-5A, 0-20A. AC Volt.
0-15V, 0-300V. DC Amp, Type 65C5. 0-2A, 0-10A,
0-20A, 0-50A DC Volt. 0-15V, 0-30V. All types 23.50
ea + P&P 50o (£4.32 incl. VAT) 0-50A D C 0-100A
D C Price £5.00 + 50p P&P £5.94 incl. VAT)

'VENNER TYPE' ERD TIME

SWITCH 2007250V AC 30 amp. 2 on / 2 off every 24 hrs. at any manually pre-set time. 36-hour spring reserve and day omitting device. Built to highest Electricity Board specification. Price £7.75 P&P 75p. (£9.18). R & T.



F

SANGAMO WESTON TIME SWITCH

Type S251 200/250V AC 2 on 2 off every 24 hours. 20 amps contacts with override switch, diameter 4" x 3", price £6.00 P&P 50p (£7.02 inc. VAT & P). Also available with Solar dial. R & T.

AEG TIMESWITCH

200/250V AC 1 on/1 off every 24 hours, 80 amp contact (ideal storage heaters). Spring reserve £10.00 P&P 50p (Total: £11.34 inc. VAT). N.M.S.

AC MAINS TIMER UNIT

Based on an electric clock, with 25 amp, single-pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins, to 6 hrs. then switch off. An additional 60 min, audible timer is also incorpo-rated. Ideal for Tape Recorders. Lights. Electric Blankets etc. Attractive satin copper finish. Size 135 mm x 130 mm x 60 mm. Price £2.55, post 40p. (Total inc. VAT & Post £2.87). N.M.S.





New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly. continuously rated. 25 WATT 10, 25, 100, 150, 250, 500, 1k, 1.5k ohm £2.40 Post 20p [£2.81 inc. VAT & P), 50 WATT 100, 250 ohm £2.90 Post 25p (£3.40 inc. VAT & P), 100 WATT 1 / 5, 10 / 25 / 50 / 100 / 250 / 500 / 1k / 1.5k / 2.5k / 5k ohm. £5.90 Post 35p (£6.75 inc. VAT & P).

Black Silver Skirted Knob calibrated in Nos. 1-9, 1½ in dia brass bush. Ideal for above Rhosats, 24p ea.

SPECIAL OFFER

BERCO type L RHEOSTAT 85 ohm 300 watt 1.86 amp £7.50 P&P 50p (Total: £8.64 inc. VAT). FRACMO MOTOR

anti-vibration cradle mounting. Supplied complete with transformer for 230 / 240 V AC op. £10.00 P&P £1.00 (Total: £11.88 inc. VAT). N.M.S.

N.M.S. — New Manufacturers' Surplu: R & T — Reconditioned and Tested ACCOUNT CUSTOMERS

MIN. ORDER £10.00

PERSONAL CALLERS ONLY

9 LITTLE NEWPORT STREET, LONDON, WC2H 7JJ

Now ... the next generation of bench DMMs!

Two New Keithley Models offer uncompromising performance and outstanding value!

- Accuracy 31/2's can't match 0.04% + 1 digit on do
- Large, bright, 20,000-count LED display that's quick and easy to read.
- Convenient bench size that won't get "lost" yet doesn't crowd.
- Exceptional reliability.

Model 178 offers functions and ranges for most measurement needs 100 µ V to 1200V dc, 100 μ V to 1000 V ac, 0·1 Ω to 20 MΩ. Model 179 is a full-function, multi-feature model offering the same advantages as the 178. Plus TRMS AC; 10 µ V Sensitivity; Hi and Lo Ohms; AC and DC Current Yet it's still half the price you'd expect. Only £199.

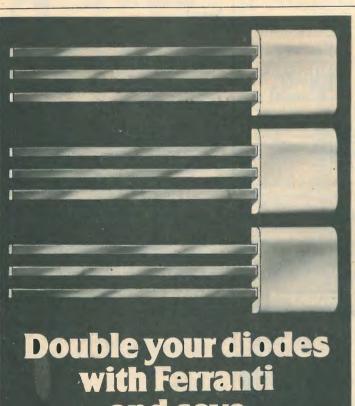
Both models feature designed-in reliability Rugged circuits use a minimum of parts - high quality, off-the-shelf parts - carefully assembled and tested by Keithley. Outstanding overload protection and rugged mechanical design keep both units going even after severe abuse. One-year accuracy specifications minimise recalibration costs. A battery option, user installable, gets you off "line" for critical

For complete specifications on the 178 and 179, call Keithley Instruments, 1 Boulton Road, Reading. Phone 0734 861287

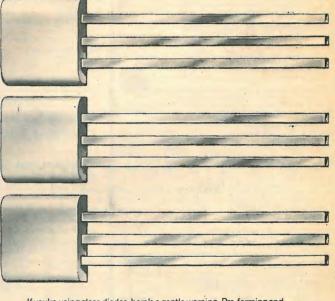
measurements or for field use.

The measurement engineers.

WW-029 FOR FURTHER DETAILS



and save on system costs.



If you're using glass diodes, here's a gentle warning. Pre-forming and insertion costs can make them more expensive than you think on the assembly line. Ferranti ZDX double diodes save you all that. Each package contains two connected diodes so you save both on insertion cost and component counts.

The ZDX range includes both switching and general purpose diodes. Common anode, common cathode or series pair. Ready to plug into your PCB—another saving. And they're competitively priced. Saving again.

Data and samples? Contact: Discrete Components Marketing, Ferranti Electronics Limited, Fields New Road, Chadderton, Oldham CL9 8NP. Call—061-624 0515.

Semiconductors

WW-037 FOR FURTHER DETAILS

To obtain further details of any of the coded items mentioned in the **Editorial or Advertisement pages** of this issue, please complete one or more of the attached cards entering the reference number(s). Your enquiries will be passed on to the manufacturers concerned and you can expect to hear from them direct in due course. Cards posted from abroad require a stamp. These Service Cards are valid for six months from the date of publication.

Please Use Capital Letters

If you are way down on the circulation list, you may not be getting the information you require from the journal as soon as you should. Why not have your own copy?

To start a one year's subscription you may apply direct to us by using the card at the bottom of this page. You may also apply to the agent nearest to you, their address is shown below.

OVERSEAS SUBSCRIPTION **AGENTS**

Australia: Gordon & Gotch (Australasia) Ltd, 380 Lonsdale Street, Melbourne 3000, Victoria

Belgium: Agence et Messageries de la Presse, 1 Rue de la Petite-ILE Brussels 7

Canada: Davis Circulation Agency, 153 St. Clair Avenue West, Toronto 195, Ontario

Cyprus: General Press Agency Ltd, 131 Pro-dromou Street, P.O. Box 4528, Nicosia

Denmark: Dansk Hovedvagtsgade 8, Dk. 1103 Kobenhavn.

Finland: Rautakirja OY, Koivuvaarankuja 2, 01640 Vantaa 64, Finland.

France: Dawson-France S.A., B.P.40, F-91121, Palaiseau

Germany: W. E. Saarbach GmbH, 5 Koln 1, Follerstrasse 2

Greece: Hellenic P.O. Box 315, 245 Syngrou Avenue, Nea Smyrni, Greece

Holland: Van Ditmar N.V., Oostelijke Handelskade 11, Amsterdam 1004

India: International Book House, Indian Mercantile Mansion Ext, Madame Cama Road, Bombay 1

Iran: A.D.A., 151 Khiaban Soraya, Tehran

Israel: Stelmatzky's Agency Ltd, Citrus House, P.O. Box 628, Tel Aviv

tions Distribution Agency, 170 Nishi-Okubo 4-chome, Shinjuku-Ku, Tokyo 160

Lebanon: Levant Distri-butors Co., P.O. Box 1181 Makdesi Street, Halim Hanna Bldg, Beirut

Malaysia: Times Distributors Sdn. Bhd., Times House, 390 Kim Seng Road,

Malta: W. H. Smith Continental Ltd, 18a Scots Street, Valleta New Zealand: Gordon & Gotch (New Zealand) Ltd, 102 Adelaide Road, Wellington 2

Nigeria: Daily Times of Nigeria Ltd, 3 Kakawa Street, P.O. Box 139,

Norway: A/S Narvesens Kioskompani, Bertrand Narvesens vei 2, Oslo 6

Portugal: Livaria Bertrand s.a.r.l Apartado 37, Amadora

South Africa: Central News Agency Ltd, P.O. Box 1033, Johannesburg

Spain: Comercial Atheneum's.a. Consejo de Ciento, 130-136 Barcelona 15

Sweden: Wennegren Williams A B. Fack S-104, 25 Stockholm 30

Switzerland: Naville & Cie SA, Rue Levrier 5-7, CH-1211 Geneve 1 Schmidt Agence AG, Savogelstrasse 34, 4002 Basle

U.S.A.: John Barios. IPC Business Press, 205 East 42nd Street, New York, N.Y. 10017 be paid by Licensee

Do not affix Postage Stamps if posted in Gt. Britain, Channel Islands or N. Ireland

BUSINESS REPLY SERVICE Licence No. 12045

WIRELESS WORLD, PRODUCT REPLY SERVICE, 429 BRIGHTON ROAD, SOUTH CROYDON, SURREY **CR2 9PS**

Enquiry Service for Readers	or Professional	WIRELESS WORLD Wireless World, March 1979 WW 963					
wwww.		the appropriate reference numbers or which have been effected in the					
ww ww.							
ww ww.	ww	Name of Company					
ww ww.	ww	Address					
		Telephone Number					
ww ww.		BUBLICHEDE					
wwww.		*					
ww ww.	ww						
ww ww.	ww	Nature of Company/Business					
ww ww.	ww	No. of employees at this establishment					
ww ww.	ww	I wish to subscribe to Wireless World					
ww ww.	ww	VALID FOR SIX MONTHS ONLY					

Wireless World: **Subscription Order Form**

To become a subscriber to Wireless World please complete the reverse side of this form and return it with your remittance to:

Subscription Manager, **IPC Business Press,** Oakfield House, Perrymount Road, Haywards Heath, Sussex RH16 3DH. England

Postage will be paid by

ww.... ww.... ww...

ww.... ww.... ww....

Do not affix Postage Stamps if posted in Gt. Britain, Channel Islands or N. Ireland

VALID FOR SIX MONTHS ONLY

BUSINESS REPLY SERVICE Licence No. 12045 WIRELESS WORLD,

PRODUCT REPLY SERVICE, **429 BRIGHTON ROAD,** SOUTH CROYDON. SURREY

Wireless World

GR2 9PS

Subscription Order Form Wireless World, March 1979 WW 963

UK subscription rates

1 year: £7.00

USA & Canada subscription rates

1 year: \$23.40

Other Areas 1 year: £9.00

Please enter my subscription to Wireless World for 1 year

I enclose remittance value

made payable to

IPC BUSINESS PRESS Ltd.

Address

New York, NY 10017 - Telephone: (212) 689 5961 - Telex: 421710 Mr. Jack Farley Jnr., The Farley Co., Suite 1548, 35 East Wacker Drive, Chicago, Illinois 60601 - Telephone: (312) 6 3074

Mr. Victor A Jauch Elmatex International, P.O. Box 34607,

Los Angeles Calif. 90034 U.S.A. Telephone: (213) 821 8581 Telex: 18-1059. Mr. Jack Mentel, The Farley Co., Suite 605,

OVERSEAS ADVERTISEMENT

Hungary Mrs. Edit Bajusz, Hungexpo

Advertising Agency, Budapest XIV,

Varosliget - Telephone: 225 008 -

Servizio Estero, Via Mantegna 6,

Telex: 37342 Kompass

20154 Milan - Telephone 347051 -

Telex: Budapest 22-4525 INTFOIRE

Italy Sig. C. Epis Etas-Kompass, S.p.a. -

Japan Mr. Inatsuki, Trade Media - IBPA

United States of America Ray Barnes,

*IPC Business Press 205 East 42nd Street,

(Japan), B212 Azabu Heights, 1-5-10

Roppongi, Minato-Ku, Tokyo 106-

Telephone: (03) 585-0581

Ranna Building, Cleveland, Ohio 4415 -Telephone: (216) 621 1919 Mr. Ray Rickles, Ray Rickles & Co., P.O. Box 2008, Miami Beach, Florida 33140 - Telephone: (305) 532 7301 Mr. Jim Parks, Ray Rickles & Co., 3116 Maple Drive N.E., Atlanta, Georgia 30305. Telephone: (404) 237 7432 Mike Loughlin, IPC Business Press, 15055 Memorials, Ste 119, Houston, Texas

Canada Mr. Colin H. MacCulloch, International Advertising Consultants Ltd., 915 Carlton Tower, 2 Carlton Street,

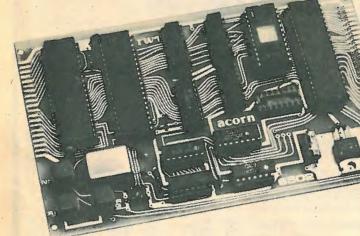
Toronto 2 - Telephone (416) 364 2269

77079 - Telephone: (713) 783 8673

*Also subscription agents

WIRELESS WORLD, MARCH 1979

Introducing
Acorn



A professional MPU card

Designed as a general purpose industrial controller based on the 6502 MPU, this card is complemented by a matching Eurocard hex keyboard and CUTS standard cassette interface, to create the new...

Acorn Microcomputer



This compact stand-alone microcomputer is based on standard Eurocard modules, and employs the highly popular 6502 MPU (as used in APPLE, PET, KIM, etc). Throughout, the design philosophy has been to provide full expandability, versatility and economy, Take a look at the full specification, and see how Acorn meets your requirements

Acorn technical specification

The Acorn consists of two single 1. MPU card

6502 microprocessor 512 x 8 ACORN monitor 1Kx8RAM

16-way I/O with 128 bytes of RAM 1 MHz crystal 5 V regulator, sockets for 2 K EPROM and second RAM I/O

> 2. Keyboard card 25 click-keys (16 hex, 9

control) 8 digit, 7 segment display CUTS standard crystal controlled tape interface

circuitry Keyboard Instructions: M. Memory Inspect/ Change (remembers last address used)

Stepping up through memory Stepping down through memory P Set or clear break point

R Restore from break I load from tane

S Store on tape G Go (recalls last address used) RST Reset

Compact, easy to use **Acorn Monitor includes** the following features:

 System program Set of sub-routines for use in programming

 Powerful de-bugging facility displays all internal registers Tape load and store routines

Acorn - with real expandability!

The standard Acorn is fully expandable to 65 K of memory. and the Acorn bus is available on the 64-way edge-connector. Whether you're a beginner in the field, an ambitious home computer buff, a development engineer, a teacher or a businessman, the Acorn and its family of modules will provide a practical solution in

virtually every situation Future expansion for Acorn includes the following software and hardware.

Software

Basic interpreter, assembler, disassembler, editor, TTY and disk operating system

Hardware

Memory-mapped VDU system (with upper and lower case ascii graphics and hardware scroll) floppy disk controller for 51/4 in and 7 in disks a memory card with 8 K bytes of static RAM (2716) and 4 K bytes of EPROM (2114), a PROM programmer (for all types of PROM usable on ACORN a full ascii keyboard, a backboard for the ACORN bus, and a Eurocard racking system.

Acorn

Operating Manual

With Acorn, you'll receive an operating manual that covers computing in full, from first principles of binary arithmetic, to efficient hex programming with the 6502 instruction set. The manual also includes a listing of the monitor programs and the instruction set, and other useful tabulations; plus a selection of 12 interesting and educative program samples

Acorn, as a kit or fully assembled, the choice is yours with this coupon!

With such flexibility at such a price, the ACORN package is one you'll want to make the most of, soon. Whether you're a hobbyist, computer technician, R&D engineer or a computer user, Acorn provides you with a highly cost-effective basis for a computer or an industrial development system.

To get your Acorn, just complete this coupon, enclose a cheque (or an official company order) and send it to us. If Acorn doesn't meet your highest expectations return it to us as received within 14 days, for a full cash refund.

Acorn comes with a comprehensive guarantee covering replacement of any faulty components, plus an expert service facility.

Take another look at Acorn's spec, check the price again, then send your order today Acorn Computers Ltd.

4A Market Hill, Cambridge, Cambs. Cambridge (0223) 312772.

l enclose an official compan

Please send me further

details of this and other

order

Acorn options

0-4		2-	
Ord	er	TO	
9.4	٠.		

Send to: Acorn Computers Ltd. 4A market Hill, Cambridge, Cambs. Please send me the following

(qty) Acorn Microcomputer(s) (Acorn MPU card with 1 K RAM and keyboard card with cassette interface, in kit form, with assembly instructions) at £65.00 plus £5.20 VAT

(qty) Acorn Microcomputer(s). as above, assembled and tested at £75.00 plus £6.00 VAT

(qty) Acorn controller(s) (minimum configuration MPU board with 6502, RAM I/O, TTL logic and capacitor-controlled clock at £35.00 plus £2.80 VAT (Post and packing free on all orders) Please allow 28 days for delivery. enclose a cheque for £... (indicate total amount) made out to Acorn Computers Ltd.

WW - 109 FOR FURTHER DETAILS

C. T. ELECTRONICS (ACTON) LTD.

267 & 270 ACTON LANE, LONDON W4 5DG, Telephone: 01-994 6275

Registered in England 1179820

CMOS

400000	0.17	40210	0.44	40/30	0.2
4001UB/B	0.17	4028B	0.77	4076B	1.1
4002UB/B	0.17	4029B	1.03	4077B	0.3
40068	1:04	4032B	0.89	4078B	0.2
4007UB	0.18	4034B	1.71	4081B	0.2
40088	0.87	40408	0.97	4082B	0.2
4011UB/B	0.18	4043B	0.88	40938	0.8
4012UB/B	0.20	4044B	0.84	40160B	1.1
4013B	0.43	4049UB	0.50	40161B	1.1
40148	0.83	4050B	0.43	40162B	1.1
40158	0.83	4051B	0.82	40163B	1.1
4016B	0.48	4052B	0.82	40174B	0.8
4017B	0.79	40538	0.82	401758	0.8
40188	0.83	4066B	0.55	401948	1.1
4020B	1.11	4068B	0.20	4510B	1.0
4021B	0.90	4069U8	0.20	4511B	1.2
40228	0.82	40708	0.46	45128	0.9
4023UB/B	0.18	4071B	0.20	4516B	1.0
4024B	0.70	40728	0.20	45188	0.9
4025UB/B	0.20	40738	0.20	452BB	8.0

6' IMHOFF 19" Racks. Brand new. £25.00 each

We have at time of press over 2 million Electrosil & Welwyn Metal Oxide Resistors well below manufacturer's price Phone for details.

This advertisement is a fraction of stock held by us.

No mail order accepted unless over £5.00. Hours of business 9.30am-6pm, Mon-Sat continuous. Carriage & packing charge extra. Govern-

We have considerable stock of PT10 & PT15 Presets. Special price for PT15 of the following value: 100Ω . 1k5, 2k2, 4k7, 10k, 22k, 47k, 100k. All the above values @£25/1,000. @121/2 VAT. Retail prices all values 10p either PT10 size or PT15. Open or

2200 µF 100V computer grade electrolytic Mullard £1.00 + VAT. 121/2.

PL259 Plugs with Reducers 50p each retail. SO239 o suit Plug (259) Bulkhead Socket 45p each +8%

BNC Plugs. Brand new. 30p +8% VAT. Either 50Ω or

N Connectors available at a fraction of list price. Phone

Sealectro Plugs (miniature) Conhex for VHF & UHF applications **75p** straight entry type 51-130-3187-91. **90p** right-angled gold plated type 055-014-3196.

All the above RF Connectors are held in depth and are brand new.

Cassette Monotage Heads 14" £1.00 each, Brand Cassette Erase Tape Heads 14" £1.00 each. Brand

Potentiometers W. Wound 1Ω-100v by A. B. or

Colvern Ltd, 11/2 watt 40p, 3 watt 60p, 5 watt 80p. ROTARY SWITCHES available in 30 different types,

prices range from 45p-£1.20 +8%.
PREH Television Push-button Tuner Units. 4 and 6 button, brand new in original boxes. 75p each

+ 121/2% VAT, Large quantity available. *SPECIAL OFFER* 100k LIN Mono Slider Potentiometer by Noble (metal body). 63mm length, price 20p each +121/2 VAT. All boxed as original. Discount on quantity.

SPECIAL OFFER 2k 2 LIN single gang Potentiometer by Egen, 14" shaft, 36" bush plastic spindle. Price 10p each +12½% VAT. Discount on quan-

Miniature Moulded Track Presets by Plessey Screwdriver operation, 0.25W dissipation, PCB fixing. 15p each +8%.

Open Cermet Presets. Most values in stock. 15p each +8% VAT.

Trimpots 10Ω-500kΩ 10 turn and 20 turn 50p each +8% VAT. By MEC, Paignton, Bournes Mini Square 34" rectangular or 11/2" rectangular Cermet or W Wound.

Convergence Pots. Most television values. 20p each +121/2% VAT

MOTORS (+8% VAT)

PAPST Motor HSZ 20-25-2-425 FFM, 42V 50C/S 10 µf cap across size: < 6cm Diam 3.4cm. Shaft: < 1.7cm Diam 4mm. £1.00 each.

Smiths Motor 240V 50 C/S 3-hole fixing. Spaced 4.75cm 3rpm. Shaft 1.5cm 3mm diam. £1.50 each. Cassette-deck Motor by Fujiya. 6V DC. <3.25cm. Diam. 3.5cm. Shaft diam 2mm < .9mm. 3-hole fixing 4cm to centres. £1.25 each.

General Time Motors with clutch. 240V 1/5rpm. 2-hole fixing. 4.75cm, 3cm depth. Body diam. 4.85cm. Shaft length 1cm, diam. 3mm. £1.50 each. Crouzet Motors, Speeds from and 10rnm, 2-hole fixing. 4.75cm, 3.9cm depth. Body diam. 4.5cm. Shaft < 0.9cm. Diam. 4mm. £1.50 each.

Miniature DC Motor 4-15V operation. High torque. < 3.5cm. Body diam. 2cm, 2-hole front fixing, shaft diam. 1.75mm. £1.00 each. Plus large stocks General Time Motors in the following

speeds: 1/180, 1/2 rph 12V DC; 1/5rpm 240V; 1rpm 240V

Miniature Motor Clutches by General Time (USA) 24V operation. Body diam. 2.2cm, 6mm shaft centre. £1.30 each.

PUSHBUTTON SWITCH UNITS

4-way 2P/CO. 50p each. 7-way 5,2P/CO 2,4P/CO.

Mullard Pot Core FX2241 30p each 8% VAT. Mullard Ex-computer Electrolytic 20,000 µ F / 45V.

Toko FM, AM, IF Coils etc. Stockholding now in excess of 1/2 million PCS. Any style available to callers only. 10p each or 50 PCS for £1.00 +VAT 121/2%.

EDGE CONNECTORS

Single-sided 0.1 pitch. 40-way fixing holes 118mm — RS type £1.20. 24-way fixing holes 73mm — UCL **70p**. Single-sided 0.15 pitch.

15-way fixing holes 75mm - gold plated - EB 60p. 18-way fixing holes 85mm including locating pin. 75p. 32-way fixing holes 136mm — gold plated — EB. £1.50. 27-way fixing-holes 122mm £1.30. Double-sided 0.1 pitch.

2 x 40-way fixing-centres 117mm gold-plated -Viking £2.00.

Double-sided 0.15 pitch. 2 x 40-way fixing-centres 165mm gold-plated £2.00.

W H Retail Price Type L W H Ret

ALUMINIUM BOXES, PLAIN

4	1	. 0.70	RB 2 (ins 8 5 2	.1
24	1.	0.70	RB 3 fins 9 5 25	1 1
· 51 ₃	1	0.70	RB 4 fins 11 6 3	2
21/2	2	0.85	RB 5 (ins 11 712 312)	2
21/2	1	0.70		
4	2	1.00	ALUMINIUM BOXES, BLUE	REX
5	2	1.20	COVERED	
6	3	1.55	Type L W H Ret	ail P
7	3.	1.75	RB 1 (ins 6 4'z 2'z	
41/2	3 1	1.45	RB 2 (ins 8 5 3	i
5	3	1.75	RB 3 (ins 9 5 312	1
8	3	2.40	RB 4 fins 11 6 4 1	2
			RB 5 (ins 11 7'2 4'2)	2

The above advertisement is a fraction of our stock holding. Trade & Export welcome. No Mail Order other than trade. VAT extra 8% or 12%. P&P dependent on article, etc.

TRANSFORMERS

(+12½ % VA!)	
6-0-6 500n: A (240V Pri) (63×35×43)	£1.40
0-11 2A 0-22 1A (240V Pri) (76×64×60)	£2.40
12V 130mA (240V Pri) (36×45×40)	£0.75
18V 140mA (240V Pri) (38.4×31×32)	"£0.80
18V 2A (240V Pri) (80 × 55 × 70)	£2.80
18V 21:A (240V Pri) (115×65×62)	£2.50
28V. 2A (240 Pri) (53×45×37)	£1.00
32V 250mA (240V Pri) (46 x 37 x 31)	£1,20
Auto 110, 115, 120, 220, 230, 240, 250V 150VA	£1.50
0-2-4-6-8-10-12V 0-1-2V 5A (RMS) 240V Pri (98 × 67 × 80	£6.00

TTL

7400	0.14	7449	1.00	74125	0.50
7401	0.14	7450	0.20	74132	0.70
7402	0.14	7451	0.20	74141	0.75
7403	0.14	7453	0.20	74150	1.00
7404	0.14	7454	0.20	74151	0.70
7405	0.18	7460	0.20	74153	0.70
1406	0.32	7470	0.35	. 74154	1.00
7407	0.32	7472.	0.30	74155	0.70
7408	0.20	7473	0.30	74156	0.85
7409	0.20	7474	0.30	74157	0.70
7410	0.18	7475	0.45	74160	0.95
7411	0.20	7476	0.35	74161	0.50
7412	0.20	7480	0.60	74162	1.00
7413	0.30	7481	1.00	74163	1.00
7414	0.70	7482	0.90	74164	1.00
7416	0.30	7483	0.80	74165	1.00
7417	0.30	7484	1.10	74166	1.00
7419	0.50	7485	0.90	74167	2.50
7420	0.18	7486	0.30	74170	2.00
7421	0.20	7489	1.60	74174	0.95
7422	0.35	7490	0.35	74175	0.80
7423	0.32	7491	0.50	74176	0.80
7425	0.30	7492	0.45	74177	0.80
7426	0.30	7493	0.40	74180	0.80
7427	0.30	7494	0.90	74181	1.85
742B	0.40	7495	0.65	74182	0.95
7430	0.18	7496	0.65	74184	1.50
7432	0.26	7497	1.90	74185	1.50
7433	0.50	74100	1.40	74188	2.50
7437	0.30	-74104	0.70	74190	1.00
7438	0.30	74105		74191	1.08
7440	0.18	74107	0.30	74192	1.00
7441	0.70	74109	0.55	74193	1:00
7442	0.50	74110	0.55	74194	1.00
7443	1.30	74118	0.95	74195	0.95
7445	1.00	74119	1.30	74196	0.95
7446	1.00	74121	0.28	74197	0.80
7447	0.75	74122	0.55	74198	1.60
7448	0.75	74123	0.55	74199	1.60
1440	0.73	14120	0.00	74283	1.60
				. 4200	

VEROBOARDS

0.1" Pitch Copper Clad			
2.5"×5"	0.59	0.15" Pitch Copper Clar	d
2.5"×3.75"	0.50	2.5"×5"	0.53
2.5"×17"	1.77	2.5"×3.75"	0.44
3.75"×5"	0.66	3.75"×17"	1.98
3.75"×3.75"	0.59	3.75"×5"	0.74
3.75"×17"	2.28		
4.7"×17.9"	2.99	0.15" Pitch Plain Board	
2.5"×1" (Sold in 5s)	0.70	5"×3.75"	0.47
		2.5"×5"	0.30
0.1" Pitch Plain Board			
3.75"×17.9"	1.49	New V-Q DIP Board	1.11
3.75"×2.5"	0.36		
3.75"×5"	0.56		

Ri	EXINE	ı		
ail	Price 1.30 1.55 1.65 2.10 2.55			
RE	XINE			
iit	Price 1.45 1.70 1.80 2.30			

U.K. RETURN OF POST MAIL ORDER SERVICE, ALSO WORLDWIDE EXPORT SERVICE

Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel. Suitable for home use.

Cabinet £4 extra. Will operate from 200MV to 100 watt signal.

R.C.S. "MINOR" 10 watt AMPLIFIER KIT

This kit is suitable for record players, guitars, tape playback, electronic instruments or small P.A. systems. Two versions available. Mono, £12.50; Stereo, £20. Post 45p. Specification 10W per channel; input 100my; size 9½ x 3 x 2in. approx. S.A.E. details. Full instructions supplied. A.C. mains powered.

R.C.S. DRILL SPEED CONTROLLER/LIGHT DIMMER KIT

R.C.S. STEREO PRE-AMP KIT. All parts to build this pre-amp. Inputs for high, medium or low imp per channel, with volume control and P.C. Board

20V, 40v, 60V, 1 amp 12V, 3 amp 10V, 30V, 40V, 2 amp 40V, 2 amp 20V, 1 amp 20V-0-20V, 1 amp 30V-0-30V, 2 amp 2 of 18V, 6 amp, each 12-0-12V, 2 amp 9V, 4 amp

£2.95

£3.35

ALL POST 75p

R.C.S. LOW VOLTAGE STABILISED

All parts and instructions with Zener diode, printed circuit rectifiers and double wound mains transformer. Input 200/240V a.c. Output voltages available, 6 or 7.5 or Pos 9 or 12V d.c. up to 100mA or less. Size 3 x 2½ x 1½in.

Fasy to build Full instructions supplied

POWER PACK KITS

R.C.S. POWER PACK KIT

Easy to build kit. Printed circuit
Will control up to 480 watts AC mains

Can be ganged to make multi-way stereo mixers

MAINS TRANSFORMERS
250-0-250V 70mA, 6.5V, 2A
250-0-250V 80mA, 6.3V 3.5A, 6.3V 1A
300-0-350V 80mA, 6.3V 3.5A, 6.3V 1A
300-0-300V 120mA, 2×6.3V 2A C.T., 5V 2A
220V 45mA, 6.3V 2A
1HEATER TRANSFORMER, 6.3V ½ amp £1.50
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs
2 amp, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V
1 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60
2 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60
5 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60
5 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60

AUTO TRANSFORMERS. 115V to 230V or 230V to 115V 150W 250W ... £6.00. 400W £7.00 500W FULL WAVE BRIDGE CHARGER RECTIFIERS. 6 or 12V outputs, 2 amp.....75p. 4 amp.....£1.25 CHARGER TRANSFORMERS: 1½ amp....£3.50. 4 amp....£8.50. 12V, 1½ amp Half Wave Selenium Rectifier

EXTENSION SPEAKERS £3.95 ea.

12V, 100mA £1.00 12V, 750mA £1.30 10-0-10V 2amp £2.45 30V, 5 amp and 17V-0-17V,

30V, 5 amp and 17V-0-17V, 2 amp £3.45 0, 5, 8, 10, 16V, ½ amp £1.95 9V, 3 amp £2.75 25-0-25V 2 amp £3.50 30V, 2 amp £3.00 30V, 1½ amp £2.75

9V, 3 amp 25-0-25V 2 amp 30V, 2 amp 30V, 1½ amp

COMPACT

SPEAKERS

plug is supplied. Full Range Quality

13 × 10 × 6in. approx.

£16 pair Post £1.30

Globe shaped cases in high gloss mouldings finished with chrome frontal trim and pro-

Frequency Response Impedance: 8 ohms
Power Peak: 5 watts

LOW VOLTAGE ELECTROLYTICS

12 VOLT 300mA KIT, £3.15.

BSR DE LUXE AUTOCHANGER

£17.50 Post £1 Plays 12". 10" or 7" records, Auto or Manual. A high quality unit backed by BSR reliability. Stereo Ceramic Cartridge. AC 200/250V. Size 13½-11 Ain. 3 speeds. Above motor board with Ceramic Stereo / Mono cartridge.

BSR Budget Autochanger with stereo cartridge, plays all size records £14.95

WIRELESS WORLD, MARCH 1979

HEAVY METAL PLINTHS ONLY

£3.50 Model "B" Size 16 x 13¾ x 3in.
TINTED PLASTIC COVERS ONLY £4.50

Sizes: 14½ × 12½ × 4½in. £3. 17½ × 14 × 4in. £4.50. 15¼ × 13½ × 4in. £3.75. 15 × 13½ × 3in. £3.50. 17¼ × 9½ × 3½in. £3. Post £1 14½ × 14¾ × 2½in. Rosewood sides £4. Ideal for record decks, tape decks, etc.

BSR SINGLE PLAYER

Ideal replacement or disco deck with cueing device and stereo ceramic cartridge. 3 speeds. Large turntable, modern desi

£19.50 Post £1 BSR P182 3 speeds flared aluminiu arm, cueing device, ceramic cartridge £22.50.
BSR MP60/P128 Stereo Ceramic, balanced

GARRARD HILFI **AUTO CHANGER** Model 5-300 3-speed stereo cartridge. £14.95

SMITH'S CLOCKWORK 15A TIME SWITCH 0-6 HOURS £3.30 Post 35p (199)

Single pole two-way. Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or

ELAC HI-FI SPEAKER 8in. TWIN CONE

Large ceramic magnet. 50-16,000 c/s.
Bass resonance 40 c/s.
8 ohm impedance.
10 watts. RMS.

£5.95 Post 35p

20 watt model **£8.95** Post 45p LOW VOLTAGE POWER PACK for MODELS Ready made. Famous make. Will supply 10 volts D.C. at 400mA. With terminals and mains lead. £2.50 Post 50p

VOLUME

CONTROLS 5kΩ to 2MΩ LOG or LIN L/S **35p.** D.P. **60p.** Stereo L/S **85p** D.P. **£1.** Edge 5K. S.P. Transistor **45p.**

80 Ohm Coax FRINGE LOW LOSS 15p yd.

0

PLUGS 10p. SOCKETS 10p. LINE SOCKETS 25p OUTLET BOXES 80p 300 ohm FEEDER 5p vd.

EMI 131/2 x 8in. LOUDSPEAKERS

3 or 8 ohm.

With tweeter and

£8.95

£10.50

crossover, 20 watt. 8 or 15 ohm. 20 to 20,000 c.p.s. Post 75p Suitable Bookshelf Cabinet Size 16 x 11 x 8 inches approximately

THE "INSTANT" BULK TAPE ERASER Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/250V. Leaflet S.A.E.

RELAYS. 12V DC 95p. 6V DC 85p. 240V AC 95p.

BLANK ALUMINIUM CHASSIS. 6 x 4-95p; 8 x 6£1.40; 10 x 7-£1.55; 12 x 8-£1.70; 14 x 9-£1.90; 16 x
6-£1.85; 16 x 10-£2.20. ANGLE ALI. 6 x ¾ x ¾in-15p.

ALUMINIUM PANELS. 6 x 4-24p; 8 x 6-38p; 14 x
3-40p; 10 x 7-£4p; 12 x 8-70p; 12 x 5-44p; 16 x
6-70p; 14 x 9-94p; 12 x 12-£1; 16 x 10-£1.16.

PLASTIC AND ALI BOXES IN STOCK. MANY SIZES
VARICAP FM TUNER HEAD with circuit & connections.

Some technical knowledge required £4.95.

TAG STRIP 28-way 12p.

TAPE OSCILLATOR COIL. Valve type, 35p.

BRIDGE RECTIFIER 200V PIV ½ amp 50p. 8 amp £2.50.

TOGGLE SWITCHES SP 30p. DPST 40p. DPDT 50p.

MANY OTHER TOGGLES IN STOCK. Please enquire.
PICK-UP CARTRIDGES ACOS. GP91 £2.00. GP94 £2.50.

SONOTONE SIERO £2.50.

SONOTONE stereo £2.00.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt 15p.
CASSETTE MOTOR. 6 volt £1.00.

ELECTRO MAGNETIC PENDULUM MECHANISM 95p Post 30p

1.5V DC operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays,

MICRO SWITCH SINGLE POLE CHÂNGEOVER 20p. SUB-MIN MICRO SWITCH, 25p. Single pole change over. TWIN GANG, 385 + 385pf 50p; 500pf standard 75p. 365 + 365 + 25 + 25pf. Slow motion drive 65p. 120pf TWIN GANG, 50p; 365pf TWIN GANG, 50p. NEON PANEL INDICATORS 250V. Amber or red 30p. NEON PANEL INDICATORS 250V. Amber or red 30p. RESISTORS. 10Q to 10M. ½W, ½W, 1/W, 1/W, 20% 2p; 2W, 10p. HIGH STABILITY. ½W 2% 10 ohms to 1 meg., 12p. Ditto 5%. Preferred values 10 ohms to 1 meg., 5p.

RCS SOUND TO LIGHT KIT Mk. 2 BAKER MAJOR 12" £15



£20 Please state 4 or 8 or 16 ohms.

"SALE" BAKER "BIG-SOUND" SPEAKERS. Post £1 Group 25'
12 inch
30 watt £12
4 or 8 or 16 ohm

Group 25'
12 inch
40 watt £14
4 or 8 or 16 ohm
6 or 16 ohm
8 or 16 ohm
8 or 16 ohm

BAKER LOUDSPEAKER, 12 INCH. 60 WATT.
GROUP 50/12, 4 OR 8 OR 16 OHM HIGH POWER.
FULL RANGE PROFESSIONAL QUALITY.
RESPONSE 30-16,000 CPS
MASSIVE CERAMIC MAGNET
WITH ALUMINIUM PRESENCE CENTRE DOME.

TEAK VENEERED HI-FI SPEAKER CABINETS
For 13x8in. or 8in. speaker
For 6½in. speaker and tweeter

£8.50 Post
£5.95 Post Many other cabinets in stock. Phone your requirements.

SPEAKER COVERING MATERIALS. SamplesiLarge S.A.E.

LOUDSPEAKER CABINET WADDING 18in wide 20p ft.

R.C.S. 100 watt VALVE AMPLIFIER CHASSIS



Four inputs. Four way mixing, master volume, treble and bass controls. Suits all speakers. This professional quality amplifier chassis is suitable for all groups, disco, P.A., where high quality power is required. 5 speaker outputs. A/C mains operated. Slave output socket. Produced by demand for a quality valve amplifier. 100V line output to order £10 extra. Send for leaflet. Suitable carrying cab £16.50 Price £99 carr. £6.00

Hom tweeters 2-16kc/s. 10W 8 ohm or 16 ohm £3.60.
Audax Tweeters 3-18kc/s. 50W 8 ohm £7.50.
CROSSOVERS. TWO-WAY 3000 c/s 3 or 8 or 15 ohm £1.90.
E1.90. 3-way 950 cps/3000 cps. £2.20.
LOUDSPEAKERS P.M. 3 OHM 7x4in. £1.50; 6½in., £1.95;

8x5in., £1.90; 8in., £2.50.

SPECIAL OFFER: 80 ohm. 2¼in., 2¾in., 35 ohm, 3in., 3½in., 25 ohm, 2½in., 3in., 5x3in., 7x4in., 8 ohm, 2½in., 3in., 3½in., 5in., 15 ohm, 3½in. dia, 6x4in.; 7x4in., 5x3in., 8in. diameter 4W £2.50. 10in. diameter 5W £2.95; 12in. diameter 6W £3.50. 3/8/15 ohms, please sta MOTOROLA PIEZO ELECTRIC HORN TWEETER. £7.95

BLACK PLASTIC CONSTRUCTION BUX with brushed

BAKER 150 WATT PROFESSIONAL

MIXER AMPLIFIER
All purpose transistorised.
Ideal for Groups Disco All purpose transistorised.
Ideal for Groups, Disco
and P.A. 4 inputs speech and music. 4 way mixing.
Output 4 8/16 ohms. A.C. Mains. Separate treble and

bass controls. Master volume control.

100 volt line model £99 £79 £1.50 carr

BAKER 50 WATT AMPLIFIER £59 Post £1 Superior quality ideal for Halls, PA systems, Discos and Groups. Two inputs with Mixer Volume Controls, Master Bass, Treble and Gain Controls. 50 watts RMS. Three loudspeaker outlets 4, 8, 16 ohm. AC 240V (120V available). Blue wording on black cabinet

GOODMANS COMPACT 12-INCH BASS WOOFER. Standard 12in. diameter fixing with cut sides 12 x 10 14.000 Gauss magnet. 20 watts R.M.S. 4 ohm imp. Bass resonance = 30 c.p.s. Frequency response 30-8000 c.p.s. £9.95 each Post £1



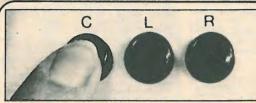
ALUMINIUM HEAT SINKS, FINNED TYPE. ALUMINIUM HEAT SINKS. FINNED TYPE. Sizes 5" × 4" × 1" 95p. 6½" × 2" × 2½" 65p. JACK PLUGS. Plastic 25p; Metal 30p. JACK PLUGS Stereo Plastic 30p; Metal 35p. JACK SOCKETS. Open 20p; Closed 25p. JACK SOCKETS Stereo Open 25p; Closed 30p. FREE SOCKETS — Cable end 30p. 2.5mm and 3.5mm JACK SOCKETS 15p.
2.5mm and 3.5mm JACK PLUGS 15p.
DIN TYPE CONNECTORS Sockets 3-pin, 5-pin 10p. Free Sockets 3-pin, 5-pin 25p.
Pluga 3-pin 20p; 5-pin 25p.
PHONO PLUGS and SOCKETS ea. 10p.
Free Socket for cable end ea. 15p.
Screened Phono Plugs ea. 15p.
TV CONVERGENCE POTS

15p each
Values = 5, 7, 10, 20, 50, 100, 200, 250, 470, 2000 ohms.

MONO PRE-AMPLIFIER. Mains operated solid state pre-amplifier unit designed to complement amplifiers without low level phono and tape input stages. This free-standing cabinet incorporates circuitry for automatic R.I.A.A. equalisation on magnetic phono input and N.A.B. equalisation for tape heads.

RADIO COMPONENT SPECIALISTS 337 WHITEHORSE ROAD, CROYDON Open 9-6. Closed all day Wed. Open Sat. 9-5.
Radio Books and Components Lists 20p. (Minimum posting charge 30p.) Cash prices include VAT. (We accept Access or Barclaycard. Phone your Order)

Tel. 01-684 1665



bush.



... connect

read

As fast and as simple as that, for batch testing, laboratory use or instrument servicing.

Accuracy 0.25% over a wide measurement range. With its companion CA4 jig unit, the B424 Meter forms an easy-to-use L, C and R

> Component Test Station ... and all for less than £600.

Write or ring today for details

DURBAN ROAD BOGNOR REGIS WEST SUSSEX PO22 9RL ENGLAND TELEPHONE BOGNOR (02433) 25811

AUSTRIA - Peerless & Handels-GmbH BELGIUM - Regulation-Mesure SPRL FINLAND - Finnmetric OY FRANCE - Tekelec-Airtronic

GERMANY - Keithley Instruments GmbH ITALY - Ing.S & Dr. G. Belotti SRL NETHERLANDS - C. N. Rood BV NORWAY - Metric AS SPAIN - Unitronics SA SWEDEN - Scandia Metric AB

Tel: (02) 28-26-24 U.S.A. - Mechanical Technology Inc, Latham, NY. Tel: (518) 785-2211

Tel: 0222 83 22 24 Tel: (010 32 2) 771.20.20 Tel: 460844 Tel: (Paris) 027.75.35 Tel: (089) 7144065 Tel: (Milan) 54.20.51 Tel: (070) 99.63.60

Tel: (Madrid) 242.5204 Tel: (Stockholm) 82.04.10

PRECISION DIAL GAUAGES John Bull No. 6 series 1. 01mm. £6 P.P. 50p COAXIAL CRYSTAL DETECTORS, (Marconi-Saunders), 200 MHZ-12 GHZ, £7,50 FIBREGLASS COPPER-CLAD BOARD

9x4½x1/16in. 40p P&P 10p 9x6x1/16in. 50p P&P 10p 9x6x1/16in. 50p P&P 15p 9x4½x1/16in. (double sided) 50p P&P 10p 9x6x1/16in. (double sided) 65p P&P 10p 15x15x1/16in. (double sided) £2.50 P&P 50p

OFF-CUT PACKS. 150 sq. ins. £1 P.P. 25p.
LOW PROFILE RELAYS (ZETTLER) P.C.
Mounting. 6v or 12v. D.C.
1 P. c/o 50p. P&P 10p.
2 P. c/o. 75p. P&P 10p.
4 P. c/o. £1. P&P 10p.

1 P. c/o (Latching) 50p. P&P 10p 2 P c/o (Latching) 50p. P&P 10p

PLUG-IN (CRADLE) RELAYS 6/12/24/48V.W.

P.A.R. BI-STABLE RELAYS. 24v d.c. 4 c/o £1 P.P. 15p.

PLUG-IN RELAYS 240v a.c. 10 amp contacts 3 pole c/o (11 pin) £1 P.P. 15p 2 pole c/o (8 pin) 85p P.P. 15p

U.H.F. COAXIAL CABLE (white) Double screened. Lab. quality 100m. drum £10 p.p. £1.50.

MULTICORE CABLES

4 CORE RIBBON (RAINBOW) CABLE 4 — 10/.2m.m.
Forming ¼in. wide strip. 10m—75p' 50m—£3; 100m—£6, P&P 1p per metre.

10 CORE CABLE 10 x 7/76 (10 colours) P.V.C.

O.D. 7m.m. 10m-£2. 50m-£8.50: 100m-£16. P&P 2p per metre

16 PAIR RIBBON CABLE 16x2 core P.V.C. Double sheathed forming 2in wide strip 10m—£3; 50m—£13.50; 100m—£25. P&P 2p per metre.

E.H.T. MODULES (resin encapsulated, in metal box) i/p 240x.50hz. o/p 13.7 kv. @ 7 watts (150x95x72m.m.) £10 P.P. £1.

P.C. EDGE CONNECTORS

P.C. EDGE CONNECTORS
32 way (.1 pitch) finished end 49p P&P 10p
56 way (.1 pitch) cuttal*-le 65p P&P 15p
64 way (.1 pitch) cuttable 75p P&P 15p
64 way gold plated pins 90p P&P 15p
Mounting pillars for 56/64 way 15p per pair.

'DRYFIT' RE-CHARGEABLE BATTERIES (Lead / Acid)

Ex. Equip. Good condition, tested 6v @ .9 A.H. £1.25 P&P 35p 6v @ 6 A.H. £3.50 P&P 75p 6v @ 7.5 A.H. £5.00 P&P 75p

J. B. PATTRICK

191/193 London Road Romford, Essex RM7 9DJ Romford 44473

BUILD THESE ADVANCED DESIGN INSTRUMENTS

DM-2



DC Volts.....1mV to 1000V AC Volts......1V to 500V DC Current...0.1mA to 0.2A

■ Battery Test Point

fincl, casel

Auto Polarity & Zero

● Total cost less than £30

Resistance1 Ω to 20M Ω

FG-1a

FUNCTION GENERATOR

■ 30mV to 10V pk-pk DIGITAL MULTIMETER

> ■ 1Hz to 100kHz DC coupled amplifier

Sine, Square & Triangle

Seperate TTL output

■ Total cost less than £20 (case extra)

To: JAYEN Developments, 21 Gladeside, Bar Hill, Cambridge CB3 8DY

Tel: (0954) 80285 Please send a JAYEN DM-2 @ £4.85 FG-1a @ £4.50 (Incl VAT and P&P)

Each kit comprising a PC board, punched and lettered Front Panel, Instructions and Component Shopping List. Money to be refunded if the kit

is returned within 10 days. WW-073 FOR FURTHER DETAILS

Gatronics NEW

WW TELETEXT DECODER

components and PCB for new Character Rounding "Board 4" available now. PCB £14.60. Kit (inc. PCB) £25.75

Board 3' is also available as an additional unit to update the 'Wireless World' Teletext Decoder to give double height characters, colour background, conceal / reveal, etc., as described in December 1977 and January 1978 issues of Wireless World
The Kit includes plated-through hole P.C.B., all components and installation instructions. Price 53.68 + VAT (£3.47) + P&P (30p) = £37.45 total. P.C.B. available separately at £19.30.

nted circuit boards and com

A reprint of the series of articles is available at £1.95 + large 18½p SAE (included free in complete kit). Prices on the right are for the Version with TEXAS X887, including VAT.



Also PLATED THROUGH hole PCBs at additional cost of £26

FULL FAULT-FINDING AND REPAIR SERVICE AVAILABLE COMPONENTS ALSO AVAILABLE SEPARATELY — SAE for price list READY BUILT AND TESTED DECODERS — £241.87 + £5 Carr. DE LUXE VERSION WITH NEW FACILITIES — £292.50 + £5 Carr.

FULL SPEC. PROFESSIONAL TELETEXT DECODER

We are now agents for V.G. Electronics Ltd., and can offer their model VGE1022 (as supplied to broadcasting authorities, etc.) at the SPECIALLY REDUCED PRICE of £248 + VAT = £279

FREQUENCY COUNTER CHIPS

74C926 £5.30; MK50395 £7.55; ICM7208 £15.70; ICM7216C £22.70; ICM7216D £19.65; ICM 7226 £27.20. Application information also available Try us for 7 segment displays, display drivers and prescaler I.C.s

All prices include VAT but please add min. 30p p&p CATRONICS LTD. (Dept. 923)

Communications House, 20 WALLINGTON SQUARE, WALLINGTON, SURREY. Tel. 01-669 6700

WW-923 FOR FURTHER DETAILS

		CD4015	0.83°CD4032	0.89 004049	0.50 CD40/2	0.20 CD4099	1.65
		CD4016	0.48 CD4033	1.25 CD4050	0.43 CD4073	0.20 CD4502	0.81
	0000	CD4017	0.79 CD4034	1.71 CD4051	0.82 CD4075	0.20 CD4510	1.01
	CMO:	CD4018	0.83 CD4035	1.06 CD4052	0.82 CD4076	1.17 CD4511	1.25
	Mainly RCA	CD4019	0.50 CD4036	2.86 CD4053	0.82 CD4077	0.39 CD4514	2.47
	CD4000 0.	15 CD4020	1.11 CD4037	0.85 CD4054	1.04 CD4078	0.20 CD4515	2.82
	CD4001 0.	17 CD4021	0.90 CD4038	0.96 CD4055	1.18 CD4081	0.20 CD4516	1.01
	CD4002 0.	17 CD4022	0.82 CD4039	2.78 CD4056	1.18 CD4082	0.20 CD4518	0.97
	CD4006 1.0	04 CD4023	0.18 CD4040	0.97 CD4059	4.29 CD4085	0.64 CD4520	1.04
	CD4007 0.	18 CD4024	0.70 CD4041	0.75 CD4060	1.00 CD4086	0.64 CD4527	1.43
	CD4008 0.4	87 CD4025	0.20 CD4042	0.69 CD4063	0.98 CD4089	1.39 CD4532	1.21
	CD4009 0.5	50 CD4026	1.55 CD4043	0.88 CD4066	0.55 CD4093	0.80 CD4555	0.78
	CD4010 0.	50 CD4027	0.44 CD4044	0.84 CD4067	3.35 CD4094	1.69 CD4556	0.78
	CD4011 0.1	18 CD4028	0.77 CD4045	1.26 CD4068	0.20 CD4095	0.94 MC14528	0.93
-	CD4012 0.2	20 CD4029	1.03 CD4046	1.20 CD4069	0.20 CD4096	0.94 MC14553	4.43
	CD4013 0.4	43 CD4030	0.50 CD4047	0.89 CD4070	0.46 CD4097	3.35	
	CD4014 0.8	B3 CD4031	2.00 CD4048	0.50 CD4071	0.20 CD4098	0.98	

OMPONENTS

DISPLAYS
3.10 TYPE FND500 CC 1.30 32 786 KHz 2.95 MC8800
3.45 TYPE TII 321 CA 1.30 MEMORIES/, Ups 2.80 ACP 2102A6 2112A4 2.90 720 - CT 200 - P10 COMPONENTS CLOCK CHIPS Free data is available on some of these items. SEND FOR FREE CATALOGUE

> **SOME 74LSTTL NOW AVAILABLE PLEASE SEND FOR LIST**

FAST SERVICE. We guarantee that Telephone Orders for goods in stock, received by 4.15 p.m. (Mon.-Fri.) will be dispatched on the same day by 1st Class Post (some heavy items by parcel post) and our stocking is good. Private customers should ephone and pay by giving their Access or Barclaycard number with a minimum value of £5. Official orders no minimum. Official orders, Companies, Govt., Nats. Ind... and Univ. ORDERS: C.W.O. add VAT at 8% + 35pp.6). TELEPHONE and CREDIT invoiced ORDERS add VAT at 8% + 60p p&p minimum charge (the balance will be charged at cost). Please send FAST SERVICE EXPORT ORDERS welcome. no VAT Dut add 10% (Europe). 15% (Overses) for Air Mail p&p. For export postage rates on heavy tiems—contact us first.

0 G



C

A

A

SEND YOUR PO BOX 75C OXFORD SINTE Tel: 0865 49791



TRANSFORMERS SAME-DAY DESPATCH

MAINS ISOLATOR
PRI 120 or 240V Sec 120 or 240V
Centre Tapped and Screened Amps 12v 24v 0.5 0.25 1.0 0.5 111 213 71 18 85 70 108 72 116 17 115 187 226 2.20 2.64 3.51 4.03 5.00 5.35 7.42 8.12 8.99 10.72 13.98 17.05 36.14

k115 or 240 sec only. State volts required. Pri 0.220-240V. **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

VOMM5 MINOR

Avo Cases and Accessories
P&P £1.15 VAT 8%
MINIATURE TRANSFORMER

ABS PLASTIC BOXES

ards (boards) flush fitting lid

15W £3.75. 25W £3.95 Stand for above £1.52. P&P 46p. VAT 12½%.

WEE MEGGER

 roltages available 3, 4, 5, 6, 8, 9, 10, 12

 20, 24, 30V or 12V-0-12V and 15V-0

 Ref.
 Amps
 £

 112
 0.5
 2.64

 79
 1.0
 3.57

 3
 2.0
 5.77

 20
 3.0
 6.20

 21
 4.0
 7.99

 51
 5.0
 9.87

 117
 6.0
 11.17

 88
 8.0
 14.95

 89
 10.0
 17.25

30 VOLT RANGE

SCREENED MINIATURES Primary 240V mA 200 200 3-0-3 1A, 1A 0-6, 0-6 90-9 330, 330 0-9, 0-9 500, 500 0-8-9, 0-8-9 1A, 1A 0-8-9, 0-8-9 200, 200 0-15, 0-15 50MA 12-0-12 300, 300 0-20, 2-20 700 (DC) 20-12-0-12-20 1A, 1A 0-15-20, 0-15-27 500, 500 0-15-27, 0-15-27 1A, 1A 0-15-27, 0-15-27 2.85 2.14 1.99 2.77 3.53 1.99 2.57 P&P £ P&P 235 3.88 96 207 5.91 96 208 7.60 1.14 236 11.00 1.32 239 12.52 1.84 214 15.84 1.64 221 18.06 1.84 206 25.56 OA 203 29.55 OA 34.06 OA 3.41 4.63 3.99 6.04

AUTO TRANSFORMERS
Ref. VA (Watts) TAPS £
113 15 0.115-210-240V 2.4
64 75 0.115-210-240V 4.6 HIGH VOLTAGE £ P&P 6.70 1.32 16.43 1.84 37.10 OA 61.81 - OA BRIDGE RECTIFIERS Step Up or Step Down

CASED AUTO TRANSFORMERS

MINI-MULTIMETER DC1000V, AC-1000V AC/DC-1000Ω/V DC-100mA. Res — 150K TEST METERS
AVO8 Mk. 5 £81.70
AVO71 £33.50 Bargain at £7.20 VAT 8% P&P 62p 00VA £49.97 £66.90 TT169 (tests transistors

PANEL METERS 43mm x 43mm 60... A £6.20 0-50 µA TT169 (tests transistors in circuit)
U4315 budget meter (42 ranges) 20kΩ V/DC 1000V
AC/DC (9 ranges) 2.5A AC/DC 500K resistance, in robust steel 0-50 μA £6.20 0-50 μA £6.70 0-500 μA £5.95 0-500 μA £6.70 0-1mA £5.95 0-1mA £6.70 0-30 £5.95 0-30V £6.70 VU Indicator Panel 90 mm 250 μa £3.36 VU Indicator Edge 54 mm x 14 mm μa FSD £2.60 Carriage 65p VAT 8%

EM272 31.6 KΩ v £53.70 DA116 Digital £102.00 Megger BM7 (Battery) £44.15 MM5 Multiminor £27.56

NEW RANGE TRANSFORMERS Pri 0-120; 0-100-120; (120v or 220-240v) Sec. 0-36-48 twice to give 72v or 92v.

2A 12.14 PP £1.40 4A 18.17 PP £1.90 3A 14.70 PP £1.50. 5A 26.64 PP £2.20

ELECTROSIL metal oxide low noise resistors PLUG-IN - SAVE BATTERIES

MVA30. 6, 7.5. 9v at 300mA plugs direct into 13A socket (fused), 4-way multi plug £4.00 ALUMINIUM BOXES—with 1/2 lip lid and screws
L VV H Price cards (boards) flush fitting illo.
PB1 80mm x 62 x 40 .65p
PB2 100mm x 75 x 40 .73p
PB3 120mm x 100 x 45 .87p
PB4 215mm x 130 x 85 £2.54
P8P 29p. VAT 8%

ANTEX SOLDERING IRONS

P&P29p. VAT 8% other sizes available PLEASE ADD VAT AFTER P&P

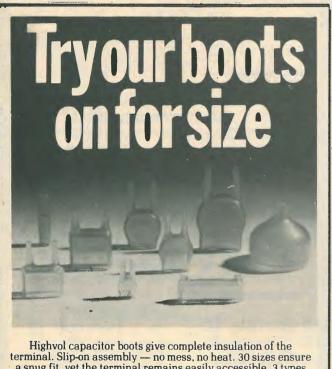
Barrie Electronics Ltd.

3.THE MINORIES, LONDON EC3N 1BJ TELEPHONE: 01-488 3316/8

NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST.

	LINEAR	SELECTION			DIODE	/TRANSISTOR SE	LECTION	
CA3130T	1.06	- µA709	0.65					
LM301-8	0.30	uA710	0.66	BAX13	0.05	BC209C 0.1	15 0A91	0.17
LM308-8	0.95	uA723-14	0.45	BAX 16	0.05	BC212 O.	11 ZTX1078	0.09
LM309K	1.95	uA741-8	0.27	BC107	0.10	BC214B 0.	15 1N4001	0.05
LM3900N	0.68	Ua747-14	0.97	BC108	0.10	BCY70 0.	15 1N4004	0.96
NE555-8	0.32	uA748-8	0.47	BC189	0.10	BCY71 0.3	20 1N4148	0.04
NE556-14	0.82	7805-UC	0.81	BC207	0.10		15 1N54D1	0.11
TBA810	1.30	7812-UC	0.81	BC207B	0.11		30 2N3053	0.16
TBA820	0.80	7905-UC	1.30	BC208	0.10		20 213055	0.49
ZN414	1.40	7912-YC	1.30	BC208A	0.10	DA47 D.		0.10
72702	0.79	1915-10	1.30	BC209	0.10	0A90 D.		0.09
ILIUL	0.65			_			Lifeton	0.00
	0.00				BZY88 Z	ENER DIDDES 247	-334 0.06	
		CMOS SEL	ECTION			TAN	ITALUM CAPS	313
4000	0.14	4023	0.15	4093	0.64			0.122
4001	0.15	4026	1.28	4507	0.49	0.1mfd 35v 0.0		0.122
4002	0.16	4027	0.48	4508	2.21	0.15mfd 35v 0.0		0.208
4008	0.90	4030	0.46	4510	1.02	0.22mfd 35v 0.0		0.211
4010	0.46	4051	0.83	4511	0.98	0.33mfd 35v 0.0		0.211
4011	0.15	4053	0.83	4518	0.98		87 10mfd 25v	0.122
4012	0.16	4060	0.98	4520	1.05	0.68mfd 35v 0.0		0.109
4013	0.41	4066	0.48	4528	0.90	1mtd 35v 0.0		
4016	0.39	4069	0.17	4556	0.85	1.5mfd 35v 0.0		0.208
4017	0.76	4075	0.17	,	0.00	2.2mfd 35v 0.0		0.122
4020	0.89	4081	0.17			3.3mtd 35v 0.0	93 10mfd 16v	0.109
4022	0.81	4082	0.17			4.7mtd 35v 0.1	09 100mfd 6.3v	0.208
		TTL SELE	CTION	-		Red 3mm 0.12		
						Red 5mm 0.12		
7400	0.12	7496	0.57	74186 .	7.15	Green 3mm 0.16		1.85
	0.12	74110	0.45	74190	0.99	Green 5mm 0.16		
7402	0.12	74120	0.80	74193	0.97	Yellow 3mm 0.19		
7404	0.13	74121	0.25	7446A	0.67	Yellow 5mm 0.19		
7405	0.13	74122	0.38	7447A	0.64	FN0500 1.41		
7407	0.26	74123	0.53	.7448	0.59	FN0501 1.41		ie 1.85
7410	0.12	74126	0.44	7470	0.28	FND507 1.41		
7411	0.18	74132	0.67	7473	0.25	7 Conmant Disalous		
7413	0.25	74136	0.72	7474	0.25	7 Segment Display		
7420	0.12	74141	0.58	7480	0.45	Height: 8mm Comm	Anode 1	.50
7421	0.27	74142	1.96	7484	0.88			
7422	0.17	74160	0.78	74147	1.25			
7427	0.24	74161	0.78	74148	1.15	ORDERS:		
7428	0.32	74162	0.78	74150	0.96		-	
7430	0.13	74163	0.78	74151A	0.60	CWO; P.O., Chequ All price include		
7440	0.13	74164	. 0.87	74153	0.60	Wil buce jucings	TAI	
7422A	0.52	74165	0.87	74154	1.03	DICCOUNT	1	
7485	0.83	74173	1.16	74157	0.63	DISCOUNT:	ine EV	
7490	0.33	74174	0.87	74159	1.65	Orders over £10		
7493	0.37	74175	0.68	74197	0.87	Over £20 less 11		
7494	0.75	74180	0.87	74198	1.45	Over £50 less 1		
7495	0.51	74184A	1.18	74393	1.94	Over £100 less		
						Add 30p for P&P		
						Send SAE for ou	r complete stock list	

WW - 085 FOR FURTHER DETAILS



terminal. Slip-on assembly — no mess, no heat. 30 sizes ensure a snug fit, yet the terminal remains easily accessible. 3 types for Tantalum, Aluminium and Ceramic capacitors, all conforming to UL safety and flammability ratings. FREE samples and catalogue showing our full range of insulator covers on request.



HIGHVOL CONNECTORS LTD.

Uddens Trading Estate, Nr. Wimborne, Dorset BH21 7NL Tel: Ferndown (STD 0202) 871411/2/3/4 Telex: 41408

WW - 081 FOR FURTHER DETAILS

Nevenco mixing consoles sophisticated performance from the pioneers



he new Nevenco range of mixing consoles is low on cost and high on guality and performance. It is lestigned exclusively for non-profit organisations; the Christian communicator, broadcaster, music or rogramme producer; and for universities, colleges and training studios with specialised needs and he ever-growing demand or sophisticated production.

n Portable: 8 mono or stereo inputs, 2 programme and 2 auxiliary outputs a studio: Desk-mounted version with studio interface. Console: 16 input, 4 bus full production console for the programme and s

s and layout to your needs — the sort of equipment you would expect from Rupert and Evelyn Beoff Watts and Alan Foster, pioneers of the world's most advanced audio consoles.

WW-023 FOR FURTHER DETAILS

for a good deal better than most

YOUR LEADING **DIRECT SUPPLIERS FOR**

Transistors

Opto-electronics

Rs and Cs

Associated items of all kinds

ALL IN OUR 120-PAGE CATALOGUE NO. 9 - FREE FOR THE ASKING

WE PAY POSTAGE

value. If under, add 27p handling

WE GIVE DISCOUNTS

on C.W.O. orders in U.K. — 5% on list value over £10: 10% on list value over £25 except net items.

WE STABILIZE PRICES

ew. clean and to

WE ARE NATIONAL DISTRIBUTORS FOR

NASCOM MICROCOMPUTERS For delivery from stock

Nascom 1 - £165 (net) + V.A.T. Also full supporting Nascom programme, club details, etc. Brochure on request.

MOTOROLA Evaluation Kit (for M680 Microprocessor) £175.67 (net) + V.A.T.

TRADE ENQUIRIES INVITED

Dept. WW3, 24 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB. Phone Egham 3603. Telex 264475

Northern Branch (Personal shoppers only), 680 Burnage Lane, Burnage, Manchester M19 1NA, Phone (061) 432 4945.

ALL INVOICES, ENQUIRIES, ETC. TO **OUR TEMPORARY ADDRESS OF**

CHILTMEAD

NORWOOD ROAD READING

Telephone No.: READING 65916

Until you've tried it, you won't believe how much capability we've packed into the Pocket Terminal. We've gone

all-out to make it the most practical and useful hand-held data communications device available.



WIRELESS WORLD, MARCH 1979

Here's just a few of the facilities:

- Transmits 128 ASCII codes.
- Displays full 64 character
- ASCII set clearly. 30 character memory accessible
- through display.
- Single 5V supply required at 400mA max.
- •110 or 300 baud transmission, 20mA loop or V24/RS232 level
- versions available. Parity codes and stop bits settable
- to your standard.
- ◆Reacts to bell, cursor and formatting control codes.

Pocket Terminal is a convenient, versatile, totally portable tool for anyone who needs to communicate with computers or their peripherals. Send for details now from

GR ELECTRONICS LTD.

Fairoak House, Church Road, Newport, Gwent NPT7EJ. U.K. Telephone: Newport (0633) 67426 Telex: 28604 Ref.1796

WW-103 FOR FURTHER DETAILS

MAIL ORDER PROTECTION SCHEME (Limited Liability)

If you order from mail order advertisers in this magazine, except for classified advertisements, and pay by post in advance of delivery, Wireless World will *consider* you for compensation if the advertiser should become insolvent or bankrupt, provided

- . You have not received the goods or had your money returned: and
- You write to the publisher of Wireless World explaining the position not earlier than 28 days from the day you sent your order and not later than 2 months from that day.

Please do not wait until the last moment to inform us. When you write, we will tell you how to make your claim and what evidence of payment is roquired.

We guarants to meet claims from readers made in accordance with the above procedure as soon as possible after the advertisor has been declared bankrupt or insolvent up to a limit of £3,550 per annum for any one advertisor so affected and up to £10,000 per annum in respect of all insolvent advertisors. Calaims may be paid for higher amounts, or when the above procedure has not been complied with, at the discretion of Wireless World; but we do not guarantee to do so in view of the need to set some limit to this commitment and to learn quickly of readers' difficulties.

This guarantee covers only advance payments sent in <u>direct</u> response to an advertisement in this magazine (not, for example, payments made in response to catalogues, etc., received as a result of answering such advertisements. Personal advertisements are excluded.

PROFESSIONAL STYLE AUDIO LEVEL METERS





These British made audio level meters are based on the Sifam taut band movement, and are suitable for use in portable equipment for stage or location. They are calibrated for use with 3K6 resistor 4VU above the scale marking so that reference deflection (0VU) is produced by a signal 4VU above 1mW in 600 R (1.228V).

AL22 £7.00 each or £13.50 pair AL22F £8.50 each or £16.50 pair

All prices inclusive of VAT, Add 75p P&P. Access Welcome.
For full details of this product and the complete Sifam meter range from our stock,

BRENSAL ELECTRONICS LIMITED

24 Park Row Bristol BS1 5LJ Telephone Bristol (0272) 294188

WW-087 FOR FURTHER DETAILS

OPERATIONAL AMPLIFIERS

Second Edition

G. B. Clayton, BSc

The first edition has been extensively rewritten and enlarged, to provide an introduction for the newcomer to the subject and a comprehensive coverage of the known modes of operational amplifier action. The enormous expansion in operational amplifier use has been taken into account and many useful circuits are presented. The text will prove equally valuable to both students and the practising engineer in the measurement sciences.

0 408 70202 8 £9.50 US \$ 21.50

PROGRAMMING FOR MICROPROCESSORS

Andrew Colin, MA, FBCS, CEng, FIEE

This book will enable electronic engineers, and amateurs with a knowledge of digital electronics, to learn microprocessor programming in the quickest and most efficient way. It covers the level of detail essential to the successful design of microprocessor systems and warns of common pitfalls. The Motorola 6800 is the main example used, but the techniques described can easily be transferred to other devices.

0 408 00320 0 £7.95 US \$ 18.00

NEWNES - BUTTERWORTHS

Borough Green, Sevenoaks, Kent TN15 8PH

Electronic Brokers Ltd Galibrated
Sound Level

GENERAL RADIO

1933 Sound Level Meter with 1935 Cassette Data Recorder. 10dB-130dB. A, B & C weighting. Supplied with ½ microphone. Fast and slow response. Builtin Octave band analyser with 10 centre frequencies from 31.5Hz to 16kHz, uses normal high quality C60 cassettes. Both Inits are hattery coperated. Units are battery operated £2,600.00
15658 Portable Sound Level Meter
40-1404B, A, B & C weighting. Fast and
slow response £225.00
1981 Portable Sound Level Meter 701204B. A weighting. Digital and analogue
reading. Maximum hold facility on digital

ADVANCE

VM77E Transistorised Voltmeter 10Hz-6Mz, 1mV-300V I/P Z 10M 0hms

91H RF Valve Voltmeter 20KHz-1200MHz. 100µV-300V ... £415.00

BRADLEY

112RF Millivoltmeter 3mV-300mV. 1-300MHz. Battery operated £375.00

BRUEL & KJAER

2409 Electronic Voltmeter 2Hz-200KHz. 10mV-1000V True RMS £245.00

HEWLETT PACKARD

PM.2503 Electronic Multimeter AC/DC Voltage and Current £90.00

ROHDE & SCHWARZ

U.R.V. RF Voltmeter 1KHz-2400MHz with 50 Ohms insertion unit 20mV-10V

AM324 AC Voltmeter 15Hz-500Khz

Analogue

AVO		
Model 7	1	£40.0
Model 8		
Test Set No. 1	1	65.0
Precision Avo	1	£45.0
Lords Donds slipe for Avo's		64 0

GENERAL RADIO

1911A Recording Sound Vibration Analyser 2.5Hz-25kHz. 1/3 and 1/10 octave bandwidth. Recorder spec: 7Hz-200kHz, 1mVac sensitivity 20-40 or 80dB range. £2,100.00

HEWLETT PACKARD

310A Wave Analyser

1kHz-2.5MHz. 10 µV-100V voltage range.
> 76dB dynamic range. B.F.O. and recorder
0/P. Has built in AM, LSB and USB detector.
A SUPERB UNIT OF THE HIGHEST

409 Modulation Meter 3-1500MHz. AM & FM £345.00

ROGERS/SIGN

DM.344 Distortion Meter 20Hz-20KHz £230.00

TEKTRONIX

1L30 Spectrum Analyser Plug In 925MHz-10.5GHz £1200.00 1L40 Spectrum Analyser Plug In 1.5-12.4GHz £1275.00

D.566B Distortion Meter 10Hz-1MHz. 0.03 to 100% £305.00

MARCONI INSTRUMENTS

T.F. 791D Deviation Meter 4-1024MHz. Dev. 10Hz 125KHz £195.00

Attenuators

MARCONI **INSTRUMENTS**

TF.1073A Series Step Attenuator DC-100MHz 0-100dB 50 or 75 Ohms

TF.2162 Step Attenuator DC-1MHz. 0-111dB 600 Ohms £120.00

ROHDE & SCHWARZ

RBD Attenuator BN 33662/60 DC-600MHz 20dB 60 Ohms £40.00 DPR Step Attenuator BN 18042/60 DC-300MHz 0-100dB 60 Ohms £90.00

ROHDE & SCHWARZ

A copy of our trading conditions is available on request

PAGE CATALOGUE

Containing latest information on our stocks of test equipment, minicomputers, computer peripherals, stroboscopes and tachometers.

Airmail to overseas addresses, £2

GENERAL RADIO

1608A Impedance Bridge C, 0.05 μF - 1100 μF L, 0.05 μH - 1000 H R, 0.05 MOhms - 1.1 MOhms

MARCONI **INSTRUMENTS**

TF.2701 In Situ Universal Bridge £395.00 TF.1245 'Q' Meter Supplied with TF.1246 Oscillator 40KHz-50MHz £625.00

WAYNE KERR

B.221 (CT.530) Univ. Bridge 0.1% accuracy £275.00 0.221 Low Impedance Adaptor for use £75.00 with B.221 **E B.521 (CT.375) Univ. Bridge** 1%

HEWLETT PACKARD

740B DC Voltage Source & Differential £850.00 Voltmeter £850.00
7418 DC Voltage Source & AC/DC
Differential Voltmeter £975.00

FLUKE

332A DC Voltage Calibrator0-1111.1110V in 3 ranges. 1ppm resolution. 0.003% calibration accuracy. 0/P current 0-50mA £1350.00 931B True RMS Differenti 10Hz-1MHz. 0.01V-1100V 883AB. AC/DC Differentia



TEKTRONIX

184 Time Mark Generator 2901 Time Mark Generator 2101 5nS Pulse Generator

£400.00 £525.00

ELECTRONIC BROKERS LIMITED ADD 8% 49-53 Pancras Road, London NW1 2QB VAT Tel. 01-837 7781. Telex: 298694

Hours of Business: 9 a.m.-5 p.m. Mon.-Fri.: closed lunch 1-2 p.m.

Carriage and Packing charge extra on all items unless otherwise stated.

WW-107 FOR FURTHER DETAILS





ADVANCE

DRM6 True R.M.S. DVM 41/2 digit, scale

B020A DMM. 3 1/2 digit LED Display. DC volts and current. Resistance and diode test. 8030A-01 DMM. 31/2 digit LED Display. DC Voltage and current. True rms AC Voltage and current. Resistance and diode test. age and current. Hesistance and diode test. Rechargable battery supply ... £135.00 8600A-01 DMM 4 ½ digit LED display DC-AC voltage and current. Resistance. Mains or battery operated ... £335.00 8600A as 01 model but no battery opt

HEWLETT PACKARD

3490A DM 5½ digit, scale length 120000.
AC Volts 1V-1kV 10µV resolution. DC Volts 100mV-1kV, 1µV resolution. Resistance 100 Ohms-10M Ohms, 1M Ohms resolution. Full auto-ranging and variable sample rate. Self check facility £595.00
34702A DMM C/W 34740A Display 4½ digit. AC/DC & Ohms £295.00

PHILIPS PM2243 DMM 4 digit £300.00 PM.2443 DC DVM 4½ digit, scale length 1999 £430.00 PM2513 D.M.M. 3½ digit £90.00 PM.2513A DMM 3½ digit, scale length

S.E. LABORATORIES SM210 DC DVM 4 digit, scale length 9999. 100mV-1kV, 10µV resolution . .

\$M214 AC-DC DVM 5½ digit, scale length 10999 SC-DC Volts 1.1V-1.1kV, 10µV resolution £300.00

WESTON
4449 3½ digit D.M.M. AC-DC works and current, resistance £79.50

Miscellaneous

resolution multiplier £525.00
1925A Multifunction Counter 9 digit LE0
display. 5Hz-125MHz. 15-25mV sensitivity. Adjustable trigger level. EMI Proof E.N.I. 500L R.F. Amplifier 2-500MHZ. 20DI case £405.00
1953A-07 Universal Timer Counter 9
digit LED display DC-520MHz. 30mV sensitivity variable trigger level £675.00
1953A-15-16 Universal Timer Counter 9
digit LED display. DC-125MHz. 30mV
sensitivity. Variable trigger level IEEE interface rear inputs. £850.00 gain. 300mW o/p £315.00 FLUKE
412B H.V. Power Supply 0-2100V.

£825.00

Resolution 5mV o/p current 5-40mA £365.00 **BRUEL & KJAER**

2607 Measuring Amplifier 2Hz-200kHz. 10 µV-300V range. Average times 0.15-300S. A, B, C and D weighting. Output signal 10V rms for F.S.D. on meter

COSSOR

CDU 150 Dual Trace Oscilloscope DC-35MHz. 5mV20V/div. Full delayed sweep. Long persistence CRT £450.00 4000 Dual Trace Oscilloscope DC-50 MHz. 5mV-10V/div. Full delayed sweep. Unused £495.00

DYNAMCO

7100 Dual Trace Portable Oscilloscope with 1Y2 and 1X2 modules DC-30 MHz. 10mV-20V/div. Full delayed sweep £350.00

HEWLETT PACKARD

184B Storage Scope Rack style variable persistance, c/w 1808A Dual Channe Vertical Amp, DC75MHz. 1825 Tim

base and Delay Generator, UNU: CONDITION — BARGAIN £1,600 1707B Dual Trace Portable
Oscilloscope DC-75MHz. 10mV-5V/
div. Full delayed sweep £895.00

SOLARTRON

CD 1400 Dual Trace Oscilloscope with 2 off CX 1441 and 1 off CX 1448 modules. DC-15MHz £155.00

TEKTRONIX

TEKTRONIX

531A Bench Oscilloscope with Dial trate vertical Plug-In unit CA DC-13.5MH; Sensitivity 50MV-20V/div. £290.06

647A Bench Oscilloscope with Dual trate vertical Plug-in unit 10A2A and delayed time base plug-in unit 11B2A DC-100MH; Sensitivity 10MV-20V/div. £1,200.00

585A Bench Oscilloscope with Dual trate vertical Plug-in unit 82 DC-80MHz. Sensitivity 10MV-50V/div. £775.00

547B Bench Oscilloscope with dial trate vertical Plug-in unit 1A1 DC-50MHz. Sensitivity 50MV-20V/div. £775.00

545B Bench Oscilloscope with Dual trace vertical Plug-in unit CA DC-24MHz. Sensitivity 50MV-20V/div. £775.00

545B Bench Oscilloscope with Dual trace vertical Plug-in unit CA DC-24MHz. Sensitivity 50MV-00V/div. £25.00

17-1020A Series RF Power Meter 20Hz-35KHz. 1MW-10WI-PZ 2.5 0hms-20K 0hms 150-300W FS. 0hms on 150-300W model. 50

17-2 Portable Scope Dual Trace (PC 25MHz, 1mW//Dy. 8UPCRB COASTTON. QUANTITIES AVAILABLE £485.00

TELS.



661 Sampling Scope c/w 5T3 and 4S Dual Trace and accs. £585. CA Plug In for 530, 540 and 580 series

T832 Dual Trace Portable oscilloscope DC-35MHz. 2mV-10V/div. Sweep speeds 0.5S-10nS/div. With trigger hold off £550.00

7313 Split Screen Bistable Storage scope c/w 7A18 and 7B53A modules. DC-25MHz. 5mV-5V/div. Full delayed sweep C.R.T. readout. 4.9cm/µS writing speed. Auto erase can be converted to 4 trace unit with addition of another 7A18 module. EXCELLENTLY PRICED AT ONLY

7A26 Dual Trace Plug In Unit. DC-200MHz.
5mV-5V/div £610.00
7D11 Digital Delay Plug In Unit. Delay by time or events. Digital delay readout to 7½ digits. 100nS-1S delay time. 1nS resolution. Delay internal CRT display £850.00 tion. Delay internal CNT display \$2.50.00
543B Bench Oscilloscopes with Dual trace vertical Plug-in unit CA £350.00
555 Dual Beam Scope (Mainframe) DC 33MHz wide choice of Plug-ins £300.00
422 Dual Trace Battery Portable Oscilloscope DC-15MHz. 10mV-20V/div £750.00

A copy of our trading conditions

Please note: All instruments offered are secondhand and tested and guaranteed 12 months unless

Hours of business: 9a.m.-5p.m. Mon.-Fri. Closed lunch 1-2p.m. WW-107 FOR FURTHER DETAILS

Electronic Brokers Ltd 49-53 Pancras Road, London NW12QE The Test Equipment People

Oscilloscope

PROBES

EB90 X1 Probe Kit DC-20MHz. 1.5 mtr
cable 40pF I/P cap. 500V DC max. working. BRAND NEW £9.00

EB91 X10 Probe Kit. DC-80MHz. 1.2 mtr.
cable I/P Z 10M Ohms paralleled by
10.8pF. Compensation 15-50pF. BRAND
NEW £11.00. PM.3240 Dual Trace Portable cable I/P Z 10M Ohms paralleled by Oscilloscope DC-50MHz 5mV-2V/div, Full delayed sweep. From £950.00 PM3010 Ministure Scope DC5MHz Dual Trace. Battery/Mains operation. Light. weight 1.8 Kg £325.00 weight 1.8 Kg £325.00 L2 mtr. cable. BRAND NEW £15.00

GREENPAR

200MHz. 10M Ohms I/P resistance. Com-pensation 15-50pF, UNUSED ... £27.00

MU964 AF Power Meter 20Hz-50KHz. 1mW-10W I / P Z 2.5 Ohms-20K Ohms £175.00,

ADVANCE
PG.52B Modular Pulse Generator 0.1 Hz-30MHz c/w 2 x P3, 3 x P2, P4, P5, P

PM5715 Pulse Generator Similar spec. to

Omniscribe 5000 Strip Chert Recorder 1
and 2 pen models available. Please contact
us for full details on modules and main

PHILIPS

PM8110 Mini Single Channel Chart Recorder Sensitivity 10mV-10V full span. Chart width 12cm. Chartspeed 5 and 20mm/min £250.00

3" Paper Width Recorder with 500 µA sensitivity FS. Left-hand zero. 1 and 6 per hour chart speed £75.00

EDDYSTONE

730/1A Communication Receiver 480KHz-30MHz in 5 ranges, BFO, noise limiting, AF filter, AVC, RF/gain, S Meter

730/4 Communications Receiver 480KH-30MHz, 5 Bands, BFO, noise limiting, AVC, RF gain, AF filter. UNUSE CONDITION £275.00 CONDITION 8275.00 880 Communications Receiver 500kHz 30.5MHz in 1MHz wavebands. BFO, AGC RF-IF gain, noise limiting, AF filter, S Meter

RA117E Communications Receiver 1-30MHz MHz and KHz tuned separately. Selectivity 100Hz-13kHz in 6 ranges. BFO, AVC, Noise limiter, RF/IF gain, S meter

Signal Sources

ADVANCE H1E LF Sine/Square Oscillator 15Hz

H1E LF Sine / Square Oscillator	50kHz Sine Square	£75.00
J2E LF. Oscillator	15Hz-50kHz	£90.00
J4 LF. Oscillator	10Hz-100kHz	£135.00
SG67A Wide Range Oscillator	1Hz-1MHz	656.00

6160A/DX Synthesised Signal Generator 4-30MHz. 1Hz resolution . . . £675.00

HEWLETT PACKARD

202H AM/FM Signal Generator 54-216MHz. From £495.0 608D VHF Signal Generator 10-420MH 612A U.H.F. Signal Generator 540-2004 From £950.00 1230MHz. From £950. 616A U.H.F. Signal Generator 1 4.2GHz 626A S.H.F. Signal Generator 10-£500.00 AM Generator 608E, 10-480MHz. AM

MARCONI

INSTRUMENTS
TF.801D/1 AM Signal Generator
10kHz-470Mhz £400.00
TF.995A/5 AM/FM Signal Generator
1.5MHz-220MHz £380.00

TF2015/1 AM/FM Generator. 10-520MHz Narrow Deviation model for mobile radio testing. Pristine condition TF2006 AM/FM Generator, 10-220 MHz TF2100 AF Oscillator 20Hz-20kHz

MUIRHEAD
D890A L.F. Decade Oscillator 1Hz111.1kHz £260.00

PHILIPS

PM5125 Sine / Square Oscillator 10Hz-1MHz £145.00 PM5167 Function Generator 1 MHz-10MHz. Sine. square, + pulse, ramp, triangle, single shot with variable phase

PM5105 LF Oscillator 10Hz-100kHz

PM5324 AM/FM Signal Generator £450.00 100KHz-110MHz £450.00 PM5326 AM / FM Signal Generator 100KHz-125MHz Digital Readout

TELECOMMUNICA-TIONS

SG5U Battery Operated F.M. Signal Generator 400-480MHz £390.00

SIGN ELECTRONICS

\$324 Low Distortion Oscillator 6Hz-60kHz Battery operated £90.00

154C Sweeper Main Frame with PM 7650B Plug-in Unit 50KHz-110MHz

MARCONI INSTRUMENTS

TF1099 MF Sweep Generator 100KHz-20MHz £175.00

ROHDE & SCHWARZ

Polyscop SWOB I Wideband Sweeper and Display 0.5-400MHz £1,000.00 SWH LF Sweep Generator 50MHz

INSTRUMENTS

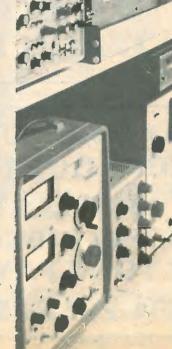
TF.2332 AF Transmission Test Set

ADD 8% VAT

49-53 Pancras Road London NW1 2QB Tel: 01-837 7781, Telex: 298694

WW-107 FOR FURTHER DETAILS





LB1 TRANSISTOR/DIODE TESTER

Tests 1CO, Alpha and Beta. Measure: parameters of transistors so that readings can be checked against manufacturers specification. Quick Test socket mounted or front panel. Full view meter for accuracy and

TE20D R.F. SIGNAL GENERATOR

rately covers 120 KCS. To 500 MCS in

£6.95

140 × 215 × 170mm

LT101, 1,000 OPV

ading. 178 × 108 × 83mm

1 1 2 2

£19.95

£57.00

0.75 0.75 0.85 0.85 1.45 1.05 0.90 1.10 2.10 1.05 0.95 0.95 0.95 0.95 0.95 0.95

AC volts

Resistance

0 to 10, 50, 100, 500 1000 0 to 5, 25, 50, 250, 500, 2500 0 to 50 ua, 2.5 ma, 250 ma 0 to 6K ohms, 6 meg ohms -20 to + 22 db 10 pf, 0.01 uf, 0.1 uf 4½ × 3¼ × 1 inch TMK500 MULTITESTER

C7205EN MULTITESTER

0 to 10, 50, 250, 1000 0 to 5, 25, 125, 500, 1000 0 to 50 ua, 250 ma 0 to 300 ohms, 6K, 30K 6 meg ohms - 20 to + 22 db 115 × 78 × 33mm

IT 1/2 20,000 OPV

£11.95

£20.95 0 to 2.5, 10, 25, 100, 250, 500, 1000 0 to 0.25, 1, 2.5, 10, 25, 100, 250, 1000 0 to 50 ua, 5 ma, 50 ma, DC current

12 amp. 0 to 6K, 60K, 6 meg, 60 meg. — 20 to + 56 db 20p P&P unless otherwise show

ELECTRO-TECH COMPONENTS LTD.

0.40 0.90 0.90 0.20 0.80 0.20 0.55 0.75 1.00 1.25

364 EDGWARE ROAD, LONDON, W.2. TEL: 01-723 5667 CALLERS WELCOME

DATA GENERAL COMPUTERS WE HAVE SEVEN COMPLETE SYSTEMS, EACH COMPRISING:

Cabinet with power supplies. Fans, mains filter units, 240V 50HZ. Nova 820 mainframe 240V 50HZ, Nova 820 expansion chassis 240V 50HZ. CPU1 (8206) power mon and restart. CPU2 (8207) mult/div. I/O int (4007/4010) for TTY.

8192K 16-bit memory board (8269/8274) word word Disc pack controller board (4046).

TO5 8 Pin DIL 14 Pin DIL 8 Pin DIL 8 Pin DIL TO5 14 Pin DIL

RAM

2102 450 nSec. £1.40

Gen. purpose int. bd. with data channel (4040/4042).

2.5m byte disc storage system (Diablo) Series 30 (4047A) moving head. Disc power supply (240V 50HZ) with adaptor and logic board (4047). Computer Control Panel.

OFFERS AROUND £5000

C.T. ELECTRONICS (ACTON) LTD.

267 & 270 ACTON LANE, LONDON, W4 5DG Telephone: 01-994 6275

GET MORE

WATT PER £

WITH ASTEC

ANY MAKE-UP OR **COPY QUERIES** CONTACT JOHN GIBBON **OR TONY FAYERS** 01-261 8353

IS YOUR POWER SUPPLY **OUTGROWING SYSTEM SIZE?** THEN SWITCH TO ASTEC SWITCH MODE **POWER SUPPLIES**

50W Range 4" × 8.5" × 2"

2lb. 5V 10A and other voltages 100W Range 6.5" × 8.5" × 2",

3.3lb. 5V 20A and other voltages **VIDEOTIME PRODUCTS**

56 Queens Road, Basingstoke, Hants, RG21 1REB Tel: (0256) 56417 Telex 858747

WW-102 FOR FURTHER DETAILS



WIRELESS WORLD, MARCH 1979

Electronic Brokers The Computer People

SEALECTRO PATCH BOARDS

ing and intercon

x 20 XY matrix. Interconnection is by reans of shorting, skip and component holding pins (not included) imensions: 7½" x 5¾" x 1"

PRICE: £12.50

NEW KEYTOP/KEYSWITCH KITS - ASCII CHARACTER SET

Pack of 58 keytops and keyswitche

PRICE: £15.00

SURPLUS ASCII KEYBOARDS

KB3 ROM-encoded ASCII keyboard with 63-push-button key stations. Selectable mode — either full ASCII or TTY. Selectable parity. TTL-compatible. Power requirements, +5V-12V. Constructed on rugged PCB with metal mounting plate. Supplied with full technical data. **BRAND NEW SURPLUS** Manufacturers surplus

ONLY £35.00 + p.&p.



MASSIVE BULK PURCHASE BRINGS YOU HAZELTINE VDUs AT LOWEST EVER PRICES

PRICE: £425



H1000 ONLY £350 HAZELTINE H1000

SCREEN CAPACITY -960 characters 80 per line x 12 lines. CHARACTER GENERATION - 5 x 7 dot

CHARACTER SET - 64 ASCII alphanumerics and symbols.

CHARACTER SIZE —1/8 inch (.32cm) nomin

TUBE PHOSPHOR — P4 (white on black)
REFRESH RATE — 50 fields per second.
KEYBOARDS — TTY format attached.
INDICATORS — Power On. Parity Error.

Dataset ready. **PARITY** — Parity error indicated by Parity light and question mark (?) displayed in character TRANSMISSION — Asynchronous. Sw

OPERATING MODES — Full/half Duplex. MEMORY — High speed MOS refresh. STANDARD INTERFACE — CC ITT V-24.

REMOTE COMMANDS — Home Cursor, Clear Screen

HAZELTINE H2000 SPECIFICA

SCREEN SIZE - 12" diagonal. 1998 cha racters; 74 per line x 27 lines.

CHARACTER GENERATION — 5 x 7 dot CHARACTER SET — 64 alphanumerics and

HARACTER SET ymbols. 32 ASCII control codes. (EYBOARD :— Detachable, solid state, eletypewriter design. 10-key numeric cluster plus editing and cursor control keys.

Asynchronous. Switch KEYBOARD

plus editing and cursor control keys.

TRANSMISSION — Asynchronous. Switchelectable for combinations of 5 standard rates, 75 to 9600 baud. OPERATING MODES — Switch-selectable, full

EDITING FEATURES - Full Cursor controls STANDARD INTERFACE - CC ITT V-24 (EIA

RS-232 B/C) or 202C Compatible.
REMOTE COMMANDS — Insert / Delete Line,
Clear Screen, Clear Foreground Data Only, Home
Cursor, Address Cursor, Set Background Intensity, Carriage Return,
Backspace, Ring Bell, Transmit, Print.



H-2000A ONLY £495

AUXILIARY OUTPUT - Standard printer TUBE PHOSPHOR — P39 (green on black)

Mini~Computer Exchange

DEC BIG SAVINGS ON OUR LARGE STOCK OF PROCESSORS, PERIPHERALS **AND ADD-ON MEMORY**

PDP8A Add-on RAM Read/Write MS8AA 1K £225 00

PDP11-04/11-34 Add-on MOS £550.00 £1,200.00

PDP11-05/11-40/11-45 Add-on Parity Core

MM11LP 8K MM11UP 16K MF11UP 16K MF11UP 16K MF11UP 16K complete with backplane PC81 High Speed Reader/Punch & Control for PDP8 £895.00 DD11A 4 SPC-slot backplane DR11B DMA Interface complete with backplan VT8E Alphanumeric & graphic Display

PR11 High-speed paper tape reader and control £1,450.00 RTO1AB Numeric single-line data entry terr

£650 (ASR) CENTRONICS

£1.000.00

with PDP8E interface KW11P Programmable Clock £345.00

TC11 TU56 DECtape drive and control

Printers and Terminals LARGE STOCKS OF ASR33

AND KSR33 TELETYPE **TERMINALS**

* ASCII Keyboard
 * Hard-copy unit (friction or sprocket paperfeed)
 * Paper tape punch and reader (ASR33 only)
 * Line unit (20mA/6V/80V)

Prices from £425 (KSR) and

MODEL 101 MATRIX PRINTERS

racter set

165 Characters per second 5 x 7 dot matrix PRICE: £750.00

- SCOPE DATA 240 CPS MATRIX PRINTER

r 80 Column Receive-Only Printer with full upper & lower case ASCII character set. Standard RS232 interface Electro-Sensitive printing ensuring quiet operation

Dimensions: 17½" x 13½" x 5½
PRICE: ONLY £695

ANOTHER SCOOP PURCHASE WANG THERMAL

PRINTERS

Kevboards TOP QUALITY ASCII KEY-BOARDS AT LOW, LOW

KB756 56 key-stations, mounted £49.50

(mail order total £55.08) K8756MF As above, fitted with metal ONLY £55.00 mounting frame for extra rigidity

Mail Order Tota KB15P Edge connector
KB701 Plastic Enclosure £ 3.35 £12.50 £25 00 Steel Enclosure £28.62

LATEST ADDITION TO THE RANGE



KB771 71 Station keyboard incorporating separate

PRICE £95.00 Quantity Discounts

ELECTRONIC BROKERS LIMITED (COMPUTER DIVISION) 49-53 Pancras Road, London NW1 20B. Tel. 01-837 7781, Telex: 298694

Hours of business: 9 a.m.-5 p.m. Mon.-Fri. Closed lunch 1-2 p.m. WW - 110 FOR FURTHER DETAILS

ADD 8% VAT Carriage & Packing charge extra TO ALL PRICES on all items unless otherwise stated

We are now able to offer this superb compact VVM we are now able to offer at even lower prices.
Original specifications 1v-300v AC 300mv-1000v DC 1Ω-1000MΩ resistance

Input Z 0.3v range $10M\Omega$ 1v range $30M\Omega$ All others $100M\Omega$

Features include: Large readable meter, switchable centre zero Large readable meter, switchable centre zero, lightweight, supplied complete with manual and mains plug, believed in good condition but untested NEW LOW PRICES

NEW LOW PRICES

Grade 1 damaged A.C. probe £25.00 + p.p.

Grade 2 less A.C. probe £20.00 + p.p.

Probe circuit shown in manual.

Post and Packing £1.75.

HARTLEY CT436

SNIP DC-6 MHZ DOUBLE BEAM OSCILLOSCOPES

A new Ministry release enables us to offer this much coveted mains portable scope, featuring a real double beam C.R.T. with independent brightness controls, and sensitivity of 10 mv/cm. Dimensions of only 10 x 10 x 15 make this ideal for portable work, T.V. servicing etc. etc. Supplied in good external condition complete with mains lead, but untested Full service manual £5.00 purchased with scope, £10.00 purchased separately.

+ p.p. £4.50

Superb professional fully enclosed, made for the G.P.O. to the highest standard, offered at a fraction of their original cost they feature aluminium sides, hinged removable front panel, which can be secured by 2 screws to prevent prying fingers. All are finished in two tone G.P.O. grey and although believed brand

new may have minor scuff marks/scratches due to 45p each 3 for £1-00.

bad storage. Dimensions:

SMALL 16: D x 6½: H x 8½: W £5.25 + P + P £1.00

MEDIUM 16: D x 6½: H x 14½: W £7.25 + P + P £1.15

LARGE 16: D x 12½: H x 17½: W £10.75 + carr £1.75

Ideal equipment cooling etc. tested, ex-equipment. 240 v 50-60 HZ £5.75 + p.p. 40p 110 v 50-60 HZ £4.75 + p.p. 40p

CHARACTER

GENERATORS Purchased from a major V.D.U. manufacturer, this end of line Motorola 3 chip R.O.M. set is preprogrammed to give a full 96 upper and lower case character font on a 10x7 mattrix for the upper case and a 14x5 mattrix for the lower descenders

rgip q vi thus resulting in a superb and extremely legible display. Full ASCII. input, TTL compatible in and out. Supplied with 9 page data and instruction pack. brand new at only This item cannot be

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, Suß-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
71b £ 4-75
14lb £ 7-50

ONE INCH

NUMERIC DISPLAYS

DISCOUNT

56lb £21.00

P.P. £1-00

repeated. Hurry while stocks last.

ELECTRONIC COMPONENTS

& EQUIPMENT

28lb £12.75

112lb £34-00

Due to our massive bulk purchas

OPTO SMASH

TIL 302/MAN 7 7 segment LED readou common anode direct drive (via resistors) from 7447 £1-10 each TIL 119/OC72 Darlington opto isolator 3 for £1-00. SAVE THAT SPACE! THICK FILM RESISTOR NETWORK 7×100() resistor in DIL pack. Ideal for use with 7 seg. displays etc. 4 for £1-00.

TIL305 0.3" 7 x 5 matrix I FD alphanumeric readouts £4.75 each. PHOTO TRANSISTOR Fairchild FPT-100 NPN silicon 30v

Fairchild FPT-100 NPN silicon 30v, 25ma. 4 for £1.00.
DISPLAY 1.C. AND
TRANSISTOR BARGAINS
TRANSISTOR BARGAINS
TRANSISTOR BARGAINS
Well known manufacturers and fully
guaranteed. No fall outs. Comprehensive data on 1.C.'s 12p per type.
2N4351 N channel MOS FET, 2N4352 P channel MOS FET, 95p each £1.50 per pair.
HIGH VOLTAGE NPN POWER 20p each 6 for £1-00. LM380N-SL6051 14 D.I.L. 2 watt A.F. amp. 75p each 8 for £5-00.
CA3028B DC-120 MHZ differential/
cascode amp £1-00 each 3 for £2-50. TMS3114 DUAL MOS 128 bit static shift reg. DC-2.5mhz £1-75 each 4 for £5-00. HIGH VOLTAGE NEN POWER

E5-00.
TMS 4050 4096 x 1 dynamic ram
£4-75 each 8 for £30-00.
NE555 10 for £2-40
GE424 zero voltage switch, triac SCR, relay driver TO5 can £1-00 each 7 for £5-00. SWITCHING transistors BVcbo 600v BVceo 500v BVebo 5v 1c 5 amps Pc 125 watts HFE 60 typ ft 2.5 mhz ideal invertors, etc. TO3 £1.50 each 4 for £5.00. CA3011 20MHZ wideband amp T099 case 60p each 2 for £1-00. FSA 2719 8 diodes1N4148-1N914 type in 16 D.I.L. pack all BF258 NPN 250v @ 200 ma 40p each

3 for £1-00. 3 for £1-00.

A.E.I. power TRIACS 10 amp 400v ready mounted on 2%" x 2%" heatsink 95p each 4 for £3-50.
I.R. BSB01 2.5 amp 100v bridge rec.
P.C. mount long leads. 30p each 4 for independently connected 35p each 4 for £1-00 PPO3725 4 NPN 50v 500ma silicon transistors in 14 D.I.L. pack 65p each a 2 for £1-00. TEXAS LOW PROFILE I.C. SOCKETS

N4998 4 amp 100v P.C. mount diodes IN4998 4 amp 100v P.C. mount diode: Long leads 12p each 10 for £1:00. I.R. 25G60 60. amp 600v silicon stud diodes £1.80 each 8 for £10:00. E.C.C. 1.6 amp 400v triacs 35p each 4 for £1:00. 2N16718 unijunction 450mw 30v

IN4004-SD4 1 amp 400v diodes 6p each 20 for £1-00.

2NS109 R.F. power output 400ma 2.5 watts up to 1200 mhz TO5 70p each 2 for £1-00. AF279 low noise P.N.P. germanium up to 780 mhz 30p each 4 for £1-00. I.R. 10 AMP BRIDGE RECS. 200 volt 2N4304-WN720 F.E.T. transistor. 35p working, £1-00 each each 4 for £1-00. ULTRA 39 WAY 0.1 DOUBLE SIDED EDGE CONNECTORS. Open ended, ideal verboard, easily cut 75p each.

PLESSEY EDGE STACKABLE DECADE SWITCHES Gold plated contacts,

dimensions 2x 2x 3₈ 80p each 8 for £5.00.

LM309K +5v 1.2 amp regulator £1.00 each 6 for £5.00

AMPHENOL 50! BNC chassis socket single hole fixing 45p each

C90 Audio Cassettes screw type construction 40p each 3 for £1.00.

C90 Audio Cassettes screw type construction 40p each 3 for £1-00.

Scotch 215 Long Play Tape Brand new '" low noise on 1200' 54"

spools £1-50 each 4 for £5-00 + P.P. 45p.

1000 Watt fully shrouded auto transformers term, block connections £13-75

+ P.P. £2-25 *.

Bulbs 24v 14 watt white frosted S.B.C. 8 for £1-00.

S.B.C. Bulb Holders All steel cad, plated panel mount easily fixed via nut and round hole, Ideal disco displays, scoreboards etc. 4 for £1-00.

Xtal filters S.E. 1. QC11211/B miniature low insertion loss P.C. mount

C.F. 10.7 mbz with B.W of 7.5 kbz. 2000 £2 imp. in-out Brand new at £7-50.

Heavy Duty Flat Insulated Earth Braid 80-100 amp braided tinned copper in heavy clear P.V.C. sheath 40p per metre £5-00 for 15 metres P.P. 8p per metred.

BULGIN miniature 6 way male chassis mount socket and matching stroughed. neary clear P.V.C. sheath 40p per metre £5-00 for 15 metres P.P. 8p per metre. BULGIN miniature 6 way male chassis mount socket and matching shrouded free plug. 60p each 2 for £1-00.

Red L.E.D.'s full spec. 0.2" 12p each 10 for £1-00.

Dynamic Stick Mics 600 52 with built in on/off switch complete with lead and min. jack plug £1-00 each

TOS HEATSINKS "Thermaloy" black anodised press on aluminium finned

P+P 30p.

type. 15p each 10 for £1.00

MANY HUNDRES IN
TRANSFORMERS IN
TRANSFORMERS IN
TRANSFORMERS IN
STOCK SEND SAE
STOCK ST right nut and bolt for the job. Pack contains
B.A. Metric, Unified, Self Tap. etc. nuts, bolts,
screws, washers, etc. in brass bronze and
steel. All steel items plated. Average
contents 400-600 pieces.
sold by weight, 2-lb bag

DIODES - DIODES CRYSTALS

N914-types etc. mixed and untested

CRYSTALS

CRYSTALS

FREQUENCY CASE
100 KHZ B7G
250 KHZ B7G
50 MHZ HC18/U C2
0 1200 baud etc. C2.75* 1N4148-1N914-types etc. mixed and untested 1000+ bag £1-50 P P. 40p. Buy some for a friend!

Where cost of post and packing not indicated please add 25p per order Collection saves cost of postage but if collecting please telephone to check availability. We are always interested in buying P.C.B 's surplus components, test equipment, valves, etc. Phone for details for 2400, 1200 bad etc. 27.75 Standard 1200 bad etc. 27.7

constructed to project numerals between "0" and '9" and a " + " and " " sign onto an opaque 103 Tamworth Road Croydon CR9 1SG 01 688 1833 sign onto an opaque screen to give extremely legible, rounded characters of up to 1 in height. Features easily replaceable 6 volt bulbs, changcable negative for different character forts. Dimensions 1) x1 x31 supplied complete with bulbs and plug in £1.75 p.p. 30; carrier. Ex equipment

MAIL ORDER INFORMATION: All prices inclusive of VAT. Cash with order, Minimum order value £1-00. Postage quoted for UK only. Bona Fide account orders minimum £10-00. Export and trade enquiries welcome. Orders despatched same day where possible. Access and Barclaycard welcom

transformers, power supplies, scopes, sig. gen's, motors, periphera 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.

SUPER VALUE PCB Special

This superb P.C.B. consists of 59 digital I.C.'s including 7442, 7475, 7404 etc. etc. All I.C.'s are plugged in on 14 and 16 pin D.I.L. top quality gold plated sockets. The board also includes 77 long lead 2N3704 NPN transistors, 1 TIP 33, 77 IN4148

Unbeatable value at and Rail Stations and Rail Stations and Rail Stations silicon diodes, res. caps. connectors etc. All components easily removable. Original cost well over £100.00.

2N3001 30 volt 350 ma S.C.R. TO18

14 DIL 14p each 9 for £1-00 22 DIL 25p each 5 for £1-00 24 DIL 30p each 4 for £1-00

/ictoria or Londo West Croydon Bus and Rail Stations. 25 minutes

+ p.p. 75p. Gatwick Airport. M.P.U. CORNER

SAVE £120 TANDY TRS 80 MEMORY UPDATE

Update your new or existing TRS 80 from 4K to 16K of RAM. Install your own chips and save £120.00. Kit includes full iinstructions and 8 x 16K full spec. devices. Simple plug-in and jumper £108

TRS 80 software now in stock. Programs include:
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 3, etc. Phone
Micro Chess, Space Fighter, Startrek 4, etc. Phone
Micro Che

screw fixing, complete with library cases, 2 for £1.00, 1 for £4.50, p + p 70p.

Self-adhesive die cut Cassette labels 20 for £1.00.

POWER SUPPLY UNITS
5 VOLT 2.5 AMP T.T.L. P.S.U.
Made for T.T.L. this compact ex computer systems
unit features a 10 amp transformer with D.C.

outputs of 5 volts @ 2.5 amps and 7.5 volts @ 5 amps. The 5 volt output is fully regulated and smoothed and has electronic current limiting. May be easily moded for 5 volts @ 7.8 amps, believed working but untested.

Complete with circuit

7.25 p.p. £1-50

YBOARD

A special bulk purchase enables us to offer the above Keyboard at a lowest ever price. 49 coded keys encoded into a direct TTL compatible 7 bit output. Features such as delayed strobe, 5 volt D.C. single rail operation and rollover protection make this an absolute must for the MPU constructor! Supplied complete with connection diagram and edge connector, at a secondhand "no tin to test" price of only £18.50 P.P. £1-50

> **SEMICONDUCTOR** 'GRAB BAGS'

Amazing value mixed semiconductors, include transistors, digital, linear I. C. 's, triacs, diodes, bridge recs etc. etc. All devices guaranteed brand new, full spec. wit manufacturers markings, fully guaranteed. 50 + BAG £2.75 100 + BAG £4.95

> MULLARD + PLESSEY HY-GRADE SMOOTHING CAPS 1500 mF 100v Screw Term 3300 mF 63v Screw Term 4500 mF 25v Screw Term ex equipment but tested

EFFICIENCY SMITHS RADIAL BLOWERS

Are your hot parts sweltering? Then keep them cool with our high efficiency radial snail type blowers. Made with our high efficiency radial snail type blowers. Made by Smiths, designed for continuous use in expensive electronic equipment very powerful and quiet, gives massive air flow to prolong component life and reliability. Easily mounted, air aperture 2%" x 3" supplied complete with fixing bolts. Ideal linears etc. Please state 240v or 110v operation. 50hz only.

MINIATURE SNAIL BLOWER This superb "little" blower, imagined as a cube measures

This superb "little" blower, imagined as a cube measure only 3½ x 3½ x 3½ with a 1½ x 1½ air output aperture. Almost silent running, ideal for miniature projectors, computers, P.S.U.'s etc. Please state 110v or 240v operation. £3.99

VALVES VAT PLEASE ADD 121/2%

PL509 3.25 PL802 2.80 PLL80 1.80 PY33 0.60 PY81 0.60 PY81 /8000.55 PY82 0.45 PY83 0.50 PY88 0.65 PY500 1.35 PY801 0.60 QQV03-102.50 QQV03-122.50 20L1 20P1 20P3 20P4 20P5 25L6G1 25Z4G 30C15 30C17 3A4 0.60
3D6 0.40
3D21 20.00
3E29 5.50
3S4 0.50
3S4 0.50
3S4 0.50
5B/255M 6.50
5B/255M 6.50
5B/255M 6.50
5B/355M 6.50
5B/355M 6.50
5B/35M 0.50 0.75 0.50 0.80 see 30F5 30F12 30F112 30F112 30F113 30F114 30L15 30L17 30P11 30P11 30PL13 30F114 35L6GT 50C5 50C06G 75 75C1 766 78 85 A2 723A/B WQV06-4OA

\(\) 14.00
\(\) 03-12 2.50
\(\) 20.31-2 2.50
\(\) 20.31-2 2.50
\(\) 20.31-2 2.50
\(\) 20.31-2 2.50
\(\) 20.31-2 2.50
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.35
\(\) 20.30
\(\) 20.30
\(\) 20.35
\(\) 20.30
\(\) 20.30
\(\) 20.35
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.35
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.35
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.35
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(\) 20.30
\(SASS 0.80
SATS 0.75
SAUS 0.40
SAVS 0.50
SAVS 0.50
SAVS 0.50
SAVS 0.75
SBAG 0.40
SBAG 0.50
SBAG 0.40
SBGGG 1.00
SBGGG 1.00
SBGGG 1.00
SBGGG 1.00
SBGGG 0.50
SBUG 2.80
SBWG 2.80
SBWG 2.80
SBWG 2.80
SBWG 2.80
SBWG 0.55
SCY5 0.90
SCC4 0.40
SCG 0.55
SCY5 0.90
SCC4 0.40
SCG 0.55
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY5 0.90
SCY 0.50 6AX4GT
0.75 6AX5GT
0.50 6BX6
0.80 6BC6
0.80 6C6
0.45 6BW7
0.75 6BW7
0.75 6C4
0.75 6BW7
0.75 6C1
0.80 6C6
0.50 6C7
0.80 6C6
0.50 6C7
0.80 6C6
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.50 6C7
0.5 803 805 807 813 829B 832A 866A 931A 954 955 956 | VRIO5/30 | 6D6 | 0.50 | 120/76T | 0.50 | 5783 | 2.50 |
VRI50/30	6F66B	0.80	12SC7	0.55	5842	6.50	
VRI50/30	1.25	6F86B	0.75	12SJ7	0.55	5842	6.50
Z66	0.90	6F12	0.85	12SJ7	0.55	6057	0.85
Z600U	3.00	6F15	0.65	12SU7	0.55	6056	0.85
Z800U	3.00	6F15	0.60	13D6	0.60	6065	0.85
Z801U	3.50	6F17	1.00	14S7	1.00	6067	1.00
Z901U	1.50	6F17	1.00	14S7	1.00	6067	1.00
Z901U	1.50	6F24	0.80	19A05	0.75	6080	3.50
Z900T	1.50	6F24	0.80	19A05	0.75	6080	3.50
Z900T	1.50	6F24	0.80	19G3	1.00	6146	3.80
1A3	0.60	6F33	4.20	19G3	1.00	6146	4.20
1R5	0.55	6J4WA	1.75	19H5	17.00	6380	2.00
1S5	0.40	6J5GT	0.55	20D1	0.60	8020	5.50
114	0.60	6J5GT	0.55	20D2	0.60		
122	1.10	0.55	242	0.55			
2K25	11.00	0.55	242	0.55			
2K25	11.00	0.50	242	0.55			
Lag	1.10	0.55	242	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.55	0.55			
Lag	1.10	0.55	0.				

MARCONI SIGNAL GENERATORS

TF 2400/1 Frequency Converter up to 510MHz.
MODULATION METER 210A. 2.5-300MHz. AM
0-100% FMD+100Hz in 4 rantes. AIRMEC
VHF WAVE ANALYSER 248 Freg from 5MHz to

300MHz.

TF 801 D/1/S SIGNAL GENERATOR. Range
10.485MHz in 5 range R F output 0.1 V-1V. Source

10-485MHz in 5 ranges. R.F. output 0.1 V-1V. Source CM. 500, output impedance. Internal modulation at 1KHz at up to 90%. TF 995 A/1 or A/2 or A/2M or A5 SIGNAL GENERATORS. Very high class AM /FM 1.5MHz to 220MHz. Detailed spec. and price on application. TF 995/3S with additional amplifier to give extra high

TF 995/38 with additional amplifier to give extra nign output between 1.5 and 5 Mc/s.
HIGH FREQUENCY SPECTRUM ANALYSER.
MARCONI TYPE 1094A/S. Basic Freq. range 3 to 30 Mc/s and with LF unit from 100Hz to 3 MHz. Measures relative amplitudes up to 60d8.
TF1041 B VALVE MULTIMETER. DC voltage from 300mV to 1000V. AC voltage from 300mV to 300V. at up to 1,000MHz.

WHITE NOISE TEST SET. The instrument consists of two units: a Marconi Moise Generator Type TF 2091 and Noise Receiver Type TF 2092. Measures noise and intermodulation on wide band multichannel telephone systems. Suitable for 12 channel to 2,700 channel system.

MARCONI TF 887 SIGNAL GENERATOR
Range 15KHz to 30MHz. Output 0.4 µ V to 4V to 13 or
75 ohms. Impedance with termination (supplied). Built
in crystal check facility with handbook. CT 478: CT479:
0T480 Signal Generators frequency from 1.3kMS up to
11kHz output up to 1mV CW and imp. mod.

LEVEL OSCILLATOR TYPE REL 3W29 Frequency from 0.3 to 1200Kc/s. Mod. ext. output from +16dB to -60dB. Impedance output 75, 140, 600 ohms.

36' AERIAL MASTS consisting of 6 sections 6' 8'' × 2'4" dia. Complete with all accessories to erect and instal.

RHODE & SCHWARZ Z-g DIAGRAPH TYPE 2DU 30-420MHz-500. Model type ZDD, Frequency 300-2400MHz. Directly measures multiterminal networks, phase shift, phase angle with complementary POWER SIGNAL GENERATOR TYPE SMLM high frequesiolution, internal external mod. up to 3y out.

LOW RESISTANCE HEADPHONES TYPE CLB £1.50. 40p postage. VAT 12½%.

TRANSISTORS

VALVES AND

OUR ANNUAL SALE TEST EQUIPMENT STARTS FEBRUARY 1st

OSCILLOSCOPES (NEW PRODUCTION)
SCOPEX 48-6, 6MHz. Single Beam, 10mV sensitivity.
Display — 6 cm x 8 cm. Weight: 4.5kg.
SCOPEX 49-10A, 10MHz. Dual Trace, 10mV sensitivity. SCOPEX 4D-10A, 10MHz, Dual 1780s, 10MH sensitivity. Display — 6 cm x8 cm, Weight: 6kg, DARTON D12, 15MHz. Dual 1780s. 1mV sensitivity. Display — 8 cm x 10 cm, Weight: 7.8kg.

SIGNAL GENERATOR H.P. MODEL 680C. High

power, stable and high accuracy. Frequency 10 to 480MHz. Modulation level 0 to 95% at carrier levels 0.5V output level continuously from 0.1 µV into a 50 ohm. Maximum output 1V.

FOR EXPORT ONLY Mullard C11, High power installation, 1000vv Technical details and prices available on request.

TEKTRONIX OSCILLOSCOPES

545A, Bandwidth DC to 30MHz.
570 CHARACTERISTIC CURVE TRACE
CABLE LAYING APPARATUS No. 11. New produc FURZEHILL SENSITIVE VALVE VOLTMETER
TYPE V200A full scale from 10mV to 1000V in 6 steps

without amplifier.
EDDYSTONE COMMUNICATIONS RECEIVER
MODEL 730/1A 730/4. Frequency from 500kc/s to

28Mc/s.
HIGH VACUUM VARIABLE CAPACITORS ceramic envelopes — UC 1000A/20/150=VMMHC 1000 60-1000 µF, 20kv-150A RF max=27MHz. TEST SET FT2 for testing Transceivers A40, A41, A42

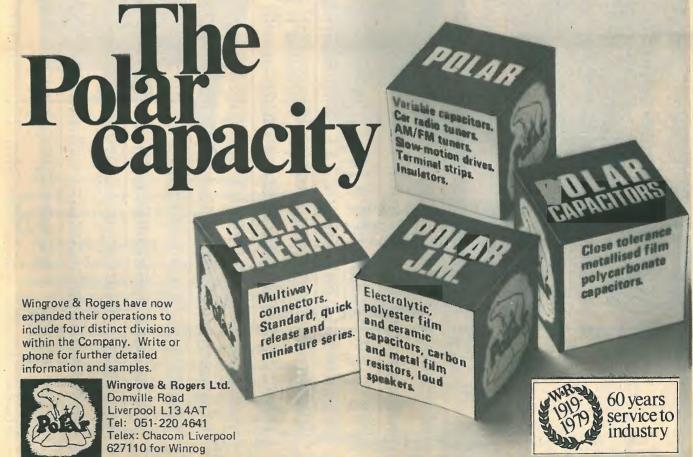
INIVERSAL WIRELESS TRAINING SET No 1 Mk 2 YA 8316 to train 32 operators simultaneously on key and phone. Complete instellation consists of 3 kits packed in 3 special transit cases.

HARNESS "A" & "B" CONTROL UNITS "A" "IT" "31" "12," Microphones No 5, 6, 7 connectors, s, carrier sets etc.

VAT FOR TEST EQUIPMENT PLEASE ADD 8%

COLOMOR

170 Goldhawk Rd., London W.12 Tel. 01-743 0899 Open Monday to Friday 9-12.30, 1.30-5.30 p.m.



WW - 112 FOR FURTHER DETAILS

LANGREX SUPPLIES L

Climax House, Fallsbrook Rd., Streatham, London SW16 6ED

	KSI	T	el: 01	-677 2	424 T	elex:	94670	8		RSI
The second secon	AA119 AAY30 AAY30 AAY30 AAY30 AAY30 AAY30 AAY30 AAY30 AAY30 AA213 AA213 AA213 AA213 AA213 AA217 AC107	ASZ15 1.25 BC172 0.10* ASZ16 1.25 BC173 0.12* ASZ16 1.25 BC173 0.12* ASZ16 1.25 BC173 0.12* ASZ17 1.25 BC173 0.15* ASZ20 1.50 BC178 0.16* ASZ21 2.00 BC179 0.16* ASZ21 2.00 BC179 0.16* AU113 1.70* BC182 0.11* AU110 1.70* BC183 0.11* AV110 1.70* BC183 0.11* AV110 1.70* BC184 0.11* BA145 0.13* BC22 0.12* BA145 0.13* BC22 0.12* BA145 0.09 BC237 0.00* BA155 0.09 BC237 0.00* BA155 0.09 BC237 0.00* BA156 0.09 BC338 0.12* BA167 0.12* BC308 0.10* BC108 0.12* BC308 0.10* BC109 0.12* BC308 0.10* BC109 0.12* BC308 0.10* BC109 0.12* BC308 0.10* BC109 0.12* BC308 0.10* BC109 0.12* BC308 0.10* BC109 0.12* BC308 0.10* BC109 0.12* BC308 0.10* BC109 0.12* BC307 0.10* BC108 0.10* BC337 0.18* BC118 0.10* BC337 0.18* BC118 0.10* BC338 0.17* BC118 0.10* BC338 0.17* BC118 0.10* BC338 0.10* BC117 0.10* BC733 0.90* BC125 0.00* BC733 0.90* BC125 0.00* BC734 0.90* BC125 0.00* BC734 0.90* BC126 0.00* BC734 0.90* BC127 0.10* BC735 0.16* BC137 0.15* BC742 0.25* BC148 0.08* BC770 0.15* BC148 0.08* BC770 0.15* BC157 0.09* BC772 0.13* BC158 0.09* BC772 0.13* BC159 0.09* BC772 0.13* BC150 0.09* BC772 0.15* BC167 0.12* BD121 1.20* BC170 0.10* BD121 1.20* BC170 0.10* BD121 1.20* BC170 0.10* BD121 1.20* BC1000000000000000000000000000000000000	BD131 0.35 BD132 0.38 BD135 0.34* BD136 0.34* BD136 0.34* BD137 0.35* BD139 0.49* BD137 0.45* BD139 0.49* BD139 0.49* BD139 0.49* BD139 0.49* BD139 0.49* BD139 0.49* BD140 0.44* BD122 1.48* BD139 0.49* BD140 0.44* BD122 1.48* BD237 0.45* BD237 0.45* BD238 BD	BF257 0.24 BF258 0.26 BF259 0.32 BF335 0.30 BF336 0.30 BF338 0.31 BF328 2.23 BF328 0.20 BF528 0.20 BF759 0.26	CRS3/60 0.90 GEX66 1.50 GEX61 1.75 GI3M 0.75 GI3M 0.75 GI3M 0.75 KS100A 0.45* MJE340 0.90 MJE370 1.17 MJE371 0.61 MJE520 0.52 MJE2855 0.75 MPF102 0.30* MPF104 0.30* MPF105 0.30* MPF104 0.30* MPF105 0.30* MPF105 0.30* MPF104 0.30* MPF105 0.30* MPF104 0.30* MPF105 0.30* MPF104 0.30* MPF105 0.30* MPF105 0.30* MPF106 0.30* MPF107 0.30* MPF107 0.30* MPS106 0.45* MPS010 0.45* MPS010 0.45* MPS010 0.55* OA10 0.60 OA20 0.45* OA30 0.45* OA30 0.45* OA30 0.45* OA30 0.48* OA30 0.85 OA30 0.86 OA30 0.86 OA30 0.86 OA31 0.80 OA320 0.89 OA3200 0.89 OA3200 0.89	OAZ201 1.00 OAZ206 1.00 OAZ206 1.00 OAZ207 1.00 OC16 2.00 OC16 2.00 OC22 2.50 OC22 2.50 OC23 2.75 OC24 3.00 OC25 0.90 OC26 0.90 OC28 2.00 OC28 2.00 OC28 2.00 OC35 1.50 OC36 0.50 OC36 0.50 OC37 0.5	OC203 1.75 OC204 2.59 OC206 2.59 OC206 2.59 OC206 2.59 OC207 1.75 OCP12 0.75 R2008B 1.75 R	ZTX502 0.16* ZTX503 0.17* ZTX503 0.17* ZTX504 0.20* ZTX531 0.20* ZTX531 0.20* ZTX553 0.16* N916 0.60 11* N916 0.67 N4001 0.66 N4003 0.67 N4005 0.88 N4007 0.90 N4008 0.81 N4007 0.90 N41448 0.61 N4008 0.81 N4007 0.90 N41448 0.61 N5201 0.87 N5401 0.13 N540	2N1309 0.55 2N1613 0.25 2N1613 0.25 2N1613 0.25 2N1611 1.50 2N1893 0.25 2N2114 1.75 2N2148 1.65 2N2219 0.24 2N2220 0.18 2N2221 0.18 2N2222 0.18 2N2222 0.18 2N2222 0.18 2N2222 0.18 2N2222 0.18 2N2222 0.18 2N2223 0.77 2N2369 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.25 2N2366 0.21 2N2366 0.25 2N2366 0.25 2N2366 0.21 2N2366 0.25 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.21 2N2366 0.25 2N2366	2N3771 1.75 2N3772 2.00 2N3773 3.00 2N3819 0.36 2N3823 0.45 2N3823 0.55 2N3826 0.72 2N3904 0.13 2N3906 0.13 2N3906 0.13 2N3906 0.13 2N3906 0.13 2N3906 0.13 2N3906 0.13 2N3906 0.13 2N4029 0.10 2N4029 0.10 2N4029 0.10 2N4029 0.10 2N4029 0.10 2N4029 0.10 2N4029 0.10 2N4029 0.10 2N4029 0.10 2N4029 0.10 2N5029
	DA42 10.70 DA691 6.60 DAF91 0.40 DAF91 0.40 DAF96 1.00 DET24 46.00 DF91 0.40 DF91 1.00 DF96 1.00 DF96 1.00 DF91 1.05 DF96 1.00 DF91 1.05 DF96 1.00 DF91 1.05 DF96 1.00 DF91 1.05 DF96 1.00 DF91 1.05 DF96 1.07 DF96 1.07 DF96 1.07 DF96 1.07 DF96 1.07 DM71 1.25 DM71 1.25 DM71 1.25 DM71 1.25 DM71 1.25 DM71 1.25 DM71 1.25 DM71 1.25 DM71 1.25 DM71 1.25 DM71 1.25 DM71 1.25 DM71 1.25 DF96 7.7 DF96	EPS	GUS0 GUS0 GUS1 GWU1 GWU3 GWU3 GWU3 GWU4	PC88† 0.85* PC97 1.00* PC98 0.60* PC28 0.60* PC28 0.60* PC28 0.60* PC28 1.00* PC28 1.00* PC28 1.00* PC28 0.60* PC98 0.60*	OVR8-100 89.30 OVR8-101 89.30 OVR9-85 44.50 OVR9-86 20 55.60 OVR9-86 20 20.60 OVR9-86 20 20.60 OVR9-86 20 20.60 OVR9-86 20 21.51 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.55 OVR9-86 21.56 OVR9-86 20 20.55 OVR9-86	UF41 1.00 UF42 1.25 UF891 0.50 UF	3V4	Bit 1.75	12AUG 0.65* 12AU7 0.47* 12AV7 0.47* 12AV7 0.47* 12AV7 0.5* 12AV7 1.5* 12AV7 0.85* 12AV7 0.85* 12BH7 0.85* 12BH7 0.85* 12BH7 0.5* 12BH7 1.00* 12BH7 1.05* 12BH7 1.12* 13BH1 1.32* 13DH1 1.5* 13DH1 1.72* 4212H 147.74 54.80 554.80 554.81 58.90 75 5552A 94.30 5551A 89.75 5552A 94.30 5561A 89.75 5552A 94.30 5562 1.80 5662 1.94 5670 2.86 5670 2.86 5687 4.80 5726 3.52 5727 4.80 57551 4.80 5726 3.52 5727 4.80 5762 3.52 5727 5663 4.80 5862 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 4.80 5866 566 566 566 566 566 566 566 566 56	
	BASES B7G unskirted B9A unskirted B9A skirted Int Octal Loctal Loctal Loctal Loctal Lotal 14 pin DIL 14 pin DIL 16 pin DIL valve screening cans all sizes 0.30 Terms of busine	CRTs 2API* 8.50 3BPI 9.00 3BPI 8.00 3CPI 5.00 3CPI 5.00 3CPI 6.00 3CPI 6.00 3CPI 6.00 3CPI 6.00 3CPI 6.00 3CPI 7.00 3CPI 6.00 3CPI 7.00 3CPI 6.00 3CPI 7.00 3CPI 8.00 3CPI 9.00 3CPI 8.00	VCR138* 10.00 VCR138A*12.50 VCR139A* 8.00 VCR517A*10.00 VCR517B* 6.00 VCR517C 6.00 Tube Bases 0.75 * Surplus VAT 8%	7400 0.16 7401 0.16 7402 0.16 7403 0.16 7403 0.16 7403 0.16 7404 0.17 7405 0.16 7407 0.40 7408 0.20 7409 0.40 7409 0.40 7409 0.40 7409 0.20 7409 0.32 7410 0.32 7410 0.32 7420 0.17 7422 0.26 0.29 onductors 25p per	ATED CIII 7423 0.32 7425 0.30 7427 0.30 7427 0.30 7429 0.47 7430 0.47 7431 0.32 7440 0.36 7437 0.32 7440 0.18 7441 0.85 7442 0.72 7447AN 0.90 7459 0.18 7453 0.18 7453 0.18	RCUITS 7460 0.18 7470 0.33 7472 0.33 7472 0.33 7474 0.40 7474 0.40 7476 0.00 7480 0.55 7482 0.75 7483 0.90 7484 1.00 7480 0.52 7491 0.80 7490 0.52 7491 0.80 7492 0.60 7493 0.60	7495 0.72 7496 0.80 7497 3.00 7497 3.00 74107 0.45 74109 0.70 74110 0.50 74110 0.70 74111 1.75 74118 1.00 74112 0.83 74121 0.40 7412 0.60 7412 0.55 74126 0.55 74126 0.55 74126 0.60	74132 0.70 74136 0.55 74141 0.80 74142 2.30 74143 2.50 74144 2.50 74145 0.90 74148 1.75 74150 0.85 74151 0.85 74151 0.85 74157 0.85 74157 0.75 74155 0.85 74157 0.75 74157 4.74 74170 2.30 74172 4.40	74173 1.40 74174 1.50 74175 0.90 74175 0.90 74176 1.10 74178 1.25 74180 1.15 74190 1.50 74191 1.50 74191 1.50 74192 1.35 74193 1.35 74193 1.25 74195 1.00 74197 1.10 74196 1.26 74197 1.10 74198 2.25 74199 2.25 74199 2.25 76013N 1.75*	TAA570 2.30* TAA6305 3.50* TAA700 3.91 TBA4800 1.84* TBA520Q 2.30* TBA5500 2.30* TBA5500 3.22* TBA560CQ 3.22* TBA560CQ 3.22* TBA760CQ 2.0* TBA780Q 1.52* TBA780Q 2.0* TBA780Q 2.0* TBA780Q 2.0* TBA820Q 2.9* TCA270Q 2.9* TCA270Q 2.9* TCA70Q 2.9* TCA70Q 2.9* TCA70Q 2.9*

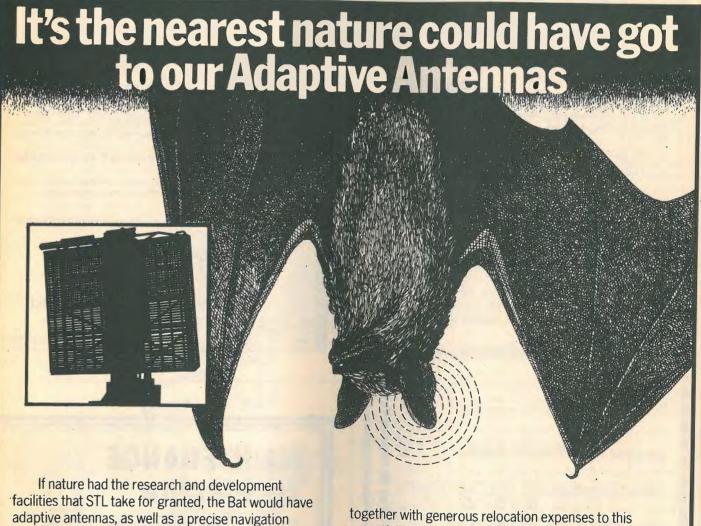
Telephone 01-677 2424/7 Telex 946708

Appointments

Advertisements accepted up to 12 noon Friday, February 23 for April issue, subject to space being avail-

DISPLAYED APPOINTMENTS VACANT: £8.50 per single col. centimetre (min. 3cm) LINE advertisements (run on): £1.20 per line, minimum three lines. BOX NUMBERS: 60p extra. (Replies should be addressed to the Box Number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London SE1 9LU.) PHONE: Barry Leary on 01-261 8508

Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.



system. The one thing we don't take for granted are our R & D people. Because when you're working on projects like satellite navigation systems, adaptive microwave antennas and novel radar concepts the future's very

much in your hands. And that means you. High-calibre graduate and post-grad men and women with R & D experience in any of the following: radar system design and modelling; antenna systems, particularly arrays; VHF-UHF receiver circuits; high-speed digital circuit design; signal processing for radar and spread spectrum signals; microprocessor integration with radio and radar systems.

As ITT's principal European Research Centre, we can naturally offer you excellent salaries and benefits together with generous relocation expenses to this essentially rural area on the Herts/Essex border.

If you're ready for the future now, please send the coupon or contact Vaughan Hartridge, Personnel Department, Standard Telecommunication Laboratories Ltd., London Road. Harlow, Essex CM17 9NA, or telephone him on: Harlow 29531 ext. 361

Please send an application form to: Name Address	146/78 WW1/79
Where the future's happening now	SIL

Professional Careers in Electronics



All the others are measured by us...

At Marconi Instruments we ensure that the very best of innovative design is used on our range of communications test instruments and A.T.E. We have a number of interesting opportunities in our Design, Production and Service Departments and we can offer attractive salaries, productivity bonus, pension and sick pay schemes together with help over relocation. If you are interested to hear more, please fill in the following details:-

Name Age
Address
Telephone Work/Home (if convenient)
Years of experience 0-1 1-3 3-6 Over 6
Present salary £2,500- £3,500- £4,500- over 3,500 4,500 5,500 £5,500
Qualifications None C&G HNC Degree
Present job

Return this coupon to John Prodger, Marconi Instruments Limited, FREEPOST, St. Albans, Herts, AL4 0BR. Tel: St Albans 59292

Marconi Instruments

A GEC MARCONI ELECTRONICS COMPANY

OFFSHORE OPPORTUNITIES

COMMUNICATION ENGINEERS £8,500 + p.a. Repair and Maintenance of VHF, UHF, Troposcatter and Multiplex equipment. HNC qualification or Forces experience (Foreman of Signals) preferred and experience essential. Engineers work 2 weeks on/offshore schedule.

COMMUNICATION TECHNICIANS £7,000 p.a. ONC or City & Guilds Communications with 2 years practical experience.

ELECTRONIC ENGINEERS c. £8/9,000 p.a. Experienced on following equipment: CCTV Systems, Process Instrumentation, Acoustic Equipment, Microprocessors. HNC or BSc qualification preferred.

ELECTRONIC TECHNICIANS c. £7,000 p.a.+ Technicians with some computer, digital and analogue instrumentation experience. Aberdeen based with periodic offshore work. Relocation assistance will be given.

COMPUTER ENGINEER/PROGRAMMER c. £8,000 p.a.

Qualified to BSc. or HNC level with indepth experience of computer and peripheral equipment. Reasonable knowledge of programming in Cobol/Fortran languages.

c. £8,000 p.a.

To work offshore on 2 week on/off schedule. Petrochemical or heavy industrial experience required.

For further information and application forms please contact Margaret Duthie.

GTS

Grampian Technical Services Ltd.

27 York Place, Aberdeen . Tel: (0224) 28921

Licence No. SC 144

MAINTENANCE TECHNICIAN

Experience in audio / visual electronic installation and a knowledge of light engineering / fabrication techniques would be an advantage.

You should have at least seven years' experience and be qualified to ONC level.

Salary within the scale £3,675-£4,212.

Application form from the Staffing Officer, Polytechnic of the South Bank, Borough Road, London SE1 0AA. (01-928 8989) quoting ref. ETS5.

Polytechnic of the South Bank

(8972)

Keeping in touch...

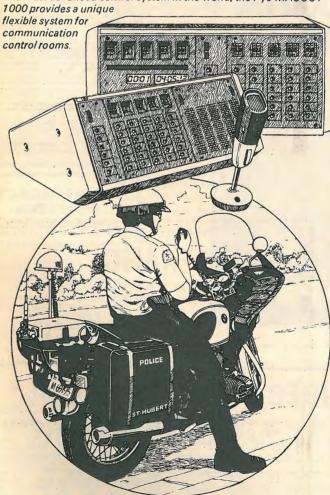
We are Europe's leading exporters of two way radio communications systems and as such can offer you the chance to work on exciting new development projects in some of the best equipped laboratories in the country.

Join us in Cambridge and you will be benefiting from a plan of growth and development that has seen £7 million recently invested in a new laboratory, production and headquarters complex on the banks of the Cam

Electronic Development Engineers (RF or Digital)

RF. Engineers to join teams working on the development of fixed, portable and link products or sub-units. Must have radio communications development experience and be familiar with design of VHF/UHF communications equipment or low medium

The most advanced control system in the world, the Pye MASCOT



capacity multiplex radio links. We also require engineers with hand portable development experience.

Digital engineers to work on computer-based interactive systems including digital signalling, encoders/decoders, speech synthesis and data display. Must have experience of either machine code and assembler language programming or the design of digital and analogue circuits. We're looking for men and women qualified to B.Sc. or HND level, with at least 2 years' experience.

Systems Development Engineer

To evaluate technical feasibility of new enquiries and to propose cost-effective engineering solutions. This entails provision of technical documentation and liaison with production, installation and field service departments.

Applicants should be qualified to Degree, HND or HNC level and have experience of Systems Engineering, Commissioning, Design/Development or Field Work. Knowledge of two or more of the following is essential; HF/VHF/UHF equipment; data and line transmission; control; logic and processors; telegraphy, line printers or exchange practice.

Electronic Designers

To make a major contribution to a project team developing !ow capacity FDM/PCM radio links. Applicants should hold a degree/HND or equivalent qualification in Electronics and have had at least 10 years' relevant design experience.

Mechanical Designers

To participate in the total design of new products. You should have acquired experience of product design for medium to large quantity production runs, and have extensive knowledge of design in sheet-metal, plastics and diecast metal. An HNC or equivalent qualification is desirable.

PCB Draughtsmen

To join small teams of product engineers. You should have sound knowledge of the latest PCB design layout techniques and high quantity PCB production methods. Experience of computer aided design and precision plotting is a major asset. A relevant ONC or equivalent qualification is preferred.

We're offering good salaries to applicants of either sex with generous relocation expenses and good career prospects plus an extremely attractive working environment, including sports ground, pavilion and social facilities within the complex. Living in Cambridge has its own benefits too, not only is it an attractive city, but it offers excellent sporting, recreational and cultural facilities and a wide choice of reasonably priced housing. Added to which, London is quite close to hand, with the new M11 opening in Autumn and a rail journey soon to be brought down to under 1 hour. So, apply now quoting job title to Alan Depauw, Personnel Officer, Pye Telecommunications Ltd., St. Andrews Road, Cambridge, CB4 1DW. Telephone Cambridge 61222 Ext. 305.



If you've seen our distinctive product advertising in the national press, you'll be aware of our new range of Direct Entry computer controlled typesetting systems that are making such an impact on the printing and publishing industry worldwide. Isn't that the kind of field you should be working in - a new technology that is really going places?

Naturally we're looking for rather special field service engineers and to join us you have to be the type of man or woman who can think logically, look for the unexpected, and can diagnose and repair faults single handed - even when you're miles from

And because you'll have a lot of customer contact, often at high level, you'll have to be

diplomatic and tactful. Technically, you should be qualified to ONC or HNC level and have had several years relevant field experience. A knowledge of optical physics and a general mechanical aptitude would also be useful. You can expect to travel widely initially about 2 days per week. We're offering up to £5000, a Cortina 1600 Estate, generous expenses and benefits. And with our policy of continual development bringing new equipment onto the market every year, your prospects could not be better.

So, don't you think it's time you responded to this challenge? If you do, contact David Hilton, Personnel Manager, Linotype-Paul Ltd., Kingsbury Road, London NW9 8UT.

ISN'T IT TIME YOUR SERVICE **ENGINEERING SKILLS TOOK ON** A NEW CHALLENGE?



QUEEN MARY COLLEGE (University of London) TECHNICIAN

(Grade 5)
required to join the Molecular Astronomy
Group in the Physics Department at Queen
Mary College. The post is tenable to the 31st
December, 1981 and the successful applican will be expected to assist in the deve-lopment, construction and testing of Electronic/Optical systems and equipment, including Microwave Components. He will assist the group in preparing and carrying out observing campaigns at observatories in both Northern and Southern Hemispheres both Northern and Southern Hemispheres. HNC equivalent qualification is desirable, but more important is practical ability in Electronics and General Workshop practice. Salary scale £3,186 to £3,394 per annum (under review), plus £465 per annum London Weighting. 5 day week. 4 weeks' annual leave, plus a week at Christmas and Easter, which includes the public holidays. Further information may be obtained from Mr. D. A. Young, telephone 980 4811, ext. 349.

AUDIO + VIDEO LTD.

We are acknowledged as being the largest video tape duplicators in Europe with 5 Quad machines, 3 colour T/Cs, our own digital Standards Converter and countless duplication machines of all standards, providing unsurpassed quality. We are obviously looking for Engineers to match and will pay up to £7,000 for the right persons. If you have the desired experience contact Cliff Carroll on 01-580 7161.

(8993)

THE ROYAL FREE HOSPITAL

Medical Physics Technicians (Electronics) Grades III and IV

Two electronics technicians are required for the Electronics Workshop of this major eaching hospital to assist with the development and maintenance of electronic circuit

Applicants (male or female) for the Grade III post should hold the City and Guilds Full Technological Certificate in appropriate subjects or an equivalent qualification and have good practical experience in the design of electronic circuits using state-of-the-a

Similar qualifications are required for the Grade IV post. A working knowledge of

Grade IV post. A working knowledge of analogue and digital circuit techniques and an ability to service electronic equipment would be an advantage.

Salaries for these posts are on scales: £4,098-£5,142 p.a. (Grade III) and £3,432-£4,488 p.a. (Grade IV), including all allowances. The Grade and starting salary will depend on qualifications and experience.

perience. Application forms (to be returned by 15th March, 1979) and Job Description available from the Personnel Department, The Royal Free Hospital, Pond Street, Hampstead, London NW3 2QG. Tel. 01-794 0500 Ext. 4286. Please quote ref. Grade III 0758 and Grade IV 0761.

Camden and Islington Area Health Authority. (T).

UNIVERSITY OF WARWICK

ELECTRONICS TECHNICIAN

Applications are invited for the post of Electronics Technician Grade 7 in the Department of Chemistry and Molecular Sciences to take charge of a well-equipped electronics workshop. The duties harge of a well-equipped electronics workshop. The duties responsibility for maintenance of both electrical and onc equipment in the Department, design and construction scillated electronic equipment, modifications to existing ment, and the supervision of a Brade 4 Technicals employed if you repair and maintenance work. The Department is sed with a wide range of scientific instrumentation including spectrameters. a magnitir exponence instruments opholometers and characteristic productions of the scitt candidate grater/emalely will probably hadd an HNC or static candidate grater/emalely will probably hadd an HNC or some constructions. equivalent in the field of electronics and have wide experience in the design and maintenance of complex electronic equipment. The University is situated in pleasant rural surroundings within easy. Starting salary is on an incremental scale £4.254.£4.782 P.a. (under review with effect from 1 Delober 1976) and will depend on experience and qualifications. Applications giving full details including the names of two referees should be sent to the Personnel Office. University of Warvick. Coventry, CV 7AL as soon as possible. Pleasa quale reference number 22/20/78.

MAINTENANCE **ENGINEER**

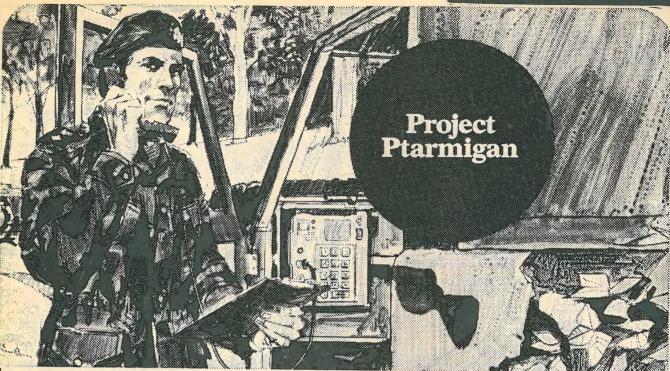
A Maintenance Engineer is required for the repair and testing of a range of professional audio and lighting trol equipment.

Applicants should have sound knowledge of modern analogue and digital techniques and, ideally, possess a current driving licence. Salary will be negotiable around £4.000 p.a.

Apply with full details of qualifications to Box No. 8956

CHIEF TECHNICIAN (Grade 7) required in School of Education, University of Reading, to head team of 4 technicians providing service for teaching and research. Facilities include general labs, photographic lab, language lab, TV studio and A/V aids lab and other specialised workrooms and labs. HNC or equivalent qualification desirable with substantial appropriate experience. Salary in scale f4254-4782 p.a. (under review). Apply for further details, quoting Ref. TW07A, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, Berks, RG6 2AH. (8940)

RADIO TELEPHONE SERVICE ENGINEER required in Croydon. Proven ability to repair equipment more important than formal qualifications. Salary commiserate with ability. Contact LONDON CAR TELEPHONES on 01-680 1010. (8822



Technician Engineers

The Plessey Development Laboratory at Havant, Hampshire, is sub-contractor for the most advanced VHF communications system ever to be developed for the British Army. This system - known as "Single Channel Radio Access" - allows mobile subscribers to use the Ptarmigan trunk telephone network for both voice and data messages.

We are now proceeding with the second phase of development, creating new career opportunities for Technician Engineers who wish to advance their knowledge.

What jobs are on offer?

We are looking for Technician Engineers with experience in industry or H.M. Services to work in the following fields.

VHF Radio Equipment Development and Evaluation

Successful candidates will be involved in the development of transmitters and receivers and in the evaluation of their electrical and environmental performance under a variety of conditions.

Development and Evaluation of Digital Equipment

Candidates with a special interest in digital circuits and systems will find opportunities to work under the guidance of experienced senior engineers on the most up-to-date techniques, including microprocessors.

What qualifications?

The type of work we do needs people with practical experience of transistorised equipment, a common sense approach and a willingness to work with others towards a common goal. Ideally, you will possess a City & Guilds Full Tech. Cert., ONC or HNC.

Salaries and career prospects?

We operate a separate structure for Technician Engineers which offers scope for career development. You could become a Principal Technician Engineer in charge of a small section, while the exceptional younger person would be encouraged to qualify to transfer into the Professional Engineering grades. Because our plans for business expansion are soundly based on a full order book for a wide range of both government sponsored and private venture products, we can offer you both job stability and the up-todate experience which is essential to our future growth.

Technician Engineers are recognised as important members of our teams and are rewarded accordingly. Situated in a semi-rural environment near Portsmouth, Chichester, the South Downs and several seaside resorts, we are well placed for housing, educational and recreational amenities. Generous relocation assistance will be given as appropriate and there is a comprehensive range of large company

Please write with brief career details or telephone for an application form. L. Wise, Recruitment Manager, The Plessey Company Limited, Martin Road, West Leigh, Havant, Hants. Tel: (0705) 486391. Applications are invited from either sex.



Electronics Engineers on the move

WALLINGTON, SURREY

REF. WW95

BERKSHIRE

ENFIELD

REF. WW96

AUDIO TAPE ENGINEER

For design and development of magnetic tape copying machines, tape play-back machines. Experienced H.N.C. level.

Attractive salary offered

DIGITAL/LOGIC DESIGNERS

Self-motivating engineers experienced in MSI and LSI techniques required by R&D group of a major British defence contractor engaged in development of new equipment.

Salaries up to £7,000 p.a.

Capital Appointments Ltd. 29/30 Windmill St. London. W.1. 201-637 5551

30 MILES S.W. OF LONDON

REF. WW98

REF. WW100

POWER CONVERSION **SPECIALIST**

Engineer experienced in design of static invertors and power supplies (in a range up to 1KVA) to lead a team developing

Salary negotiable up to £7,000 p.a.

STANDARDS/SPECIFICATION

ENGINEER

CIRCUIT DESIGN ENGINEER

An electronics company seeks a young circuit design engineer to join the existing small dynamic development team. Good prospects. Formal qualifications preferred.

Salary c. £5,000 p.a. initially

Capital Appointments Ltd. 29/30 . Windmill St. London, W.1. 1201-637 5551

WATFORD

REF. WW99 **ALL UK AREAS**

SALES ENGINEERS

rial control equipment and scientific instruments.

An interesting opening for a mature engineer with previous design experience to join a dynamic team working on sophisticated medical equipment using latest state of art devices including

Salary c. £7,500 p.a.

Are urgently required for client companies selling electronic components, computers and peripherals communications, indust-

Salaries to £10,000 p.a

Capital Appointments Ltd. 29/30 Windmill St. London, W.1. 101-637 5551

REF. WW101

ILFORD

REF. WW102

PERSONNEL MANAGERS COULD YOU USE THIS SPACE?

TELEPHONE BRIAN CORNWELL FOR DETAILS

TEST ENGINEERS

Technician engineers to test and trouble shoot mod transmitter, receivers. Minimum 4 years' experience. H.N.C. Electronic Engineering or C.&G. Full Tech. Cert. preferred.

Salary to £4,950 p.a.

Capital Appointments Ltd. 29/30 Windmill St. London. W.1. 201-637 5551

ENFIELD

REF. WW103

SOUTH-EAST LONDON

SOUTH COAST

REF. WW104

TEST EQUIPMENT ENGINEERS

We need your skills! A new department has been formed to design test gear and ATE for in house use. Several appointments will be

Salary £5,000-£7,000 p.a.

PROJECT ENGINEER

Design and development of special purpose machines. Experience of AC and DC rotating machines and the associated electronic control equipment

Salary to £6,000 p.a.

Capital Appointments Ltd. 29/30 Windmill St. London. W.1. 🕿 01-637 5551

OVERSEAS

REF. WW105

REF. WW106

TECHNICAL REPRESENTATIVE

Well-qualified engineer to represent major communications company throughout Middle East. Good knowledge of UHF/VHF

SYSTEM DESIGN ENGINEER

To be responsible for the analysis and design of avionic systems including software design and customer acceptance.

Salary range £4-6,000 p.a.

Capital Appointments Ltd. 29/30 Windmill St. London, W.1. 201-637 5551

Electronics Engineers on the move

INVEST

Improve your chances of obtaining the best Electronics job available by registering with us NOW. We are recruiting for over 3,000 Companies throughout the U.K. whose products range from computers to communications. Salary levels for experienced Engineers are highly competitive. The specific jobs advertised on the facing page are all urgent positions to be filled. Phone us if you wish to discuss any specific vacancies.

IN YOUR

By returning the application form below, your job requirements will be matched against our clients' numerous vacancies, many of which are not advertised. Your application will be treated in strict confidence and no approaches will be made to existing employers or to any other companies you care to specify. Please remember, our service is completely FREE to

applicants.

If you wish to discuss any aspect of the Electronics job market, you are welcome to phone any time. Please ask for Brian

Capital Appointments Itd 20/20 Windmill Ch Landon W. 1 @ 01.627 EEES

AME:			ADDRESS			
el: (Home):		(Office):				
ate of Birth:	Place of Birth:			Nationality now:	If not British, is a Work Permit req'd?	
arital Status:	Car Driver:			Car Owner:		4
ype of Position req	uired:				Approx. Salary level:	-
	as in which you are pro	epared to work	:	Are you a houseowner?	Are you willing to relocate?	
Cent. London	S. Coast	E. M	idlands	Are you prepared to travel — In U.K?	Overseas?	
S.E. London	West Country	W. M	lidlands		Overseus.	
.W. London	N.W. Engld.	E. An	iglia	State of health:		- 11
I.E. London	N.W. Engld.	Wale	S	Notice Period required:	Availability for Interview:	= 1
N.W. London	Scotland	Overs	seas			
Iome Counties: N.	W. N.E.	S.W.	S.E.	6		
EDUCATION: Secondary Scho College or Unive Any Professiona						
INDUSTRIAL EXE	Company & Location	Products	Job Title	Responsibilities		Final

Period of Employment	XPERIENCE: Company & Location	Products	Job Title	Responsibilities	Reason for leaving	Fina Salar
					7 2 HT 1	1
		100	- 1			
*		1.50			ar.	
			-1/1/5/18		1 - 7 2 2 2 1	
		哥門				
٠						
					na "	

EL	ELECTRONICS PROFILE: Indicate extent of experience— A—Extensive; B—Moderate; C—Limited; If Nil experience, leave blank.							
	Telephone Eqpt.	Data Commns.	Radio/Hi-Fi/T.V.	Broadcast Egpt.				
-	Digital/Logic	Analogue Eqpt.	Software/Programming	Minis/Microprocessors				
-	Computers/Periphs.	Test Gear/ATE.	Process Control	Power Supplies				
-	UHF/VHF. Comms.	Microwave	Radar/Navaids.	Medical Electronics				
-	Signalling Systems	Security Eqpt.	Avionics	Simulators				
	Weapons	Scientific Eqpt.	Data Recorders	Photocopiers				
	Phototypesetting	Servo-mechs.	Components-Active	Components—Passive				
L	Product Eng.	Electrical Eng.						
Oth	ners — Please state.							

Please indicate any Companies you do not wish us to contact.

Ref. Nos. of specific vacancies in which you are interested:

If you wish to detail further aspects of your experience or job requirements. please enclose on a separate sheet.

(8988)

SENIOR RADIO TECHNICIANS Starting Salary £8,500-£10,800 pa tax free

Saudia, flag carrier of the Kingdom of Saudi Arabia requires Senior Radio Technicians for its Communication Division based in Jeddah and Riyadh. Duties will include general maintenance and repair of ground radio equipment as well as the upkeep of technical manuals, service records and spare part logs. Some travel will be involved visiting various locations served by the Airline within Saudi Arabia.

Applicants should have had at least 3 years recognised technical training and 5 years related experience. City and Guilds certificate or equivalent would be an advantage. Current driving licence is essential.

Commencing point on the salary scale related to qualifications and experience.

These posts which are open to men aged between 25-45, are offered on a two-year renewable contract together with free accommodation, free and reduced rate air tickets for you and your family, 40 calendar days vacation per annum plus relocation allowance.

Please write with full personal and career details quoting job title and department number to:-

> Area Personnel Manager-Europe, Saudi Arabian Airlines, Department 153/1, 508/510 Chiswick High Road, London W4 5SQ.

Closing Date: February 28th, 1979.



manent and Contract

To £6,000

637 5551 day:636 9659 eve

APPOINTMENTS ELECTRONICS

£5-£10.000 Take your pick of the permanent posts in:

- MEDICAL MISSILES COMPUTERS

COMMS MICROPROCESSOR HARDWARE - SOFTWARE

For free expert advice and mmediate action on salary and career improvement, phone or write to, Mike Gernat BSc.

Technomark

11 Westbourne Grove London W2. 01-229 9239

ELECTRONICS TECHNICIAN (Grade 5) required in Department of Psychology, University of Reading, to take charge of the electronic workshop. The work involves both design and construction, and advice to staff and students on electronic problems, with considerable vice to staff and students on elec-tronic problems, with considerable freedom of choice in methods used. The departmental programme al-ready depends heavily on advanced analogue and digital techniques. Minimum qualifications would be a recognised membership; at least recognised membership; at least 7 years varied experience desirable. Salary in scale £3186-£3720 p.a. (under review). Apply with full details and names of 2 referees, quoting Ref. T06A, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, Berks, RG6 2AH. (8939

CAPITAL APPTS.

FREE LISTS

101 Design / Development

SEISMIC ENGINEERS

We are looking for two young electronics engineers with degree or equivalent qualifications, to join our marine seismic acquisition

This is a field position, with the successful applicants joining the technical crew of our exploration vessel M/V GOEL EGEDE for on-board training in seismic technicques. They will start as Assistant Technicians with a salary of £6,000+ per annum, and one month's leave after each two months on the crew.

The seismic industry offers an interesting career with world-wide travel, and rapid promotion for the right person.

Geophysical Offshore Exploration is a member of the Sefel Group, which has seismic processing centres in Houston, Denver, Calgary and

Please write with full curriculum vitae to:



General Manager Geophysical Offshore Exploration Turriff Building Great West Road Brentford Middlesex TW8 9HY

(9008)

ELECTRONIC SERVICE ENGINEERS

LONDON - BRISTOL - MANCHESTER - GLASGOW

Our Company specialises in both sales and servicing of Discotheque Sound and Lighting Equipment.

We are the UKs leading Company in this specialised field and due to continued expansion, we have vacancies in London, Bristol, Manchester and Glasgow.

Applications are invited from Electronic Service Engineers who have had at least 5 years' experience working with either Hi-Fi, Studio, PA or similar equipment.

We offer excellent salaries (depending on age and experience) generous staff discount scheme, a bonus paid 4 times per year, plus the opportunity to progress with a young, go-ahead

In the first instance, ring or write to: Mrs. L. Cooper, Personnel Officer for further details. (Reverse charges if you wish)

Herts. EN5 5SA. Telephone: 01-441 191

SERVICE SPECIALIST

WIRELESS WORLD, MARCH 1979

Kontron Intertechnique

PRODUCT SPECIALIST

ments. The position involves field service in Laboratories mainly in the South of England. Knowledge of state-of-the art digital systems

Individual of state-of-the art digital systems is required. This is a very demanding job but the company is prepared to reward a successful engineer with attractive remuneration and work satisfaction.

John Clapham (Technical Director) P.O. Box 88

(9010)

MARINE **ELECTRONICS**

We need an engineer familiar with Radar, MF/HF synthesised SSB/ VHF Autopilots, etc. to service and install anywhere, but must be based

If you are able to be your own boss apply giving details of experience

We are also prepared to offer an engineering partnership arrangement, if you are the right man.

TELESONIC MARINE LTD. London N W 1

DEVELOPMENT

Radar or Transmitter Design

Marconi Communication Systems Ltd., is amongst the world leaders in the design, development and manufacture of a wide range of advanced communication systems for industrial and

Right now we are currently working on several exciting projects concerning communication and radar equipment for the Merchant Navv.

As a result we now need to recruit additional engineers (men/women) who will be immediately involved in the design and development phase with the extended responsibility of overseeing the designs through to production.

If you have a degree or equivalent coupled with practical experience of communications or radar displays and techniques, then we would like to talk to you about a position at our headquarters

The prospects for the future are bright and in addition to an attractive negotiable salary, we offer good conditions and benefits including removal expenses in appropriate cases.

Why not find out more by telephoning Gordon Short on Chelmsford (0245) 53221 or write to him at Marconi Communication Systems Ltd., New Street, Chelmsford, Essex, for an application form,

A GEC-Marconi Electronics Company



(8946)

The pass card to 3000 potential employers. Our clients are keen to meet men and women, aged 20 to 41. Our clients are keen to meet men and women, aged 20 to 41. With potential earnings of between £4000 and £7000 p.a.

Here is a unique and efficient way of placing your name and abilities before many potential employers without leaving your armchair.

It won't involve you in inconvenient meetings or undercover 'phone calls. You won't be pestered by us. You won't be asked for any money.

Over 3,000 good employers, of all'sizes in all industries, send us details of their personnel requirements. When you post the coupon below, we will send you an application form to be completed and returned with relevant details about yourself and those companies you don't want to join (which we guarantee to treat as

We match your skills and ambitions with our clients' needs. Only when we find one of them is looking for someone like you - only when we have checked again that you have not included them on your list of employers not to be contacted - will we tell them about you. Then the invitation to talk comes directly from that employer.

If you think of all the different types of jobs offered by those 3,000 companies and we've been doing this for seven years - you can see that we've helped thousands of people to better opportunities and higher earnings.

Post this coupon today.

Lansdowne Appointments Register, Design House, The Mall, London

Tel: 01-579 2282 (24 hour answering service).

For those too busy doing a good job to find a better one.

Development Engineer-

Electronics Measurements

The person selected for this position will be a member of a team which provides an electrical measurement service for Motor Car chassis and engine development.

Some of the more specific duties include:-

The application of strain-gauges and the installation of lead, pressure, displacement, noise and vibration transducers in motor car chassis and engines and the calibration and operation of these devices, together with the appropriate signal conditioning and recording apparatus.

Other areas of responsibility include the preparation of engineering reports, data analysis and the servicing and calibration of apparatus.

Candidates should possess Degrees or Higher National Certificates in electronic engineering and preferably have been employed for a number of years in the field of electronic measurements.

Our expansion in the field of modern technology offers good prospects for the successful applicant.

Persons selected from outside areas will be offered generous assistance with

Holidays commence at 28 days per annum, good social and welfare facilities and a subsidised employee canteen are available.

Male/female candidates should write, or better still phone, for further information to:

John Williams or Edward Owen, Rolls-Royce Motors Limited, Car Division, Pym's Lane, Crewe CW1 3PL. 0270 55155 Ext. 3339.

RADIO TECHNICIANS

Keep police

day — so if this equipment suddenly acts up, the police are seriously handicapped. That's where you can make a difference.

As a Police Radio Technician in Central or South London,

you'll help make sure our wide range of equipment is in top

Qualifications: two years' experience together with either C & G

Telecommunications Technicians Intermediate Certificate; ONC or

Salary: from £3092 - £4165 p.a. according to age at entry, rising to £4717 p.a. including Inner London Weighting Allowance. There are

substantial extra allowances for those employed on shiftwork at

New Scotland Yard. Benefits include day-time release to study for higher qualifications, assistance with course fees and

4 weeks' holiday a year. Good prospects of promotion.

The Secretary, Room 213/WW 'RT, 105 Regency Street, London SW1P 4AN. Telephone 01-230 3122 (24 hour answering service).

For details and an application form, contact:

working condition.



UNIVERSITY OF LEEDS

DEPARTMENT OF PHYSIOLOGY

ELECTRONICS TECHNICIAN **GRADE 5**

The successful applicant will be responsible to the Chief Electronics Technician for the development construction and mainte nance of a wide variety of electronic equip-ment associated with research and teaching of biological studies.

Candidates should hold ONC or equivalent qualifications in relevant subjects and have at least 7 years' appropriate experience, including any training period. Salary on the scale £3186-£3720 a year.

Applications stating age, qualifications and full experience together with the names and addresses of two referees should be addressed to Mr. E. French, Departmental Superintendent, Department of Physiology, Medical and Dental Building, The University of the property of sity, Leeds LS2 9JT.



CAPITAL APPOINTMENTS LTD.

FREE JOBS LIST

FIELD SERVICE ENGINEERS BASIC SALARIES TO £7,000 + CAR

30 Windmill Street, London, W1 01-637 5551

APPLIED MICROSYSTEMS

There are vacancies for a

LOGIC DESIGNER

with some 6800 microprocessor experience and also for a person to undertake printed circuit assembly in a small and growing company.

Ring or write to Steve Brown at 17 Baker Street, Weybridge, Surrey. Weybridge 48177.

NEWCASTLE AREA HEALTH AUTHORITY (TEACHING) **ELECTRONICS & MEDICAL ENGINEERING SECTION** NEWCASTLE GENERAL HOSPITAL

CHIEF ELECTRONICS **TECHNICIAN (GRADE 2)**

Applications are invited for the above position. The Chief Electronics Technician and medical engineering equipment

The position offers a unique opportunity to lead a specialist team of Technicians equipment and communications

Salary Scale: £4,470 rising to £5,610 by 8 annual increments.

Candidates must have a broad experience of electronics, experience of medical electronics an advantage. Minimum academic qualifications - H.N.C. Electtronic Engineering or equivalent.

Job description and application forms available from Area Engineer's Office, Newcastle Area Health Authority (T), Area Headquarters, Scottish Life House, 2-10 Archbold Terrace, Newcastle-upon-Tyne NE2 1EF. Closing date for completed application forms: 7th March, 1979.

ELECTRONICS TESTER

A vacancy exists in our Instrument Shop for an Electronics Tester, must have previous experience of testing electronic equipment including logic circuits.

Good working conditions, canteen facilities

Apply: Mr. M. Leigh, Manager Instrument Workshop, PO Box 290, Technico House, Christopher Street, London EC2P 2ER.

Radio Officers

If you've seen quite enough of the sea, and are thinking now of a shore-based job that suits your qualifications, the Post Office Maritime Service can offer you interesting work, job security, good pay, plus the pleasure of enjoying all the comforts of home where you appreciate them most - at

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 £4450; after 3 years service this figure rises to around £5750. (If you are between 19 and 24 your pay on entry will vary between approximately £3500 and £4050). Overtime is additional, and there is a good pension scheme, sick-pay benefits and at least 4 weeks' holiday a year.

For further information, please telephone Andree Trionfi on Freefone 2281 or write to her at the following address: ETE Maritime Radio Services Division (WW), ETE17.1.1.2, Room 643, Union House, St. Martins-le-Grand, London EC1A 1AR.



UNIVERSITY OF LIVERPOOL DEPARTMENT OF PHYSICS

EXPERIMENTAL or SENIOR **EXPERIMENTAL OFFICER**

To collaborate with academic staff in the design and development of systems for collecting and processing experimental data. Work involves exploitation of microcom-Work involves exploitation of microcomputers with links to PDP11's and large S.R.C. computers. Candidates must have some knowledge of digital circuits and computers and hold degree or equivalent qualification. Good opportunity for young graduate to gain experience. Salary according to age and experience, on the scale for Experimental Officers — up to E5604 p.a. — or Senior Experimental Officers — up to £6555 p.a. — (under review).

Applications forms may be obtained from The Registrar, The University, P.O. Box 147, Liverpool. L69 3BX.

Quote Ref: RV/474/WW

SERVICE ENGINEER

Seta countries. We are seeking a Field Service Engineer to work in the area South of the Thames. The engineer would be res-ponsible for field service within his own area.

This is a very demanding job but the company is prepared to award a successful engineer with attractive remuneration and work satisfaction.

Apply to:

John Clapham

(Technical Director)

Electronic Engineers-What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £8000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you. All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL PERSONNEL SERVICES. 12 Mount Ephraim. Tunbridge Wells, Kent. TN4 8AS.

Tel: 0892 39388

Please send me a TJB Appointments Registration form:

Engineer

existing equipment.

apply.

(Electronics)

The Development Instrumentation Department, at the

Section Leader to head a small group which is responsible for

Rolls-Royce East Kilbride Engine Test Facility, has a vacancy for a

maintenance and manufacture of signal processing and recording

Work includes development and construction of specialised instruments as well as maintenance, fault diagnosis and repair of

Applicants should have appropriate experience and hold an H.N.C. or equivalent qualification. Salary will be in the range

Aero Division - Scotland, East Kilbride, Glasgow G744PY.

Please apply in writing quoting experience to:

Personnel Manager, Rolls-Royce Limited,

£4482 - £5082 and the usual excellent conditions of employment will

WIRELESS WORLD, MARCH 1979

TECHNICIAN required to assist in electronic equipment development work in the Respiratory Division of the Department of Medicine.

Department of Medicina

Experience in analogue, digital and software techniques desirable, together with an

Salary on scale £3646 to £5086, initial

may be obtained from the Personnel Office, Royal Postgraduate Medical School, 150 Du Cane Road, London W12 OHS, quoting reference number 2/120/WW.

UNIVERSITY OF LIVERPOOL DEPARTMENT OF PHYSICS

ELECTRONICS **TECHNICIAN**

To assist in developing and commissionin

qualification and have previous experience Salary on a scale up to £4365 p.a. according lifications and experience (under

tion forms may be obtained The Registrar, The University, P.O. Box 147, Liverpool. L69 3BX.
Quote Ref: 473/WW

ENGINEER TECHNICIAN

required to be responsible for expanding the electronic research and development laboratory for a small professional firm of consulting engineers. Salary by negotiation

Please apply, quoting qualifications and experience, to Dr. Bruce Smith, Smith ssociates Consulting System Engineers imited, 20 Queens Road, Weybridge

ELECTRONICS SERVICE ENGINEER

This position is for a qualified senio person of proven technical ability capable of managing a small busy workshop.

Apply in writing to:
John Denby
ENTEC

TELEVISION PROJECT ENGINEER

Pro-Bel Ltd manufactures custom built vision and audio

switching systems for the professional broadcast industry, and markets the CapGen character generator and Elcon tape cleaner.

Due to expansion we require additional junior and intermediate

engineers to be responsible for customer liaison, design and test of

The position offers a chance to join a small expanding company and to

be involved in all stages of contracts from initial planning to customer

acceptance. A certain amount of U.K. and overseas travel will be

In addition to a good salary we offer BUPA membership, a friendly

AERO DIVISION

Instrumentation

8992

AUDIO SERVICE ENGINEERS

The work involves the maintaining, servicing and overhauling of top quality audio

For further information, in strict confidence, please contact Maureen Sleight on Gerrards Cross (STD 02813) 88447 or write giving full C.V. to Mr. J. Rudling

6 Bendall Mews, Bell Street, LONDON NW1

pro-bel

environment and excellent career prospects.

For more details contact David Steel at:

switching systems.

TERRACE ROAD, BINFIELD, BRACKNELL BERKSHIRE RG12 5DN ENGLAND me BRACKNELL (0344) 56969/56960

Appointments

We've always looked for Test Engineers who weren't afraid of New Ideas

Pye Telecommunications have made many original contributions to the technology of mobile radio; for instance, we were the first manufacturer to use printed circuit boards. But whatever we have achieved, we have always backed it with the specialist skills and abilities of our test engineers the men and women who put the final seal of approval onto all our equipment.

If you welcome the challenges offered by a wide variety of products, many incorporating up-to-the-minute technology, then you'll fit in at Pye. To join us you should have had sound experience of fault diagnosis, alignment, and testing at PCB level, preferably on communication equipment. Forces experience would be particularly suitable.

As the leading manufacturer of two-way UHF/VHF radio

systems in Europe, we can offer you excellent working conditions, well-equipped workshops with a broad range of modern test gear, good career prospects and a stable company structure where you will find security and job satisfaction. Starting salaries are between £3800 and £4300 depending on technical ability.

The positions are based at Haverhill in Suffolk, where keyworker housing may be available for those moving from other parts of the country.

For further details please write or phone, reversing the charges where necessary, to Mrs. Catherine Dawe, Senior Personnel Officer,

Coine Valley Road, Haverhill, Suffolk Tel: Haverhill 4422.



Pye Telecommunications Ltd

Colne Valley Road, Haverhill, Suffolk,

Exporting Colour TV sets is never easy

Every market requires something different and whether it's a change to the circuitry for differing TV standards or systems, or an alternative styling or finish, it invariably requires engineering involvement in ensuring our customers get what they want.



WE ARE SEEKING A PROJECT LEADER TO LOOK AFTER THE TECHNICAL NEEDS OF OUR DORIC CUSTOMERS AT HOME AND ABROAD.

Ideally you will be a qualified, professional, self motivated TV engineer who can apply your skills to organizing a small but enthusiastic team to solve a wide variety of problems associated with the design, production and operation of a sophisticated range of colour TV receivers. You will be experienced in project management, development of colour TV and customer service, with particular emphasis on export markets. Some knowledge of safety performance of domestic electronics, test house approvals and quality assurance assessment in a modern factory environment will also be useful.

The team also checks out audio products from world-wide sources, prior to purchase, and hence some experience of the performance and constructional requirements of this type of equipment will be an asset.

You will be based at our engineering centre at Chessington, Surrey, but occasional visits to our factories in the North East and to our customers, both at home and overseas, will be required.

You will be paid an attractive salary and generous assistance with relocation expenses will be offered, where appropriate.

If this sort of challenge is of interest and you feel you can make a real contribution to the success of our operation, please write or telephone to:-



Mr. H. Brearley, Rediffusion Consumer Electronics Limited. Fullers Way Sth., Chessington, Surrey. KT9 1HJ

We require additional staff to join our small team in our Service Department based

Ideally, you should have previous experience in this field, although product training will be given. On some occasions you would also be required to visit other

In return, we are offering very attractive salaries plus non-contributory pension scheme and four weeks' annual holiday.

HAYDEN LABORATORIES LIMITED



We've variety and interest to offer you as a service and test engineer in Stanmore

It's the variety that comes with working on a wide range of equipment. And the interest of knowing that your skills and experience are playing a vital role in maintaining the critical standards demanded by major airlines and Air Forces for their highly sophisticated avionics equipment.

Working either in aircraft or in our well equipped and pleasantly situated workshops in Stanmore, Middlesex, you will be involved in the repair, maintenance and overhaul of a variety of advanced airborne electronics equipment, both British and American.

It's work for which you'll need

to have sound practical experience of radio and electronics theory, ranging from audio to microwave. You should also have experience of using advanced test equipment for fault diagnosis, although training can be given where necessary.

We can offer you an excellent salary and benefits together with really first-class working conditions and subsidised staff restaurant, so if it's variety and interest you're looking for write now with details of your experience to: Mrs. E. Wagg, Marconi Avionics Limited, 22-26 Dalston Gardens, Stanmore, Middlesex HA7 1BZ. Telephone: 01-2043322.

MARCONI

SOUND ENGINEER

The Royal Opera House requires an Assistant Sound Engineer. The position would suit someone with Studio or Broadcasting experience who is prepared to work long and unsocial hours. The work is very varied and requires an en-gineering background and some

Apply to Eric Pressley, Royal Opera House, Floral Street, London WC2E 7QA. (8978)

TOP JOBS IN **ELECTRONICS**

Posts in Computers, Medical, Comms, etc. ONC to Ph.D. Free

Phone or write: BUREAUTECH AGY, 46 SELVAGE LANE, LONDON, NW7. 01-959

Engineers

- DESIGN / DEV
- TEST
- · FIELD SERVICE

High Salaries - Most Areas Phone 01 - 731 4353

Thex Personnel

EMI

SENIOR DESIGN **ENGINEER/PROJECT ENGINEER**

Pantak (EMI) Ltd., based in Windsor, Berkshire, are one of the world leaders in Industrial, Security and Medical X-ray equipment.

We require one Senior Design/Project Engineer in our Development/Design Dept. who will be principally concerned with the design of our new range of specialist electronic products which are based around inverter and switch mode circuits. The successful applicant will also be in control of a small team. Minimum qualifications would be an HND with experience in the specified technologies, with approximately 10 years' previous experience. A B.Sc in Electronic Engineering would be a distinct advantage.

Benefits for the position are those you would expect from the EMI Group, and include:

- ★ An attractive salary around £7,000 p.a.

- A nattractive salary around £7,000 p.a.
 Career opportunities.
 A 35-hour working week.
 Four weeks' holiday.
 First-class pension scheme with free life assurance.
 Excellent subsidised canteen
 Generous relocation expenses where applicable.

ONE ELECTRONIC TEST

circuits.
For this position we offer a salary around £4,000 p.a. with all other benefits as

above.
To find out more, telephone DAVID DRAKE, Personnel Officer, now on Windsor 55611, or write to him at:
PANTAK (EMI) LTD., VALE ROAD, WINDSOR, BERKS.

(8962)

Automatic Test Engineer North West London

Radiomobile, the leading manufacturer of in-car entertainment equipment is looking for a young Electronics Engineer who is willing to take a key role in a new and important development at their main production unit.

- * to take an active part in the implementation and running of Automatic Test Equipment.
- ★ To produce jigs and programmes for this equipment and to run self-check programmes when required.
- To monitor the information from the A.T.E. and feedback details of component failures to the production area

Applicants should be qualified to HNC (Electronics), C & G FTC (Electronic) or equivalent.

If you have a keen and demonstrable interest in radio and looking for an appointment with an attractive salary, plus bonus, plus benefit package.

Executive

Contact: Jane Brooks on (01) 235 7030 Ext. 246 (answering service out of hours (01) 235 6938)

Applications are welcome from both men and women (8955)

Your responsibilities will be:range of highly complex electronic equipment in the fields of communications and aviation services.

maintain and repair SHF, UHF, VHF, and HF(SSB) radio equipment and systems and who preferably have knowledge of systems engineering and microwave systems. Lockheed's operations cover the installation, repair and maintenance of a wide

Lockheed Aircraft International in Saudi Arabia

are now offering two year contracts worth £16.350 tax

free to Ground Radio Technicians who can install,

299858 PO WO G 0299992 PO TS G FB69 1224 LONDON T 43

JOHN J SMITH BRIDGE ST YORKS

REFERENCE TO TWO YEAR CONTRACT - GROUND RADIO - SAUDI ARABIA STOP

COL 20 WI 01-574 5000

So a two year contract with them will not only see a sizeable increase to your bank balance - it will also see you developing your specialist experience in an operational environment.

The minimum total earnings we have mentioned include bonus and cost of living allowance.

Then there's a substantial benefits package which includes:

* Three paid leave periods annually with three free flights home to the UK

POST OFFICE TELEGRAM

NO CHARGE FOR DELIVERY

JOHN J SMITH

BRIDGE STREET

YORKS

* Free food, laundry and bachelor accommoda-

* Free medical care and life insurance

* Good recreational facilities

* Excellent prospects for employment beyond the contract period.

If you are interested in hearing more about these excellent opportunities, write or phone,

quoting ref: 017L, to Recruitment Officer, IAL, Aeradio House, Hayes Road, Southall, Middlesex. Tel: 01-574 5000.

RADIO TECHNICIANS

TSO FB69

Here's a

communication that's worth

£16,350 tax free

PLEASED TO TELL YOU THAT YOUR APPLICATION FOR TECHNICIAN
POST IS ACCEPTED STOP WE WOULD TO FINALIZE VIZA /
PASSPORT ARRANGEMENTS ETC PLEASE
PASSPORT ARRANGEMENTS TODAY STOP

O1-5714 5000 SOONEST TODAY STOP

POST OFFICE



HAMPSHIRE **FARNBOROUGH COLLEGE OF TECHNOLOGY** Ref. 79/1/A22

LECTURER

Grade I in Electrical Engineering

Able to teach up to at least T.E.C. Certificate level. Appropriate qualifications required, with practical experience in Electronic Further particulars from:

The Staffing Officer Farnborough College of Technology Boundary Road, Farnborough, Hants, GU14 6SB S.A.E. please Closing date: 9th March, 1979

CANCER RESEARCH CAMPAIGN **ELECTRICAL ENGINEER/PHYSICIST** PHYSICS OR ELECTRONICS TECHNICIAN

for operation application and development of this unique multi-purpose machine for non-dinical research into biological and biochemical effects of radiation to improve cancer therapy. Neutron and pulsed and continuous beams of electrons produced. Lecturer or S.R.O. to manage accelerator and its technical staff, should have degree (or equivalent) or high degree and experience of particle accelerators, lonizing radiations, electronics, vacuum technology mechanical design starting salary to £6.530 (CMRC Grade 2) according to experience, qualifications and age.

TECHNICIAN Candidates, preferably with HNC or degree and some experience as above Starting salary to £5,034 (MCR Tech) according to experience, qualifications and age. Apply: Deputy Director CRC Gray Laboratory, Mount Vernon Hospital, Northwood, Middlesex HA6 2RN.

Major DME developments for 2900 and a new small system

Our work in progress could mean real career progression for you!

Bracknell, Berks; Kidsgrove, Staffs £4,000-£8,500

Join the company where exciting things are happening on brand new hardware! Right now we are working on major new Small System developments at Bracknell

This could be your opportunity for real personal career progression. There will be considerable scope for your skills in one of our integrated development teams where both hardware and software people have the opportunity to work profitably together or you could find a rewarding future specialising in your chosen field.

every opportunity for fast personal development and this, coupled with our unrivalled reputation for training, adds up to an offer not to be missed.

The successful application of your skills is vital to our total systems development. That is why we need:

Programmers

with assembler, operating systems development or microcode experience.

Engineers

with a background in state-of-the-art technology.

In both cases we expect you will be in your 20's with at least 2 years experience behind you.

Naturally relocation expenses and full large company benefits are available.

Call John Milner on Bracknell (0344) 24842 Ext: 2373 or Peter Mills Ext: 2169 or write to ICL, Lovelace Road, Bracknell, Berks, RG12 4SN quoting reference WW 1173

International **Computers**

think computers - think ICL



(8958)

ELECTRONICS TECHNICIAN

c.£4,000 p.a. Southampton

STRUCTURAL DYNAMICS LIMITED

is a specialist, high technology company with a team of over 30 offering consultancy services in the vibration analysis of large steel structures and associated rotating machinery. The company's services include monitoring systems for machinery and structures and vibration / acoustic troubleshooting.

To support continued expansion an **ELECTRONICS TECHNICIAN** is required to assist on a number of electronic projects associated

Candidates should preferably have an education to ONC standard, although a demonstration of practical ability in constructing and testing prototypes would be considered satusfactory. A knowledge of Linear I.Cs and CMOS devices would be advantageous

Salary in accordance with experience, BUPA contributory pension scheme and four weeks' annual holiday.

Telephone J. G. Sindall on Southampton (0703) 35611 for an application form, or apply directly in writing to Structural Dynamics Limited, 18 Carlton Crescent, Southampton SO1 2ET.

ST. BARTHOLOMEW'S HOSPITAL RADIATION PHYSICS DEPARTMENT **MEDICAL PHYSICS/ ELECTRONICS TECHNICIAN GRADE III (or IV)**

To assist in the servicing of a new 20 MeV Linear Accelerator, a 4 MeV Linear Accelerator, E.M.I. Body and Head CT scanners and other radiotherapy equipment. To assist in the manufacture of dosimetry equipment and devices required for development and research

Experience in Radiation Physics or computers would be advantageous but not essential as training will be given where necessary.

There will be opportunities to obtain higher qualifications

Applicants should possess ONC/HNC (Electronics) or other appropriate qualifications and for Grade III, at least 3 years' relevant experience as a Grade IV technician or equivalent.

Salary Scale £3423-£5142 p.a. inclusive.

Application forms from Personnel Department, St. Bartholomew's Hospital, London, EC1A 7BE, in writing, or phone 01-600 9000, ext. 3186. Please quote ref. no. PTB/203.

Closing date 10 days to 2 weeks from date of appearance

Opportunities in **Broadcast Technology**

Pye TVT now have openings for Development Engineers. Based in Cambridge, you will be working in our studio and transmitter development laboratories on a wide variety of projects.

TRANSMITTER DEVELOPMENT

You will be involved on a number of aspects of design in television f.m. sound and a.m. sound broadcast transmitters and transposers. Broadcast experience is an asset, but first essentials are interest and enthusiasm.

STUDIO ENGINEERING

Openings exist in aspects of the design of digital equipment for broadcast T.V. application and in the design and development of analogue and digital video processing systems for broadcast T.V. pick-up devices. Experience of high speed digital signal and/or data processing equipment is essential.

Opportunities exist at all levels and salary will depend on previous experience and background. Applicants should be qualified to degree/H.N.D. level. Pye TVT offer generous relocation expenses, competitive salaries, good holidays, plus the opportunity for career advancement within the broadcast industry.

> For an application form, contact: Alison Millar, Personnel Officer. Pye TVT Limited, Coldhams Lane, Cambridge CB1 3JU. Telephone Cambridge (0223) 45115



PyeTVT Limited

The Broadcast Company of Philips

8991

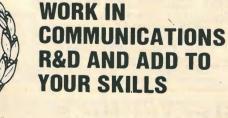


At the Government Communications Headquarters we carry out research and development in radio communications and their security, including related computer applications. Practically every type of system is under investigation, including long-range radio, satellite, microwave and telephony.

Your job as a Radio Technician will concern you in developing, constructing, installing, commissioning, testing, and maintaining our equipment. In performing these tasks you will become familiar with a wide range of processing equipment in the audio to microwave range, involving modern logic techniques, microprocessors, and computer systems. Such work will take you to the frontiers of technology on a broad front and widen your area of expertise — positive career assets whatever the future brings.

Training is comprehensive special courses, both in-house and with manufacturers, will develop particular aspects of your knowledge and you will be encouraged to take advantage of appropriate day release

You could travel — we are based in Cheltenham but we have other centres in the UK, most of which, like Cheltenham are situated in environmentally attractive locations. All our centres require resident Radio Technicians and can call for others to make working visits. There will also be some opportunities for short trips abroad, or for longe periods of service overseas.



You should be at least 19 years of age, hold, or expect to obtain shortly, the City and Guilds Telecommunications Technician Certificate Part 1 (Intermediate), or its equivalent, and have a sound knowledge of the private of the control of the con the principles of telecommunications and radio, together with experience of maintenance and the use of test equipment. If you are or have been in HM Forces your Service trade may allow us to dispense with the need for formal qualifications.

You start on £2927 at 19, up to £3700 if you are 25 or over, rising to £4252, and promotion will put you on the road to posts carrying substantially more. There are also opportunities for overtime and on-call work paying good rates.

Get full details from our Recruitment Officer, Robby Robinson, Cheltenham (0242) 21491, Ext. 2269, or write to him at GCHQ, Oakley, Priors Road, Cheltenham, Glos. GL52 5AJ. If you

prepare and maintain the latest in

nmunications equipment used by the

Police and Fire Brigade in England and

You will need to be qualified at least to City and Guilds Intermediate Telecommunication

wide range of equipment from computer based data transmission to FM and AM radio

systems. You would live near to and work from

one of our service centres located throughout

England and Wales or our Headquarters in

training are run to assist staff to keep up to date with developments and new equipment,

the London area. Specialised courses of

and there are opportunities for day release

to gain higher qualifications. Applications

from registered disabled persons will be considered.

Promotion prospects are good and the

skills in locating and diagnosing faults in a

standard and be able to demonstrate practical

Racal cabinets for RA-17/117 £30.00

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

Prices of above £70 to £500 Also Transport Docks only available

We have a large quantity of "bits and pieces" we cannot list — please send us your requirements probably help — all enquiries answered.

QUAITY

* Textronix 543A Oscilloscopes CA

* Textronix 545A Oscilloscopes BO

* Textronix 581A Oscilloscopes BO

* Marconi Tr 2200A Oscilloscopes

* Solatron CO 1014 Oscilloscopes

* Salatron 1016 Oscilloscopes

* Salatron 1016 Oscilloscopes

Reduced TT 220M0 describescopes

Reduced TT 220M0 describescopes

Selection 101 D14 Gestibescopes

Selection 101 D14 Gestibescopes

Rhode & Schwart 2700 Disripa 300 C/400 McS

Rhode & Schwart 270 McS (Spale Generators 200 C/400 M

Rhode & Schwart 270 McS (Spale Generators 200 C/400 M

Rhode & Schwart 270 McS (Spale Generators 16/2.48 M

Rhode & Schwart 270 McS (Spale Generators 16/2.48 Model 200 McS (Spale Generators 16/2.48 McS (Spale Generato

* B6-7.5 C.R.T.s

* Unsclectors. 10 Bank 25-way

* 40ft. Sectional Aluminium Masts. complete

* Narda S04 Freq. meters 200-500 M/cs

* Multi-purpose Trolleys with Jacks 19 x 17

* E.M.I. Documents CCTV Outfit

* Advance 33VA CV Transformers

* Metal V.O.U. Tables 30" x 36" x 30"

MANUALS
We have a quantity of Technical Manuals of Electronic Equipment, not photostats, 1940 to 1960. British and American. No lists. Enquiries invited. * Data Efficiency Responsers 240v
** Belling Les 100 Amp interference Filters
** Belling Les 100 Amp interference Filters
** Dacillascope in Service From
** Racal MA1976 pre-Selectors
** Rack Maunting Operator Tables
** Samont Kladle F140 Finter Meters
** 750f Aluminium Lattice Masts, 20° sides
** 750f Aluminium Lattice Mast

We have a quantity of Power Transformers 250 watts to 15KVA at voltage up to 40KV. Best quality at low prices. Lists available.

Racal RA-63 SSB Adaptors, new
 Racal RA 298 L.S.B. Transistorised Converters
[new]

We have a varied assortment of industrial and professional Cathode Ray Tubes available. List on

P. HARRIS ORGANFORD, DORSET, BH16 6BR

BOURNEMOUTH (0202) 765051(8981)

Skilled in Electronics? You could become a Systems Engineer

- Are you at least 20 years of age?
- Have you 2 years' practical electronics experience plus any one of the following?
- ☐ City & Guild's full electronic certificate
- ☐ HNC in electronics
- ☐ A completed electronics apprenticeship
- An H.M. Forces electronics training
- Will you accept the challenge of maintenance and diagnosis on ICL's complex computer systems?

you to join our skilled teams of Systems Engineers in maintaining our customers' computers. After a thorough initial training you will be based on one of our customer sites in the U.K. Within 18 months you should be a fully trained Systems Engineer with a career rich in opportunity ahead of you. You will have the satisfaction of using all vour technical expertise, tact and personality as a representative of ICL.

If you are interested in one of these jobs, with excellent salaries and

think computers-think ICL

YES? Then we are interested in training conditions even during training, then return this coupon or phone David Reeves on Stevenage (0438) 68347 or 68334 for an application form.

TO: David Reeves, CED Recruitment, ICL,

I would like to find out more about being a Systems Engineer.

HOME OFFICE

International **Computers**

Address

PAY PEANUTS GET MONKEYS

The firms for whom we are recruiting want Electronic Engineers not monkeys. The salaries we obtain for our clients reflects this

New graduate £4,500 p.a. 28 Year old project leader £8,000 + car. 25 year old graduate £6,000. 24 year old £4 an hour (contract).

CURRENT VACANCIES INCLUDE

- Design Development Engineers for a telecommunications command control project involving P.C.M.; Time division multiplexing, A/D conversion, active filters and circuits for speech compression. To £8,000. Middlesex, Berks. border.
- 2. Project Engineers, Systems Engineers for industrially sponsored research association with particular emphasis on automation and computerisation for the process industries. To £7,500.
- 3. Young Hardware / Software Systems Engineer for design and development associated with mini computer/microprocessor, controlled A.T.E. Exp. assembler programming preferred. To
- Logic Designers all levels for state of the art equipment used in the printing industry. Microprocessor/minicomputer based systems. To £6,500. West Country. Computer Field Engineers — Vacancies throughout U.K. including Home Counties. Southern England, Nottingham, Newcastle, Northampton, Leeds, Coventry, Bristol, Swansea.

FOR PERMANENT STAFF

LITERALLY thousands of vacancies including Contract Test Engineers and Contract Prototype Wiremen. Home Counties and on the South Coast.

Excellent rates. For further details please contact:

Charles Airey Associates

PROBABLY THE BEST KNOWN SUPPLIER OF ELECTRONICS ENGINEERS IN THE COUNTRY" 155 KNIGHTSBRIDGE, LONDON, SW1. TEL: 01-581 0286

Radio Technology - London

TELECOMMUNICATIONS OFFICER

The work includes the study of radio propagation matters over the whole of the radio spectrum (10kHz-275GHz); forward planning and regulation of frequency bands allocated to broadcasting, maritime and land mobile services; type-approval of equipment for mobile services; development of equipment for the location and suppression of radio

Candidates (aged at least 23) must have ONC in Engineering (with a pass in Electrical Engineering 'A') or in Applied Physics, or an equivalent qualification. In addition, they should have had experience in the operation of radio receiving equipment and have a knowledge of current operational systems of radio communications.

Salary starting between £4080 and £4820 (according to age) and rising to £5170. Promotion prospects. Non-contributory pension

For further details and an application form (to be returned by March 14, 1979) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). Please

HOME OFFICE

(8984)

Cavendish Road, Stevenage, Herts SG1 2DY

Electronic

Test Engineers We manufacture and market audio noise reduction equipment which is used by major recording companies, recording studios and broadcasting authorities

throughout the world and have enjoyed successful growth since incorporation in The success of such films as "Star Wars" and "Close Encounters of the Third Kind"

SITUATIONS VACANT

Work represents a secure future with

Possession of a driving licence is essential

The salary is £2627 (at 17), £3176 (at 21) and

£3700 (at 25), rising to a maximum of £4252.

write for further details and an application

Telecommunications Horseferry House Dean Ryle Street LONDON SW1P 2AW

form stating where you are interested in

Mr.C.R.Constable Directorate of

Telephone: 01-211 6420

If you are interested in working with us, then

since some travelling will normally be

generous leave allowances and a

non-contributory pension scheme

Telecommunications

has led to an increased demand for our cinema equipment and contributed to our need for experienced test engineers for all our professional products

If you have practical knowledge and experience of electronic testing, think you can test, calibrate and trouble-shoot our sophisticated equipment, enjoy the challenge of quality and delivery pressures and want to hear about the excellent pay and conditions, telephone Tony Hill, 01-720 1111.

Dolby Laboratories Inc 346 Clapham Road London SW9 9AP Telephone 01-720 1111

Medical Sales Engineers

Kontron Instruments Limited develop, manufacture and market a comprehensive range of medical and analytical equipment throughout the world. Planned expansion creates the follow-

Patient Monitoring

A vacancy exists covering the northern home counties. Candidates should preferably be aged 23 to 35 with an HNC Degree or equivalent in bio medical engineering, electronics or life sciences. Relevant selling experience or a hospital background in physiological measurement or medical electronics would be equally acceptable.

Salary + commission £7–8,000 p.a. Company car, pension and other attractive fringe benefits. Cardiology

Our fast expanding cardiology division has vacancies in various parts of the country. Applications are invited from candidates aged 23 to 35 having the qualifications and/or experience

Salary + commission £7–8,000 p.a. Company car, pension and other attractive fringe benefits. These positions would suit ambitious sales engineers or senior hospital technicians, with a keen

Contact or submit curriculum

Personnel Manager, Kontron Instruments Ltd., Campfield Road, St. Albans, Herts. Tel: St. Albans (0727) 33221

Serving hospitals throughout the world

KONTRON (ROCHE)



A VITAL ROLE FOR edical Electrical/ equipment engineers for Hospitals

These opportunities are in the Scientific and Technical Branch which provides the scientific, engineering and other professional services essential to the provision of medical apparatus, instrumentation and supplies to

The successful candidates will join a team working on the specification, laboratory testing, inspection and quality control of a wide range of medical electrical and electronic equipment used in the National Health Ser-



Candidates must have a degree or an equivalent qualification in electronics or electrical engineering and at least 2 years' experience in the design of electronic equipment covering analogue and digital circuits. Experience of medical electrical equipment

Starting salary between £4,790 and £6,200 depending on qualifications and experience. Noncontributory pension scheme. Promotion prospects.

For further details and an application form (to be returned by 15 March, 1979) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). Please quote T(40)85/2.

Field Technicians and Technician Engineers

for Installation/Commissioning/Maintenance work on to Telecommunications/Radio systems currently being commissioned

Instrumentation/Telemetry

At least 3 years experience in electronic instrumentation or digital telemetry is required for work on this unique computer controlled telemetry system.

Radio Relay

At least 3 years' experience in radio system installation or maintenance is required to work on the installation, commissioning and subsequent maintenance of the 24 channel, microwave/UHF/VHF integrated radio

subject to experience and qualifications SALARY SCALE RISES TO £5493 per annum

For an application form and further details without commitment, telephone READING 593331 or write to the DIVISIONAL MANAGER, Thames Water, Conservancy Division, Nugent House, Vastern Road,

Thames Water

(9006)

ARTICLES FOR SALE

LAB CLEARANCE: Signal Generators; Bridges; Waveform, transistor analysers; calibrators; standards; millivoltmeters; dyna-mometers; KW meters; oscillo-scopes; recorders; Thermal, sweep, low distortion true RMS, audio FR, deviation. Tel. 040-376236. (8250

G.W.M. RADIO LTD., 40/42 Portland Road, Worthing, Sussex. Tel. 34897. Pneumatic masts 40ft. By Scam Clark. 300 watt radar calorimeters, noise generators, type CT410, Eddy-stone communication receivers 730/4, v.g.c. £185.00 inc. Many bar-gains for callers, surplus always

INVERTERS High quality DC-AC. Also "no break" (2ms) static switch, 19" rack. Auto Charger.



Interport Mains-Store Ltd. POB 51, London W11 3BZ Tel: 01-727 7042 or 0225 310916 TECHNALOGICS CPG6RF colour bar and pattern generator. UHF Ae 1/P, new colour power battery design, 8 descending PAL colour bars crosshatch, dots, etc., full kit incl. case, etc., f36. Built f54. PG6RF kit f21.50, built f28 Add-on colour bar unit C6 in kit f15.50, built f22 plus f1 p&p. 8% V.A.T. Mail order from Technalogics, Dept WW, 8 Egerton St., Liverpool L8 7LY. (8951

solar CELLS: bits, books and bargains. Send stamp for list or 95p for Solar Cell booklet and Data sheets. Edencombe Ltd 34 Nathans Road, North Wembley, Middlesex HAO 3RX. (8061

ARTICLES FOR SALE

COLOUR, UHF AND TV SPARES. CEEFAX, ORACLE IN COLOUR. MANOR SUPPLIES "EASY TO ASSEMBLE" TELETEXT KIT.

MANOR SUPPLIES "EASY TO ASSEMBLE" TELETEXT KIT. Including TEXAS Decoder. Aerial Input, completely external unit, no further connections to set. Full facilities, mixed TV programme and Teletext, Newsflash. Update, and many special features not found in other units. Demonstration model in operation at 172 West End Lane, NW6. Phone or write for further information.

TEXAS TIFAX XM11 Decoder module, new, £130, p/p £1.00.

NEW COMBINED COLOUR BAR GENERATOR PLUS CROSS HATCH KIT (Mk4) UHF Aerial input type. Eight vertical colour bars plus R-Y. B-Y, Luminance combinations, Grey scale etc. Pushbutton controls. Battery operated £35°, De Luxe case £4.80°, aluminium case £2.40°, battery holders £1.50°, mains supply kit £5.78°, p/p £1.00. Built and tested (battery) £58°, p/p £1.20. CROSS HATCH KIT, UHF Aerial input type, also gives peak white and black levels. Battery operated, £11° p/p 45p. Add-on Grey Scale kit £2.90° p/p 35p. Aluminium case £2°, p/p 85p. Cross Hatch Unit, complete and tested in De Luxe case £20.80°, p/p £1.

"WIRELESS WORLD" TV Tuner and FM Tuner Projects by D. C. Read. Kits of parts available, CRT test

FM Tuner Projects by D. C. Read.
Kits of parts available, CRT test
and reactivator kit for colour and
mono £19.80 p/p £1.20. UHF Signal
Strength Meter kit £18* p/p 90p.
£25 TV HF Unit for Hi-fi amps or
tape recording £6.80 p/p 70p. Decca
Colour TV Thyristor Power Supply
Unit, incl. H.T., L.T., etc. Incl. circuits £3.80 p/p £120 Bush A823
(A807) decoder panel £7.50 p/p
£1. Bush 161 T-B panel A634 £3.80,
IF panel A583 £3.80 p/p 90p. Bush
Portable TV 11V stab power supply
unit £4.80 p/p £1. Bush CTV 25
Convergence Panel plus yoke, blue
lateral £3.60 p/p 90p. Phillips Single
Standard Convergence Units complete, incl. 16 controls £3.75 p/p
85p. Colour Scan Coils, Mullard or
Plessey, £6 p/p 90p. Mullard or
Plessey, £6 p/p 90p. Mullard AT
1023/05 Converg. Yoke £2.50 p/p
75p. Mullard or Plessey Blue Laterals 75p p/p 35p. BRC 3000 type
Scan Coils £2 p/p 90p. Delay LinesDL20 £3.50, DL50 £3.50. DLIE, DLI
85p p/p 45p. Lum delay lines 50p
p/p 40p. 68 Tripler £6. BRC 300
Tripler £6.60 p/p 75p. Others available Philips G8 Decoder partcomplete £2.50 p/p 75p. Others available Philips G8 Decoder partcomplete £2.50 p/p 75p. Others available Philips G8 Decoder £5.00.
Time Base £5.00, p/p 90p. VARICAP
TUNERS UHF: Gen. instr. £3.50.
ELC 1043 £4.50, ELC 1043/05 £5.50.
VHF: ELC 1042 £4.80, Philips VHF
£3.80. Salvaged UHF & VHF Varicaps £1.50 p/p 35p. VARICAP CONTROL UNITS, 3 position, £1.20, 4
PSN £1.50, 5 PSN £1.80, 7 PSN
£2.80. Special offer 6 position £1.
p/p 35p. UHF Transd. Tuners incl.
slow motion drive £2.80 d position
push button £2.50 c psn. £4.20, p/p
90p. Helical Pots 100K, 4 for £1.20
p/p 30p. Thorn 850 Dual Std. Time
Base panels 50p. Philips 625 IF
panel incl. oct. 50p p/p 70p.
Mullard Mono Scan Coils for
Philips Stella, Pye, Ekco, Ferranti,
Invicta £2.00 p/p 85p. Large selection LOPTs, FOPTs available for
most popular makes. MANOR SUPPLIES 172 WEST END LANE.
LONDON, N.W.6. Shop Premises.
Callers welcome. Thousands of additional items available not normally advertised. (Nos. 28, 159 buses or

TRANSFORMER PROBLEMS?

1VA-1KVA Prototypes in 7-10 days Phone Vince Sellar on 06076

TRENT TRANSFORMERS LTD Chapel Street Long Eaton, Nottm.

Development Engineers for sub-hunting and train spotting

Ultra Electronic Communications, part of the international Dowty Group are world leaders in sonar buoy design and manufacture, advanced railway and train location networks, sophisticated aircraft communication systems and search and rescue beacons.

Development Engineers are highly regarded at Ultra and enjoy considerable autonomy and opportunities for travel and customer liaison worldwide, and the chance to contribute and influence projects in a sophisticated technological environment.

To join us you should be qualified to degree level Electronics or Mechanical Engineering and have upwards of 4 years experience of development work in an electromechanical/ electronics environment.

WIRELESS WORLD, MARCH 1979

Salaries will be negotiable and accompanied by a wide range of attractive large company benefits, including a very generous relocation package.

Men and women, for further information and an application form, please phone or write to Mr. Gavin Rendall, Personnel Manager, Ultra Electronic Communications Limited, 419 Bridport Road, Greenford, Middlesex, UB68AU.

Tel: 01-578 0081.

The Polytechnic of North London

TECHNICIAN (Grade IV)

Applications are invited for the appointment of a Grade IV Technician in the Department of Electronic and Communications Engineering.

This interesting post involves the operation and maintenance of high grade test equipment, together with the general responsibility for students' day-to-day requirements with experiments and projects in students day-to-day to-day to the laboratory. Participation in R and D work in the audio engineering field in liaison with the audio team is encouraged

Educational level: ONC/OND, City and Guilds, approved apprenticeship or equivalent qualifications.

Experience: at least 7 years (including training period).

Salary Scale: £3441-£3891 inclusive of London Weighting

Application form obtainable from the Establishment Officer, The Application form obtainable from the Establishment Officer, The Polytechnic of North London, Holloway Road, N7 8DB. Further details from the Departmental Laboratory Superintendent (Telephone: 607 2789, Extn. 2176).

ARTICLES FOR SALE

Electronic Communications Ltd

THE VINTAGE WIRELESS COMPANY 1920 to 1950

data, historical research, books

THE VINTAGE WIRELESS COMPANY
64 Broad Street, Staple Hill, Bristol BS16
5NL
Tel: Bristol 565472 (8966)

TIRRO's new mail order price list of electronic components now available on receipt of SAE. Tirro Electronics, Grenfell Place, Maidenhead

CONSTRUCTOR PLANS — Hundreds sold! Pulse Induction Metal Locator, advanced economical switched CMOS design, Mk II f1.50, Mk III with stabiliser, 5 ICs f1.75. Radio Telescope 5-Metre f2. Solar Energy Furnace f1.80. Digital Multistested/frequency counter 22 ranges f1.50. R & E Publications. Highlands, Needham Market, Suffolk.

EX BBC VIDEO AND SOUND MODULES — mainly unissued. Lot includes two waveform monitors, quantity of colour distribution amps., and sound mixer modules S.A.E. for list to Geen, 8 Millgate, Delph, Nr. Oldham. (8957)

1 Pye base radio station type F27 with five radio control units and five microphones, all in serviceable condition.

ROYAL BOROUGH OF KINGSTON-UPON-THAMES

DISPOSAL

OF SURPLUS

STORES

Offers are invited for the fol-

lowing item

Goods may be viewed between 0730 and 1130 or 1300 and 1600 on Mondays to Fridays at the Villiers Road Depot by arrangement with the chief storekeeper, Mr. P. Beckinsale, Tel: 01-549 1257.

SURPLUS CAPACITORS: C280 250v. Price per hundred including postage — 0.068 £1.50; 0.33 £2.00; 0.1 £1.00 (1,000 £8; 5,000 £30). B. Maloy, 66 Woodvale Avenue, Belfast BT13 3EX. N. Ireland. (8964

ARNETT

NOGNOT

THE FABULOUS D2
MICROPROCESSOR EVALUATION

KIT FROM MOTOROLA

Featuring '24 key keyboard 'Seven segment display 'Cassette interface 'Erom & Ram Expandable 'Interface Capability. 'Full Documentation '5 Volt power supply required 'One year's FREE membership of The

Amateur Computer Club with every purchase £176 + £1.50 P&P + 8% VAT.

ENAMELLED COPPER WIRE

Tinned Copper, Even Gauges 14-30 £3 per lb. Multicore 60/40 Solder 18SWG £3.24

per lb. Prices include P&P and VAT.
SAE brings list of copper and resistance

THE SCIENTIFIC WIRE COMPANY

PO Box 30 London E.4 (77771

Grystal ACCURATE RELIABLE

(幸)

Private enquiries send 13p in stamps for brochu

THE QUARTZ CRYSTAL CO. LTD.

Q.C.C. WORKS, WELLINGTON CRESCENT NEW MALDEN, SURREY 01-942 0334 & 2988

CLEARANCE SALE: Linsley-Hood
75 Watt Power Amp Modules. Fit
Powertran standard chassis. Basic
Module £10.50, module with BDY56
power transistors £13.50. LinsleyHood amplifiers constructed and repaired. Prices inclusive, details
free. I. G. Bowman (Dept WW), 59
Fowey Avenue, Torquay, S. Devon.
(8999

60KHz MSF Rugby Receiver, BCD TIME OF DAY OUTPUT. High performance, phase locked loop radio receiver, 5V operation with 1 second LED indication. Kit complete with tuned ferrite rod aerial 14.08 (including nostage and

\$14.08 (including postage and VAT). Assembled circuit and cased-up version also available. Send for details, Toolex, Sherborne (4359), Dorset. (8252

T.V. TUBE REBUILDING, Complete

plant, equipment, supplies and training. If you can afford the best contact Western-Whybrow Engineering. Tel. 073 676 2265. (8048)

| Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net | Net

ARTICLES FOR SALE

SOWTER TRANSFORMERS

WITH 37 YEARS' EXPERIENCE we have the expertise to design and manufacture ANY TYPE OF AUDIO TRANSFORMER AT THE RIGHT PRICE

Whilst we specialise in every kind of transformer for audio control decks and mixers, demands are increasing for LOUDSPEAKER TRANSFORMERS and 100 VOLT LINE AUDIO OUTPUT TRANSFORMERS for most kind of amplifier from 30 watts to 500 watts output. We have standard designs for AMCRON and BOSE amplifiers and can also supply. Multi-output transformers for COLUMN LOUDSPEAKERS in a wide variety of powers. A recent tendency is the demand for OUTPUT TRANSFORMERS FOR ULTRA LINEAR VALVE AMPLIFIERS using KT88 and KT66 BEAM TETRODES and for these we have standard designs with exceptional performance. Many of our output transformers for loudspeakers have been installed in Theatres, Television Studios, Lecture and Concert Halls, Churches and Outdoor Arenas whilst others are in constant use for high quality portable Public Address Systems. We will supply single transformers, or any quantity, with short delivery times and, without obligation on your part, will quote price and exact dispatch on receipt of your requirements.

KINDLY NOTE OUR NEW ADDRESS AND TELEPHONE NUMBER: E. A. SOWTER LTD., Transformer manufacturers and designers, P.O. BOX No. 36, IPSWICH IP1 2EL, ENGLAND. Tel: Ipswich (0473) 52794-219390.

SYSTEM DESIGN WITH MICRO **PROCESSORS**

SOFTWARE DESIGN FOR MICRO-COMPUTERS by C. A. Ogdin Price: £7.00 BASIC FOR HOME COMPUTERS: A SELF-TEACHING GUIDE by B. Albrecht Price £4.55 BEGINNER'S GUIDE TO HOME COMPUTERS BASIC COMPUTER GAMES

by Texas Inst. Price: £4.15
USING DIGITAL &
ANALOG INTEGRATED CIRCUITS

SEMICONDUCTOR MEMORY BOOK

THE MODERN BOOK CO. SPECIALISTS IN SCIENTIFIC & TECHNICAL BOOKS 19-21 PRAED STREET

LONDON W2 1NP

HUGE BARGAIN PACK OF ELECTRONIC AND RADIO GOODIES. Too many items to list. All brand new and useful. No junk. Valve at least £25. Only £9 including post and packing. C.W.O. (U.K. only). Refund if not delighted. A. Philpott, 171 Great Brays, Marlow, Essex CM18 6DT.

(08692) 44551.

CHESS CHALLENGER 10 level version, ultra low prices including V.A.T. and postage and packing only £160. Gammonmaster 2 with doubling cube £115. Atari home video computer £127, extra cartridges only £12. Mail order only to Jagberry Limited, 95 Ardwell Avenue, Barkingside, Ilford, Essex. 01-588 7352.

TEST EQUIPMENT 2,000 plus items to go

inclusive

Some other makes cheaper. Signal generators from £20.00 and many other bargains.

P & R TEST EQUIPMENT

Salcott Mill, Goldhanger Road, Heybridge Near Maldon, Essex

REVOX BTT TAPE RECORDERS,

REVOX BT7 TAPE RECORDERS, limited number, used approx. 50 hours 34/7½ two-track, guaranteed for twelve months. £515 inc. V.A.T. EMI AND RACAL ZONAL, professional tape on 7in and NAB spools. Keen prices. Send for list. NEVENCO C90 cassettes £6.50 for 10 inc. V.A.T. Audio equipment for professional users, e.g. Uher, AKG, Beyer, Sennheiser etc. New range of NEVENCO mixing consoles especially for churches, charities and missions. NEVENCO LIMITED, 2 Hills Road, Cambridge CB2 1JP. Tel: (0223) 62392. (8950

Wireless World publication). We had announced that this publication was out of print but we now discover that we have 350 copies in stock. Due to our announcement, many readers were disappointed, many readers were disappointed, but we are now pleased to inform them that copies are available from The General Sales Manager, Room CP34, Dorset House, Stam-ford Street, London SE1 9LU. Please forward your order together with your remittance of £1.50 (including P&P) made payable to IPC Busi-ness Press Ltd. (8652

ARTICLES WANTED

SPOT CASH

ment and components.

550 Kingston Road, London Tel: 01-404 5011 Telex: 24224 Quote Ref 3165

WE PURCHASE ALL FORMS OF ELECTRONIC **EQUIPMENT AND** COMPONENTS, ETC.

7, 9, 11 Arthur Road Reading, Berks. Tel. (0734) 582 605

TURN YOUR SURPLUS Capacitors, transistors, etc., into cash. Contact CULES-HARDING & Co., 103 South Brink, Wisbech, Cambs. 0945-4188. Immediate settlement. We also welcome the opportunity to quote for complete factory clearance. (7439

ELECTRONIC SCRAP. Components, etc., Receivers, Transmitters Test Equipment wanted. Ferrographs from £15 in stock. Contact M & B Radio, 86 Bishopgate Street, Leeds 1. Tel. Leeds 35649. (8011

storage space is expensive, why store redundant and obsolete equipment? For fast and efficient clearance of all test gear, power supplies, PC boards, components, etc., regardless of condition or quantities. Call 01-771 9413. (8209

SPOT CASH for all types test equip ment, receivers, transmitters, valves, components, cable and surplus electronic scrap. M. & B. plus electronic scrap. M. & B. Radio, 86 Bishopgate Street, Leeds LS1 4BB. 0532 35649. (8789

MINICOMPUTERS PERIPHERALS INSTRUMENTATION

For fastest, better CASH offer Phone:

CHILTMEAD LTD. Reading (0734) 586419

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

21 LODGE LANE NORTH FINCHLEY, LONDON N12 8JG Telephone Nos. 01-445 0749/445 2713 After office hours 958 7624

A.R. Sinclair

Stevenage 812193

Mechanical and Flectronic Equipment and Surplus stocks. (8189)

Dalton, M.I.E.R.E. Authentic, nostalgic, readable. Volume I. How Radio Began. From electrics to radio 1914. Volume II. Every One An Amatuer 1920/26, constructors & BBC. Volume III. The World Starts to Listen 1926/30. Receivers, transmitters, talkies, television. Each volume £4.50 p&p 50p. Adam Hilger Ltd., Techno House, Redcliffe Way, Bristol BS1 6NX. (9014

COURSES

BOLTON - HUDON
With sound practical experience and the necessary qualifications - degree, diploma, professional qualifications, HND, HNC, FTC, etc., depending on your specialisation - you can train as a lecturer in Further and Higher Education. A one-year grant-aided course will prepare you to teach in one of the following areas:

Agriculture & Horticulture ● Business Studies ● Catering & Allied Subjects ● Clothing & Fashion

Construction

Education for the Disadvantaged

Engineering

English

En Languages ● Liberal Studies ● Nautical Studies ● Nursing & Health Studies ● Management ● Mathematics ● Painting and Decorating ● Printing & Graphic Arts Sciences ● Social Work

For further details, either phone or send the coupon to any of the following colleges:-Bolton College of Education (Technical), Chadwick Street, Bolton BL2 1JW. Tel: Bolton 22132.

Garnett College, Downshire House, Roehampton Lane, London SW15 4HR. Tel: 01-789 6533. The Polytechnic, Huddersfield, Holly Bank Road, Lindley, Huddersfield HD3 3BP.

Tel: Huddersfield 25611. Wolverhampton Polytechnic, Faculty of Education, Compton Road West, Wolverhampton, WV3 9DX. Tel: Wolverhampton 24286.

I.H.S. SYSTEMS

Due to expansion of our manufacturing facilities we are able to under take assembly and testing of circuit boards or complete units in addition to contract development.

WIRELESS WORLD, MARCH 1979

LONDON

We can produce, test and calibrate to: a high standard digital analogue and RF equipment in batches of tens to thousands.

Telephone to arrange for one of our engineers to call and discuss your requirements, or send full details for a

TEL. 01-253 4562

COIL WINDING Large or small

PRODUCTION RUNS AIRTRONICS LTD

GARDNER INDUSTRIAL ESTATE

KENT HOUSE LANE RECKENHAM KENT BR3 1UG

ELECTRONIC CIRCUIT Design and prototype construction production assembly. Test and PCB artwork design. Write: Powerline Electron-ics, High Street, Bognor Regis. Sussex PO21 1EZ or telephone STD 024-32 (Pagham) 66587 evenings. (8963 Wind your own coils

Short runs. Long runs. One type. Many types, Simple. Complex.

You name it



will help you wind it

AVO LIMITED Archcliffe Road, Dover, Kent, CT 17 9EN. Tel: 0304 202620 Telex: 96283

SKILLED HAND assembly, one-offs and small batch runs. — I. G. Bowman, 59 Fowey Avenue, Torquay, S. Devon. (9000

Specialised PCB Service Layouts . Photography . Drilling

Roller Tinning - Gold Plating Legend Printing · Profiling

Special quick prototype service

Crofton Electronics Limited 35 Grosvenor Road, Twickenham Middlesex - Tel. 01-891 1923

HIGHWAY ELECTRONICS. Logic design, PCB artwork, assembly, testing, custom built electronics, Unit 112, Springvale Ind. Estate, Cwmbran, Gwent NP44 5BG. Telephone Cwmbran (06333) 68042. (8347

PCB ARTWORK DESIGN SERVICE with component notation masters and assembly drawings. PADS Electrical Ltd, 01-850 6516, 45 Southwood Road, New Eltham SE9.

EDUCATIONAL

C AND G EXAM

Make sure you succeed with an ICS hor study course for C and G Electrical Installett Work and Technicians. Redio/TV/Electroni Technicians. Telecomms Technicians and Rad

COLOUR TV SERVICING Make the most of the current boom! Learn the techniques of servicing Colour and Mono TV sets through new home study courses approved by leading manufacturers.

TECHNICAL TRAINING

SERVICES

W.K.F. ELECTRONICS

(R.P.C.B.S. Ltd.) IRCUIT BOARD SPECIALIS

Contractors for: P.C.8. Production. Contract Drilling, Electroplating, Laminate Cutting. Services for: Master Artwork Preparation, Process Photography, Circuit Diagrams, Layouts & Legends. Consultants for: Instrument Engineering, Automatic Control & Applications.

Do-It-Yourself Won't Do: Today's assemblies Goodbye to the Long Wait: 3 to 7 Day Prototype
P.C.B. Production Service

every process.

Short or Long Term Production now according 1 to 10,000 units.

We Universally Distribute: Laminate, Carbide Drill Bits & Routers, Process Chemicals (any), Pre-sensitised Laminate, Drilling Machines (Manual, Multi-spindle, N.C./C.N.C. Control), Graphic Art

We Manufacture to Specification: Quality Circuit Boards (Single or Double Sided with any finish). Due to expansion we now have space available for prototype or long term production.

For Quotations: Submit Copy Masters, Roughs Circuit or Sample units for costing.

W.K.F. ELECTRONICS
FLEET HOUSE, WELBECK STREET
WHITWELL, WORKSOP, NOTTS.
TEL. WORKSOP (0909) 720695
TELEX: 547616

NOTICE TO OTHER MANUFACTURERS

H RATES ARE VERY RESONABLE AND THI ST SERVICE WILL ENSURE THAT YOUR ISTOMERS: DELIVERIES ARE MET

TEST EQUIPMENT

We are disposing of a considerable amount of good quality test gear including Tektronic scopes at silly prices.

* Ring Derek Pattinson now and discuss your requirements. Crofton Electronics Ltd.

35 Grosvenor Road, Twickenham, Middlesex.

Tel. 01-891 1923 (8211

PRECISION SHEET METAL WORK. chassis, panels; etc., steel, stain-less or aluminium, long/short runs, good deliveries. EES Ltd., Clifford Rd Monks Road, Exeter 56280 36489. (8060

petent engineering effort available for all aspects of electronic design. Single circuits or complete systems, prototype to production run. E.I.A., 80 Wheatland Lane, Wallasey, Merseyside, 051-639 9122. (8615

DESIGN SERVICE. Electronic Design Development and Production Service available in Digital and Analogue Instruments, RF Transmitters and Receivers for control of any function at any range. Telemetery, Video Transmitters and Monitors, Motorised Pan and Tilt Heads etc. Suppliers to the Industry for 16 years. Phone or write Mr. Falkner, R.C.S. Electronics, 6 Wolsey Road, Ashford, Middlesex. Phone Ashford 53661. (8341)

by D. Zissos Price £7.00

by M. Grosswirth Price: £3.20

by D. H. Ahl Price: £6.00 DIGITAL INTEGRATED CIRCUITS & COMPUTERS by B. Woollard Price: £3.55 THE OPTOELECTRONICS DATA BK FOR DESIGN ENGINEERS

by L. W. Shacklette Price: £8.50
VIDEO YEARBOOK 1979
Price: £13.00
INTEL THE

Price: £11.00

* Prices includes postage *

Closed Sat. 1 p.m.

PYE SPEECH SCRAMBLERS. Price
pur.: Creed 75 teleprinter £40;
Creed syn motor 3,000 rpm £5;
Advance PP3 twin stab DC supply
£30; Advance double pulse gen PG
5002C £35; H.P. ratio meter mod
416B £30; H.P. Audio sig gen 205AA
£33; Cossor RMS meter 1453 £27;
Marconi valve volt meter TF 1100
£15; Mufax 18in recorder type
D-649 £120; Teleprinter tape and
paper, 1' and ½ mag tape Dynamco 2001 MKZ DRM £75; Airmec
oscillator-amplifier type 254 £55
plus V.A.T. Skipton Electronic Suppliers, 29 Keighley Road, Skipton,
North Yorkshire. Tel: 0756 4397.
(8949

CLEARANCE SALE: Linsley-Hood

Z80 MOSTEK DEVELOPMENT BOARD SDB80 plus power supply all neatly mounted as one unit. Includes circuits and all handbooks, ready to go. £700 new. £300 o.n.o. to R. Tuthill, Golden River Co.

WAVEFORM GENERATOR feedback TWG501, £55; dual variable power supply, 18v, £25. Phone 0305 852 136. (8952

BIG SALE OF

Sale starts Saturday, 10th March through to the 17th Sunday

Open from 9 o'clock till 6

EXAMPLE Polyscope SW0B 1 £220.00. Tetscope from £60.00 to £120.00 for a mainframe

Tel: Maldon (0621) 57446

HI-FIDELITY DESIGNS No. 1 (a

paid for all forms of electronics equip

F.R.G. General Supplies

SPOT CASH CHILTMEAD LTD.

Electronic Stockholders

We purchase all types of

BOOKS

THE STORY OF RADIO by W. M. Dalton, M.I.E.R.E. Authentic, nostal-

Wireless World, March 1979

SHURE



- & Best Value for money.
- *Used by professional engineers, D.I.Y. enthusiasts, hobbyists, service engineers.
- * World-wide proven reliability.
- Low servicing costs.
- 20K/volt sensitivity and high accuracy.
- * Large mirror scale meter.
- * Fully protected against overload.
- Large range of inexpensive accessories.
- *12 month warranty, backed by a full after sales service at E.B.Sole U.K.Distributors.

Prices from £16.60 - £32.00 + VAT Send for full colour leaflet and prices on whole range including accessories.

ELECTRONIC BROKERS LIMITED

49-53 Pancras Road, London NW1 2QB. Tel: 01-837 7781. Telex: 298694.

INDEX TO ADVERTISERS Appointments Vacant Advertisements appear on pages 129-151

PAGE	FAGE		
	Ferranti	Pattrick, J. B.	110
Acorn Computer 113	Ferranti 11, 41, 112.	Powell T	108
Acoustical Mfg. Co. Ltd 4	Future Film Developments	Powertran Electronics 106,	10
AEL Crystals 32	Fylde Electronic Labs Ltd	Precision Petite Ltd.	109
AMP of Great Britain 8, 9		Pye Unicam	1:
Ambit International	GEC M-O Valve	Pye Unicam	, 1
Antex	C.P. Flectronics	1 (0) 1 1 1 1 1 1 1	10
Aspen Electronics Ltd	Greenwood Electronics Ltd	Quarndon Electronics (Semiconductors) Ltd	10
Aspen Electronics Ltd	Gleenwood Electronics 2tal		
Astra-Pak	Harmsworth Townley & Co. Ltd	Radford Lab. Insts. Ltd.	10
Audix Ltd	Harris Electronics (London) Ltd 16, 24	Radio Components Specialists	113
Avo Ltd 16, 64	Hart Electronics	Radio Shack	10
	Hart Electronics	Radio Supplies Comps	- 11
05	Hi-Fi Y/Book	Ralfe, P	104
Bang & Ollufson	Hivol Connectors	R.C.S. Electronics	98
Barr & Stroug Ltd	H. L. Audio	R.S.T. Valves	128
Barrie Electronics Ltd 117		R.S.1. Valves	
Bell & Howell 2, 14, 15	I.L.P. Electronics Ltd	0.11 (177) 1.43	30
Bever Dynamics (GB) Ltd	Industrial Tane Applications	Sabtronics (UK) Ltd.	3
Bib Hi-Fi Accessories Cover iv	Integrey I td	Conducell Dignt I td	o
Bi-Pak Semiconductors Ltd 102, 103	Interface Quartz Devices Ltd	Coopey Instruments I td	ુ
Boss Industrial Mouldings Ltd 19		Saccom	-4
Brensal Electronics Ltd	Jayen Developments	Complete Trading Co	11
Bulgin Electronics Soundex Ltd	JPS Associates	Comic & Electronics Sales I td	10
Bull. J	JPS Associates	Churc Electronics I td	er
	110	Cintal	11
Butterworth & Co. (Pub.) 120	K. & A. Distributors	SME Ltd.	2
	Keithley Instruments Ltd	Southern Electronics	3
Cambridge Learning	KGM Electronics Ltd	Southern Electronics Sota Communication System	10
Carston Electronics Ltd	Kirkham Amplifier 6	Sota Communication System	3
Carter Associates		Special Products Ltd.	3
Carrer Associates	Labgear Ltd	Sugden, J. E. & Co. Ltd	0
Catronics	I angrey 128	Surrey Flectronics Ltd.	. 7
CEC Corporation	Lascar Electronics	Swanley Electronics Ltd.	9
Chiltmead Ltd	Levell Electronics Ltd 3		
Circards No. 3	London Instrument Repair Centre 109	Technomatic Ltd.	11
Citadel Products Ltd	Lowe Electronics Ltd	Teleradio Hi-Fi	. 4
C. N. Stevenson 34	Lowe Electronics Etc.	Transtel Communications	3
Colomor (Electronics) Ltd 127	MacInnes Laboratories Ltd 12		
Clarke Smith (Vortexion)	Maplin Electronic Supplies		-
Continental Specialities	Marco Trading	Valradio Ltd	. 3
Crimson Elektrik 28	Marco Trading	Vero Flectronics Ltd.	. 4
CT Electronics 114, 124	Marconi Instruments Ltd Cover ii	Videotime Products	12
	Marshall, A. & Sons (London) Ltd 104	Viewdata	. 3
Datong	Martin Accordates	, viewada	
Datong	Medelec	Watford Electronics	2
Display Electronics	Milward, G. F	West Hyde Developments Ltd	C
	Multicore Solders Ltd Cover IV	West London Direct Supplies	10
ECM (K9 Comps)	MHZ Electronics	West London Direct Supplies	11
Electro-Tech		Wilmot Breeden Elec. Ltd.	10
Electronic Brokers Ltd 121, 122, 123, 152	Nevenco	Wingrove & Rogers Ltd.	14
Electronic Brokers Ltd. (Second Hear Computer Div.)		Wilmslow Audio	. 4
Electronic Brokers Ltd. (Second User Computer Div.)	Olson Electronics Ltd		
125		Z. & 1. Aero Services Ltd	, 10

OVERSEAS ADVERTISEMENT AGENTS:

France: M. D. Soubeyran, Compagnie Francaise D'Editions, Division Internationale, 40 Rue du Colisee, Paris 8e Telephone 225-77-50 — Telex 280274.

Hungery: Mrs. Edit Bajusz, Hungexpo Advertising Agency, Budapest XIV, Varosliget Telephone: 225 008 — Telex: Budapest 22-4525 INTFOIRE.

Italy: Sig. C. Epis, Etas-Kompass, S.p.a. — Servizio Estero, Via Mantegna 6, 20154 Milan. Telephone: 347051 — Telex: 37342 Kompass.

Japan: Mr. Inatsuki, Trade Media — IBPA (Japan), B 212, Azabu Heights, 1-5-10 Roppongi, Minato-ku, Tokyo 106, Telephone: (03) 585-0581.

UNITED States of America: Ray Barnes, IPC Business Press. 205 East 42nd Street. New York, NY 10017 — Telephone: (212) 689 5961 — Telex: 421710. Mr. Jack Farley Jnr., The Farley Co., Suite 1584, 35 East Wacker Drive, Chicargo, Illinois 60601 — Telephone: (312) 6 3074.

Mr. Victor A. Jauch, Elmatex International, P.O. Box 34607, Los Angeles, Calif. 90034, USA — Telephone (213) 821-8581 — Telex 18-1059.

Mr. Jack Mentel. The Farley Co., Suite 650, Ranna Building, Cleveland, Ohio 4415 — Telephone: (216) 621 1919. Mr. Ray Rickles, Ray Rickles & Co., P.O. Box 2008. Miami Beach, Florida 33140 — Telephone: (305) 532 7301. Mr. Tim Parks, Ray Rickles & Co., 3116 Maple Drive N.E. Atlanta, Georgia 30305. Telephone: (404) 237 7432. Mike Loughlin, IPC Business Press, 15055 Memorial. Ste 119, Houston, Texas 77079 — Telephone (713) 783 8673.

Canada: Mr. Colin H. MacCulloch, International Advertisi Consultants Ltd., 915 Carlton Tower, 2 Carlton Street, To 2 — Telephone: (416) 364 2269. *Also subscription agents.

Printed in Great Britain by QB Ltd., Sheepen Place, Colchester, and Published by the Proprietors IPC ELECTRICAL-ELECTRONIC PRESS LTD., Dorset House, Stamford Street, London, SEI 9LU, telephone 01-261 8000. Wireless World can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co., CANADA: The Wm. Dawson Subscription Service Ltd, Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd: William Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Distribution Inc., 14th floor, 111 Eighth Avenue, New York, N.Y. 10011.

fact: you can choose your microphone to enhance your sound system.

Shure makes microphones for every imaginable use. Like musical instruments, each different type of Shure microphone has a distinctive "sound," or physical characteristic that optimizes it for particular applications, voices, or effects.

Take, for example, the Shure SM58 and SM59 microphones:

SM59

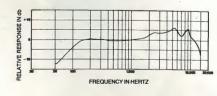
Mellow, smooth, silent...

The SM59 is a relatively new, dynamic cardioid microphone. Yet it is already widely accepted for critical studio productions. In fact, you'll see it most often where accurate, natural sound quality is a major consideration. This revolutionary cardioid microphone has an exceptionally flat frequency response and neutral sound that reproduces exactly what it hears. It's designed to give good bass response when miking at a distance. Remarkably rugged—it's built to shrug off rough handling. And, it is superb in rejecting mechanical stand noise such as floor and desk vibrations because of a unique, patented built-in shock mount. It also features a special hum-bucking coil for superior noise reduction!

SM58

Crisp, bright "abuse proof"

Probably the most widely used on-stage, hand-held cardioid dynamic microphone. The SM58 dynamic microphone is preferred for its punch in live vocal applications...especially where close-up miking is important. It is THE worldstandard professional stage microphone with the distinctive Shure upper mid-range presence peak for an intelligible, lively sound. Worldrenowned for its ability to withstand the kind of abuse that would destroy many other microphones. Designed to minimize the boominess you'd expect from close miking. Rugged, efficient spherical windscreen eliminates pops. The first choice among rock, pop, R & B, country, gospel, and jazz vocalists.



professional microphones...by

Shure Electronics Limited, Eccleston Road, Maidstone ME 15 6AU—Telephone: Maidstone (0622) 59881



ts it togethe

Toolbox Reels

Three solders that cover all your electrical applications. 40/60 Tin/Lead

60/40 Tin/Lead Savbit Alloy/



Soldering Flux Paste

A fast non-corrosive, rosin flux for general and electrical soldering. Use in conjunction with 'Ersin' Multicore solders. 48p inc. VAT Size RF10

'Arax' Use in conjunction with 'Arax' Multicore solder for general metal fabrication Size AF14 48p inc. VAT

Multicore Desoldering Wick

For desoldering component leads from PCB's or removing solder from virtually any joints.

Size AB10 97p inc. VAT

Wire Strippers and Cutters

Easily adjustable for most sizes of flex and cable. Fitted with extra strong spring for automatic opening. Easy grip handles

and handle locking device. £1.15 inc. VAT



Handy Dispensers (All prices inc. V.A.T.)

Size 19A All electrical work	63p
Size PC115 For small components	69p
Size SV130 Use with copper bits and wires	£1.08
Size AR140 Metal repairs	86p
Size AL150 Aluminium	76p
Size SS160 Stainless Steel	£1.08

Savbit Dispenser

For radio, TV and similar work. Reduces copper erosion.

Size 5 58p inc. VAT

Emergency Solder

Self fluxing, tin/lead solder tape that melts with a match. For electrical and non-electrical applications. Size ES36 39p inc. VAT



Econopak

A reel of 1.2mm 'Ersin' Multicore solder for general electrical use.

Size 13A £2.59 inc. VAT

A reel of 3mm 'Arax' Multicore solder for general non-electrical use.
Size 16A £2.59 inc. VAT

Solder Cream

Tacky mixture of solder powder and correct percentage of flux for difficult to reach areas. Electrical/Electronic ('Ersin' Flux) Size BCR10 £1.08

Metal joining ('Arax' flux) Size BCA14 £1.08

Stainless Steel & Jewellery ('Arax Flux) Size BCA16 £1.38 (All prices inc. V.A.T.)



keepsitn



Make editing simple with the Bib splicer, tape cutter and splicing tape. Standard pack with 6.3mm adaptor. Ref 56 £1.99 inc. VAT

> In permanent storage case with tape piercer and winder remover. Ref 98 £2.70 inc. VAT

П

USA Pat. No. 4067563 (splicer) Brit. Pat. No. 1507583 (splicer) Brit, Pat. No. 1258280 (method of splicing)



Parallel tracking, it cleans whilst disc plays. Engineered in chromed steel and with two bases to suit all decks. Pat. Pending Ref 101A £3.97 inc. VA1 Brit. Reg. Des. No. 982790 U.S.A. Reg. Des. No. 247622



Groov-Stat Electronic 3000

This improved static reducer, powered by one small battery, neutralises record surface static in seconds. Comes in permanent

storage box with FREE static tester.

Ref 3000 £9.98 inc. VAT (Pat. pending)



All prices shown are recommended retail, inc. VAT.



In difficulty send direct, plus 20p P & P. Send S.A.E. for free copy of colour catalogue detailing complete range. Bib Hi-Fi Accessories Limited, Kelsey House, Wood Lane End, Hemel Hempstead, Herts., HP2 4RQ.



ı

and humid velvet pad edge remove dus and humid velvet pad collects particles. This advanced cleaner is engineered in chromed steel and is supplied with dust cover in permanent storage box.

Ref 110 Pat. Pending E5.49 inc. VAT Reg. Des. No. 98180

Pat. Pending Reg. Des. No. 981808



Tape Head Maintenance Kit

Everything necessary for cleaning heads, capstan and pinch wheel on all types of recorders

Cleaning and polishing pads, cleaning liquid and brush inspection mirror included.

Standard Pack Ref 25 £1.99 inc. VAT Permanent Storage Box with cleaning cloth Brit. Pat. No. 1485069 Ref 99 £2.70 inc. VAT