

Wireless World

ELECTRONICS &

\$375

May 1984 85p.

SC-84 advanced microcomputer

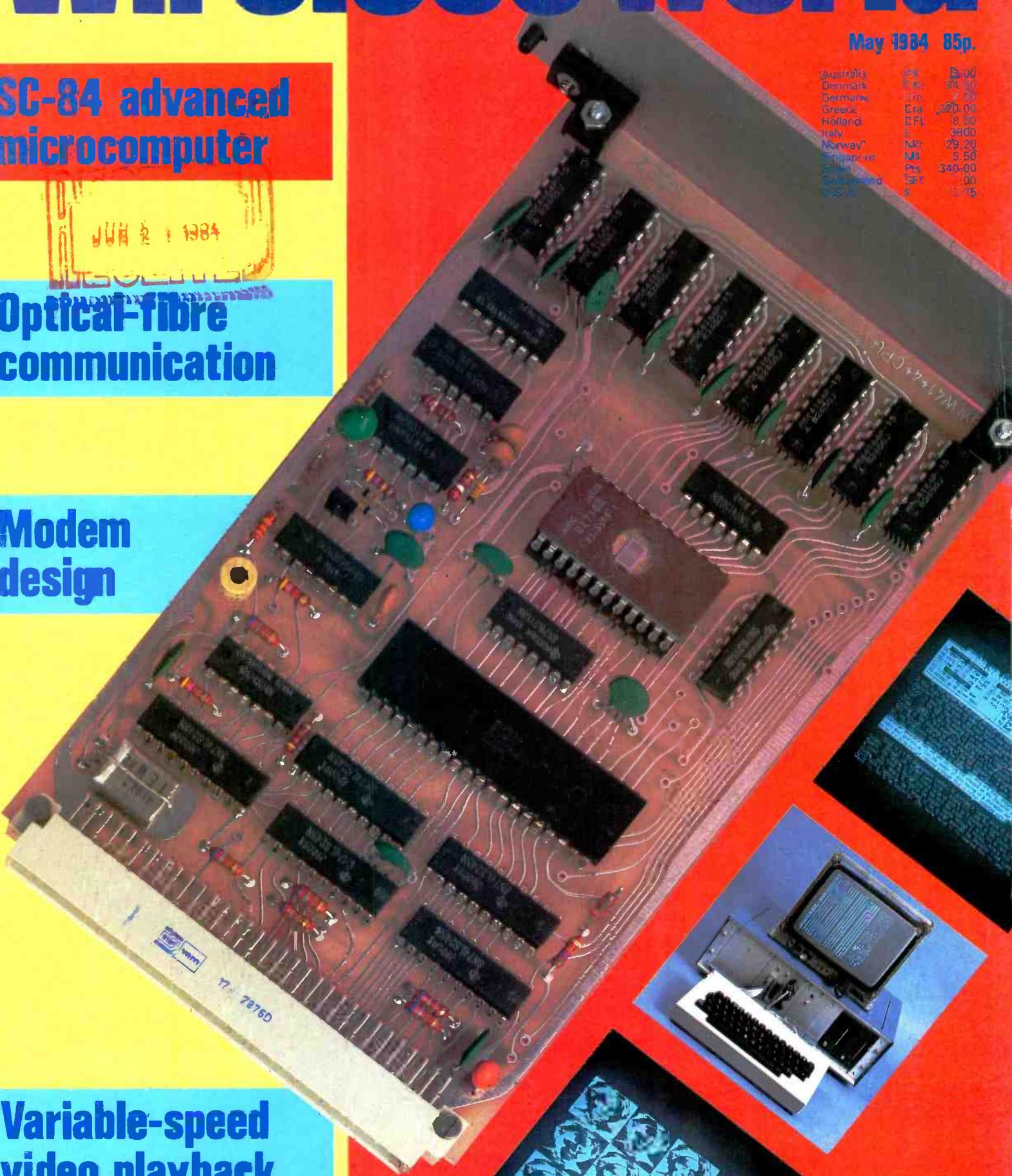


Optical-fibre communication

Modem design

Variable-speed video playback

Australia	£4	£2.00
Canada	Can	34.50
Denmark	Dm	7.00
France	Fra	220.00
Germany	DM	8.50
Greece	Gr	3600
Holland	Dfl	29.20
Italy	Lira	5.50
Japan	Yen	340.00
Norway	Nkr	0.00
Spain	Ptas	3.75
Sweden	Skr	
Switzerland	Sfr	
USA	\$	



Farnell Instruments have been active in the manufacture and marketing of bench power supplies for almost 30 years. The experience gained during this time, together with Farnell's philosophy of constant improvement and the introduction of new technology has culminated in the company's present position as the major U.K. supplier of bench power supplies.

Whatever your bench power supply needs, Farnell would welcome the opportunity to discuss them. The company believes that almost any requirement can be met from amongst its extensive range of unmetred and metred, bench and sub-bench, analogue or digital, single or multi-output power supplies.

bench power supplies



For your copy of our 1984 catalogue circle this magazine's reader response number ncw.

... from



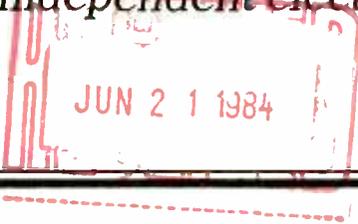
Farnell

FARNELL INSTRUMENTS LIMITED · SANDBECK WAY · WETHERBY · WEST YORKSHIRE LS22 4DH
TEL. (0937) 61961 · TELEX 557294 FARIST G

WW-001 FOR FURTHER DETAILS

ELECTRONICS & Wireless world

over 70 years in independent electronics publishing



FEATURES

27

Pausaid

by P. J. Pickersgill and N. J. Stewart
WW design competition second prize winner helps to counter dysarthritic speech. Full circuit details.

37

SC84 microcomputer

by John Adams
A new design for engineers and enthusiasts, SC84 uses a 6MHz Z80 and has 64K bytes of ram.

59

Multi-standard modem

by R. Lambley
Introduction to the design of a universal single-chip modem. Describes transmission of data by telephone.

29

ZX81 generation and measurement interface

by J. Skinner
Circuits and programs for timing, signal generation and frequency measurement.

41

Fibre optic communications

by Brett Wilson
First of three articles. Part 1 deals with optical fibres and waveguide transmission.

62

Information society

by A. E. Cawkell
A. E. Cawkell's reappraisal of the interaction between technology and society.

33

Improving colour tv decoding

by D. C. A. Read
Countering the loss of h.f. luminance that can happen in decoder i.cs.

55

Variable-speed video playback

by J. R. Watkinson
A combination of servo head-tracking and digital timebase correction allows wide range of playback speeds.

69

Roots of relativity

by W. A. Scott Murray
The author of our recent 'Heretics Guide' draws attention to one of Einstein's rare, but important, mistakes.

REGULARS

6

Comment

7

News

World Telecommunications Day, laser v.l.s.i. etching, video discs in training



47

Communications

G.C.H.Q. Cheltenham, tv hazards, cable and stereo tv

49

Letters

Current-dumping amplifiers, colour-coding

52

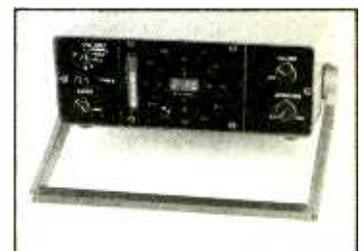
Circuit ideas

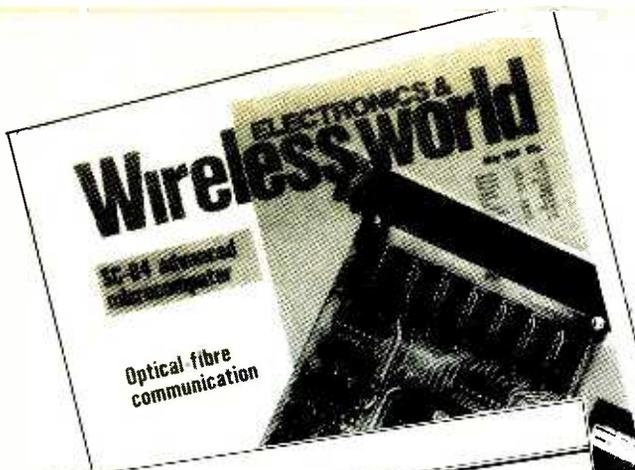
Combination lock, universal crystal oscillator, simple music synthesizer

77

New products

Microcontroller, p.c.b. - c.a.d., compact direction finder





Front cover shows first board to be described — the processor/memory — in John Adam's series on the SC84 micro.

NEXT MONTH

Computer cassette recorder

A. J. Ewins describes the control electronics for a solenoid-operated cassette deck, which can therefore be used in an automatic SAVE and LOAD mode, commanded from the 8-bit parallel port of a microcomputer.

Modem

Richard Lambley details the design of the WW multi-standard modem, for which printed boards will be made available.

Cellular radio

A report on the current situation in this up-and-coming field of communications

Current issue price 85p, back issues (if available) £1.06, at Retail and Trade Counter, Units 1 & 2, Bankside Industrial Centre, Hopton Street, London SE1. Available on microfilm; please contact editor.

By post, current issue £1.30, back issues (if available) £1.40, order and payments to EEP Sundry Sales Dept., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Tel.: 01-661 3378.

Editorial & Advertising offices: Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Telephones: Editorial 01-661 3614. Advertising 01-661 3130. See leader page. **Telex:** 892084 BISPRSG (EEP) **Subscription rates:** 1 year £15 UK and £19 outside UK. **Student rates:** 1 year £10 UK and £12.70 outside UK.

Distribution: Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Telephone 01-661 3248. **Subscriptions:** Oakfield House, Perrymount Road, Haywards Heath, Sussex RH16 3DH. Telephone: 04444 459188. Please notify a change of address. **USA:** \$49.40 surface mail, \$102.60 airmail. Business Press International (USA). Subscriptions Office, 205 E. 42nd Street, NY 10017.

USA mailing agents: Expeditors of the Printed World Ltd, 527 Madison Avenue, Suite 1217, New York, NY 10022, 2nd class postage paid at New York. © Business Press International Ltd 1984. ISBN 0043 6062.

Editor
PHILIP DARRINGTON
01-661 3128

Deputy Editor
GEOFFREY SHORTER, B.Sc.
01-661 8639

Technical Editor
MARTIN ECCLES
01-661 8638

Projects Editor
RICHARD LAMBLEY
01-661 3039

News Editor
DAVID SCOBIE
01-661 8632

Drawing Office Manager
ROGER GOODMAN
01-661 8690

Technical Illustrator
BETTY PALMER

Advertisement Manager
BOB NIBBS, A.C.I.I.
01-661 3130

BARBARA MILLER
01-661 8640

ASHLEY WALLIS
01-661 8641

Northern Sales
HARRY AIKEN
01-661 8861

Midland Sales
BASIL MCGOWAN
021-356 4838

Classified Manager
BRIAN DURRENT
01-661 3106

IAN FAUX
01-661 3033

Production
BRIAN BANNISTER
(Make-up and copy)
01-661 8648

Publishing Director
DAVID MONTGOMERY
01-661 3241

The list of International Agents and the Advertisers Index can be found at the back of the issue.

PAUSAID

Pausaid

This low-cost speech training aid won second prize in Wireless World's recent design competition. It offers help to a large number of people with moderate speech impairments.

by P.J. Pickersgill
B.Sc. and
N.J. Stewart
B.Sc.

by A.E. Cawkell

The information society

SPECIAL FEATURE

SC84 Micro-computer

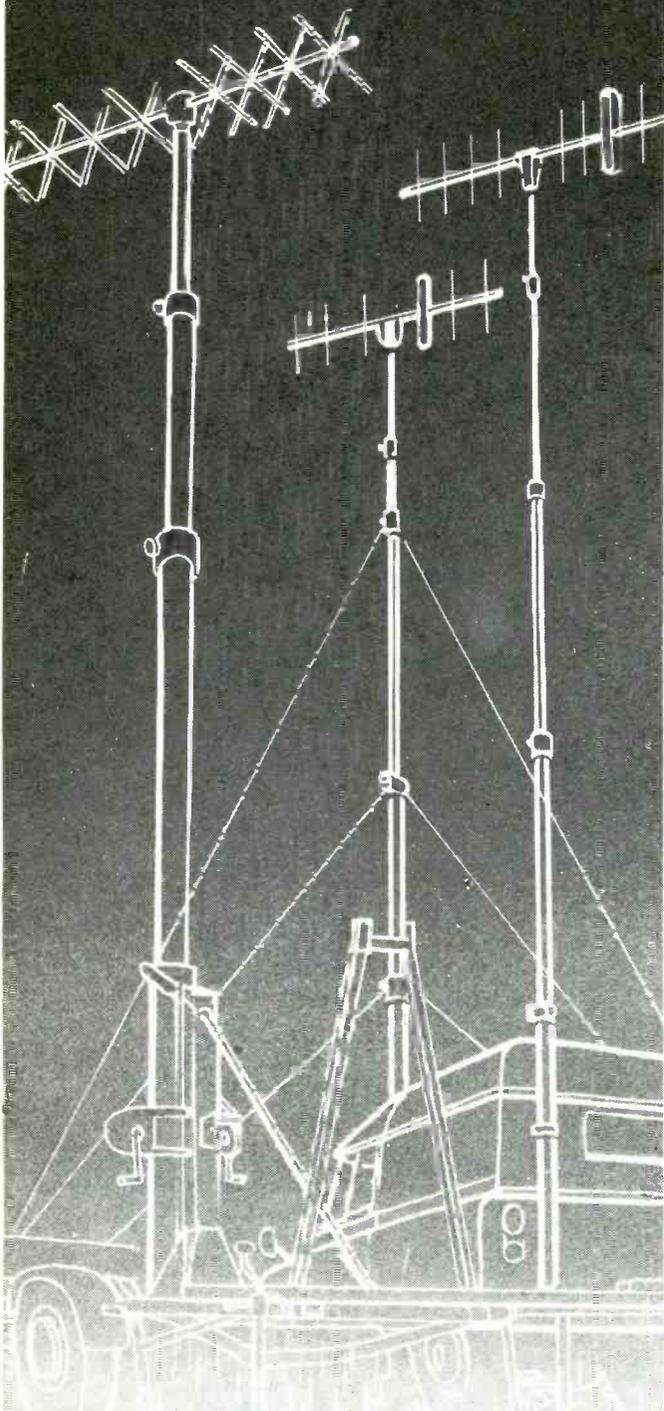
Designed for engineers and enthusiasts, the SC84 microcomputer uses a 6MHz microprocessor and has 280 bytes of ram — but its main feature is that it can be used with a disc operating system and much readily available applications software.

by J. H. Adams

SC84 Processor
Display
Input/output

TELESCOPIC MASTS

Pneumatically operated telescopic masts.
25 Standard models, ranging from 5 metres
to 30 metres



Hilomast Ltd

THE STREET HEYBRIDGE — MALDON
ESSEX CM9 7NE ENGLAND
Tel. MALDON (0621) 56480
Telex No. 995855

CIRCLE 014 FOR FURTHER DETAILS.

E.M.S. POWER SYSTEMS



Solve all your Power Problems by contacting
E.M.S.

E.M.S. specialise in systems to eliminate your
power problems.

Products range from 35VA switched square wave
Power Packs to 1KVA fully uninterruptible sine
wave systems.

E.M.S. also manufacture chargers which range up
to 60 amps.

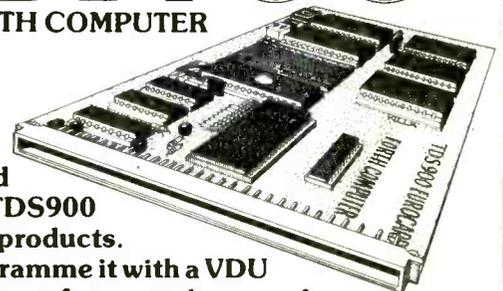
For further details please contact:

E.M.S. Manufacturing Limited
Chairborough Road
High Wycombe
Bucks
Tel: (0494) 448484

CIRCLE 007 FOR FURTHER DETAILS.

TDS900

FORTH COMPUTER



**Build
the TDS900
into products.
Programme it with a VDU
and your forecasts become fact.**

Software costs are significant in all industrial applications of microprocessors. They cannot be amortised over the large quantities associated with personal computers and electronic games. This C-MOS embedded computer card aims at resolving this problem by including FORTH high level language programming and developmental facilities. The software can be written quickly and made to work correctly at lowest possible expense. Using a high level programming language rather than assembler gives a fast reaction time to market opportunities. Production products use the same board as employed in the prototypes.

No microprocessor development system is needed since the card contains a screen editor working with simple visual display units (VDUs). It also has the compiler for the FORTH source code. Debugging is inherent in the FORTH language and once the code is working, this can be output to a PROM programmer.

Use of C-MOS throughout has brought the power consumption down to 28mA, making the TDS900 especially suitable for portable and battery-driven applications.

Triangle Digital Services Limited
100a Wood Street, Walthamstow, London E17 3HX Tel: 01-520 0442
Visitors to our laboratories are welcome by appointment.

CIRCLE 009 FOR FURTHER DETAILS.

WIRELESS WORLD MAY 1984

Are you as fast as a bullet?

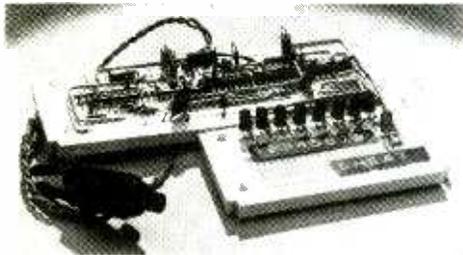
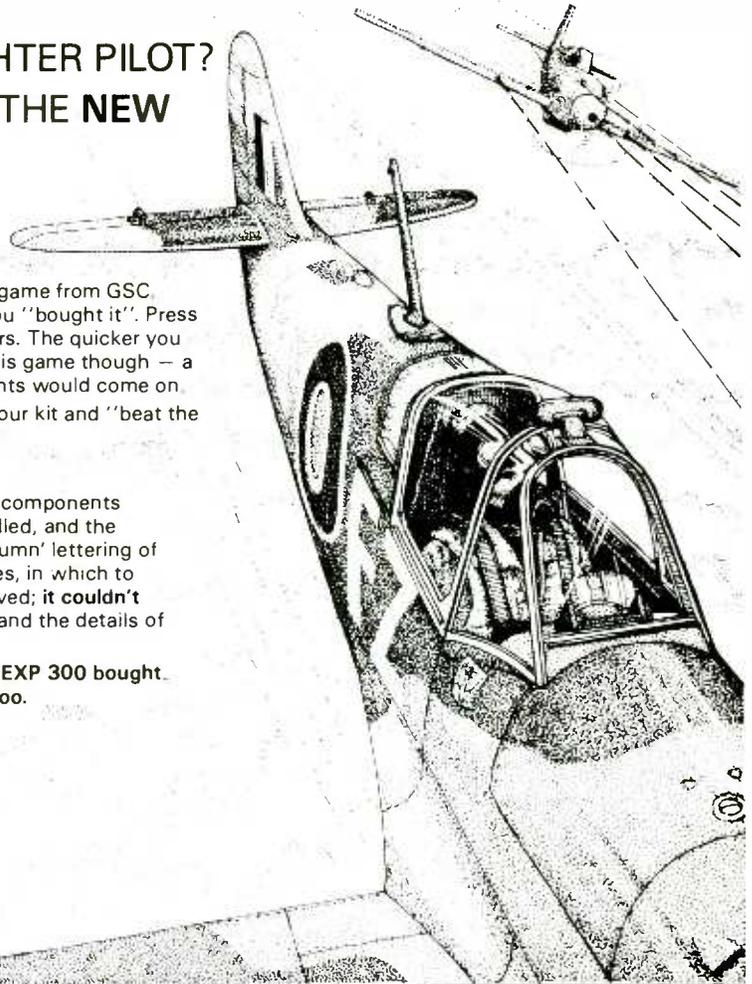
WOULD YOU HAVE MADE A FIGHTER PILOT?
NOW YOU CAN FIND OUT WITH THE NEW
REACTION TESTER
A FREE PROJECT FROM GSC

Split second timing is essential for this, the latest and fastest game from GSC. Find out how long you could have stayed "upstairs" before you "bought it". Press start switch, after a random time period, a moving light appears. The quicker you press the button, the longer you "stay alive". You can't fool this game though — a "cheat" light will tell everyone that you guessed when the lights would come on. Speed and concentration are the names of this game — build our kit and "beat the bullet".

HOW DO YOU MAKE IT?

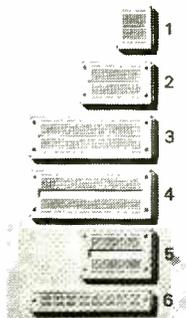
Our **FREE** project sheet gives you a large, clear diagram of the components layed out on an **EXP 300** breadboard. Each component is labeled, and the values are given in a component listing. Even the 'row and column' lettering of our **EXP 300** is shown to make the location of the correct holes, in which to push the components, easy to find. There's no soldering involved; **it couldn't be easier!** As an extra bonus, there's a full circuit description, and the details of a regulated power supply on the other side of the sheet.

"Clip the coupon" and get your **FREE** project sheet with each **EXP 300** bought. **AND** a free catalogue! Just ask about our other free projects too.



EXPERIMENTOR BREADBOARDS

The largest range of breadboards from GSC. Each hole is identified by a letter/number system. **EACH NICKEL SILVER CONTACT CARRIES A LIFE TIME GUARANTEE.** Any Experimentor breadboard can be 'snap-locked' with others to build a breadboard of any size.



1. **EXP 325 £2.25** The ideal breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22 pin ICs. Has 130 contact points including two 10 point bus-bars.
2. **EXP 350 £3.80** Specially designed for working with up to 40 pin ICs perfect for 3 & 14 pin ICs. Has 270 contact points including two 20 point bus-bars.
3. **EXP 300 £6.50** The most widely bought breadboard in the UK. With 550 contact points, two 40 point bus-bars, the EXP 300 will accept any size IC and up to 6 x 14 pin DIPS. Use this breadboard with Adventures in Microelectronics.
4. **EXP 600 £7.95** Most MICROPROCESSOR projects in magazines and educational books are built on the EXP 600.
5. **EXP 650 £4.75** Has 6" centre spacing so is perfect for MICROPROCESSOR applications
6. **EXP 4B £2.75** Four more bus-bars in "snap-on" unit.

PROTO-BOARDS

The ultimate in breadboards for the minimum of cost. Two easily assembled kits.

7. **PROTO-BOARD 6KIT £12.00** 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips.
8. **PROTO-BOARD 100 KIT** Complete with 760 contacts accepts up to ten 14-pin Dips, with two binding posts and sturdy base. Large capacity with kit economy



"Clip the coupon" and get your **FREE** project sheet with each **EXP 300** bought. **AND** a free catalogue! Just ask about our other free projects too.

For further details of our **FULL PROTO-BOARD RANGE**, please send for our free catalogue.

GLOBAL SPECIALTIES CORPORATION



G.S.C. (UK) Ltd. Dept. 7J8
Unit 1, Shire Hill Industrial Estate,
Saffron Walden, Essex CB11 3AQ
Telephone: Saffron Walden (0799) 21682

G.S.C. (UK) Limited Dept 7J8 Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ
Price include P & P and 15% VAT

1	QTY.	2	QTY.	3	QTY.	4	QTY.	5	QTY.	6	QTY.	7	QTY.	8	QTY.
	£3.45		£5.23		£8.63		£10.29		£6.33		£4.03		£14.95		£20.07

Name _____ Address _____

I enclose Cheque/P.O. for £ _____ or debit my Barclaycard/Access/American Express card no. _____ expiry date _____

FOR IMMEDIATE ACTION - The G.S.C. 24 hour, 5 day a week service
Telephone (0799) 21682 and give us your Barclaycard, Access, American Express number and your order will be in the post immediately

For **FREE** catalogue tick box

CIRCLE 048 FOR FURTHER DETAILS.

Plus ça change

Once in a while, the appearance of *Wireless World* changes a little as fashions in typography and layout evolve. In recent times, the changes have been somewhat tentative — a bold-face heading here, a rule here and a bit of unjustified typesetting (meaning ragged, not unnecessary) somewhere else. It is even possible that they have been so slight that not many readers have noticed, and also possible that uncoordinated, small changes here and there led to a style which did not hold together as well as it might have.

With that in mind, our designers and editorial people decided that the moment was right for a full-blooded effort, starting from scratch, to make the journal more attractive to

the eye, since recent printing and production charges have made possible the introduction of colour and rather better paper. The new layout of pages is a great deal more in line with the best of current practice than was the earlier style and is, we think, fresher and visually more appealing.

Content is unchanged, except insofar as it is continually changing as the subject moves forward: computing, for example, occupies much more space than it did even five years ago. But the well-established features remain, and will do so long as readers want them.

One result of adopting the new style is that the familiar 'perfect-bound' method of making the issue has gone,

and is replaced by 'saddle-stitching', which also means that advertisements tend to appear in unfamiliar places in the page make-up — part of the price one has to pay for the use of colour in editorial pages.

We hope you like the new appearance, which is celebrated by the first part of a description of John Adams' new computer. His first design, the Scientific Computer, was extremely successful and this new development is similarly advanced, being disc-based and running a good deal of CP/M software. The new WW multi-standard modem also starts this month — the second design by Richard Lambley to emerge from our laboratory.

Pirate chips

Encouraged by the successful tests of Plymouth Poly's ingenious satellite tv system, research teams in *Wireless World's* laboratory block are pressing ahead with their own plans for broadcasting in the 1990s. One promising idea now under development may help do away with the ubiquitous radio pirates of which the IBA complains.

Our researchers note that the three or four pop pirates audible most evenings hereabouts are virtually indistinguishable in style and content: a needless duplication which is wasteful both of human effort and spectrum space.

To replace it, they propose a new national pop radio channel; possibly, for economies of scale, even a pan-European one. This could be distributed by satellite or perhaps as a subscriber on an existing network.

At the listener's end would be an intelligent receiver, designs for which are already at an advanced stage. Fitted inside each one would be a speech synthesiser chip which, on receipt of encoded cues from the network, would fill gaps here and there in the spoken announcements with brief contributions of its own.

Equipped with a suitably

programmed eeprom, the device would draw upon a large repertoire of local place-names which it could slot into record requests and motoring flashes. With a few station ident jingles, and the addition of heavy audio compression over all, the illusion of a real local radio station would be complete.

The idea seems to have something in it for everyone. In

those underprivileged regions which don't at present have their own d.j.s, listeners would (for the price of an eeprom) be able to feel the sense of local identity now enjoyed by the more fortunate. And the former pirates themselves would be spared the hazards of possible prosecution — slight though these appear to be. Any takers?

Long queue for the QL

Once again, Sinclair Research has failed to deliver a product when promised. At a champagne breakfast launch, at which the QL computer was extensively demonstrated, Sir Clive assured us that *this* time there would be no delays and that the computer would be available to mail-order purchasers 'towards the end of February'. Unfortunately the production of the QL hit a few snags. 'Bugs' have to be eliminated and this has led to the usual delays which could add four or five months to the promised date for delivery.

By launching a product when it is *nearly* ready, a manufacturer hopes to steal a march on competitors who may also be ready to launch new products. Such 'jumping the gun' is not new in the computer industry. It has

been known for main-frame manufacturers to launch an empty box with an impressive specification and then spend the next few months attempting to meet that specification, if sufficient interest is shown by potential customers. But in the case of a personal computer like the QL, we would have thought it important to have the product ready before launch. No doubt, when it does come, the computer will be as impressive as it seemed to be, but the delays lead to a large number of disappointed customers and leaves an impression that we have all been taken in by the undoubted charisma of Sir Clive, and that gives the champagne a nasty taste. Incidentally, has anyone seen a Sinclair miniature, flat-screen tv recently?

World Telecommunications day

Telecommunications:

Expanding Horizons is the theme chosen by the International Telecommunications Union for the 16th World Telecommunications Day to be held on 17th May. The day marks the foundation of the ITU which is now 119 years old. In his annual message, Richard E. Butler, Secretary-General of the ITU, praised the success of World Communications Year (1983) which combined many of the abilities of operators, manufacturers and users of telecom systems and pointed out that many nations were retaining their national committees set up for WCY so that the work may be continued.

The improvement of communications in under-developed countries has been a particular concern for the Union as it is believed that telecommunications can play a key role in development. Mr. Butler points out that 90% of all services are confined to about 15% of the world's nations.

Studies carried out by the ITU and the OECD have shown that rural communities, which had been steadily dwindling, could remain viable if they had the means of communication. This does not only apply to the 'Third World'; poorer parts of the United States became more prosperous when telephone services were installed under the Rural Electrification Administration, instituted nearly 40 years ago. Telecommunications can contribute to the amelioration of rural conditions by improving the social environment.

Such improvements come not only from improved living conditions but also from reducing the feeling of isolation felt by many rural inhabitants. Communications channels also work the other way and can inform urban dwellers of the conditions in the country and perhaps give them the will to improve them. Other spin-offs include improvements in conservation and better use of energy, in reduced transportation costs through the provision of telecommunications, for example.

Optical-fibre cables and satellite links will further improve rural communications. On the subject of the use of satellites, Mr Butler maintains that at present they are chiefly used for high capacity trunk circuits which could probably be better served by ground-based links and relays, especially high-capacity digital fibre-optic trunk lines including trans-oceanic links. Over the long term, he says, there are only three major areas that will always be better served by satellite communications than by any other means: aircraft, ships and rural areas.

Satellite communications are by their very nature distributed. It is much more economical to install an earth station in a rural

community than to lay down a cable and one or a few channels in each village is much better than large numbers of facilities in fewer locations. The advantages of such satellite communications will become more pronounced as appropriate satellites and earth stations become available.

In brief

Ambit International, component suppliers to industry and especially to the home construction hobbyist, have moved to Park Lane, Broxbourne, Herts, though it will be retaining a sales counter at its former Brentwood home.

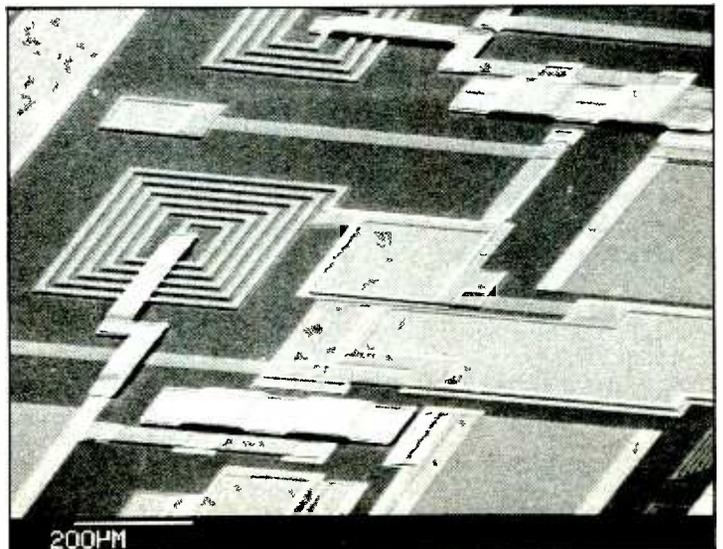
Laser etching — a path to bigger i.cs

A new process, using a laser instead of the conventional photo resist, has been developed for the production of v.l.s.i. circuits by Toshiba in Japan. Scientists at the R & D centre, who were working on the use of lasers as a means of reducing radiation damage caused by the etching radiation, discovered that an etching phenomenon occurred when u.v. light was radiated onto a silicon wafer in chlorine gas. Based on this discovery, they subsequently demonstrated that a excimer (excited dimer) laser beam directed at a silicon wafer could etch the surface accurately without the usual photo-resist mask. The laser used is a chlorine xenon gas tube with a wavelength of 308nm. The phenomenon is believed to occur when chlorine molecules are decomposed into chlorine atoms by the action of the short wave laser beam. The chlorine atoms attach themselves to electrons freed from the silicon surface by the laser radiation. The silicon reacts to these chlorine ions to produce a silicon-chlorine gas thus etching away at the surface.

This process will enable Toshiba to reduce the number of pattern forming steps from seven to one and ensure that damage caused by the etching and pattern forming process itself is eliminated.

Toshiba expects that when the process becomes operational "within a few years", it will make possible a major advance in precision processing of wafers and will have a great influence on the production of extremely large scale integration; a 16M bit memory has been mentioned. Fine-line engraving of 0.5 microns or below would become possible without the inherent danger of damage to the circuits caused by reactive ion etching. The expensive production equipment needed for resist coating, developing and resist removal in clean room conditions would all be eliminated.

Part of a gallium arsenide microcircuit for microwave applications, showing integrated inductors with bridge connections. Because of the particular suitability of GaAs i.cs for microwave circuits including satellite communications, Plessey, who supplied the picture, are to mass-produce such circuits. Up to now they have only been made in small batches.



Software course for teachers

The second pack in the Open University's *Micros in Schools* project is a training program for teachers which discusses software design and helps them to select the best programs from those available commercially. The course is intended for those teachers experienced enough to connect up a computer and run a fairly complex program. The first OU pack on educational computers, *Awareness*, would bring a user up to this level. The course requires some 40 to 50 hours' study and is suitable for both primary and secondary school teaching.

The pack starts by showing how a small Logo program is constructed and how the user can modify its operation and make short procedure calls. Educational programs are discussed, including simulations, models and

information retrieval programs; drill and practice; adaptive programs and intelligent systems.

This leads to a critical analysis of three commercially published computer-assisted learning packages so that the teacher can understand the qualities that make good software good.

Educational Software includes a study book, activities book and course reader, programs on disc and three commercial packages. There is also an audio cassette.

Version of the course are available for Apple II, which includes an offer for a generous discount on Apple Logo; and for the RML 380Z which includes its own RML Logo. Versions for the RML 480Z, the ZX Spectrum and the BBC model B computers are being prepared. Details from *Micros in Schools Project*, Open University, Milton Keynes.

Walter Tusting Cocking

It is with much regret that *Wireless World* announces the death at the age of 77 of Walter Tusting Cocking, C. Eng., MIEE.

Walter Cocking was first associated with the journal in the early '30s when, as a young experimenter, he developed a number of wireless circuits. He first worked as a freelance experimenter and writer and later he was invited to use the *Wireless World* laboratory facilities. Shortly afterwards, he became a full-time member of staff. In the days before the second world war, he established his reputation as a first-class engineer with an eye for detail and an ability to convey his developments in a concise and easy-to-understand manner.

Before the existence of an electronics industry and supporting component

manufacturers, it was his contention that we should publish nothing unless the constructor could make all the special parts himself. Thus, when he developed and published the first constructional articles for television, he gave precise instructions how to wind the scan coils, first having made the flared winding mandrel out of blocks of wood. Such was the quality of his engineering.

At the outbreak of war, he had already published a number of books, including his definitive work on television, *Television Receiving Equipment*. Not surprisingly, he was 'co-opted' into the army, where he was involved in secret work on military projects throughout hostilities. He never discussed this work, even years later. He liked to tell the story of coming back to Dorset House, the home of *Wireless World*, years later, to be greeted by the newspaper seller at the door with 'Evening Standard as usual sir?'. The equally undramatic Cocking simply said 'thank you'.

In the post-war era, with the editor (H. S. Pocock and later F. L. Devereux) Walter Cocking made an enormous contribution to *Wireless World*, helping to maintain and improve the engineering standards and integrity of the journal. Pursuing his goal of excellence in engineering, he developed an audio amplifier using triode valves in push-pull (PX4s) that preceded the famous Williamson amplifier.

Whilst continuing to provide constructional articles and other more theoretical material, he edited the famous *Wireless Engineer*. Under his editorship, this achieved such a reputation for quality and integrity that a number of overseas universities accepted publication of a paper or thesis in it as being of appropriate standard to award the author a degree.

Later in his career, Cocking became editor-in-chief of *Wireless World* and of the successor to *Wireless Engineer*. He retired in 1972 but maintained constant contact through letters to the editor. A truly great technical journalist, Walter Cocking was a tremendous influence on all who worked with him and will be sadly missed. TJB

Interactive video discs for union education

It can't be very often that a trades union gets a pat on the back from a Conservative minister. Such however is the case when the Electrician's Trades Union installed an interactive video disc player in their Union Training College at Cudham. The system is to be used to train union members in microelectronic technology and the system is to be developed jointly by the union and Epic Industrial Communications with the Department of Industry providing two-thirds of the £150 000 costs. The union and Epic will provide the balance and will market the system to industry and training institutions, next year.

At the announcement of the project, Kenneth Baker, Minister for Information Technology, said, "I am very pleased to see this project launched. A trade union, an enterprising British firm and an exciting new technology are working together in a way that should be a pattern for all".

The system will combine laser video discs with one or more microcomputers to produce a package of information

graphics. According to the Managing Director of Epic, Eric Parsloe, "The system will provide a low-cost solution to a major industrial training and productivity problem and should certainly give the UK a lead in Europe".

Frank Chapple, General Secretary of the Electrical, Electronic, Telecommunications and Plumbing Union, commented; "The EETPU is the only union to have its own training facility for running courses in new technology. Through this development the union has been able to offer a first class service that ensures that members are able to keep pace with developments in industrial technology and provide industry with the appropriate skills needed to install, commission and maintain modern plant and machinery. The joint development of the interactive videodisc learning system combines a training program on microelectronic technology with the very latest in teaching techniques and adds to the uniqueness of the union's programmes supplemented with computer-generated text and

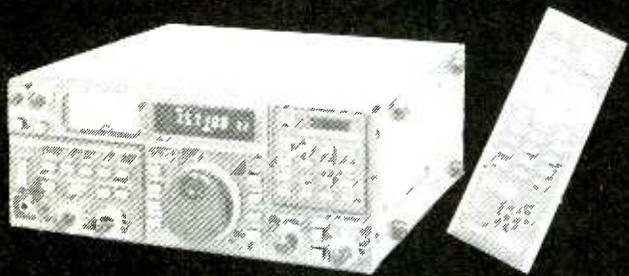
achievement".

The videodisc learning system will be able to illustrate difficult electronics concepts and will show industrial applications of installation, maintenance and repair. The disc will contain a mixture of still frames, sequences of operation with a voice commentary and live action sequences. The computer graphics will include circuit diagrams for fault diagnosis. The union will use the system to supplement their tutors and for self-paced student learning.

The hardware to be used has not yet been selected. One option is to combine a Phillips Professional Laservision player with a BBC model B micro, using the Microtext language but other approaches are also being considered.

Epic have produced other interactive video systems including a project for an electronic manual for Rolls Royce and a diagnostic disc on gastroenterology for a drugs company.

An ICOM remote-control receiver, it's what the wireless world's been waiting for.



The IC-R71E, latest HF receiver from ICOM, with remote control.

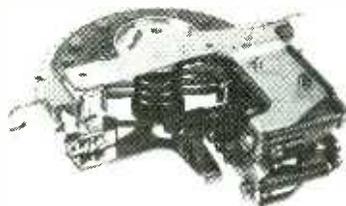


Thanet Electronics

143 Reculver Road, Herne Bay, Kent, England.
 Telex: 965179 Tel: (02273) 63859/63850

CIRCLE 040 FOR FURTHER DETAILS.

UNISELECTORS TYPE 2 SERIES



Uniselectors are designed to meet the requirements for mechanisms having long life and dependability. They are approved by British Telecom and used extensively by them.

Uniselectors can be supplied with double-ended wipers giving two appearances of 25 points per revolution. 4, 6, 8, 10 and 12 level uniselectors can also be supplied with single-ended wipers, connected in adjacent pairs which give 2, 3, 4, 5 and 6 complete circuits of 50 points per revolution respectively. Wipers may be bridging or non-bridging and can be adjusted for position on bank contacts independently of mechanism adjustments.

Also in stock: Miniature Uniselectors, 3000 Type Relays, Carpenter Polarised Relays, High Speed Relays, Transformers, 2000 and 4000 Type Selector Mechanisms, etc.

As one of the few remaining suppliers of Strowger components in the U.K. we would welcome your enquiries and look forward to discussing your needs.

Cynpex Ltd

Telecommunication component factors
 Unit 3, Argyle Way, Stevenage, Hertfordshire SG1 2AD
 Telephone (0438) 352497/352326. Telex 825617

CIRCLE 051 FOR FURTHER DETAILS.

MIDWICH

COMPUTER COMPANY LIMITED

RICKINGHALL HOUSE, HINDERCLAY ROAD, RICKINGHALL, SUFFOLK IP22 1HH. TEL. DISS (0379) 898751.

BBC Microcomputers

Model B	348 26
Model B + Disc Int	433 21

NB Credit cards are not accepted in payment for BBC Microcomputers

BBC Micro Econet

Full range of products available. Installation service available

BBC Compatible Disc Drives

Cased drives, finished to match the BBC Micro are supplied complete with connecting cables, manual and utilities disc

All single cased drives may be expanded to dual configuration by the addition of the appropriate uncased mechanism

Disc capacity	Single	Dual	Uncased
100K 40T	160 83	291 95	130 00
400K 40/80T D S	264 35	479 15	215 00

Trade/quantity discounts are available

BBC3 Disc Interface	84 95
---------------------	-------

Please send for our BBC Micro price list. Full range of accessories available

Memories

2114L-20	D1	0 92
4116-15	D2	1 05
4116-20	D2	0 88
4118-15	D1	3 75
4164-15	D2	4 33
4164-20	D2	3 95
4416-20	D2	6 60
4564-15	5 25	7 912
5516-25	7 73	7 915
6116-3	D1	3 72
6116-LP3	D2	4 67
2532-45	D2	3 50
2708-45	D2	3 25
2716-35	D1	4 50
2716-45	D1	3 50
2716-3	D1	4 50
2732-35	D1	4 58
2732-45	D1	3 75
2764-30	D1	3 92
2764-250NS TT	3 92	
2764-250NS BBC	5 95	
2564-30	D2	6 00
27128-30	D2	24 50

Buffers

81LS95	0 95
81LS96	0 95
81LS97	0 95
81LS98	0 95
8T26A (6880AP)	0 78
8T28A (6889)	0 78
8T95 (6885)	0 78
8T97A (6887)	0 78
8T98 (6888)	0 78

Data Converters

ZN435	D1	3 70
UPD7002	D1	4 65
ZN425E-8	D1	3 13
ZN426E-8	D1	1 67
ZN427E-8	D1	5 75
ZN428E-8	D1	4 38
ZN429E-8	D1	1 33
ZN432C-10	D1	25 98
ZN432E-10	D1	10 88
ZN433C-10	D1	20 98
ZN440	D1	47 43
ZN447	D1	6 70
ZN448	D1	5 75
ZN449	D1	2 35
ZN441	D1	40 32

Crystals

A111B 1MHz	4 22
A112A 1 008MHz	3 42
A113A 1 8432MHz	2 88
A116A 2 4576MHz	2 88
A169A 3 6984MHz	1 55
A120B 4MHz	0 85
A132A 6MHz	0 72
A140A 8MHz	1 00
A173A 9 8304MHz	1 40
A182A 19 6608MHz	2 07

UHF Modulators

UM1111 6MHz	2 17
UM1233 8MHz	3 25

Floppy Disc Controllers

8271P	53 33	
FD1771P	D5	21 25
FD1791	D6	17 00
FD1793	D6	17 00
FD1795	D6	24 33
FD1797	D6	24 33
WD1691	D2	12 00
WD2143 01	D2	7 90

Prices: all prices

exclude V.A.T. and carriage. Please add these to your order.

All prices correct at time of going to press.



6500 Family

6502	D3	4 40
6502A	D3	4 67
6520	D1	2 67
6520A	D1	2 80
6522	D5	3 47
6522A	D5	4 40
6532	D2	5 33
6532A	D2	5 87

Linear & Interface Devices

6402	6 00	
AY3-1015	D2	2 92
AY3-1270	6 50	
AY3-8910	D6	4 48
AYS-3600	D2	7 37
DP8304	D1	1 92
L203	0 80	
LF398	3 17	
LM301AN	0 24	
LM308AN	0 73	
LM308N	0 47	
LM311N	0 84	
LM319	2 23	
LM324N	0 32	
LM339N	0 37	
LM348N	0 53	
LM358N	0 28	
LM359N	0 34	
LM725CN	1 33	
LM741CP	0 18	
LM747CP	0 48	
LM748CP	0 22	
MC1413P	D1	0 66
MC1416	D1	0 66
MC1458CPL	0 26	
MC1495L	7 13	
MC1498P	0 65	
MC1723P	0 32	
MC3242A	5 25	
MC3302P	0 40	
MC3340P	1 97	
MC3357P	1 56	
MC3423P	0 67	
MC3441AP	2 40	
MC3446AP	D1	2 40
MC3447P	3 58	
MC3448AP	D1	3 32
MC3470P	5 23	
MC3480P	D5	6 47
MC3487P	D1	1 50
MC14411	D1	8 52
MC14412	11 87	
NE555P	0 19	
NE556CP	0 45	
RO3-2513L	D1	7 82
RO3-2513U	D1	7 82
SN75107BN	0 58	
SN75110AN	0 68	
SN75150P	0 72	
SN75154N	0 87	
SN75159N	1 19	
SN75160AN	2 15	
SN75161AN	2 35	
SN75162AN	3 31	
SN75172NG	1 64	
SN75173N	1 21	
SN75174	1 64	
SN75175	1 21	
SN75182	0 62	
SN75183	0 62	
SN75188	0 44	
SN75189	0 44	
SN75451BP	0 24	
SN75452BP	0 24	
SN75453BP	0 24	

SN75454BP	0 24
SN75468N	1 08
SN75491AN	0 46
SN75492AN	0 61
TL010CP	0 38
TL061CLP	0 28
TL062CP	0 47
TL064CN	0 89
TL066CP	0 28
TL071CP	0 28
TL072CP	0 47
TL074CN	0 91
TL081CP	0 24
TL082CP	0 41
TL084CN	0 85
TL091CP	0 41
TL092CP	0 60
TL094CN	1 37
TL487CP	0 55
TL489CP	0 55
TL494CN	1 66
TL496CP	0 30
TL507CP	1 02
ZN450E	5 25
ZN451E	6 38
ZN451KIT	25 65

DIL Sockets

Pin	Tin	Gold	W/W
8	0 10	0 24	0 58
14	0 12	0 28	0 77
16	0 13	0 32	0 86
18	0 16	0 32	1 08
20	0 17	0 41	1 23
24	0 17	0 48	1 31
28	0 20	0 63	1 44
34	0 23	0 57	1 59
40	0 33	0 99	1 96

ZIF Sockets

24 Pin	5 80
28 Pin	6 35
40 Pin	8 45

Data sheets are available on items marked D

Prices are as follows
 D1 0 75 D5 2 50
 D2 1 00 D6 3 00
 D3 1 25 D7 4 00
 D4 2 00

A full range of the following products is carried in stock and is listed in our FREE catalogue

- * 74LS Series TTL
- * 4000 Series CMOS
- * TTL Bipolar Memories
- * 9900 Series Micros
- * Crystals
- * IDC, Card Edge & D Type Connectors
- * Dip Jumpers
- * Monochrome & Colour Monitors (MFC & KAGA)
- * Euron Pin-headers & Ensets
- * Custom Cable Assemblies

SPECIAL OFFER SPECTRUM 32K UPGRADE KIT £24 95

Carriage: Orders up to £199 are sent by 1st class post and £200+ by Securair

0 £100 0.50 £100 £199 1 25 £200+ 5 00 by Securair

Prices quoted (+ carriage charges) are exclusive of VAT and are subject to change without notice

Quantity Discounts are available on many products, please enq for details

Official Orders are welcome from Education Establishments, Government Bodies and Public Companies

Credit Accounts are available to others subject to status. Payment is due strictly net by the 15th of the month

Credit Cards are accepted (Access and Visa) for telephone and postal orders and NO SURCHARGE is made

Out of stock items will follow automatically at our discretion, or a refund will be given if requested



SPECIAL TELEPHONE NUMBER FOR FAST, IMMEDIATE SERVICE, TELEPHONE YOUR ORDER TO: DISS (0379) 898751

For FREE CATALOGUE, post to Midwich Computer Company Limited, Rickinghall House, Hinderclay Road, Rickinghall, Suffolk IP22 1HH

Name _____
 Address _____
 Telephone _____



TYPE 9051



TYPE 9046

V MOS WIDEBAND LINEAR POWER AMPLIFIERS. 4 watts RF output. Without tuning. Power gain 10 dB. 24V+ supply

TYPE 9046 100 KHz.-100 MHz £84.50 + £3.50 p&p
TYPE 9051 20 MHz.-200 MHz £84.50 + £3.50 p&p



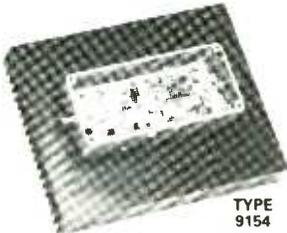
TYPE 9152



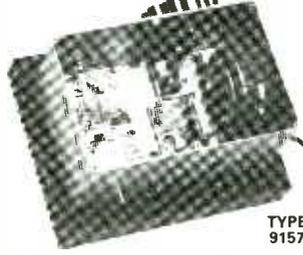
TYPE 9159

TELEVISION LINEAR POWER AMPLIFIERS. Tuned to your specified channels in bands IV or V

TYPE 9061 150 mV. input, 10 mW. output £120 + £5 p&p
TYPE 9152 10 mW. input, 500 mW. output £160 + 5 p&p
TYPE 9159 500 mW. input, 5 watts output £180 + £5 p&p



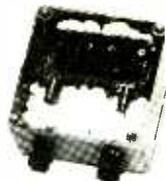
TYPE 9154



TYPE 9157

V MOS LINEAR POWER AMPLIFIERS. Tuned to your specified frequency in the range 10-250 MHz

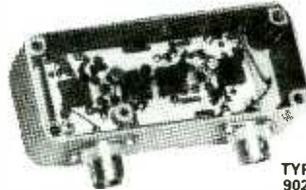
TYPE 9155 3 Watts input, 30 watts output £240 + £10 p&p
TYPE 9165 As above with integral mains power supply unit £320 + £15 p&p
TYPE 9086 FM TRANSMITTER 88-108 MHz. 50 watts RF output. 24V+ supply. Complete modular system £380 + £20 p&p
TYPE 9087 As above with integral mains power supply unit £460 + £25 p&p



TYPE 9010

TWO STAGE GASFET STRIPLINE PREAMPLIFIERS
Tuned to your specified channels in bands IV or V

TYPE 9002 Two stage Gasfet preamplifier. N.F. 0.7 dB. Gain 25 dB. High Q filter. 15V. + DC £85 + £2 p&p
TYPE 9004 UHF two stage Gasfet preamplifier. N.F. 0.6 dB. Gain 25 dB. Aligned to your specified frequency in the range 250-500 MHz. High Q filter. 15V. + DC £85 + £2 p&p
TYPE 9012 Gasfet preamplifier mains power supply unit £24.50 + £3 p&p
TYPE 9010 Masthead weatherproof unit £6.50 + £2 p&p



TYPE 9026



TYPE 9035

GASFET/MOSFET RF PREAMPLIFIERS. Aligned to your specified frequency in the range 30-250 MHz. Masthead/local use

TYPE 9026 N.F. 1.0 dB. Gain 10-40 dB. variable £49.50 + £2 p&p
TYPE 9026FM As above. Band II 88-108 MHz £49.50 + £2 p&p
TYPE 9006 Gasfet. N.F. 0.6 dB. Gain 10-40 dB. variable £65 + £2 p&p
TYPE 9035 Mains power supply unit for above types £24.50 + £3 p&p



TYPE 8034

TYPE 8034 PHASE LOCKED SIGNAL SOURCE using low frequency reference crystal. Specify output in the range 1-600 MHz. Output 10 mW. + 10 dBm £79.50 + £2 p&p
TYPE 9113 TELEVISION FREQUENCY CONVERTER. Changes channels in the range 40-1000 MHz £242 + £5 p&p
TYPE 9056 1500 MHz. PRESCALER. Divides 100-1500 MHz. by 10 £69.50 + £2 p&p

RESEARCH COMMUNICATIONS LTD.
UNIT 3, DANE JOHN WORKS, GORDON ROAD, CANTERBURY, KENT CT1 3PP
TELEPHONE: CANTERBURY (0227) 56489
PLEASE ADD 15% V.A.T. ON TOTAL

CIRCLE 049 FOR FURTHER DETAILS.

Affordable Accuracy – Low Cost Multimeters from Armon

SPECIFICATION HC 6010 DIGITAL

- ★ 10 Amp AC/DC
- ★ Battery: Single 9V PP3. Life: 200 hrs
- ★ Dimensions: 170 x 89 x 38mm
- ★ Weight: 400g inc. battery
- ★ Mode Select: Push Button
- ★ AC DC Current: 200µA to 10A
- ★ AC Voltage: 200mV to 750V
- ★ DC Voltage: 200mV to 1000V
- ★ Resistance: 200Ω to 20MΩ
- ★ Input Impedance: 10MΩ
- ★ Display: 3 1/2 Digit 13mm LCD
- ★ O/load Protection: All ranges
- ★ Accuracy: 0.5% DC Volts

28 RANGES, EACH WITH FULL OVERLOAD PROTECTION. BATTERY & TEST LEADS INCLUDED



HC 6010 £29.95



HC 1015 £7.95

ARMON ELECTRONICS LTD.

Dept "A", Cottrell House, 53-63 Wembley Hill Road Wembley, Middlesex HA9 8BH
Telephone: 01-902 4321 (3 lines). TELEX No. 923985

Please add 15% to your order for VAT. P&P free of charge. Payment by cheque with order. Offer applicable to mainland UK only.

TRADE ENQUIRIES INVITED. FULL RANGE OF METERS ON APPLICATION

SPECIFICATION HC1015 ANALOGUE

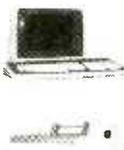
- ★ DC Voltage: 0.25, 2.5, 25, 250, 1,000 Volts, 10,000 Ohms/Volt
- ★ AC Voltage: 10, 50, 250, 1,000 Volts, 4,000 Ohms/Volt
- ★ DC Current: 1, 10, 500mA
- ★ Resistance: 0 to 1 MegOhm in 3 ranges
- ★ Decibels: -20dB to +62dB
- ★ Battery: One 1.5V size AA (incl)
- ★ Size & Weight: 105 x 63 x 32mm; 130gr

19 RANGES, COMPLETE WITH BATTERY AND TEST LEADS

Please allow 15 days for delivery.

CIRCLE 035 FOR FURTHER DETAILS.

Lynwood GD1 VDUs: Intelligent Green micro controlled, RS232, printer port, 101 key k/b. Full Video enhancements. ONLY £149 + £15 P&P (S/H)
Burroughs MT686/7/TD710: Intelligent Green 12" VDU with 3 micros and 64K store. RS232. Programmable. Only £199 new or £149 S/H + £15 P&P
Videocom Apollo VDUs: Stylish 15" Green Z80 controlled VDU with printer port and lots of very advanced features. Only £399 new or £249 S/H + £15 P&P
Centronics 306 Line printers: Professional fast (120 cps), superb quality, 80 column printer. Parallel i/f. ONLY £149 + £17.50 P&P
Computhink Act 800 Computer system. Dual floppies (2.4Mb) with Qume Sprint daisywheel and lots of business software ONLY £1,200
Diablo 630 Daisywheel printer. RS232, NEW £599 + £15 P&P.
Diablo Hitype 2 Daisywheel, Tractor unit, S/H £399 + £15 P&P



BECKENHAM PERIPHERALS LTD

Callers welcome by appointment

01-778 3600
124 Lennard Road, Beckenham Kent BR3 1QP

SAE for LIST and enquiries

CIRCLE 019 FOR FURTHER DETAILS.

RADFORD

Audio Measuring Instruments, Audio Amplifiers, Loudspeakers and Loudspeaker Components for the professional and enthusiast

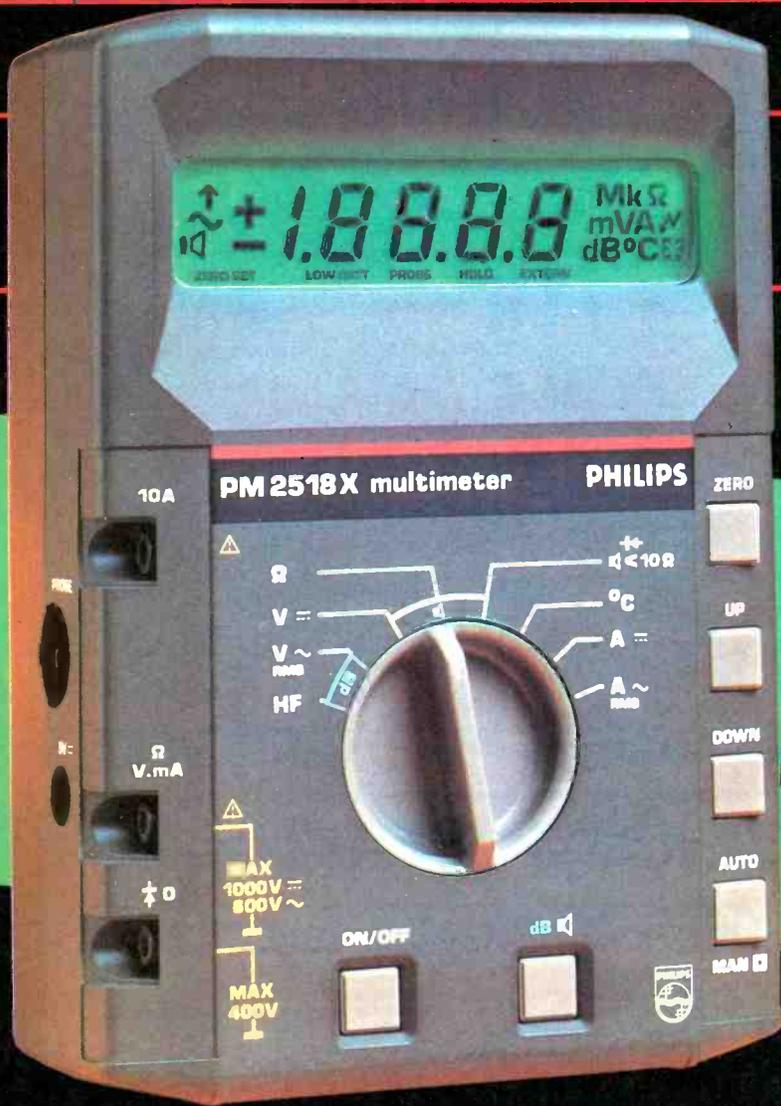
RADFORD AUDIO LTD.

10 BEACH ROAD
WESTON-S-MARE, AVON BS23 2AU

TEL. 0934 416033

CIRCLE 011 FOR FURTHER DETAILS.

Electronic Brokers



INTRODUCE THE
New
Generation
PM2518X
Portable
Multimeter with

**ELECTRO
LUMINESCENT
DISPLAY**

Electronic Brokers bring you the PM2518X — an exciting new development in electronic test and measuring. The PM2518X is a hand held digital multimeter with accuracy and performance equal to more expensive bench models.

An outstanding feature is the Electro Luminescent Display which automatically switches itself on in the dark — invaluable when taking readings in dimly lit areas.

The PM2518X also offers autoranging, 20 amp current range, true RMS measurements on AC voltage/current, extended 4 digit capability, dB/relative reference, and much, much more.

Contact Electronic Brokers today for the full facts on this amazing new multimeter.

£199 + VAT
Complete with Batteries.

Also available without Luminescent Display at £165 + VAT.

Electronic Brokers Ltd., 61/65 Kings
Cross Road, London WC1X 9LN.
Tel: 01-833 1166. Telex 298694



Electronic Brokers
A copy of our trading conditions can be supplied on request.

**5 YEAR
GUARANTEE**

Covering manufacturing defects.

Only at Electronic Brokers

CUBE JOBBER – the industrial computer

The CUBE Jobber is not so much a specific computer, but more an example of what can be done with the CUBE range of computer modules.



as illustrated:-

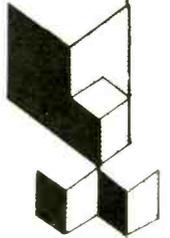
- Choice of 6809 or 6502 processors
- BBC BASIC option on 6502
- 8 KB of battery-backed RAM fitted
- Up to 64KB RAM optional expansion
- 24-column impact printer
- 24-character x 2 row liquid crystal display
- Centronics printer port
- 25-position keyboard, supplied blank white
- 19" enclosed rack, with power supply
- RS-422/423 serial port + 20-channel digital port

Alternatively, other modules from the CUBE range can be fitted, including video, memory, EPROM programming, floppy disk, digital and serial i/o, analog interface, micro development aids, and many more.

£718
ex. VAT

Send for free
catalogue to:

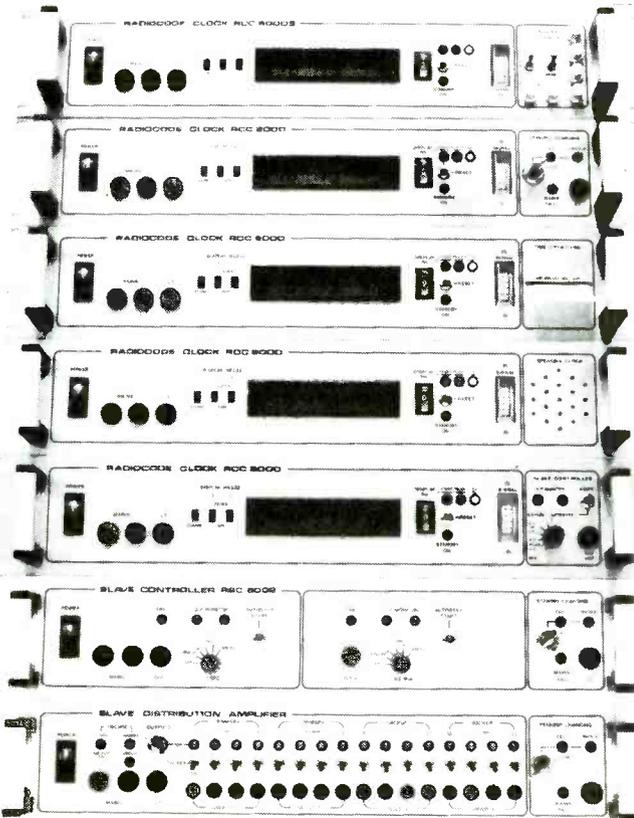
Control Universal Ltd
Anderson's Court
Newnham Road,
Cambridge CB3 9EZ
Tel 0223 358757 Telex 995801



CIRCLE 050 FOR FURTHER DETAILS.

RADIOCODE CLOCKS SOLVE PROBLEMS

ATOMIC TIME, FREQUENCY AND SYNCHRONISATION EQUIPMENT



NEW PHASE-MODULATION SYSTEMS

Until recently, atomic time and date information was only available on v.l.f. transmissions using amplitude modulation. The RCC 8000AM series of equipment uses these transmissions to offer high noise immunity and high accuracy, particularly at very long range.

The new RCC 8000PM series of equipment uses, for the first time, phase modulated transmissions with massive radiated powers of up to 2 Mega-Watts to offer long range, excellent noise immunity and no scheduled maintenance periods.

NEW PRODUCTS

The AM and PM series of Radiocode Clock equipment has been further expanded to include seven new models (from top) **8000S** – combined clock, frequency standard and optional stopclock. **Internal standby power supply** – with dual rate constant current charger. **Time-event log** – prints hours, minutes, seconds, milliseconds and day of year, on receipt of a log pulse. **Speaking clock** – time announcement or audio recording. **Slave controller** – total control of single-standard master/slave systems ie one pulse/sec. **Dual standard slave controller** – total control of two different and independent slave systems, ie. one pulse/sec and one pulse/half min. **Slave distribution amplifier** – maximum flexibility for the largest master/slave installations requiring dual standard operation, multiple circuits and complete master/slave backup.

NEW OPTIONS

A continuously expanding range of fully integrated software and hardware is available for both series of Radiocode Clock equipment. Standard options now include:

- IRIG B precision serial o/p
- RS232/V24 1mS resolution
- General purpose parallel o/p
- FSK record/replay system
- Keypad entry of alarm times
- Keypad entry of time/date
- Time code generators
- Intelligent slave systems
- Standard frequency outputs
- Stopclock operation
- Calibrated systems for increased accuracy

Radiocode Clocks Ltd*

Unit 19, Parkengue, Kernick Road Industrial Estate
Penryn, Falmouth, Cornwall. Tel: Falmouth (0326) 76007
(*A Circuit Services Associate Co.)

CIRCLE 023 FOR FURTHER DETAILS.

Electronic Brokers Ltd



*Authorised
Distributor*

FOR
Philips • Fluke
Hameg • Ice
Test Equipment

Full Colour Catalogue
Send for your free copy now



Philips PM3207 15MHz Oscilloscope £325
Compact, portable, lightweight oscilloscope designed for field and workshop use. 15MHz bandwidth with 5mV sensitivity. TV and auto triggering from either channel, with adjustable level. Add and invert facilities and X-Y mode. Large screen with internal graticule.



Hameg HM103 10MHz Oscilloscope £158
This small oscilloscope has been designed specifically for field service personnel and advanced electronic hobbyists. Single trace, 10MHz bandwidth with 2mV sensitivity. TV and auto triggering with adjustable level. Internal graticule and in-built component tester.



Philips PM3217 50MHz Oscilloscope £850
High 2mV sensitivity, dual trace, 8 x 10cm display with small spot size, high light output and illuminated graticule, auto trigger mode, TV triggering on line and frame. Full X-Y display facilities. Comprehensive second time base facility. Compact dimensions and low weight.
Philips PM 3215 Single time base £695



Hameg HM203-4 20MHz Oscilloscope £264
Designed for general purpose applications in industry and education. Versatile triggering performance to at least 40MHz. Dual trace X-Y operation, TV triggering, add and invert mode and component tester make the price/performance ratio of this scope most attractive.

Philips PM3219 Storage Oscilloscope £2675
Provides comprehensive, cost effective storage of single-shot transients and low frequency events. Variable persistence and variable storage. Auto erase between 1 and 10 seconds, and read button facility. Auto store up to 1 minute, up to 24 hours in 'baby sit' mode. 2mV sensitivity at 50MHz.



Hameg HM204 20MHz Oscilloscope £365
High performance scope with peak value triggering up to 50MHz. Versatile triggering facilities and variable hold off control. Dual trace, delayed sweep mode, Z modulation, X-Y operation, internal illuminated graticule and component tester complete the attractive specification.



Philips PM3256 75MHz Oscilloscope £1245
Tough, light-weight ruggedised unit, with shoulder strap, that can be used in harsh service environments. Fast trigger circuits to over 100MHz. TTL triggering is standard. Trigger view third channel and full X-Y display. Dual trace with 2mV sensitivity and delayed time base.
Philips PM 3254 Single time base £1145



Hameg HM605 60MHz Oscilloscope £487
Outstanding performance with versatile triggering to 80MHz. Sensitivity 1mV to 30MHz and 2mV above. Bright display from 14kV CRT. Switchable 1kHz/1MHz probe calibrator. Dual trace, delayed sweep, X-Y operation, Z modulation, internal illuminated graticule and component tester.

Philips PM3267 100MHz Oscilloscope £1250
Versatile and economic instrument designed for advanced electronic environments. Separate main and delayed time base controls with comprehensive triggering facilities and trigger view third channel. Dual trace, 2mV sensitivity, full X-Y display, Z modulation and internal illuminated graticule.

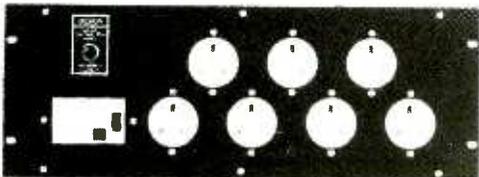


Hameg HM705 70MHz Oscilloscope £588
General purpose scope with multitude of operating modes and trigger facilities. Extremely bright and well defined displays, with 8 x 10 cm. screen and internal illuminated graticule. TV triggering, Z modulation, X-Y display facilities and sweep delay mode. Dual trace.



Electronic Brokers

ADD 15% VAT TO ALL PRICES. Carriage and Packing extra
**Electronic Brokers Ltd., 61/65 Kings Cross Road,
London WC1X 9LN. Tel 01-833 1166. Telex 298694**



**V
E
R
T
I
C
A
L**

HORIZONTAL OR

VERTICAL RANGE FROM 3-10 SOCKETS
ALL EX-STOCK!
SPECIALS TO ORDER

OLSON ELECTRONICS LIMITED



**WHEN
IT COMES
TO POWER
FOR RACKS
IT MUST BE OLSON**

5-7 LONG STREET LONDON E2 8HJ
TEL: 01-739 2343 TELEX 296797

CIRCLE 028 FOR FURTHER DETAILS.

COMPLETELY NEW EQUIPMENT

Westminster Mobile Sets type W15AM tuned and including crystals for 121.7 Mc/s, complete with loudspeakers, microphone and mobile aerials.

Price: **£95.00 each.**

Pye SSB type 130M 2 Channell — Price:
£440.00 each

Pye SSB type 130M 4 Channell — Price:
£515.00 each

For above: PSU 12 VDC — Price: **£88.00 each**
PSU 230 VAC — Price: **£105.00 each**
Remote Control — Price **£72.00 each**

Reflectometers type R.F.L.1A made by Telecommunication Ltd freq. 68 - 174 Mh, 50 ohms impedance.
Price: **£75.00 each.**

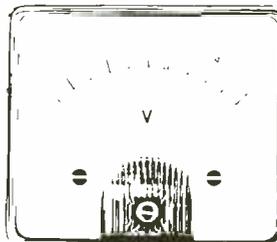
Prices shown do not include VAT.

Large quantity of spare parts for:
Pye Linear Amplifier A200
Pye Otimpic type M202
Pye 1000T SSB
Pye Tx Type T1000 FM VHF
Pye W15 FM
Pye TX Type R17/R18 VHF FM
Pye SSB 130 M & F

COLOMOR (ELECTRONICS LTD.) 170 Goldhawk Rd, London W12
Tel. 01-743 0899 or 01-749 3934. Open Monday to Friday 9 a.m.-5.30 p.m.

CIRCLE 006 FOR FURTHER DETAILS.

METER PROBLEMS?



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

Full Information from:

HARRIS ELECTRONICS (London)
138 GRAY'S INN ROAD, W.C.1 Phone: 01-837 7937
Telex: 892301

CIRCLE 069 FOR FURTHER DETAILS.

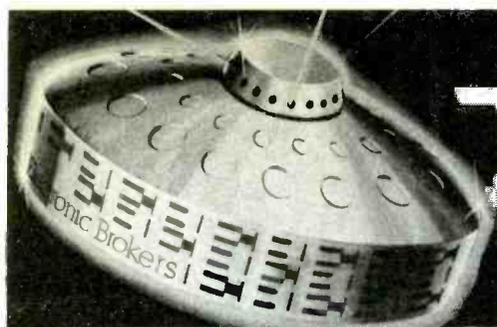
STEREO MICROPHONE AMPLIFIER



- 50 or 200 Ohm balanced microphones to balanced lines
- Variety of low frequency characteristics for improving the clarity of recordings
- Inputs filtered against radio interference
- Complete boxed unit or double mumetal screened amplifier module alone

APRS STAND 133

Surrey Electronics Ltd., The Forge, Lucks Green, Cranleigh, Surrey
GU6 7BG England. Tel: 0483 275997



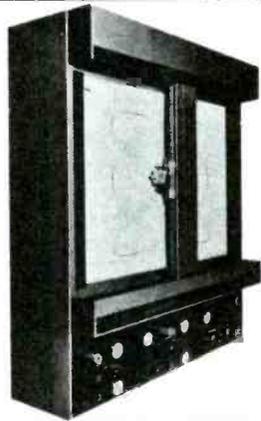
THE SOURCE OF ALL GOOD USED TEST EQUIPMENT

Electronic Brokers are Europe's largest specialists in quality second user test equipment, computers and associated peripherals. All second user test equipment offered by Electronic Brokers is calibrated to meet the original manufacturer's sales specifications and guaranteed for 12 months. Our latest catalogue contains full details of our extensive inventory. Contact us for your free copy now.

BRYANS SOUTHERN XY/T Recorder 25000

THESE UNITS ARE UNUSED A4 Size.
X-Y Ranges: 1mV to 1V Per CM.
Slew Speed: 49 CM/Second.
Timebase: 0.1 to 10 SEC/CM.
Price: **£750**

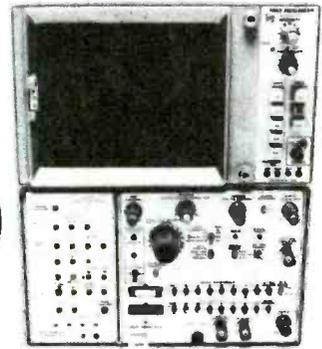
Save: **£388**
On New Price.



TEKTRONIX Logic Analyser 7D01 with DF1.

16 Stored Channels, up to 1024 words deep. State and timing with up to 100MHz sample rate
Price: **£2,000**

Save **£4,558**
On New Price



Illustrated with 7603 Mainframe (Extra)

TEKTRONIX Portable Data Analyser 308

For Timing, State, Serial and Signature Analysis.
8 Data Lines.
20MHz
Price: **£2,100**

Save: **£1,027**
On New Price.



RACAL-DANA Counter/Timer 9514

0.100MHz Counter
100ns to 10⁹ Sec Period
IEEE Interface

Superb Condition
Price: **£850**



ANALYSERS

Hewlett Packard	
334A Distortion Analyser	£1,200.00
1611A Logic Analyser	£3,000.00
3581A Wave Analyser	£1,800.00
Tektronix	
AA501 opt 01 Distortion 10Hz-100KHz to Less than 0.0025%	£1,450.00
DF1 Display Formatter For 7D01	£500.00
492 (opt 01 08) Spectrum Analyser 50KHz-21GHz	£13,000.00
7L5 opt 25 (Tracker) and L3 (Input plug in) 20Hz-5MHz	£7,800.00
7L12 Spectrum Analyser 100KHz-1.8GHz	£6,000.00
7L18 Spectrum Analyser 1.5GHz-60GHz	£3,950.00
TR502 Tracking Generator 100KHz to 1.8GHz (for use with 7L13 or 7L14)	£3,000.00
TR503 Tracking Generator (for 492/496 series)	£4,250.00
7D01 16 Channel 100MHz Sample Rate	£1,500.00
7D02/01 Logic Analyser	£3,950.00

OSCILLOSCOPES

Hewlett Packard	
1332A High Quality CRT Display 9.6 x 11.9cm	£1,250.00
1744A 100MHz Variable Persistence Storage	£3,000.00
1809A 100MHz 4 Channel Plug In	£2,000.00
1821A Timebase Plug In	£1,000.00

Philips	
PM3232 Dual Bean 10MHz	£495.00
PM3244 50MHz 4 channel	£1,500.00
Tektronix	
212 500KHz Dual Trace Miniscope	£850.00
305 Battery 5MHz Dual Trace Oscilloscope/DMM	£1,000.00
335 Dual Trace 35MHz Small portable with delay T Base	£1,300.00
434 opt 01 25MHz Storage	£2,350.00
475A 250MHz Dual Trace Portable	£3,300.00
475 200MHz Dual Trace Portable	£2,500.00
7313 100MHz Storage Mainframe	£2,225.00
7603 100MHz Mainframe	£1,950.00
7704A Scope DC-200MHz Mainframe	£2,850.00
C12 Camera	POA

Telequipment	
D34 15MHz DT Battery Portable	£350.00
CT71 Curve Tracer	£550.00

SIGNAL SOURCES

EH Labs	
1398 Pulse Gen	£950.00
Hewlett Packard	
214A Pulse Gen	£950.00
11720A Pulse Modulator	£1,950.00
8004A Pulse Gen	£450.00
8011A-01 Pulse Gen	£695.00
8013B Pulse Gen	£750.00
8620C Sweeper Mainframe	£2,100.00
86240B Sweeper Plug In 2-8.4GHz	£4,200.00
8640A Sig Gen	£2,750.00

Marconi	
TF2002B AM/FM Sig Gen 10KHz-88MHz with TF2170B Synchroniser	£1,750.00
TF2008 Sig Gen	£3,000.00
TF2015 Sig Gen	£1,350.00
TF2015/1 Sig Gen	£1,350.00
TF2120 Waveform Gen	£850.00

Tektronix	
284 70pS Pulse Generator	£950.00

TEKTRONIX PLUG INS

We stock a complete range of Plug Ins for use with 7000 and 5000 series Mainframes.

TEKTRONIX TM500 SERIES

We stock a very wide range of these versatile modular equipments

MISCELLANEOUS

Avo	
Model 8 Multimeters	£80.00
7 Electricians Multimeter	£65.00
Bruel & Kjaer	
2209 Sound Level Meter	£850.00
1613 Filter	£400.00
Bryans Southern	
25000 XY/T Recorder	£750.00
26001 A4 with 2 x 26116 Amplifiers and 26201 Timebase	£1,400.00
As above but with 26202 Power Unit instead of Timebase	£1,250.00
29300 XY/T Recorder	£1,000.00

Datalabs	
DL901 Transient Recorder	£750.00

Fluke	
8010A 01 3 1/2 digit DMM with built in battery pack	£150.00
8050A 4 1/2 Digit DMM	£200.00
931B Diff V Meter	£1,000.00
2020A-3-6 Printer	£500.00
8921A DMM	£695.00

Hewlett Packard	
427A AC/DC Voltmeter	£495.00
461A Amp 20/40DB 1KHz-150MHz	£120.00
467A Amplifier	£725.00
415E VSWR Meter	£950.00
3556A Psophometer	£850.00
3552A Trans Test Set	£1,500.00
4815A Vector Impedance Meter	£3,850.00

Marconi	
2438 520MHz Counter/Timer	£795.00
TF1313A LCR Bridge	£775.00
TF2603 RF Millivoltmeter	£750.00

Racal	
9514 Counter/Timer IEEE	£850.00
9904 50MHz Counter/Timer	£325.00

Tektronix	
106 Square Wave Generator 1ns risetime 10Hz-1MHz without accessories	£175.00
2701 Step Attenuator 50n 0.79dB in 1dB steps. DC to 2GHz	£295.00

WE NOW STOCK A RANGE OF HEWLETT PACKARD COMPUTERS AND CALCULATORS.

ADD 15% VAT TO ALL PRICES Carriage and Packing extra Trading Conditions Available on request



Electronic Brokers Ltd., 61/65 Kings Cross Road, London WC1X 9LN. Tel: 01-278 3461. Telex 298694

Modem Filters

INDUSTRY STANDARD

New Low Prices in OEM Quantities From Stock

- R5630** Full-duplex 300 baud, 103 compatible filter in 16 pin DIP.
- R5631** Full-duplex 200/300 baud, V.21 CCITT compatible filter in 16 pin DIP, pin-for-pin compatible with R5630.
- R5632** Full-duplex 1200 baud, 212/V.22 combo filter.
- R5633** General purpose programmable filter array for full-duplex 103, V.21, DTMF and Videotex.
- R5626** Mask programmable to your specification.

Reticon also provides a wide variety of other standard and specialised custom filters and signal processing devices using Reticon's proven NMOS Switched-Capacitor Technology.

Contact us on your needs at Chicago (312) 640-7713; Boston (617) 745-7400; Japan 03-343-4411; England (0734) 788666; Germany (089) 928-060.



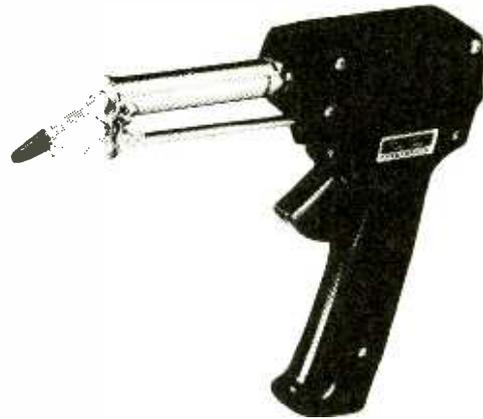
**STAND 779
HALL A UPPER**



34/35 MARKET PLACE, WOKINGHAM, BERKSHIRE RG11 2PP
Telephone: Wokingham (0734) 788666 Telex: 847510 EGGUK

CIRCLE 057 FOR FURTHER DETAILS.

SELF-FEED



SELF-FEED SOLDER GUN

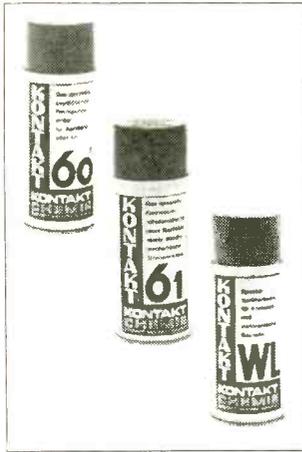
Eliminates need for a third hand on tricky jobs, feeds a controlled length of Solder to the joint at the squeeze of the trigger. Solder may be fed from standard reels, or loaded onto gun-mounted holder. Two models - 40w and 60w, 240V.

**Light Soldering
Developments Ltd**
97/99 Gloucester Road
Croydon CR2 0DN 01-689 0574

CIRCLE 044 FOR FURTHER DETAILS.

AA17 0.90	BCV70 0.160	BU111 1.400	1BA530 0.750	2N 3771 0.850	JAPANESE TRANSISTORS	PC685 0.420	LED
AA19 0.090	BCV71 0.160	BU126 0.700	1BA540 0.750	2N 3779 0.900	PC780 0.580	LED 3mm	
AA32 0.900	BCV72 0.160	BU126 0.700	1BA550 0.700	2N 3773 1.000	PC1200 1.350	RED 0.500	
AC107 0.280	BD15 0.260	BU205 0.700	1BA800 0.350	2N 4031 0.250	2SA104 0.320	PCF801 1.100	YELLOW 0.100
AC126 0.170	BD124P 0.500	BU208 0.750	1BA805 0.800	2N 4036 0.250	2SA198 0.220	PCF802 0.570	LED 3mm
AC127 0.150	BD124 1.100	BU208A 0.800	1BA820 0.750	2N 4037 0.250	2SA203 0.300	PCF806 1.150	YELLOW 0.100
AC128 0.150	BD128 0.350	BU208D 1.200	1BA920 0.800	2N 4440 0.800	2N 4440 0.760	PCM200 1.000	LED 3mm
AC128K 0.230	BD131 0.250	BU326 0.850	1BA950 0.800	2N 4444 0.760	2N 4444 0.760	2SA473 0.370	LED 3mm
AC144 0.230	BD132 0.250	BU406 0.850	1BA990 0.800	2N 5061 0.200	2N 5061 0.200	2SB54 0.250	GREEN 0.100
AC147K 0.220	BD135 0.200	BU407 0.750	1CA800 0.800	2N 5294 0.300	2CA800 0.800	2SB77 0.320	LED 5mm
AC153K 0.230	BD136 0.200	BU408 1.000	1CA940 0.850	2N 5296 0.300	1CA940 0.850	2SB837 1.200	RED 5mm
AC176 0.180	BD137 0.200	BU500 1.100	1DA1170 0.800	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	LED 5mm
AC176K 0.200	BD138 0.200	BU526 0.800	1DA1420 0.500	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	RED 0.050
AC187 0.150	BD139 0.200	BU526 0.800	1DA2002 0.800	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	LED 5mm
AC187A 0.200	BD140 0.200	BU526 0.800	1DA2003 0.500	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	YELLOW 0.100
AC180 0.170	BD144 0.900	BU533 0.800	1DA2021 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	LED 5mm
AC188A 0.230	BD150 0.300	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	GREEN 0.100
AC198 0.480	BD157 0.380	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AC199 0.480	BD158 0.380	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AD142 0.600	BD166 0.300	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AD149 0.450	BD175 0.300	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AD161 0.220	BD177 0.300	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AD162 0.220	BD179 0.320	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AF124 0.250	BD181 0.450	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AF125 0.250	BD201 0.320	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AF126 0.250	BD202 0.380	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AF127 0.250	BD203 0.420	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AF139 0.220	BD204 0.420	BU533 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AF239 0.220	BD222 0.310	CA270 0.150	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AL172 0.700	BD225 0.310	CA3086 0.250	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AL173 0.800	BD230 0.310	CA3089 1.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AS215 1.800	BD237 0.210	CA3240 0.900	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AS217 1.800	BD238 0.240	CA3240 0.900	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
	BD243 0.260	CA3240 0.900	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AD110 1.100	BD437 0.280	MC1327 0.700	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AY102 1.800	BD535 0.380	MJ2500 1.000	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
AY106 1.800	BD536 0.380	MJ2501 1.100	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
	BD537 0.400	MJ2955 0.550	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BA145 0.100	BD538 0.400	MJ3000 1.150	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BA148 0.100	BD539 0.400	MJ3001 1.150	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BA154 0.060	BD165 0.800	MJ29A 0.300	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BA157 0.120	BF180 0.160	MJ30A 0.300	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BB014 0.120	BF181 0.160	MJ30B 0.250	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BB103 0.160	BF183 0.200	MJ350 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BB105B 0.180	BF184 0.200	MJ350 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC107 0.070	BF194 0.050	MJ350 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC108 0.070	BF195 0.050	MJ350 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC109 0.070	BF196 0.050	MJ350 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC115 0.180	BF199 0.060	MJ350 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC118 0.110	BF200 0.160	MJ350 0.800	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC140 0.150	BF257 0.180	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC141 0.150	BF258 0.180	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC142 0.150	BF259 0.180	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC143 0.150	BF259 0.180	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC144 0.150	BF259 0.180	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC148 0.855	BF338 0.200	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC149 0.855	BF338 0.200	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC152 0.855	BF338 0.200	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC159 0.855	BF338 0.200	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC162 0.855	BF338 0.200	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC163 0.855	BF338 0.200	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC164 0.855	BF338 0.200	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC167 0.070	BF194 0.050	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC168 0.070	BF195 0.050	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC169 0.070	BF196 0.050	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC171 0.070	BF197 0.050	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC172 0.070	BF198 0.050	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC173 0.070	BF199 0.050	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC174 0.070	BF200 0.160	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC175 0.070	BF201 0.320	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC176 0.070	BF202 0.380	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC177 0.070	BF203 0.420	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC178 0.070	BF204 0.420	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC179 0.070	BF205 0.450	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC180 0.070	BF206 0.480	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC181 0.070	BF207 0.510	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC182 0.070	BF208 0.540	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC183 0.070	BF209 0.570	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC184 0.070	BF210 0.600	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC185 0.070	BF211 0.630	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC186 0.070	BF212 0.660	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC187 0.070	BF213 0.690	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC188 0.070	BF214 0.720	DA202 0.070	1DA2031 0.400	2N 5298 0.300	2N 5298 0.300	2SB840 0.220	
BC189 0.070	BF215 0.750	DA202 0.070	1DA2031 0.400	2N 529			

KONTAKT



NEW from Kontakt

The capability and effect of compressed air in a handy can. TENSION 67 efficiently removes dust and deposits from electronic components, electronic and electrical apparatus, microscopes, medical equipment, cabinets, etc. Absolutely no spray residues. No compressed airline needed. With plug-in nozzle even blows around corners. Ready for use in the service kit.

Kontakt 60

Dissolves oxides and sulphides, removes dirt, oil, resin and traces of metal abrasion. Protects against erosion. Ensures perfect contacts.

Kontakt 61

Special cleaning, lubricating and anti-corrosion fluid for NEW (non oxidised) and specially sensitive contacts. An excellent lubricant for all electrical and electro-mechanical systems.

Spray Wash WL

A rapid cleaner for reliable washing and degreasing of electrical equipment and components. For removal of dirt, grease, oil, soldering residues and other impurities.

ALSO AVAILABLE:

A COMPLETE RANGE OF INDUSTRIAL AEROSOL SPRAYS

SK10 Soldering Lacquer, K75 Cold Spray, K70 Plastic Spray, K88 Oil Spray, K701 Vaseline Spray, K90 Video Spray, K33 Graphite Spray, K100 Antistatic Spray, K101 Fluid Spray and, of course, Positiv 20 positive photo resist for printed circuits.

Details from:

Special Products Distributors Ltd.

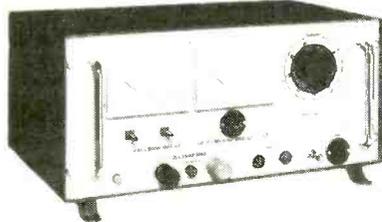
81 Piccadilly, London W1V 0HL
Tel: 01-629 9556. Telex: 26500 (answerback RACEN)
Cables: Speciproduct, London W1

CIRCLE 033 FOR FURTHER DETAILS.

Valradio

POWER UNITS

NOW AVAILABLE
WITH 3 VARIABLE
OUTPUTS



Input 200-250V. 50Hz or 100-120V
60Hz to order.
Output 1: 0-30V. 25A. D.C.
Output 2: 0-70V. 10A. A.C.
Output 3: 0-250V4A. A.C.

ALL CONTINUOUSLY VARIABLE

Other units are also available
with outputs of:

0-60V 12A
0-120V 6A
0-240V 3A

**SERVICING
EDUCATION
DEVELOPMENT
PRODUCTION
TESTING**

**SEND FOR FURTHER DETAILS
OF THESE VERSATILE UNITS
TO**

Valradio POWER LIMITED
A.K. INTERNATIONAL BUILDING
LAWRENCE ESTATE, GREEN LANE
HOUNSLOW, MIDDX. TW4 6DU
ENGLAND 01-570 5622

CIRCLE 030 FOR FURTHER DETAILS.

WIRELESS WORLD MAY 1984

DEC SALE

a selection from our
huge stocks. All items
reconditioned unless
otherwise stated.

Visit us at
DEXPO Europe 84
Kensington
Exhibition Centre
London
May 30-June 1, 1984
BOOTH No. 2

DEC 11/70 SYSTEMS

11/70 CPU
Dual Rack Cabinet
1MB MOS Memory
2 x RM03 Disk Drives
DH11AD Multiplexor
LA120 Console

£55,000

DEC 11/34 SYSTEMS

11/34A CPU
10 1/2" Chassis
256KB MOS. Cabinet
2 x RK07 Disk Drives
DZ11A Multiplexor
VT100 Console

£10,250

DEC 11/23 SYSTEMS

11/23AB CPU 5 1/4" Chassis
128KB MOS Memory
DLV11J 4-line Interface
RXV21 Dual Floppy Disk Drive
Cabinet
VT100 Console

£5,795

DEC 11/03 SYSTEMS

11/03N CPU 5 1/4" Chassis
64KB MOS Memory
DLV11 Serial Interface
RXV11 Dual Floppy Disk Drive
Cabinet
LA36 Console

£3,500

DEC DISK DRIVES

RK05F 5MB fixed £695
RK05J 2.5MB £975
RK06 14MB £750
RK07 28MB £1,500
RLV22 RLO2 and 11/23+ cpl NEW £4,500
RM02 67MB £5,750

RM05 256MB £14,500

RX11
RXV11

£995
£995

Range of Controllers also available

DEC MODULES

HUGE STOCKS OF OPTION
MODULES FOR VAX, UNIBUS,
GBUS AND OMNIBUS

DEC TERMINAL OFFER

Fully Reconditioned Units covered by
90 days parts & labour warranty

LA36 30cps KSR Terminal

Tractor feed unit
with integral stand

Price:
(with 20mA I/F) £295
(with EIA I/F) £325



VT100 VDU
Terminal Price £775
Extra Cost
Options available —

VT1XXAA (20mA) £112

VT1XXAB (AV) £75

VT1XXAC (Printer Port) £125

LOW COST VDUS

Hazeltine 1500 £325
Newbury 7009 £325

DAISY WHEEL PRINTERS

Anderson Jacobson AJ832 £375
Diablo 1345A £395

TEKTRONIX GRAPHICS

606B Monitor £950

4006 Terminal £1,525

4010/1 Terminal £1,995

4015/1 Terminal £7,250

4027A Colour Terminal £1,995

4051 Desktop Computer £1,750

4052 Desktop Computer £4,950

4114 Terminal £10,500

4662 Plotter from £1,995

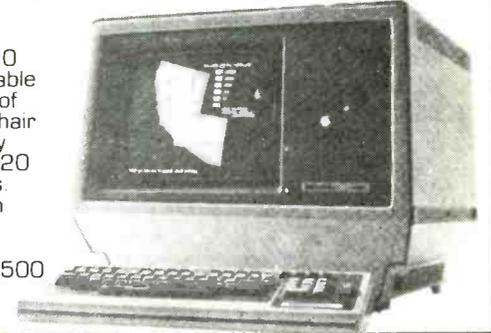
4952 Joystick £275

TEKTRONIX COLOUR GRAPHICS

Ex-Demonstration Stock
in Original Manufacturer's Packaging

Colour Graphics Terminal Model 4027A

Providing full colour
graphics and
alphanumerics. Plot 10
compatible. 8 displayable
colours from palette of
64. Full screen crosshair
cursor 34 x 80 display
(2720 characters). 120
user-defined patterns.
RS232 Interface with
up to 9600 baud
transmission.
Original List Price £9,500
Our Amazing Price
Only £1,995



A copy of our Trading Conditions can be supplied on request.

ADD 15% VAT TO ALL PRICES Carriage and Packing extra

**Electronic Brokers Ltd., 61/65 Kings Cross Road,
London WC1X 9LN. Tel: 01-278 3461. Telex 298694**



Electronic Brokers

COLOURJET 132

7 COLOUR INK JET PRINTER

Logic seeking in dot address mode

132 Column Compressed Mode

Cash price **£499** + VAT

Centronics parallel interface with full Viewdata and free BBC Micro dump listing.

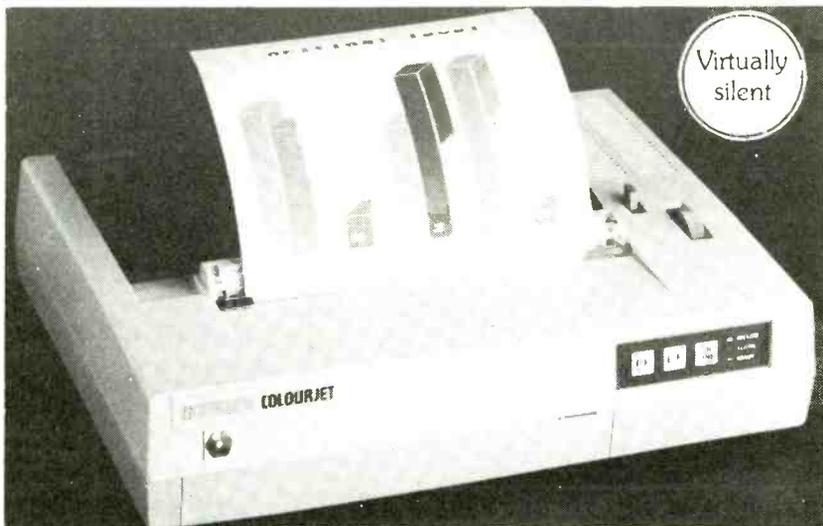
also: prints **OVERHEAD TRANSPARENCIES**

Options available

- Buffered RS232/Viewdata interface
- Apple II & IIe interface
- IBM pc dump

Specifications:

1280 dots/line in double res. mode
37cps in full colour
Friction feed roll paper and single sheet feed A4
Ink cartridges 4 million character life



INTEGREX LIMITED

Portwood Industrial Estate, Church Gresley
Burton-on-Trent, Staffs DE11 9PT
Burton-on-Trent (0283) 215432. Telex: 377106



Sowter Transformers

With 40 years' experience in the design and manufacture of several hundred thousand transformers we can supply:

AUDIO FREQUENCY TRANSFORMERS OF EVERY TYPE

YOU NAME IT! WE MAKE IT!

OUR RANGE INCLUDES

Microphone transformers (all types), Microphone Splitter/Combiner transformers, Input and Output transformers, Direct Injection transformers for Guitars, Multi-Secondary output transformers, Bridging transformers, Line transformers, Line transformers to G.P.O. Isolating Test Specification, Tapped impedance matching transformers, Gramophone Pickup transformers, Audio Mixing Desk transformers (all types), Miniature transformers, Microminiature transformers for PCB mounting, Experimental transformers, Ultra low frequency transformers, Ultra linear and other transformers for Transistor and Valve Amplifiers up to 500 watts, Inductive Loop Transformers, Smoothing Chokes, Filter, Inductors, Amplifier to 100 volt line transformers (from a few watts up to 1,000 watts), 100 volt line transformers to speakers, Speaker matching transformers (all powers), Column Loudspeaker transformers up to 300 watts or more.

We can design for RECORDING QUALITY, STUDIO QUALITY, HI-FI QUALITY OR P.A. QUALITY. OUR PRICES ARE HIGHLY COMPETITIVE AND WE SUPPLY LARGE OR SMALL QUANTITIES AND EVEN SINGLE TRANSFORMERS. Many standard types are in stock and normal dispatch times are short and sensible. OUR CLIENTS COVER A LARGE NUMBER OF BROADCASTING AUTHORITIES, MIXING DESK MANUFACTURERS, RECORDING STUDIOS, HI-FI ENTHUSIASTS, BAND GROUPS, AND PUBLIC ADDRESS FIRMS. Export is a speciality and we have overseas clients in the COMMONWEALTH, E.E.C., USA, MIDDLE EAST, etc. Send for our questionnaire which, when completed, enables us to post quotations by return.

E. A. Sowter Ltd.

Manufacturers and Designers

E. A. SOWTER LTD. (Established 1941) : Reg. No. England 303990
The Boat Yard, Cullingham Road, Ipswich IP1 2EG, Suffolk
P.O. Box 38, Ipswich, IP1 2EL, England
Phone: 0473 62794 and 0473 219390
Telex 987703G Sowter

CIRCLE 008 FOR FURTHER DETAILS.

VELLEMAN-KITS

High quality range of electronic kits for serious amateurs, qualified engineers and training schools and colleges:

NEW INTERFACE SYSTEM FOR SINCLAIR ZX81 and SPECTRUM COMPUTERS:

K2615	Motherboard for ZX81	£25.69
K2616	Motherboard for Spectrum	£25.69
K2609	DC Output board	£19.01
K2610	A/D Converter	£28.26
K2611	Opto coupler input board	£20.66
K2614	Centronics interface	£30.83
K2618	D/A converter	£24.66

NEW KITS NOW AVAILABLE

K2594	Zero Cross Programmable timer	£11.41
K2598	Car Amplifier	£15.41
K2600	2 Amp dimmer	£5.32
K2601	Stroboscope	£10.79
K2602	4 channel running light with music modulator ..	£20.55
K2606	LED audio power meter	£12.48

SEND FOR FREE ILLUSTRATED POSTER OF COMPLETE RANGE AND LIST OF STOCKISTS from address below:



VELLEMAN (UK) LTD.

P.O. Box 30, St. Leonards on Sea,
East Sussex TN35 7NH
Tel: 0424 753246



CIRCLE 064 FOR FURTHER DETAILS.



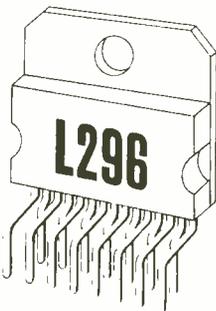
NEW VALVES										R.F. POWER TRANSISTORS									
National, Varian, Mullard, RCA, ITT ...										Many other types available									
A2426	28 50	NT2	2 50	6AV6	1 30	12AX7	1 60	6085	8 60	2N3375	9 20	25C1120	12 50	25C2290	27 50	MRF428	57 00	SD1019	24 70
AH205	708 00	PCL805	1 85	6AW8A	2 65	12AX7WA	4 80	6094A	420 00	2N3375	2 00	25C1121	24 00	25C2347	0 30	MRF428A	75 00	SD1019.5	24 70
AH211A	85 00	PL509	5 50	6AZ8	3 80	12BA6	2 90	6101	2 20	2N3632	10 00	25C1122	18 00	25C2369	2 00	MRF433	16 21	SD1020	1 50
AH221	48 00	PL519	5 75	6BA8	1 60	12BA6	2 00	6130	24 50	2N3733	13 20	25C1162B	0 90	25C2370A	18 00	MRF449A	14 95	SD1074	16 10
AH238	35 00	QV02-6	19 50	6BARA	2 75	12BA7	3 00	6146A	7 50	2N3866	0 85	25C1165	6 95	25C2379	15 00	MRF450	11 90	SD1076	18 50
AH2511	90 00	QV03-10	5 50	6BE6	1 90	12BE6	1 90	6146B	7 50	2N3926	11 26	25C1169	8 95	25C2385	15 00	MRF453	11 90	SD1077	1 60
AH2532	31 50	QV07-50	12 00	6BH6	2 00	12BM7A	2 50	6155	49 00	2N3927	11 82	25C1176	14 00	25C2407	1 00	MRF453A	16 90	SD1078	26 50
AJ2256	7 50	QV03-12	4 50	6BJ6	1 85	12BY7A	2 40	6156	59 00	2N4416	10 20	25C1177	17 25	25C2420	18 00	MRF454	21 00	SD1080	1 55
B0512A	31 50	QV3-65	52 50	6BK4C	4 15	12BZ6	3 70	6159B	12 50	2N4427	0 75	25C1178	18 00	25C2494	16 00	MRF454A	21 00	SD1080.6	7 50
BK656	295 00	QV3-125	48 00	6BL6	68 50	12CK6	1 50	6856	6 50	2N4500	13 90	25C1209D	0 64	25C2509	6 00	MRF455	16 00	SD1080.7	7 50
BK448	110 00	QV4-250	59 00	6BL7GT	3 80	12DW7	4 25	6227	12 95	2N5109	2 00	25C1213A	0 40	25C2538	1 50	MRF456	21 50	SD1080.8	26 00
BK482	485 00	R1-169	80 00	6BL8	1 45	12E1	25 00	6267	1 75	2N5160	4 80	25C1213C	0 50	25C2539	15 00	MRF456A	21 00	SD1080.9	40 10
BK484	144 00	RG3-1250	35 00	6BM6	93 95	12FQ8	12 00	6293	14 00	2N5190	1 50	25C1239	2 40	25C2539	15 00	MRF456	16 00	SD1080.9	7 50
BK486	375 00	RG3-250A	15 50	6BM8	1 40	12GN7A	4 00	6360A	5 50	2N5589	8 00	25C1241	15 00	25C2540	24 95	MRF457	2 40	SD1115.2	2 50
BK488A	525 00	RG4-1250	48 00	6BN8	2 45	12K7GT	1 80	6426	1690 00	2N5590	8 50	25C1245	10 00	25C2545E	0 29	MRF475	2 00	SD1115.7	2 10
BK7103	250 00	RC4-3000	90 00	6BD5	1 80	12SL7GT	3 95	6442	48 00	2N5591	8 90	25C1260	1 11	BRF90	1 50	MRF475	2 25	SD1127	2 50
BLT119	320 00	RM1-350	1060 00	6BR8A	2 95	13E1	15 00	6472	15 00	2N5913	13 00	25C1303	5 00	BRF91	2 00	MRF477	12 50	SD1131	3 25
B75	51 50	RR3-250	15 00	6BK6	2 35	21JZ6	3 40	6528	18 00	2N5913	2 50	25C1306	1 00	BRF96	2 00	MRF492	27 50	SD1133	9 50
B75B	51 50	RR3-1250	34 50	6BK6Z	2 50	30KD6	5 00	6550A	7 25	2N5945	8 95	25C1307	0 40	BLW99	10 00	MRF515	3 90	SD1134.1	2 50
BT17	142 00	SP41	3 80	6C4	1 85	40K6G	5 50	6688	9 25	2N6080	6 05	25C1311E	0 32	BLW60C	15 00	MRF517	3 50	SD1134.2	10 00
BT17A	142 00	SSR13	12 00	6CA4	1 65	40K6GA	5 75	6693	9 25	2N6081	8 75	25C1311A	25 00	BLW60FC	15 00	MRF517	18 00	SD1134.8	10 00
BT19	36 00	T160L	29 50	6CA7	3 50	42EC4	4 00	6699	2 80	2N6082	9 00	25C1318	0 40	BLW4C3	65 00	MRF643	27 50	SD1134 STUD	7 60
BT69	295 00	T28RHHDG	589 00	6CB6A	6 00	150C2	2 80	6779	19 50	2N6083	12 00	25C1368B	1 00	BLW78	61 80	MRF646	28 00	SD1135	10 25
BT95	129 90	T22-3	10 00	6CF6	1 90	83A1	885 60	6856	66 80	2N6084	8 00	25C1368	0 30	BLW80	10 25	MRF646	33 00	SD1135.3	12 00
BT125	72 50	TYS-500	225 00	6CG7	2 25	90C1	3 50	6857	99 20	2N6094	8 00	25C1424	1 35	BLW81	13 90	MRF646	46 00	SD1136	12 50
BT127	95 00	UJ5	25 00	6CH6	9 95	90CG	12 00	6858	14 20	2N6095	8 00	25C1509	6 00	BLW90	13 00	MRF646	46 00	SD1143	9 45
CIK	20 00	VL5631	14 50	6CJ3	2 30	90CV	14 20	6859	103 50	2N6255	14 20	25C1546	0 45	BLW98	110 00	MRF901	2 75	SD1143.1	10 00
CJ3	22 50	VR75	5 45	6CJ6	10 95	150B2	6 50	6883B	3 90	25C382	3 45	25C1568	0 45	BLX39	13 75	MRF903	2 95	SD1144.1	2 50
CJ3A	28 50	VR150	4 95	6CK6	6 30	150C3	10 92	6922	19 50	25C458	0 22	25C1569	5 00	BLX65	2 45	MRF91	2 50	SD1144.2	7 95
CJ3J	30 00	XG12	30 00	6CL6	1 95	6939	19 50	6939	19 50	25C458B	0 36	25C162	0 33	BLX67C	9 50	MRF91.75	22 50	SD1201	7 35
CIK6	120 00	XG1-2500	51 50	6CM5	2 30	150C4	4 50	6973	3 70	25C458C	0 22	25C1623	0 22	BLX68C3	10 00	MRF517.7	43 00	SD1212.4	6 00
CK1907	17 70	XG2-500	36 00	6CN6	4 95	21Z6	170 00	6975	66 00	25C460	0 25	25C1688	19 80	BLX68C3	10 00	MRF517.7	43 00	SD1212.4	6 00
CK568WA	41 00	XG2-6400	152 00	6CQ6	2 20	290A	1150 00	7014	44 50	25C460B	0 25	25C1674	0 25	BLX69A	20 00	PT3134A	1 50	SD1212.7	4 00
DL516	18 00	XG5-500	24 50	6CW4	6 50	350A	22 50	7015	66 50	25C461	0 28	25C1675	0 20	BLX69A	20 00	PT3134A	1 50	SD1212.8	8 70
DQ4	31 50	XR1-1R00A	29 50	6CWS	1 95	350B	22 50	7017	85 50	25C461B	0 28	25C1676	0 28	BLX69B	36 00	PT3134B	2 75	SD1212.9	11 00
DR2010	40 00	XR1-3200	72 50	6CY5	3 80	404A	12 00	7018	18 50	25C462	0 38	25C1730	0 25	BLX69C	11 00	PT3134C	1 50	SD1213	18 00
DR2100	9 00	YR1-6400	95 00	6CY7	3 00	572B	29 50	7022	66 80	25C463	0 38	25C1730	0 25	BLX69C	11 00	PT3134C	1 50	SD1213.1	9 50
DR2110	1 80	Y602B	69 40	6CZ5	3 15	575A	35 00	7023	103 50	25C464	0 24	25C1765	7 75	HLX89C	11 00	PT3161A	1 75	SD1222.5	11 00
DV51	9 85	ZB03J	19 50	6DA6	2 30	615	18 50	7025	2 50	25C464B	0 25	25C1765	7 75	HLX89C	11 00	PT3161B	1 75	SD1222.5	11 00
E0511	44 00	ZT1011	29 50	6DC6	2 45	710	29 90	7027	4 60	25C465	0 28	25C1815Y	0 28	BLX91A	36 00	PT3134B	2 75	SD1216	11 00
EB0CC	8 60	Z1000551	13 50	6DC8	1 50	740L	66 80	7034	4 20	25C466	0 28	25C1906	0 33	BLY90	45 00	PT3161C	8 50	SD1224.2	13 00
EB0F	13 10	ZM1000	18 15	6DJ8	1 95	760P	103 50	7056	42 00	25C467	0 28	25C1907	0 30	BLY91C	45 00	PT3161F	30 00	SD1229 STUD	10 95
EB0L	12 95	ZM1001	18 15	6DK6	3 95	805	103 50	7056	42 00	25C468	0 28	25C1907	0 30	BLY91C	45 00	PT3161F	30 00	SD1229 STUD	10 95
EB1CC	3 20	ZM1020	15 65	6DT5	2 30	807	2 30	807	2 30	25C469	0 28	25C1946A	16 50	MRF212	12 00	PT4261A	16 00	SD1256	6 95
EB8CC	3 90	0A2	3 10	6DW8B	2 30	810	50 00	7199	4 20	25C470	0 28	25C1946A	16 50	MRF212	12 00	PT4261A	16 00	SD1256	6 95
EB9F	9 25	0A2WA	5 50	6E5	4 20	811A	19 90	7203	19 90	25C471	0 40	25C1946A	16 50	MRF212	12 00	PT4261A	16 00	SD1256	6 95
EO9CC	8 50	0A3	5 45	6E8B	2 45	812A	19 90	7203	19 90	25C472	0 40	25C1946A	16 50	MRF212	12 00	PT4261A	16 00	SD1256	6 95
EO9CC	6 50	0B2	3 95	6E8H	1 65	813	28 50	7233	8 75	25C473	0 36	25C1946A	16 50	MRF212	12 00	PT4261A	16 00	SD1256	6 95
E130L	23 00	0B2WA	5 95	6EH7	2 00	813	28 50	7233	8 75	25C474	0 36	25C1946A	16 50	MRF212	12 00	PT4261A	16 00	SD1256	6 95
E180F	8 50	0B3	2 50	6EJ7	2 00	829B	17 20	7247	3 20	25C475	0 38	25C1966	11 00	MRF231	12 36	PT4316C	12 00	SD1272	10 95
E188CC	7 50	0C3	2 50	6E14A	1 15	833A	61 50	7289	39 00	25C476	0 38	25C1966	11 00	MRF231	12 36	PT4316C	12 00	SD1272	10 95
ES070	27 50	0D3	4 95	6E5B	2 70	843	10 00	7308	7 50	25C477	0 38	25C1966	11 00	MRF231	12 36	PT4316C	12 00	SD1272	10 95
EB91	1 95	1B21A	100 00	6EV7	2 85	845	48 30	7322	604 00	25C478	0 38	25C1966	11 00	MRF231	12 36	PT4316C	12 00	SD1272	10 95
EB91	1 30	1B35A	39 00	6EW6	1 50	857B	708 00	7360	90 00	25C479	0 38	25C1966	11 00	MRF231	12 36	PT4316C	12 00	SD1272	10 95
EB91	1 30	1B35A	39 00	6EW6	1 50	857B	708 00	7360	90 00	25C480	0 38	25C1966	11 00	MRF231	12 36	PT4316C	12 00	SD1272	10 95
EC90	1 85	1B63B	58 00	6FH8	16 50	868	24 00	7527	73 30	25C481	0 38	25C1966	11 00	MRF231	12 36	PT4316C	12 00	SD1272	10 95
EC90	1 85	1B63B	58 00	6FH8	16 50	868	24 00	7527	73 30	25C482	0 38	25C1966	11 00	MRF231	12 36	PT4316C	12 00	SD1272	10 95
EC90	1 85	1B63B	58 00	6FH8	16 50	868	24 00	7527	73 30	25C483	0 38	25C1966	11 00	MRF231	12 36	PT4316C	12 00	SD1272	10 95
EC90																			

Track down SWITCHMODE power supply

...Barlec-Richfield
and \$\$\$ have
the solution

L296

SWITCHING REGULATOR



- Available ex-stock
 - Cost effective
 - Short circuit protected
 - Output over voltage protection
 - 5.1v to 40v output
 - 4A output current
 - Up to 160w output power
 - Programmable current limiter
 - Soft start
 - Reset output
 - Precise ($\pm 2\%$) on-chip reference
 - Very few components
 - Switching frequency to 200kHz
 - Very high efficiency (up to 90%)
 - Thermal shutdown
 - Remote inhibit and sync input
 - Control circuit for crowbar SCR
- For complementary evaluation kit please write to Barlec-Richfield on your company headed paper.



Phone: 0403 51881

Telex: 877222

**BARLEC
RICHFIELD**

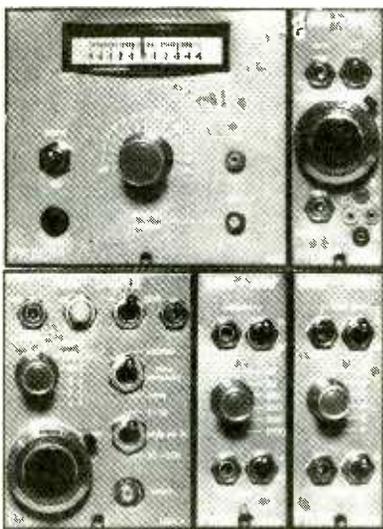
now better served to serve you better

Barlec-Richfield Ltd
Foundry Lane, Horsham, West Sussex RH13 5PX
A member of the IBR Electronics Group

CIRCLE 079 FOR FURTHER DETAILS.

FYLDE

TRANSDUCER and RECORDER AMPLIFIERS and SYSTEMS



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

FYLDE

Fylde Electronic Laboratories Limited.

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

CIRCLE 034 FOR FURTHER DETAILS.

IN VIEW OF THE EXTREMELY RAPID CHANGE TAKING PLACE IN THE ELECTRONICS INDUSTRY, LARGE QUANTITIES OF COMPONENTS BECOME REDUNDANT. WE ARE CASH PURCHASERS OF SUCH MATERIALS AND WOULD APPRECIATE A TELEPHONE CALL OR A LIST IF AVAILABLE. WE PAY TOP PRICES AND COLLECT.

R. Henson Ltd.

21 Lodge Lane, N. Finchley, London, N.12. 5 mins. from Tally Ho corner

Telephone 445 2713/0749

CIRCLE 012 FOR FURTHER DETAILS.

Ex-Gov 27ft telescopic aerial close to 5ft. Good condition, complete with all base & fittings £45. P&P paid. Callers welcome £25.
Pye Pocketfone Nightcall for PF1/TX/RX. New boxed £17.00.
Whip aerial Ex-Gov. 4ft collapsible £1.00.
Crystals HC6U Ex. Equip. 5 000 mc/s. 7 000 mc/s. 8 000.1. M. C. mc/s. 9 000 mc/s. Also Glas Crystal 100 Kc/s. to fit B7G base. All at £2 p&p paid
Telephones — Type 706 good condition £5 p&p paid
Small 230V fans. 4 in. x 2 1/2 in. 2,500 r.p.m. £4.50 p&p paid
Pye Pocketfone PF1, battery charger, 12 way with meter £10 p&p paid. PF1 TX batteries £2 each p&p paid
We have also for sale the following items which are too numerous to advertise. Callers only, valves, transformers, tuning units, receivers, bases, wave-guide, scopes, plugs, sockets, power units, capacitors, aerials, headsets, cable, signal generator, BC221
Ni-Cad batteries for Pye PF1 RX. 5 for £2 p&p paid. Min. order 5. All these batteries are ex-eq. but good condition
Bargain Parcels 14lbs at £10, 28lbs at £20 and 56lbs at £40, p&p paid. Contains pots, res., diodes, tagboards, caps., chassis, valve holders etc. Good value save £££. Lucky dip service
AVO multimeter test meter. Tested £20. Ex. eq. p&p paid
AVO 7X. Tested. Ex. eq. £40 p&p paid

Opening times
Monday-Friday 8 30am-5 00pm. Saturday 8 30am-12am

Please allow 14 days for delivery. (MAINLAND ONLY).

A. H. THACKER & SONS LTD
HIGH STREET, CHESLYN HAY, NR. WALSALL, STAFFS.

CIRCLE 070 FOR FURTHER DETAILS.

RECORD DECKS 240 volt AC. Post £2				
Make	Model	Drive	Cartridge	Price
BSR	P170	Rim	Ceramic	£22
GARRARD	6200	Rim	Ceramic	£24
BSR	P207	Rim	Ceramic	£20
BSR	P232	Belt	Magnetic	£28
BSR	P200	Belt	Magnetic	£34

AUTOCHANGERS 240 VOLT				
Model	Drive	Cartridge	Price	
BSR Budget	Rim	Ceramic	£18	
BSR Deluxe	Rim	Ceramic	£20	
BSR GARRARD	Rim	Magnetic	£26	
GARRARD	Rim	Ceramic	£22	

THE "INSTANT" BULK TAPE ERASER £11.50 Post 95p
Suitable for cassettes and all sizes of tape reels. AC mains 200/250V. Hand held size with switch and lead (120 volt to order). Will also demagnetise small tools. **Tape Head Demagnetiser** £5.

ALUMINIUM CHASSIS. 2 1/2in. deep 6x4 £1.75; 8x6 £2.20; 10x7 £2.75; 12x8 £3.20; 14x9 £3.60; 16x6 £3; 16x10 £3.80; 12x3 £2.20; 14x3 £2.50; 13x9 £2.80.

ALUMINIUM PANELS. 6x4 55p; 8x6 90p; 14x3 90p; 10x7 £1.15; 12x8 £1.30; 16x6 £1.30; 14x9 £1.75; 12x12 £1.80; 16x10 £2.10.

ALUMINIUM BOXES. 4x4x1 1/2 £1.20, 4x2 1/2x2 £1.20, 3x2x1 £1.20, 6x4x2 £1.90, 7x5x3 £2.90, 8x6x3 £3, 10x7x3 £3.60, 12x5x3 £3.60, 12x8x3 £4.30; 9x4x4 £3.

POTENTIOMETERS 5k/2meg. LOG or LIN. L/S 50p. DP 90p. Stereo L/S £1.10. DP £1.30. Edge Pot 5L SP 45p.

MINI-MULTI TESTER £7.50 Post 50p
Pocket size moving coil instrument. 4000 o.p.v. 11 ranges: DC volts 5, 25, 250, 500. AC volts 10, 50, 500, 1000. DC amps 0.250mA, 0.250mA. Ohms 600K.

De Luxe Range Doubler MULTI-METER £19.50
50,000 o.p.v. 7x5x2in. 50 Micro Amp
43 Ranges, 1,000V, AC-DC, 20 MEG 10 amp DC Post £1

PANEL METERS 50µA, 100µA, 500µA, 1mA, 5mA, 50mA, 100mA, 500mA, 1 amp, 2 amp, 5 amp, 25 volt, VU 2 1/4x2 1/4. Stereo VU 3 1/4x1 5/8x1in. £5, p.p. 50p

RCS SOUND TO LIGHT CONTROL BOX £27 Post £1
Complete ready to use with cabinet size 9x3x5in. 3 channel, 1000 watt each. For home hi-fi or disco
OR KIT OF PARTS £19.50

BATTERY ELIMINATOR Mains to 9 volt D.C. 400MA. Stabilised, safety cutout, 5x3 1/4x2 1/2in. £5. Post £1.

DISCO GRAPHIC MIXER EQUALISER £108. Post £2.
4 channel stereo, 5 band graphic, red + green LED. VU display, headphone monitor.
Deluxe Model, 5 channel 7 band graphic. £118.

FAMOUS LOUDSPEAKERS						
MAKE	MODEL	SIZE	WATTS	OHMS	PRICE	POST
AUDAX	WOOFER	5in	25	8	£10.50	£1
GODDMANS	HIFAX	7 1/2 x 4 1/4	100	8	£30	£2
GODDMANS	HB WOOFER	8in	60	8	£12.50	£1
WHARFEOALE	WOOFER	8in	30	8	£9.50	£2
CELESTION	DISCO/GRUP	10in	50	8/16	£21	£2
GODDMANS	HPG/GROUP	12in	120	8/15	£28.50	£2
GODDMANS	HPD/DISCO	12in	120	8/15	£28.50	£2
GODDMANS	HP/BASS	15in	250	8	£72	£4
GODDMANS	HPD/BASS	18in	230	8	£84	£4

RCS STEREO PRE-AMP KIT. To build Inputs for high, medium or low imp volume control and PC Board. Can be ganged for multi-channel **£3.50** Post 65p

MAINS TRANSFORMERS		
Model	Price	Post
250-0-250V 60mA, 6.3V 3.5A, 6.3V 1A	£7.00	£2
350-0-350V 250mA, 6.3V 6A CT	£12.00	£2
220V 25ma 6V lamp £3.00	220V 45ma 6V 2 Amp	£4.00 £1
250V 60mA, 6V 2A		£5.00 £1

Step-Down 115V to 240V 150W £9. 250W £12. 500W £14 £2

GENERAL PURPOSE LOW VOLTAGE

Tapped outputs available	Price	Post
2 amp 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V	£6.00	£2
1 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£6.00	£2
2 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£10.50	£2
3 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£12.50	£2
5-8-10-16V 1/2 amp	£2.50	£1
0-8-12V 5 amp	£5.00	£1
6V 1/2 amp	£2.00	£1
15-0-15V 1 amp	£4.00	£1
6-0-6V 1 1/2 amp	£3.50	£1
15-0-15V 2 amp	£5.00	£1
9V 400ma	£1.50	£1
20V 1 amp	£4.00	£1
9-0-9V 50ma	£1.50	£1
0-12-27V 2 amp	£4.00	£1
9-0-9V 1 amp	£3.50	£1
20-40-60V 1 amp	£3.50	£2
10-0-10V 2 amp	£4.00	£1
25-0-25V 2 amp	£5.50	£1
10-30-40V 2 amp	£5.50	£1
24V 5 amp Twice	£12.00	£2
12V 100ma	£1.50	£1
30V 1 1/2 amp	£5.00	£1
12V 750ma	£2.50	£1
30V 5 amp and		
12V, 3 amp	£4.50	£1
17-0-17.2a	£4.50	£2
12-0-12V, 2 amp	£4.50	£1
35V 2 amp	£4.00	£1

LOW VOLTAGE ELECTROLYTICS
500mf 12V 15p; 25V 20p; 50V 30p; 1200mf 76V 80p.
1000mf 12V 20p; 25V 35p; 50V 50p; 100V £1.20.
2000mf 30V 42p; 40V 60p; 100V £1.40; 1500mf 100V £1.20.
2500mf 50V 70p; 3000mf 50V 65p; 4700mf 40V £1.

CAPACITORS WIRE END High Voltage
.001, .002, .003, .005, .01, .02, .03, .05 mfd 400V 10p.
.1MF 400V 14p. 600V 15p. 1000V 25p.
.22MF 350V 12p. 600V 20p. 1000V 30p. 1750V 60p.
.47MF 150V 10p. 400V 25p. 630V 30p.

HIGH VOLTAGE ELECTROLYTICS			
Model	Price	Post	
2/500V	45p	32+32+16/350V	90p
16/450V	45p	100+100/275V	50p
20/500V	75p	150+200/275V	50p
32/350V	75p	32+32/350V	85p
32/500V	95p	32+32+32/450V	95p
32/150V	95p	50+50+50/300V	50p
125/500V	£2	8+8/500V	£1
		50+50/350V	80p

BAKER AMPLIFIERS BRITISH MADE
PA150 Watt MICROPHONE VOCAL AMPLIFIER £129
4 channel mixing, 8 inputs, dual impedance, 50K-600 ohm, volume, treble, bass. Presence controls on each channel. Master volume control, echo send return socket. Slave sockets Post £3
150 Watt MIXER AMPLIFIER 4 Inputs £99
Discotheque, Vocal, Public Address. Speaker outlets for 4, 8 or 16 ohms. Four inputs, 20 mv, 50K ohm. Individual volume controls "Four channel" mixing. Slave output 16" x 8" x 5 1/2" Wt - 14lb; Master volume control 240V AC. Post £2.
100 Volt Line Model, 150 watt £114. MONO SLAVE, 150 watt £80.
Baker Stereo Slave 150 + 150 watt 300 watt Mono £125. Post £4

BAKER MOBILE PA AMPLIFIER. All transistor, 60 watt RMS, 12v DC & 240V AC, 4 inputs 50K. Aux + 2 mics + 1 phono. Output 4-8-16 ohm + 100 volt line. **£89** Post £2

WATERPROOF HORNS 8 ohms, 25 watt £20. 30 watt £23. 40 watt £26. 40W plus 100 volt line £32. Post £2

BAKER PORTABLE DISCO 150 watt. Twin console + amplifier + mike and headphones + twin speakers £330. 300 watt £399. Carr. £30 Console + decks + pre-amp £105 Carr. £12.

PA CABINET SPEAKERS, Complete. 8 ohm 60 watt 17x15x9in. £27. Post £4. 4 or 8 or 16 ohm 75 watt 23x15x11in. £52. 90 watt 32x15x11in. £71. 150 watt £80. Carr. £10. Black vinyl covered

BAKER LOUDSPEAKERS					
MODEL	INCHES	OHMS	WATTS	TYPE	PRICE
DG50/10	10	8-16	50	PA	£18
MJORANGE	10	8	100	MID	£25
MAJOR	12	4-8-16	30	HI-FI	£16
SUPERB	12	8-16	30	HI-FI	£26
WOOFER	12	8	80	HI-FI	£25
AUDITORIUM	15	8-16	60	Woofer	£37
GROUP 45	12	4-8-16	45	PA	£16
OG 75	12	4-8-16	75	PA	£20
DG 100	12	8-16	100	PA	£26
DG 100	15	8-16	100	PA	£35

REPAIR service to most Baker loudspeakers. SPEAKER COVERING. Samples S.A.E. **CABINET WADDING** 18in wide 35p ft.

MOTOROLA PIEZO ELECTRIC HORN TWEETER, 3 3/8in. square £5
100 watts. No crossover required. 4-8-16 ohm. 7 3/8 x 3 3/8in. £10
HORN BOXES, complete 200 watt £30. 300 watt £35. Size 16x6x6in. Black vinyl covered with handle Post £4

CROSSOVERS. TWO-WAY 3000 cps 30 watt £3. 60W £3.50. 100W £4.
THREE-WAY 950 cps/3000 cps. 40 watt rating. £4. 60 watt £6. 100W £8.
LOUDSPEAKER BARGAINS. Please enquire, many others in stock.
4 ohm, 5in, 7x4in. £2.50; 6 1/2in, 8x5in, £3; 8in, £3.50. 6 1/2in 20W, £7.50.
8 ohm, 2 9/16in, 3in, £2; 5x3in, 6x4in, 7x4in, 5in, £2.50; 3in, 10W £4
8x5in, £3; 8in, £4.50; 10in, £5; 12in, £6. 8in 25W £6.50. 60W £12.50
15 ohm, 2 1/4in, 3 1/2in, 5x3in, 6x4in, £2.50. 6 1/2in 10W £5. 8in £4. 10in £7.
25 ohm, 3in, £2; 5x3in, 6x4in, 7x4in, £2.50. 120 ohm, 8in, 3in dia. £1.
EMI 13 1/2x8in. Bass & Tweeter 4 or 8 ohm 10 watt £8 pp £1

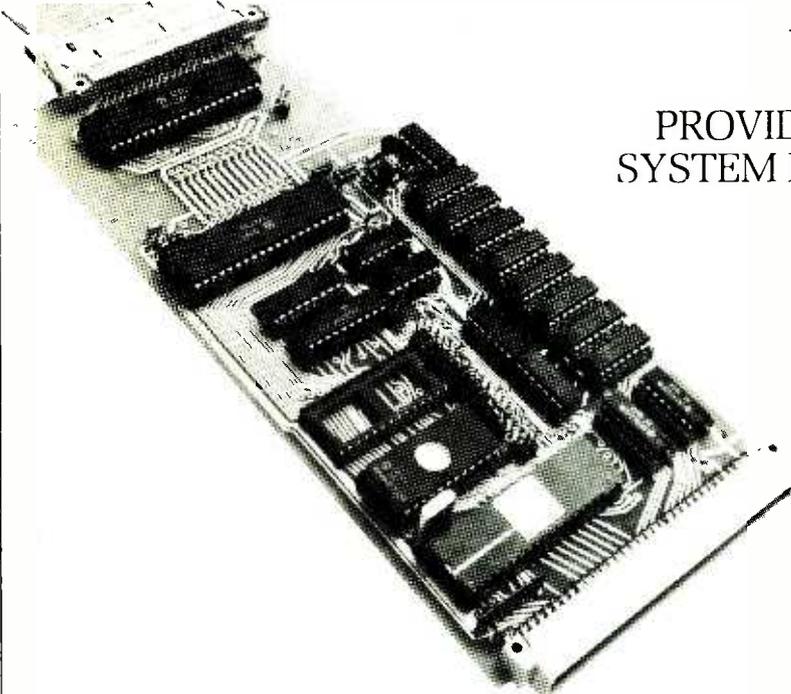
Dept 1, 337 WHITEHORSE ROAD, CROYDON
Open 9-6. Closed all day Wed. Open Sat. 9-5.
1665 for SAME DAY DESPATCH. Cash prices include VAT.
www-7

RADIO COMPONENT SPECIALISTS

Books and Components Lists 32p stamps. (Minimum post/packing charge 65p.) Access or Barclaycard Visa. Tel: 01-684 1665

SINGLE BOARD 6809 2nd PROCESSOR FOR THE BBC MICRO.

PROVIDES A LOW-COST DEVELOPMENT SYSTEM FOR INDUSTRIAL APPLICATIONS.



- Sits inside the BBC or plugs into an extension rack
- Enables standard Flex format Discs to run on BBC
- Supports High Level Language Compilers
- Cross Assemblers and Disassemblers for most micros
- Connects directly on to the tube
- 64k DRAM on board
- Two 28 pin byte wide memory sockets
- Acorn Bus compatible DIN 41612 Bus interface
- Also available as a single board controller

For full information contact Phil Taylor at:



11 St Margarets Road
Girton, Cambridge CB3 0LT
(0223) 276791

Cambridge
Microprocessor
Systems Limited

CIRCLE 074 FOR FURTHER DETAILS.

FIBRE-OPTICS EDUCATOR



A New Concept in Optical Equipment

The Fibre-Optics Educator is a **low-cost**, versatile instrument designed primarily for organisations involved in or about to enter the field of fibre-optics.

It can function as:

TEST EQUIPMENT e.g. for accurate fibre attenuation measurements to a range of 50dB, optical level measurements, and for testing out analogue and digital optical transmitters and receivers. Also, it may be set to give an audible indication of low level infra-red radiation using the analogue loudspeaker output or the digital buzzer output, with a length of optical cable acting as a probe.

TRANSMISSION EQUIPMENT for both **analogue** and **digital** data, over **free-space** as well as **optical fibres**. It is also ideal for:

TRAINING engineers, technicians and executives in the growing field of fibre-optics. Suitable for industry, colleges and technology training centres.

The Fibre-Optics Educator comprises fully portable optical transmitter and receiver units, optical cables, together with numerous accessories, a comprehensive manual, and carrying case.

Designed and Manufactured in the U.K.

For further details contact:
ELLMAX Electronics Ltd.
Unit 29, Leyton Business Centre,
Etloe Road, Leyton, London. E10 7BT.
Tel: (01) 539 0136

**ELLMAX
ELECTRONICS**

CIRCLE 031 FOR FURTHER DETAILS.

If an advertisement
is wrong we're here
to put it right.

If you see an advertisement in the press, in print,
on posters or in the cinema which you find
unacceptable, write to us at the address below.

The Advertising Standards Authority. ✓

ASA Ltd, Dept 3 Brook House, Torrington Place, London WC1E 7HN

AMBISONIC SURROUND SOUND DECODERS

Ambisonic surround sound gives a realism in the reproduction of music that is hard to describe without using hackneyed expressions like 'natural' and 'being there'. Positioning of the performer becomes obvious and the acoustic of the original environment comes through to the listening room. The Minim decoders also provide enhanced results from conventional stereo material. We can now supply UHF encoded records, tapes and compact discs.

And don't forget our other products:

**PROGRAMMABLE WEEKLY TIME SWITCHES
TELEVISION SOUND TUNERS**

Please send me information on Timeswitches/Television
Tuners/Ambisonics

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

Minim Electronics Limited, Lent Rise Road
Burnham, Slough SL1 7NY. Tel. Burnham 63724 WWS

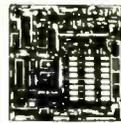
CIRCLE 080 FOR FURTHER DETAILS.

HENRY'S COMPUTER SHOP

OPEN 6 DAYS A WEEK · ORDER BY POST OR PHONE
CALL IN AND SEE FOR YOURSELF

PRICES
EXCLUDE
VAT

SOFTWARE • PERIPHERALS • MULTI-BOARDS



80 - BUS MULTI-BOARDS

BUILD A CUSTOM SYSTEM
FROM SCRATCH or expand
your GALAXY or NASCOM
Demonstrations for callers

GM811 CPU	£125.00
GM832 SVC	£195.00
GM829 FDC/SASI	£145.00
GM813 CPU/64K RAM	£225.00
EV814 IEEE 488 CONTROLLER	£140.00
GM802 64K DYNAMIC RAM	£125.00
GM827 87 KEY KEYBOARD	£85.00
GM839 PROTOTYPING	£12.50
MP826 STATIC RAM	£185.00
GM816 MULTI-I/O	£125.00
IO 828A SUPER PLUTO COLOUR GRAPHICS	£125.00
PROCESSOR 192K RAM	£499.00
GM833 RAM-DISK 512K	£450.00

(UK C/P & export extra at cost)
ALSO IN STOCK — MOTHER BOARDS, FRAMES,
CABLES, POWER SUPPLIES, KEYBOARDS,
SOFTWARE etc.

FULL LEAFLETS/DETAILS OF SUITABLE
PERMUTATIONS — SEND LARGE SAE

We can advise also with terminals and complete
Galaxy computers with monitors and Disks ready
to use.

NASCOM - 2

Available in both kit and built form. Featuring
Microsoft Basic, NAS-SYS monitor, full QWERTY
keyboard of the highest quality, 4MHz Z80A
processor, full RS232 I/O and parallel I/O. One of
the most flexible computer cards around.
Expansion capabilities are impressive using the
NASBUS and compatible 80-BUS expansion
cards. Expansion includes hi-res colour graphics
full CP/M disk system and much more.
Send SAE for full leaflets.

NASCOM 2 kit	£225.00
NASCOM 2 built	£265.87

ITT 2020 CABINET

Professional computer case
18" x 15 1/2" x 4 1/2" (Front slopes)
As previously advertised £23.91 (UK C/P £21.0)



TOROIDAL TRANSFORMER



100 watts isolations
230/240V AC plus 8.0-8V 4A
15.0-15V 0.645A 30V 0.16A
size approx 4 1/2" dia x 1 1/2"
£6.91 (UK C/P 75p)

PRESTEL KIT

Complete set of PRESTEL adaptor cards. Con-
sisting of main processor card with battery
backed RAM, modem card, direct line coupler and
keypad. Outputs are composite monochrome and
separate RGB. Suitable for use with colour
monitors or suitable TVs. (PS +/-12V and +5V)
£60.83

ASCII KEYBOARDS

Computer keyboards.
All models brand new
QWERTY (UK C/P £1.00)
All models +5V and -12V 1 Amp P/S £7.78
(UK C/P 60p)



69SD5 Exclusive Special Purchase. Compact

64 key (half effect) +5 function keys -ve/-ve
stroke. Normal ASCII but all definable. Steel frame.
All facilities complete with plugs £30.43

SMK 69 Key general purpose, steel plate.
Redefinable output, Neg strobe pulse, 4 user
definable keys, shift and control keys etc.
With connector £37.35

Discounts for quantities - please enquire
Computer/calc., etc. keyboard bargains for callers

**PLUS ALWAYS KEYBOARD BARGAINS
FOR CALLERS**



SOFTWARE

MDIS (C) INTELLIGENT
DISASSEMBLER

For all CP/M based machines £50.00

others (please enquire). Provides Pseudo high
resolution graphics £15.00

DISKPEN (C) Version 3. Low cost word
processor for Gemini and others
(please enquire) £50.00

Plus large range or overlays for Diskpen.

HENRY'S CP/M UTILITIES DISK (C)

41 Programs for the CP/M Systems programmer

5 1/4" format £15.00

8" format £17.35

Ask for details on all of above. WHEN ORDERING
PLEASE SPECIFY FORMAT REQUIRED.

Contact Computer Dept. if uncertain.

(C) Copyright Cubegate Ltd - all rights reserved.

All above available to retailers and distributors -
contact Computer Dept. for details.

COMPUTER POWER SUPPLY

Switched mode. Stabilised. Self protecting.

S/C protected, etc. 220/240V AC. +5V 3.3A. -12V

2.4A 40% cycle. -5V 0.5A. -12V 0.5A Suitable

Apple replacement £50.00

(UK C/P £1.50)

COMPUTER FANS

CU7983 115V 50/60Hz

12/13W Impedance protected

(use 2 in series for 230V)

4 1/2" x 4 1/2" x 1"

Two for £8.70 (UK C/P 70p)

220/240V as new only £4.78 (UK C/P 50p) each



THERMAL PRINTER



**NEW LOW
PRICE**

COMPLETE WITH FULL

HANDBOOK 3 ROLLS PAPER £43.43

(UK C/P £1.50)

SUITABLE FOR: TANDY · BBC · DRIC · NASCOM ·
GEMINI · ACORN · NEW BRAIN · DRAGON · ETC.
ETC. (interface unit with leads £13 - state model)
(your enquiries invited)

CHERRY KEY PAD

16 button key pad non-encoded

£5.17 (UK C/P 30p)



MODEM CARDS/ COUPLER

Brand new, tested, answer and originate 300

BAUD uncased acoustic modem card by famous

manufacturer. RS232 input/output. Power supply

+/- 12V at 180mA. Requires 2 magnetic

earpieces, 2 switches, 2 LEDs and connectors to

complete. Circuits and connection data supplied.

Card only £26.04

Card and remainder of small components £29.09

Telephone Direct Line coupler type LTU 11 MKII.

Suitable for direct coupling PRESTEL adaptors

and the above acoustic modems. Integral Line

select and autodial relays requiring TTL inputs.

Circuits and connection data supplied.

LTU 11 Coupler £13.00

1200 BAUD receive 75 BAUD send direct coupled

modem for PRESTEL. Requires +5V supply with

TTL inputs for data, line select and autodial.

LTU 11 direct coupler required. See above.

Connection data supplied.

PRESTEL modem card £13.00

STOCKISTS FOR Printers: Paper, Thermal, Daisy-

wheel Disk Drives Boxed, Chassis also Winchester

Monitors: Green, Orange, White, Colour, Micro's: BBC,

Electron, Nascom, Galaxy, Plus others. Cables,

plugs, blank disks & tapes, software, books, etc.

Official orders welcome.

(Subject to confirmation)

Please add 15% VAT

(UK only)

Export orders allow

adequate CIF

Details available

most models send SAE

HENRY'S

COMPUTER SHOP

404-406 Edgware Road, London W2

01-402 6822

ORDER BY POST OR PHONE

CIRCLE 041 FOR FURTHER DETAILS.

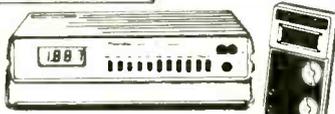
HENRY'S AUDIO ELECTRONICS

OPEN 6 DAYS A WEEK

TEST EQUIPMENT · COMPONENTS · COMMUNICATIONS · COMPUTERS

ALL MODELS ON DISPLAY

ALL PRICES EXCLUDE VAT



DIGITAL MULTIMETERS

PROFESSIONAL SERIES
Thandar Bench Portables
TM355 3 1/2 digit LED 29 ranges 10A AC/DC 20 Meg ohm - 0.25% basic **£85.00**
TM356 3 1/2 digit LCD 27 ranges 10A AC/DC 20 Meg ohm - 0.25% basic **£95.00**
TM351 4 1/2 digit LCD 29 ranges 10A AC/DC 20 Meg ohm - 0.1% basic **£115.00**
 (*Optional carry case £5.95)
Thurby Bench Portables
 (*Optional carry case £18.00)
1503 4 1/2 digit LCD 0.05% basic 10A resolution plus frequency measurement up to 4MHz AC/DC 10 Amps **£159.00**
1503H 4 1/2 digit LCD as above but 0.03% basic **£175.00**
1054 4 1/2 digit LCD True RMS version **£185.00**
1905a 3 1/2 digit intelligent multimeter 1uA resolution 0.015% basic **£325.00**
METRIX HAND/BENCH PORTABLES (ITT)
 (Size 188 x 86 x 50mm Rotary control)
MX522 3 1/2 digit LCD 21 ranges 10A AC/DC 2 Meg ohm Basic 0.5% **£87.00**
MX562 3 1/2 digit LCD 29 ranges 10A AC/DC 20 Meg ohm Basic 0.2% Plus continuity tester **£95.00**
MX563 True RMS 3 1/2 digit, 30 ranges 10A AC/DC, 20 Meg ohm, 20Hz to 30kHz 0.1% basic **£155.00**
MX575 4 1/2 digit True RMS, 21 ranges 10A AC/DC, up to 50kHz, 0.05% basic **£175.00**

HAND HELD MODELS

Controls: S = Slide R = Rotary PB = Push button
 All feature AC/DC volts, DC amps (many with AC amps) ohms etc. (UK C/P 65p)
ALL MODELS WITH CARRY CASE
KD25C 12 range 0.2A DC 2 Meg ohm (S) **£24.43**
KD30S 14 range 10A DC 2 Meg ohm (S) **£24.30**
KD30C 26 range 1A AC/DC 20 Meg ohm (R) **£29.13**
METEK 3000 30 range 10A AC/DC 20 Meg ohm (R) **£33.00**
6010 28 range 10A AC/DC 20 Meg ohm (PB) **£33.00**
KD55C 28 range 10A AC/DC 20 Meg ohm (R) **£34.74**
KD615 18 range 10A DC 2 Meg ohm plus Hfe tester (R) **£34.74**
7030 As 6010 but 0.1% basic (PB) **£41.30**
DM3350 Autorange plus cont. tester 18 range 10A AC/DC 2 Meg ohm (R) **£43.44**
DM2350 Mini autorange plus cont. tester 18 range 10A AC/DC (20A Max) 2 Meg ohm (PB) **£54.73**
SK6330 De-luxe autorange plus cont. tester 23 range 10A AC/DC, 0.5% Meg ohm (PB) **£79.00**

LOGIC PROBES

TTL, DTL etc.
LP10 10MHz **£19.96**
DLP50 50MHz **£43.44**
 (UK C/P either model £1.00)

ANALOGUE MULTIMETERS

Metrix (ITT)
Professional range
 (UK C/P 65p) Size 110 x 45 x 185mm
MX130 25 ranges 5000 ohms per volt 7 DC V 0.1 to 1000, 5 AC V 10V to 1000, 6 DC Amps 100uA to 30A, 5 AC Amps 30uA to 30A 2 ohms 1K to 10K **£65.00**
MX230 29 ranges 20K/Volt 100mV to 1000 V DC, 3V to 1000V AC 50uA to 10A DC, 3uA to 10A AC 1K to 10 Meg ohm **£59.00**
MX430 32 ranges 40K/Volt DC 4K/V AC 10mV to 1500V DC, 5V to 1500V AC 25uA to 15A DC, 1uA to 15A AC 50 ohm and 500 ohm (linear scale) 200K ohm and 20 Meg ohm **£89.00**

HIGH VOLTAGE METERS

Direct meter reading
LHM80A 0/40KV **£23.00**
KHP30M 0/30/45KV **£34.74**
 (UK C/P either model £1.00)

AC CLAMPMETER

0/300A, 0/600V AC 0/1K ohm
 Total 9 ranges with carry case and leads ST300 **£26.04** (UK C/P 65p)

FREQUENCY COUNTERS

All models BMC sockets
 Bench portables (UK C/P £1.00)
 (PFM200A pocket counter (C/P 65p))
METEOR SERIES
 UK made, 0.1Hz resolution, 8 digit, LED display, mains operated 220/240V AC, switchable gate times
MET1000 2 range 5Hz to 100MHz (120MHz typical) **£89.00**
MET600 3 range 5Hz to 600MHz (700MHz typical) **£115.00**
MET1000 3 range 5Hz to 1GHz (1.2GHz typical) **£159.00**
 (Optional 6 x nicads £9.95)
SABTRONICS
 New models, LED display, switchable gate times.
8110A 8 digit 20Hz to 100MHz **£79.00**
8610B 9 digit 10Hz to 600MHz **£109.00**
8000B 9 digit 10Hz to 1GHz **£149.00**
8500B 9 digit up to 1 1/2GHz **£239.00**
THANDAR
 UK made LCD displays with batteries
TF40A 8 digit 10Hz to 40MHz LCO, 1Hz resolution 40mV sensitivity 2 gate times with batteries **£120.00**
TF200 8 digit 200MHz LCO, 2 ranges resolution 1ppm, 10mV RMS sensitivity, 5 gate times with batteries **£165.00**
 Optional carry case £5.95, AC mains adaptor £6.95
PFM200A Pocket 8 digit 20Hz to 200MHz, 2 band LED display with battery 0.1Hz resolution, 10mV sensitivity with battery **£69.50**
PRESCALERS
 Suitable for most types of counters to extend range. (Thandar) BNC sockets
TP600 40MHz to 600MHz, 10mV RMS direct powered by counter **£45.00**
TP1000 100 to 1000MHz complete with AC adaptor P/S, 25mV RMS sensitivity **£65.00**
 Optional probe kits - suitable for all models
 X1 **£6.90** X10 **£8.26**

VARIABLE POWER SUPPLIES

220/240V AC input
PP241 single meter, A/V switch, 0/30V 1 amp **£30.43**
PP243 3 amp version **£45.65**
230N Twin meter 0/30V 1A **£83.00**
330N 3 amp version **£142.00**
 (UK C/P above models £1.00)
 PL Laboratory series - LED readout - QMD versions series/parallel etc.
PL310 30V 1A **£118.00** **PL310** QMD **£259.00**
PL320 30V 2A **£145.00** **PL320** QMD **£315.00**
 (UK C/P above models £2.50)

ANALOGUE MULTIMETERS

General range (*mirror scale)
 (UK C/P 65p)
HC6015 15 range pocket 10K/Volt 1 meg ohm **£7.39**
M200 30 range 20K/Volt 20KHz Special purchase **£8.85** (list price £19.00)
HM102B 22 range 20K/Volt 10A 3C plus cont. Buzzer, 10 Meg ohm **£11.74**
TMK500 23 range bench, 30K/Volt 12A DC Plus cont. buzzer, 20 Meg ohm **£20.83**
NH56R 22 range 10K/Volt 8 Meg ohm **£10.39**
830A 26 range 30K/Volt 10A AC/DC, 10 Meg ohm **£20.83**
360TR 23 range bench, 100K/Volt, large scale, 10A AC/DC plus Hfe tester, 10 Meg ohm **£34.74**
AT2100 31 range de luxe 100K/Volt 10A AC/DC, 100 Meg ohm **£29.13**
AT1020 18 range de luxe 20K/Volt plus Hfe tester, 5 Meg ohm **£18.26**
YN360TR 19 range 20K/Volt plus Hfe tester 1 Meg ohm **£12.13**
KRT5001 Range doubler 35 range total 50K/Volt 10A DC 20 Meg ohm **£17.35**
ST303TR 22 range 20K/Volt plus Hfe tester 12A DC 1 Meg ohm **£15.81**

ELECTRONIC INSULATION TESTER

500V/0-100 Meg ohm with carry case, leads etc.
YF501 **£59.13** (UK C/P 65p)

SIGNAL GENERATORS

220/240V AC (UK C/P & ins £1.00)
 Bench portable all sine/square/triangle/TTL/etc.
 External sweep mode.
FUNCTION
Thandar TG101 * 0.02Hz to 200KHz various facilities **£105.00**
Thandar TG102 * 0.2Hz to 2MHz various facilities **£155.00**
Sabtronic 5200A 0.1Hz to 2MHz **£239.00**
Thandar Pulse Bench portable **£105.00**
TG105 * 5Hz to 5MHz Various facilities + Optional carry case **£5.95**
AUDIO
Leader LA627 5 band sine/square 0/P/0/5V RMS Dist 0.05% 10Hz to 1MHz **£93.00**
Leader LA6120A 5 band 10Hz to 1MHz to 0.3V RMS into 600 ohm 0.05% dist sine/square **£145.00**
Leader LA6125 5 band 10Hz to 1MHz to 0.3V RMS into 600 ohm sine/square/burst signals 0.03% dist **£330.00**
TRIO AG202A 4 band 20Hz to 200KHz, 10V RMS 0/P 0.5% dist, CR OSC 0/10V pp 0/P **£89.00**
TRIO AG203 5 band 10Hz to 1MHz, 0.1% dist 0/7V RMS 0/P **£139.00**
RF
TRIO SC402 6 range 100KHz to 30MHz RF 0.1V RMS int/ext mod **£72.00**
Leader LS617 6 band 100KHz to 150MHz (96 to 450MHz on Harmonic) RF 0.1V RMS, int/ext mod, AF 1KHz 1 volt (1MHz Xcal optional) **£95.00**

DIGITAL CAPACITANCE METERS

Direct reading LED meters
DM6013 Pocket/bench 8 range 0.1pF to 2000mfd 3 1/2 digit 0.5% with battery (UK C/P 65p) **£52.13**
CM200 Bench model 4 digit 0.2% 1pF to 2500mfd 6 ranges (UK C/P 85p) **£89.00**

DIGITAL THERMOMETERS

Pocket size LCD thermometers complete with battery! Accept any type K probe (UK C/P 65p)
TH301 LCD -50 C to +750 C, 1 C resolution with thermocouple **£59.50**
TH302 LCD -40 C to +1100 C Cent/Fahrenheit 0.1° and 1° resolution with thermocouple **£79.50**
 Range of various probes in stock **£17.50 to £25.00**

COMPONENTS · ACCESSORIES TOOLS

Large range in stock semiconductors, relays, tools. Plus millions of capacitors, resistors, presets, controls, plugs/sockets etc. For bulk export users. Tel: 01-723 1008 with enquiries.

OTHER EQUIPMENT IN STOCK

Send SAE for full specifications
 (* UK C/P £1.50 + UK C/P £1.00)
LHC 909B - VHS/BETA video head tester **£45.00**
OM358 - Scope multiplexer, 35MHz, expands any scope to eight channels **£169.00**
LTC905 - Scope add-on semicon curve tracer **£99.00**
LCT906A - Transistor tester (all types) **£109.00**
LTC907 - Transistor tester, signal injector tracer **£178.00**
LVT72 - FET/VOM/transistor tester **£143.00**
LCR740 - LCR bridge: cap, inductance and resistance **£195.00**
LDM170 - Distortion meter 20Hz to 20KHz **£310.00**
LFG1300 - Sweep 0.3° function generator 0.002Hz to 2MHz **£395.00**
TC40 - VHF/UHF FM and TV field strength meter Battery operated with carry case **£177.00**
MC321 - UK PAL TV colour pattern generator **£222.60**
MC32B - As above but Secam B-G-H **£222.60**
DM801 - 700KHz to 250MHz Dip meter inductive/cap res. freq. measurement etc. **£62.00**
CHART RECORDER 100mV (2mA) Panel mount 240V AC **£149.00**
LFM39 A-0 - Wow and flutter meter, Jis. CCIR. Din. **£445.00**
HZ65 - Scope add on component tester **£24.00**
MT910A - CRT tester/rejuvenator for b/w and colour **£175.00**

OSCILLOSCOPES

Full specification any model Send SAE
 UK C/P - & ins
 Single trace Dual trace carrier **£2.60** **£3.50**
 TNT **£5.20** TNT **£7.00**
 Securitor **£10.45** Securitor **£13.00**
 2 years warranty
HAMEG
HM103 Single trace, 10MHz, 2mV, 6 x 7cm display plus component tester **£158.00**
HM203 Dual trace 20MHz 2mV Algebraic add, 7 Mod plus component tester (Optional carry case £21.50) **£264.00**
HM204 Dual trace 20MHz, sweep delay, 2mV, plus component tester (optional carry case £21.50) **£365.00**
HMG605 Dual trace 50MHz, delay line, 1mV, 1MHz CALGEN (optional carry case £21.50) **£487.00**

HITACHI

All models 5mV (1mV using x5 magnifier)
 All models complete with 2 probes.
 2 years warranty.
V212 Dual 20MHz bench portable 6 CRT CH1 D/P **£335.00**
V222 Dual 20MHz, portable with DC offset and alternate magnifier **£375.00**
V302F 30MHz dual trace laboratory portable, 5" CRT **£369.00**
V422 Dual 40MHz, portable with DC offset and alternate amplifier **£580.00**
V203F Dual 20MHz lab portable with sweep delay 5" CRT **£375.00**
V650F Dual 60MHz lab portable with dual time base **£850.00**

Also in stock V134 storage, VC6015 digital storage scopes, Battery/Mains Scope, Vector & TV monitor available

CROTECH

3030 Single trace 15MHz, 5mV, 95mm CRT plus component tester **£154.00**
3132 Dual 20MHz, 2mV, 5 CRT Algebraic +/- 2 mod, plus component comparator and DC source outputs **£283.00**
3034 Battery/mains dual trace 15MHz, 5mV, 95mm CRT, algebraic +/- **£400.00**

TRIO

2 years warranty
GS2310B Single trace 10MHz, 5mV, 75mm display mains portable **£132.00**
SC1562A Dual trace 10MHz, 130mm CRT, 10mV, 1 microsec, with 2 probes **£260.83**
SC1566A Dual 20MHz, 140mm CRT, 5mV, 0.5 microsec, with 2 probes **£332.60**

THANDAR

2 years warranty
SC110A 10MHz battery bench portable, 10mV 32 x 26mm display, Size 256 x 150 x 50mm **£165.00**
 (Optional carry case £5.95, AC adaptor/charge £6.95) **Rech Nicad £11.00**

EDUCATIONAL; MIXED QUANTITY & EXPORT DISCOUNTS

We would be pleased to quote. Contact sales office at 406.

TRANSISTOR TESTER

Direct reading PNP/NPN and diodes. Hfe, leakage etc. General purpose TC1 **£19.96** (UK C/P 65p)

PROBE KITS

In wallets with adaptors etc. BNC fittings for scopes/counters/generators etc.
 X1 **£6.90** X1/X10 Switchable **£10.00**
 X10 **£8.26** Demodulator **£18.00**
 X100 **£16.00**
 (UK C/P free with other item or 65p per 1 to 3 kits)

RETAIL · MAIL ORDER · EXPORT · INDUSTRIAL · EDUCATIONAL Official orders welcome. (Subject to confirmation) Please add 15% VAT (UK only) Export allow adequate CIF PRICES EXCLUDE VAT

Shop **HENRY'S** 404-406 Edgware Road, London, W2
 Computers 01-402 6822 · Equipment 01-724 0323 · Components 01-723 1008
 Shop **AUDIO ELECTRONICS** 301 Edgware Road, London, W2
 Test Equipment, Audio, Communications 01-724 3564
 All mail to Cubegate Ltd, 1st Floor, 406 Edgware Road, London W2 1ED

ORDER BY PHONE OR BY POST OR CALL IN AND SEE FOR YOURSELF

Pay with Access VISA AMERICAN EXPRESS

Order by Post with CHEQUES/ACCESS/ VISA or you can telephone your order. Up to £1000 instant credit Available through Lombard Tricity Finance

CATALOGUES

Send large SAE (20p UK) Specification sheets Any model (State which) Send SAE Schools, colleges, companies Export free on written request

CIRCLE 042 FOR FURTHER DETAILS.

B. BAMBER ELECTRONICS

Marconi Modulation Meter Type TF2301A	£330
Marconi RMS AC/DC Voltmeter Type TF 2607	£185
Marconi RF Power Meter Type OA 7024/4	£195
Marconi UHF Attenuator Type TF 2168	£100
Wavetek LF Generator Type	£380
Solartron DVM Type 1420 2	£65
Hewlett Packard Power Supply 0-40v \pm 30amp Type 6268B	£450
Schomandi Modulator Type MAF BN 841962	£650
Schoolmandi Synthesizer Type ND 100M	£1200
Rohde & Schwarz Decade Signal Generator 0.3-500Mhz Type SMDV BN 41104	£1200
Rohde & Schwarz Sweep Signal Generator 50Khz - 12Mhz Type BN 4242/2	£75
Rohde & Schwarz Power Signal Generator 0.1-30Mhz Type BN 41001	£125
Rohde & Schwarz Frequency Indicator Type BN 47051	£50
Rohde & Schwarz Group Delay Measuring Equipment Indicator	£50
Marconi AM Signal Generator 10 - 500Mhz Type TF 801B	£125
Marconi AM Signal Generator 10 - 310Mhz Type TF 801A/1	£85
Marconi Standard Signal Generator 15Khz - 440Mhz Type TF 867	£85
Marconi RC Oscillator 20Hz - 200Khz Type TF 1101	£85
Marconi AM/FM Signal Generator Type TF 995A/5	£230
Marconi VHF Signal Generator Type TF 1064B/5M	£125
Marconi Tx & Rx Output Test Set Type TF 1065	£85
Pye Modulation Meter 68 - 510Mhz Type MM1	£60
Airmec Sweep Signal Generator 20Hz - 200Khz Type 352	£45
Marconi Universal Bridge Type TF 868B	£110
Marconi Universal Bridge Type TF 1313	£250
Tektronix Oscilloscope Type 647	£196
Tektronix Oscilloscope Type R647A Less Plugins	£25
EMI Wide Band Amplifier Plug-in Type 7/1	£85
Advance Oscilloscope Type OS15ALP Tube 3Mhz	£125
Advance Oscilloscope Type OS25A Twin Beam 3Mhz	£85
Tektronix Oscilloscope Type 502	£85

Pye Base Station Type F30 AM High Band & Low Band from	£220
Pye Base Station Type F401 AM High Band	£250
Pye Base Station Type F17 FM High Band	£250
Pye Reporter Type MF6 AM High Band & Low Band	£90
Pye Europa Type MF5 FM High Band	£70
Pye Europa Type MF5 UHF	£70
Pye Olympic Type M201 AM High Band	£65
Pye Motofone Type MF5 AM High Band & Low Band	£45
Pye Westminster Type W30 Low Band	£25
Pye Pocketphone Type PF5 UHF Complete with Batteries	£35
Burndepi UHF Portable Type BE 471 with manual	£125

Servomex AC Voltage Stabiliser Type AC2 240 vac 9amp	£45
Servomex AC Voltage Stabiliser Type AC7 240 vac 40amp	£95
Hewlett Packard Sweep Generator Type 6920 1 B - 4 2Ghz	£300
Tektronix Plug in Power Unit Type 133 with Type O Plug in	£85
Tektronix Storage Display Unit Type 611	£120
Tektronix Oscilloscope Type 515A	£85
Tektronix Plug in Type CA	£25
Schomandi Frequency Meter Type FD1 30 - 900Mhz	£50
Rohde & Schwarz AF Wave Analyzer Type BN 48302	£50
Rohde & Schwarz UHF Test Receiver Type BN 1523 280-940Mhz	£75
Airmec Modulation Meter Type 210 3-300Mhz	£95
Marconi Carrier Deviation Meter Type TF 791 D 4-1024Mhz	£125
Marconi FM Signal Generator Type TF 1066B/1 10-470Mhz	£260
Marconi AM Signal Generator Type TF 144H/4S 10Khz - 72Mhz	£125
Marconi Out of Limits Indicator Type TF 2404	£60
UCC Micro - Film Reader Cassette Type	£35
Marconi Transmission Line Test Set Type TF 1267	£40
Marconi Variable Attenuator 75ohm Type TF 1073A/2S	£20
60 amp Alternator & Generator Noise Filter	£1 00 each
Instrument Fans 4 1/2" x 4 1/2" 240vac £3 each. 110vac £1 50 each	
Garrard Car Cassette Player Mechanisms. Stereo Head	£2 50
Tektronix Oscilloscope Probes	£10 each
Pye Pocketphone Rx Ni-Cad Batteries	3 for £1 00
Mullard Vari-cap TV Tuners Type ELC 2003 Ex. Brand New Sets	£3 50
Pye Cambridge/Vanguard 18 Way Control Leads	£4 00
Sony 1/2" Video Tape 5" Reels	£2 00
BNC Plugs 75ohm	50p each
IC Test Clips 28 pin & 40 pin	£2 00 each
Circulators 590 - 720 Mhz 'N' sockets	£25
Transistors Type 2N3055	4 for £1 00
Transformers 30 volt \pm 1 amp	£1 00
Transformers 36 volt \pm 1.5 amp	£1 00
Transformers 600 - 0 - 600 \pm 250mA plus 460 - 0 - 460 \pm 230mA	£10 00
'Variacs' 2 amp, 5 amp, 8 amp, 15 amp, 20 amp, 25 amp	
Loudspeakers Richard Allan Type CP12 12" 15ohm	£6 00
Capacitors 16 mfd 6.5kv £25 each. 0.33 mfd 10kv	£4 00 each

WANTED Second Hand Radiotelephone Equipment

Pye Bantam Battery Chargers	£10
Rank Telecoms Battery Charges	£10
Pye pocketphone PFI Battery Chargers 12 Way	£10
ITT Starphone Battery Chargers	£10
Tektronix Hard Copy Unit Type 4601	£125
Advance Pulse Generator Type PG 5002	£85
Siemens Milliwattmeter 50ohm 500mW 0-12 4Ghz	£95
Gaumont - Kalee Flutter Meter	£40
Siemens Transistor Power Unit 0-30v 2amp	£30
Avo Valve Characteristic Meter Type 3	£40
Airmec Wave Analyser Type B53 30Khz - 20Mhz	£45
Sullivan RC Oscillator 40Hz - 125Khz	£35
MESL Sweep Oscillator Type M1000 8-12Ghz	£125
Electronome 9" Video Monitor metal case	£50
Aztec 20" Video Monitor metal case	£40
ITT 20" & 24" Video Monitors wooden case	£30
General Radio Microwave Oscillator Type 1360B1 7 - 4.1Ghz	£125
Wayne Kerr Component Bridge Type B521	£45
Marconi Oscillator Type TF 1246 40Khz - 50Mhz	£95
Wandel & Golttermann Level Meter Type FPM 43 10Khz - 14Mhz	£60

PYE POCKETPHONE PF1 UHF RECEIVER

440-470 MHz, Single Channel, int. speaker and aerial. Supplied complete with rechargeable battery and service manual, **£6 each plus £1 p.p. plus V.A.T.**

BREAKING TEK 545A SCOPES FOR SPARES

CRT type T543 P2 **£12 each**. Mains Transformers T601 **£15**. High Volume Transformer T801 with valves **£25**. Also Switches, Knobs, Fans, Capacitors and Metalwork.

RADIOSONDE RS21 METEOROLOGICAL BALLOON TRANSMITTER

with Water Activated Battery, contains all-weather sensors, fully solid state, **£5 each plus £1 p.p. plus V.A.T.**

P. & P. or Carriage and V.A.T. at 15% on total must be added to all orders.

Callers very welcome, strictly between 9 a.m. and 1 p.m. and 2 and 5 p.m. Monday to Friday inc.

Barclaycard and Access taken
Official orders welcome

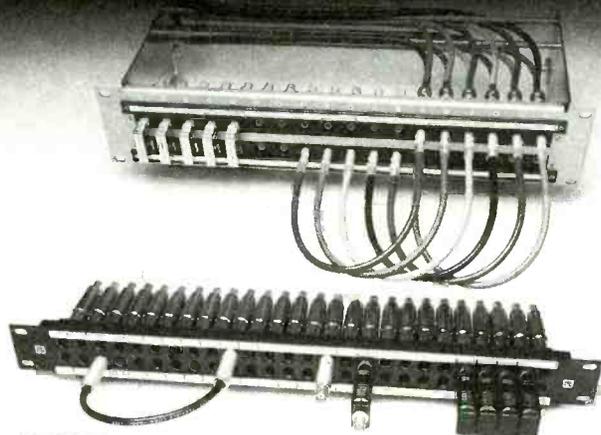


5 STATION ROAD, LITTLEPORT, CAMBS CB6 1QE
PHONE: ELY (0353) 860185



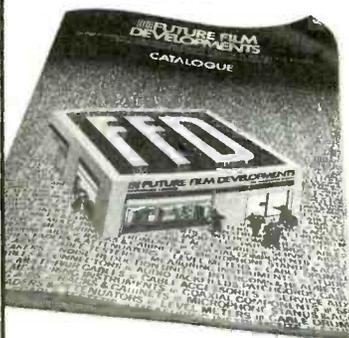
CIRCLE 072 FOR FURTHER DETAILS.

Video/Data Jackfields?



MUSA & American pattern are listed in our Catalogue.

Write or call for your free copy.

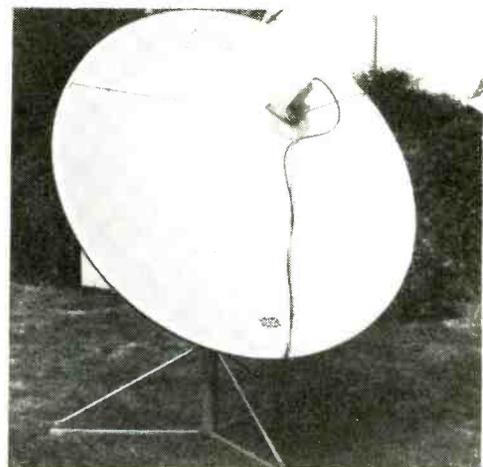


FUTURE FILM DEVELOPMENTS

114 Wardour Street, London W1V 3LP, England.
Telephone: 01-434 3344 & 01-437 1892. Telex: 21624 ALOFFD G

CIRCLE 004 FOR FURTHER DETAILS.

SATELLITE RECEIVING EQUIPMENT



1.9M, 2.5M and 5M Harrison Dishes. Sat-Tec R5000 4GHz Receivers. Avcom COM-2B 4GHz Receivers. California Amplifier 4GHz LNAs. Chaparral Horns. Harrison Feed Horns.
Demonstrations by appointment only.

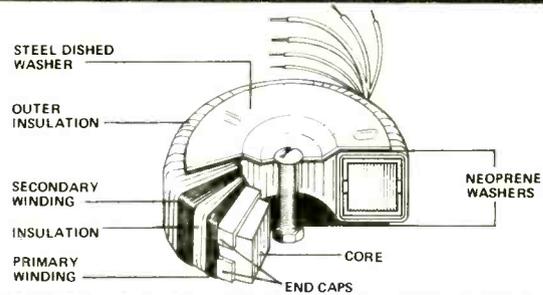
Dealer enquiries welcome

For further details contact: **Harrison Electronics, 22 Milton Road, Westcliff-on-Sea, Essex SS0 7JX. Telephone: Southend (0702) 332338.**

TOROIDALS

The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidals offer in size, weight, lower radiated field and, thanks to I.L.P., PRICE.

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 14 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with no price penalty.



15 VA 62 x 34mm Regulation 19%	50 VA 80 x 35mm Regulation 13%	120 VA 90 x 40mm Regulation 11%	225 VA 110 x 45mm Regulation 7%	500 VA 140 x 60mm Regulation 4%
SERIES SECONDARY RMS No Volts Current 0x010 6+6 1.25 0x011 9+9 0.83 0x012 12+12 0.63 0x013 15+15 0.50 0x014 18+18 0.42 0x015 22+22 0.34 0x016 25+25 0.30 0x017 30+30 0.25 (encased in ABS plastic)	2x010 6+6 4.16 2x011 9+9 2.77 2x012 12+12 2.08 2x013 15+15 1.66 2x014 18+18 1.38 2x015 22+22 1.13 2x016 25+25 1.80 2x017 30+30 0.83 2x028 110 0.45 2x029 220 0.22 2x030 240 0.20	4x010 6+6 10.00 4x011 9+9 6.66 4x012 12+12 5.00 4x013 15+15 4.00 4x014 18+18 3.33 4x015 22+22 2.72 4x016 25+25 2.40 4x017 30+30 2.00 4x018 35+35 1.71 4x028 110 1.09 4x029 220 0.54 4x030 240 0.50	6x012 12+12 9.38 6x013 15+15 7.50 6x014 18+18 6.25 6x015 22+22 5.11 6x016 25+25 4.50 6x017 30+30 3.75 6x018 35+35 3.21 6x026 40+40 2.81 6x025 45+45 2.50 6x033 50+50 2.25 6x028 110 2.04 6x029 220 1.02 6x030 240 0.93	8x016 25+25 10.00 8x017 30+30 8.33 8x018 35+35 7.14 8x026 40+40 6.25 8x025 45+45 5.55 8x033 50+50 5.00 8x042 55+55 4.54 8x028 110 4.54 8x029 220 2.27 8x030 240 2.08
30 VA 70 x 30mm Regulation 18%	80 VA 90 x 30mm Regulation 12%	160 VA 110 x 40mm Regulation 8%	300 VA 110 x 50mm Regulation 6%	625 VA 140 x 75mm Regulation 4%
1x010 6+6 2.50 1x011 9+9 1.66 1x012 12+12 1.25 1x013 15+15 1.00 1x014 18+18 0.83 1x015 22+22 0.68 1x016 25+25 0.60 1x017 30+30 0.50	3x010 6+6 6.64 3x011 9+9 4.44 3x012 12+12 3.33 3x013 15+15 2.66 3x014 18+18 2.22 3x015 22+22 1.81 3x016 25+25 1.60 3x017 30+30 1.33 3x028 110 0.72 3x029 220 0.36 3x030 240 0.33	5x011 9+9 8.89 5x012 12+12 6.66 5x013 15+15 5.33 5x014 18+18 4.44 5x015 22+22 3.63 5x016 25+25 3.20 5x017 30+30 2.66 5x018 35+35 2.28 5x026 40+40 2.00 5x028 110 1.45 5x029 220 0.72 5x030 240 0.66	7x013 15+15 10.00 7x014 18+18 8.33 7x015 22+22 6.82 7x016 25+25 6.00 7x017 30+30 5.00 7x018 35+35 4.28 7x026 40+40 3.75 7x025 45+45 3.33 7x033 50+50 3.00 7x028 110 2.72 7x029 220 1.36 7x030 240 1.25	9x017 30+30 10.41 9x018 35+35 8.92 9x026 40+40 7.81 9x025 45+45 6.94 9x033 50+50 6.25 9x042 55+55 5.68 9x028 110 5.68 9x029 220 2.84 9x030 240 2.60

Why a Toroid?

- * Smaller size & weight to meet modern 'slimline' requirements.
- * Low electrically induced noise demanded by compact equipment.
- * High efficiency enabling conservative rating whilst maintaining size advantages.
- * Lower operating temperature.

Why ILP?

- * Ex-stock delivery for small quantities.
- * Gold service available. 21 days manufacture for urgent deliveries.
- * 5 year no quibble guarantee.
- * Realistic delivery for volume orders.
- * No price penalty for call off orders.

Prices including P&P and VAT

VA	Size	£	VA	Size	£
15	0	7.43	160	5	12.90
30	1	8.08	225	6	16.30
50	2	10.10	300	7	18.55
80	3	10.81	500	8	25.73
120	4	11.73	625	9	31.63

Mail Order — Please make your crossed cheques or postal orders payable to ILP Electronics Ltd.

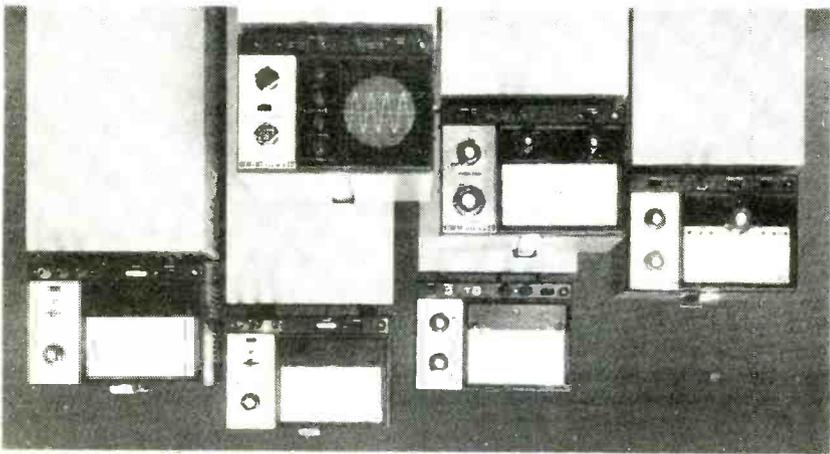
Trade — We will open your credit account immediately upon receipt of your first order.

Post to: ILP Electronics Ltd., Dept. 3
 Graham Bell House, Roper Close,
 Canterbury, Kent. CT2 7EP
 Tel: (0227) 54778 Telex: 965780



ILP ELECTRONICS LTD.

CIRCLE 021 FOR FURTHER DETAILS.



- High-Sensitivity 5MHz Oscilloscope **CO-1303D**
- RC Oscillator **AG-202A**
- Regulated DC Power Supply **PR-602A**
- Regulated DC Power Supply **PR-601A**
- Wideband RF Signal Generator **SG-402**
- High-Sensitivity Electronic Voltmeter (FET VOM) **VT-108**

TRIO

hi! 2 year guarantee

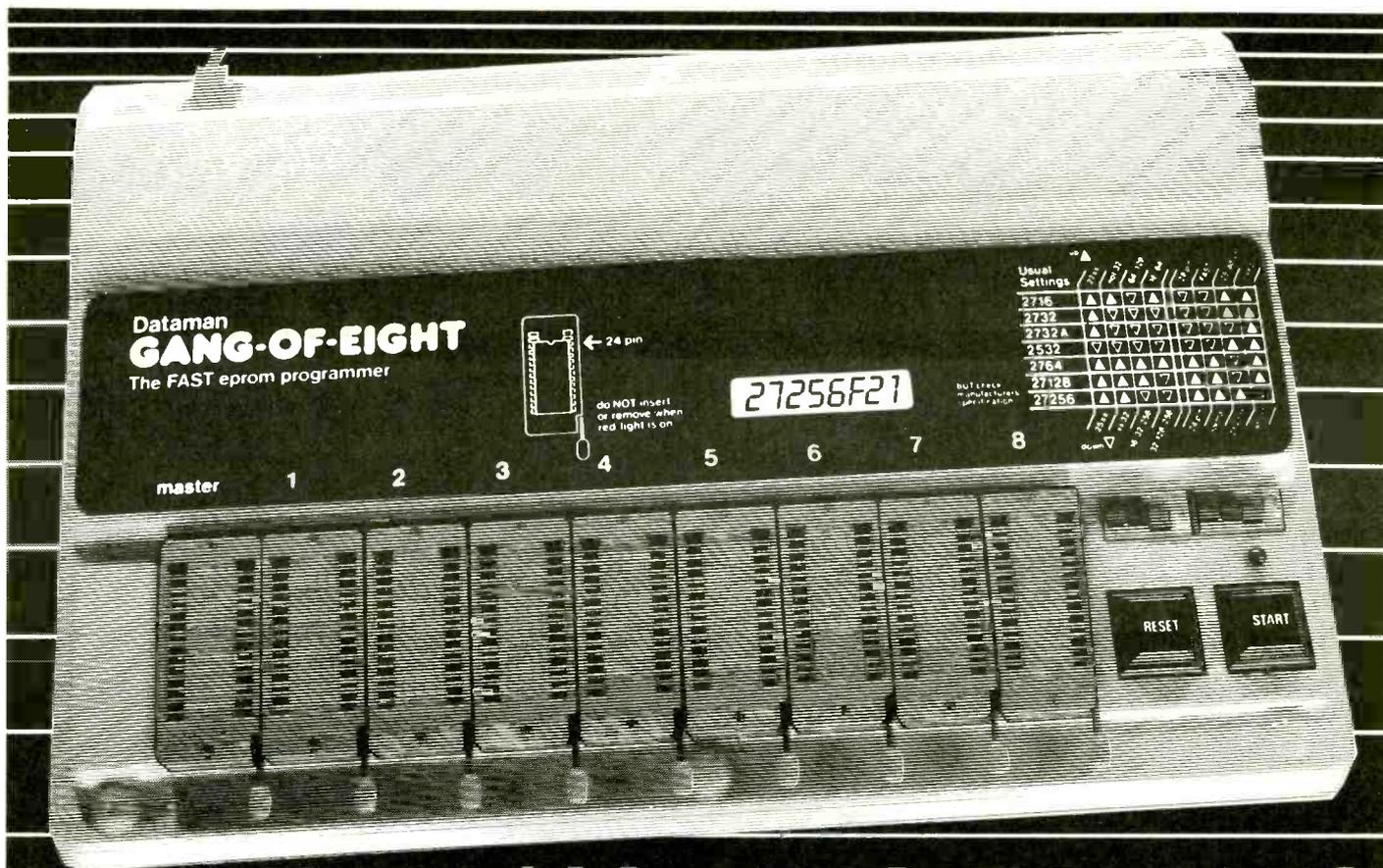


& series

hi!

House of Instruments Ltd.
 Clifton Chambers, 62 High Street
 Saffron Walden, Essex CB10 1EE
 Tel: (0799) 24922 Telex: 818750

CIRCLE 054 FOR FURTHER DETAILS.



FANCY A BURN-UP?

FAST PROGRAMMING

When manufacturers' recommended Fast Programming Algorithms can be used. GANG-OF-EIGHT IS FIVE TIMES AS FAST AS A STANDARD PROGRAMMER. This means you can program a set of 27128's in 2 minutes — not 14 minutes. Or 2764's in 1.25 minutes instead of 7 minutes.

GANG-OF-EIGHT will program all single-rail devices from 2716 to 27256 with FAST or NORMAL algorithms. All possible levels of programming voltage are covered — even the latest 10.5 and 12.5 volt levels.

FAST THROUGHPUT

GANG-OF-EIGHT has SINGLE-KEY OPERATION, which makes life very easy for the operator. It always performs VERIFY and BLANK-CHECK operations automatically: it won't let you program the same EPROMS twice, or program EPROMS which are not blank. In the FAST programming mode, GANG-OF-EIGHT can produce several times the output of a standard programmer.

FAST DELIVERY

At the time of writing, DATAMAN has more than enough stock to meet the expected demand for GANG-OF-EIGHT. If you want confirmation before sending your cheque, please telephone us with an order number and a GANG-OF-EIGHT will be packed and set aside for you.

GANG-OF-EIGHT, including instruction card, power supply and carriage **£395**
+ VAT (= £454.25)

FAST MONEY BACK GUARANTEE

Part of our value-for-money deal is the REFUND GUARANTEE: if you don't want your GANG-OF-EIGHT you can return it within a fortnight and we'll send your money back immediately, less the cost of postage. We realise that this is like operating a free hire service, but we believe that most engineers are straight. *We will be most surprised if we get any GANG-OF-EIGHTS back.*

FEATURES

- ★ CONVERSATIONAL LIQUID CRYSTAL DISPLAY
- ★ NINE INDUSTRY — STANDARD TEXT TOOL ZIF SOCKETS
- ★ SWITCH-SELECTION OF EPROM TYPE (NO MODULES TO BUY)
- ★ PROGRAMS ALL SINGLE RAIL EPROMS INCLUDING 27256
- ★ USER CAN CHOOSE NORMAL OR FAST PROGRAMMING ALGORITHM
- ★ SINGLE KEY OPERATION
- ★ WORKS FASTER THAN STANDARD PROGRAMMER
- ★ INTELLIGENT OPERATION TRAPS OPERATOR ERRORS
- ★ SAFETY FEATURES BUILT-IN
- ★ LOW-COST DESIGN

*Dataman
Designs*

Lombard House, Cornwall Road,
Dorchester, Dorset, United Kingdom
Telephone: Dorchester (0305) 68066.
Telex: 418442

Pausaid

This low-cost speech training aid won second prize in *Wireless World's* recent design competition. It offers help to a large number of people with moderate speech impairments.

There are a number of speech disorders which cause patients to lose control of their rhythm of speech or to run words together. One relatively common example is dysarthria, which results from damage to the central or peripheral nervous system. This may lead to slurring, lack of co-ordination or altered muscle tone, which reduce the intelligibility of the speaker's words. The effects can range from a slight difficulty in pronouncing certain syllables to complete loss of the power of speech.

Dysarthria can be a sign of such diseases of the nervous system as Parkinsonism, multiple sclerosis and Huntington's chorea, or it may be the result of some incident such as a stroke or head injury.

The main aim of speech therapy with dysarthritic patients is to improve the clarity of speech and to minimise the abnormal characteristics. Patients are encouraged to reduce the speed of their speech and to enunciate each syllable separately, so that they can articulate with greater precision.

Unfortunately, most find it hard to monitor their own speaking rate: they do not know when they are speaking too fast or that

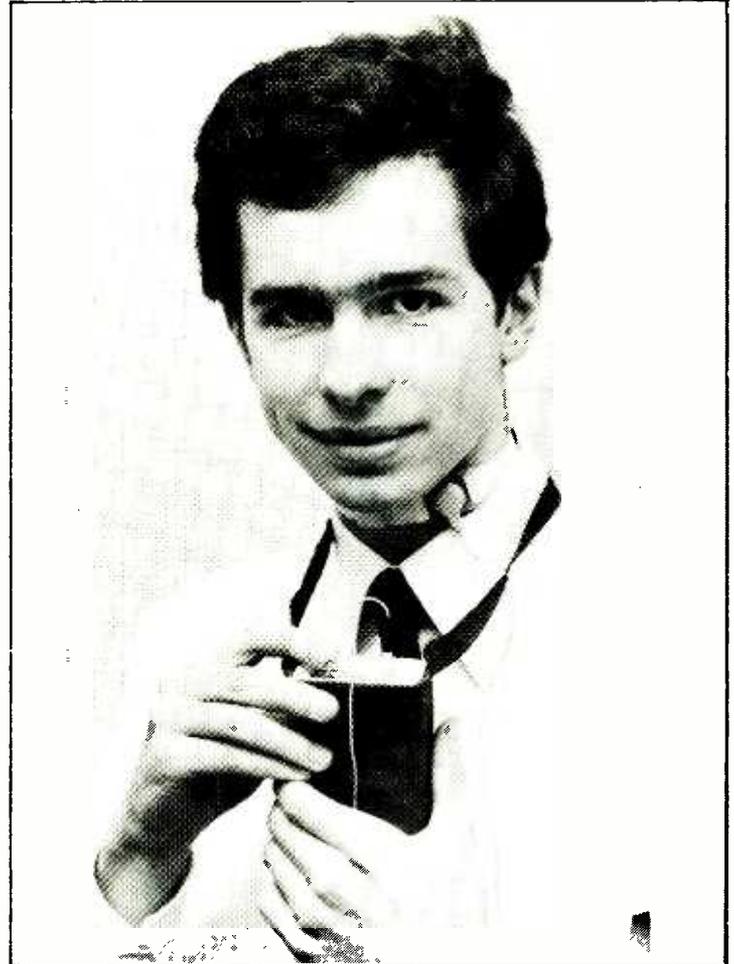
they are eliding words and syllables.

Some patients in these groups have spoken rapidly for most of their lives, and to change such a deeply ingrained pattern of behaviour may take a sustained effort. Many improve their speech dramatically during therapy sessions, only to slip back to their old ways when they return home. But with help of a simple training aid, these people might be able to continue their practice at home, freeing the speech therapist to deal with more sufferers.

The aid described in this article was developed in co-operation with Dr Pam Enderby, chief speech therapist of the Frenchay Hospital in Bristol. A survey carried out by Dr Enderby's department indicates that there are some 400 000 people in the United Kingdom with moderate speech disorders; and she believes that such an aid may be able to help at least 250 000 of them.

Circuit design

The function of the aid is to monitor the wearer's speech, analyse it for pauses and to sound a warning



Racal Electronics Ltd

if the pauses are absent or spaced too widely.

To avoid false triggering by extraneous noises a throat microphone is used. The type chosen is already widely found in speech therapy departments; it is very light and comfortable to wear. The microphone plugs into a small plastics box containing the electronics, which may be supported by a carrying pouch hung around the neck. Since the aid is intended for remedial exercises

by
P.J. Pickersgill
B.Sc. and
N.J. Stewart
B.Sc.

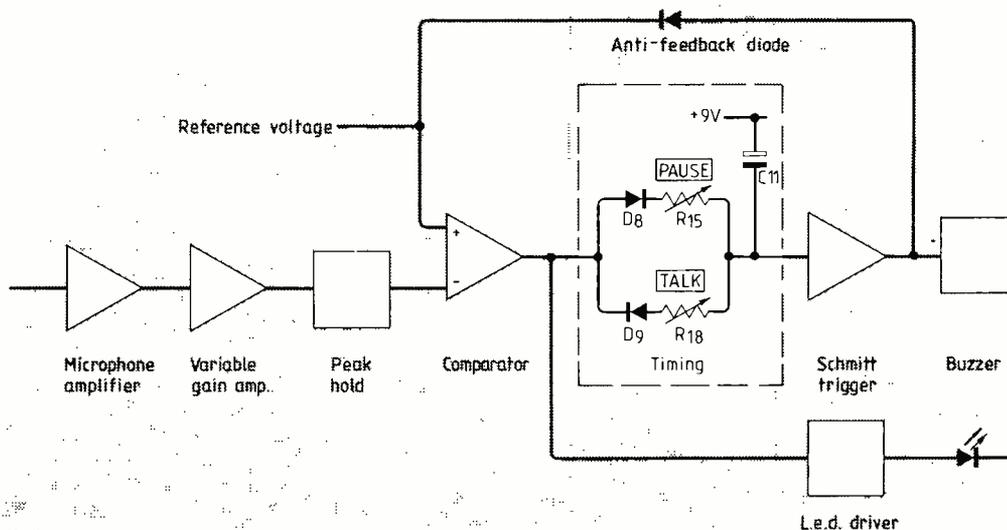


Fig. 1. How Pausaid works: C₁₁ charges when the user speaks and discharges during moments of silence. If he fails to pause now and then, the buzzer sounds.

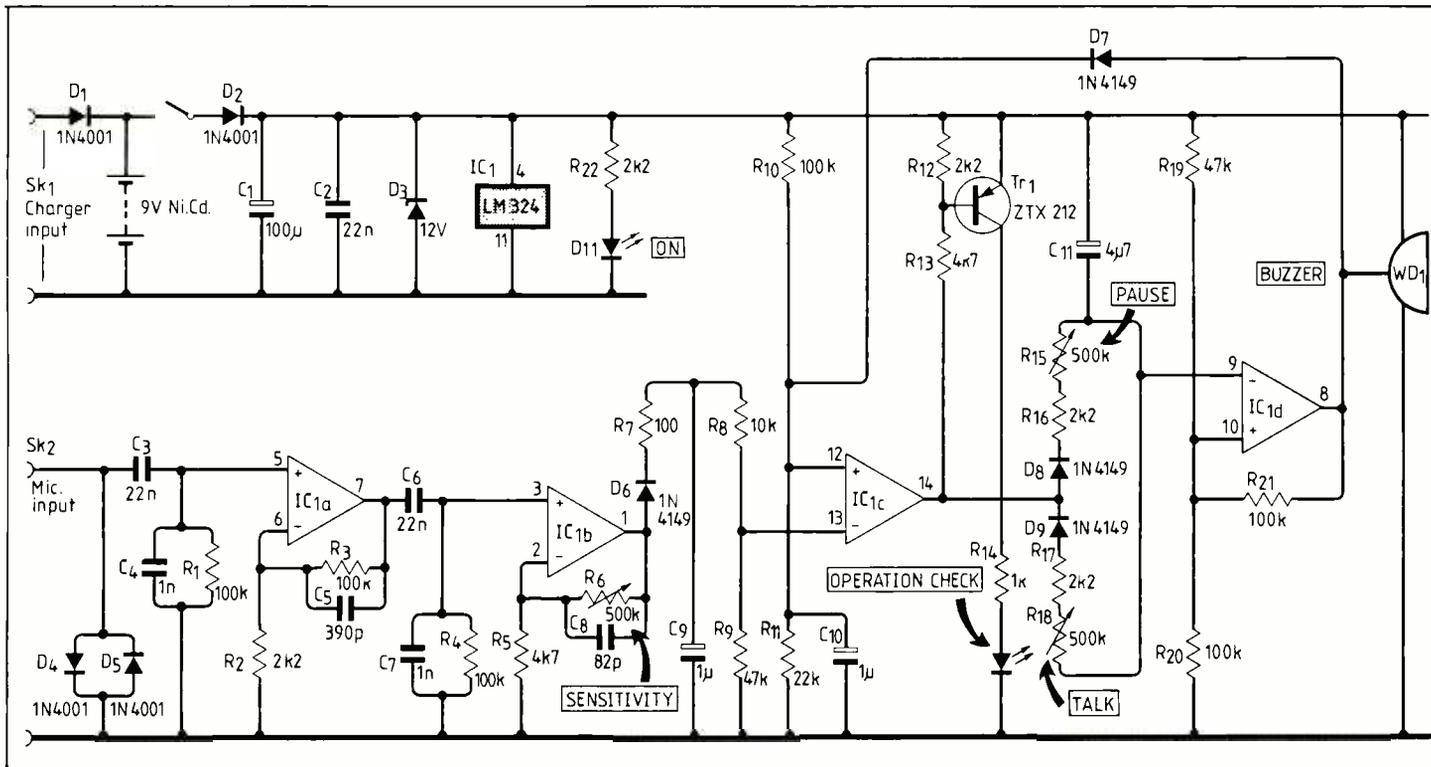


Fig. 2. Complete circuit of Pausaid. R₁₅ and R₁₈ are miniature multi-turn presets. Sensitivity control R₆ should be adjusted so that the led flashes whenever the patient talks.

and not for everyday communication, there is no need to conceal it.

Operation of the aid is centred on a capacitor which charges up as the patient speaks and discharges during pauses. If the charge exceeds a preset threshold a buzzer is triggered.

The design is based upon an LM324 quad op-amp. One section, IC_{1a}, forms a microphone amplifier with a gain of about 50. Its input is clamped by D₄ and D₅ to prevent damage should the battery charger be plugged into the wrong socket. IC_{1b} is arranged as

a variable gain amplifier with a maximum gain of 100 controlled by the preset resistor R₆. A peak-hold function is provided by D₆, R₇ and C₉. IC_{1c} is used as a comparator, its reference voltage supplied by R₁₀ and R₁₁.

The talk without pause time limit is fixed by D₉, R₁₇, R₁₈ and C₁₁; pauses necessary to prevent triggering of the buzzer are determined by D₉, R₁₅, R₁₆ and C₁₁. R₂₁ sets the hysteresis for the Schmitt trigger IC_{1d}, which drives the control input of the buzzer directly. D₇ resets the circuit and prevents unwanted feedback.

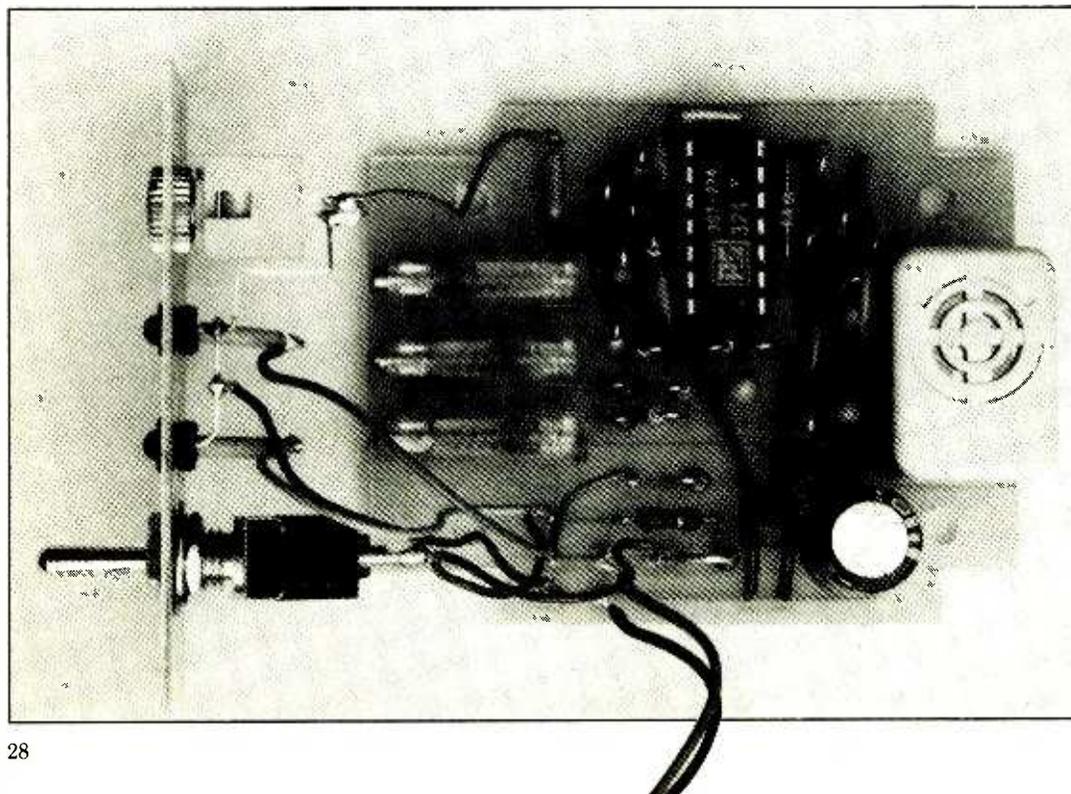
Using Pausaid

The unit is powered by a PP3 battery, from which it draws about 10mA during normal use. A rechargeable battery can be fitted if required: there is a charger socket on the front panel. The preset controls are accessible with the help of a trimmer tool, but the patient need be concerned only with the on-off switch and the 'signal received' light.

Prototypes have been in use at the Frenchay Hospital for several months with good results. Dr Enderby reports significant improvements in the intelligibility of patients using the aid and she describes her initial tests as 'extremely encouraging'. One development she has suggested is the possibility of replacing the buzzer with a body-worn vibrator. This would help patients with hearing problems and might enable the aid to be used by others in everyday conversation without the embarrassment a buzzer causes.

Phil Pickersgill is a design engineer with Racal's mobile communications company in Reading. He studied electrical and electronic engineering at Bristol University, graduating in 1982. Since then he has worked on the design of a variety of h.f. mobile radios.

Nic Stewart is an assistant consultant with General Technology Systems, a small independent consultancy based in Brentford, Middlesex. He studied at Bristol University, graduating with a degree in geography in 1981.



ZX81 generation and measurement interface

by J. Skinner

Addition of a few i.cs to the ZX81 allows one to measure and generate signals with remarkable ease and accuracy. This simple circuit provides a signal generator, a d.v.m., a frequency counter/timer and a spring-board for those new to microprocessor interfacing.

Apart from its applications in games and bank-balance analysis, the home computer can prove a useful tool for measurement and control. This simple interface provides a signal generator, d.v.m. and frequency counter/timer and although it has limitations in relation to professional instruments, its performance is more than adequate for many applications. Basic program examples shown are tried and tested but you will no doubt find ways of improving them. Higher operating speeds can of course be obtained using machine code. Although both hardware and software were designed for the ZX81, modification to suit other micro-computers should be easy.

Digital voltmeter

Conversion of analogue levels to digital form may be carried out using a digital-to-analogue converter (d-to-a) and comparator circuit. The program is designed

so that the computer sends out digital information to form an analogue ramp at the converter output, Fig. 1. The comparator compares the signal to be measured and the ramp voltage; when the two are equal, the comparator output changes state. On detecting this change of state the computer halts ramp generation and so holds the digital equivalent of the unknown analogue signal. Program flow for analogue-to-digital conversion program is also shown in Fig. 1. This cycle may be repeated continuously, as it does in the digital voltmeter program List 1.

Using a technique known as successive approximation would be faster but I haven't tried it yet. In this method, the computer sends a digital value of half the maximum to the converter. If the comparator output is unchanged, the value is increased by 50% until it does. Similarly, if half the maximum value is too high and changes the comparator output

state, the value is reduced by 50% until the comparator output changes back. The ramp approach may then be used as before or the 'too-much, too-little' approach continued until the final value is reached.

Signal generation

Signal generators such as the 8038 i.c. produce a range of waveforms with variable amplitude and frequency. They depend on an RC network for timing, which is good enough for general audio work, but where stability and repeatability are important a crystal frequency reference is desirable. Phase-locked circuits are an answer, but they become complicated when wide variations in frequency, amplitude and wave shape are required while retaining repeatability and stability. This design provides accurate programmable square and pulse signals and — with some limitations — synthesized wave-

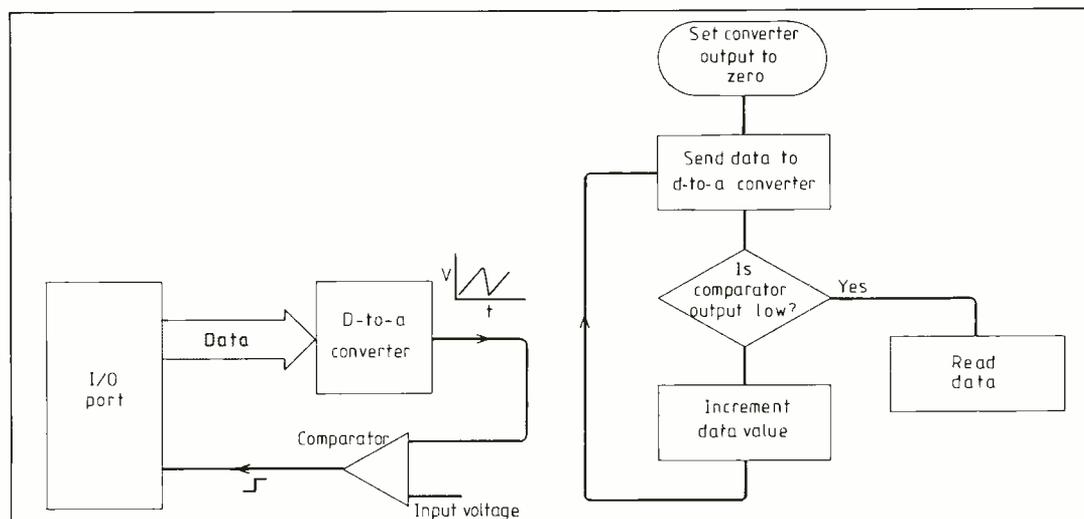


Fig.1. For analogue-to-digital conversion, used to measure voltages, the computer feeds a digital-to-analogue converter with digital values starting at zero and incrementing to form a voltage ramp at the converter output. Unknown input voltage is compared with the steadily rising ramp and when the two are the same, the comparator output changes state. Sensing this change, the computer stops incrementing the digital value and thus holds a value representing the unknown input voltage.

forms are constructed from a number of discrete segments. A drawback of this method is the time taken to build the shape, i.e. if 128 steps are used, a clock running at 128 times the resulting waveform frequency is required. The more steps, the better the waveform, but for most applications 128 steps suffice. Digital values representing segments of the waveform are supplied to the d-to-a converter by the computer in the appropriate sequence. These values may be calculated by the computer and stored ready for transfer. List 2, used to generate sinewaves, is easily modified to produce more segments or other waveforms.

Squarewaves can be generated in many ways, the simplest being to use a continuously looping program which sends one and zero logic levels alternately to the output, Fig. 2. Using Basic and ZX81 fast mode, the highest frequency obtained is 190Hz, or 12kHz using machine code; lower frequencies are obtained by introducing a delay into the program. Different delays between the two logic levels will produce pulses but more interestingly, the delay may be varied each time round the loop to produce swept fre-

quencies or frequency-modulated signals.

Drawbacks to this approach are that matching the delay to the frequency required is done by trial and error and the upper frequency is rather limited. A more elegant way of controlling the generation process is to use a dedicated circuit such as the 8253 which has three separate and independently programmable 16-bit counters. The device operates by dividing a clock signal by a certain preprogrammed value, and functions up to 2MHz. Each counter may be used in one of five modes, including ones for pulse and squarewave generation. Unfortunately, when the divisor is small, gaps between each programmable frequency are large, i.e. $f/2$, $f/3$, $f/4$, etc, but with a high clock frequency this is not so important.

List 3 is a program for squarewave generation and simply requires a control word and two data bytes for each counter section. Division factor n is the clock frequency divided by the output frequency and must be equal to or greater than two. It is presented to the circuit as two bytes. The computer may be used to calculate these bytes using

integer $(\frac{n}{256})$

Least-significant byte =

$$(\frac{n}{256} - \text{integer}(\frac{n}{256})) \times 256$$

Where n is low, the resulting frequency's precise value can be calculated by dividing the clock frequency by the integer of n . How to use the 8253 timer is outlined separately.

Frequency/period measurement

Frequency is measured by simply counting the number of input pulses during a known gate period. Conversely, a period is measured using the period as a gate and counting the number of pulses of a known frequency that occur during the event. Both of these measurements may be made using the 8253 by connecting it according to Fig. 3. Counters zero and one are set as squarewave generators in mode three and the third counter is set to mode zero for pulse counting. In mode zero the counter is preset to a known value, usually $FFFF_{16}$. When a positive edge is received, the counter is decremented by the clock until the gate returns to zero. The computer can then read the remaining value, subtract it from $FFFF_{16}$, multiply the result by the clock-cycle period and display the final result.

In the case of frequency measurement, counter zero is set to produce 1kHz and counter one to divide this down to 0.5Hz. Counter three is then gated by the resulting 1s positive section of this signal so that frequency may be read directly in hertz.

The gating period for period and interval measurement will depend on the range required. For intervals of, say, 1s, clock pulses of 1kHz would resolve 1ms but for

Fig. 2. Pulse generation by software is simply a matter of writing a program which loops round, switching a digital output line on and off on each cycle. Mark/space ratio of the output signal is determined by proportions of delays x and z . Varying these delays for each loop can produce frequency and/or pulse-width modulation.

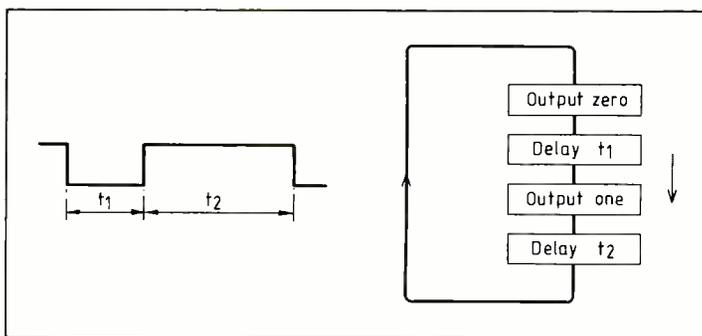
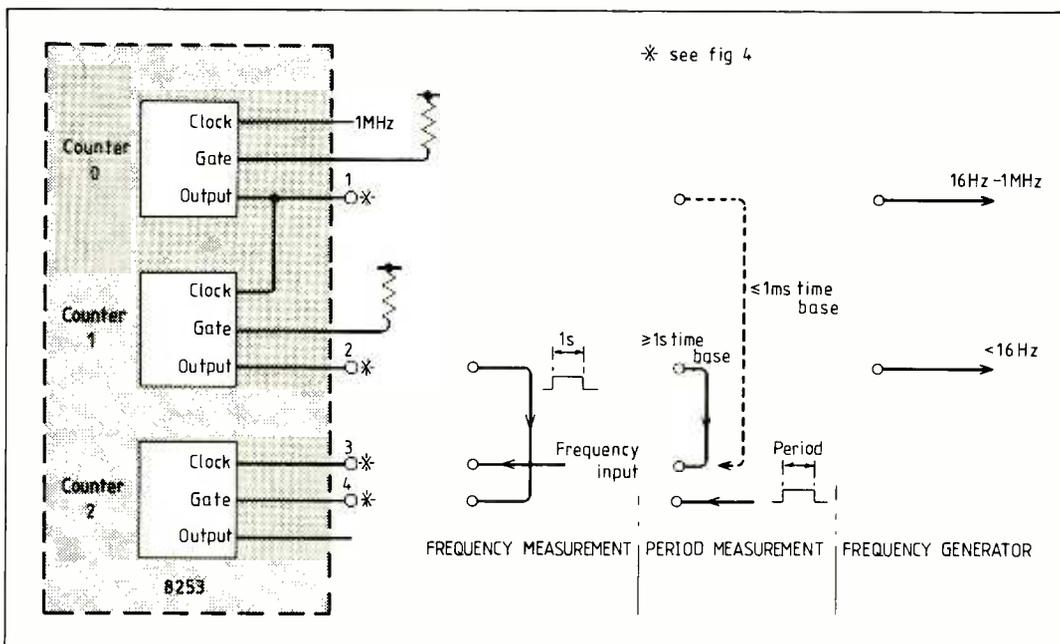


Fig. 3. Timer/counter connections. For frequency measurement, input pulses are counted during a period of known length and conversely for period/interval measurement, pulses of known frequency are counted during a period determined by the input signal. Frequency generation is simply a matter of sending a division ratio and control word to the 8253 timer/counter i.e.



intervals of several minutes, a 1s clock is more appropriate. Setting the desired clock rate for best resolution is relatively simple. List 4 is a program for these measurements.

Hardware

Some input/output hardware is required for sending data to the d-to-a converter and for reading inputs from the comparator and timer circuits. It is also useful to have spare lines for other purposes. A popular and easy-to-use device for this purpose is the 8255. It provides two eight-bit and two four-bit ports, all individually programmable. Figure 4 shows the complete interface circuit.

Decoded address lines select the 8253 and 8255 devices; memory locations C000₁₆ to FFFF₁₆ are free in the ZX81. When the circuit is active, ZX81 ram needs to be disabled so the RAMCS signal is taken low. Address lines A₇₋₁₅ are decoded by gates, output of which enables the 74LS138 data-selector circuit. This in turn selects the 8255 for A₂ and the 8253 for A₂. Lines A_{0,1} are inter-

List 1. Voltage measurement using the ZX81

```

10 POKE 49155,137      Initialize 8255
20 FOR D=0 TO 255
30 POKE 49152,D        Output step to d-to-a converter
40 LET A = PEEK 49154   Read comparator
50 IF A = 2*INT(A/2)   Read value D0, jump if 1
   THEN GOTO 70
60 NEXT D
70 PRINT D;"V"        Print result
80 GOTO 20
  
```

List 2. Sinewave generation program

```

Store sine values x, X increments
1  REM xxxxx... xxxxx      (x No of chars)
10 INPUT X
20 FOR N=1 TO X
30 LET P = 16513 + N
40 LET S = INT(128 * (1 + COS((2*PI/360) * N * 360/X)))
50 POKE P,S
60 NEXT N
70 GOTO 20
  
```

Run this then delete lines 40 to 70

```

40 LET Q = PEEK P
50 POKE 49152,Q
60 NEXT N
70 GOTO 20
  
```

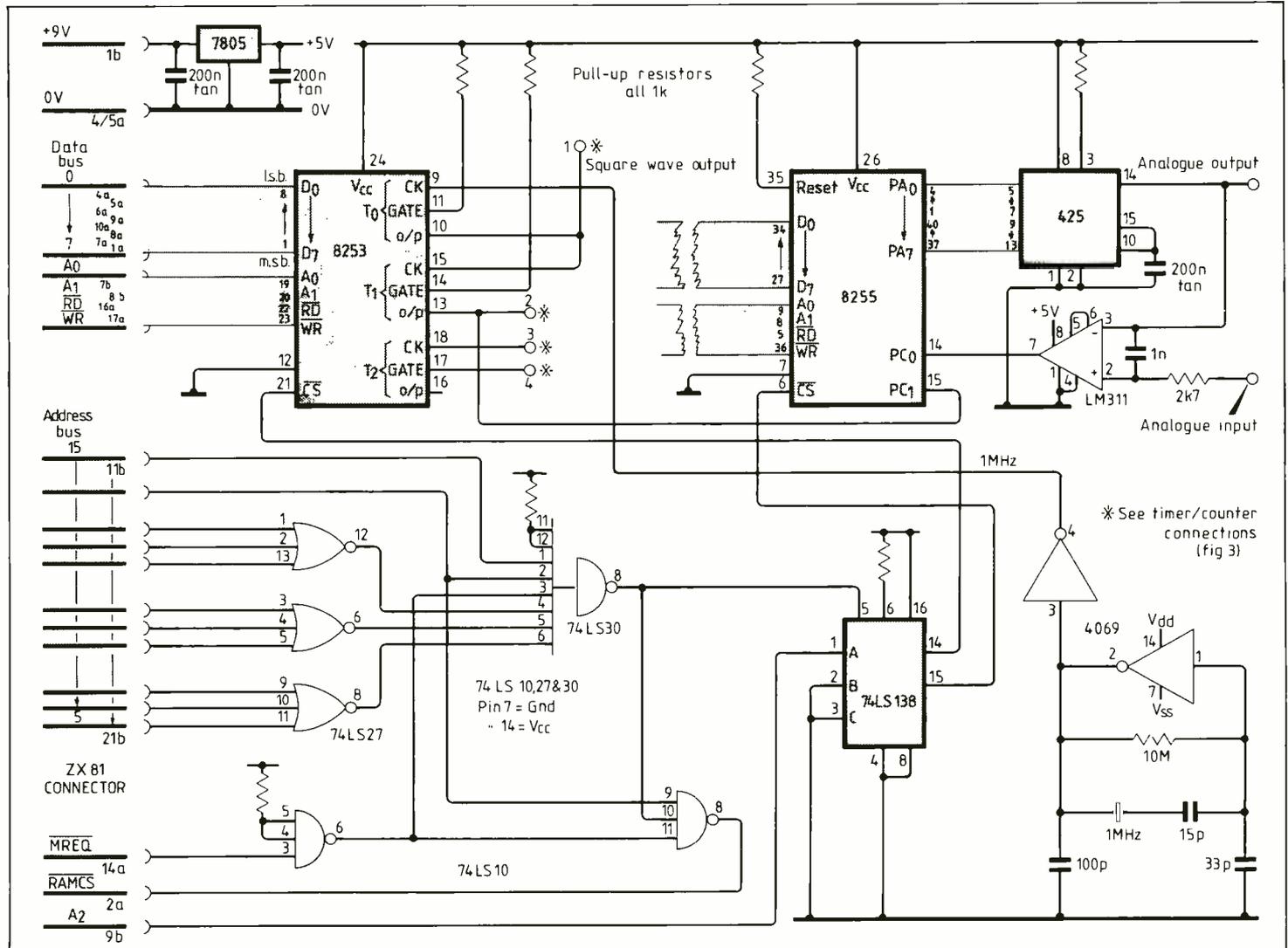
Note Frequency may be reduced by inserting

```

55 PAUSE x
  
```

where x is the pause value.

Fig. 4. Measurement and signal-generation interface for the ZX81 provides voltage, period/interval and frequency measurement, accurate and programmable pulse/squarewave signals and low-frequency synthesized waveforms through software. Spare digital i/o lines are available on the 8255 i.c.



nally decoded by both devices. Input/output port A of the 8255 supplies data to the d-to-a converter and the converter output is connected to D_0 of port C. Counter one output of the 8253 is connected to D_1 of port C.

A 5V supply is available from the computer, but using this can lead to problems. It is better to use the 9V unregulated supply and a separate 5V regulator with a small heat sink. The ZX81 transformer should cope with this provided that no other external loads are applied. Each program shown will operate on its own using the standard 1K-byte memory; if further memory is available all of the functions could be incorporated in one large program and selected at will.

The 8253 needs an accurate clock signal best derived using a crystal. Readily available but running at 6.5MHz, the ZX81's own clock is not convenient for this purpose so I added a 1MHz crystal oscillator. The LM311 comparator is readily available and operates from a single supply rail but any similar i.c. may be used. Improved resolution at higher frequencies could be obtained by using a 2MHz crystal.

Using the 8253 counter/timer i.c.

Each of the 8253 timers is set up independently by sending a control word to the device. The control word selects the operating mode and has to be followed immediately by associated data. In mode zero, the data presets the count to be decremented while in mode three the data sets the division ratio. Control word format is according to Table 1. Bits four and five select the form in which the data is loaded, which can be least-significant byte only, most-significant byte only or least-significant byte followed immediately by the most-significant byte. A further option is to read and latch the counter. The double-byte load option is used here. Binary count is selected by a zero at bit zero.

Yet another facility is provided for reading the count after decrementing. Sending control word 80_{16} reads the count and transfers it to a separate register. The register is then simply read using two 'peek' operations. Addresses for the counters are

49156 for counter zero

49157 for counter one

49158 for counter two

49159 for control

Table 1. Control-word format for the 8253 counter/timer

Bit	Function	Data		
		T_0	T_1	T_2
7	Counter No	0	0	1
6		0	1	0
5	Read/Load	1	1	1
4		1	1	1
3	Mode No	1	1	0
2		1	1	0
1		1	1	0
0	Bin./Dec.	0	0	0

Data word in decimal	T_0	T_1	T_2
	54	118	176

Table 2. Control-word format for the 8255

Bit	Function	Data
7	Set flag	1
6	Sel. mode zero	0
5		0
4	Port A	0
3	Port C, upper	1
2	Sel. mode zero	0
1	Port B	0
0	Port C, lower	1
Decimal data		137

Note: Logic level 1 data sets port for input, logic level 0 for output.

List 3. Squarewave generation

```

10 POKE 49155,137           Initialize 8255
20 INPUT F                  F is desired frequency
30 CLS
40 LET N = 1,000,000/F
50 LET M = INT (N/256)      l.s.b.
60 LET L = INT ((N/256 - M) * 256) m.s.b.
70 POKE 49159,54           8253 Control
80 POKE 49156,L             l.s.b.
90 POKE 49156,M             m.s.b.
100 PRINT 1,000,000/INT N; "HERTZ" Print actual frequency
110 GOTO 20                 Next frequency
    
```

List 4. Frequency counter/timer program

```

10 POKE 49155,137           Initialize 8255
20 POKE 49159,54
30 POKE 49156,232           }
40 POKE 49156,3             } T0 = 1kHz
50 POKE 49159,118           }
60 POKE 49157,208           }
70 POKE 49157,7             } T0 + T1 = 1s
80 POKE 49159,176           }
90 POKE 49158,225           } T2 = full count
100 POKE 49158,255          }
110 LET A = (PEEK 49154)/2   read port C, d1
120 IF A - 2 * INT (A/2)     wait for D0 = 0
    THEN GOTO 110           read port C, D1
125 LET A = (PEEK 49154)/2   wait for D1 = 1
130 IF NOT (A - 2 * INT (A/2)
    THEN GOTO 125
140 POKE 49159,128           }
150 LET X = PEEK 49158       read T2 count
160 LET Y = PEEK 49158
170 CLS
180 PRINT 65536 - ((Y * 256) + X; "HERTZ"
190 GOTO 80
    
```

Programming the 8255

The function of each port is set up by sending a control word to address 49155. Port A is set as an output and port C as input. Remaining ports may be set and used as required. Control-word format is according to Table 2. The program to initialize the circuit is

```

POKE 49155,137
(send control word)
POKE 49125,DATA
(send data to d-to-a converter)
POKE 49153
(read lower port C data)
    
```

Addresses for 8255 control are

49152 for port A
 49153 for port B
 49154 for port C
 49155 for control

Improving colour television decoding-5

by D. C. A. Read
B.Sc. (Eng),
M.I.E.E.

In obtaining improved horizontal resolution consideration must be given to the loss of luminance high frequencies that can occur in the decoder i.c.s; at this stage of signal processing the luminance is clamped, blanked and matrixed with the colour difference signals to produce the red, green and blue signals for outputs at low impedance. The TDA3561A one-chip decoder response has a 3dB point at 5MHz but further h.f. losses occur in the following circuitry which provides the red, green and blue colour tube drives, typically 100V pk-pk, to the tube cathodes.

RGB tube drive stage

Many home receivers, of three or more years old will have single transistor class A video output amplifiers. These work well on negative-going edges as the load capacitance (c.r.t.+tube base and stray=12pF) can discharge through the transistor. On positive edges, the rise-time is determined by the load resistor; a.c. feedback cannot help. To obtain a reasonable performance, low-valued resistors have to be used, resulting in high dissipation (10-20 watts).

A better solution is to use some form of push-pull circuit with complementary transistors or active pull-up by means of an emitter follower.

Advantages of newer types of output stage, are better symmetrical bandwidth, lower dissipation, similar rise/fall times, and larger output amplitude. A complementary circuit is shown in Fig. 40, taken from a note issued by the Mullard Applications Laboratory, Mitcham. In this circuit, both the upper (BF423) and the lower (BF422) transistors are biased to conduct sufficiently to maintain correct d.c. conditions (at picture back level) and the capacitor 4.7nF and 2.2µF enable the transistors to provide peak currents (on voltage transients) of several times the means. This will give rise/fall times of 100ns, with a full amplitude response flat to 4MHz falling to 3dB down at about 5.6MHz and providing up to 40V pk-pk output to 9MHz. It will also handle the tube cathode input impedance of down to 9kΩ without

introducing non-linearity. The colour tube current can peak to 7.5mA on peak white and at black level the input impedance reaches maximum capacitance. Dissipation in this type of output stage, in typically 1W per channel. The lower-dissipation circuit can be readily mounted on the tube base thus reducing the load capacity to 8pF and improving performance further.

It is better to use the voltages on the A₂ second grids of the c.r.t. to balance the cut-off voltages of the three RGB electron guns. The guns then operate with similar resolution (defocusing at high beam currents), video drive, black to white grey-scale tracking and input cathode loading.

For the regular TX10 receiver, Fig. 39, lower trace was obtained by applying the line sweep to pin 10 (the luminance input) of the decoder chip (TDA3561A) and using a low capacitance (2.2pF) ×100 test probe at the output of the video drive amplifier which feeds the cathode of the green gun (see Fig. 37). Figure 39, centre screen, shows that the colour subcarrier frequency is 6dB down. In fact the situation is somewhat worse than this because, in addition there is the effect of a subcarrier notch, a 6MHz sound notch and a (far from perfect) luminance delay line before the decoder chip. As it is not intended to use these three components in the modified receiver (although details of them will be given later), it is only necessary to consider from pin 10 (luminance input) of the i.c. (TDA3561A) onwards.

The output drive stages to the c.r.t. cathodes plus equalisation circuits for TDA3561A remain to be considered for improvement. The TX10 receiver video output circuit provides both active pull-up and active pull-down and a line sweep shows that a video excursion of 100V pk-pk can be achieved nearly up to the edge of the band.

Such an output stage is shown in the circuit diagram of the decoder chip TD3561A, Fig. 40. Some compensation for the 3dB response drop across the decoder chip, and for the loss that occurs in the three transistor output stages may be achieved by adding capacitance across the feedforward resistors carrying the RGB

decoder outputs. In the circuit of Fig. 40 capacitances of 27-33pF connected across the 2.7Ω resistors from pins 12, 14 and 16 (R, G and B outputs, respectively) will give a suitable lift.

The type of output stage used in the Ferguson TX10 receiver, Fig. 41, is a class A stage in which the lowest transistors 653, 652 and 651 form the amplifying stages for each of the R, G and B feeds and 659, 658, 657 emitter followers provide active pull-up; note that resistors 665, 664 and 663 must be low-capacitance components. Some crossover distortion occurs as the emitter followers begin to conduct on pull up. This effect can be seen on a line-sweep oscilloscope trace of the output waveform but it is difficult to discern on inspection of the displayed picture. Again, the feedforward resistors on the output pins 12, 14 and 16 are shunted with a series LCR combination of 33µH, 51pF and a 1kΩ resistor (for the TX10) to give a flatter

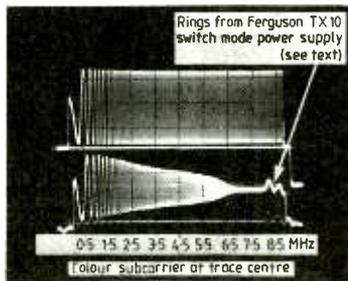


Fig. 39. Top trace is the luminance sweep 0.5 to 8.5MHz applied to pin 10 of the TDA3561A decoder chip. Lower trace is the signal at the tube cathode (pin 2) showing loss in response at high frequencies in the decoder chip and the video output drive circuit.

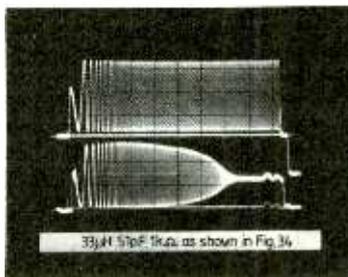


Fig. 42. Typical frequency response of TDA3561A colour demodulator chip through to the RGB output stage. This was the green drive to the c.r.t. cathode.

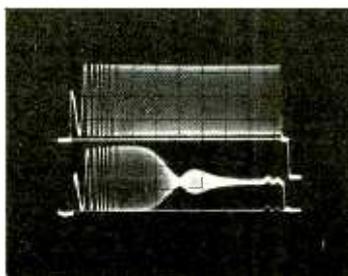


Fig. 43. Video sweep showing output of modifier comb board with the subcarrier notch retained by the f.e.t. gate connected to ±12V rail; modifier turned off.

switched into circuit by connecting the gate of the f.e.t. to the +12V rail so that the colour subcarrier (centre of the trace) is removed.

Alternative circuits between the i.f. and decoder

The added circuit board shown last month may not be appropriate if the tuner i.f. uses a surface acoustic wave filter with the colour subcarrier frequency 4-6dB down, or if the tube cannot display video signals in the region 3.5 to 5.5MHz, or if the received signal is poor.

To investigate these difficulties reception tests were carried out on a South of England transmitter with the results shown in Figs 44 to 51. The test equipment was first placed 'back-to-back' to determine response flat-

ness and the effect of channel filters. Insertion gain and group delay responses are shown in Fig. 44 and 45. The extra marker indicates f_{sc} : the left end of the trace is zero in terms of the baseband frequency (0-5.5MHz video). Figs 46 and 47 are the gain and group delay responses with the transmitter included in the chain. Amplitude errors are within ± 1 dB over the range 0-5.5MHz, but the phase errors increase greatly above f_{sc} . Subtracting the test equipment errors (back-to-back test, Fig. 45) from the Fig. 47 full-line trace gives the broken-line response curve which indicates approximately the resulting group delay and shows that at 5MHz the error is 100ns or nearly half the period of f_{sc} . With such an error it is difficult to obtain zero 7.8kHz twitter at the chroma transitions (chroma input

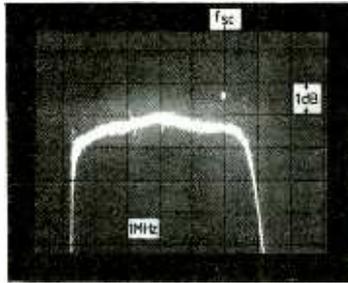


Fig. 44. Figure shows amplitude response of the test modulator and demodulator connected back-to-back (1dB/cm).

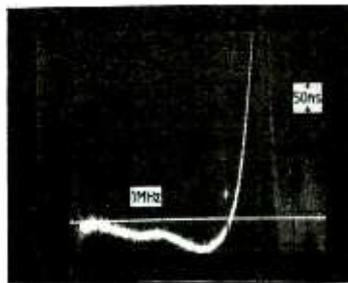


Fig. 45. Trace shows the group delay response of the modulator and demodulator (50ns/cm).

Fig. 41. Part of the TX10 receiver showing components associated with the decoder chip. ▽

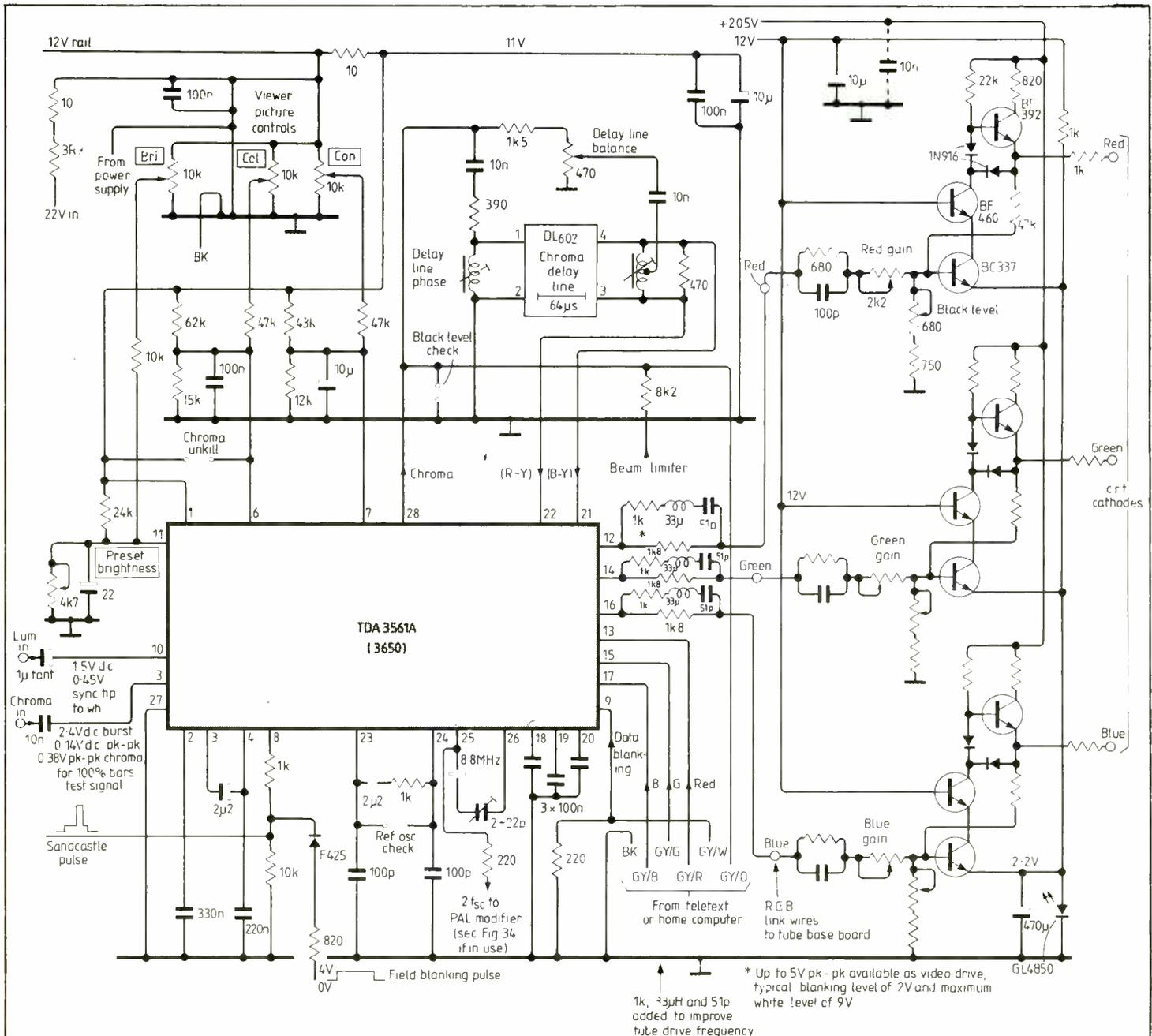


Fig. 46. A BBC 1 transmitter in the south of England. Figures show the amplitude response (right), group delay characteristic (Fig. 47, middle) and i.t.s. test signal performance (Fig. 51, below)

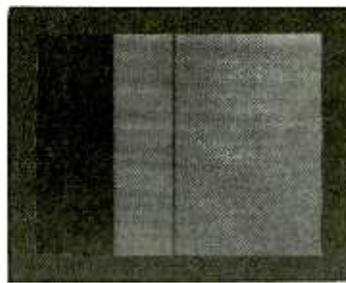
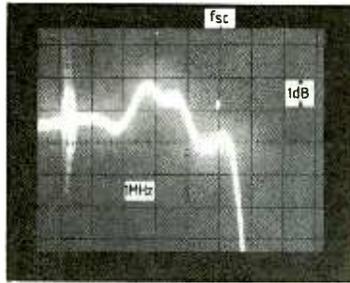


Fig. 48. Television screen photograph showing similar effects of residual 7.8kHz at colour transitions caused by lack of amplitude and/or phase symmetry in chroma path. Such symmetry should be maintained because the V-spectrum shifts on alternate lines, see Fig. 4 Dec 1983 issue; also Fig. 72.

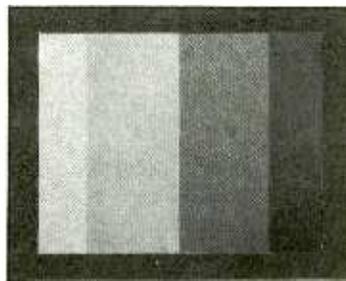
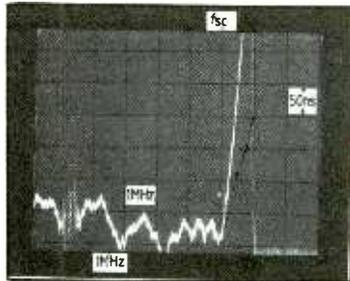
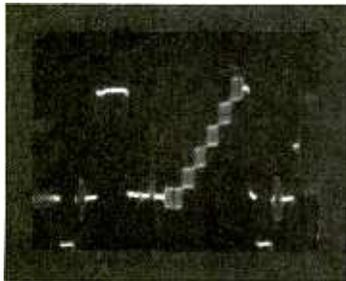


Fig. 49. With an input of 100% colour bars, photograph shows screen with a minimum of cross-luminance at colour transitions. Colour bar generator was fed directly to the comb filter (Fig. 34 circuit).

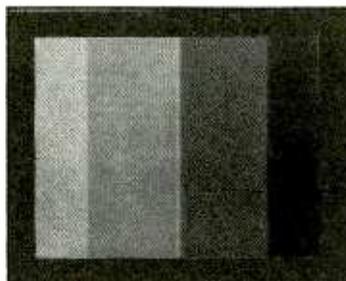
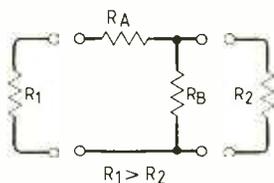


Fig. 50. Conditions as for Fig. 49 but with inclusion of the transmitter and receiver tuner plus i.f. section in the signal path. Results are still better than a luminance notch decoder only, but the possible improvement compared with Fig. 49 conditions is about half.

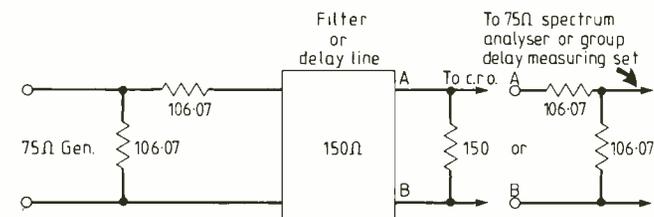
Impedance matching for measurement



To reduce the need for low impedance drive stages and to avoid awkward inductor or capacitor values it is often advantageous to scale the network impedance. To use standard 75ohm test equipment these networks are suggested.

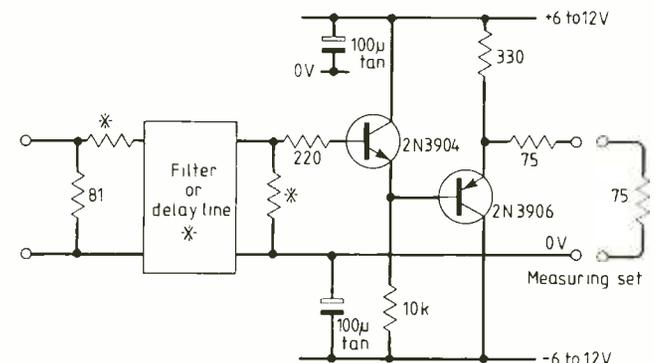
R_1 is 510Ω the characteristic impedance of gaussian band-pass filter used for chroma filtering, Fig. 34 March, R_2 is 75Ω. Calculated values:

R_A 471.01Ω
 R_B 81.21Ω
 Power loss 14.01dB
 Forward voltage loss 22.33dB
 Reverse voltage loss 5.68dB
 Insertion loss 10.51dB



R_1 is 150Ω, the characteristic impedance of post modifier/modulator filter used in Fig. 34 March, R_2 is 75Ω. Calculated values:

R_A 106.07Ω
 R_B 106.07Ω
 Power loss 7.66dB
 Forward voltage loss 10.67dB
 Reverse voltage loss 4.65dB
 Insertion loss 7.14dB



This circuit avoids the high losses of matching pads. 81Ω resistor may be removed to reduce insertion loss. With the above circuit placed close to the generator the output waveform was unaffected — but check with oscilloscope.
 * 820 to 1.8kΩ to suit delay line. For 150Ω filter, make left two resistors 106Ω, 150Ω on right. For 510Ω filter make left 471Ω, right 510Ω.

decoder pin) using the colour bar test signal.

The diagonal-to-vertical chroma transition will also have an upward moving Hanover bar disturbance visible at each colour change, in a manner similar to the black and white photograph of Fig. 48. Also the modified performance will certainly be marred by cross-luminance returning to the luminance channel, giving subcarrier dot crawl at vertical transitions as shown in Figs 49 and 50. Figure 51 shows the i.t.s. performance for this transmitter. Given such transmitter performance, it is necessary to know the condition of the received signal before deciding whether to add the extra board and/or improve the i.f. strip, or the alternative filter circuits, to be described next. Where the incoming signal is received from a chain of transmitters i.e. receive re-broadcast links, then almost certainly the alternative passive filter circuits are to be preferred.

To be continued

Part 4 March issue

In the inductor details for the Fig. 34 circuit L_5 should read 10µH not 5. Inductors 13 & 14, not included on that list, are 22µH Painton or Sigma chokes. Also in that diagram, please ignore the 60ns delay figure at DL_2 and disregard the last five words in note 3 (which refer to the phase equalizer C_{21} , L_8 , C_{18} and L_9). Capacitors 20 and 25 should be polystyrene types.

Apologies for the slip in the caption on page 32, where Tr_{15} should have read Tr_{14} , p. 10.

Pin connections

Top view

Mullard
M9918D/C
or 1167BD

Siliconix
VN0610L or 2222L

View on leads

* A circuit board layout that will be available for the decoder design has a dual in-line arrangement for the 796 i.c. (Motorola's MC1496 or 1596 suffix G or L is available from Ambit.)

36

WIRELESS WORLD MAY 1984

www.americanradiohistory.com

SC84 Micro-computer

Designed for engineers and enthusiasts, the SC84 microcomputer uses a 6MHz Z80 processor and has 64K-bytes of ram — but its main feature is that it can be used with a disc operating system and much readily available applications software.

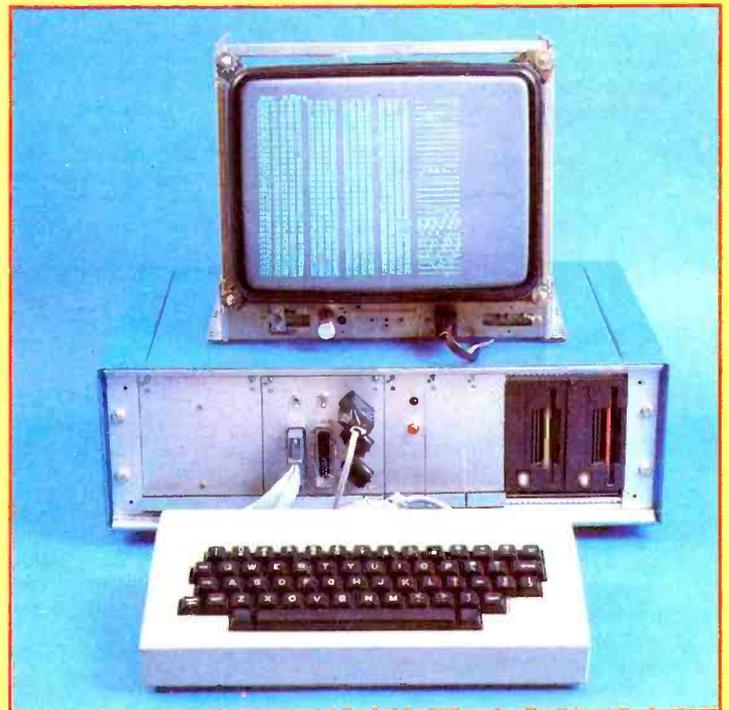
I designed my first computer, the Scientific Computer published by *Wireless World* in 1979, to gain experience with microprocessors. This small system had novel features for its time including a hardware number cruncher and up to 5K-byte of ram! Looking back, the Scientific Computer appears embarrassingly primitive but, judging from correspondence, it served its purpose of giving readers the best possible introduction to microprocessors — hands-on experience.

This new design has a similar objective but it also permits the use of much readily-available software including word processors, language interpreters and compilers. Retained features are the Z80 microprocessor, the resident machine-code operating system extended to provide extra commands, and general accessibility needed for engineering applications. New features are the 64K-byte of user memory, a high-resolution c.r.t. controller and a flexible i/o section including interfacing for 3.5, 5.25 or 8in single or double-sided, single or double-density disc drives. Up to 32 lines of 96 characters or 192 by 192 picture elements may be displayed and graphics and characters may be mixed.

My disc operating system, SciDOS (see note at end of article), is compatible with most software written for the standard 8-bit operating system CP/M. I have also designed software to make use of special features of the computer, in particular the v.d.u. These programs include utilities, disc editors and an extended Basic interpreter. Much of this software was developed in conjunction with the Scientific Com-

puter whose disc interface came later, so users of the original computer will find that their software runs on the SC84 with little or no modification.

SC84 reflects the shift towards microcomputers with most of their programming on disc rather than in read-only memory. The only rom in this design is an 8K-byte eprom which on switch-on or reset copies the resident operating system into random-access memory (ram) and is then switched out, leaving the system entirely dependent on ram. There are two advantages in this approach. Firstly, having everything in ram means that every aspect of the computer is open to experimentation. Secondly, while a system with, say, Basic in rom will be ready to program in Basic as soon as it is switched on, that rom is an encumbrance when you want to use anything else but Basic. The classic argument against disc-based systems is that a rom-based system is ready for use as soon as you switch it on, whereas initiating a disc-based system can take as much as 45 seconds. SC84 initiates in just under one second and leaves virtually all of the system ram available for whatever you want — Basic, Pascal, machine-code assembly, word-processing etc. A major feature of SC84 is that a disc operating system, SciDOS, has been written especially for it. As well as implementing those commands and functions necessary for CP/M compatibility, this software provides some extra commands and functions which make the system of use to those who see a computer as more than a black box. SciDOS has been kept small by efficient programm-



ing; when it is loaded and running, up to 58K-bytes of memory are free for user programs.

SC84 is built on 100 by 160mm Eurocard p.c.bs interconnected through a 64-way bus system. The basic configuration consists of a processor card, a character v.d.u. card and an i/o card. Frames for housing Eurocards are available in various sizes and materials, the interconnecting bus or 'backplane' being either a p.c.b. — again readily available — or a series of card sockets linked using wire-wrapping techniques. Prototypes have been constructed using both methods and while a p.c.b. saves time, wire-wrapping a series of sockets together is recommended as being cheaper and giving a little more flexibility should you not want all of the connectors wired strictly in parallel, as would be the case in a 'daisy-chained' interrupt system. Bus signals are shown in Table 1. Pin designations refer to a standard DIN 41612 64/96 connector i.e. the type with spacing for three rows of pins but with the middle row missing. Power is provided through the outer two pairs of pins at each end of the connector which suits p.c.b. backplanes available from Vero and other manufacturers. All signals are buffered in and out of the processor board using low-power Schottky t.t.l. i.cs.

Processor/memory board

On this p.c.b. is the Z80, 64K-bytes of ram, system rom and a buffered interface to the rest of the computer. The decision to integrate memory with the microprocessor was taken as the size

by J. H. Adams

SC84

Processor

4/6MHz Z80 processor.
Maximum 64K-byte ram.
58K-byte ram available using SciDOS.

Display

Up to 32 lines of 96 characters fully programmable. Scrolling window determined by software.
Graphics mode 0 gives 192 by 96 pixels, mode 1 gives 192 by 192 resolution. Characters and graphics may be displayed simultaneously.

Input/output

Up to four single or double-sided 8, 5.25, 3.5 or 3in disc drives may be used, either single or double density.
RS232 serial i/o data rates range from 1 to 38400baud with separate transmit/receive clocks. Synchronous serial i/o format is 5 to 8-bit auto-search and sync. or asynchronous 5 to 8-bit with 1, 1.5 or 2 stop bits. RTS and CTR signals control serial data flow.
Eight-bit parallel data input is buffered by schmitt i.cs. Eight-bit parallel output drives five t.t.l. loads.
Three mos i/o lines operate event counters, pulse timers and Z80 interrupts. Four mos timer lines are available for timing and sound generation.

John Adams is currently working on a high-resolution colour-graphics processor using the 7220, and an eprom programmer interfacing to SC84 but with its own processor.

SPECIAL FEATURE

Timing for Z80 memory read and write cycles. 'Early write' cycles are common in larger systems but are not found in most eight-bit processors.

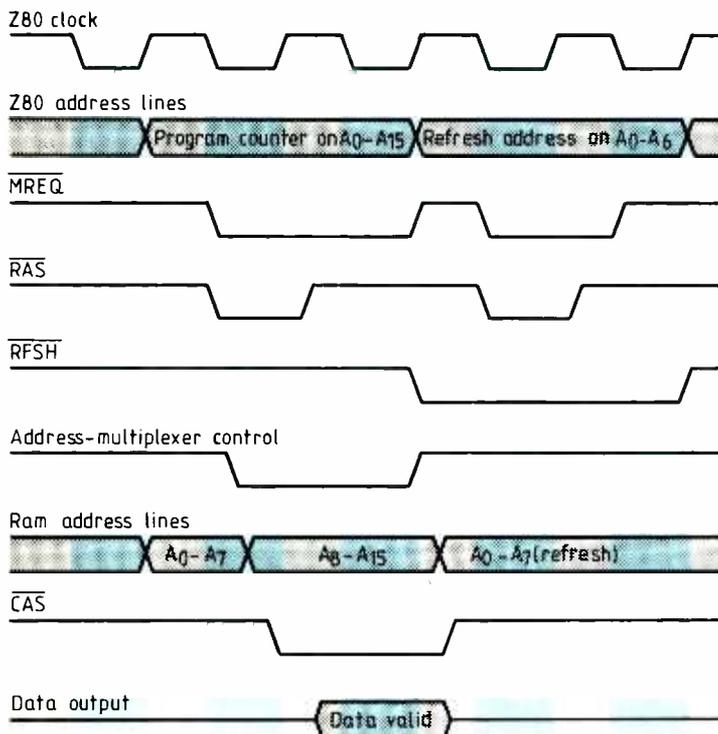
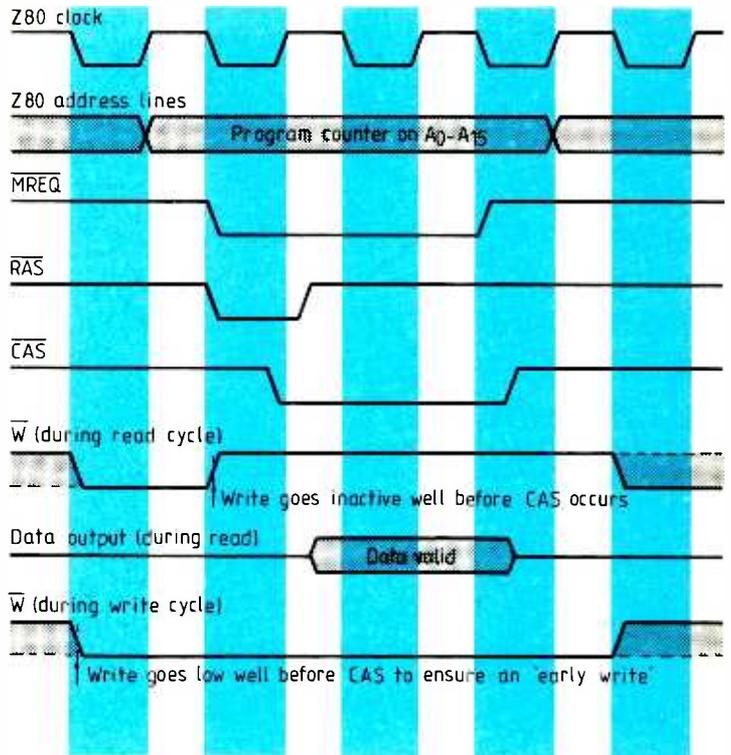
First of SC84's three main sections — the processor — with 64K-byte ram, operating system eeprom and logic for dynamic-ram, bus-driver and reset control (far right). On resetting, part of the rom content is loaded into high ram and the rom is then switched out, leaving up to 64K-bytes for user programs.

Timing for an op-code fetch. The Z80 microprocessor has a special register for use with dynamic rams which provides a refresh address coinciding with a refresh control signal.

of the system memory is largely determined by the processor. Also, without the memory the processor board would be rather bare and an extra Eurocard would be needed. Integrating the two on one board doesn't preclude the use of extra memory on other boards — as indeed happens with the v.d.u. memory. Timing diagrams shown will be referred to throughout this explanation of the processor board.

There are three types of memory cycle that the Z80 can execute. Fetching of an instruction or 'op-code' from memory is illustrated in the first diagram. The second is a composite diagram illustrating the writing or reading of data to or from memory. The difference between fetching an op-code and fetching data from memory is that the op-code fetch is shortened and followed by a special memory cycle intended, and used in this case, to refresh dynamic memory. Three relevant Z80 control signals in accessing memory are MREQ indicating that the current cycle is a memory cycle, RFSH indicating that memory refresh can now take place and RD which indicates that the current cycle will involve data passing into the Z80. There is also a signal called M1 which becomes active during op-code fetches and interrupt acknowledge periods, and a WR signal which indicates that data is to pass from the Z80 to the system. Neither signal is used in memory access although M1 takes part in controlling the buffering of the data bus.

Z80 control signals and virtually all others in this design are active low, i.e. they assert their



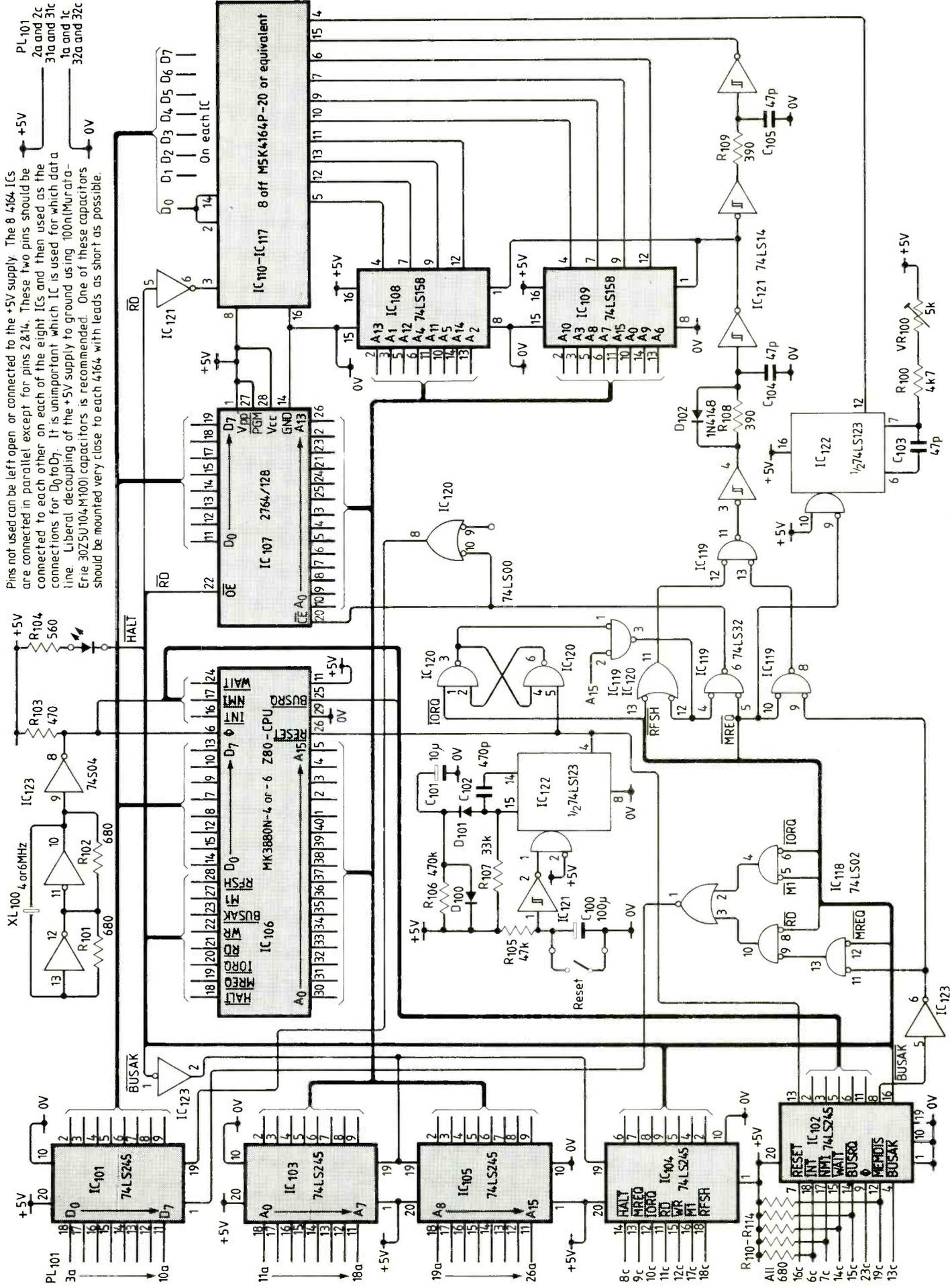
function by going to the negative or '0' state. The normal description of a gate function is based upon positive logic so that, for instance, a 74LS02 is deemed to contain four two-input NOR gates. In this circuit diagram and following ones, gates are shown in their logical context. This can be seen in the 74LS02 which arbitrates the data-bus buffer direction (IC₁₁₈). Here, three of the four gates have been drawn in their inverse form, i.e. as AND gates with active low inputs rather than as OR gates with an active low output. Having differently shaped gates in the same i.c. takes some getting used to but it helps understanding of the logic. For example, in the case of IC₁₁₈, direction line IN becomes active when (M1 and IORQ) or RD and not (MREQ and not MEMDIS) are active. Translated into English, this means that the data buffer faces towards the Z80 during interrupt acknowledges and during any read other than one on the processor board memory.

Control gating for the bus buffer is fairly complex as the buffer has to respond to various conditions, summarized in Table 2. One reason for such a tight definition of the bus operation arises from the use of mode 2 interrupts. This is the Z80's most complex mode of interrupt organization where, in response to the Z80 acknowledging an interrupt by taking control lines M1 and IORQ low simultaneously, the interrupting device supplies eight bits of an address. This address combined with the contents of the Z80 'I' register forms a 16-bit pointer to a table of addresses of

interrupt-service routines. Each device capable of interrupting is supplied with one or a range of such 'interrupt vectors' during the computer's initialization so upon an interruption the Z80 is able to pick out and make a call to specific routines for each interrupting vector. The strength of the system though is that by changing the interrupt vector or a particular entry in the table of addresses, different service routines can be provided for the same interrupt line. This is particularly important, for example, with the disc controller used which uses one interrupt line to signal both a request for data from the system during disc writing and the offer of a data byte during disc reading. This 'interrupt acknowledge' sequence is condition seven in Table 2. On receipt of an interrupt the Z80 disables its interrupt sequence but pauses before acknowledging to allow what may actually be several interrupting devices to decide which has the highest priority. This is done by the daisy-chain technique mentioned earlier. In this way lower priority devices that might need service are prevented from interrupting more important tasks. Note that condition four must be implemented as during an interrupt service, all devices capable of interrupting will want to watch what is being fetched from memory so that they can spot the return-from-interrupt op-code being fetched and automatically re-initialize themselves.

The dynamic memory control is quite novel. For this reason, and for the bad publicity that dynamic memory sometimes gets, it is worth detailing a few

Pins not used can be left open or connected to the +5V supply. The 8 4164 ICs are connected in parallel except for pins 2&14. These two pins should be connected to each other on each of the eight ICs and then used as the connections for D₀ to D₇. It is unimportant which IC is used for which data line. Liberal decoupling of the +5V supply to ground using 100nF Murata-Erie 30Z5U104-M100 capacitors is recommended. One of these capacitors should be mounted very close to each 4164 with leads as short as possible.



SPECIAL FEATURE

Table 1. Bus connections

Row A	Pin	Row C	Function
GND	1	GND	
+5V	2	+5	
D0	3		
D1	4		
D2	5		
D3	6	INT	Z80 maskable interrupt line*
D4	7	NMI	Z80 non-maskable interrupt line*
D5	8	HALT	Z80 has executed a HALT instruction
D6	9	MREQ	Z80 is performing a memory operation
D7	10	IORQ	Z80 is performing an input/output operation†
A0	11	RD	Z80 is requesting data from the bus
A1	12	WR	Z80 is writing data to the bus
A2	13	BUSAK	Z80 has relinquished control of the system
A3	14	WAIT	Z80 is being asked to extend the current instruction*
A4	15	BUSRQ	Z80 is being asked to relinquish system control*
A5	16	RESET	20µs pulse generated when RESET is operated
A6	17	M1	Z80 is fetching an op-code†
A7	18	RFSH	Z80 is performing a memory refresh cycle
A8	19	MEMDIS	Non-system memory is to be used for this operation*
A9	20	VDUSEL	Character v.d.u. is mapped into memory
A10	21		
A11	22		
A12	23	CLK	System clock (from processor board)
A13	24		
A14	25		
A15	26		
	27		
	28		
	29		
+12	30	-12	
+5	31	+5	
GND	32	GND	

Note: address and data (A and D) lines are active high

* These lines have a pull-up resistor on the processor board and should be driven by open-collector drivers.

† When M1 and IORQ are both active the processor is inviting a peripheral device to supply part of an interrupt vector — interrupt acknowledge.

Table 2. Data-bus driver logic

Condition	Bus-buffer drives
1 I/O write	towards bus
2 I/O read	towards Z80
3 System-memory write	towards bus
4 System-memory read	towards bus
5 External-memory write	towards bus
6 External-memory read	towards Z80
7 Interrupt acknowledge	towards Z80

features of its operation before describing the external circuits. Modern dynamic memories use a multiplexed addressing technique where the address is split in two, in this case eight-bit parts. This reduces the number of address pins on the i.c. from 16 to 10, eight address pins and two 'strokes' to latch the address bytes into the memory. A prime consideration here is that this reduces the package size and hence the cost, but it also allows the memory access to be broken into two stages with consequent benefits.

Consider a 64K-bit dynamic memory to be a matrix of memory stores 512 by 128, each row of 128 being connected to a single bus line. Each store is a minute capacitance connected by gates to these lines. When the first part of the address known as the row address is latched into the memory, the highest bit is stored and the other seven are decoded to decide which of the 128 cells in each of the rows should be connected to the bus line for that row.

Thus access starts well before the full address is in. The bus line is, naturally, physically much bigger than the individual cell which has now been connected to it by activation of the row-address strobe (RAS) and so the potential stored in the cell is all but lost on the bus. At one point on the bus is a sense amplifier connected back onto the bus lines with positive feedback. While RAS is inactive the sense amplifier is held in balance so now, even though it has been all but lost, the potential delivered by the cell is enough to tilt the amplifier one way or the other. Having positive feedback, the amplifier pushes the potential on the line heavily in the direction of the input potential, putting the line — and the cell — back to the level in the cell prior to the access. There are two implications here. Firstly that there is a minimum length for the active RAS pulse in that if it goes off before the bus line is recharged by the sense amplifier it will disconnect the read cells from their bus lines before they have had a chance to recharge. Secondly there is a minimum inactive time for RAS as the sense amplifier is brought back into a state of balance. These conditions are paramount and to meet them RAS is driven by a monostable i.c. triggered by a signal directly from the Z80 rather than one which has been combined with others and might therefore be subject to glitches caused by timing problems between the various constituent signals. The monostable i.c. sets the minimum active RAS period and thus by definition the minimum inactive.

Once the leading edge of the RAS pulse has latched the first address byte into the memory i.c.s., the address may be changed to that of the bus row to be fed to the output of the memory. The eight bits are gated in by the starting edge of the column-address strobe (CAS) signal and combined with the stored bit from the previous addressing strobe to operate a 1-out-of-512 data multiplexer which selects and latches the signal from one of the 512 bus lines within the memory. Once this is done, RAS may go inactive; indeed it is a good thing if it does as then the sense amplifiers may return to a balanced state as soon as possible, ready for the next access. CAS also controls the state of the memory-output driver. While it is active the output is enabled and the selected data bit held there. CAS is a far less sensitive signal as far as integrity of the memory is concerned, the main consideration being that it becomes active as soon as possible in the access and stays on until the data is definitely available and the Z80 has it.

This has been a description of a memory read cycle. A write cycle is similar in that the RAS signal connects cells to buses and releases sense amplifiers and then the CAS signal operates the latching multiplexer and activates the output driver. What is different is that the signal on the data-input pin is routed through the multiplexer to the cell. During a conventional write cycle the data output pin will follow the output of the cell while CAS is active. This might seem to preclude the use of dynamic memory in circuits usually associated with static memory, where the same line is used for data input and output, but it is possible to prevent the output of a dynamic memory from coming on when CAS goes active by arranging for the write signal to go active before CAS does. These 'early-write' cycles are common in large systems but are not found in most eight-bit microprocessors such as the Z80 where the WR signal goes active well into the memory cycle and is too late to be of use. One answer is to use an eight-bit three-state buffer between the ram outputs and the data bus, but my solution is to use the inverse of RD as a write strobe to the memory. Whenever RD goes high, i.e. at the end of reading memory or i/o, the write strobe goes low and so the dynamic memory is primed for an 'early write'. As RAS will be over long before RD goes high, there is no chance of a memory-read cycle being transformed into a memory write cycle. Should it be a read cycle then the write strobe is removed from the memory by RD going active low at the beginning of the cycle, well before CAS is applied. Except for a slight increase in current consumption during the write-line strobe, the effect is unnoticeable.

The sequence of pulses for the dynamic memory is generated by a series of Schmitt buffers (IC₁₂₁). RAS is generated by the leading edge of memory-request signal MREQ which triggers monostable IC₁₂₂. A potentiometer sets the RAS pulse length. For the devices specified in the diagram RAS should last for at least 200ns and should have a minimum off period of 120ns. In practice this adjustment is not too critical with a system running at 4MHz as a complete RAS cycle lasts at least two clock cycles which corresponds to 500ns. Set the potentiometer to give the off-period required for the dynamic memories used or, if measurement is not possible, to its mid-position for a 4MHz microprocessor or at or near its minimum for a 6MHz version.

Continued on page 51

WIRELESS WORLD MAY 1984

by Brett Wilson

Fibre optic communications

First of a three-part series reviews the fundamentals of fibre optic transmission and outlines the main advantages and limitations in using optical fibres as a communications medium.

Part 1 — Optical fibres and waveguide transmission

An optical fibre is a dielectric waveguide made of glass (or occasionally of a transparent polymer) and essentially consists of two regions, a core region and a cladding region, Fig. 1. Protection and a degree of mechanical strength is provided by the outer jacket. The fibre is characterized by a refractive index profile as a function of radial distance from the fibre axis, as illustrated in Fig. 2. Silica is used for the majority of fibres with either germanium or boron doping to achieve the desired refractive indices. Inexpensive fibres can be made from perspex polymer but they exhibit very high losses of around 500-1000 dB/km.

The most convenient type of fibre to describe is the multimode step-index fibre of Fig. 2(a), where the core region has a constant refractive index n_c that is larger than the constant refractive index n of the cladding region. This fractional refractive index step difference Δ is only small, usually around 1%, but is sufficient to produce light guidance by total internal reflection under certain conditions. In a multimode fibre the core diameter is large compared to the wavelength of light, hence propagation in the fibre can be modelled adequately by using geometrical optics. For a typical multimode step-index fibre we might have $n_c = 1.5$, $n = 0.99n_c$ with $\Delta = 0.01$, core diameter of $50\mu\text{m}$ and a cladding diameter of $100\mu\text{m}$.

Lengths of optical fibre can be joined together with very low losses (0.1 to 0.3dB) by fusing their ends together whilst clamped in a special alignment jig. Demountable connectors require a high degree of mechanical precision for best results, with losses of around 1dB per connector pair being

typical. In Figure 3 a point source is shown emitting light rays over a wide range of angles. Ray 1 enters parallel to the fibre axis and simply propagates straight along the axis. Ray 2 strikes the fibre at an angle θ_{ext} relative to the axis. Because the air outside the fibre has an index of refraction of 1.0 whilst the fibre core has a refractive index of about 1.5, the ray is bent toward the fibre axis according to Snell's law of refraction. After travelling a short distance along the fibre ray 2 strikes the core-cladding boundary and is refracted again. If the angle of incidence at the core-cladding interface is sufficiently shallow, the ray will totally internally reflect and continue to propagate along the fibre following a zig-zag path. However, if the angle of incidence is too large, ray 3 for example, the ray will enter the cladding region and ultimately be absorbed by the higher losses in the cladding and jacket. Note that the light will still be correctly guided even when the fibre is subject to bending or twisting. Obviously under these conditions the zig-zag light paths will be somewhat modified.

The maximum internal angle θ_{int} a ray may have relative to the fibre axis and still be guided is given by Snell's law:

$$\sin \theta_{\text{int max}} \approx n_c^{-1} \sqrt{2\Delta} \text{ and}$$

$$\sin \theta_{\text{ext max}} \approx \sqrt{2\Delta}$$

where n_c is core refractive index, n the cladding refractive index, and Δ the fractional index step $(n_c - n)/n_c$. For $n_c = 1.5$ and $\Delta = 0.01$ then $\theta_{\text{int max}} = 5.5^\circ$, corresponding to $\theta_{\text{ext max}} = 8.1^\circ$. An equivalent way of describing a fibre is by way of its numerical aperture (NA), defined as $\sin \theta_{\text{int max}}$; in this example $\text{NA} \approx 0.1$.

It is a feature of optical fibres that they require a light source with a narrow emitting angle to efficiently couple power into the fibre. Two requirements conflict when deciding on a suitable value of Δ and hence NA for a fibre. A large step index makes it easier to couple power into the fibre but the increased total internal reflection angle allows a greater number of zig-zag paths per unit length. The increased length for some rays tend to smear out fast data pulses and reduces the potential bandwidth available. On the other hand a low value of Δ produces a higher bandwidth fibre but makes it more difficult to couple energy into the fibre.

The two major fibre characteristics of interest from a commu-

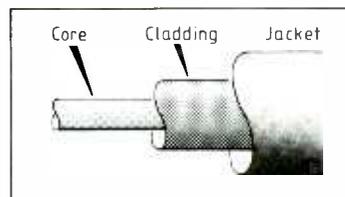


Fig.1. An optical fibre consists simply of an inner flexible rod of very pure glass surrounded by a cladding layer of slightly lower refractive index.

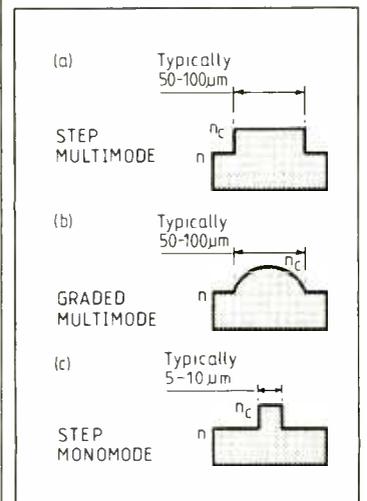


Fig.2. Choice of refractive index profile determines the propagation characteristics of the fibre.

Fig.3. Light in the fibre is guided by a process of multiple internal reflection caused by the difference in refractive index between the core and the cladding.

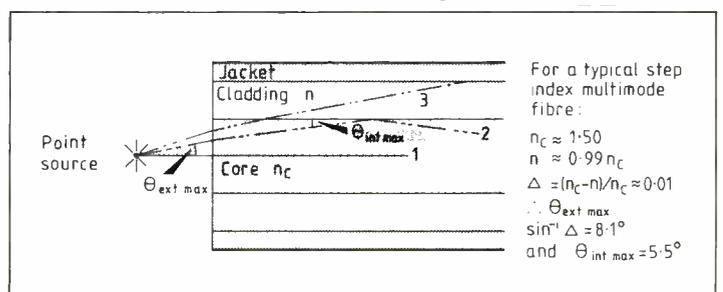


Fig. 4. Light loss in a multimode fibre approaches the theoretical minimum except at the wavelengths associated with water impurities.

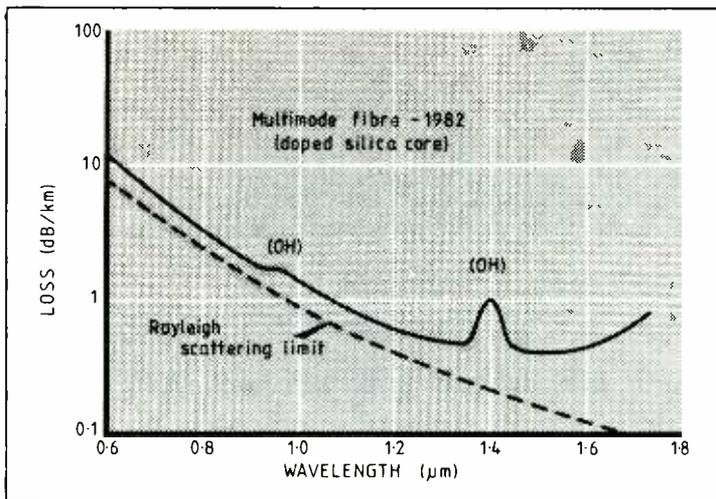


Fig. 5. If the bandwidth of the fibre is insufficient then adjacent data pulses can be spread out to the extent of becoming indistinguishable.

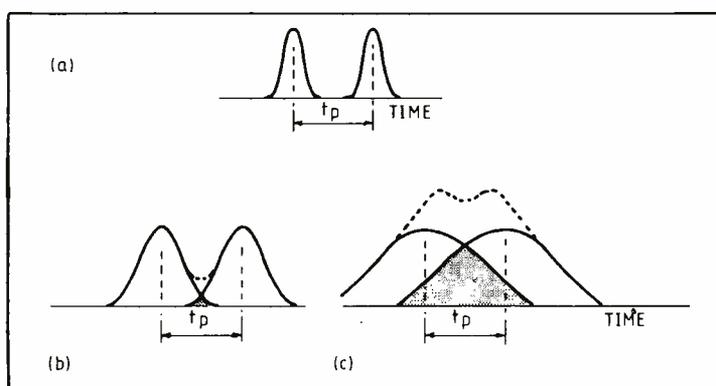
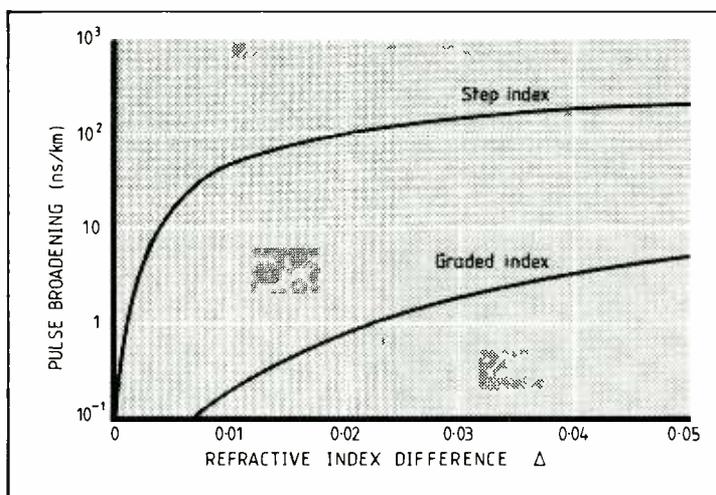


Fig. 6. Pulse spreading is much less noticeable with graded index fibres than with step index multimode fibres.



communications point of view are signal attenuation and bandwidth.

Absorption of light by conversion into heat and scattering principally determine the attenuation of an optical fibre. Recently-developed laboratory fibres have attenuation figures approaching the limits set by Rayleigh scattering due to the intrinsic molecular inhomogeneities of glass. At the popular wavelength of 0.85 μm (low-cost high-lifetime aluminium-gallium arsenide i.e.s) the Rayleigh scattering limit is about 2 dB/km; at a wavelength of 1.3 μm the limit is around 0.3 dB/km; whilst at 1.55 μm the limit is as low as 0.15 dB/km, Fig. 4. Presently available commercial 'premium' fibres exhibit losses of

around 2.5 to 3 dB/km at 0.85 μm and 0.7 to 1.5 dB/km at a wavelength of 1.3 μm [1].

Apart from the Rayleigh scattering limit the main loss mechanism in optical is that due to OH 'water' molecular excitation, as illustrated in Fig. 4. Fortunately, advanced processing and drying techniques have brought these loss regions down to manageable proportions within the last five years or so, although it is obviously wise to avoid the 1.4 μm wavelength of OH excitation. Optical sources such as i.e.s and injection laser diodes covering these near infrared wavelengths will be described in the second part of the series.

It is instructive to compare

typical attenuations for different technologies to illustrate the potential advantages of optical fibres for communication. A twisted pair of 0.65 mm wires has a typical attenuation of 15 to 20 dB/km at 1 MHz increasing as $f^{1/2}$, but crosstalk problems restrict their use at higher frequencies. Coaxial cables require optimization for best attenuation figures, with a value of around 75 dB/km being common at 100 MHz. Optical fibres are clearly superior in terms of attenuation and in addition exhibit far higher bandwidths.

The maximum usable bandwidth or bit rate for a communication link occurs when two adjacent, but separate, input pulses emerge from the far end of the link smeared out in time to an extent that they are indistinguishable (assuming that the receiver has a sufficiently high bandwidth). Thus the two input pulses in Fig. 5(a) will still be detectable separately if they emerge as in (b), but not if they overlap to the extent of (c).

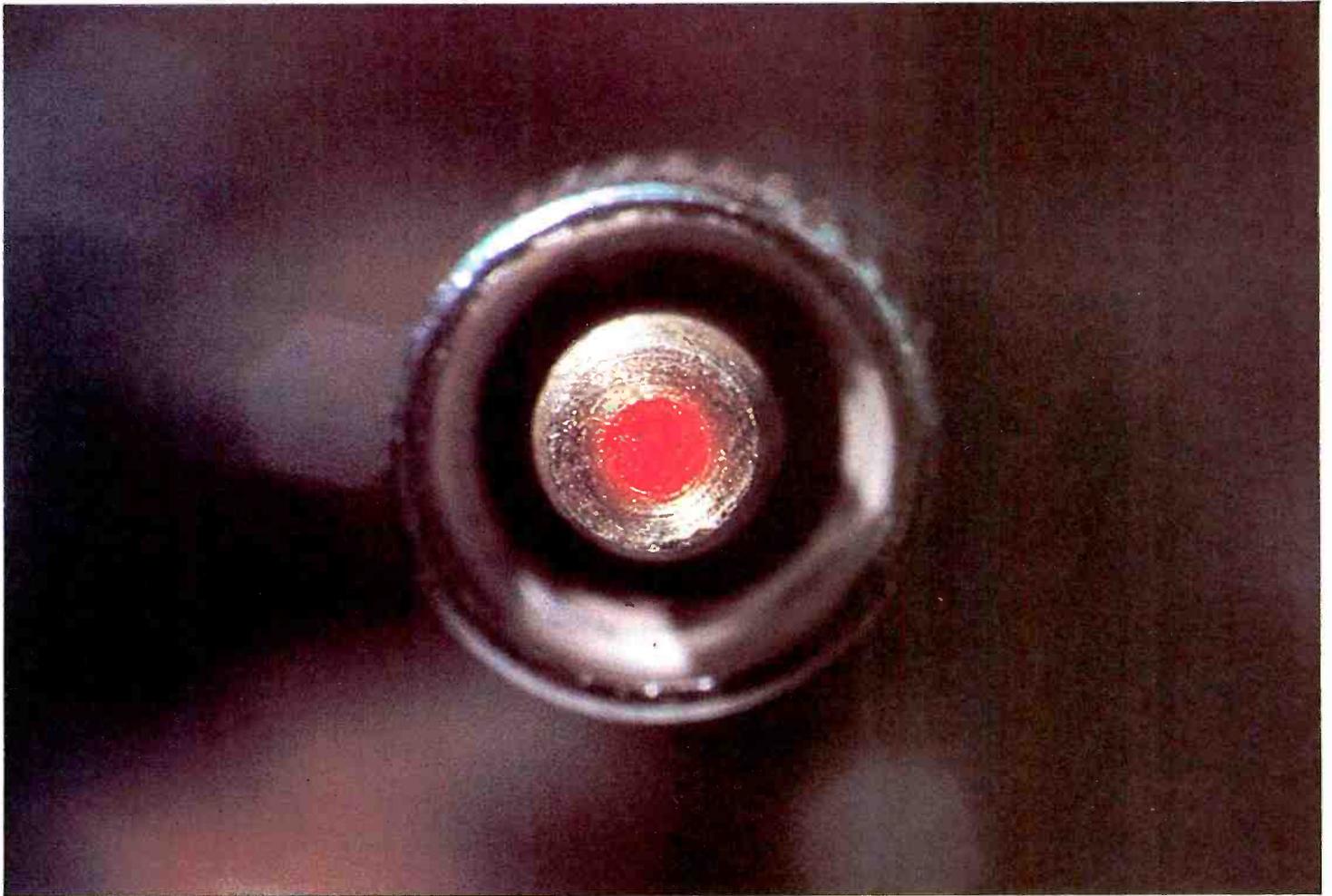
In a multimode fibre the bandwidth is primarily determined by two mechanisms: modal delay spread and material dispersion coupled to the source spectral bandwidth. As the amount of pulse-spreading depends on the length of the fibre it is most useful to quote the performance of a fibre as the product of its bandwidth and length. For any given fibre and source, bandwidth can be traded off against length (however the maximum length may be restricted by the allowable system attenuation, see part 3).

Modal delay spread

The first of these bandwidth-limiting factors, modal delay spread, refers to the differences in the group delays of different waveguide modes. In terms of ray optics, this is equivalent to saying that the rays which are totally internally reflected at the higher angles of incidence on the core-cladding boundary take a longer zig-zag path before emerging at the far end of the fibre. Referring back to Fig. 3 shows that a ray travelling at an angle θ_{int} relative to the fibre axis takes $1/\cos \theta_{int}$ longer to travel an axial distance than does a ray travelling straight along the axis. The maximum time delay difference² will be

$$\delta T_{max} \approx \Delta n_c / c \text{ (ns/km)}$$

where c is the speed of light in *vacuo*. For a typical fibre with an index step $\Delta = 0.01$ and a core refractive index $n_c = 1.5$, then $\delta T_{max} \approx 50 \text{ ns/km}$. The pulse-smearing caused by this delay spread is equivalent to a modulation bandwidth-length product of around 5 to 10 MHz km. In other



words, due to modal delay spreading a 1km fibre of this type would exhibit a usable modulation bandwidth of 5 to 10MHz.

One method of reducing the modal delay spread in a multimode fibre is to make the refractive index of the core graded rather than stepped (refer back to Fig. 2(b)). Rays propagating in such a graded-index fibre have nearly equal delays as the higher mode zig-zag rays now take a helical path, keeping to the outer regions of the core where the refractive index is lower and hence the speed of propagation faster. By choosing a suitable index profile (usually parabolic) the modal delay-spreading can be reduced by two orders of magnitude or more relative to multimode step-index fibres.

Figure 6 shows how the modal delay spreading varies with refractive index difference Δ for both step index and graded-index multimode fibres at a wavelength of $0.85\mu\text{m}$. To achieve the best compromise between bandwidth and source coupling efficiency it is usual for most multimode fibres to have a Δ value of around 0.01, producing typical modal delays of 50ns/km and 0.3ns/km for step and graded-index fibres respectively³. This corresponds to a fibre bandwidth-length product of

approximately 1 to 5GHz km at $0.85\mu\text{m}$ due to modal delay spreading for a graded-index fibre; a substantial increase. The penalty is the extra manufacturing difficulty of retaining tight control over the index profile, for even slight unplanned deviations in the index profile will cause a disproportionate reduction in the bandwidth-length product.

An alternative way to reduce the modal delay spread is to make the fibre core region much narrower than the multimode fibre core but still with a step index, Fig. 2(c). As the core diameter is reduced toward the wavelength of light, fewer and fewer of the higher order zig-zag modes can propagate and the fibre eventually becomes a monomode waveguide (HE_{11} mode) when the core diameter falls below approximately three times the wavelength of the optical radiation. It is extremely difficult to make fibres with such a narrow diameter (2 to $3\mu\text{m}$) and so usually diameters in the range 5 to $10\mu\text{m}$ are used and a few low-order propagation modes tolerated⁴. (In contrast, a typical multimode step-index $50\mu\text{m}$ fibre may support several thousand propagation modes.)

The modal delay-spreading of a true monomode fibre must be

zero, but there are usually several low-order modes present in a practical fibre, making it difficult to give meaningful figures. For a step-index monomode fibre modal delay spreading is not usually the restricting factor on the operational bandwidth-length product (it is probably well beyond 100GHz km). Instead, the practical restriction placed on the bandwidth-length is due to the second mechanism — that of fibre material wavelength dispersion and the spectral width of the optical source.

Material dispersion

Material dispersion refers to the variation in group velocity with wavelength of light in the fibre. The dispersion causes pulse spreading in fibres driven by optical sources with a finite spectral width; the greater the source spectral width the greater the pulse spreading and therefore the lower the bandwidth-length product. A typical $0.85\mu\text{m}$ l.e.d. exhibits a spectral width of around $0.05\mu\text{m}$ (50nm) in contrast to an injection laser diode whose spectral width is typically $0.002\mu\text{m}$ (2nm). These figures translate to bandwidth-length products of about 500MHz km and 25GHz km for l.e.ds and

Visible red light rather than infra-red is often used with the low-cost polymer fibre shown.

OPTICAL FIBRES

After a postdoctoral fellowship at Manchester University, Brett Wilson taught in Baghdad for a year and then returned to work on optical position detectors and sensitive non-contact current measurement. He then lectured at Nottingham University, where he's been concerned with novel uses of op-amps in addition to fibre optics, and from Easter returns to Manchester, this time at UMIST. His Ph.D. was on a high-speed laser stroboscope for magnetic bubble research. Hobbies include walking, cycling, climbing, motorcycling, films, literature and photography.

Table 1. Principal limitations on fibre optic systems.

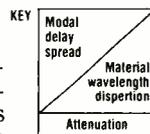
OPTICAL SOURCE	MULTIMODE	FIBRE	MONOMODE
	Step index	Graded index	Step index
i.e.d. $\lambda 0.85\mu\text{m}$ $\delta\lambda 50\text{nm}$	10 MHzkm 500 MHzkm 3dB/km	1.5 GHzkm 500 MHzkm 3dB/km	>100 GHzkm 500 MHzkm 2.5dB/km
i.e.d. $\lambda 1.3\mu\text{m}$ $\delta\lambda 2\text{nm}$	10 MHzkm 2.8 GHzkm 1dB/km	1.5 GHzkm 2.8 GHzkm 1dB/km	>100 GHzkm 2.8 GHzkm 0.7dB/km
i.l.d. $\lambda 0.85\mu\text{m}$ $\delta\lambda 2\text{nm}$	10 MHzkm 25 GHzkm 3dB/km	1.5 GHzkm 25 GHzkm 3dB/km	>100 GHzkm 25 GHzkm 2.5dB/km
i.l.d. $\lambda 1.3\mu\text{m}$ $\delta\lambda 2\text{nm}$	10 MHzkm ≈ 100 GHzkm 1dB/km	1.5 GHzkm ≈ 100 GHzkm 1dB/km	>100 GHzkm ≈ 100 GHzkm 0.7dB/km

i.l.d.s respectively at 0.85 μm .

Fortunately a material dispersion minimum has been discovered at 1.3 μm which allows for wide bandwidth transmission over distances, >100GHz km, even with an i.e.d.⁵. Combined with the generally lower losses at 1.3 μm , this has provided the impetus for much recent research at longer wavelength operations for future optical sources and detectors.

For any given fibre type and optical source there are therefore two main limitations on the maximum achievable bandwidth-distance product that can be achieved. Either modal delay spreading or material dispersion will dominate depending on the fibre type, source type and operating wavelength. Table 1 summarises the points discussed so far in a convenient form, including figures for the highest modulating speeds so far achieved with i.e.d.s and i.l.d.s. Clearly there is much development to be done on source modulation before the bandwidth potential of the best fibre system is reached.

Step-index multimode fibres are best employed in sort-haul medium bandwidth systems, probably with an inexpensive 0.85 μm i.e.d. source as modal delay spreading restricts the performance to around 10MHz km. Graded-index multimode fibres are the natural choice for long-haul high data-rate links operating up to approximately 15GHz km at 1.3 μm , probably using an i.l.d. source for faster modulation. Monomode fibres operating at 1.3 μm with an i.l.d. source offer the best performance for ultra-high data rates. It may not always be possible to trade off



the extremes of the bandwidth-distance product because of system power level restrictions imposed by fibre attenuation.

The only area in which present optical fibre systems are inferior to traditional metal cable systems is in the allowable power budget between the transmitter and receiver. It is presently difficult to launch more than several hundred microwatts of optical power into a fibre from an i.l.d. (less for an i.e.d.), whereas r.f. transmitters can inject many times this level of input power into ordinary copper cables. Similarly, optical detector-receiver arrangements are rather less sensitive (≈ 1 to 20nW) than r.f. receivers.

The allowable power loss between transmitter and receiver in an optical fibre system is therefore restricted to a maximum of around 30 to 40dB for acceptable bit error rates or signal-to-noise ratios⁶. This is much less than a conventional cable system. Fortunately, attenuation of an optical fibre is much less than that of traditional coaxial cables, resulting in potentially longer spacings (20 to 50 km) where there are few cable splices or optical junctions. The problem of restricted power budget must be kept in mind when considering optical fibres for data network systems where there may be many junctions, couplers or splitters with attendant high losses. There is no optical equivalent of a high impedance tap!

A general comparison is made in Table 2 between the characteristics of twisted pairs, coaxial

Table 2. Comparison of major communication cable types.

CHARACTERISTIC	TWISTED PAIR	COAX CABLE	OPTICAL FIBRE
Length-bandwidth product (MHzkm)	1-2	50-100	1,000-5,000
Spacing between repeaters (km)	1-2	1-2	5-20
System cost	Low, small increase in future	Medium small increase in future	High now, large decrease in future
Lifetime (years)	20-40	20-40	2-5, 10-40 in future
Crosstalk	High	Low	Negligible
Noise immunity	Low	Medium	High
Input-output isolation	No	No	Total
Weight, size	High	High	Low
Cable connections	Soldering, standard connectors	Soldering, standard connectors	Splicing, well aligned connectors
Fabrication control	Loose	Medium	Precise

cables and fibre optics used as communication links. The many advantages of a fibre optic link are clearly evident.

Main benefits of fibre optic systems over metal cables:

- higher system channel capacity
- larger bandwidth and small loss
- longer distance between repeaters
- electrical isolation of input and output
- almost complete immunity to e.m.i.
- almost complete freedom from signal leakage and crosstalk
- almost complete security against unauthorized interception
- smaller size and weight
- lower system cost per channel km.

In contrast to metal cable systems fibre optics is a rapidly developing technology. It is obvious that fibre optics is currently superior in most respects to metal cable transmission techniques these advantages can only be strengthened as the technology matures. Over the next ten years or so we are likely to see the increased use of integrated optics in couplers, switches, modulators, sources and receivers further increasing the advantages of guided optical transmission over metal cable techniques.

Optical transmitters and receivers are discussed in part 2 of this article.

References

1. T. Li, "Advances in optical fibre communications: an historical perspective", *IEEE Journal on selected areas in communications*, vol.SAC-1, no.3, 1983, pp.356-72.
2. H. F. Wolf, "Handbook of fibre optics", chapter 2. Granada, London, 1979.
3. S. D. Personick, "Review of fundamentals of optical fibre systems", *IEEE Journal on selected areas in communications*, vol.SAC-1, no.3, 1983, pp.373-80.
4. J. W. Fleming and V.R. Raju, "Low-loss single-mode fibres prepared by plasma-enhanced MCVD", *Electronics Letters*, vol.17, Nov.1981, pp. 867/8.
5. D. N. Payne and W. A. Gambling, "Zero material dispersion in optical fibres", *Electronics Letters*, vol.11, April 1975, pp.176-8.
6. J. R. Stauffer, "FT3C — a light-wave system for metropolitan and intercity applications", *IEEE Journal on selected areas in communications*, vol.SAC-1, no.3, 1983, pp.413-9.

**'The report of
my death was
exaggerated'** (MARK TWAIN)

the same can be said
of the

**ZENER
DIODE**

**— still going strong
and selling by the
million**

With a range of over 20 different families from 400mW to 50W it is almost certain that there is a Zener to meet every application. For your free Short Form guide to these and other Thomson Discrete Products contact us at the address below.



THOMSON-CSF
COMPONENTS

THOMSON-CSF COMPONENTS AND MATERIALS LTD.
RINGWAY HOUSE, BELL ROAD, DANESHILL, BASINGSTOKE, HANTS RG24 0QG.
TEL. (0256) 29155 TELEX 858865

Distributors

Abacus Electronics 0635-33311 · Bloomer Electronics 0762-39818 · E.S.I. 0256-57166
Lock Distribution 061-652-0431 · Phoenix (Airdrie) 0555-892393 · Pronto Electronics 01-554-6222
Semiconductor Specialists 08954-46415 · Solid State Supplies 0892-34366
Statelite 021-454-2655 · Transworld Scientific 0494-36381 · United Components 0494-444712

CIRCLE 078 FOR FURTHER DETAILS.
www.americanradiohistory.com

Carston

Carston sell

Carston

Used test equipment, calibrated to Manufacturer's original specification.

SPECIAL OFFER

All this for £995 +VAT
Fully calibrated and guaranteed for one year.



A multi-function combination of items comprising:- a high performance 50MHz dual trace, dual delayed timebase oscilloscope, a 4 digit, auto-ranging multimeter and a 7 digit 1000MHz frequency counter.

* TEKTRONIX model 455 Oscilloscope - 50MHz bandwidth, dual/delayed timebase, dual trace.

PLUS

* PHILIPS model PM2517 4 digit autorange multimeter, light weight, battery operated. AC/DC volts, current & ohms.

PLUS

* PHILIPS model PM6668 7 digit microprocessor controlled frequency counter. Operates to 1000MHz.

Full Details Available on Request

ORDER NOW WHILE STOCKS LAST

Carston Electronics Ltd
01-267 5311

Shirley House, 27 Camden Rd, London NW1 9NR. Telex. 23920

Carston buy

Contact us for a cash quote on your under utilised test equipment

CIRCLE 077 FOR FURTHER DETAILS

www.americanradiohistory.com

Tv hazards

The problems that can arise when a television mast, or aerial system, fails were underlined in the incident that put all four channels off-air at Durriss, near Aberdeen at the height of the appalling weather conditions on January 17. While it proved possible for IBA, BBC, Grampian ITV and British Telecom riggers and engineers to restore service to most viewers in a matter of days, some viewers remained virtually without television until February 9. Although this incident is the first time that a very large number of UK viewers have lost all services for a matter of days, (the collapse of the Emley Moor mast in 1969 left BBC-1 unaffected) basically similar incidents have happened elsewhere.

Last October, for example, a 315-metre mast of Belgian television at Wavre, serving Brussels with a considerable number of radio and two television services, was blown down. While a temporary substitute for the 'Radio 21' service used a spare transmitter at the Palais de Justice, other services were lost over an extended period, including television services of BRT-2 and RTBF-2. However a large percentage of Belgian viewers are on cable systems and steps were taken quickly to improve the distribution of programmes directly to the cable stations.

An electrical fire put an American tv transmitter WOWV-TV in West Virginia off the air in the afternoon of January 12. Before the station could be put back on the air that night a second fire broke out, completely destroying both transmitters. Finally a new transmitter was brought in, but the station was off-air for four days.

Satellites

Although the European Ariane launch vehicle scored a major success with the Intelsat V communications satellite launched on March 5, the problems for Immarsat have not been entirely overcome. The marine communications organization refused to accept the Intelsat V F7 spacecraft as unworkable and the March

satellite is to an earlier design still not entirely debugged. The F9 launch scheduled for summer 1984 has been put back to 1985. The problems with the booster engines on the Space Shuttle satellites has increased the demand for the Ariane, and production of the European vehicle may have to be stepped up from six per year. The sensitivity of the insurance market after the double failure with the Space Shuttle may be a deciding factor in the bright commercial future for the largely-French Ariane, despite the earlier set backs. It remains to be seen, however, whether the market for high-power DBS satellites will prove as large as forecast until recently. DBS, like multi-channel cable systems, are being subjected to a more realistic scrutiny. Many of the would-be cable programme providers in the UK have already merged or quietly vanished.

One of the fastest production jobs on a new scientific/educational/amateur radio satellite, the second UOSAT design, was successfully into low earth orbit on March 1, 1984. Built, tested and launched in a few months, it represents a real achievement by the University of Surrey team.

Services and GCHQ

Among the millions of words that have been written about the banishing of unions at GCHQ, surprisingly few commentators have noted the implications of this badly-handled affair for other sectors of British and NATO defence communications or come up with a credible reason for the Prime Minister's determination to press ahead with this action at this time. The usual scenario has been to blame it on either American pressure following the Prime case (as for the introduction of the polygraph machines) or simple union-bashing.

There is, I would suggest, an alternative and inherently more likely explanation — the strong wish of the Services, particularly Navy chiefs, to reverse the post-war trend towards having defence communications and signals intelligence networks manned and controlled by

civilians. The suggestion of de-unionisation, stemming from within GCHQ, can then logically be seen as a move to counter increasing Service pressures against the 'demobilisation' of the defence communications set-up.

For many years, the monitoring and interception of the radio traffic of real or potential enemies was the responsibility of the Y-service at stations manned largely by the Services, though backed up by civilian personnel. This tradition changed following the war-time successes of Bletchley Park with the formation of the Composite Signals Organization as an inherent part of GCHQ. A typical example of the resulting changes can be safely quoted without breaching security since the station closed down several years ago. Flowerdean, near Winchester, was for many years a Y-service h.f. station of the Royal Navy. It became, under the GCHQ regime, a civilian-manned CSO station run from Cheltenham.

Although Service signals personnel still man some intercept stations, the direct role of the Services in this work, as in many other branches of Defence communications, has clearly decreased. The Royal Navy, always quick to take umbrage at any attack, real or apparent, on its assumed role as the 'senior Service' has consistently opposed such diminution of its responsibilities.

Stereo on tv

A further series of test transmissions of the BBC's digital stereo tv system suitable for use on terrestrial networks were carried out early in March in the London area, on the Crystal Palace high-power transmitter and its local relays. This followed earlier tests in the hilly South Wales area from Wenvoe where the main purpose was to check digital performance under multipath propagation conditions. The London tests concentrated on compatibility with the wide range of television receivers in use.

The system uses a phase-modulated second sound carrier at 6.55 MHz above the vision carrier phase modulated with a bit rate of about 700 kilobits/second.

If the system proves satisfactory in all types of terrain and does not cause interference problems with existing monophonic receivers, the BBC hope to put it forward for European standardization, though this may not prove easy in view of the current use in West Germany of an alternative analogue tv-stereo system. These days it is not enough to develop a good system to ensure winning a standards battle!

A long struggle

Although political lobbying by the Services is usually conducted behind closed doors, in 1978 Admiral Sir Edward Ashmore, then a recently retired Chief of the Defence Staff, in a lecture to the Royal Signal Institution, made no secret of his vehement dislike of the command structure of NATO and the whole organisation of defence communications. He advocated strongly that defence communications should be securely in the hands and control of the Services, reversing the post-war trend towards a part civil, part Service, system, on the grounds that civilians might be provoked into industrial sabotage by hostile propaganda.

RN dislike of providing communications facilities for the civilian media was evident during the Falklands campaign, while the influence of the Defence Staff on the Prime Minister was underlined at that time, when she was persuaded by the then Chief of Defence Staff, Admiral Sir Terence (now Lord) Lewin, to agree that HMS Conqueror should sink the Argentine cruiser General Belgrano.

The hostility of the Services to Intelligence activities over which they have no direct control, by people not subject to Service discipline and traditions, is of long standing, particularly in the field of Sigint. It dates back at least to the period following World War 1 when the Navy's cipher-cracking operation passed from Room 40 at the Admiralty to the Foreign Office-controlled Government Code & Cipher School. It was reflected during World War 2 in the refusal of the Admiralty to agree to Ultra intelligence being distributed to the Navy by MI6's Special Communication Units, as for

Army and RAF Commands. Viewed in this light the GCHQ fracas emerges as part of the old struggle between a Navy-dominated Ministry of Defence and the civil departments of Government, including the Foreign and Commonwealth Office — a view supported by later reports of political 'vetting' at MoD.

Here and there

In many major urban centres in the USA, broadcast listening on f.m. is now significantly ahead of a.m. with the Dallas-Fort Worth area showing f.m. with a 69.4 per cent share of listening. A few major urban centres, including San Francisco, still remain a.m.-orientated. The a.m. broadcasters hope to win back listeners with a.m. stereo. Meanwhile the f.m. broadcasters are being given greater freedom to use Subsidiary Communications Authorization (SCA) facilities, including the use of a second sub-carrier. The use of broadcast transmissions for area or nation-wide radio-paging based on the second SCA sub-carrier is attracting increasing interest.

The first part of the ITU conference on h.f. broadcasting, early this year in Geneva, seems to have gone smoother than expected, with even the Americans, often critical of ITU conferences, expressing satisfaction. Frequency allocations requested by countries are to be computerized and a check is to be made to establish the extent of deliberate jamming. However the conference was concerned only with establishing technical parameters and the main problems may come next time in 1986. 615 delegates from 90 countries attended.

The Pentagon is planning to double its spending during 1985 on the protection of ground and airborne electronic command centres from the effects of e.m.p. (electromagnetic pulses generated by nuclear blasts). Also planned is the establishment of a world-wide network of five terrestrial electro-optical surveillance centres to detect and identify objects in deep space, for completion by 1988.

Amateur Radio

Telephone and cable r.f.i.

The lack of attention paid to e.m.c. problems by those supplying electronic equipment for homes, cars, petrol pumps etc. is becoming ever more noticeable. The consumer-electronics industry assumes that very few of its products will ever be used in places subject to high levels of r.f. despite the many thousands of broadcast, amateur-radio, c.b. transmitters, cordless telephones, two-way car radios etc.

The latest problem is arising from the new telephone handsets and inserts that replace the traditional carbon-granule microphone with an electret transducer and integrated-circuit amplifier. As fitted, these telephones appear to be most susceptible to local transmitters, yet there is evidence that this can often be much reduced by improved r.f. bypassing, sometimes by utilizing components already fitted.

The RSGB reports that the interference to amateurs using the 144 MHz band at Milton Keynes has been traced by DTI to radiation by and feed-through at the British Telecom cable frequency translation units at about 120 points in the cable area, where a television channel centred on 143 MHz is changed to u.h.f. for final distribution into homes. No significant leakage has been traced to the main buried distribution cable. Each translation unit feeds about 50 homes. The problem does not arise with translation units built in metal cabinets but only where these are contained in fibreglass cabinets, where filters have to be fitted.

The DTI measured high levels of radiation at distances up to 100 metres from the translation units. DTI have stated that the local Radio Interference Service teams will fit suitable filters in fibreglass units near the homes of radio amateurs, but only if complaints are received. Since

the BT cable installation at Milton Keynes is normally regarded as a technically advanced system the problems that seem likely to arise as more and more television signals are distributed at frequencies within the amateur bands may prove severe.

50,000-plus

At the end of December 1983, the number of UK amateur radio licences was 50,635, of which 24,359 were Class A and 26,276 were Class B. During 1983 the number of Class A licences were, thus, for the first time overtaken by the 'no-morse-test' Class B licences (144 MHz and above). When the Class B licence was introduced in June 1964 it was for 420 MHz-and-above only, and was then intended to encourage the development of the U.H.F. bands by technically-minded experimenters. Unlike the FCC system, where radio amateurs voted 20-to-1 against the introduction of a no-code licence, the British Class B licence for first u.h.f. and later extended to v.h.f., resulted from closed-door discussions.

The FCC state: "Morse code is a fundamental communications skill critical to the nature of the Amateur Radio service."

ATV repeaters

The DTI have approved the setting up of the first five amateur-television repeater stations in the UK. They will use the 1.3 GHz band and accepting vision and sound a.m. or f.m. signals, located at Leicester, Bath, Luton, Stoke-on-Trent and Worthing. The Leicester (GB3GV), channel RMT1, Luton (GB3TV) Channel RMT2 and Worthing (GB3VR) channel RMT2 repeaters should be active by the time these notes appear.

Aerial polarization both incoming and out-going is horizontal. RMT-1 has vision-in 1276.5 MHz vision-out 1311.5 MHz, sound-in 1282.5 MHz and sound-out (a.m.) 1317.5 MHz. RMT has vision-in 1249.0 MHz, vision-out 1318.5 MHz, sound-in 1255.0 MHz, sound-out 1324.5 MHz. The British Amateur TV

Club has appealed to its members: "Since these are the first such licences to be issued in the UK, it is incumbent on us all to use the facilities in a responsible manner in order that the authorities may look favourably on any future expansion plans to the amateur-television network."

In brief

Dr Owen Garriott, W5LFL, the radio-amateur scientist on board the STS-9 Space Shuttle took part in a London meeting of the Royal Society during February where the general scientific work of the mission was discussed. There are signs that future Space Shuttles are likely to have amateur radio equipment on board but most observers agree that it will be essential to achieve greater operational discipline and co-operation by those on the ground as well as a less-noisy environment on board the Shuttle. . . . Japan is introducing 900 MHz c.b. with 80 channels and 25-kHz spacing. Automatic transmission of identification signals will be incorporated. Although Japan has supplied the world with c.b. equipment it is one of the last major countries to introduce c.b. . . . Mobile rallies to be held during May include an Anglo-Scottish rally at Kelso on May 6; Swindon (Oakfield School) and Otley (Flower Show Hall, Harrogate) on May 13; Drayton Manor Park (near Tamworth) on May 20; and East Suffolk Wireless Revival (Suffolk Showground, Ipswich) on May 27. . . . In the period to May 1984, the Radio Amateur Licensing Unit of the Post Office is sending a questionnaire to each licensed radio amateur in the UK. However the main purpose appears to be to check postal addresses and post codes. . . . Solar flux levels were unexpectedly high during February 1984, reaching the highest levels since December 1982. . . . The RSGB have extended the deadline for the additional 50 MHz permits to April 30 at the request of the DTI.

PAT HAWKER, G3VA

PREFERRED HISTORIES

Mr Scott, in the January issue, has drawn quite the wrong conclusion for his final quotation, and his conclusion reflects his thinking throughout. The modern camel has been designed by a large committee of users, whose lives and livelihood have depended on their transport. Camels work for them, as horses work for Mr Scott and Jorrocks. Horses one may recall, did not work for Captain Scott.

The appropriate quotation might be Belloc: "Only an aristocracy can be governed by committees". When the preferred number system and colour coding were standardized the light-current engineers had something of the character of an aristocracy. Tenuous links of common education or common experience extended almost everywhere, just as we can see the family links in the books of Anthony Powell.

The two basic factors were the almost universal use of carbon composition resistor, and the boom, highly seasonable, in the manufacture of wireless sets. There really were, every year, new ideas at Olympia, and one large manufacturer closed for six months each year because no-one bought in the early summer. The carbon composition resistor was not very stable, so that designers were forced to live with $\pm 20\%$ tolerance. The method of manufacture had a lot in common with the production of the stodgy school puddings which you can now get only at a decent London club. Two buckets of A, one of B, a shovelful of C and D to taste. Blend, mould to shape, place in a hot oven. Sort.

Sort in fact into bins, with 0.8-1.0-1.2: 1.2-1.44-1.728: As long as they were inside ceramic tubes the resistance could be printed on the tube. Changes of mix to make them fairly damp-proof gave a black body which did not need to be encased. Like the £1 coin it all made sense to have a set of values and a colour coding system. The trouble with answers which make sense is that no-one likes them. In the 1945 edition of Langford Smith the Radio Manufacturers Association (US) has a long list of popular

values, few of which are our preferred number. Colour coding yes; E6 or E12, no.

One important trick, and a jolly good one, was to link value and colour. The use of 3.3 instead of 3.2 means more colour contrast, and as it means 2.7 to 3.9 anyway, how does it matter. To use the full colour range we can pick either 4.7, 6.8 or 4.6, 6.7. But 4.7, 6.8 gives us a double colour contrast. The committee, in fact, lifted its collective eyes from the slide rule and looked at the real world, as they knew it.

Full acceptance of the system came only with the War, with the drafting of specifications and lists, and with pressures on designers like the ruling that even 10% tolerance could only be used if application and justification were made in writing.

The functional nature of the preferred number series was discussed in a series of articles in *Wireless Engineer* nearly 40 years ago. The initial problem was to produce simple band-separating filters, the sort the PO used to provide if a local embassy transmitting in the h.f. band interfered with your Band I television, subject to the condition that the capacitor should have preferred values. The usual method was to design conventionally and wonder what the effect of 220 instead of 270 would be. Using as an example the typical equation $C = \frac{1}{2\pi f_c R}$, we have $\log_6 C = -(\log_6 2\pi + \log_6 f_c + \log_6 R)$. If $2\pi = 6.8$ we can choose f_c and R as preferred numbers. Then $\log_6 C$ is an integer and so C is a preferred number. We have defined the design limitations at the beginning, not fudged them at the end. For equations containing a square root, $\log_6 X$ will be $n/2$, and thus will be in the E12 range.

Mr Scott should ask himself what sort of people he thinks we are, not to have noticed that $10_{1/6}$ is not 1.5. And then, what sort of a person do we think he is?
Thomas Roddam
Arundel
W. Sussex

DBX AND DOLBY

I am writing with regard to an article entitled "BSR clammers out of depression" in the January 1984 issue of *Wireless World* which states that "They (dbx, Inc.) have produced a neat little playback decoder, battery operated, for use with headphone cassette players for both dbx and Dolby B decoding." If this statement is referring to the dbx PPA-1 decoder, it is incorrect, since this unit does not have a Dolby B-type decoding facility. In its dbx B mode, the PPA-1 does have static decode characteristics that approximate to those of Dolby B-type, but it does not have the dual path circuitry, the overshoot suppression, the dual-rate control circuit and other characteristics that it would need before it could be said to have "Dolby B decoding". I would appreciate it if you would advise your readers of this.

Ian Hardcastle
Vice president
Dolby Laboratories
San Francisco, LA

ELECTRIC CHARGE FROM A RADIO WAVE

In his letter (January 1984) Peter Hesketh gives a step by step method of changing Professor Jennison's apparatus to produce an ideal waveguide bent into a circle. I agree with him that no amplifier is in principle necessary to maintain a wave in such a guide, and so far, his assumptions are completely justified. However, I do not see how he can use this idealised equipment, even in his imagination, to support Professor Jennison's contention.

Is it not true that the velocity in space of a guided electromagnetic wave is independent of the motion of the conductors that do the guiding? In other words, even in principle we cannot drive a waveguide backward so that the wave it carries is arrested in space.

Now this objection does not apply to the discrete component machine described in the article. The waves associated with such a machine are not electromagnetic waves in space, but as I said in my earlier letter, more like the waves we find on a polyphase

machine. As such they have a velocity relative to the hardware of the machine. Perhaps Mr Hesketh has raised unwittingly a more serious objection to Professor Jennison's demonstration than at first occurred to me. We cannot use a machine that generates waves having a velocity which can be vectorially combined with the velocity of the machine to explain a phenomenon where the waves have a velocity that is independent of the machine velocity.

Perhaps in what I say here I am mistaken. I would certainly like to see Professor Jennison's defence of his apparatus.

Chris Parton
Department of Electrical & Electronic Engineering
Bell College of Technology
Hamilton

Letters to the editor

Letters for publication are always very welcome. Many more come in than can be published, since space in the journal is limited, and I would therefore ask that letters be short and to the point, so that heavy cutting need not be suffered. Letters on new subjects will now be printed on the Feedforward page, those referring to past topics, already mentioned in articles or previous letters, going in the Feedback section.

Ed.

TELEVISION TECHNOLOGY

I think it is time something was done about Television. It has become rather nasty. I am referring not to video vice and violence, but to circuit technology. The whole science has, like Topsy in Uncle Tom's Cabin, "just growed". Well, what of it? one might ask, it works well enough, doesn't it?

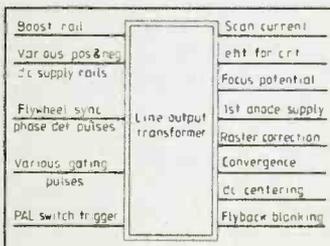
Get yourself a circuit diagram of your own receiver, study it, and then ask yourself how you would like to track down an obscure fault in the heart of it. Logical, step-by-step fault tracing is not so easy.

The point I wish to make is that it has all developed out of pre-war neon relaxation oscillator technology. If there had never been any television prior to 1980 say, then we would not have started from there, and we would not still be perpetuating that piece of non-ideal practice. At present I believe the following line standards exist, 405, 525, 625, 819, 929, and the Japanese are developing 1251 lines.

The advent of satellite television broadcasting gives the world a chance to make a clean break with the past, and to adopt a new, elegant and simple global standard. For a start, lack of bandwidth need surely no longer compromise and complicate system design. For instance, one could have three separate colour carriers, thus greatly simplifying everything. Since all receivers are likely to incorporate at least one frequency crystal, there is no need to transmit line as well as frame synchronizing pulses. Interlacing could probably be dropped in favour of some round number of lines, e.g. 1200, 1500, 1800, 2400 or 3000, and the sooner the shadow mask goes the better.

Modern tv receivers certainly are reasonably reliable. However, they do sometimes break down, and the involved circuitry around the line timebase (diagram) can give even experienced servicing engineers a great deal of trouble, wasting a lot of time. This results in heavy charges for customers to pay. Components in the line timebase are the most highly stressed in the set. Even the scanning coils may have a thousand volts across them.

If, instead of the present



scan-and-flyback system, we had a zig-zag scan-scan system, the line timebase would be much more wholesome, and far less lethal. It would be a simple matter to generate the e.h.t. by a separate oscillator and Cockcroft-Walton voltage multiplier. Synchronizing pulses and most of the other pulses at present supplied by the line output transformer could come straight from an internal crystal-controlled waveform generator. The crystal frequency and phase would be trimmed by a received frequency burst, which also serves as the frame sync signal.

As tv receivers do not usually last much longer than 15 years, I submit that it is not essential to make the system for the future compatible with anything now in existence. Let's start again, and this time make it all elegantly simple, rational and straightforward, for in the end this will save everybody a lot of time, trouble and money. Many expensive items like colour cameras could probably be sent back to the manufacturers to be refurbished to the new system, only printed boards ending up on the scrap heap. Getting rid of fast flyback should also significantly reduce the fire hazard of tv receivers, and greatly increase reliability.

The prospects for international co-operation over programmes, and for tv "globe-trotting" would obviously be much enhanced if there was a single universal system. The co-operation of all nations is really needed in order to evolve the best possible system and to get it universally accepted.

H. G. May
Barton-on-Sea
Hants

** Double the line standard and you are likely to end up with twice the voltage across the deflector coils, unless you abolish flyback and have a zig-zag scan.*

SHIFTING WAVES

I wonder if any of your readers could explain to me the odd behaviour of u.h.f. transmissions which I outline below?

To receive domestic television signals from the Sandy Heath transmitter, a simple half-wave dipole with a sheath balun is positioned at an anti-node in the standing-wave pattern which the transmissions set up in a rectangular brick enclosure of approximately $6 \times 4 \times 2\frac{1}{2}$ metres. (Sometimes referred to as a sitting-room).

While the anti-node positions for BBC 2, ITV and C4 are practically coincident, that for BBC 1 displaced from them by nearly 50 cm. Since the point of transmission is the same for all four and the wavelength variation trivial, it is difficult to understand this.

An attempted analysis has postulated the irradiation of two of the enclosure walls by a plane wavefront travelling horizontally and then generated a Huygens wavelet construction from those walls. Mathematical ineptitude prevented a rigorous solution of the expressions arising but they did not, in any case, appear to contain the seeds of an explanation.

H. C. Wright
Blisworth
Northampton

CODED TELEPHONE NUMBERS

May I suggest a simple method of removing one of the most frustrating and error prone activities of any business. This is, the dialling of unfamiliar telephone numbers.

By means of a simple decoder attached to a standard telephone this would use trade directories, visiting cards etc. carrying their bar-encoded telephone numbers. The reader would be a simple wand with possibly a slot to allow cards to be passed through.

This system would, of course, only be of use if a significant number of the business sector used it. Perhaps you would be good enough to raise the subject and help start by producing a suitable adaptor.

John Wilkins
Somersham
Cambridgeshire

SC84 microcomputer continued from page 40

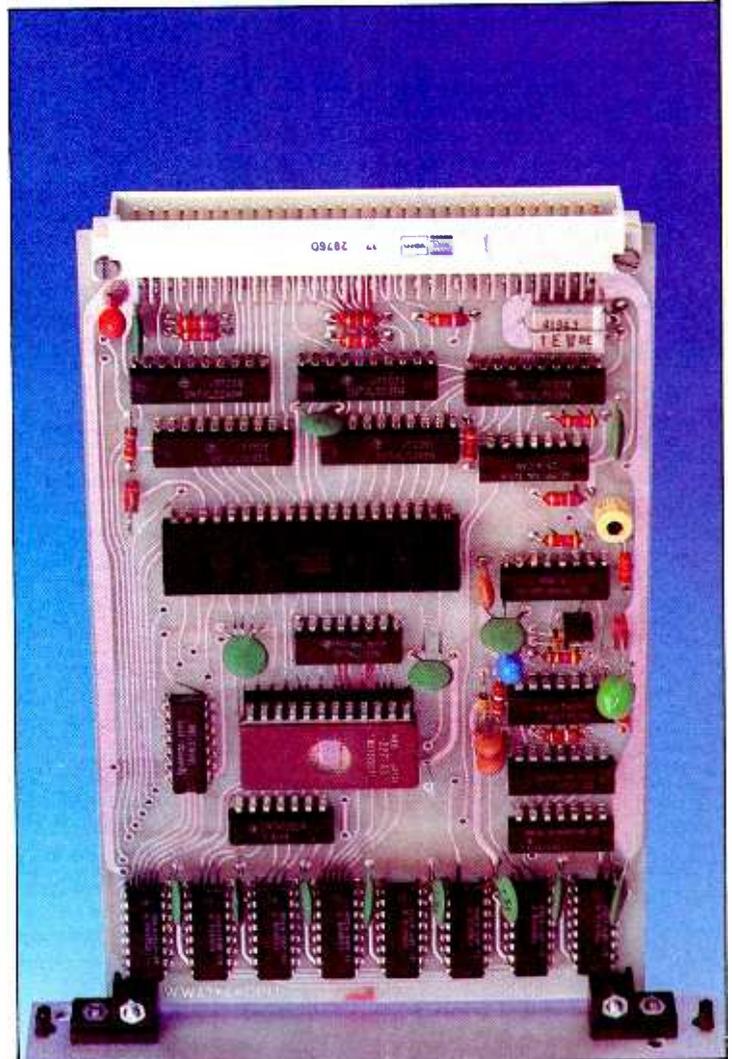
The signal at the start of the Schmitt buffers is (MREQ and not MEMDIS) and not (RFSH or ROMEN), i.e. unless MEMDIS, RFSH or ROMEN is active it is MREQ delayed by a couple of gates. The starting (falling) edge of MREQ becomes a rising edge at the output of the first Schmitt gate. This rising edge is slowed down by the RC combination between the first two buffers so that the falling edge at the second output is somewhat later than that of MREQ. This signal is used to switch addresses being supplied to ram through multiplexers IC_{108,9}. Further delay is applied to produce CAS. To provide a quick end to the memory access so that the multiplexers are definitely reset to the row-address position ready for a refresh cycle, a diode shunts the first time delay which would follow MREQ's trailing (rising) edge. Refresh occurs when MREQ cycles while the RFSH signal is active. During this period, the Z80 puts out a seven-bit value from a special internal register which increments after every refresh. MREQ triggers the monostable i.c. to set off a RAS cycle but the RFSH signal inhibits production of address-multiplex or CAS signals. From the previous discussion of dynamic memory operation, one can see that the sole result of the RFSH cycle, or any memory cycle during which MEMDIS or ROMEN is active, is to 'refresh' 1/128th of the memory.

A simple inverter ring produces the system clock. The crystal frequency will depend on the microprocessor used, i.e., 4MHz for the Z80A or 6MHz for the Z80B. A Z80A should work with a popular 4.1943MHz crystal. These are relatively cheap and although the MK3880-4 or Z80A-CPU is only specified up to 4MHz, it is unlikely that they will not work at this slightly higher frequency. Each i/o section has its own crystal and oscillator, so the crystal used on the processor board will not affect i/o data rates, etc., with the proviso that the processor clock must not fall below 3.6MHz if 3.5 or 8in double-density disc drives are used. When the RESET pin on the Z80 is active everything, including memory refresh, stops. For this reason the reset monostable i.c. generates a short pulse and no matter how long the reset button is held in, refresh is only briefly interrupted so that no memory corruption occurs. As well as providing a reset signal for the Z80 and all peripheral circuits, the pulse is used to set a bistable i.c.

formed from two gates of IC₁₂₀. The output of this bistable device gates with A₁₅ to produce ROMEN, a signal which follows A₁₅ while the bistable i.c. is set and enables rom whenever A₁₅ is low, i.e. during access at any address from zero to 7FFF₁₆. On receiving a reset signal, the Z80 starts to fetch and execute instructions from address location zero. This means that following reset, the Z80 executes instructions from eprom. At the base of the eprom it finds instructions to copy a part of the rom at the top 8K-bytes of system memory followed by a jump that area. This copied software is the machine-code operating system whose first instruction is an i/o read which, due to the IORQ line going active during its execution, resets the flip-flop and forces ROMEN to the inactive high state, disabling the eprom and freeing the entire 64K-byte ram. The timing circuit on the reset monostable i.c. arranges for a much longer time constant to be applied during power-up, providing a reset pulse long enough to allow start up of all of the system clocks. Eprom IC₁₀₇ is shown as a 2764 or 27128 but the board may be modified to take 27256 or 27512 devices.

Prototypes of the computer have been made in wire-wrapped and soldered wiring forms, the most recent version using Vero 03-2989L boards and wiring pen type 79-1732G. Suggested wiring layouts and component placement diagrams for such boards can be obtained by sending a large s.a.e. to *Wireless World's* editorial offices. Construction using p.c.bs is a much easier matter and will be the assumed method. When using these boards the i.c.s should be soldered directly onto the boards with the exception of eproms which should be fitted in good quality sockets. Sockets may be used if required, but only good quality ones. Dynamic rams are best soldered in. The natural fear is that of removing i.c.s should faults occur. This is quite easy though, either using a desoldering tool or by snipping all of the pins off the i.c. body and removing them one by one. A system as complicated as this should not be repaired using the swap-and-see technique so for those who do not have the test facilities to trace a fault, a repair service will be available — for systems built on p.c.bs! Standard pitches have been used for discrete components, details of which appear with each circuit diagram.

John Adams' next article describes SC84's input/output



board. SciDOS with utility software, extended Basic with graphics facilities and Basic with enhanced file manipulation, i/o control, numeric/constant string handling and 12-digit precision are available for £36, £22.50 and £31.50 respectively. These prices include vat and postage and become £24, £15 and £21 respectively for non-commercial users. Further discounts are available for those buying more than one software package at once. Write enclosing s.a.e. to J.H. Adams, 5 The Close, Radlett, Herts.

A set of three Eurocard-format plated-through hole boards for SC84 is available from Combe Martin Electronics, King Street, Combe Martin, Devon EX34 0AD. Price is £39 for the set including v.a.t. and inland or overseas postage. John Adams is considering producing a kit of parts for these boards and John Hodson - secretary of the Scientific Computer User Group - is organizing the SC84 user group. For further information send an s.a.e. to John Adams for kit details or John Hodson, 189 Trent Valley Road, Oakhill, Stoke-on-Trent ST4 5LE, for user group details.

DON'T WASTE GOOD IDEAS

We prefer circuit ideas with neat drawings and widely-spaced typescripts, but we would rather have scribbles on "the back of an envelope" than let good ideas be wasted.

Submissions are judged on originality or usefulness - not excluding imaginative modifications to existing circuits so these points should be brought to the fore, preferably in the first sentence.

Minimum payment of £30 is made for published circuits, normally early in the month following publication.

Combination lock with deterrent

This electronic lock operates on entering the correct four-digit combination on a hexadecimal keypad but should an incorrect entry be made, a further entry is not permitted for one minute. Each subsequent incorrect entry increases the entry-inhibit period by one minute up to a maximum of 15 minutes, after which the delay period is reset.

Inputs A-H of shift registers IC_{21,22} are used to set the combination and A-D inputs of counter IC₅ set the combination size (four in this case). Pressing the internal clear key resets the control-sequence counter IC₁₂ and control-pulse generator IC₁₃. On pressing the enter key, positioned externally on the keypad, outputs of decoder IC₁₃ and counter IC₁₂ are enabled through bistable IC_{11a}.

Activating X₁ loads the combination size into counter IC₅, loads the keyword into shift registers IC_{21,22}, clears previously entered trials in registers IC_{3,4}

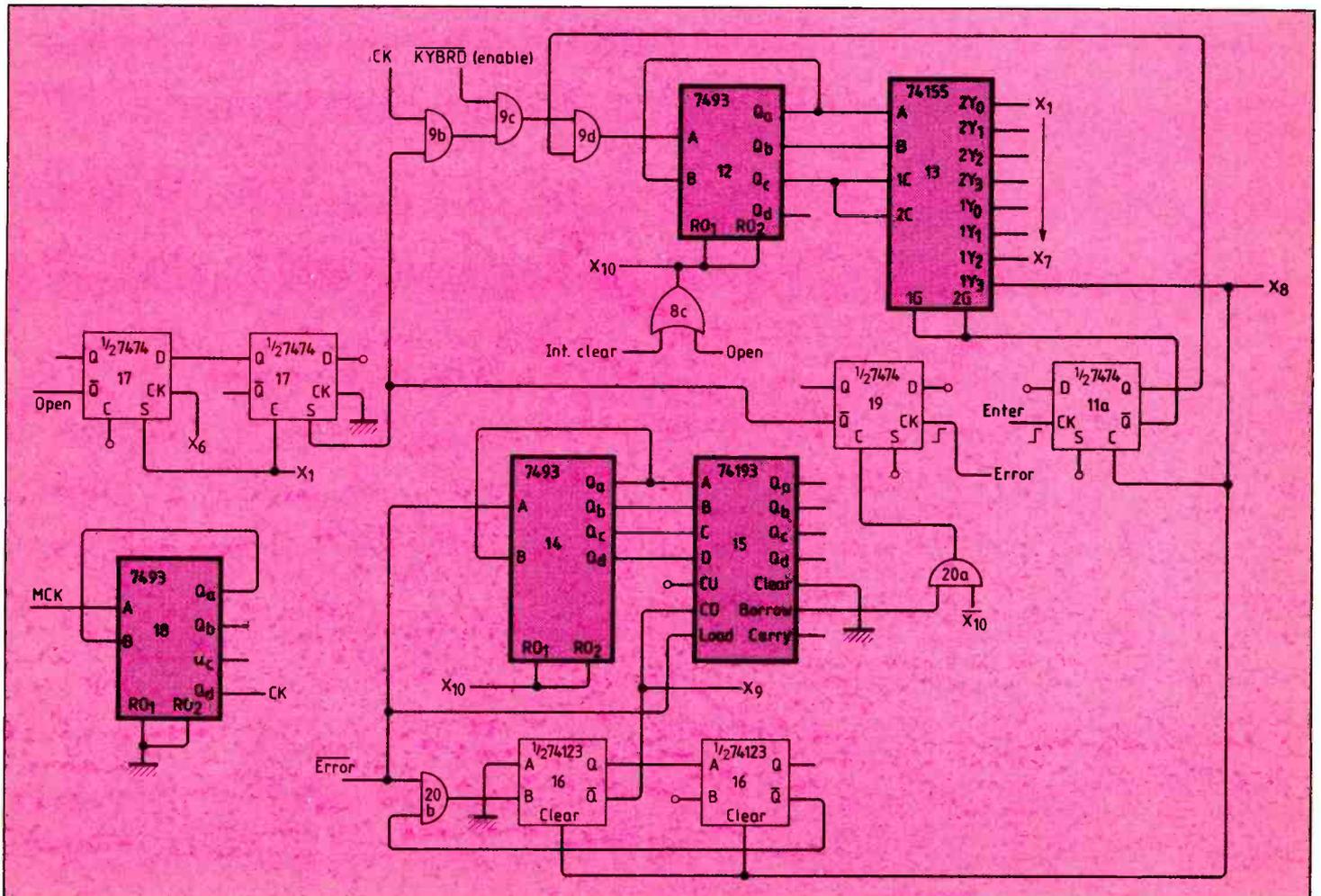
and resets the open signal of bistable IC₁₇. Activating X₂ sets bistable IC_{11b}, which was reset when the internal clear key was pressed through IC_{8c,10,9a}, to enable the hexadecimal keypad decoder IC_{1,2} so that digits entered are stored in IC_{3,4} sequentially. On entry of each digit, monostable IC₆ generates a pulse which decrements counter IC₅ by one. Following entry of the four-digit combination, the borrow output of IC₅ goes low and disables IC_{11b}, inhibiting further entry of digits into encoders IC_{1,2}. Keyboard activation is indicated by the l.e.d.

Activating X₅ connects clock MCK to clock inputs of shift registers IC_{21,22}, causing the internal keyword to be transferred serially through the Q_H output of IC₂₂ to one of the inputs of the exclusive-Or circuit comprising IC_{10,20c,20d,8d}. Also, activating X₅ will put shift registers IC_{3,4} in shift mode due to IC_{10,8b} outputs and connect clock MCK to inputs of both registers causing the entered keyword to be shifted in

synchronism with the internal keyword to the second input of the exclusive-Or circuit. This permits a comparison which if untrue, sends the error line high. Note that MCK is 4n times the CK clock frequency, where n is the number of codeword digits.

If the comparison is true, IC_{19,17b} will be cleared, and with the activation of X₆, the 'open' line will go high and open the lock. Otherwise, IC₁₉ will be set on the first low-to-high transition of Error, setting IC_{17b} and clearing the open line on X₆ activation to keep the lock engaged. The change of state in Error inhibits the sequence counter IC₁₂, through setting of IC₁₉, and activates a 1/60 Hz multivibrator IC₁₆ with a duty cycle of 30s. Also, the delay counter is incremented by one and its contents loaded into counter IC₁₅ which holds the control sequence for the specified delay steps; after this the borrow output goes low clearing IC₁₉ and allowing sequence counter IC₁₂ to continue.

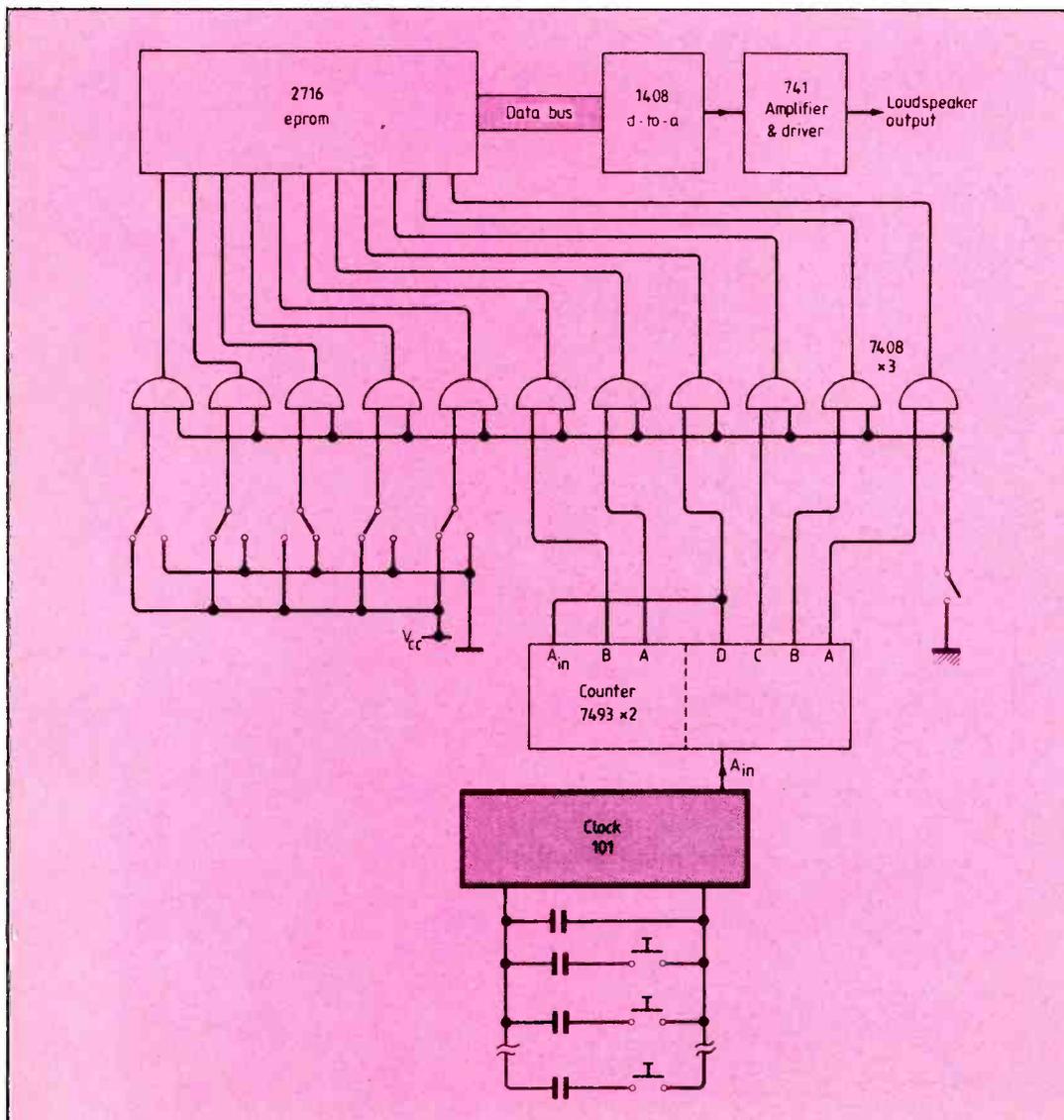
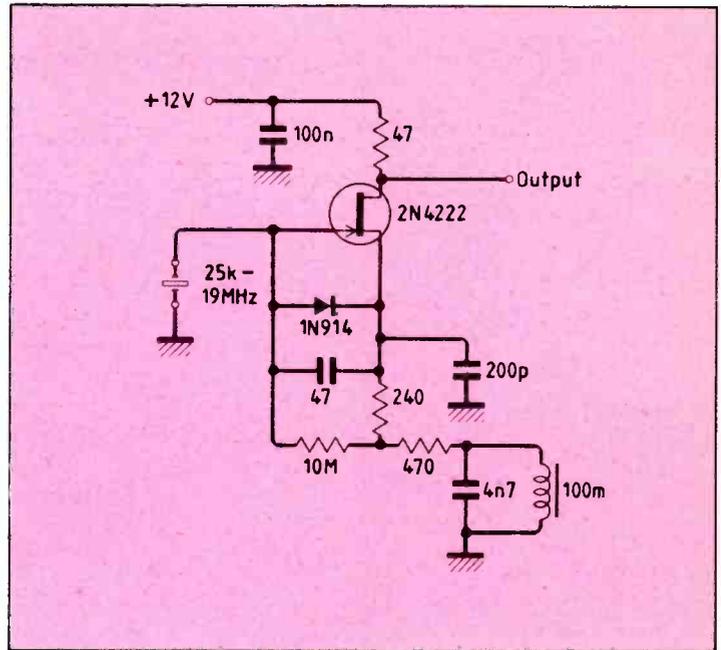
At the end of each control sequence, multivibrator IC₁₆ is



Universal crystal oscillator

Design of a universal crystal oscillator is hampered by the wide variation in crystal parameters — series resistance of low-frequency crystals can be more than 200 times that of h.f. types. This simple modified Pierce circuit works with crystals from 25k to 19MHz. Oscillation frequency is the parallel-resonant frequency of the crystal shunted by about 45pF; output is about 1Vpk-pk. The inductor, used only as a choke, is not critical and if the circuit is used below 100kHz it may be replaced by a 1kΩ resistor.

F. Brown
Lake San Marcos
California.



Simple digital music synthesizer

Musical notes of 32 instruments can be generated using this circuit. Basic sound patterns of the 32 instruments contained in a 2716 eeprom are in 64-byte blocks which are sampled at 64 uniform intervals. Six lower address lines corresponding to a memory block of 64 locations are driven by a 7493 counter. This is clocked by a variable oscillator whose frequency is determined by nine non-locking push switches to control pitch. Five locking switches program the upper eeprom address lines to select one of 32 memory blocks containing instrument patterns. Eeprom data outputs feed a digital-to-analogue converter and loudspeaker amplifier.

K. Balasubramanian
NSS College of Engineering
Palghat
India

Variable-speed video playback

The C-format broadcast video recorder uses helical scan on 1 in tape. This short series shows how servo-controlled head tracking and digital timebase correction allows playback of broadcast-standard video over a wide speed range.

C-format is a helical-scan system, using an omega wrap around the drum as in the sketch. A head on the drum traces a diagonal track across the tape, where one drum revolution corresponds to one video field. Because of the open base of the omega, the head will be out of contact with the tape for a short period once every revolution, which is timed to coincide with the vertical sync. pulse where there is no visible picture information.

Vertical interval sync. pulses can be easily taken from reference signals and, for this reason, storing the vertical interval is optional under C-format. Where vertical sync. storage is implemented, a second, sync.-only head, positioned 30° behind the video head, records in an area between the control and Audio 3 tracks. If vertical-sinc. recording is not implemented, a dummy head replaces the sync. head, and a further audio track is available in the area vacated by the sync. information.

Figure 1 shows the resultant pattern on the tape, and includes the linear audio and control tracks. The drum turns against the direction of tape travel and the video-head-to-tape velocity is the vector sum of the drum peripheral velocity and the linear tape velocity. Similarly the angle of the tape tracks is a function of the drum geometry and the tape speed. During playback the capstan and drum servos must phase lock to an external video reference, such that off-tape video has the same timing as the reference, which means that correctly timed playback can take place at one tape speed only. Furthermore, the video head will only accurately trace the tape tracks if drum and capstan turn in a fixed relationship.

For variable-speed playback,

the capstan servo must be unlocked: thus the video head will no longer accurately trace the tape tracks, and the timing of the off-tape signal will no longer correspond to the reference.

Two systems are necessary to overcome these problems. A track-following video head solves the geometrical problems, and a timebase corrector restores the timing to that of reference video.

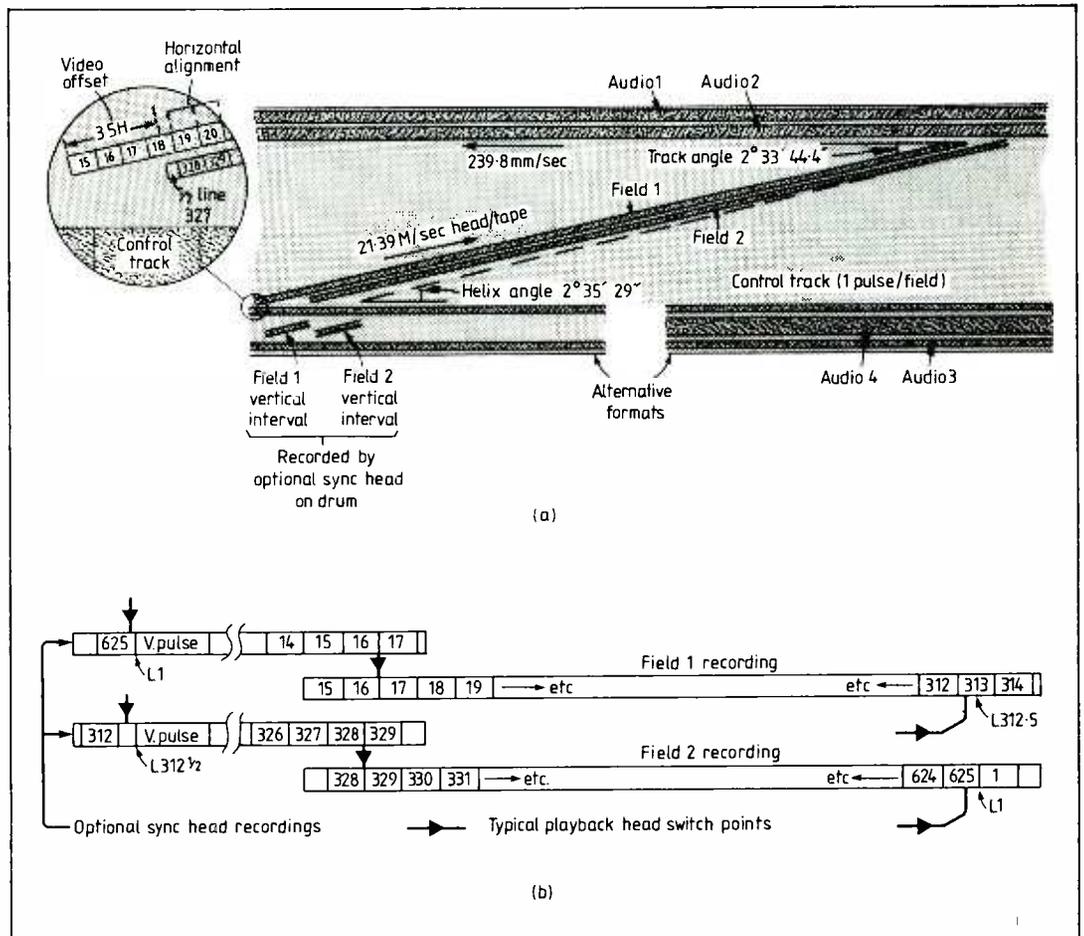
Video track following

Track following was originally applied to video recording in order to improve compatibility between machines. This technique will be discussed first, followed by the additional requirements of variable-speed track following. The principle appears under various trade names:

by J. R. Watkinson, M.Sc., B.Sc.

Fig 1(a) shows essentials of PAL C-format. Tape is guided round drum at helix angle, but movement of tape against drum rotation causes track angle to be slightly smaller than helix angle. Tape speed is chosen to give video offset of 3.5 lines, which gives horizontal alignment condition (inset). Vertical interval storage is optional and a fourth audio track is an alternative.

Where optional sync. head is used, vertical interval is recorded separately (b), without overlap. Effect of interlace is to record two types of field. Two-field sequence repeats endlessly. Addition of chrominance to interlace sequence causes sequence to extend — see appendix.



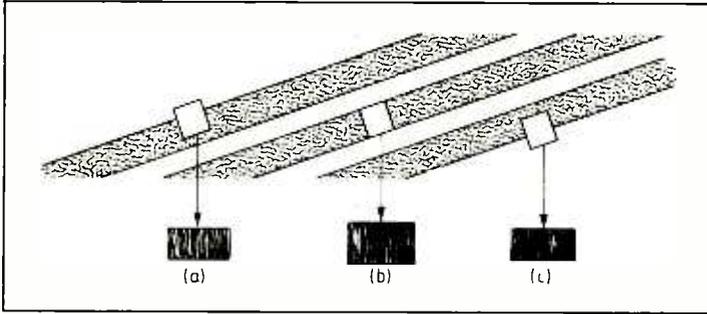
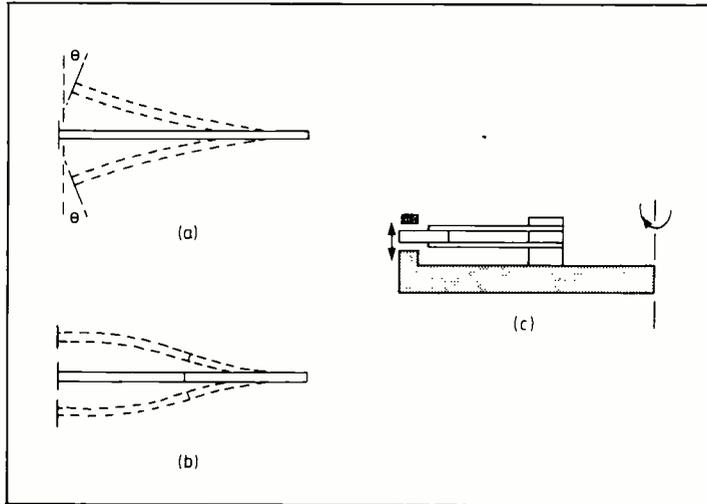


Fig. 2. Effect of tracking error on playback signal. Signal amplitude in (a) and (c) is identical, despite sense of tracking error. Maximum signal occurs with correct alignment as in (b).

Fig. 3. Simple single bimorph at (a) changes head contact angle. At (b) compound bimorph closely approximates parallel action. Tracking head mounted in video drum is shown at (c).



Ampex use the term Automatic Scan Tracking, whereas Sony's description is Dynamic Tracking.

Essentially, the playback video head can move at right angles to the tape track, and forms part of a position servo and, as with all servo systems, a position error is required. The system used differs completely from those used in track following disc drives.

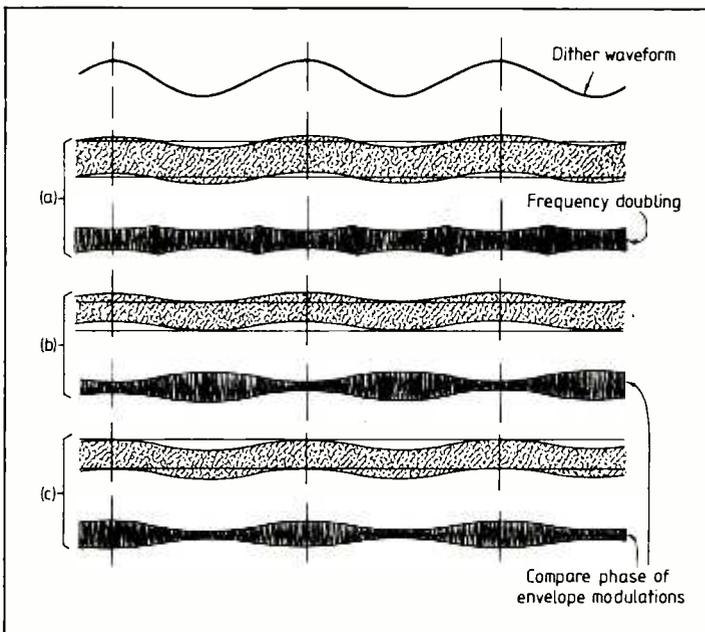
Figure 2 shows three configurations of head to track, and corresponding output. Video recorders use f.m. recording, to cater for the wide bandwidth of the sig-

nal, and the waveforms in Fig. 2 correspond to the r.f. envelope of the f.m. carrier. Case (a) and case (c) display the same output, although the tracking error is in the opposite sense. Simple processing of the r.f. level thus only provides the magnitude of the tracking error, not the sense. To extract the sense of the tracking error, a dither is superimposed on the tracking head, which is driven by a piezo-electric bimorph

by positional feedback from the bimorph. A break is formed in the electrodes on the surface of the bimorph which apply the electric field for deflection, and the small strip of electrode which is isolated in this way becomes a sense strip, which generates a deflection signal used for damping and for feedback during the vertical interval, when the head is out of contact with the tape.

If the capstan of the v.t.r. is made to run slightly slow, the drum speed will not change because it determines the field rate. Thus, the tracking servo will cause the bimorph to bend further and further down the drums as it attempts to follow tracks which are not passing quickly enough. Conversely, if the v.t.r. runs slightly fast, the bimorph will bend further and further up the drum to follow tracks which are passing too quickly. In both cases, if nothing were done, the bimorph would eventually run out of travel. To allow continuous operation it is necessary to make the tracking head jump as it crosses the base of the omega, reducing the bimorph travel. When running slow, the jump will be one track back, such that from time to time one field is played twice to maintain field rate, whereas when running fast, the jump will cause a tape field to be missed periodically. The more the speed differs from unity, the more often will such jumps be necessary. Figure 6 shows several examples of jumping, and also shows the drive signal which will be sent to the bimorph (neglecting the dither signal). Note the dips which are needed to accelerate and decelerate the tracking head during the jump.

Fig. 4. Top, dither waveform which causes head to oscillate across track. At (a) is optimum alignment, showing frequency doubling in r.f. envelope. With head above track centre, as in (b), r.f. amplitude increases as head reaches lowest point, whereas reverse applies in case (c).



mounted in the drum, as in Fig. 3.

In the interests of good head-to-tape contact, it is necessary to give the head an approximation to parallel motion by combining two bimorphs, whose bending tendencies will then cancel. An a.c. component of between 400 and 700Hz is added to the bimorph drive, which causes the head to execute an approximate sinusoid. One field scan contains many cycles of dither. The effect of the dither on the r.f. envelope, as shown in Fig. 4, is an amplitude modulation of the carrier, which has little effect on the video, owing to the insensitivity of the f.m. system to amplitude variations. Figure 4 (a) shows that the effect of the dither on a correctly aligned head is a dither frequency doubling in the r.f. envelope. Figures 4(b) and (c) show the effect of the head off track. Both examples appear similar, but the phase of the envelope modulation is determined by the sense of the tracking error.

In Fig. 5 the r.f. is detected to obtain a level, which is fed to a phase-sensitive rectifier, whose reference is the dither drive signal. The output of the phase sensitive rectifier is a tracking error signal which contains both magnitude and sense. This tracking error is fed back to the bimorph drive circuit to cancel the error.

As the track following head and the bimorph form a mechanical resonant system, the resonance must be above the frequencies used in operation, and damping is required. This is provided

It is possible to stop the tape completely and maintain an output. In this case the bimorph can be made to follow one field continually by making a one-track reverse jump at the vertical interval, using the drive waveform in Fig. 7(a). An alternative is repeatedly to play one frame, where a two-track jump occurs every two fields, as shown in Fig. 7(b). If the tape is reversed at normal speed, the tracking head can still follow the tracks, but has to make a two-track reverse jump once every revolution.

From Fig. 8 it can be seen that the waveforms needed for $-1\times$ and $+3\times$ speeds are the inverse of one another. This is because the $+1\times$ speed is obtained by drum geometry, and the $-1\times$ and $+3\times$ represent an equal departure from it. This must be looked at in the context of head to tape speed. Because the drum peripheral velocity is the dominant factor, stopping or reversing the tape only reduces the head-to-

VARIABLE-SPEED VIDEO

Fig. 7. Still-field mode at (a) repeats one field endlessly. With tape stationary, one-track reverse jump is needed once per field. Still-frame mode at (b) repeats two fields endlessly. Two-track reverse jump once per frame. Depending on where tape stops, d.c. component may be needed.

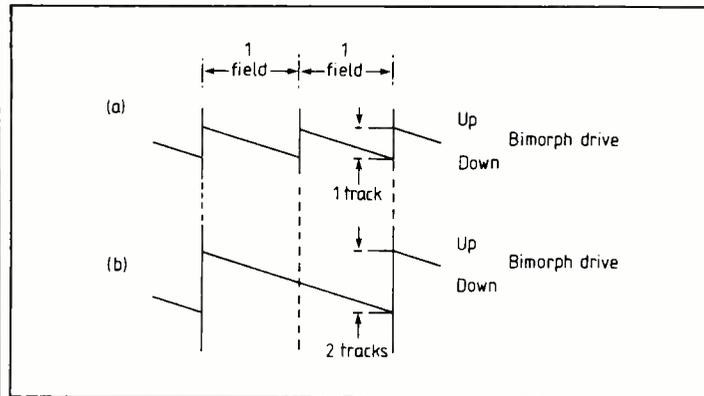
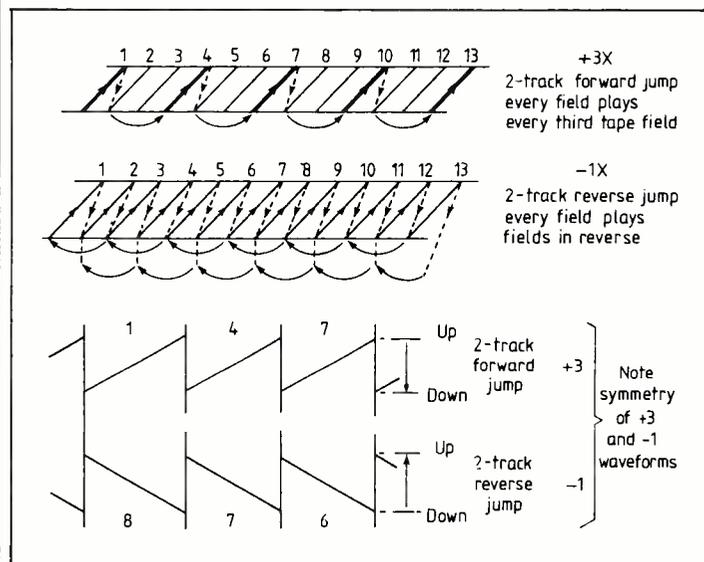


Fig. 8. Single-track advance is obtained by normal tape movement. Two-track jump forwards adds to give $\times 3$ speed; two-track backwards subtracts to give -1 speed.



obtained. The feedback system has now only to correct for difference between actual track position and predicted track position, and the tracking error will be independent of bimorph excursion. Figure 9 shows details of the system.

Stability criteria for a dither-based servo warrant a closer study. The tracking error is sampled at the dither frequency by the phase-sensitive rectifier. As it is a sampled system, then Nyquist's sampling theory suggests that there will be no information above one half the dither frequency. It is essential to filter the tracking error to prevent aliasing components distorting the feedback. The presence of a low-pass filter in a feedback loop is undesirable in a servo system, since the overall response cannot exceed the response of that filter without instability.

One approach is to use a comb filter in conjunction with a carefully chosen dither frequency. Figure 9(b) shows that the harmonics of the tracking error are at multiples of 50Hz, the drum speed. If the dither frequency is set between multiples of 50Hz, the sampling spectrum will interleave the base spectrum. A comb filter with peaks at 50, 100, 150Hz etc. can recover the tracking error and reject the aliasing components, giving the highest possible response rate for a given dither frequency. Clearly an NTSC machine with 60Hz drum rate will need a different dither frequency.

The mechanism of track following has been discussed, but this can only function if it is correctly coordinated with jumping control. To reduce jerkiness in the picture, the jumps should be as small as possible, which implies that they will be as frequent as possible. The smallest jump possible is one track, and to give broadcastable pictures, the jump can only occur at the vertical interval. From stationary to $+2\times$, single-track jumps are sufficient, their frequency varying from never at $+1\times$ to once per rev. at $+2\times$ where every other field is played back. This variation in jump rate is infinite, and therefore it is not easy to calculate when to jump by processing the tape speed. From 0 to $+2\times$, a single-track jump will be made if the bimorph displacement exceeds $1/2$ track at the end of a field. This will cause the bimorph displacement to become half a track the other way, and if that tape speed is maintained, the error will return to zero over a number of fields, and build up to half a track again, causing a further jump.

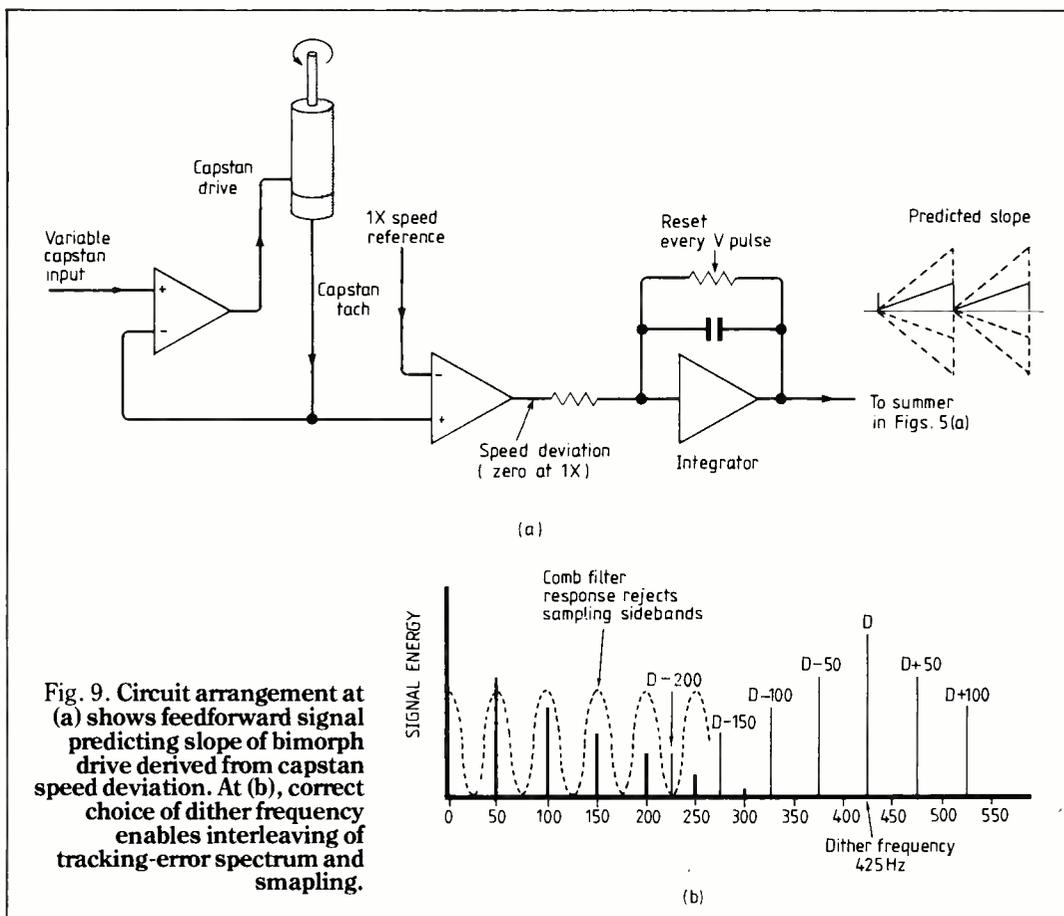


Fig. 9. Circuit arrangement at (a) shows feedforward signal predicting slope of bimorph drive derived from capstan speed deviation. At (b), correct choice of dither frequency enables interleaving of tracking-error spectrum and sampling.

To be continued

WIRELESS WORLD MAY 1984

Multi-standard modem

Suitable for any computer with an RS232-type serial port

Until fairly recently the average electronics hobbyist would have had little use for a modem. But now the situation has changed considerably, with the emergence of a multitude of dial-up information services accessible to anyone with a suitable home computer.

One of the very biggest databases, British Telecom's Prestel, can be reached from most parts of the country for the price of a local telephone call. Besides well-publicised services such as home banking and teleshopping Prestel includes thousands of pages for microcomputer users, with news and information and software to download

The basic Prestel service is available to home users for £5 per quarter at present. There are other databases costing still less to use, or nothing at all. A number of electronic component suppliers, including Maplin Electronics, Display Electronics, Ambit International and STC Electronic Services, allow customers to search their stock-lists by microcomputer and place orders directly. In addition, there is a chain of privately-run 'bulletin boards' offering facilities such as software down-loading and electronic mail.

One problem faced by would-be modem constructors (or buyers) has been in deciding which transmission standard to go for. Prestel follows the CCITT V23 standard, sending data to the subscriber at 1200 baud and receiving at 75 baud. Many other systems operate at 300 baud in each direction. There is also a 600 baud CCITT standard; and the situation is complicated further by the existence of yet other standards across the Atlantic, some of which are used by databases in Britain.

Multi-mode modems have tended to be complex and expensive; but the introduction by Advanced Micro Devices of a versatile modem chip capable of supporting all common standards has now made them a practical possibility for the home constructor.

The Am7910 is a 28-pin l.s.i. device signal processing through-

out. Audio-frequency tones received from the telephone line are sampled by an 11-bit analogue-to-digital converter and tones transmitted are generated by an 11-bit d-to-a. The shape of the sine-wave is governed by data stored in an internal rom and frequency stability is assured by a quartz crystal. Even the filtering is performed within the chip and so there are no setting-up adjustments to be made. All the designer has to do is to interface the device to the telephone line and to the computer and of course to provide mode-switching. There are five control lines with

which it is possible to set up any of nine normal operating configurations. For testing, one line sets transmit and receive filters to the same frequency, allowing data to be looped back through the modem. The other modes are reserved by the manufacturer for diagnostic purposes.

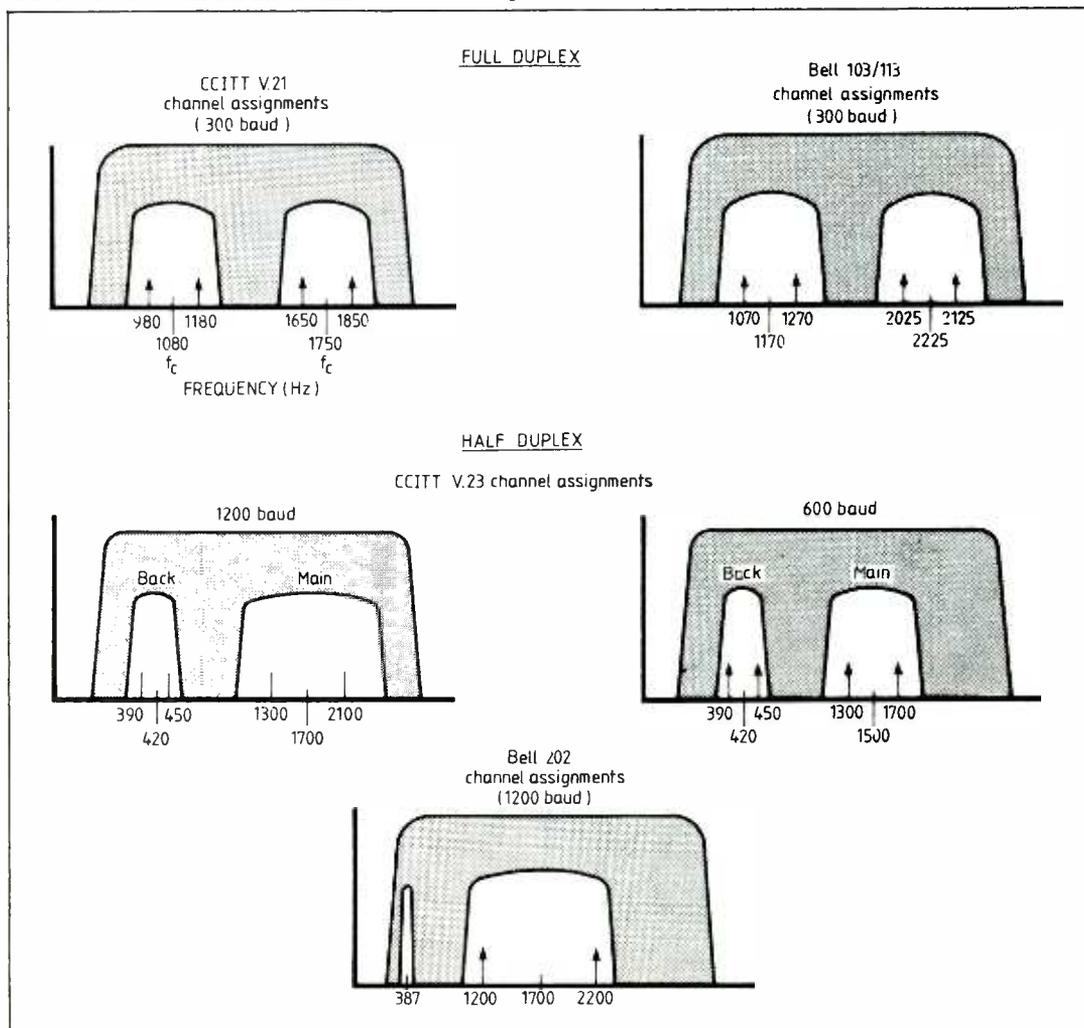
Frequency assignments for the various standards are shown in Fig. 1. The Bell 202 and CCITT V23 modes are described rather misleadingly as 'half-duplex', which means that the data rates in each direction are different. Prestel's 75 baud 'back' channel can transmit data much faster than most people can type it, but the equivalent in the Bell system offers a rate of only 5 bits per second and its uses are therefore more limited. To prevent conflict in the full-duplex modes, the modem originating the call should transmit on the lower pair of frequencies and the answering modem on the higher.

The Am7910 has data and handshaking ports for a standard RS232 computer interface and

by Richard Lambley

A Wireless World Design

Fig. 1. Full duplex modes allow simultaneous 300baud transmission in both directions. In the half-duplex modes, the return channel is of limited bandwidth.



MULTI-STANDARD MODEM

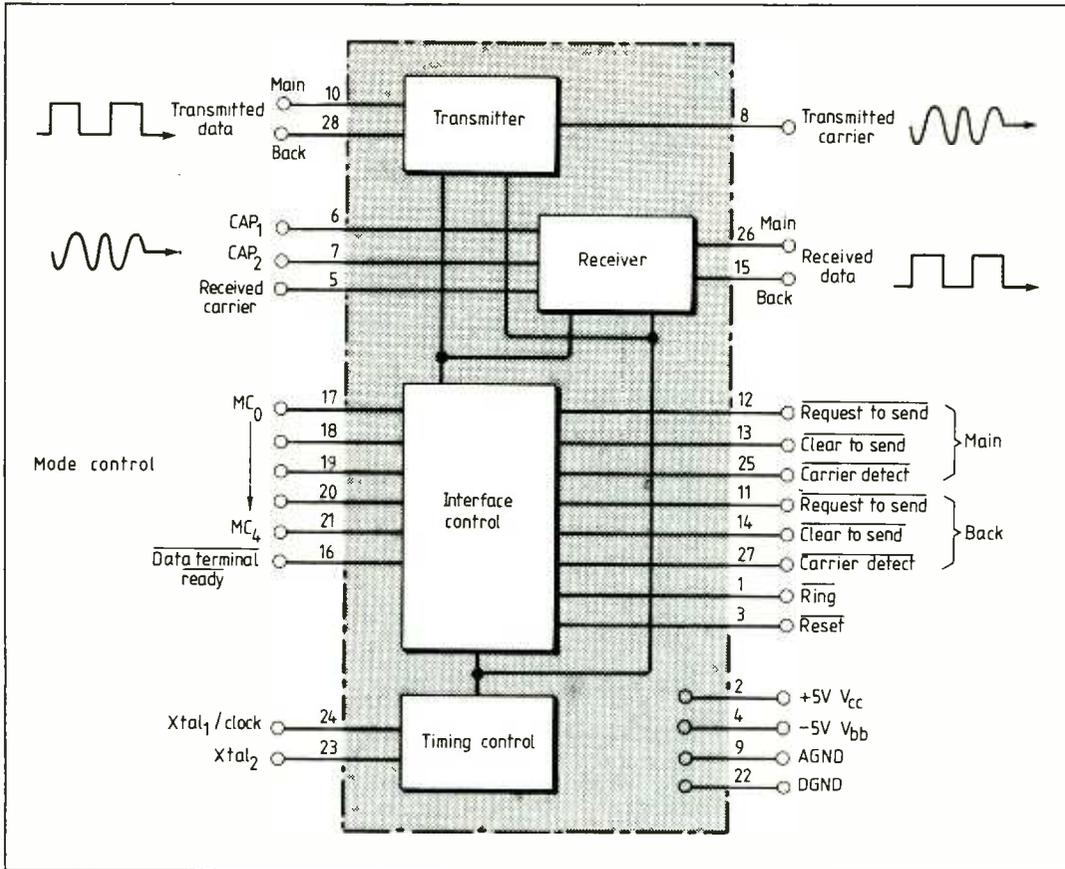


Fig. 2. Block diagram of the AM7910. The mode control pins provide selection of a variety of common European and American standards. No external filters are required.

the i.c. is the facility to operate what might be termed a reverse Prestel mode - in other words, receiving at 75 baud and transmitting at 1200 baud. This allows the user to communicate with the growing number of Prestel subscribers equipped with 1200/75 baud modems. In this condition, data to be sent is applied to the TD pin and the back-channel received data appears on BRD instead of RD.

In a full RS232 interface, the 25-pin connector has separate terminals for the main and back channels; but for home computers which do not, transmitted and received signals can be routed to the appropriate pins of the modem via switching logic governed by the setting of the mode switch.

The same switching must be applied to the handshake signals CTS and RTS. The computer sets the RTS (request to send) line to +12V to indicate that it is ready to receive data, and in response the modem drives CTS (clear to send) to +12V to signify that the computer may transmit. These signals are inverted by the RS232 buffers and are presented to the Am7910 as RTS and CTS, or BRTS and BCTS in the case of the back channel. Note that the RS232 line itself is governed by a negative logic convention and thus provides a good deal of scope for confusion.

To indicate that it is receiving a carrier from the telephone line, the Am7910 takes to 0V either its CD (carrier detect) pin or, for the back channel, its BCD pin. Again, in a full RS232 interface these signals appear on the separate pins. However, in the Bell 202 mode transmission in the back channel consists simply of keying a 387Hz carrier on and off. It follows that not all the modem's back channel signals are meaningful. BCTS and BRD are not used at all; and on the transmit side keying is applied to the BRTS line while BTD is held at +5V.

To complete the RS232 interface, the Am7910 has a DTR pin ('data terminal ready'), which acts as a sort of chip select line. Held at +5V, the DTR pin disables the internal logic and the inputs and outputs. It may be convenient to use this as a method of switching the modem on- or off-line. All digital inputs and outputs of the Am7910 are

Telephone interface

The transmit carrier appears on the TC output of the Am7910 at a level of about -3dBm into 600Ω. In an acoustically-coupled modem it can be applied direct to the microphone of a telephone handset; but in a direct-coupled design

Viewfax 258 (right) is available through Prestel.

Browsers welcome: Distel (below) is soon to offer automatic mode selection to match the user's modem.

```

V I E W F A X 258      258217a      Op
  _____
  |  TELESOFTWARE  |
  |  Viewfax      |
  |  _____    |
  |  LAST UPDATED 21/03/84  |
  |  Key for       |
  |  11 Index to downloadable programs |
  |  12 Acorn & Micronet Prestel ROM review |
  |  14 ZX Spectrum Telesoftware interface |
  |  15 What is Telesoftware |
  |  16 The Gnome Service - Telesoftware |
  |  17 Telesoftware via a Gateway |
  |  18 The CET difference |
  |  2  Telesoftware charts |
  |  5  Sell your programs on Prestel! |
  |  8  Prestel Education T'software Index |
  |  9  Prestel Telesoftware Index |
  |  Magazine      |
  |  _____    |
  
```

```

08-Mar-84 22:51  PORT 14

Welcome to DISTEL (C) Display Electronics 1981

Control 'S' & 'Q' can be used to slow down output for reading

'H' For HELP FILE ** Recommended for first time users **
'D' For DISTEL including mailing list and topical info
'J' For DISTEL main menu

Enter Command H
Use Control 'S' and 'Q' to stop and start data output.

The DISTEL data base contains a lot of information. READ this help
file to enable you to make the best use of it. Good Luck !!

All data from the DISTEL computer is selected by an 8 choice MENU.
Menu explanation:
'1' SEARCH Data base by GENERIC part numbers. A lot of manufacturers
make similar items and identify them by alpha prefixes. For example
an SN7400 would be found by 7400. Remember the FEMER digits you enter
the MORE items you list. 2N entered on its own will list a lot of
transistors !
'2' SEARCH Data base by TYPE of Product, for example: PRINTERS, DISKS,
POWER SUPPLIES, TRANSISTORS etc. The GENERIC search still applies
so the less you enter the more types of product headings you will
see. Enter the 3 digit category number to see all SUB categories
under the chosen heading. Full names of PRODUCTS are NOT required
DISTEL will search from just single characters.
'3' SEARCH by RS Components catalog number. We stock a LOT of items that
match or exceed the spec of RS items. The only difference is the PRICE !
Items may be found by entering the RS part number ie. 308-657 remember to
include the '-'. "No such item" means we do not have it at present.
  
```

requires only a set of inverting buffers to drive the line and receive from it. However, many home computers are not equipped to handle the full set of RS232 signals and external logic may be needed to combine some of them.

Although the Am7910 has only one transmitter and one receiver (Fig. 2.), separate connections are provided for the main data channels and the half-duplex 'back' channels. Thus, for Prestel, received data appears on the RD pin, just as it does in the full duplex modes: but data to be transmitted must be applied to separate back channel input, BTD, instead of the main channel input TD.

A useful feature provided by

MULTI-STANDARD MODEM

this signal must be fed to the same connections from which the received signal is to be extracted. It is desirable to provide some degree of separation between transmitted and received signals, and this can be achieved simply with an op-amp duplexer (Fig. 3). The impedance of the telephone line is matched by the 600Ω resistor, and the network introduces a 6dB loss between the transmitter and receiver. In practice, the line is unlikely to match the resistor perfectly and may even be quite reactive; however, this should not matter much.

Sensitivity of the receiver is very high: the modem will accept signals between 0dBm and -48dBm, although the carrier detect pin will not turn on unless the level exceeds -43dBm.

A matching transformer provides coupling to the telephone line and the necessary degree of electrical isolation. On the line side of the transformer the modem must also include a d.c. path to hold the telephone line once it has been acquired.

To allow automatic answering of calls, the Am7910 has a RING input. This may be forced low by a signal derived from a ringing tone on the line, whereupon it will switch the modem into an answer sequence. If the modem is on-line it responds with a period of silence at the TC output (1.9s under European regulations) followed by a few seconds of answer tone. The call is then established and data can be exchanged between the computers at each end.

Table 1. Frequency assignments. In the Bell 202 back mode, a 387Hz tone corresponds to a mark, its absence to a space.

Mode	Data rate (baud)	Duplex	Transmit frequency		Receive frequency		Answer tone freq. Hz
			space Hz	mark Hz	space Hz	mark Hz	
Bell 103 originate	300	full	1070	1270	2025	2225	—
Bell 103 answer	300	full	2025	2225	1070	1270	2225
CCITT V.21 originate	300	full	1180	980	1850	1650	—
CCITT V.21 answer	300	full	1850	1650	1180	980	2100
CCITT V.23 mode 1	600	half	1700	1300	1700	1300	2100
CCITT V.23 mode 2	1200	half	2100	1300	2100	1300	2100
Bell 202	1200	half	2200	1200	2200	1200	2025
CCITT V.23 back	75	—	450	390	450	390	—
Bell 202 back	5	—	450	390	450	390	—

Table 2. Control pins on the Am7910 provide selection of nine operating modes and ten 'loopback' modes for testing. Optional equalisation is available to cope with long or poor-quality lines.

MC ₄	MC ₃	MC ₂	MC ₁	MC ₀	
0	0	0	0	0	Bell 103 originate 300 baud full duplex
0	0	0	0	1	Bell 103 answer 300 baud full duplex
0	0	0	1	0	Bell 202 1200 baud half duplex
0	0	0	1	1	Bell 202 with equalizer 1200 baud half duplex
0	0	1	0	0	CCITT V.21 originate 300 baud full duplex
0	0	1	0	1	CCITT V.21 answer 300 baud full duplex
0	0	1	1	0	CCITT V.23 mode 2 1200 baud half duplex
0	0	1	1	1	CCITT V.23 mode 2 with equalizer 1200 baud half duplex
0	1	0	0	0	CCITT V.23 mode 1 600 baud half duplex
1	0	0	0	0	Bell 103 originate loopback
1	0	0	0	1	Bell 103 answer loopback
1	0	0	1	0	Bell 202 main loopback
1	0	0	1	1	Bell 202 with equalizer loopback
1	0	1	0	0	CCITT V.21 originate loopback
1	0	1	0	1	CCITT V.21 answer loopback
1	0	1	1	0	CCITT V.23 mode 2 main loopback
1	0	1	1	1	CCITT V.23 mode 2 with equalizer loopback
1	1	0	0	0	CCITT V.23 mode 1 main loopback
1	1	0	0	1	CCITT V.23 back loopback

Regulations

Potential constructors should be aware that the telecommunications authorities in Britain still place heavy restrictions on what may be connected to a public telephone line. Direct-coupled modems have to be approved by the British Approvals Board for Telecommunications, which unfortunately can only examine finished equipment. Even so, many commercially-manufactured modems available to the home user are not approved, even though they may include components designed to meet the official specifications.

What seems to worry British Telecom is the possibility that someone will accidentally connect a telephone line to mains electricity. This could happen in a modem through faulty construction and might damage the telephone network as well as being dangerous for its users.

Constructional details of a modem using the Am7910 will follow next month.

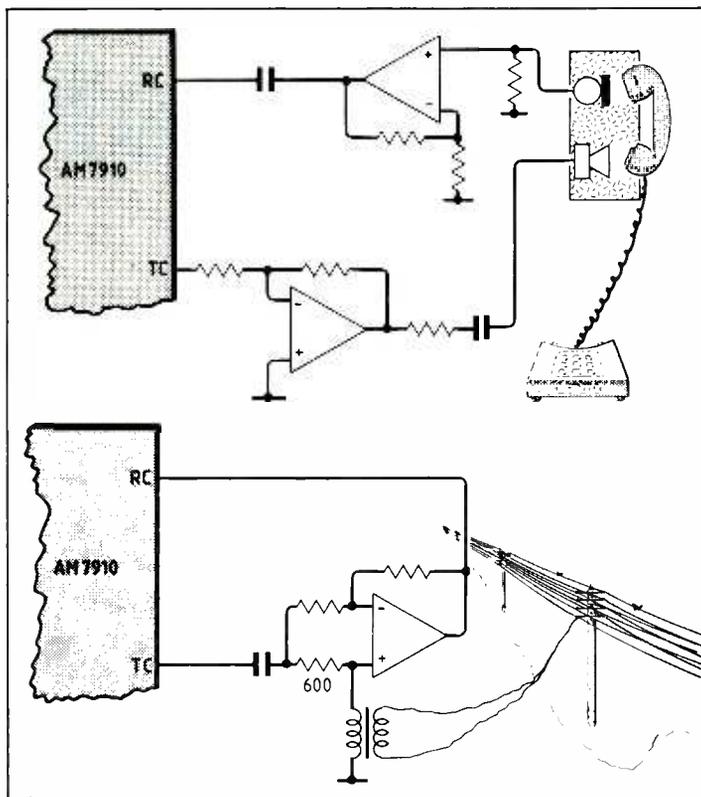
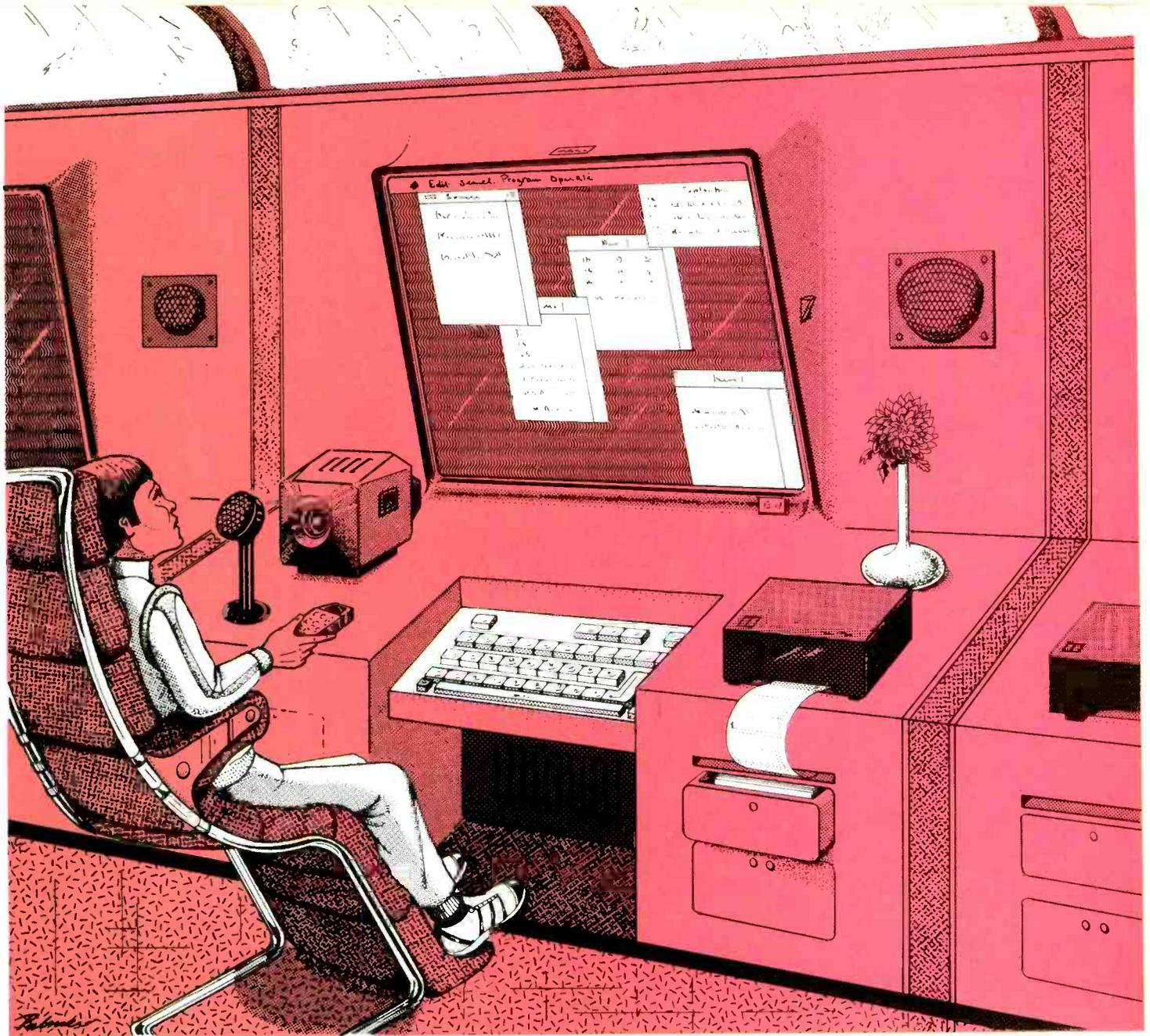


Fig. 3. Connection to the telephone line can be via an acoustic coupler, or (below) through an op-amp duplexer and an isolating transformer.



by A. E. Cawkell

The information society

1 — Technology, politics and infrastructures

A. E. Cawkell looks back at his 1978 piece “The paperless revolution” and forwards to the year 2000. In this first article, he considers the interactions of politics with technology and the infrastructures which influence, support and enable an information society.

In 1978 I wrote an article in this journal about forces controlling the introduction of new technology¹. At that time the arrival of the silicon chip, just introduced to a marvelling public, was being discussed with both optimism and foreboding.

The article was entitled "The paperless revolution" and featured a machine called the Consumersole, an information interface between man and the world outside, to become a reality, perhaps, by the year 2000; universal data communications were assumed to be in place. Reading this article again, I see that I took a rather gloomy view of the technological future.

Information is a curious and unique resource. It is unsatisfactory to call it a commodity. You cannot evaluate it until you have obtained it; once you have it it may be almost impossible to evaluate in monetary terms, but on other occasions there may be no doubt about its value — ask a dealer on the money market about the value to him of timely, accurate information. The value of a train time-table to a man standing on Paddington station who wants to get to Penzance is obvious. It is equally clear that the same information displayed to a Martian is valueless. Information is destroyed when consumed and so has no scarcity value in the usual sense, and yet the meaning of the phrase "there is a scarcity of information about the effects of video nasties on crime" is perfectly clear.

Information is obtained for pleasure and entertainment, for monetary gain or the acquisition of power, or simply to satisfy curiosity, but nearly always it has to be moved before it is changed from mere data into knowledge. These days transference often involves using an electrical rather than a paper-based system.

The idea of an "The Information Society" was implicit in Fritz Machlup's work in 1962². In 1974 Marc Porat, in an unpublished paper, analysed occupations in the United States and concluded that 50% of the labour force was engaged in information processing occupations. Parker and Porat discussed political issues and headed part of a 1975 article with the phrase "The Information Society"³.

The concept of an industry centred on a resource more important than oil — information — was introduced later. Information Technology Year (IT 82) was launched to rub in the message 'Britain Needs Information Technology'. Before considering the outlook for the rest of the decade, let me establish my forecasting credentials, if any, by conducting a brief post mortem on the 1978 article.

Semiconductor technology has advanced and costs have dropped at about the rate predicted. Expectations for bubble memories and holographic storage have not materialised. The mismatch between the information processing capacity of the eye/brain and the amount provided by the c.r.t. screenful is being improved. Larger display devices will be available rather sooner than predicted. Teletext is successful but Viewdata/Prestel is slower to gain acceptance, although private Viewdata-type systems are making progress. Teleconferencing is still in its infancy and so are electronic journals, but electronic publishing is advancing. Electronic mail was much discussed in 1978 and it still is today; implementation lags. The rate of progress in speech recognition has been slow, also as predicted.

I think my end-of-term school report should read "Forecasting — very fair; Cawkell should try harder". However it is no worse than most other forecasts, and rather better than those mentioned below.

Wild forecasting

Before considering the likely rate of formation of a telecommunication infrastructure — the backbone of the Information Society — it is instructive to consider the development rate of other technologies contending mainly with technical problems. The telecommunication/service infrastructure will be contending mainly with political and social problems which will greatly slow down the growth rate.

In the July 1966 issue of *Datamation* it was stated that "economies of scale are swinging increasingly in the direction of large computers" and in a 1970 issue of *Computer Decisions* "Small businesses are not going to have small computers; it's not a practical way to go". In 1972 it was forecast that "40-60% of American homes will have cable tv by 1980", and at the end of 1979 a UK forecast of "100,000 Prestel sets in 1980, equally split between domestic and business" was made.

In 1979 it was anticipated that "By 1983 all the 220,000 telephone subscribers in the Ille et Villaine department of Brittany will possess desk-top video terminals costing £33 each providing access to a local and national database of telephone numbers".

All these forecasts were wildly off target.

As recently as late 1981 one pundit said that the world total for all types of microcomputer in use by the end of 1983 would be 4 million units costing \$3550M. But another now thinks, with the con-

siderable advantage of hindsight for most of the period, that the total will be 17 million units costing \$79kM (79 billion dollars)!⁴

The delay factor

Forecasters are often misled by manufacturer's announcements about development work which may or may not be followed by production, limited application, and more general application. The interval between these events, for technical and political reasons, may be many years, but new-technology announcements inspire speculative articles in the press which prompt discussion and awareness, and new products or services get talked into existence.

Euronet and a set of separate European PTT telecommunications networks are expected to become a unified network by about 1985 — 15 years after the pioneering work with ARPANET in the US. It took about 10 years before working local area network (LAN) systems were installed in any quantity following the development of the ALOHA network⁵.

The next transatlantic cable will be the optical-fibre type. The idea of optical-fibre communications was first mooted in 1966⁶ and the development of more efficient monomode cables accelerated their use. Such cables started to be installed in 1980 — an interval of 14 years after the early work.

Many years passed before Clarke's 1945 forecast that global communications using three geostationary satellites⁷ would be possible. By 1980 satellites were being routinely used as relay stations in the United States. In this case it took 18 years for the idea falteringly to be realised, a further 10 years before satellites became used as telephone relay stations in the Intelsat network, and several more years for tv relay satellites to become commonplace.

The Electronic Scientific Journal was suggested in 1976⁸, pioneered with mixed results in 1979-1982⁹, and is the subject of further experiments today¹⁰. It seems unlikely that the final form will replace the scientific and social functions of the conventional journal for many years.

It has turned out to be extremely difficult to design an electronic device which can recognise continuous speech from any speaker. According to a classic 1976 article¹¹ it will be many years before this becomes possible. A very large research effort seems to have produced rather limited results, but this simply reflects the difficulty of the problem. The interval between the first substantial research

Heading picture is an artist's impression of an office in 2000 A.D., of which the essence is comfortable simplicity. There is a large colour screen with voice control of the display. The keyboard will probably still be needed because continuous speech recognition will not yet be possible. A noise-cancelling microphone for display control doubles as voice-controlled telephone number selector. High-quality paperwork is still used, and can be transmitted and reproduced by the Imagemaster text/picture machine, which digitizes paperwork for storage. No other devices are needed.

work in the '70s and the application of continuous speech recognition may well be 50 years.

A recent television programme described progress with synthetic speech — a much easier achievement — and then showed the recognition of single words and short phrases by a machine, which had almost certainly been preceded by a human/machine training session which was not mentioned. This led naturally to speculation and an interview, firstly with an equipment supplier about this 'here and now' technology, and then with a lay audience about how comfortable they would feel when conversing with machines. This kind of 'logical extension' from one thing to another against a background of impressive rows of knobs and c.r.t. screens encourages false expectations.

Very-large-screen display devices may become generally available during the next 5 years, 60 years after the c.r.t., not much changed today, was first introduced by von Ardenne in the 1920s. Technical advances have been rapid in image processing systems¹² but facsimile machines of rather low resolution have been available since the 1930s. After the war, machine compatibility was the problem. The interval between the introduction of the first usable machines, the evolution of standards, and fairly widespread use in business was 50 years.

The development of Teletex, a system for transmitting text rapidly between telex-replacement/word processing machines, is progressing slowly, and microforms — around since the Franco-Prussian war — are still not widely used.

I conclude that a significant new development in information technology usually takes at least 10 years from point A in time to point B, where B is useful small scale application. Point A — the 'starting date' is hard to define. It is not so much that something significant actually happens on that date, but that a preliminary announcement about Widgetisors gets transformed into a report (not in this journal!) that "Colossus Systems Ltd are believed to be considering the construction of a new factory for the production of Widgetisors". The information-technology industry is skilled in convincing us that only fossilised people can afford to ignore 'imminent' developments which may still be a gleam in the inventor's eye.

An exception

Technical developments, falling costs, and a combination of other circumstances may enable something new to be offered and

applied rather quickly. If political, human acceptability, and economic factors are favourable, the offering will catch on faster — an exception to the ten year rule appears.

The microcomputer is such an exception, so its brief history is of some interest. The first commercially available machine to be produced in any quality was the Altair 8800, provided as a kit by MITS in 1975¹³. The ingredients which made that possible were developments of the transistor (first patent filed 1948); improvements in photolithography and diffusion techniques enabling transistors and other circuit elements to be manufactured as integrated circuits (Fairchild 1959)¹⁴; M. E. Hoff's invention of the Intel 4004 microprocessor containing over 2000 transistors on a chip in 1970, further developed into the 8080 in 1973; US government subsidisation of semiconductor developments amounting to about \$1000M in 1958-1974; a large local computer market capable of absorbing and encouraging improved circuits.

For a period the Altair and its successors were limited by small memories and the absence of disc storage to a market composed of enthusiastic hobbyists. Software for useful applications was non-existent. Demand increased with increasing software familiarity, better reliability, and falling costs but two further related developments may be singled out as major contributors to the explosive demand which started around 1978.

IBM introduced a terminal incorporating the FD-11 floppy disc in 1971. Competitors announced copies almost immediately, but in September 1972 IBM announced the 3740 data entry station incorporating a "diskette", and a host of competitors followed^{15, 16}.

In 1975 Gary Kildall wrote some software for controlling files stored on a floppy disc. He was asked by Imsai, a floppy disc supplier, to design an operating system for them, and the first version of CP/M, 1.3, became available. Hardware-dependent functions were concentrated in one section of it, enabling it to be adapted for use with microcomputers using the 8080 and later the Z80 c.p.us. Kildall founded Digital Research in 1976 and more versions were released later, including one for 16-bit machines, CP/M 86.

Microcomputers with CP/M and floppy discs offering up to 1 Mbyte were manufactured at reasonable prices and the "business microcomputer" was born.

A parallel development started with the IBM Ramac "hard disc" introduced in 1956, but in 1973 IBM announced the

3340 "Winchester Disc" a sealed unit with the heads flying 20 microns above the disc surface. In 1978 Shugart announced the SA4000 Winchester for microcomputers, and in 1980 Seagate introduced a 5 Mbyte 5.25 inch Winchester selling for \$925. Tandon replied in 1982 with the same unit for \$400¹⁴, and microcomputers can now be purchased with built-in Winchesters to store 10 Mbytes or more for around \$4000. These machines can deal with advanced information storage and retrieval, word processing, etc.

Interactive infrastructures

In order to discuss some of the wider issues as we move into the Information Society it may be helpful to refer to Fig. 1 which shows the forces influencing an information services infrastructure.

Technical advances are a necessary but far from sufficient requirement for progressing towards an information society. The rate of advance will be much more dependent upon the interplay of the factors shown in the figure. Exceptions like the microcomputer may arise in special cases where successful application can be independent of most of the delaying factors.

Two prime forms of information are shown — the "old technology", that is print-on-paper in the form of written letters, typed reports, printed newspapers, magazines and books, and the "new technology" — that is radio, television, tape or disc recordings, videotex, databases and information banks. Associated with these systems and information channels is the hardware and software required to put the information into machine-readable form, process it, and convert it back into human-assimilable form.

The old technology is well entrenched. It has been developed by trial and error since 1455, when Gutenberg demonstrated the feasibility of movable type. A set of compromises in compilation, distribution, storage, display, aesthetics, convenience, accessibility and cost has emerged which serves us quite well.

The new technology has been developed during the last 50 years, but 90% of it during the last 15. In that time radio, television, automation and computers have been followed in quick succession by pocket calculators, home computers, online systems, word processing machines, and video and optical discs, backed by a semiconductor technology proceeding at an unprecedented speed.

The general momentum of all
WIRELESS WORLD MAY 1984

One long, indeed, for a unit of knowledge which might be called perhaps a 'wit', analogous to the 'bit'.

K. E. Boulding

this encourages the belief that almost anything is possible by the introduction of more technology. There is no shortage of people with vested interests to foster this belief. However, application takes time, as has been discussed already. Ordinary people get in the way. They have contra-beliefs generated both by innate conservatism and, in some areas, by well-founded scepticism. This scepticism is in part a reaction to sales razzamatazz, to the observed general mismatch between men and machines, and to the fact that for every prediction which turned out to be an underestimate, there are several which turn out to be unduly optimistic or simply wrong.

Readiness potential and enabling infrastructure

Some years ago the phrases Readiness Factors and Enabling Forces were used with reference to teleconferencing¹⁸. The similar phrases Readiness Potential and Enabling Infrastructure are apt in the context of the information infrastructure generally. For a new undertaking to be feasible the state of the ingredients needed for success must be considered. A readiness potential exists when the development of those ingredients, considered collectively, seems to indicate that the time is ripe for launching the undertaking. They include

- processing technology (hardware and software)
- appropriate telecommunication facilities
- encouraging experimental work
- credible advocates and publicity
- optimistic forecasts
- apparent economic viability
- apparent need (markets)

Figure 1 shows the factors which then control success — the factors with which the driving force, a group of manufacturers or services, or perhaps one only, must successfully contend. They seem to be

- human factors associated with the use of machine
- reliability
- standardisation/compatibility
- success momentum
- political reality
- service infrastructure

Success momentum continues if the earlier hot air can be backed up by success in practice, with circulation of the good word, favourable technical articles and reviews, further purchases with wider usage etc. Success breeds success.

Political reality means both concentration on the art of the possible and conducting operations which will take advantage

of PTT or government policy instead of clashing with it. Current attitudes and actions in communications deregulation, particularly in the US and now in the UK obviously need close attention.

What should governments do and what will they actually do? You may take the view that the less a government does, the better, you may think it should have a limited role, or you may think it should intervene at all levels. I see little evidence that any government has had any success in intervening at the market level: it may result in a disaster — witness the rise and fall of Nexos. In this area of rapid changes and new emerging markets, bureaucratic involvement seems unhelpful.

All governments seem to be more or less involved with many of the areas shown in Fig. 1, that is, employment, control of telecommunications, and privacy and security. Involvement in communications, because of the importance of what is communicated, particularly news, spills over into topics like data protection, the flow of information across borders, and the concern of underdeveloped countries about this topic.

The government has a role in co-ordinating national and international standards. Perhaps it can best continue to do that by supporting organisations like NPL, British Standards and ISO in the UK, National Bureau of Standards and ISO in the US, and similar activities in other countries.

In the US, the IEEE has succeeded in establishing standards which have become international, such as the RS232 communications interface. Some manufacturers have established *de facto* standards such as Digital's CP/M microcomputer operating system software and IBM's SNA communication protocol. Europe often follows the US in this field. In Europe German DIN standards have been adopted in some fields (not in information technology).

Telecommunications and the market

A service infrastructure will be the technological backbone of an information society. Digitized information (or, for the purists, data, which may be one man's information but another's noise) will flow from source to recipient.

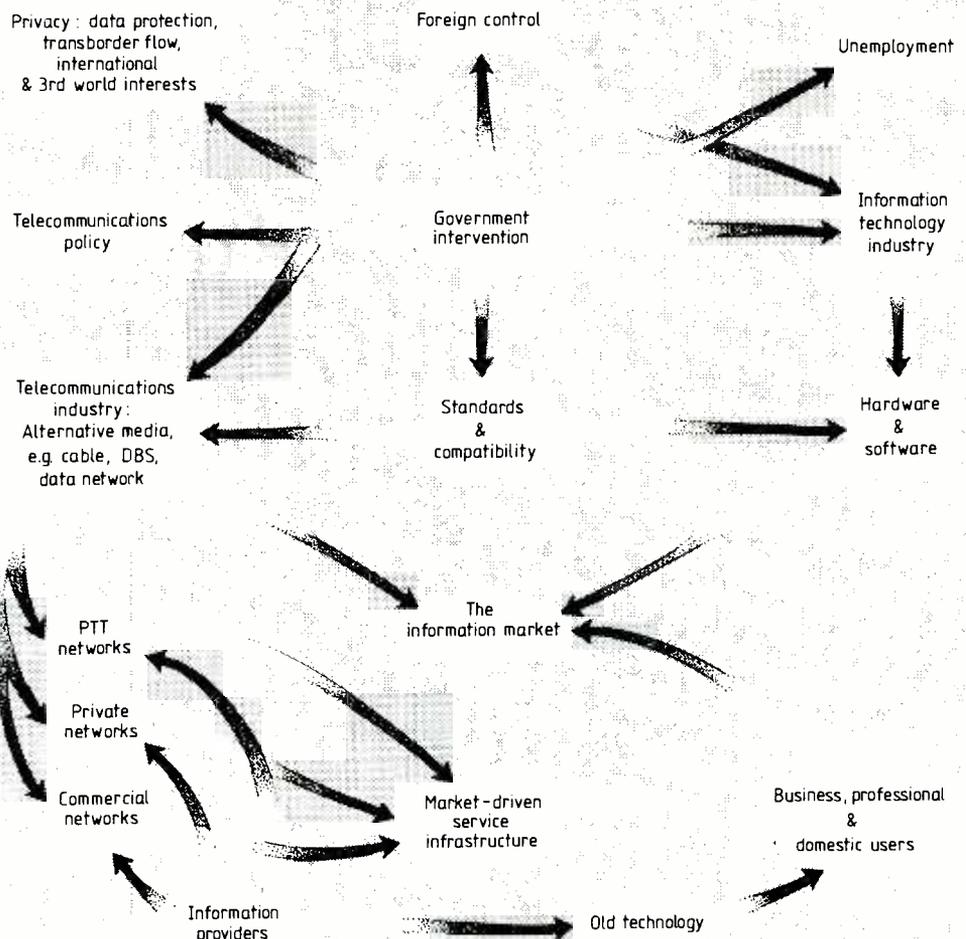


Fig. 1. The information infrastructure and the forces which influence it.

I am not referring to "service" in the "maintenance" sense (although an efficient service network in these days of increasing dependence upon machines is extremely important) but services for supplying information.

The components of a service infrastructure are a communications network accessible to a large customer base offering cheap time, independent of distance; a customer base possessing a range of compatible machines using standardized processing and communications software; and a number of information providers feeding information to the network.

When compatible terminals connected to a growing network reach a critical mass, assuming that an adequate customer base for particular service also exists, the incremental cost to a supplier mounting the *n*th service will be low. His service will ride on the infrastructure, so his direct investment involves only the injection of information.

CREATION OF A MARKET-DRIVEN SERVICE INFRASTRUCTURE

The economics and politics of telecommunications.

I do not intend here to become involved in the controversy about public interest, state control, and private enterprise. Governments are, of course, concerned about roads, medical services, police, railways, telecommunications etc. In the UK governmental interest in information technology has been strong because it is perceived as a way of generating new industries and services, increasing exports, and providing new jobs to replace those lost in decaying industries. Governmental interest in cable systems in the UK is an example.

The present government takes more of an arm's length view than has formerly been the case: in other words it is attempting to set a climate which it thinks will encourage development, rather than becoming directly involved in it, hence its action in first liberalizing and then privatizing British Telecom, in granting licenses for cable franchises, and so on. In the US the trend is similar with the de-regulation of AT&T, and there are some signs of a move in this direction in continental Europe.

Inevitably governments have been and will continue to be involved in the provision of telecommunications through the PTT's (a European abbreviation which I shall use to describe all telecom authorities). Thus the creation of a suitable PTT (see Fig. 1) depends upon the actions of PTTs/governments.

The existing national and international PTT telephone network has the great advantage that it exists. It is far from ideal for data transmission, but can be pressed into service for that purpose. Most PTTs have also created, or are in the process of creating, purpose-designed national data networks. They have also collaborated under EEC auspices in setting up Euronet, a network consisting of interconnected host computers, in different countries, running databases for information storage and retrieval (mainly scientific information) for terminal-connected users¹⁹.

The private networks shown in Fig. 1 are composed of lines leased from the PTTs for interconnecting the different sites of an organisation within a country, or may be to provide intra-organisation services for large companies such as Unilever²⁰, airlines²¹ etc., requiring international satellite or cable links.

The commercial networks in Fig. 1 refer mainly to the Value Added Networks (VANs) developed by private telecommunication companies, in consequence of deregulation in the United States, to offer special services using lines leased from AT&T, or using satellite or terrestrial microwave communications. Some private companies have been accorded the status of 'common carriers', meaning that they are permitted simply to carry traffic for others without having to quality as VANs. Some companies have 'nodes' (that is, connection points) in Europe and elsewhere.

If these three kinds of network were interconnected so that any service available on any of them was available to all in such a way that there appeared to be a single network, then a big step towards universal communications would have been made. The critical mass of customers needed to encourage more services would appear, the system would grow, costs would fall and home services would become viable.

There are some technical problems to overcome, but the main obstacles to this kind of common sense have been political. The PTTs have rigidly applied their carrier monopoly. Unlike the situation in the US, no other organization has been permitted to arrange communication links between service and customers, for instance, so that people with terminals can obtain information from a database running on a remote computer.

In 1979 an electronic journal was running in the United States, and the organizers planned an experiment to connect terminals for editorial services and contributions from the UK to the system.

British Telecom (BT) could not provide the interconnection, and it was planned to use the commercial network, Telenet, which had a node in the UK requiring connection to terminals via BT lines. The experiment had to be abandoned because BT vetoed the participation of Telenet as a "third party" carrier²². Note that if Telenet had been offering an electronic journal to UK participants — that is, if it had owned the journal's computer and facilities in the US, and was using its network to link its own customers to the system — then it would not have been acting as a third party and the veto could not have been applied.

The question is, can the existing networks be coalesced to provide the needs of the information society, and how long is it likely to take?

The 'critical mass' problem mentioned previously could of course be resolved by further separation rather than coalescence. In other words, new separate networks appear for interconnecting information sources and customers, because this group regards the value of the particular kind of information received to be worth the relatively high price they have to pay to support the facilities. The services available to stockbrokers in the City of London are an example.

A possible compromise²³ would be multiple interconnected networks, each free to innovate (a huge unified network would tend not rapidly to adopt communication new technology) but with common interconnection standards and a payments clearing-house mechanism.

To be continued



From the long line of success the affordable portables

The 2200's

The four low cost oscilloscopes in this group offer unprecedented value in initial cost and inherent high reliability.

Choose the 2213 or the 2215 for superior 60MHz performance, with single and dual time bases respectively, or the 2235 and 2236 for 100MHz bandwidth and many advanced features. The 2236 includes a counter/timer totally integrated into the vertical, horizontal and triggering systems of the instrument, providing measurement capabilities and convenience not previously attainable.

The 2300's

Compact and lightweight, these 100MHz oscilloscopes are ruggedly built to withstand tough service in the field. The 2335, 2336 and 2337 all have a fastest sweep rate of 5ns/div, making them extremely useful for high speed logic and digital applications.

A flip-top protective lid safeguards the front panel from transit damage and also houses the electronics, controls and LCD displays for delta time measurement readout in the 2336 and delta time plus DMM functions in the 2337.

The 2400's

Representing the state-of-the-art in today's portable oscilloscopes, the 2465 and 2445 provide probe-tip bandwidths of 300MHz and 150MHz respectively. On-screen cursors allow the immediate and precise determination of voltage, time, frequency, ratio and phase - with CRT readout of results.

The 2400 oscilloscopes have four independent vertical channels, two of which are optimised for logic signals. Facilities are also provided for accurate delay matching between two channels to allow detailed examination of timing.

The advanced triggering system includes a hands-off Auto Level mode, ensuring stable triggering on any pulse width or waveform at repetition rates as low as 50Hz.

The 2400 series succeeds the earlier Tektronix 400 range as the new industry-standard portable oscilloscope.



Telephone now for your free literature.



Harpenden 058 27 63141
 Maidenhead 0628 73211
 Manchester 061 428 0799
 Livingston 0506 32766
 Dublin 850166

Tektronix UK Limited
 PO Box 69, Harpenden, Herts AL5 4UP
 Tel: Harpenden 63141 Telex. 25559

Tektronix
 COMMITTED TO EXCELLENCE

CIRCLE 067 FOR FURTHER DETAILS.

Essex Tiny Basic



... the system for all reasons

You need Control? Data Acquisition? Monitoring or Datalogging?
AND you need fast development? If these are your reasons, you need the **Essex System!**

* **Powerful NSC Tiny Basic** * **FAST Software Development** * **Low Cost Hardware** * **Accurate Analogue Interfacing** * **Eurocard System** * **Full Documentation** * **Proven Industrial Record**

Processor Card - Basic interpreter, up to 8K RAM /32K ROM, RS232C, 48 I/O lines, Eprom Programmer. **12 Bit Analogue Card** - 16 channels A-D plus 2 channels D-A. **Opto-Isolator Card** - 12 inputs, 12 outputs at 3A/50V. **Buffer Timer Card** - 24 inputs, 16 outputs, 4 timers. **Memory Card** -24K battery backed RAM, 24K ROM, Real Time Clock. **'Alex'** - Assembler, disassembler, text editor & monitor in a ROM. **'Tiny Turbo'** - compiles programmes to run at twenty times normal speed. **VDUs, Memory Modules, Cases, Backplanes.**

Please send for full information



Essex Electronics Centre

Wivenhoe Park, Colchester, Essex CO4 3SQ

Telephone Colchester (0206) 865089

THIS IS THE MAST TO SUPPORT YOUR OUTSIDE BROADCASTING

New XT Series Masts from Clark Masts designed for vehicle mounting when headloads are heavy and stability required is high. This is the mast which meets all your requirements for an O.B. or E.N.G. vehicle unit. Tailored in every way for the job, Clark Masts offer the latest state of the art in mast design with the background of more than 25 years of constant development and an unflinching availability of spares over the same period.

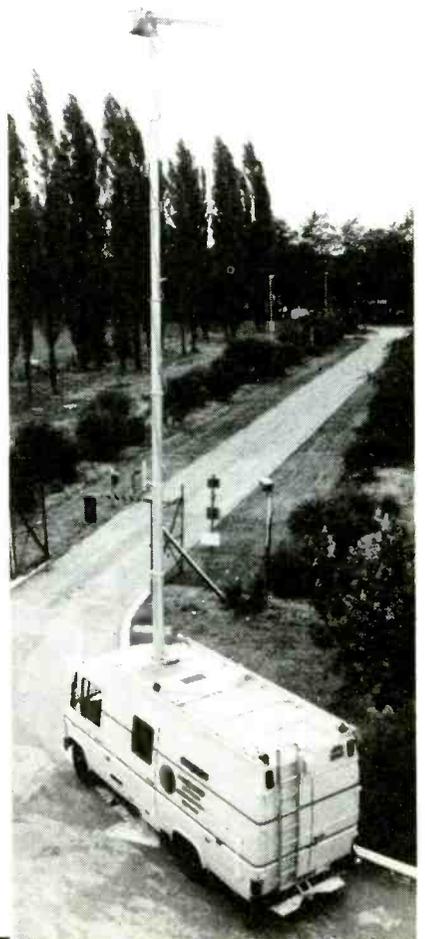
NEW **XT** SERIES

vehicle mounted stability for very heavy headloads

CLARK MASTS

UK. CLARK MASTS LTD (EWW).
Binstead, Isle of Wight, England
Tel: (0983) 63691 Telex: 866886

EUROPE GENK TECHNICAL PRODUCTS N.V.
(EWW), Woudstraat 21, 3600 Genk, Belgium
Tel: 011/38 08 31 Telex: 39354



CIRCLE 024 FOR FURTHER DETAILS.

The roots of relativity

Dr Murray avoided criticising relativity theory in his recent Heretic's Guide series, but here he makes good that omission by drawing attention to one of Einstein's very rare but crucial mistakes.

by W A Scott
Murray
B.Sc., Ph.D.

It is not unusual to encounter references to the Special Theory of Relativity between the covers of *Wireless World*, either in readers' letters or in formal articles. One interesting feature of these contributions is that they are almost invariably critical of the theory, although it is so thoroughly established. Why so?

It is true that the criticism comes from all sides, so that critics will refute each others' arguments as hotly as they refute Einstein's — for there exists as yet no singly-accepted or "received" argument in denial of Special Relativity. Einstein's theory is in every day practical use in modern physics and one is never (apparently) driven into error by employing it. Pragmatically, "it works". Nevertheless, the fact that now, some 80 years after its formulation, a large number, perhaps even a majority, of scientifically-educated people harbour niggling doubts about it may indicate that something, somewhere, might perhaps be wrong. Moreover, today's critics of Special Relativity are no longer die-hard, but well-informed, reasoning, and serious.

I am willing to wrangle with the best of them about the traditionally poor presentation of the clock paradox and the impossibility of drawing co-variant Minkowski diagrams, but to do so would only extend and support arguments that have been raised many times before: arguments which, characteristically, have never been refuted without begging the question, or even worse logical crimes, by any Relativist. (For a selection of such tricks see Professor McCausland's nicely-reasoned article in *WW*, October 1983). Criticism of this kind takes issue with the weird 'predictions' (consequences) of the theory, so that one is forced to refer to arguments, mathematical or otherwise, within the theory itself in order to criticise it. One can then always be accused of 'failing to understand the theory properly'. Naturally, no relativist would ever admit that his critic might understand the theory too well!

On this occasion I prefer to discuss the premises of the theory rather than its deductions;

and I shall not invoke the opinion of any third party, but rely only on the written words of Einstein himself. By these means I hope to present my main contention as precisely as I possibly can. But first, by way of background, let me recall how the Special Theory of relativity arose in the first place, and what it was intended to achieve.

Origins of Special Reality theory

Contrary to received belief, the idea of relativity was not a product of the early twentieth century. The concept of the relativity of uniform translational motion dates back two hundred years and more before 1905. It is directly associated with the truth of Newton's first law of motion, and there is nothing at all complicated about it. The following passage appears in Newton's *Principia* (1687):

"The motions of bodies included in a given space are the same among themselves, whether that space be at rest or moving forward uniformly in a right line without any circular motion... A clear proof of which we have from the experiment of the ship, wherein all motions happen after the same manner whether the ship be at rest, or be carried forward uniformly in a straight line."

From this quotation it is abundantly clear that Einstein did not invent the Principle of Relativity. He himself, in a passage that I shall quote later, said so in as many words. He had to re-state the Principle because, for reasons that we shall uncover shortly, his colleagues of those days had been led astray by a chain of false reasoning and had rejected the relativity principle of classical mechanics in favour of an 'aether' theory, in terms of which all motion *must* be specified absolutely. That theory was, of course, the Maxwell-Lorentz electromagnetic theory, also known as 'Maxwell's Equations'.

It is best to be frank and not mealy-mouthed about these historical facts. By the year 1905 electromagnetic theory had already failed on three separate experimental counts, namely,

1. The physical aether upon which

it depended for its operations does not exist (Michelson and Morley, 1887)

2. The radiation of energy in the form of light is not a continuous process (Planck, 1899)

3. Light quanta — 'photons' — do not dissipate whilst in transit *in vacuo* (Einstein himself, 1905)

In addition it had become clear by the turn of the century, largely as the result of the brilliant work of H.A. Lorentz, that the theory had also failed internally, in that it could not handle even the simplest of situations involving relative motion.

Einstein was acutely aware of this problem. In his view, something was obviously wrong. In the preamble¹ to his Special Relativity paper '*On the electrodynamics of Moving Bodies*' he took it as one of his starting points. He wrote (1905):

"Customary electrodynamics does not take into account the experimentally-corroborated lack of absolute motion. The description of a magnet moving relative to a conductor at rest is quite different from the description of a conductor moving relative to a magnet at rest. Yet the observed phenomena are exactly the same in both cases."

That last sentence again embodies the principle of relativity, but it is the first sentence in the quotation that provides the vital key: Maxwell's electromagnetic theory violates that principle. But there was, and still is, no doubt about the sheer power of the electromagnetic dogma among its adherents. Faced with this crisis the theory's protagonists held on adamantly to their all-dominating Faith. As I said in this connection in the third Heretic's Guide article (*WW*, October 1982 page 77), 'Human feelings at levels deeper than mere reason were involved in this conflict'. Thus Einstein again, almost plaintively² (the square brackets are my own sympathetic additions)

"Prominent theoretical physicists were therefore more inclined to reject the principle of relativity [than the e-m theory], despite the fact that no empirical data had been found which contradicted that principle [and even though experimental data had contradicted e-m theory]."

Here is as vivid a description as we are ever likely to read, by 'the man on the spot', of the intransigence of preconceived, established ideas.

Poor Einstein! Like everyone of his generation he had been brought up on the great Faraday-Maxwell theory of electromagnetism, and he himself believed completely in the reality of electric, magnetic, and gravitational fields. He did his best to help by proposing what seemed to be a wise, balanced, and above all *generally acceptable* compromise. Here he is, writing about the crisis of 1905 retrospectively³ in 1952 (the italics are his own) :

"Classical mechanics ... teaches the equivalence of all inertial systems ... for the formulation of natural laws. Electromagnetic and optical *experiments* taught the same thing with considerable accuracy. But the foundation of electromagnetic *theory* taught that one particular inertial system must be given preference, namely that of the luminiferous aether at rest. That aspect of the theory was most unsatisfactory. Was there no modification that, as in classical mechanics, would uphold the equivalence of inertial systems?"

"The answer to that question is the Special Theory of Relativity. This takes over from the theory of Maxwell-Lorentz the assumption of the constancy of the velocity of light in empty space ..."

Now it was precisely because the new theory 'took over the assumption of the constancy of the velocity of light' that modern physics became saddled with the three well-known mind-bending horrors of relativity theory: the irrational assumption itself, together with the shortening of measuring-rods in the direction of travel and the slowing-down of clocks due to relative motion, which are the inevitable mystical consequences of maintaining that assumption. Earlier, H.A. Lorentz had shown (somewhat apologetically, perhaps) that if those particular distortions of physical reality could conceivably occur in Nature, then all the internal discrepancies of the electromagnetic theory would disappear. He showed further, that such distortions were *necessary* if the electromagnetic theory were to be saved.* In direct and conscious support of Lorentz, although ostensibly from a new and independent standpoint, Einstein argued that *if* the velocity of light were universally constant, *then* those very same mathematical distortions of reality (the 'Lorentz transformations') must actually take place: for that was

* 'Saved': 'Maintained, without the need for agonising re-appraisal and re-formulation from revised first principles'. (There are good reasons for avoiding that extreme process.)

the *only way* the velocity of light could be the same for everyone, as he had assumed it to be. And in order to save the electromagnetic theory — which had already been disproved — his colleagues bought the idea.

That is how it all happened. It was a grand cover-up operation, and the people who pulled it off were acclaimed as heroes. The trouble was that their desperate and successful defence of the electromagnetic theory soon led (in 1925) to far worse difficulties. Maybe someday we shall come to wonder if their success was really worth the troubles it has caused. In the meantime let us try to find out whether there is any possibility that the Special Relativity concept might be true.

Einstein's second postulate

The precedent that Einstein said he had 'taken over from the theory of Maxwell-Lorentz' was that the velocity of light is a constant of Nature. The electromagnetic statement was

$$c = 1/\sqrt{k_0\mu_0} = \text{constant},$$

where c is the velocity of light in *vacuo* and k_0, μ_0 are artefacts of electromagnetic theory by which it seeks to attribute mechanical properties to a vacuum ('aether'); in e-m theory c is constant relative to this unique aether, and not universally. Thus the assumption of its *universal* constancy was not in truth 'taken over from e-m theory', with which it was actually inconsistent, but was introduced *ad hoc* in a curiously ambivalent attempt to reconcile c with the principle of relativity. Einstein's 'second postulate' was therefore suspect immediately. Whether or not we admit it to have been a fudge, it is certain that it leads consistently to paradox.

Nevertheless, Einstein indeed accepted that assumption without evidence (in 1905) as if it were, as he said, a "simple law" and a "natural law". Thus whatever my motion, light reaching me from any source whatever must always appear to approach me at the same velocity. For example, suppose that I am looking towards London from the hills to the north: light from the beacon on the Post Office tower shines towards me at velocity c , which is fine. But *you* are a passenger in a southbound airliner, lining up for Heathrow. According to Einstein the light from the Post Office tower is also approaching *you* at velocity c (exactly), despite the fact that you are passing over my head at about 300 mile/h the velocity of that light is the same for both of us. If that is indeed a natural law, then it would seem that something very odd must have happened to Nature. (The Relativist would say that

Nature had always been that way, but we never noticed.)

Of course, *anything* can happen in mathematics. Arguing from the Lorentz transformations, Einstein suggested that ordinary relative velocities don't add up — 2 and 1 make 2. If we call the you-to-me velocity v and the light-to-me velocity c , then (he said) the light-to-you velocity is not just the simple

$$w = c + v$$

that you thought it was, but the 'relativistic' velocity

$$w = \frac{c+v}{1+cv/c^2} = \frac{c+v}{(1/c)(c+v)} = c.$$

One can scarcely refrain from murmuring 'q.e.d.' in response! All that has been proved by this little exercise (the so-called 'Theorem of the addition of velocities') is that the steps from the assumed constancy of c to the Lorentz transformations and back again are free of *mathematical error*; the result is just a restatement of the initial assumption and the argument is entirely circular. Whether or not it corresponds to the working of the physical world has never been put to the test.

At this point I should put in the routine reminder that the velocity of light from a moving source — a *relatively* moving source — has never been measured. What Michelson and Morley found was that if light was radiated from their light source at some velocity, presumably c , its velocity remained c when it was reflected into any arbitrary direction. (There were no moving parts or relative motions within the Michelson-Morley apparatus.) Similarly, the reflection of radar signals from fast-moving earth satellites can be interpreted in two ways, one that makes sense and another that doesn't; needless to say, the way that doesn't make sense is the one that assumes the velocity of light to be universally constant, but that fact doesn't *measure* the velocity of light. All manner of laboratory experiments have been proposed, and performed, but always the quantity measured turns out to be not c itself but some associated parameter. The canonical support for Einstein's premise lies in the argument of de Sitter (1913), that light signals from spectroscopic binary stars take the same time to reach us irrespective of the motions of their sources; yet there are several cases on record in which the spectra of such systems are said to 'break up' or to show inconsistent centroid velocities — both effects to be expected if c is *not* universally constant. Apart from de Sitter's argument there exists no experimental support for the universality of c . It is

By writing down a group of mathematical equations (the 'Lorentz transformations'),

H.A. Lorentz was able to compensate for the failure of Maxwell's electromagnetic theory to cope with relative motions. In 1905 Einstein derived these same equations by postulating, without evidence, that the velocity of light was universally constant.

The resulting Restricted or 'Special' Theory of Relativity, which required space and time to become distorted as a consequence of the observer's motion, preserved electromagnetic theory intact but at the expense of classical mechanics and common sense. Many paradoxes have ensued; the one examined here, which is less well-known than some, shows that Einstein's 'relativity of simultaneity' is incompatible with his own Second Postulate.

The implication is that Einstein's arguments concerning the nature of time may be suspect and hence no longer capable, by sustaining the Lorentz transformations, of 'rendering the Maxwell-Lorentz theory plausible'.

assumed to be true because Special Relativity theory demands its truth, which is as circular an argument as you will find anywhere! There is no definitive evidence either way.

So now we have reached this situation: to save the Maxwell-Lorentz electromagnetic theory (which we already know by experiment to be wrong), we are asked to accept the 'Lorentz transformations' (which contravene all our existing experience of the nature of time and space), on the basis that the velocity of light is the same relative to all 'material' things, whatever may be their motions relative to each other (which certainly seems to deny ordinary logic). Perhaps there may be a higher logic? The whole thing begins to look like a confidence trick. One is always adjured to accept this theory simply on the grounds of the success of its predictions; but would it not be more convincing to get a line on the truth or otherwise of Einstein's second postulate from Einstein himself, if only one could find a way?

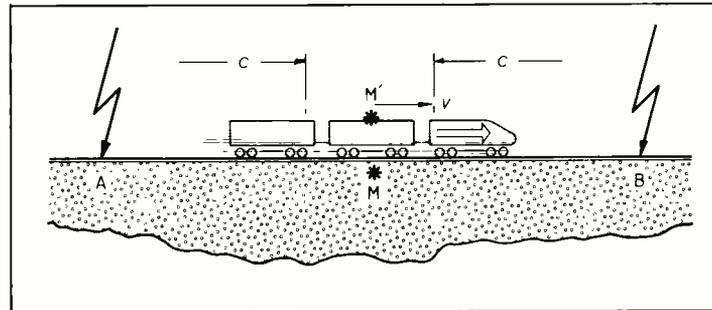
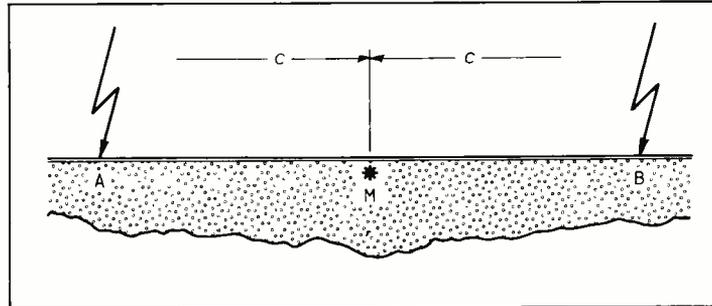
Signal error at the trackside

Einstein acknowledged that some physicists, as opposed to mathematicians, might have difficulty in swallowing these wayout ideas, so he developed an interesting argument about the nature of time and simultaneity. He envisaged a section of straight railway track running along an embankment from A to B, with M as its measure mid-point (see Figure 1). During a thunderstorm, lightning strikes the rails at both A and B simultaneously. "But what does one mean by simultaneously?" he asks, and replies simplistically,⁴

"If the observer [at M] perceives the two flashes of lightning at the same time, then they are simultaneous."

This is Einstein's definition of what he means by simultaneity, and it is clear that it depends on what an observer perceives. But he is still being haunted by the aether-ghost of his own and his contemporaries' early training, and worried that the velocity of light might not be the same over the two equal but opposite distance $A \rightarrow M$ and $M \leftarrow B$. After what, for him, is a longish discussion he concludes (his own italics):

"That light requires the same time to traverse the path $A \rightarrow M$ as for the path $B \rightarrow M$ is in reality neither a supposition nor a hypothesis about the physical nature of light, but a stipulation which I can make of my own free will in order to arrive at a definition of simultaneity."



Now a 'stipulation' — arbitrary and subject to one's own free will 'in order to arrive at a definition' — does not seem quite the same thing as a universal natural law. Is he not still talking about the velocity of light *in vacuo*? And incidentally, why should the definition (or fact) of simultaneity be associated so particularly with light signals? Could one not equally well send timing information through a vacuum by means of calibrated bullets fired from calibrated guns at velocity u ? (Of course one could not use calibrated carrier pigeons because they fly *relative to a medium*, air). But since he needs to differentiate between the behaviour of photons and rifle bullets in order to bring c into his argument about time, and since it is the electromagnetic theory that he is trying to save, let us concede to him the light-based definition of simultaneity that he proposes, *pro tem*.

Einstein next puts a train onto his railway embankment, travelling in the direction $A \rightarrow B$ at velocity v , and puts a second observer M' into the train (Figure 2), so that "just when the flashes of lightning occur (as judged from the embankment)" this M in the train happens to be located exactly opposite M' on the embankment, half-way between A and B. If the observer M' were not moving "he would remain permanently at M' , and the light rays emitted by the flashes of lightning at A and B would reach him simultaneously, *i.e.* they would meet just where he is situated." Good. But Einstein then goes on:

"Now in reality (considered with reference to the railway embankment) M' is hastening towards the beam of light coming from B, whilst he is riding on ahead of the beam of light coming

from A. Hence the observer will see the beam of light emitted from B earlier than he will see that emitted from A. Observers who take the railway train as their reference-body must therefore come to the conclusion that the lightning flash B took place earlier than the lightning flash A. We thus arrive at the important result:

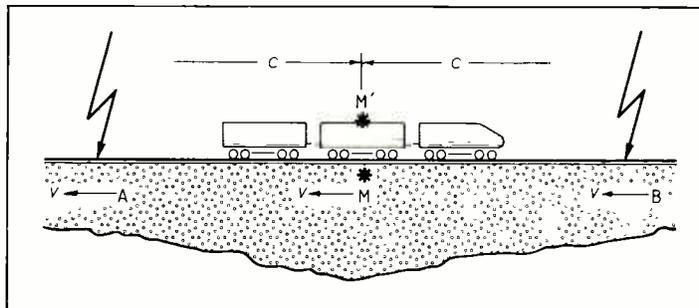
"Events which are simultaneous with reference to the embankment are not simultaneous with respect to the train, and vice versa (relativity of simultaneity). Every reference body (co-ordinate system) has its own particular time; unless we are told the reference body to which the statement of time refers, there is no meaning in a statement of the time of an event."

Let us now without passion analyse that remarkable argument by which Einstein sought to justify both his assumption of the constancy of c and the consequent 'dilation of time'. Here we find his observer M' "hastening towards the beam of light coming from B while riding on ahead of the beam of light coming from A." But at the instant when the flashes occur the position of M' coincides with M (by scenario, see above); so at that instant the distance $A \rightarrow M'$ is equal to the distance $B \rightarrow M'$, in exactly the same way that the distance $A \rightarrow M$ is equal to the distance $B \rightarrow M$. Therefore, *if the velocity of light is the same for everyone* (as assumed in the theory), its time of passage from A to M' must be the same as its time of passage from B to M' — exactly as it is over the equal distances AM and BM. Hence the light from both sources must reach M' at the same time, just as the light from both sources reaches M at the same time. But this is precisely the condition which Einstein himself has so carefully defined as 'simultaneous'!

Situation at the trackside, Fig. 1.

Situation deduced by observer M' , Fig. 2.

Situation as seen by observer M' , Fig. 3.



I will paraphrase that result because of its importance: *If the velocity of light were independent of the velocity of its source as claimed, then, as seen by two observers M and M' in uniform relative motion, the flashes which originated at points A and B when M and M' were spatially coincident at the mid-point of AB must arrive at the future positions of M and M' simultaneously.* It would then follow that the times kept by observers M and M' must be identical in an absolute sense.*

That is the exact opposite of the conclusion which was reached by Einstein in this, his own, scenario.

"Unbelievable", you will say; "there must be a mistake somewhere". There is, and we can locate it easily by transferring coordinates and joining observer M' in his 'moving' train, as we are entitled to do by the Principle of Relativity (forgotten it?). The situation is as shown in Figure 3. The distances AM' and BM' are equal, as also are AM and BM , because Einstein has chosen to make them so. The lightning flashes are simultaneous by Einstein's own definition, in that the light signals emitted from them travelled the equal distance AM , BM at velocity c and therefore reached the 'fixed' observer M at the same instant. According to his own second postulate the motions of the sources A and B relative to M' are irrelevant; each light signal travels towards M' at the same universal velocity c . Therefore, since AM' is equal to BM' (so long as the Relativist does not change the rules!), these signals must arrive at M' at the same time — that is, simultaneously.

In the quotation above Einstein was actually arguing that M' was 'hastening towards' the light from B (relative velocity $c + v$) and 'riding ahead of' the light from A (relative velocity $c - v$), so that their times of arrival at M' must differ. But even the Master may not be allowed to keep his cake and eat it. According to his

* The incidence of *future position* in this context is not unique to this scenario. It arises whenever one tries to measure the position of a moving body by means of light signals radiated from it — a fact which is not generally realised. 'Astronomical aberration' is one of many examples of the effect.

theory (second postulate) one cannot 'hasten toward' or 'ride on ahead of' a beam of light: its velocity relative to every observer is always and exactly c . If that is so, reception at M' is simultaneous by his own definitions and there is no case for denying universal time.

If the observations of M and M' differ it must be for the reason Einstein actually gave in that quotation rather than the reason he thought to give: not because the velocity of light is mystically the same for both observers but precisely because it is *not* the same — not universally constant, but *relative*. It adds up to this: one can maintain either the 'relativity of simultaneity' or the universal constancy of c , but not both.

"Please take your litter home"

In view of the simplicity of the logical error that we have been investigating, where Einstein fell so guilelessly into his own conceptual trap, does it not surprise you that so many famous Authorities have so blindly and uncritically followed him into it? Check me, if you please, by looking up the argument in any textbook of your choice, or in any popular presentation such as George Gamow's classic *Mr Tompkins*.⁵ (In the modern edition it is all done with rockets). Having checked, you may not be surprised to discover that very few people have heard of this counter-argument — which was not invented by me — nor even realised that the paradox existed. Those who wrote the textbooks did not want to know.

I suspect that most people will hold the same view about the present result as they do already about the other, better-known paradoxes of relativity theory. The established method of dealing with challenges to the logic of Special Relativity is to ignore them: and why not? For by using 'relativistic mechanics' (specifically, mass increase) in the interpretation of physical measurements one can always bring one's experimental results into line with the predictions of electromagnetic theory, which is all that a scientific technician need be concerned to do. A natural philosopher, on the other hand, will go on trying, in the hope that he may

in the end arrive at a logically consistent, paradox-free understanding of the physical universe. There are limits, intellectually, beyond which people of this second kind cannot be pushed.

It would be more in accord with the notional methods of science to make use of such anomalies rather than deny their existence. The lesson to be learned from this one is that we, mere humans, are not entitled to define the fundamental physical operator TIME in an *ad-hoc* way simply in order to 'save' any particular theory. The reason behind the demand that time 'must be' defined by the transmission of information to some observer by means of light signals is solely that such a definition, if accepted, permits an independent derivation of the Lorentz transformations. If that definition is rejected, many persistent physical and conceptual difficulties are immediately concentrated into the area where they properly belong — where also, once identified, they can be dealt with.

Up to and including the third quotation above (1905/1952) it is clear that Einstein's first intention had been to modify electromagnetic theory in such a way as to bring its erroneous predictions into line with the rest of physics rather than *vice versa*; the classical mechanics of Galileo and Newton conforms with the relativity principle. As an intention it was wholly admirable, but alas, things did not work out as intended. The only compromise acceptable in the atmosphere of 1905 seemed to be one which left the already-disproved but sacrosanct electromagnetic theory untouched but insisted instead that the simple, natural world of energy and motion, time and space must become distorted in order to accommodate its failure. The irrationality of that development was breathtaking, and the precedent it set was unfortunate: natural philosophers have had to put up with a lot of nonsense for a long time. Suppose we were to return to Einstein's original intention and try to put an end to the nonsense by correcting electromagnetic theory, rather than go on indefinitely riding roughshod over ordinary mechanics and common sense?

People working along these lines have made substantial progress recently, for example Professor Richard Waldron of the Ulster Polytechnic.⁶ It may be that only one or two more good, new ideas are needed in order to clear up this mystery, which dates back nearly a century to Michelson and Morley. If, at long last, we could get "the foundation of electromagnetic theory" right, we could take a deep breath and make a start on tidying up the mess.

References

1. Einstein, A.: 'Zur Elektrodynamik bewegter Körper', *Ann. d. Phys.*, vol. 17, 1905, pp. 891-921. The quotation is from Lanczos, *The Einstein Decade*, (Elek, 1974) p.131
2. Einstein, A.: *Relativity: The Special and the General Theory* (Methuen, 1960) p.19 (text, dated 1916).
3. Einstein, A.: *Op.cit.*(2), p.148 (appendix, dated 1952).
4. Einstein, A.: *Op.cit.*(2), pp. 22-26 (text, dated 1916). All quotations which follow are extracted in order from these five pages.
5. Gamow, G.: *Mr Tompkins in Paperback* (Cambridge, 1965) pp.13-14.
6. Waldron, R.A.: 'Electric Forces', *Radio and Electronic Engineer*, Vol. 51, 1981, pp. 553-560.

RST LANGREX SUPPLIES LTD

Climax House, Fallsbrook Rd., Streatham, London SW16 6ED **RST**

Tel: 01-677 2424 Telex: 946708

SEMICONDUCTORS

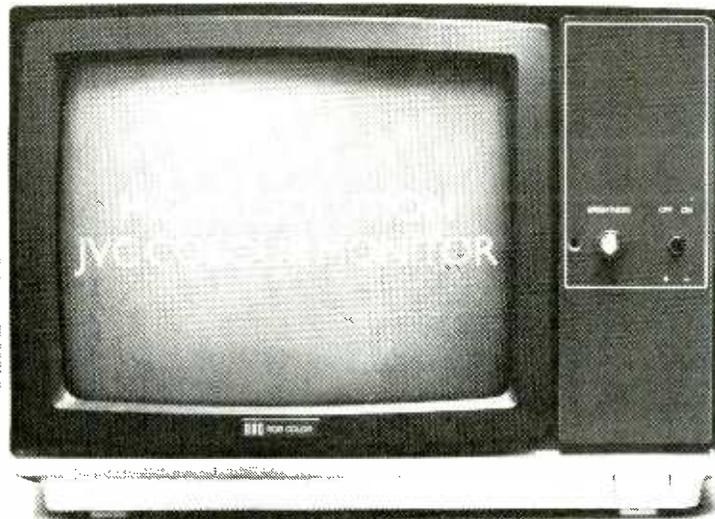
AA119 0.10	ASZ15 1.20	BC173 0.11	BD132 0.48	BF257 0.27	GEX541 5.00	OA2/207 1.50	OC205 2.75	ZTX504 0.21	2N1671 5.00	2N3819 0.30
AA130 0.17	ASZ16 1.20	BC177 0.28	BD136 0.40	BF258 0.27	GJ3M 1.50	OC16 1.50	OC206 2.75	ZTX531 0.24	2N1893 0.32	2N3820 0.39
AA130 0.17	ASZ17 1.00	BC178 0.28	BD137 0.40	BF259 0.28	GM0378A 1.75	OC20 2.50	OC207 2.50	ZTX550 0.25	2N2147 4.00	2N3823 0.60
AAZ13 0.15	ASZ20 2.30	BC179 0.28	BD138 0.48	BF336 0.34	KS100A 0.45	OC22 2.50	OC221 2.00	IN914 0.05	2N2148 3.75	2N3866 1.00
AAZ15 0.15	ASZ21 2.50	BC182 0.11	BD139 0.48	BF337 0.33	MJE340 0.70	OC23 4.00	OC234 3.00	IN916 0.09	2N2218 0.32	2N3904 0.17
AAZ17 0.15	AU113 2.50	BC183 0.11	BD140 0.50	BF338 0.36	MJE370 0.63	OC24 3.00	OC240 2.00	R2008B 1.00	2N2219 0.32	2N3905 0.17
AC107 0.55	AU110 3.00	BC184 0.11	BD141 0.50	BF521 4.00	MJE371 0.71	OC25 1.50	OC250 1.50	R2010B 2.00	2N2220 0.20	2N3906 0.17
AC125 0.25	BA145 0.13	BC185 0.11	BD142 2.00	BF522 2.25	MJE521 0.47	OC26 2.00	OC260 2.00	TIC44 2.00	2N2222 0.20	2N4059 0.20
AC126 0.25	BA148 0.13	BC186 0.11	BD181 1.20	BF523 0.97	MJE2955 1.30	OC29 2.00	OC290 2.00	TIC226D 1.20	2N4005 0.09	2N4060 0.16
AC127 0.25	BA154 0.10	BC187 0.11	BD183 0.80	BF524 0.97	MJE3055 1.10	OC35 1.50	OC350 1.50	TIL209 0.16	2N4006 0.11	2N4061 0.16
AC128 0.20	BA155 0.11	BC188 0.11	BD184 0.80	BF525 0.54	MPF102 0.35	OC36 1.50	OC360 1.50	TIP29A 0.43	2N4007 0.12	2N4062 0.16
AC141 0.28	BA156 0.10	BC189 0.11	BD185 0.80	BF526 0.54	MPF103 0.35	OC37 1.50	OC370 1.50	TIP30A 0.45	2N4009 0.07	2N4124 0.16
AC141K 0.25	BAW62 0.05	BC190 0.11	BD186 0.80	BF527 0.54	MJE371 0.71	OC38 1.50	OC380 1.50	TIP31A 0.33	2N4148 0.04	2N4246 0.16
AC142 0.28	BAX13 0.06	BC191 0.16	BD187 0.80	BF528 0.54	MJE521 0.47	OC42 1.50	OC420 1.50	TIP32A 0.36	2N4404 0.13	2N4286 0.15
AC142K 0.25	BAX16 0.06	BC192 0.16	BD188 0.80	BF529 0.54	MJE2955 1.30	OC45 0.65	OC450 0.65	TIP33A 0.54	2N4501 0.13	2N4288 0.18
AC176 0.30	BC107 0.16	BC193 0.16	BD189 0.80	BF530 0.54	MJE3055 1.10	OC47 0.65	OC470 0.65	TIP34A 0.67	2N4544 0.04	2N4289 0.18
AC187 0.28	BC108 0.16	BC194 0.16	BD190 0.80	BF531 0.54	MPF102 0.35	OC48 0.65	OC480 0.65	TIP41A 0.44	2N4592 0.08	2N4290 0.21
AC188 0.28	BC109 0.16	BC195 0.16	BD191 0.80	BF532 0.54	MPF103 0.35	OC49 0.65	OC490 0.65	TIP42A 0.45	2N4597 0.07	2N4291 0.26
ACY17 1.30	BC113 0.15	BC196 0.16	BD192 0.80	BF533 0.54	MPSU56 0.69	OC73 1.00	OC730 1.00	TIP2955 0.70	2G301 1.00	2N4292 0.22
ACY18 1.15	BC114 0.15	BC197 0.16	BD193 0.80	BF534 0.54	NE555 0.45	OC74 0.70	OC740 0.70	TIP3055 0.56	2G302 1.00	2N4296 0.15
ACY19 1.10	BC115 0.16	BC198 0.16	BD194 0.80	BF535 0.54	BSX19 0.27	OC75 0.65	OC750 0.65	TIS43 0.43	2G306 1.00	2N4305 0.26
ACY21 1.10	BC116 0.16	BC199 0.16	BD195 0.80	BF536 0.54	BSX20 0.27	OC76 1.00	OC760 1.00	ZS140 0.25	2N404 1.30	2N3054 0.55
ACY23 1.15	BC117 0.23	BC200 0.16	BD196 0.80	BF537 0.54	BSX21 0.27	OC77 1.00	OC770 1.00	ZS170 0.21	2N696 0.32	2N3055 0.65
ACY29 2.50	BC118 0.28	BC201 0.16	BD197 0.80	BF538 0.54	BSX22 0.27	OC78 1.00	OC780 1.00	ZS178 0.21	2N697 0.32	2N3056 0.65
AD149 0.75	BC125 0.18	BC202 0.16	BD198 0.80	BF539 0.54	BSX23 0.27	OC81 0.90	OC810 0.90	ZS271 0.23	2N698 0.32	2N3441 0.85
AD161 0.35	BC126 0.18	BC203 0.16	BD199 0.80	BF540 0.54	BSX24 0.27	OC82 0.90	OC820 0.90	ZS278 0.57	2N705 1.25	2N3442 1.25
AD162 0.35	BC131 0.15	BC204 0.16	BD200 0.80	BF541 0.54	BSX25 0.27	OC83 1.00	OC830 1.00	ZTX107 0.12	2N706 0.25	2N3614 2.20
AF106 0.25	BC132 0.15	BC205 0.16	BD201 0.80	BF542 0.54	BSX26 0.27	OC84 0.80	OC840 0.80	ZTX108 0.12	2N707 0.25	2N3702 0.11
AF114 0.25	BC137 0.19	BC206 0.16	BD202 0.80	BF543 0.54	BSX27 0.27	OC85 0.80	OC850 0.80	ZTX109 0.12	2N708 0.25	2N3703 0.11
AF115 0.75	BC147 0.12	BC207 0.16	BD203 0.80	BF544 0.54	BSX28 0.27	OC86 0.80	OC860 0.80	ZTX110 0.12	2N709 0.25	2N3704 0.11
AF116 0.75	BC148 0.12	BC208 0.16	BD204 0.80	BF545 0.54	BSX29 0.27	OC87 0.80	OC870 0.80	ZTX111 0.12	2N710 0.25	2N3705 0.11
AF117 0.75	BC149 0.13	BC209 0.16	BD205 0.80	BF546 0.54	BSX30 0.27	OC88 0.80	OC880 0.80	ZTX112 0.12	2N711 0.25	2N3706 0.11
AF139 0.33	BC157 0.13	BC210 0.16	BD206 0.80	BF547 0.54	BSX31 0.27	OC89 0.80	OC890 0.80	ZTX113 0.12	2N712 0.25	2N3707 0.11
AF186 1.00	BC158 0.13	BC211 0.16	BD207 0.80	BF548 0.54	BSX32 0.27	OC90 0.80	OC900 0.80	ZTX114 0.12	2N713 0.25	2N3708 0.11
AF239 0.39	BC159 0.13	BC212 0.16	BD208 0.80	BF549 0.54	BSX33 0.27	OC91 0.80	OC910 0.80	ZTX115 0.12	2N714 0.25	2N3709 0.11
AFZ11 4.00	BC167 0.11	BC213 0.16	BD209 0.80	BF550 0.54	BSX34 0.27	OC92 0.80	OC920 0.80	ZTX116 0.12	2N715 0.25	2N3710 0.11
AFZ12 4.00	BC170 0.11	BC214 0.16	BD210 0.80	BF551 0.54	BSX35 0.27	OC93 0.80	OC930 0.80	ZTX117 0.12	2N716 0.25	2N3711 0.11
ASY26 1.40	BC171 0.11	BC215 0.16	BD211 0.80	BF552 0.54	BSX36 0.27	OC94 0.80	OC940 0.80	ZTX118 0.12	2N717 0.25	2N3712 1.60
ASY27 0.90	BC172 0.11	BC216 0.16	BD212 0.80	BF553 0.54	BSX37 0.27	OC95 0.80	OC950 0.80	ZTX119 0.12	2N718 0.25	2N3713 1.80

CV Devices
Large stocks
Prices on
application

VALVES

A1834 9.00	E10L 18.50	EF85 1.75	GUS1 2.00	OD3 3.50	QY3-65 59.86	UF41 2.00	4-250A 80.00	6CG7 0.32	12AX7 1.75	5642 9.00
A2087 13.50	E180CC 10.50	EF86 1.50	GUX1 15.35	QZ4 3.50	QY3-125 66.00	UF42 2.10	4-400A 87.00	6CH6 13.00	12AY7A 4.00	5654 3.00
A2134 17.50	E180F 10.50	EF89 2.75	GUX2 30.00	PC86 2.50	QY4-250 68.50	UF80 1.75	4B32 80.00	6CL6 3.75	12BA4 3.50	5651 4.45
A2293 16.00	E180CC 8.91	EF92 6.37	GUX3 25.40	PC88 2.50	QY4-400 74.20	UF85 1.75	4C35 78.00	6CW4 8.00	12B26 2.50	5670 4.50
A2426 27.50	E280F 22.51	EF95 1.50	GUX50 20.00	PC95 1.75	QY5-1000 15.00	UF89 2.00	4CX250B 80.00	6DBE 1.50	12BE6 2.50	5675 28.00
A2521 25.00	E280CC 12.00	EF96 5.99	GZ32 3.00	PC97 1.75	QY5-300A 42.00	UL41 3.50	4CX350A 70.00	6DK6 3.00	12BH17 2.75	5687 6.00
A2900 15.00	EA52 37.25	EF98 2.00	GZ33 4.75	PC85 1.75	QZ06-20 32.70	UL84 1.75	4X150A 60.00	6DQ6B 4.75	12B7V 3.00	5696 4.50
A3343 45.00	EA76 2.50	EF184 2.00	GZ34 3.00	PC88 2.50	R10 6.00	UM80 2.00	4X150D 56.00	6EA8 3.00	12E1 20.00	5718 7.50
AZ31 2.75	EABC80 1.25	EF184 2.00	GZ37 4.75	PC89 1.75	R17 3.00	UY41 2.25	5B245A 35.00	6EB8 2.50	12E11T 28.00	5725 5.50
AZ41 2.60	EAC91 3.50	EF80A5 12.00	KT61 12.00	PC89 1.75	R19 2.24	UY85 2.25	5B255M 35.00	6EW6 2.50	12E14 65.00	5726 11.37
BK448 114.90	EAF42 2.50	EF80S5 15.00	KT66 12.00	PC89 1.75	R20 2.50	YXG1-2500 55.00	5Y3GT 2.50	6F23 1.60	12E17 17.00	5727 7.05
BK484 155.35	EAF801 2.00	EK90 1.75	KT77 Gold Line	PC806 1.60	RG3-250 32.68	XG1-6400 141.90	5Y4G 3.50	6F28 1.60	19H4 27.50	5749 2.50
BS90 58.00	EAF81 2.00	EK90 1.75	KT78 9.00	PC806 1.60	RG3-250A 32.68	XG5-500 26.60	5U4G 2.50	6GH1 14.00	30C15 2.00	5763 4.50
BS810 60.00	EAF82 2.00	EL32 2.50	KT88 9.00	PC806 1.60	RG3-250B 32.68	XG2-6400 162.00	5U4G 2.50	6GH2 2.75	30C17 2.00	5764 4.00
BT5 58.95	EBC33 4.50	EL33 4.00	KTW61 2.50	PC82 1.50	RG4-3000 99.45	XRI-1600A 53.75	5Y3GT 2.50	6GH3 2.75	30C18 2.00	5842 12.00
BT17 151.00	EBC41 2.50	EL34MUJ 1.00	KTW62 2.50	PC86 2.50	RR3-250 45.75	XRI-3200 81.75	5Z4 2.50	6H6 3.00	30F5 1.60	5876A 31.50
BT19 44.05	EBC81 1.50	EL41 2.80	KTW63 2.50	PC87 2.00	RR3-250 45.75	XRI-3200 81.75	5Z4G 2.50	6H6 3.00	30FL1/2 1.38	5879 5.00
BT29 349.15	EBC90 1.25	EL42 2.50	M8079 12.34	PCF200 3.25	RR3-250 45.75	XRI-3200A 63.00	630L2 1.75	6H7 4.75	30FL12 1.80	5886 15.00
BT69 354.80	EBC91 1.50	EL43 4.00	M8080 8.25	PCF201 3.25	SH1E2 65.00	XRI-6400 65.00	630L2 1.75	6H8 4.75	30FL14 1.50	5963 2.50
BT95 129.90	EBC83 1.75	EL83 6.00	M8082 9.69	PCF202 3.25	S130P 6.00	YD1120 102.00	6AB7 3.00	6K6GT 2.50	30L 1.50	5965 0.50
CB131 4.00	EBC89 1.50	EL84 2.25	M8083 8.58	PCF203 3.25	STV280-40 14.00	YD1120 395.00	6AC7 3.00	6K7 3.00	30L17 2.00	6021 4.50
CL33 4.00	EBC81 1.50	EL86 2.75	M8091 10.43	PCF204 3.25	STV280-80 14.00	YD1240 450.00	6AF4A 4.25	6K8 3.00	30P4 2.50	6057 10.23
CY1 3.00	EBC90 1.25	EL90 2.25	M8096 6.80	PCF205 3.25	STV280-80 14.00	Z759 25.00	6AG7 3.00	6K6 3.00	30P19 2.50	6058 12.34
CX31 20.00	EBC91 1.50	EL91 9.69	M8097 8.10	PCF206 3.25	SU41 21.00	ZM1000 8.00	6AH6 5.00	6L6G 7.00	30P19 2.50	6060 6.50
CXA 22.00	EBC92 1.75	EL95 2.00	M8100 6.15	PCF207 3.25	SU42 10.00	ZM1020 9.00	6AK5 5.99	6L6GT 3.00	30P14 1.80	6061 6.00
CXA 22.00	ECC15 380.00	EL156 30.00	M8109 8.00	PCF208 3.25	SU42 10.00	ZM1021 9.00	6AK6 1.50	6L6GT 3.00	30P15 1.80	6063 3.75
DA41 25.00	ECC33 4.50	EL160 8.50	M8109 8.00	PCF209 3.25	TD03-10 35.00	ZM1021 9.00	6AL5 1.50	6L6GT 3.00	35W4 1.00	6064 8.58
DA42 18.70	ECC35 4.50	EL500/504 3.00	M8136 10.23	PCF210 3.25	TD03-10F 35.00	ZM1022 9.00	6AM4 4.00	6L7 2.50	50C5 1.50	6067 10.23
DAF91 1.75	ECC40 4.50	EL509 7.00	M8137 10.23	PCF211 3.25	TT15 50.00	ZM1023 9.00	6AM5 9.69	6N2P 2.50	75B1 6.05	6072 6.00
DAF96 1.75	ECC81 1.75	EL821 13.00	M8140 6.00	PCF212 3.25	TT21 23.00	ZM1040 19.36	6AN5 6.02	6N3P		

WHAT RESOLUTION FOR ONLY £230. (EX.VAT)



Our RGB high resolution colour monitors (580 × 470 pixels) sell for £229.95 (excluding VAT)—a saving of over £100 compared to other leading monitors of similar specifications.

That's a bargain we guarantee you won't see from any other micro retailer.

We've managed to acquire the sole distribution rights enabling us to offer these superb monitors at this unbeatable price.

And just because you're saving on price doesn't mean you're sacrificing quality. Here's what Personal Computer News had to say about our monitors.

"There is no doubt that the JVC range of ECM colour monitors is excellent value for money... there is no loss in quality of picture after long periods... remember as more and more resolution is available with new micros, the need for a better display will be that much greater."

For those who only require medium resolution we also have a model (370 × 470 pixels) at £179.95 (excluding VAT) which is equally excellent value for money.

Both units have a 14" screen and are suitable for the BBC Micro, Spectrum QL, Lynx, Oric, Apple, IBM and

MODEL REFERENCE	1302-2 High Resolution	1302-1 Medium Resolution
RESOLUTION	580 x 470 Pixels	370 x 470 Pixels
CRT	14"	14"
SUPPLY	220-240v 50-60Hz	220-240v 50-60Hz
FEED	Minimum 19.5kv Maximum 22.5kv	Minimum 19.5kv Maximum 22.5kv
VIDEO BAND WIDTH	10MHz	6MHz
DISPLAY	80 characters by 25 lines	80 characters by 25 lines
SLOT PITCH	0.41mm	0.63mm
INPUT VIDEO	R G B Analogue TTL Input	R G B Analogue TTL Input
SYNC.	Separate Sync on R G B Positive or Negative	Separate Sync on R G B Positive or Negative
EXTERNAL CONTROLS	On/off switch and brightness control	On/off switch and brightness control

most other leading micros.

And naturally there's a years full guarantee.

Another one of our commitments is to make certain we deliver your monitor by courier within ten days of receiving your order.

You can order by filling in the coupon below and posting to: Opus Supplies Ltd., 158 Camberwell Road, London SE5 0EE. Or by telephoning 01-701 8668 quoting your credit card number. Or, of course, you can buy at our showroom between 9.00-6.00pm, Monday-Friday 9.00-1.30pm, Saturday.

To: Opus Supplies Ltd., 158 Camberwell Road, London SE5 0EE.
Please send me:

_____ High Resolution Colour Monitor(s) at
£229.95 each (ex. VAT).

_____ Medium Resolution Colour Monitor(s) at
£179.95 each (ex. VAT).

_____ Connection lead(s) at £6.00 each.

I understand carriage per monitor will cost an extra £7.00.
(N.B. A High Resolution Monitor including VAT, lead, and carriage costs £279.99. A Medium Resolution Monitor including VAT, lead and carriage costs £221.89).

Enclose a cheque for £_____ Or please debit my credit card
account with the amount of £_____. My Access/Barecard
(please tick) no. is _____

Please state the make of your computer: _____

Name: _____

Address: _____

Telephone: _____

Opus.
Opus Supplies Ltd.

WW11

CIRCLE 037 FOR FURTHER DETAILS.

SUPER HY-LIGHT STROBE KIT

Designed for Disco, Theatrical, Uses, etc.

Approx. 16 joules. Adjustable speed. Price £45 + £2 p&p (Total inc VAT £54.05). Case and reflector price £15 + £2 p&p (total incl VAT £19.55). Footscap SAE for further details including Hy-Light and Industrial Strobe Kits.

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4h 40 watt £8.70 + VAT (Callers only)
2h 20 watt £6.20 - £1.25 p&p (£8.57 inc VAT)
18m 15 watt £3.50 + 75p p&p (£4.88 inc VAT)
13m 10 watt £3.25 + 75p p&p (£4.50 inc VAT)
12m 8 watt £3.00 + 45p p&p (£3.97 inc VAT)
9m 6 watt £2.50 + 45p p&p (£3.39 inc VAT)
6m 4 watt £2.50 + 45p p&p (£3.39 inc VAT)



230V AC Ballast Kit for either 6in, 9in or 12in tubes £5.50 p&p 55p (£6.96 inc VAT)

For 13in & 18in Tubes £6 p&p 75p (£7.76 inc VAT)

For 12V DC op 12in & 13in tubes only £5.50 p&p 75p (£7.18 inc VAT)

175 WATT SELF-BALLASTED MERCURY BULBS Available for either B.C. or E.S. fitting price £11.79 inc p&p and VAT

400W UV LAMP AND BALLAST complete £38 post £3.50 (£47.73 inc VAT & p&p) 400W UV LAMP only £14 post £2 (£18.40 inc VAT & p&p)

L.T. TRANSFORMERS

*Special Offer 0-6.3V-0-6.3V at 10 Amp (12V 0.10 Amp or 6V at 20 Amp) Price £9.00, p&p £2.00 - inclusive of VAT £11.50 N.M.S.

12/24V D.C. Reversible Precision built motor manufactured by Escap - will operate from 24-V down to 2-V DC - Current consumption negligible. A range of speeds between 2 to 36 RPM obtainable: 6 Volt DC - 9 r.p.m. N/L 6 MA, 12 Volt DC - 18 r.p.m. N/L 10 MA, 24 Volt DC - 36 r.p.m. N/L 18 MA. Total length of motor and gear box 90 M/M. Max. Dia 42 M/M. Shaft Length 15 M/M. Shaft Dia 6 M/M. Approx. Half manufacturers price: £15.00, p&p £2.00 - total inclusive of VAT £19.55.

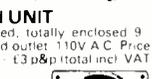
HEAVY DUTY SOLENOID

Inf by Magnetic Devices 240V A.C. intermittent operation. Approx 20lb pull at 1.25 in. Ex equip. Tested Price £7.50 p&p £1.50 (£10.35 incl VAT) R & T



VORTEX BLOWER & SUCTION UNIT

Powerful multi-stage centrifugally balanced, totally enclosed 9 dia Rotators. 3500 rpm 1 1/2" ID inlet and outlet 110V A.C. Price £20 Suitable transformer for 240V A.C. £5 - £3 p&p (total incl VAT £32.20) N.M.S.



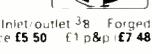
COOLING or EXTRACTOR FAN

Quiet smooth running Size 4 1/4 x 4 1/4 x 1 1/2" Supplied for 240V a.c. operation Price £4.75 (£10.8p total incl VAT) £6.62 N.M.S.



240V A.C. SOLENOID VALVE

Designed for Air Gas at 0.7 Water 5 psi Inlet/outlet 3/8" Forged brass body. Manuf Dewraswitch Asco Price £5.50 £1 p&p £7.48 inc VAT N.M.S.



VARIABLE VOLTAGE TRANSFORMERS

INPUT 230, 240V a.c. 50/60 OUTPUT 0-260V
200W 1A Max £18.00
0.5KVA 2A Max £19.00
1KVA 5A Max £27.00
2KVA 10A Max £41.00
3KVA 15A Max £54.00
5KVA 25A Max £96.00
10KVA 50A Max £181.00
15KVA 75A Max £276.00



3-PHASE VARIABLE VOLTAGE TRANSFORMERS

Qual input 200/240V or 380/415V. Star connected.
3KVA 5amp per phase max £113.40
6KVA 10amp per phase max £170.10
10KVA 16amp per phase max £345.45



Comprehensive range of TRANSFORMERS LT ISOLATION & AUTO 1110 240V. Either cased with American socket and mains lead or open frame type available for immediate delivery. Leaflet on request

12V D.C. BILGE PUMPS

700 G.P.H. 10ft. head, 3 amp. £11.50 + £1.50 p&p (£14.95 inc VAT)
1750 G.P.H. 15ft. head, 9amp. £15.00 + £1.75 p&p (£19.26 inc VAT)



SINGLE DIAPHRAGM COMPRESSOR

Max 20 PSI. One CFM approx 240 volts A.C. £18 + £2 p&p (£23 inc VAT)

EPROM ERASURE KIT

Why waste money? Build your own EPROM ERASURE for a fraction of the price of a made up unit. Complete kit of parts less case to include 12 8 watt 2537 Angstrom Tube. Ballast unit, pair of bin leads, Neon indicator, safety microswitch on/off switch and circuit.
LESS CASE Price £13.60 75p p&p (Total incl VAT £16.50)
Warning: Tube used in this circuit is highly dangerous to the eyes. Unit must be fitted in suitable case.

FROM STOCK AT PRICES THAT DEFY COMPETITION!

- | | |
|------------------------|--------------------|
| DC GEARED MOTORS | C.F. BLOWERS |
| AC MOTORS | AC CAPACITORS |
| MICROSWITCHES | STROBE KITS |
| RELAYS | FLASHTUBES |
| REED SWITCHES | CONTACTORS |
| SOLENOIDS A.C. or D.C. | SYNCHRONOUS MOTORS |
| PROGRAMME TIMERS | |
- Phone in your enquiries

Superior Quality Precision Made NEW POWER RHEOSTATS



New ceramic construction, heavy duty brush assembly, continuously rated
25 WATT 5/10/25/50/100/150/250/300/500/1K 1.5k 1 £3.80 + 30p p&p (£4.71 inc VAT)
50 WATT 250/1 £5.50 + 50p p&p (£6.90 inc VAT)
100 WATT 1/5/10/25/50/100/250/500/1K 1.5k 1V2 5k 1V3.5k 1 £7.75 + 75p p&p (£9.77 inc VAT)
Black Silver Skirted Knob calibrated in Nos 1-9, 1 1/2 in dia brass bush. Ideal for above Rheostats 30p ea. + VAT

WHY PAY MORE?
MULTI RANGE METER Type MF15A a.c. d.c. volts 10, 50, 250, 500, 1000 Ma 0.5 0.10 0.100 Sensitivity 2000V 24 range diameter 133 by 93 by 46mm including test leads Price £10.35 inc VAT & p&p



INSULATED TESTERS NEW!
Test to I.E. Spec. Rugged metal construction suitable for bench or field work constant speed clutch Size L 8in W 4in H 6in weight 6lb 500V, 300 megohms £49. p&p £2 £58.65 incl VAT 1000V 1000MΩ £55 p&p £2 £65.55 incl VAT 1 SAE for leaflet

GEARED MOTORS
5 rpm 240V A.C. Mfr by Carter £6.05 £1 p&p (£8.11 inc VAT) N.M.S.
38.3 rpm GEARED MOTOR Torque 35lb in reversible 115V AC inc start capacitor Price £11.55 p&p (total incl VAT £15.58) N.M.S.
Suitable TRANSFORMER 230V A.C. operation Price £4.50 - 50p p&p (total incl VAT £5.75)

CROWN 37 rpm 200lb in approx 110V AC reversible geared motor Price £35 p&p £4.50 (£45.42 inc VAT) N.M.S.
Suitable transformer for above £10 p&p £1.50 (£13.22 inc VAT)

CROWN 42 rpm 110/230V A.C. 50 Hz 100 lb.in. approx. Reversible geared motor Price £18.15 - £2.50 p&p (total incl VAT £23.75)



120 RPM 1/10 HP APPROX 15 lb.in. 230V A.C. Cont Rating Non-reversible Size 150mm x 90mm x 85mm spindle 8mm dia x 30mm long Complete with capacitor and relay for max load starting Offered at mere fraction of mfrs price - £11.50 inc p&p & VAT N.M.S.

CHECK METER
200-240V A.C. 50amp fully reconditioned £7.50 - £1.75 p&p (total incl VAT £10.64)

SANGAM WESTON TIME SWITCH
Type S251 200 250 A.C. 2 on 2 off every 24 hours 20 amps contacts with override switch Diameter 4 x 3 price £9.50 £12.65 inc VAT & p&p Also available with solar dia R&T Other types available from stock

N.M.S. New Manufacturers' Surplus R&T Reconditioned and tested Good normally despatched within 7 days.

Ample parking space
Showroom open Monday-Friday

SERVICE TRADING CO

57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB. 01-995 1560
ACCOUNT CUSTOMERS MIN. ORDER £10

Personal callers only Open Saturdays
9 Little Newport Street London WC2H 7JJ
Tel: 01-437 0576

CIRCLE 038 FOR FURTHER DETAILS.

- TRANSEL DOT MATRIX PRINTER Compact Serial Interface 230V With info £85 ea
- TELETYPE ASR33 - DATA DYNAMIC 390 (Printer, Keyboard Punch & Reader) RS232C £75
- RACAL MODEM type 2200/24 £100
- TRT SEMI AUTONS 1022 Modern £20
- CREED 75 TELEPRINTER Very good condition £25 ea
- 9" MONITOR Cased Non-standard, with info £20 ea
- 12" MONITOR Cased Non-standard, with info £15 ea
- AZTEC 20 Black and white MONITOR Video In Video In £50 ea
- TV Style 20" MONITOR Black and white £30 ea

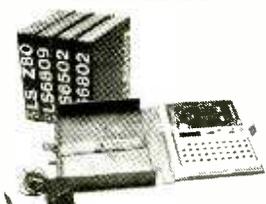
- 51 B&K LEVEL RECORDER 2305, solid state £400
- 52 B&K LEVEL RECORDER 2305, valve £200
- 53 B&K MICROPHONE AMPLIFIER 2603 £100
- 54 B&K RANDOM NOISE GEN 1402 £125
- 56 B&K RMS AUDIO VOLTMETER 2410 £40
- 59 B&K MICROPHONE 4111 with stand and cable £95
- 61 B&K AUDIO FREQ SPECTROMETER 2109 with level recorder 2304 £150
- 65 WAYNE KERR UNIVERSAL BRIDGE B221 Mk 3 (meter indicator) with low imp adaptor 0221 Mk 3 £175
- 67 WAYNE KERR UNIVERSAL BRIDGE B221 with low imp adaptor 0221 £95
- 68 WAYNE KERR COMPONENT BRIDGE B521 £45
- 69 WAYNE KERR VHF ADMITTANCE BRIDGE B801 £125
- 70 WAYNE KERR AF SIG GEN S121 10kHz-120kHz £350
- 72 ADVANCE PULSE GENERATOR PG528 £350
- 74 ADVANCE DUAL STAB DC PS P P 3 0-30V-1A twice Metered £50
- 75 SOLARTRON DVM A223 AC/DC/Dhm 4 1/2 digit £90
- 78 AVO MULTIMETER CT471A (Ex-Ministry) £40
- 79 AVO MULTIMETER 7X £25
- 80 AVO MULTIMETER 8s from £45
- 81 AVO TRANSISTOR TESTER TT169 with leads As new (P&P £2) £20
- 82 AVO VALVE CHARACTERISTIC METER VCM163 with data £250
- 88 AIRMEC MODULATION METER 210 3-300MHz AM/FM £90
- 90 BRANDENBURG POWER SUPPLY 374SEL 0-1000V £95
- 91 BRANDENBURG POWER SUPPLY PM2500R 0-2.5kv £75
- 95 TAYLOR INSULATION TESTER 130C 500V Max (P&P £3) £125
- 97 GREEN SYNTHESISED DIGITAL SIGNAL GENERATOR TG1800 1Hz-99MHz Sine/Square £600
- 40 MARCONI SIG GEN TF2002B 10kHz-88MHz AM/FM £500
- 41 MARCONI SIG GEN TF2012 400-520MHz FM £350
- 42 MARCONI MOD METER TF2300S 2-1000MHz AM/FM £125
- 43 S.E. LABS STROBE SMB £375
- 414 RACAL/AIRMEC SIG GEN 365A 1-320MHz AM/FM £325
- 375 B & K TAPE RECORDER type 7001 £600
- 380 H.P. SHF SIG GEN 620A7-1GHz £225
- 381 H.P. CALORIMETRIC POWER METER 434A DC 12-46Hz 10mW-10W £250
- 383 H.P. RF MILLIVOLTMETER 411A 500kHz-1GHz 10mV-10V £150
- 387 MARCONI DIFF DC VOLTMETER TF2606 0-1100V £275
- 390 GR FREQ METER & DISCRIMINATOR 1142-A £200
- 392 CLAUDE LYONS VOLTAGE STABTS2 AC 240V 12A £100
- 398 KINGSHILL STAB POWER SUPPLY 500 Metered 0-60V 0-0.5A (P&P £4) £40

- Item No. OSCILLOSCOPES
- 406 TEK 465 Dual Trace 100MHz Delay Sweep £950
- 407 GOUID/ADVANCE OS3300B Dual Trace 50MHz Dual Time Base £450
- 408 TELEQUIPMENT D83 Dual Trace 50MHz delay Sweep Large Screen £450
- 409 TELEQUIPMENT 075 Dual Trace 50MHz Delay Sweep £400
- 376 TEK READOUT SCOPC 567 with 6R1A Digital Unit, 3S1 Dual Trace Sampling unit DC 17Hz and 3177A Sampling Sweep Unit Complete with 2 probes £500
- 3 H.P. 180A Dual Trace 50MI 2 Delay Sweep £400
- 11 S.E. LABS SM111 Dual Trace 20MHz £200
- 5 SOLARTRON SCHLUMBERGER CD /40 dual trace 50MHz dual TB delay sweep £325
- 7 COSSOR CDU 20 dual trace 50MHz delay sweep £250
- 14 SOLARTRON CD1400 dual beam 15MHz £300
- 15 TELEQUIPMENT D43 dual beam 15MHz £90
- 16 SOLARTRON CD1014 dual beam 5MHz £60
- STORAGE OSCILLOSCOPES
- 18 PHILIPS PM3234 dual beam 10MHz £1200
- 19 TELEQUIPMENT DM64 dual trace 10MHz £450
- 20 TEK 549 with 1A1 plug-in dual trace 30MHz dual TB delay sweep £400
- 22 HP SIGNAL ANALYSER 5480B memory display with 5486B and 5485A Plug-ins £425
- 25 MARCONI SIG GEN TF2002A S 10kHz 72MHz AM/FM £475
- 27 MARCONI SIG GEN TF995A S 1.5-220MHz AM/FM Narrow deviation £250
- 28 MARCONI UNIVERSAL BRIDGE TF1313 0.25% £250
- 29 MARCONI UHF SIG GEN TF1060/2 450-1200MHz late style £150
- 31 MARCONI UNIVERSAL BRIDGE TF888 range £60
- 32 MARCONI WIDE RANGE OSC TF1370A 10Hz-10MHz Sine 10Hz-100kHz square £95
- 33 MARCONI DEVIATION METER TF7910M 4-102MHz late style £150
- 34 MARCONI SIG GEN TF995-3S 1.5-220MHz AM FM £150
- 36 MARCONI AF POWER METER TF893A 20Hz-35kHz £75
- 38 MARCONI SENSITIVE VVM TF2600 10Hz 10MHz 1mV-300V £75
- 41 HP PULSE GEN 222A Repetition rate to 10MHz £150
- 42 HP PULSE GEN 214A 200 watt pulse power £250
- 45 HP VHF SIG GEN 6080 10-420MHz £150

EXECUTIVE TELEPHONES PUSH BUTTON
Many functions including 10 number memory, repeat dialling etc. Will connect to GPO System Brand New £25 each. P&P £4

SAMPLE OF STOCK SAE or telephone for LISTS
Please check availability before ordering. Carriage all units £1. VAT to be added to total of Goods and Carriage

LEARNING MICROPROCESSOR? USING MICROPROCESSOR? GET THE LS?



LS series of microprocessor learning systems offers inexpensive trainers in learning and practising microprocessor programming and interfacing; low cost controllers in automation and OEM. The series comprises systems based on the most popular 8 bit microprocessors, 6502, 6802, 6809, Z80, and 8085.

Features:
20 editing, debugging commands in EPROM; 3-16 user keys; Hex keys; 2 K RAM; 16 programmable I/O lines; spare socket for extra 4 K EPROM or 2 K RAM; seven segment LED display; cassette recorder interface; speaker; breadboard; wire-wrap area; system bus connector; I/O lines connector; AC/DC adaptor.

Option:
LS Projects. A collection of 15 programming and interfacing projects with construction manual and components. Projects include music generator, memory expansion, I/O expansion, game, AD/DA conversion, optical sensor, real time clock, EPROM programmer, home and industrial applications.
(No soldering or wire-wrapping is required)

- Price:
- LS6502 £109.00
 - LS6802 £109.00
 - LS6809 £129.00
 - LSZ80 £109.00
 - 8085 Module (work on LSZ80) £29.00
 - LS Projects (with components) £25.00

The prices shown include surface mail postage.
90 days warranty.
Cheques to: Room 1.320, Quadrant House, Sutton SM2 5AS, Gt. Britain.

Distributors Invited
BINARY SYSTEM
MAXWELL ROAD, P.O. BOX 1583
SINGAPORE 9031
REPUBLIC OF SINGAPORE

CIRCLE 065 FOR FURTHER DETAILS.

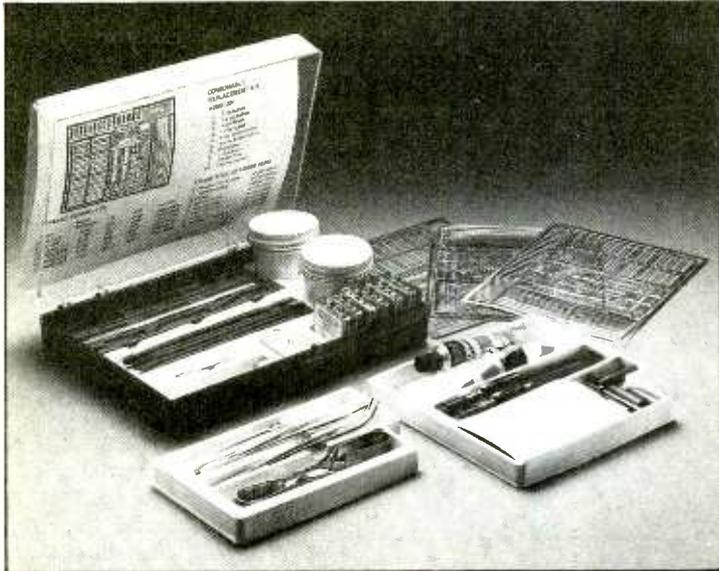
STEWART OF READING

110 WYKEHAM ROAD, READING, BERKS RG6 1PL

Telephone: 0734 68041

Callers welcome 9 a.m. to 5.30 p.m. Monday to Saturday inclusive

CIRCLE 063 FOR FURTHER DETAILS.



CIRCUIT BOARD REPAIR

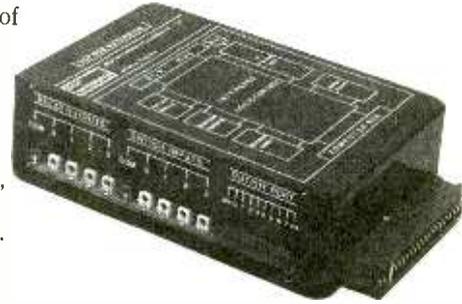
The salvage of just one complex p.c.b. assembly would pay for the repair kit used to do it, say OK Industries. Available in economy, standard and de-luxe versions, the kit includes repair tracks in most of the configurations likely to be required as well as setting tools. Additional to the standard kit are a number of consumables; epoxy

resin, flux, cleaner, spatulas, abrasive sticks, tweezers, clamps and knives. The de-luxe kit has all that and an temperature-controlled soldering iron and five pairs of pliers. All items can also be purchased separately. OK Industries UK Ltd, Dutton Lane, Eastleigh, Hants. SO5 4AA. WW 220

CONTROLLER FOR THE BBC MICRO

A controller interface designed to plug into the 1MHz bus socket of the BBC computer provides a number of useful facilities, including an eight-channel, eight-bit a-to-d converter, an eight-bit input port, eight-bit output port, four switch inputs, four relay outputs and a bus extender for further expansion.

The a-to-d converter is a single-chip device with a separate 2.45V precision voltage reference i.c. it gives 256-step resolution on all eight channels. A 5V regulator provides the supply for all the internal circuitry with a spare capacity of 80mA for external circuitry. Up to four switches can be connected directly to the switch inputs and the four internal relays can be used to switch devices of up to 12V at 1A. They could also be used to switch external relays for higher power requirements. The expansion connector uses its own configuration for add-ons designed by the makers. There is already an additional a-to-d pack which allows for high-speed operation, it takes 100K



samples/s and is said to be ideal for use with an experimental digital storage oscilloscope or similar project. This is complemented by a d-to-a converter with eight-bit resolution (256 steps) which incorporates a high-impedance input buffer. the interface module, called Interbeeb, includes a power pack for £59.95 while the AD pack and the DAC pack cost £19.95 each all prices inclusive. DCP Microdevelopments Ltd, 2 Station Close, Lingwood, Norwich NR13 4AX. WW 222

P.C.B. C.A.D.

Finding p.c.b. layout laborious and existing computer-aided design systems too expensive, Keith Ingham, a hardware and software engineer, designed his own c.a.d. system entirely in machine-code. This makes the system, Artworker plus, very fast and Mr. Ingham has managed to incorporate a number of very useful functions—curved tracks, for example, and a facility for dumping work in progress to a dot-matrix printer. At its simplest level, Artworker is a computerized analogue of a drawing board with 18 overlay sheets in register and the drafting pen replaced by a cursor. A p.c.b. designer with no computer experience could use the system with very little difficulty, claims Ingham.

The system compiles a list of all interconnections as the work progresses and if a component is repositioned, then the connecting tracks are reoriented to suit. A library of the user's company standards may be kept on disc and the redrafting of a standard board is reduced to a

minimum. Library space can also be given to a host of standard and non-standard pad layouts. Pads can be placed to an accuracy of 0.01mm and tracks to 0.6mm. Clearances between pads and tracks can be checked visually although an automatic clearance check is to be added to the system. Individual tracks or groups of tracks are initially given straight line connections and may then be moved using a 'rubber-band' control.

Output from the system may be on a precision drafting plotter

to produce camera ready artwork. It will also send output information to a photo plotter, eliminating the camera stage. Each Artworker station is a complete stand-alone system with full design facilities. Further workstations when added can share a plotter. The basic price of the Artworker is £14 530 and this with a appropriate plotter is all that is needed for a complete in-house p.c.b. design system. Wayne Kerr, Datum Ltd, Woolborough Lane, Crawley, RH10 2UG. WW 221



MORSE RECEIVER FOR ZX81

A program for the ZX81 computer can translate Morse code signal received from a radio or other source and translate them into text which is displayed on the screen. Two keys on the computer are programmed to adjust the reading speed and when this is correct, spaces appear between the words. The cassette program is loaded and a loudspeaker feed from the receiver is connected by coaxial cable to the cassette input of the computer. The instructions provide some useful hints and tips for the reception of signals including the use of a pair of back-to-back diodes to clean up the signal. This could be of use in cassette loading. The program has been successfully tested with both versions of the ZX81 r.o.m. Brian Bailey, Pinehurst Data Studios, 69 Pinehurst Park, W. Moors, Wimborne, Dorset BH22 0BP. WW 223

COMPACT DIRECTION FINDER

A radio direction finding system, the DF2, gives an instant readout of the direction of a signal both as a digital display and as points around a compass. The signals are collected from four identical antennae mounted in a square array. These are combined in a head unit which phase-modulates the signal with a special waveform. The extra phase modulation carries the information about the direction of the incoming signal. In the unit this additional modulation is separated from any other modulation and processed to give two voltages; one proportional to the sine of the bearing angle and the other to the cosine. These voltages are digitized and the

the head unit. Although the system is designed to work with f.m. signals it will also operate with a.m. or s.s.b. signals which it will interpret as n.b.f.m. Other refinements include an offset so that the antennae especially on a mobile unit, do not have to be accurately aligned, since any misalignment can be compensated. It is even possible to reverse the directions entirely so that the system can be used with upside-down antennae, under an aircraft, for example. Suitable antennae, receivers and all ancillary equipment can be obtained from the Manufacturer; Datong Electronics Ltd, Spence Mills, Mill Lane, Bramley, Leeds LS13 3HE. WW 211

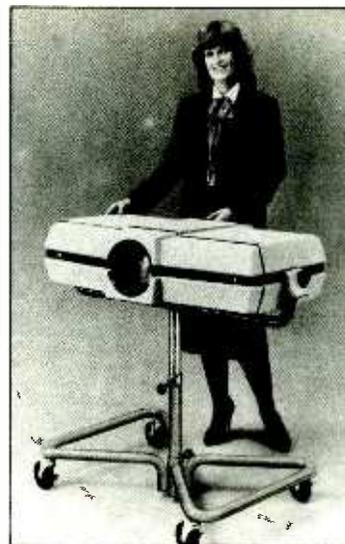


calculation to the bearing is handled by a Z80 processor, which is also used to drive the display. The phase-shift caused by signal delay through the receiver is automatically compensated for to give a superior performance than that in most Doppler-shift direction finders, according to the maker.

The DF2 is designed to be easy to install and use. In normal operation the unit instantly indicates the bearing of the received signal. If the signal fades the reading is held. Various operating modes give different selections of sampling and holding signals. The averaging time can be altered by a control but the processor control always ensures that the briefest signal will give an accurate bearing, whatever the setting. The unit may be used in conjunction with a separate receiver or may have a receiver incorporated into it. The coaxial feeder from the head unit also acts as a d.c. power cable to

MORE ON VISION

The MicroEye system for the BBC Computer has now been enhanced by the addition of two software packages. The standard MicroSight software will calculate areas and perimeters of an image and can be accessed from the Basic system. The additions are the Hi Res package which uses BBC mode 0 to give a 265 by 256 image which may be stored on tape or disc; and a Photo Graphics package which uses mode 2 and offers 'false colour' representation of different shades of grey. The system including tv camera, software and documentation costs £495. For an additional £99 it is possible to add an RGB filter system with the appropriate software to give a 'true' colour image in mode 2. Digithurst Ltd, Leaden Hill, Orwell, Royston, Herts SG8 5QH. WW 212



SINGLE-LENS VIDEO PROJECTOR

A new projector has been specifically designed to work with computer data output. The ECP 1000 differs from most other video projectors by combining the RGB images internally, working like a tv camera in reverse, and projecting the combined image through a single lens. This avoids the registration problems often encountered with three-lens projection tv and the system is capable of displaying

high-resolution images with 600 lines of 1024 elements.

The input signal is fed to the three c.r.t.s which are positioned around a cube of dichroic mirrors. The mirrors within the cube have been aligned by laser light, and the dichroic coatings, up to 35 layers on each mirror, have been selected to match the wavelengths of the outputs from the c.r.t.s. This ensures that the brightest image is available for projection. The c.r.t.s. are also liquid-cooled to improve their efficiency.

The synchronization electronics can automatically lock onto an output operating frequency so that it will synchronize with the output of, for example, an IBM3279 terminal even though this uses a non-standard vertical frequency. The ECP1000 can scan and hold frequencies between 15 and 33kHz horizontally and 45 to 100Hz vertically. This permits the projector to be used with many different output devices, from personal computers to high-resolution graphics terminals. With an optional adaptor and a tuner the system can be used to display broadcast tv or v.c.r. images, which benefit from the high resolution of the system. Electrohome Ltd, 7 Civic Way, Ellesmere Port, Cheshire L65 0AX. WW 213

FLOPPY TAPES

We have received news of two very similar products which are both intended to improve the reliability and speed of tape storage for microcomputers for those who cannot afford disc drives. The Ultra-drive from Ikon uses a standard cassette, offering a read/write speed of 1200 characters/s and a capacity of around 200k bytes on each cassette. A version compatible with the Dragon 32 computer is now available (£79.95) and others for the BBC, Nascom, Tandy, Oric, Electron and Commodore computer are to be available soon. Ikon computer products, Kiln Lane, Laugharne, Dyfed. WW 214

A different approach is taken by Phi Mag Systems, who have produced Phloopy, which uses a continuous loop of tape about three meters long in an interchangeable cartridge. Tape

speed is 15in/s and 0.25in instrumentation tape is used. Each cartridge offers a capacity of 100Kbytes and a transfer rate of 10Kbytes/s. Typically a file can be found and loaded in three or four seconds. The 'special secret' of Phloopy is that it records bytes in parallel, by using a nine-track head. The controller includes an on-board microprocessor which incorporates error-correction facilities and can take over many of the housekeeping and file-handling tasks of the computer. The system has been designed for the BBC computer, although other versions are on the way, and costs £99 plus £25 for an interface module which can handle up to eight drives. Phi Mag Systems Ltd, Tregonnie Industrial Estate, Falmouth, Cornwall TR11 4RY. WW 215

If you need assistance in HiFi/audio service:



Here's all the help you need

Philips versatile PM5109 LF generator and unique combined distortion meter/oscillator, the PM6309, give you all the help you need for HiFi and audio service applications. They're easy to operate – and economically priced.

PM5109 brings together all the high technology features you require from a test instrument. It offers symmetrical or asymmetrical outputs; pure sine wave signals; a wide 10 Hz – 100 kHz frequency range and switchable output impedances. A high 30 Vpp amplitude in the asymmetrical mode, with stepped and continuous attenuation; a 10 Vpp floating output in the symmetrical mode, and useful TTL or DIN loudspeaker outputs are

further benefits. In addition, there is a choice of low-distortion or fast-settling modes.

PM6309 is a simple-to-operate distortion meter that can handle all types of audio equipment. It has been specially designed to provide appropriate signal generation plus an accurate distortion measuring capability within a single instrument.

It offers a built-in RC oscillator, total harmonic distortion (THD), 3rd harmonic distortion and rms measuring facilities. It not only measures distortion according to DIN 45500 – but also determines the distortion figure accurately when unstable audio signals are being applied.

Fully automatic operation means that all you do is connect the input, select the test frequency – and then read-out the distortion. Separate two-channel testing is also possible for stereo equipment.

Use the inquiry service to obtain further information.

	Inquiry No.
PM 5109 LF generator	061
PM 6309 distortion meter	062

**Philips Test and Measuring
Pye Unicam Ltd
York Street, Cambridge CB1 2PX
Tel (0223) 358866 Telex 817331**

GN13



**Test & Measuring
Instruments**

PHILIPS

REQUIREMENT: AMPLIFICATION SOLUTION: CRIMSON!



More than ever, Engineers, Enthusiasts, & Professionals require a reliable source of quality amplification, crimson continue to meet this demand with a comprehensive range to suit virtually every application and support this with friendly advice and back-up. Our prices have remained stable for 18 months and with two regional distributors and our own mail order system, there has never been a better time to choose the best.

MODULES



Power amplifiers bipolar type. Incorporating full electronic protection, integral heatsink bracket, high slew/low distortion circuitry (<0.01% THD TYPICAL)

TYPE	MAX O/P	SUPPLY (DC)	PRICE
CE608	60W/8R	+/-35V	£21.50
CE1004	100W/4R	+/-35V	£25.00
CE1008	120W/8R	+/-45V	£28.00
CE1704	200W/4R	+/-45V	£35.50
CE1708	180W/8R	+/-60V	£35.50
CE3004	320W/4R	+/-60V	£49.50

NEW LOW POWER

CE308	30W/8R	+/-25V	£15.90
-------	--------	--------	--------

Power amplifiers Mosfet type. Ideal for heavy duty use — i.e. disco's or driving line transformers, integral heatsink bracket, (<0.02% THD TYPICAL)

FE908	90W/8R	+/-45V	£30.00
FE1704	170W/4R	+/-45V	£39.00

Pre-amplifiers stereo modules with R.I.A.A. eq. M.M. & line input, needs vol and bal pots and input switching. Can be used with MC2 module to allow use of low O/P MC cartridges.

CPR1X	STEREO	+/-12V/20mA	£33.90
MC2	STEREO	+/-12V	£23.00

NEW SUPER CPR

CPR2	STEREO	+/-12V/20	£47.95
------	--------	-----------	--------

Full details of our complete range including heatsins, toroidal power supplies, active crossovers etc. available on S.A.E.

HIFI KITS



Still the reference kit amplifier! for less than £250 you can own an esoteric pre-power combination with the added pleasure of building it yourself.

Write for our full brochure and review reprints.

CK1010	Stereo pre-amplifier	£92.00
CK1040	Stereo P/A 40+40 WPC	£121.00
CK1080	Stereo P/A 80+80 WPC	£134.00
CK1100	Stereo P/A 100+100 WPC	£151.00
MC2K	M/C kit for CK1010	£25.00
P.S.K.	Pre-amp power supply	£20.00

PRO POWER

A new range of 19" rack mounting power amplifiers are undergoing field trials for launch later this year. Please contact us if you have a particular requirement for this type of amplifier as the final design will depend on your needs!

TO ORDER

Send cash with order or quote Acces/Mastercharge card no. All prices include VAT, P&P.

DISTRIBUTORS

London: Bradley Marshall Ltd.,
325 Edgware Road,
Wilmslow Audio,
35/39 Church Street Wilmslow.

EXPORT

No problem, but as postage varies so much please write for a proforma invoice.



CRIMSON ELEKTRIK STOKE

PHOENIX WORKS, 500 KING STREET, LONGTON, STOKE ON TRENT, STAFFS.

PHONE 0782 330 520

FREQUENCY COUNTERS

HIGH PERFORMANCE
HIGH RELIABILITY
LOW COST

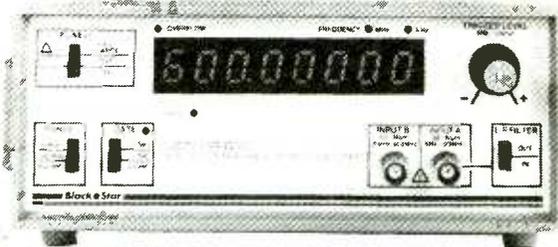
The brand new Meteor series of 8-digit Frequency Counters offer the lowest cost professional performance available anywhere.

- ★ Measuring typically 2Hz 1.2GHz
- ★ Sensitivity <50mV at 1GHz
- ★ Setability 0.5ppm
- ★ High Accuracy
- ★ 3 Gate Times
- ★ Low Pass Filter
- ★ Battery or Mains
- ★ Factory Calibrated
- ★ 1-Year Guarantee
- ★ 0.5" easy to read L.E.D. Display

PRICES (Inc. adaptor/charger, P & P and VAT)

METEOR 100	(100MHz)	£104.36
METEOR 600	(600MHz)	£134.26
METEOR 1000	(1GHz)	£184.36

Illustrated colour brochure with technical specification and prices available on request



Designed and manufactured in Britain

Black★Star

BLACK STAR LTD, Dept. WW, 9A Crown Street, St Ives Huntingdon, Cambs PE17 4EB, England
Tel: (0480) 62440 Telex: 32339

CIRCLE 032 FOR FURTHER DETAILS.

METAL FILM RESISTORS

1% Tolerance, 1/4 Watt

High quality, British made 89 (E24) values, only 3p each. VAT, p&p inclusive.

SPECIAL OFFER
5 of each 445 resistors
£12.60

SPECIAL 'POP' PACK
50 pcs: 100R, 1K, 4K7, 10K, 47K, 100K, 1M.
25 pcs: 330R, 470R, 1K5, 2K2, 3K3, 22K. Total 500 pcs. £11.50.

Extra special 1 of each kit £22

ORION SCIENTIFIC LTD - 16 Orange Street - London WC2H 7ED

CIRCLE 018 FOR FURTHER DETAILS.

TOROIDAL TRANSFORMERS

We are now able to offer a range of high quality Toroidal transformers at very competitive prices;

30VA £6.27, 50VA £7.73, 80VA £8.51
120VA £9.33, 160VA £11.43, 300VA £15.27

Prices include P&P and VAT

Available in the following voltages: 6-0-6, 9-0-9, 12-0-12, 15-0-15, 18-0-18, 22-0-22, 25-0-25, 30-0-30, 35-0-35, 40-0-40, 45-0-45, 50-0-50.

Qty. discount 50 plus 10%, 100 plus 20%

TRADE ENQUIRIES WELCOME

AIRLINK TRANSFORMERS LTD
28 Bullfields, Sawbridgeworth, Herts. Tel: 0279-724425

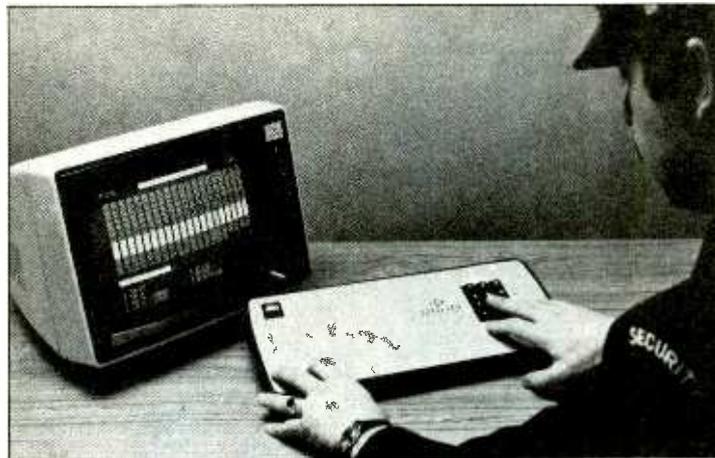
CIRCLE 084 FOR FURTHER DETAILS.

STURDY CASSETTE RECORDER

Basing their efforts on a cassette recorder designed for use in schools, Bell & Howell and Leasalink Viewdata have combined their talents to produce a cassette recorder (3179CX) for use with microcomputers. Pointing out that the use of cassettes for computing accounts for much heavier use than with audio, the player has been manufactured with a heavy-duty case, mechanism and circuit boards, said to be hard wearing and shock resistant. All the usual facilities are provided including 'cue' and 'review' and a tape counter, while the recording level can be automatic or manually controlled. Frequencies up to 8kHz can be recorded which the makers claim is ideal for computer use. The recorder also doubles as an audio machine. Bell & Howell, Alperton House, Bridgewater Road, Wembley, Middlesex. HA0 1EG. WW 216

WIDEBAND OP-AMPS

Thought to be ideal for use in high-speed data and signal applications the Teledyne Philbrick TP1437 and TP1438 operational amplifiers offer a 40MHz bandwidth with a slew rate of up to 400V/ μ s. Both need only +200pA offset bias currents, offer 95dB open loop gain and +0.5mV offset voltages. A true differential input is designed to ensure a reliable performance whether used in inverting, non-inverting or differential configurations. 1437 has a guaranteed +20mA output and is packaged in a T099 can, while 1438 in a T08 package has a guaranteed +50mA output. Typical applications include current-to-voltage digital-to-analogue converters, pulse amplifiers, radar and sonar signal processing and video systems. Available from MCP Electronics Ltd, 38 Rosemont Road, Alperton, Wembley, Middlesex HA0 4PE. WW 217



PROGRAMMABLE MAINS SWITCH CAN SAVE ENERGY

A control system which uses mainsborne signalling, the Datapath, can switch up to 256 remote mains-powered appliances. The manufacturers see the main purpose of the system as switching heating and are therefore promoting it as an energy saver, though there are a number of other applications including the switching of security appliances and lighting. It can be used for controlling contactor or switchgear. The signals only provide for on-off controls but local, e.g. thermostat, control is possible for each remote site.

The control unit includes a microprocessor, a real-time calendar clock, and a transmitter for sending the f.s.k. signals into

the mains supply. Each receiver has a frequency comparison decoder.

The frequency band used is 110 to 125kHz which is suitable for continuous transmission. Each Datapath installation uses one central frequency and all 256 remote switches are controlled from a single channel. Accuracy is ensured by including a redundant data byte at the end of each message this is used as a check byte and prevents interruption or interference from any other source. The checking procedure introduces a delay which can be up to two seconds for switch-on or up to 30 seconds to switch-off. To prevent interference with neighbours, the signal is only 10mW, which

ensures that it will not pass the metering point of the premises.

The main advantage of the system is that it needs no additional wiring. The control unit may be plugged into any convenient socket and may be easily moved. Each receiver outstation is about the size of a double-gang socket and is easily installed. The control unit can be used in an immediate mode to switch on or off any remote station. It may also be programmed to switch at specific times during the day or on specific days; off at weekends, for example. A c.r.t. monitor displays the status of all the outstations and the programmed times. Programs may be easily written to suit any requirements and although the system is self-contained it may also be programmed from a host computer. The distance at which the system will operate is restricted by the proposed standard for mains signalling equipment. In practice this has not proved to be a limitation and the system has worked in many large installations.

Different applications require different configurations of the control unit but an installation with 50 control units should cost about £7 500, or for 100 units, £13 000. FDB Electrical Ltd, Reynard Mills Trading Estate, Windmill Road, Brentford, Middlesex. TW8 9NZ. WW 218

TEST PATTERN

Two new colour bar and pattern generators have been announced by Advid. The Unaohm EP690 is a bench instrument, intended for use by broadcasting stations, close circuit studios, laboratories, production test and service departments. It can produce colour bars, cross-hatch, chequer-board, staircase and other patterns, all of which are available as composite video or r.f. modulated signals. The signals may be output in a frequency range from 35 to 950 MHz. It costs £495.

The second instrument, Type GC981, is a small hand-held device for use by the service engineer in the field. It gives ten test patterns and colour bars as a modulated r.f. output in the

range 47 to 65MHz, 175 to 217 MHz and 470 to 860MHz. It comes complete with leather case, NiCd battery and a mains

adaptor/charger for £119.95. Advid Electronics, 17a Mill Lane, Welwyn, Herts AL6 9EU. WW 219



PEAK ENVELOPE POWER MEASURED FOR HAMS

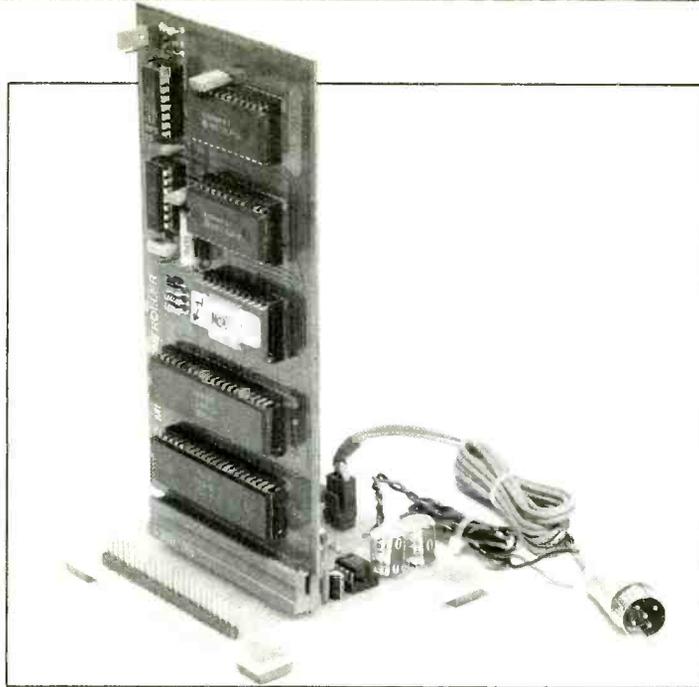
A module is produced which can be added to a forward power meter to convert it to read peak envelope.

The common s. w. r. meter or the in-line wattmeter can often give misleading readings when used with s. s. b. transmission. According to Amateur Accessories, the natural tendency of the operator is to increase the microphone gain or speak too close to the microphone in order to get some response from the meter. It is exactly these circumstances that the peak envelope reading is so valuable as it enables the user to operate within the correct parameters for the output stage.

The module consists of a p. c. b. with one integrated circuit and a number of discrete components. It has been adjusted for zero readings and then sealed. It comes with mounting hardware and may be fitted to an s. w. r. meter or an a. t. u. and needs no particular knowledge or skills to fit. When fitted the circuit is adjusted so that the meter gives the same reading as it did before fitting and the meter will behave exactly as before when used with continuous carrier modes. £12 from Amateur Accessories Ltd, Church Street, Glan Conwy, Colwyn Bay, Clwyd LL28 5LS. WW 205

FAST F.I.F.O.

For those seeking the speed of t. t. l. in spooler memories without the power consumption, they could look to the 67L401 from Monolithic Memories. The device has a maximum I_{cc} of 110mA, about 30% lower than the standard 67401. The memory is organised as a 64K by 4-bit structure and may be cascaded to any width or depth. Typical applications for these first-in, first-out memories are for print spoolers, disc controllers, communications buffers, modems etc. Monolithic Memories, Lynwood House, 1 Camp Road, Farnborough, Hants GU14 6EN. WW 206



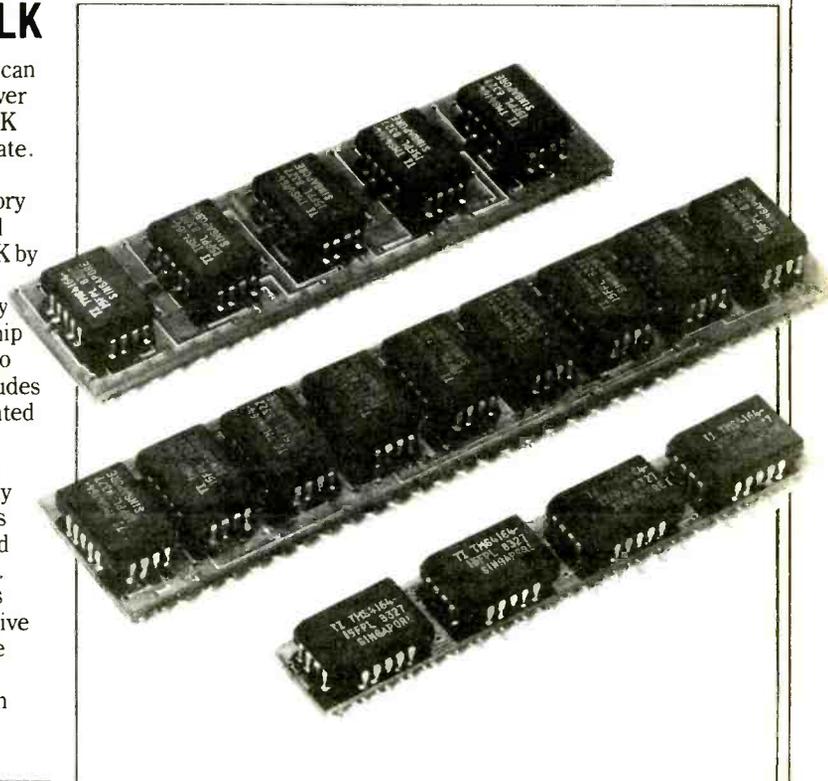
MICRO CONTROLLER

Built around the c. mos version of the 6502, a controller module may be programmed using a BBC computer. Programs are generated in assembly language on the BBC and then downloaded into the control board, where it may be stepped through or run. When development is complete, the program can be entered on an eeprom for normal operation. As c. mos is used throughout, the controller may be battery powered. Applications include robotics, machine controllers,

data loggers, automatic test equipment and any device requiring 'intelligent' control. The board may be purchased built and tested (£84.98) or as a bare board. The monitor eeprom may also be purchased separately and the technical manual supplied with the assembled circuit can be bought for £2.50. Nikam Electronics Ltd, 25 Suffolk Drive, Lacey Green, Wilmslow, cheshire SK9 4DE. WW 207

MEMORY IN BULK

High density memory arrays can be provided simply and at lower cost by combining several 64K ram i. cs on to a single substrate. Mounted in single-in-line packages, these Texas memory arrays are available in several configurations, including 64K by 4, 5, 8 or 9 bits. as well as a device organized as a 256K by one-bit memory. Leadless chip carriers are bonded directly to the substrate which also includes decoupling capacitors. Mounted vertically, the devices offer considerable saving in board space and in board complexity and assembly time. The rams require a single 5V supply and have an access time of 150ns. They are refreshed 256 times every 4ms and have a protective coating against alpha-particle intrusion, which can cause errors. Available from Jermyn Distribution, Vestry Estate, Sevenoaks, Kent. WW 208



CUSTOM POWER SUPPLIES

A small projects division set up by Grenson Electronics was able to win a large contract by designing and providing prototype switch-mode power supplies in five days. Although they cannot guarantee to be so fast every time, they say that they are geared up to the rapid design and construction of prototypes. They achieve this by separating this division from the main manufacturing of production units. Grenson Electronics Ltd, High March, Daventry, Northants NN11 4HQ. WW 209

TRANSIENT PROTECTORS

A range of power-line and data-line protectors incorporate TransZorb silicon junction transient suppressors. Mains-born transients can induce computer breakdowns and signal line interference may not be immediately detected but can cause downgrading of performance and may in the long term lead to damaged components. Hunter Electronic Components Ltd, Unit 3, Central Estate, Maidenhead, Berks. SL6 7BN. WW 210

COMPUTER WAREHOUSE

1000's OF BARGAINS FOR CALLERS

THE 'ALADDIN'S' CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT

HARD DISK DRIVES

Fully refurbished DIABLO/DRE Series 30 2.5 Mb disk drives
 DEC RK05, NOVA, TEXAS compatible.
 Front load. Free stand or rack mount £550.00
 Exchangeable type (via lid removal) £295.00
 me3029 PSU unit for 2 drives £125.00
 DIABLO/DRE 5H 4-4000A/B 5+5 ex stock from £995.00
 1000's of spares for S30, 4000, 3200, HAWK ex stock.
 Plus in house repair, refurbishing service.
 Call for details or quotation.

EX STOCK INTEGRATED CIRCUITS

D8085AH-2 D8086 D8257-5
 D8202 D8271 AM2764-3DC
 74LS86 74LS112 74LS373
 7407 2102-6 4116-3
CALL SALES OFFICE FOR PRICES

HOT LINE DATA BASE

DISTEL ©

THE ORIGINAL FREE OF CHARGE dial up data base
 1000's of stock items and one off bargains.
ON LINE NOW - 300 baud, full duplex CCITT tones. 8 bit word, no parity
01-679 1888

COMPUTER 'CAB'

All in one quality computer cabinet with integral switched mode PSU, Mains filtering, and twin fan cooling.
 Originally made for the famous DEC PDP8 computer system costing thousands of pounds. Made to run 24 hours per day the PSU is fully screened and will deliver a massive +5v DC at 17 amps, +15v DC at 1 amp and -15v DC at 5 amps. The complete unit is fully enclosed with removable top lid, filtering, trip switch, 'Power' and 'Run' LEDs mounted on All front panel, rear cable entries, etc. etc. Units are in good but used condition - supplied for 240v operation complete with full circuit and tech. man. Give your system that professional finish for only £49.95 + Carr. Dim: 19" wide 16" deep 10.5" high. Useable area 16" w 10.5" h 11.5" d.
 Also available **LESS PSU**, with FANS etc. Internal dim: 19" w 16" d 10.5" h. £19.95. Carriage & insurance £9.50.

COOLING FANS

Keep your hot parts COOL and RELIABLE with our range of BRAND NEW professional cooling fans.
 ETRI 99XUOI Dim 92 x 92 x 25 mm. Miniature 240 v equipment fan complete with finger guard. £9.95.
 GOULD JB-3AR Dim 3" x 3" x 2.5" compact very quiet running 240 v operation. NEW £6.95.
 BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00. **OUR PRICE ONLY £12.95 complete with data.**
 MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of other fans Ex Stock. Call for Details, Post & Packing on all fans £1.60.

SAVE £250

SUPER PRINTER SCOOP

BRAND NEW CENTRONICS 739-2



The 'Do Everything Printer' at a price that will NEVER be repeated. Standard CENTRONICS parallel interface for direct connection to BBC, ORIC, DRAGON etc. Superb print quality with full pin addressable graphics and 4 type fonts plus HIGH DEFINITION internal PROPORTIONAL SPACED MODE for WORD PROCESSOR applications. 80-132 columns, single sheet, sprocket or roll paper handling plus much more. Available ONLY from DISPLAY ELECTRONICS at the ridiculous price of **ONLY £199.00 + VAT** Complete with full manual etc. Limited quantity - Hurry while stocks last.
 Options: Interface cable (specify) for BBC, ORIC, DRAGON or CENTRONICS 36 way pig £12.50. Spare ribbon £3.00 each. BBC graphics screen dump utility program £8.50. Carriage and Ins. £10.00 + VAT.

ONLY £199

VIDEO MONITORS

5" CASED Superb little unit made by HITACHI in ergonomically designed free standing case. Very high definition will display small but readable 132 columns wide! 12v DC opp. @ 800 ma, so ideal for mobile use. Supplied in AS NEW condition complete with data. Composite 75 ohm vid in. Black & White CRT £45.00 or Green CRT £55.00. Carr & Ins £5.00.
 12" CASED. Made by the British KGM Co. Designed for continuous use as a data display station, unit is totally housed in an attractive brushed aluminium case with ON-OFF, BRIGHTNESS and CONTRAST controls mounted to one side. Much attention was given to construction and reliability of this unit with features such as, internal transformer isolated regulated DC supply, all components mounted on two fibre glass PCB boards - which hinge out for ease of service, many internal controls for linearity etc. The monitor accepts standard 75 ohm composite video signal via SO239 socket on rear panel. Bandwidth of the unit is estimated around 20 MHz and will display most high def graphics and 132 x 24 lines. Units are secondhand and may have screen burns. However where burns exist they are only apparent when monitor is switched off. Although unguaranteed all monitors are tested prior to despatch. Dimensions approx 14" high x 14" wide by 11" deep. Supplied complete with circuit 240 volt AC operation **ONLY £45.00 PLUS £9.50 CARR.**
 24" CASED. Again made by the KGM Co with a similar spec as the 12" monitor. Originally used for large screen data display. Very compact unit in lightweight alloy case dim 19" H x 17" D x 22" W. All silicon electronics and composite video input make an ideal unit for schools, clubs shops etc. Supplied in a used but working condition.
ONLY £55.00 PLUS £9.50 CARR & INS.

EPROM COPIERS

The amazing SOFTY 2. The 'Complete Toolkit' for writing, copying, modifying, and listing EPROMS of the 2516, 2716, 2532, 2732 range. Many other functions include integral keyboard, cassette interface, serial and parallel data i/o, UHF modulator.
 ONLY £169.00 + PP £2.50
NEW 'GANG OF EIGHT' intelligent Z80 controlled gang bang programmer for ALL single 5V rail EPROMS. Copies up to 8 27128 in 1 try. **ONLY 2 MINUTES!** Internal LCD display and checking routines for IDIOT PROOF operation. **ONLY £395.00 + PP £3.00**. Data sheets on request.

GE TERMIPRINTER

A massive purchase of these desk top printer-terminals enables us to offer you these quality 30 cps printers at a **SUPER LOW PRICE** against their original cost of over £1000. Unit comprises of full QWERTY electronic keyboard and printer mech with print face similar to correspondence quality typewriter. Variable forms tractor unit enables full width - up to 13.5" 120 column paper, upper - lower case, standard RS232 serial interface, internal vertical and horizontal tab settings, standard ribbon adjustable baud rates, quiet operation plus many other features. Supplied complete with manual. Guaranteed working **£130.00** or untested **£85.00**, optional floor stand £12.50. Carr & Ins £10.00.

TELETYPE ASR33 I/O TERMINALS

FROM £195 + CAR + VAT
 Fully fledged industry standard ASR33 data terminal. Many features including ASCII keyboard and printer for data I/O auto data detect circuitry RS232 serial interface. 110 baud, 8 bit paper tape punch and reader for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order.
 Options: Floor stand **£12.50 + VAT**
 KSR33 with 20ma loop interface **£125.00 + VAT**
 Sound proof enclosure **£25.00 + VAT**

PROFESSIONAL KEYBOARD OFFER

An advantageous purchase of brand new surplus allows a great QWERTY, full travel, chassis keyboard offer at fractions of their original costs.
ALPHAMERIC 7204/60 full ASCII 60 key, upper, lower + control key, parallel TTL output plus strobe. Dim 12" x 6" + 5 & -12 DC. **£39.50**.
DEC LA34 Uncoded keyboard with 67 quality, GOLD, normally open switches on standard X, Y matrix. Complete with 3 LED indicators & i/o cable - ideal micro conversions etc. pcb DIM 15" x 4.5" **£24.95**. Carriage on keyboards £3.00.

COLOUR MONITORS

NOVEX NC-1414-CL Fully cased brand new 14" colour monitor. Many exciting features such as RGB TTL and PAL composite video inputs, internal speaker and audio amp, "GREEN TEXT" switch for high def text applications and matching BBC colour scheme make this monitor ideal for the most exacting user. Brand new and Fully Guaranteed only **£199.00 + £10.00 carr.**

DATA MODEMS

Join the communications revolution with our range of EX TELECOM data modems. Made to most stringent spec and designed to operate for 24 hrs per day. Units are made to the CCITT tone spec. With RS232 i/o levels via a 25 way 'D' sct. Units are sold in a tested and working condition with data. Permission may be required for connection to PO lines.
MODEM 2B "Hackers Special" fully fledged up to 300 baud full duplex, ANSWER or CALL modes. **AUTO ANSWER**. Data i/o via standard RS232 25 way 'D' socket. Just 2 wire connection to comms line. Ideal networks etc. Complete with data, tested, ready to run at a **NEW SUPER LOW PRICE of ONLY £65.00 + VAT + Carr.**
MODEM 20-1 Compact unit for use with MICRONET, Prestel or TELECOM GOLD etc. 2 wire direct connect. 75 baud transmit 1200 baud receive. Data i/o via RS232 'D' socket. Guaranteed working with data **£49.95**
MODEM 20-2 same as 20-1 but 75 baud receive 1200 baud transmit **£130.00**
TRANSDATA 307A 300 baud acoustic coupler RS232 i/o **£95.00**

SUPER DEAL? NO - SUPER STEAL!!

The FABULOUS 25CPS TEC Starwriter

BRAND NEW AT ONLY £499 + VAT



Made to the very highest spec the TEC Starwriter FP1500-25 features a heavy duty die cast chassis and DIABLO type print mechanism giving superb registration and print quality. Micro-processor electronics offer full DIABLO/QUIME command compatibility and full control via CPM Wordstar etc.
 Many other features include bi-directional printing, switchable 10 or 12 pitch, full width 381 mm paper handling with upto 163 characters per line, friction feed rollers for single sheet or continuous paper, internal buffer, standard RS232 serial interface with handshake. Supplied absolutely BRAND NEW with 90 day guarantee and FREE daisy wheel and dust cover. Order NOW or contact sales office for more information.
 Optional extras: RS232 data cable £10.00. Tech manual £7.50. Tractor feed £140.00. Spare daisy wheel £3.00. Carriage & Ins (UK Mainland) £10.00.

Save over £400
 a fraction of its original cost.

SEMICONDUCTOR 'GRAB BAGS'

Mixed Semis amazing value contents include transistors, digital, linear, I.C.'s triacs, diodes, bridge recs, etc. All devices guaranteed brand new full spec, with manufacturer's markings, fully guaranteed.
 50+ £2.95 100+ £5.15.
 TTL 74 Series A gigantic purchase of an 'across the board' range of 74 TTL series I.C.'s enables us to offer 100+ mixed "mostly TTL" grab bags at a price which two or three chips in the bag would normally cost to buy. Fully guaranteed all I.C.'s full spec. 100+ £6.90 200+ £12.30 300+ £19.90

DEC CORNER

MOSTEK CRT 80E Brand new dual eurocard, 280 based VT100 PLUS emulator with graphics etc **£499.00**
BA11-MB 3.5" Box, PSU, LTC **£385.00**
DLV11-J 4 x EIA interface **£310.00**
RK05-J 2.5 Mb disk drives **£650.00**
PDP11 05C Cpu, Ram, i/o, etc. **£450.00**
RT11 ver. 3B doc kit **£70.00**
LA36 Decwriter EIA or 20 ma **£170.00**
KLBJA PDP 8 async i/o **£175.00**
MIB8 PDP 8 Bootstrap option **£75.00**
DILOG DQ100 RK05 LSI 4 x RK05 disk controller **£450.00**
MSC4804 (Equiv MSV11-L) 256k bytes ram card **£499.00**
LAX34-AL LA34 tractor feed **£85.00**
 1000's of EX STOCK spares for DEC PDP8 PDP11 PDP15 & peripherals. Call for details. All types of Computer equipment and spares wanted for prompt CASH PAYMENT

66% DISCOUNT

Due to our massive bulk purchasing programme which enables us to bring you the best possible bargains we have thousands of I.C.'s, Transistors, Relays, Caps, P.C.B.'s, Sub-assemblies, Switches, etc. etc. surplus to our requirements. Because we don't have sufficient stocks of any one item to include in our ads, we are packing all these items into the **'BARGAIN PARCEL OF A LIFETIME'**. Thousands of components at giveaway prices! Guaranteed to be worth at least 3 times what you pay. Unbeatable value!! Sold by weight.
 2.5kls **£4.25 + pp £1.25** 5kls **£5.90 + £1.80**
 10kls **£10.25 + pp £2.25** 20kls **£17.50 + £4.75**

ALL PRICES PLUS VAT

All prices quoted are for U.K. Mainland, paid cash with order in Pounds Sterling PLUS VAT. Minimum order value **£2.00**, Minimum Credit Card order **£10.00**. Minimum BONA FIDE account orders from Government depts, Schools, Universities and established companies **£20.00**. Where post and packing not indicated please add **£1.00 + VAT**. Warehouse open Mon-Fri 9.30 - 5.30. Sat. 10.15 - 5.30. We reserve the right to change prices and specifications without notice. Trade, Bulk and Export enquiries welcome.

32 Biggin Way, Upper Norwood, London SE19 3XF
 Telephone 01-679 4414 Telex 27924



CIRCLE 076 FOR FURTHER DETAILS.

MARCONI SIGNAL GENERATORS

TF2002A.S (illustrated) 10kHz-72MHz AM/FM £750
 TF2002. As above but AM only £450

MARCONI TF1066B. AM/FM Generator. 10-470MHz. 0.2uV-200mV output. FM Deviation up to ±100kHz

MARCONI TF995A.5. AM/FM Generator. Narrow deviation model 995 covering 1.5-220MHz. £450. TF2015 10-520MHz AM/FM. TF144H AM 10kHz-72MHz £295.

MARCONI TF1064B.5. AM/FM Signal generator covering in three ranges 66-108, 118-185 and 450-470MHz. FM fixed deviations of 3.5 & 10kHz. AM fixed 30%. £225

DOLBY NOISE WEIGHTING FILTERS

Cat. No. 98A. Noise weighting filters for CCIR/ARM signal-to-noise ratio measurements. As new units. £40 each (+£1 p&p).

BECKMAN TURNS COUNTER DIALS

Miniature type (22mm diam.). Counting up to 15 turn "Helipot". Brand new with mounting instructions. Only £2.50 each.

RFI RECEIVER

Stoddart Model NM52A. RF Noise & Field intensity measuring receiver. 375MHz-1GHz c/w power supply unit.

KAY SOUND SPECTROGRAPH

Model 6061B with Amplitude Display, scale magnifier. 85Hz-16kHz. Complete sound spectrograph in excellent condition.

STEPPER MOTORS

Brand new stock of 'ASTROSYN' Type 20PM-A055 stepper motors. 28V DC. 24 steps per rev. 15 oz-in torque @ 100PPS. Body length 2 1/2", diameter 2", shaft 1/2" diam x 4 1/4" spirally threaded. Weight 16oz. Price each £15 (p&p 50p). Connections supplied. INC. VAT.

MILLI-VOLT MEASUREMENT, ANALOGUE

MARCONI TF2600. Twelve ranges 1mV-300V FSD. Wide-band to 10MHz.

MARCONI TF2603. Frequency range 50kHz-1.5GHz. High Sensitivity from 300uV.

MARCONI TF2604. Electronic Multi-meter. AC/DC 300mV Full scale to 300V (1kV DC). Resistance ranged. AC Frequency range 20Hz-1500MHz.

CONSTANT VOLTAGE TRANSFORMERS

ADVANCE VOLTSTAT. Type Model MT140A. Mains input 190-260V AC. Output 230V AC @ 150W. Price each £20 + VAT + £2 carriage.

P. F. RALFE ELECTRONICS
 10 CHAPEL STREET, LONDON, NW1 TEL: 01-723 8753

OSCILLOSCOPES PLEASE PHONE FOR CURRENT STOCK

TEKTRONIX 453. Dual-trace 50MHz TELEQUIPMENT D75 Dual-trace 50MHz portable £450

HEWLETT-PACKARD 1707A Dual-trace 75MHz TRIO CS1575 5MHz Dual-trace £250

TEST EQUIPMENT

MARCONI TF1245 O-Meter
 MARCONI TF1313 1/4% LCR Bridge
 MARCONI TF868 LCR Bridge
 MARCONI TF2604 Electronic Multi-Meter
 MARCONI TF893A Audio Power Meters £85

MARCONI TF2502 RF Power Meters. DC-1GHz. 10w fsd £350.

MARCONI TF2701 In-Situ Universal Component Bridge £250.

HEWLETT-PACKARD 3450A Multi-Function Digital Multi-Meter.

ROHDE & SCHWARZ 'SDR' AM Signal Generator 0.3-1GHz

TEKTRONIX 2901 Time-mark Generator.

ROHDE & SCHWARZ Resonance Frequency Meter 470MHz-2.5GHz.

ROHDE & SCHWARZ Polyscop SWOB II.

METROHM 500V Insulation Testers Transistorised £40 pp £1.50.

BRUEL & KJAER Heterodyne Voltmeter 0.5-240MHz.

AIRMEC Display Oscilloscope 279, 4-trace, 14x10" CRT £195.

RIKADENKI 3-channel Chart Recorder, Model B-341.

AVO SIGNAL GENERATORS AFM2

We have in stock a quantity of AVO type AFM2 signal generators supplied in fully tested working condition complete with accessories. Spec as follows: 45MHz-225MHz in 8 bands. AM all bands plus FM on two bands covering 20-100MHz. Output 1uV-50mV and 200mV High O/P setting, m/c set level meter, scale shift for accurate frequency calibration, variable mod etc. PRICE EACH JUST £55 - VAT Carriage each + £4

SWEEPERS

TELEONIC 2003 System. 800-1500MHz £325

TELEONIC SM2000 with 500-900MHz plug-in £175

TELEONIC SM2000 with 0-10MHz plug-in £150

TEKTRONIX

FILE MANAGER SYSTEM MODEL 4907 Option 31 (Third disc drive), 4051 Graphic System compatible. GPIB (IEEE 488-1975) compatible.

PLEASE NOTE. 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 a three months' guarantee. For our mail order customers we have a money-back scheme. Repairs and servicing to all equipment at very reasonable rates. PLEASE ADD 15% VAT TO ALL PRICES.

COMPUTER PERIPHERALS

1.6MB 8" FLOPPY DISC DRIVES - New Stock

After our recent sell-out of the DRE7100 FDDs, we are pleased to offer another bargain package as follows: BRAND NEW AMERICAN 'MFE Corp' model M-700 DOUBLE-SIDED 8" Disc Drives. Massive storage capability up to 1.6MBytes. Full IBM compatibility. External power requirements are ±5V at 1.2A and +24V at 1.1A. Full spares/back-up available U.K. (Elcomatic's). Current list is over £315. OUR PRICE JUST £175 + VAT (including full manual worth £15). DELIVERY (48Hrs) + £10 + VAT.

4000-SERIES HARD DISK DRIVES

Data Recording Equipment 4000-Series exchangeable IBM-type 5440 Disks. Units available ex-stock and BRAND NEW. Please call us for our lowest ever quotation.

DISK CARTRIDGES

Surplus BASF 12-Sector RK05 cartridges available in small quantity only remaining at £15 each. Carriage each £1.50.

SWITCHING POWER SUPPLIES

The following DC power supplies are available now from stock in limited quantities. All fully tested and guaranteed.

3.5V SOLD OUT	£15	5V @ 10 Amps	£15
5V @ 20 Amps	£20	5V @ 40 Amps	£30
5V @ 60 Amps	£40	19V @ 30 Amps	£40
-15V @ 12V & -5V @ 11A, 4A and 40A	£50		

All prices + VAT please. Carriage + £2 each

CENTRIFUGAL BLOWERS

'TORIN' Type U62B1. 230V Cap Start (supplied), very powerful (200W, 3,000rpm) centrifugal fans for large rack cooling or enclosure extraction applications. Overall dimensions 20x12 cms, outlet 6x4 cms. BRAND NEW. Surplus stock. £15 each inc. VAT, pp £1.50.

ROTRON INSTRUMENT COOLING FANS

Supplied in fully tested excellent condition, as follows:

- 115V, 4 1/2 x 4 1/2 x 1 1/2" £5. 230V same size £5.50.
- 115V 3 x 3 x 1 1/2" £4. 230V 3" size, brand new £6. Also small quantity 115V 4 1/2" size, brand new £6. Postage each - 50p please.

CIRCLE 075 FOR FURTHER DETAILS.

BERG LOW-PROFILE 14-PIN DUAL IN-LINE I.C. SOCKET, manufactured from glass-filled polyester to UL94V-0. £7 for 100, £31 for 500, £56 for 1,000, £256 for 5,000, £460 for 10,000, £2,100 for 50,000, £3,700 for 100,000. Sample 10 sent for £1.20 + 30p P&P (£1.37 inc. V.A.T.).

BERG LOW-PROFILE 16-PIN DUAL IN-LINE I.C. SOCKET as above, £8 for 100, £36 for 500, £65 for 1,000, £295 for 5,000, £350 for 10,000, £2,390 for 50,000, £4,300 for 100,000. Sample 10 sent for £1.40 + 30p P&P (£1.96 inc. V.A.T.).

WIRE CUTTER AND STRIPPER TEMPERED STEEL BLADES, spring loaded with moulded red p.v.c. handles. Cutting and stripping adjustable up to 6mm². Overall length 135mm, weight 64gms. 10 for £15, 25 for £34, 50 for £63, 100 for £116, 500 for £525, 1,000 for £1,000. Sample pair sent for £1.75 + 25p P&P (£2.60 inc. V.A.T.).

HIGH-POWER SILICON BRIDGE RECTIFIERS, 25 amp 600v. Single-hole fixing 250 (1/4 in.), push-on connector terminals, manufactured by IR. £20 for 10, £90 for 50, £175 for 100, £800 for 500, £1,450 for 1,000. Special quotation for larger quantities. Sample sent for £2.50 + 25p P&P (£3.16 inc. V.A.T.).

METAL FILM RESISTORS FZ4. Manufactured by C. G. S. Semi-precision with a standard tolerance of ±2% and a temperature coefficient of better than 100 ppm/°C. We have a full range in stock from 100R to 1MΩ. All banded. £2.50 for 1,000 any one value.

WIRE WOUND RESISTORS. Manufactured by E. R. G. Type 16 ES with a standard tolerance ±5% of nominal resistance value. All values in stock. 3-watt Series £3.50 per 100 any one value, + £1 P&P (£4.83 inc. V.A.T.). 6-watt Series £6.50 per 100 any one value, + £1 P&P (£8.63 inc. V.A.T.). 10-watt Series £10.50 per any one value + £1 P&P (£13.23 inc. V.A.T.).

BRITISH-MADE TRANSFORMERS. Input 240v at 50Hz, output 12v-0-12v, 1/2 amp with built-in thermal overload cutout. P.C. mounting £25 for 10 + V.A.T., £115 for 50 + V.A.T., £210 for 100 + V.A.T., £950 for 500 + V.A.T., £1,700 for 1,000 + V.A.T. Sample sent for £3 + 75p P&P (£4.31 inc. V.A.T.).

LESLIE TREMOLO SPEAKER SYSTEM. A two-speed rotating baffle system which when used as part of an organ, hi-fi or disco system produces the famous Leslie effect. The unit comes complete with a 50-watt 8 ohms speaker at peak output, two 220/240v 50Hz motors with central drive to rotating horn/baffle. This gives a three way sound effect, i.e. normal tremolo sound when stationary, wraparound sound when revolving at 1 rev. per sec. and supersound at 7 rev. per sec. Baffle size 485mm x 395mm. Overall depth from speaker magnet to central boss of rotating horn/baffle 300mm approx. £200 for 5, £360 for 10, £825 for 25, £1,500 for 50, £2,700 for 100. Sample sent for £45 + £5 P&P (£57.50 inc. V.A.T.).

TWIN KEYBOARD AND FRAME. Two 44-note 'F' to 'C' keyboards mounted on a metal frame hinged for easy adjustment. Keyboards offset by one octave with keyboard separator giving simulator wood effect, clipped between the two keyboards. Manufactured overall dimensions: width 1,027mm, height 131mm, front and back 361mm, keyboard separator approx 1,094mm. £202.50 for 5, £372.50 for 10, £838.35 for 25, £1,545.35 for 50. Sample sent £45 + £4 P&P (£56.35 inc. V.A.T.).

ORGAN PEDALBOARD. A high quality 13-note 'C' to 'C' pedalboard. Notes are manufactured in a hard-wearing plastic covering steel levers. Contact switch fitted to each pedal unit. 380mm x 250mm. £108 for 5, £198 for 10, £822 for 50, £1,513 for 100. Sample sent for £24 + £4 P&P (£32.50 inc. V.A.T.).

SWELL PEDAL incorporating the latest technology. Volume controlled by photoelectric cell. Designed to be mounted in a console. Detachable metal mounting plate with roller stop for easy installation. Size 250mm x 120mm, matt-black finish, £56.25 for 5, £103.50 for 10, £238 for 25, £428.20 for 50, £788 for 100. Sample sent £12.50 + £4 P&P (£18.98 inc. V.A.T.).

TERMS C.W.O. Please add 5% to all orders for carriage by 15% V.A.T. Export enquiries welcome. We find it impossible to advertise all our stock. Please telephone or write for further enquiries. Personal calls always welcome.

ELECTRONIC EQUIPMENT Co. SPRINGFIELD HOUSE
 TYSSEN STREET, LONDON, E 8
 TELEPHONE: 01-249 5217
 TELEX: 9853906 EECO.G

CIRCLE 083 FOR FURTHER DETAILS.

AC/DC Electronic Components

BIG VALUE RESISTOR PACKS

1/4 Watt Carbon Film 1r-10mg 10/Values 720 Resistors	£5.00
1/4 Watt Metal Film 1% 50ppm 10r-1mg E24 Range 960 Resistors	£25.00

Mfrs	Device	Price
ITT	937 50 DTL GATE CER	£0.20
ISKRA	47pf 160V Polystyrene per 200	£2.00
T CSF	470pf 50V DISC CER per 1,000	£10.00
ITT	3300pf 500V DISC CER per 1,000	£10.00
MUL	344 0.022mf 400V Polyester per 250	£5.00
	0.01mf 400V Polyester Ax per 100	£2.50
PLESSEY	0.47mf 250V 'X' Radial Poly each	£0.25
	10mf 25V Bead Tant per 100	£10.00
LORLIN	10000mf 40V Comp Grade each	£2.00

FREE CATALOGUE
 Sent to every customer

Terms: C.W.O. + 75p p&p

Dept. WW, 45 Church Street, Enfield, Middlesex

CIRCLE 060 FOR FURTHER DETAILS.

VIDEO TERMINAL BOARD

★ 80 characters × 24 lines ★

Requires ASCII encoded keyboard and monitor to make fully configurable intelligent terminal. Uses 6802 micro and 6845 controller. Program and character generator (7 × 9 matrix with descenders) in two 2716 EPROMs. Full scrolling at 9600 baud with 8 switch selectable rates. RS232 interface.

Bare board with 2 EPROMs and program listing — £48 plus VAT. Send for details or CWO to:

A M Electronics
 Wood Farm, Leiston, Suffolk IP16 4HT
 Tel: 0728 831131

CIRCLE 082 FOR FURTHER DETAILS.

JPR ELECTRONICS

NEW WHOLESALE PRICE LIST AND CATALOGUE NOW AVAILABLE

HUNDREDS OF COMPONENT LINES AT COMPETITIVE PRICES AVAILABLE FROM STOCK —

CAPACITORS — RESISTORS — PRESETS — CERMETS — RELAYS — BUZZERS — NI. CAD BATTERIES — DIODES — BATTERY HOLDERS
EDGE CONNECTORS — MINIATURE SWITCHES — 7 SEGMENT DISPLAYS — POWER SUPPLIES — MAINS FILTERS — IDC CONNECTORS
FUSEHOLDERS — INVERTERS — A.B.S. BOXES — MOTORS — SPEAKERS — WIREWOUNDS — CABLES — TRANSFORMERS
D CONNECTORS — TRANSISTORS — FERRITES AND MUCH MORE

WRITE OR TELEPHONE NOW FOR A FREE CATALOGUE — TRADE ONLY
JPR ELECTRONICS, UNIT M KINGSWAY INDUSTRIAL ESTATE, LUTON LU1 1LP
TELEPHONE: LUTON (0582)410055 TELEX: 925859 JPR

CIRCLE 059 FOR FURTHER DETAILS.

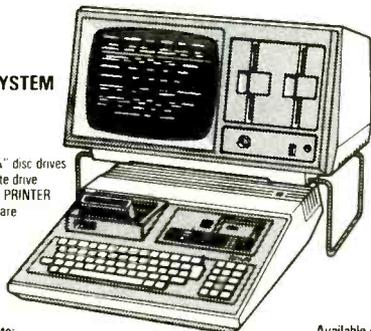
Brand NEW & EX DEMO surplus BARGAINS!

PHILIPS P2000 SYSTEM

comprising:

- Z80 based processor
- 24 x 80 green display
- Twin double density 5 1/4" disc drives
- Built in DIGITAL cassette drive
- 25 c.p.s. DAISY WHEEL PRINTER
- Word Processing software

£ 995.00



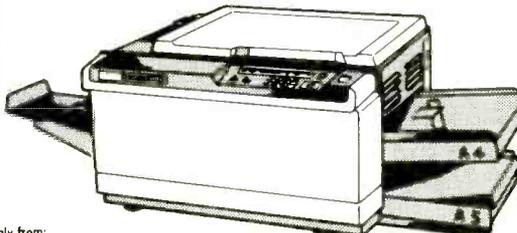
Please Note:

- All prices are ex VAT & carriage
- We have some ex demonstration machines available, please enquire for details & prices

SELEX Model 75SC COPIER

- Plain paper office copier with dry single component toner
- 12 copies per minute
- No warm up time
- Microprocessor controlled with keyboard entry

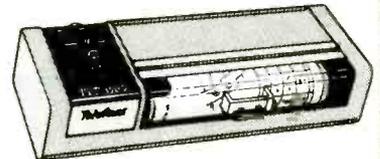
£ 395.00



Available only from:

COMPUTER APPRECIATION, 16 Walton Street, Oxford OX1 2HQ, Oxford (0865) 55163

AUTOTYPE, 1 Church Street, Cuckfield, Haywards Heath, W. Sussex, RH17 5JZ, Haywards Heath (0444) 414484 & 454377



ITT Model 3510 TELEFAX

- Group 2 facsimile transceiver for sending reproductions of documents over a phone line in two minutes
- Modern, compact, microprocessor controlled machine
- Price includes 200 sheets of TELEFAX paper and a cover for the machine

£ 350.00

CIRCLE 052 FOR FURTHER DETAILS.



LINSLEY-HOOD 300 SERIES AMPLIFIERS



30 Watt Complete Kit.....	£72
35 Watt Complete Kit, MosFet O/P.....	£79.50
45 Watt Complete Kit, MosFet O/P.....	£83.50
Reprints of 30 Watt Article from 'Hi-Fi News'.....	50p
Reprints of MosFet Postscript to above.....	30p

LINSLEY-HOOD 100-WATT MOSFET POWER AMPLIFIER

The very latest amplifier design, published in 'Wireless World' by the renowned John Linsley-Hood. This may now be taken as the standard by which the rest are judged! Our kit, approved by the designer, has massive heat sinks and power supply and includes all components needed to build. Case size 412mm wide, 254mm deep and 145mm high. Automatic switched speaker protection is included as standard. Cost of all parts is over £120. Our complete stereo kit price £105.50.

SOLENOID CONTROLLED HI FI/DIGITAL CASSETTE MECHANISM



Front loading deck with full solenoid control of all functions including optional read in fast wind modes, 12 volt operation. Fitted 3-digit memory counter and Hall IC Motion Sensor. Standard erase and stereo R/P Heads. Cheapest price ever for all these features. Only £38.90 plus VAT. Full technical specification included.

THIS MONTH'S SPECIAL OFFERS

HIGH-SPEED DIGITAL CASSETTE RECORDER

A really super buy for the computer enthusiast. These decks, made by Burroughs, use a capstanless cassette mechanism to record and replay data at 10 and 30 inches per second. The read after write head uses an NRZ system with separate tracks for clock and data. Power supplies of 5v, -12v and +12v are required. Front panel is 137mm square and the unit is 200mm deep including rear connector. Offered in good ex-equipment condition at a fraction of original cost, ONLY £44.50 inc. VAT and postage. Data inc. circuits and layouts of PCBs £3.50.

DOLBY 'B' NOISE REDUCTION IC LM1011

Marvelous opportunity for home experimenters, build your own noise reduction system. Supplied complete with circuit showing typical application. Absolute knockout price only £3.50 for two inc. VAT and post.

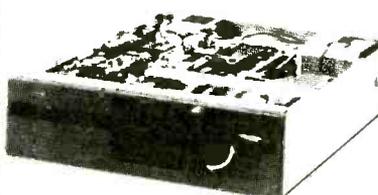
COMPLETE STEREO CASSETTE DECK

Brand new high quality top-loading Cassette Deck complete with Record/Play electronics. Supplied with connection data and circuit diagram. Automatic chrome/feric switching. Only needs 9v DC supply. Total price only £18.34 inc. VAT and post.

COMPLETE STEREO TUNER MODULE

Three band LW/MW/FM Stereo Tuner fully assembled on PCB 165 x 85mm. Supplied with Ferrite rod aerial and band switch fully wired. Facility provided to drive tuning meter and stereo LED. Only needs 12v DC supply. FM sensitivity: 2.5uV. Price only £7.99 inc. VAT and post.

HALF HEIGHT 5 1/4" FLOPPY DISK



Latest MPU controlled 80 Track Drives, support single or double density. Fully compatible with Teac, Shugart and many other full and half height drives

80 Track Single side.....	£179
80 Track Double side.....	£225

Full manual for each type £14.50 No VAT

HIGH QUALITY REPLACEMENT CASSETTE HEADS



Do your tapes lack treble? A worn head could be the problem. Fitting one of our replacement heads could restore performance to better than new! Standard mountings make fitting easy and our TC1 Test Cassette helps you set the azimuth spot-on. We are the actual importers which means you get the benefit of lower prices for prime parts. Compare us with other suppliers and see! The following is a list of our most popular heads, all are suitable for use on Dolby machines and are ex-stock.

HC20 Permalloy Stereo Head. This is the standard head fitted as original equipment on most decks.....	£5.11
HM90 High Beta Permalloy Head. A hard-wearing, higher performance head with metal capability.....	£8.06
HS16 Sendust Alloy Super Head, the best head we can find. Longer life than Permalloy, higher output than Ferrite, fantastic frequency response.....	£9.91
HQ551 4-Track Head for auto-reverse or quadrophonic use. Full specification record and playback head.....	£9.73

Please consult our list for technical data on these and other Special Purpose Heads.

HART TRIPLE-PURPOSE TEST CASSETTE TC1

One inexpensive test cassette enables you to set up VU level, head azimuth and tape speed. Invaluable when fitting new heads. Only £4.66 plus VAT and 50p postage.

Tape Head De-magnetiser. Handy size mains operated unit prevents build up of residual head magnetisation causing noise on playback.....
 £4.54 |

Curved Pole Type for inaccessible heads.....
 £4.85 |

COMPONENTS

We now list a wide range of individual components many of which are not available elsewhere. Send for your copy of our latest list which also gives further information on our Kits.

Please add part cost of post, packing and insurance as follows:

INLAND	OVERSEAS
Orders up to £10 — 50p	Please send sufficient to cover
Orders £10 to £49 — £1	Surface or Air Post as required
Orders over £50 — £1.50	

ALL PRICES EXCLUDE VAT
UNLESS STATED

Personal callers are always very welcome but please note that we are closed all day Saturday

(0691) 652894

HART
HART ELECTRONIC KITS LTD
PENYLAN MILL
OSWESTRY, SHROPSHIRE
SY10 9AF

BBC Micro Computer System OFFICIAL DEALER

Please phone for availability



Software from ACORNSOFT/
PROGRAM POWER/GEMINI in
stock

BBC Model B£348
B + Econet £389
B + DFS £429
B + DFS + Econet £470
Carriage £7

Model A to Model B
Upgrade Kit £95
Installation £15

LANGUAGE ROMs
BCPL ROM + Disc +
Manual £87

UTILITY ROMs
BBC Ultracalc £65 Toolkit £20
EXMON £20; DISC DOCTOR
£30; FX Dump £15; Graphics
ROM £28; Termi ROM £29

FLOPPY DISC INTERFACE £84 & £15 installation

BBC COMPATIBLE DISC DRIVES

These drives are supplied with manual, form disc and cables.

Single Drive: 100k £140 200k £175* 400k £195.
Single Drive with PSU: 100k £165 200k £210 400k £221
Dual Drive with PSU: 2 x 100k £320 2 x 200k £400*;
2 x 400k £420

*These drives are switchable between 40/80 tracks.
40/80 Switch Module for 1 x 400k and 2 x 400k Drive
£32.

DISKETTES: In packs of 10. W = Wabash, M = 3M
40T SSSD, W: £14 M: £16 ; 40T DSDD M: £22
80T SSSD, W: £24, M: £26; 80T DSDD, W: £26, M: £30
Carriage £2/box.

FLOPPICLENE Drive Head Cleaning Kit £14.50

Phone or send for our BBC leaflet

CASSETTE RECORDERS

SANYO DR101 Data Recorder £34 + £2.50 car-
riage.
BBC Tape Recorder £28.50 + £2.50 carriage
Cassette Lead £3 + £1 carriage
HOBBIT Floppy Tale £135 + £2.50 carriage
HOBBIT Zero Memory Option £25 + £1 car-
riage.
Computer Grade C12 cassette 50p each. £4.50
for 10 £1 carriage

MONITORS

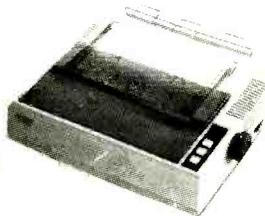
MICROVITEC 1431P 14" RGB/PAL Std Res £249
MICROVITEC 1451 14" RGB Med Res £299
MICROVITEC 1441 14" RGB Hi Res £420
MICROVITEC 2031 20" RGB Std Res £287
KAGA VISION 12" RGB Std Res £230
KAGA VISION II 12" RGB Hi Res £260
KAGA VISION III 12" RGB Super Hi Res £358
KAGA 12" GREEN Hi Res £106
SANYO DM8112CX 12" Green Hi Res £99
All leads included. Carriage £7

TORCH Z80 DISC PACK

Your BBC computer can be converted into a business machine with the addition of a TORCH Z80 disc pack. The Torch pack with twin disc drive and the Z80 processor card greatly enhances the computer's data storage and processing capability. Z80 card comes complete with 64K RAM and a CP/M compatible operating system. In addition to BBC owner's user guide and a systems disc the package is supplied with PERFECT software package comprising of DATABASE, WORD PROCESSOR & SPREAD SHEET. Complete Package for £730 + £8 carr.

PRINTERS & PLOTTERS

EPSON FX80 £350
EPSON RX80 FT £250
EPSON FX-100 £450
SEIKOSHA GP 100A £160
JUKI 6100 Daisy Wheel £350
MCP 40 Col Printer/Plotter £120
Colour Graphics Plotter A3 size £270
GRAFPAD Graphics Tablet £125
Carriage £7



ACCESSORIES

Parallel Printer Lead £10 + £1 carriage
Serial Printer Lead £8 + £1 carriage
Epson Serial Interface 2K £60 + £1 carriage
Epson Serial Interface £50 + £1 carriage
NEC Serial Interface £42 + £1.50 carriage
Epson Paper Roll Holder £17 + £1.50 car-
riage
FX80 Tractor Attachment £37 + £1.50 car-
riage
Paper Fanfold 2000 sheets £13.50 + £2.50
carriage

'TIME-WARP'

BBC REAL-TIME-CLOCK/CALENDAR

A low cost unit that opens up the total range of Real-Time applications. With its full battery backup, possibilities include an Electronic Diary, automatic document dating, precise timing and control in scientific applications, recreational use in games, etc - its uses are endless and are simply limited by one's imagination. Simply plugs into the user port - no specialist installation required - No ROMS. Supplied with extensive applications software. £29.

BBC EPROM PROGRAMMER

A fully self-contained Eprom Programmer with its own power supply, able to program 2516, 2716/32/32A/64/128 single rail Eproms.
★ Personality selection is simplified by a single rotary switch.
★ Programming voltage selector switch is provided with a safe position.
★ Warning indicator to show programming in progress.
★ Programmer can read, blank check, program and verify at any address/addresses on the EPROM.
★ Simple menu driven software supplied on cassette (transferable to disc).
★ Full editor with ASCII disassembler.
Programmer complete with cables, software and operating instructions: £89 - £2 p&p

BOOKS (no VAT; p&p £1)

Advanced User Guide (£2 p & p) £12.95
Assembly Lang Prog. for BBC £8.95
Assembly Lang programming on BBC
Micro by Ferguson and Shaw..... £7.95
Basic Prog. for BBC..... £5.95
BBC An Expert Guide..... £6.95
Easy Programming on BBC..... £5.95
Further Programming on BBC..... £5.95
Introducing BBC Micro..... £5.95
Programming the BBC..... £6.50
30 Hour Basic..... £5.95
35 Educational Programs..... £6.95
BBC Sound & Graphics..... £7.95
Creating Adventure Programs..... £6.95
Discovering Machine Code..... £6.95
Structured Programming..... £6.50
The Friendly Computer Book BBC..... £4.50
Beyond Basic BBC..... £7.25

Large number of other titles stocked

EPROM ERASERS

UV1T Eraser with a built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays. It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. £59 + £2 p&p.
UV1 as above but without the timer £47 + £2 p&p.
UV140 up to 14 Eproms £61.
UV141 as above but with timer £79.

PRODUCTION PROGRAMMER: P8000

P8000 provides reliable gang programming of up to 8 EPROMS simultaneously with device sizes up to 16k x 8 bytes. Devices supported range from 2704 to 27128 in single and three rail versions. Simple menu driven operation ensures easy eprom selection and reliable programming in minimum programming times. £695 + £6 carriage.

★★ ATTENTION ★★

All prices in this double page spread are subject to change without notice.

ACORN IEEE INTERFACE

This IEEE 488 standard interface is a general purpose system for exchanging digital data between a number of devices in a local area. The interface complies with the IEC 625-1 standard and can be connected to up to 14 other devices. Interface board is supplied complete with software in ROM, interconnecting cables, IEEE cable for connection to an external device and a comprehensive manual. £282.50 + £2.50 carr.

SMARTMOUTH

SPEECH SYNTHESISER FOR BBC

The 'infinite vocabulary' self-contained speech synthesiser unit. Uses only 5-10 bytes per word - no ROMs required - simply plugs into the user port. (Has Aux. Audio output skt.) Supplied with Demo/Development programs and simple software instructions. £37 + £2 p. & p.

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

No of ways	Header Plug	Receptacle	Edge Conn.
10	90p	85p	120p
20	145p	125p	195p
26	175p	150p	240p
34	200p	160p	320p
40	220p	190p	340p
50	235p	200p	390p

D CONNECTORS

No. of ways

	9	15	25	37
MALE				
Solder	80p	105p	160p	250p
Angled	150p	210p	250p	365p
FEMALE				
Solder	105p	160p	200p	335p
Angled	165p	215p	290p	440p
Headers	30p	85p	30p	100p
IDC 15 way plug	340p	Socket	400p	
IDC 25 way plug	385p	Socket	450p	

TEXT TOOL ZIF

SOCKETS	24-pin £5.75
	28-pin £8.00
	40-pin £9.75

DIL SWITCHES

4 way	70p	8-way	130p
6 way	100p	10-way	150p

JUMPER LEADS

24" Ribbon Cable with Headers

	14-pin	16-pin	24-pin	40-pin
1 end	145p	165p	240p	350p
2 ends	210p	230p	345p	540p

24" Ribbon Cable with Sockets

	20-pin	26-pin	34-pin	40-pin
1 end	160p	200p	280p	300p
2 ends	290p	370p	480p	525p

Ribbon Cable with D Conn

25-way Male	500p	Female	550p
-------------	------	--------	------

RS 232 JUMPERS

(25 way D)

24" Single end Male	£5.00
24" Single end Female	£5.25
24" Female:Female	£10.00
24" Male:Male	£9.50
24" Male:Female	£9.50

DIL HEADERS

	Solder Type	IDC Type
14-pin	40p	100p
16-pin	50p	110p
24-pin	100p	150p
40-pin	200p	225p

AMPHENOL CONNECTORS

	Solder	IDC
36-way plug Centronics	£5.25	£5.25
36-way socket Centronics	£5.50	£5.50
24-way plug IEEE	£5.00	£4.75
24-way socket IEEE	£5.00	£4.75
PCB Mtg Skt Ang pin		
24-way £6.00.	36-way	£6.50

EURO CONNECTORS

DIN 41617	Plug	Skt
21-way	160p	165p
31-way	170p	170p
DIN 41612		
2x32-way St. Pin	230p	275p
2x32-way Ang. Pin	275p	320p
3x32-way St. Pin	260p	300p
3x32-way Ang. Pin	375p	400p
1 DC Skt A - B 275p A - C 350p		
for 2 x 32-way please specify spacing (A, B, A - C)		

TEST CLIPS

14-pin	375p	16-pin	400p
40-pin	£10.30		

RIBBON CABLE

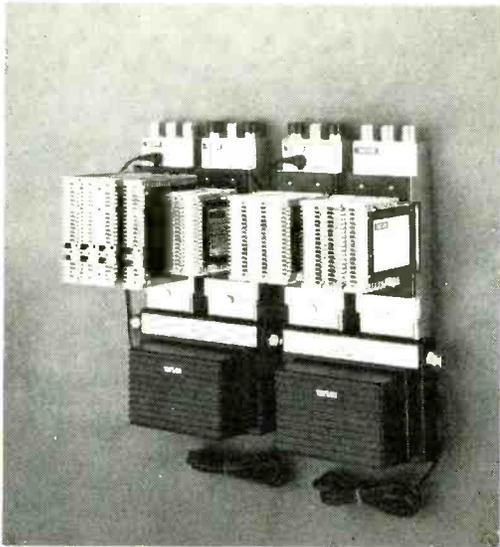
	(Grey/meter)
10-way	40p
16-way	60p
20-way	85p
26-way	120p
34-way	160p
40-way	180p
50-way	200p
64-way	280p

EDGE CONNECTORS

	0.1	0.156"
2x6-way (Commodore)		300p
2x10-way (Commodore)		
2x12-way (Vic 20)	150	
2x18-way		350p
2x23-way (ZX81)		140p
2x25-way		175p
2x28-way (Spectrum)		225p
2x36-way		200p
1x43-way		250p
2x22-way		260p
2x22-way		190p
2x43-way		395p
1x77-way		400p
2x50-way (S100conn)		600p

NEW COMPREHENSIVE CATALOGUE AVAILABLE - PLEASE SEND FOR PRICE LIST

CABLE T.V. HEAD END AND REPEATER AMPLIFIERS



CHANNEL CONVERTERS

- TCUU UHF-UHF Single channel converter Gain adjustable +2dB -16dB Maximum output +26dBmV Crystal controlled oscillator Power requirement 14V 25mA. (Quote Channels required).
 TCUV As TCUU except UHF to VHF converter. (Quote Channels required).
 TCV As TCUU except VHF to UHF converter. (Quote Channels required).

SINGLE CHANNEL AUTOMATIC GAIN CONTROL AMPLIFIERS

- TAG4863 Gain 48dB, maximum output 63dBmV Regulator + or - 8dB. Power requirement 14V 210mA.
 TAG4063 Gain 40dB, maximum output 64dBmV Regulator + or - 16dB. Power requirement 14V 210mA.

SINGLE CHANNEL AMPLIFIERS

- TSS4663 Gain 28-46dB adjustable. Maximum output 63dBmV Power requirement 14V 170mA.
 TSS3062 Gain 12-30dB adjustable. Maximum output 62dBmV Power requirement 14V 26mA.

DRIVER AMPLIFIERS

- TS1030FM FM driver amplifier. 10dB Gain. Maximum output 30dBmV. Power requirement 14V 10mA.
 TS1030B3 Band III driver amplifier. 10dB gain. Maximum output 30dBmV. Power requirement 14V 10mA.
 TS1030UHF UHF driver amplifier. 10dB gain. Maximum output 30dBmV. Power requirement 14V 10mA.
 TS1040S Single channel UHF driver amplifier. 10dB gain. Maximum output 40dBmV. Power requirement 14V 10mA. (Quote channel required).

DISTRIBUTION AMPLIFIERS

- TE2042 Domestic distribution amplifier. 1 input, 1 output. Gain 20dB Maximum output 42dBmV.
 TE1638 Domestic distribution amplifier. 1 input, 2 outputs. Gain 16dB Maximum output 2 at 38dBmV.
 TS2046 40-860MHz Gain 20dB UHF, 18dB VHF. Maximum output 46dBmV.
 TS2846 40-860MHz Gain 28dB UHF, 22dB VHF. Maximum output 46dBmV.
 TS2845 Separate UHF/UHF inputs. Gain 28dB UHF, 22dB VHF. Maximum output 46dBmV.
 TS2054 40-860MHz Gain 20dB UHF, 18dB VHF. Maximum output 54dBmV.
 TS2060 40-860MHz Gain 20dB UHF, 18dB VHF. Maximum output 60dBmV.
 TS5565 Gain 55dB UHF, 55dB VHF, 42dB FM. Maximum output 65dBmV.

REPEATER AMPLIFIERS

- TSC3660 Repeater. Gain 16-36dB UHF, 10-30dB VHF. Maximum output 60dBmV.
 TSC3665 Repeater. Gain 16-36dB UHF, 10-30dB VHF. Maximum output 65dBmV.
 TSC3060 Repeater. Gain 10-30dB VHF. Maximum output 60dBmV.

QUALITY AT LOW COST

TAYLOR BROS (OLDHAM) LTD

LEE STREET, OLDHAM - TEL. 061-652 3221 - TELEX 669911

CIRCLE 081 FOR FURTHER DETAILS.

TEST EQUIPMENT

1. Marconi TF2002B AM/FM Signal Generator with TF2170 Synchroniser £695
2. Tektronix 106 Fast Rise Pulse Generator £95
3. Tektronix 191 Constant Amplitude Generator £115
4. Tektronix T922R rack mounted dual channel 15MHz oscilloscope £375
5. Tektronix 2901 Time-Mark Generator £135
6. Tektronix 184 Time-Mark Generator £115
7. Tektronix MR501 X-Y Monitor for TM500 system £165
8. Tektronix 067-502 Amplitude Calibrator £45
9. Tektronix 067-502-01 Amplitude Calibrator £40
10. Tektronix DF2 Formatter for Logic Analysers £400
11. Tequipment DM64 10MHz Storage Oscilloscope £275
12. Gould-Brush 500 X-Y Plotter £195
13. Marconi TF2401 50Mhz Counter £45
14. Dana 5000 6 Digit Multimeter £350
15. Hewlett-Packard 8002B 10Mhz Pulse Generator £195
16. Tecktronix 613 Storage Monitor £295
17. Solartron 7201 Locator, Signature Analyser, DMM, Thermometer and Logic Analyser £495
18. Siemens D2072 W2072 100Mhz Level Measuring System £750
19. Siemens D2006 W2006 17Mhz Level Measuring System £495
20. Siemens G2022 Sweep Oscillator, various plug ins available £125
21. AVO Model 8 Mk. 3 & 4 £55
22. AVO Model 7, 7X & Mk.2 £50
23. Fluke 8020A DMM (Unused) £60
24. Cases for above (New) £12
25. J.J. Lloyd PL100 X-Y Plotter £195
26. DEC PDP 8 Computer £100
27. DEC PDP 81 Computer in rack with reader etc. £195
28. Honeywell 20MByte Disk Drive with interface £325
29. Sullivan AC Test Sets £150
30. Philips PM 2522A Digital Multimeter £145
31. Hewlett-Packard 1801A Vertical Plug in £95
32. Hewlett-Packard 1821A Timebase Plug in £95
33. Ice Digital Multimeters £45
34. Tektronix 3S3 Sampling plug in £50
35. Tequipment D1010 Dual Trace Oscilloscope £195

Many other items in stock please phone with your requirements. All prices exclude VAT and carriage.



TIMEBASE Q-TEK ELECTRONICS

94 ALFRISTON GARDENS, SHOLING, SOUTHAMPTON SO2 8FU

TELEPHONE: 431323 (0703)

Callers welcome. Access/Barclaycard: Telephone your order



CIRCLE 025 FOR FURTHER DETAILS.

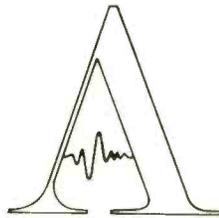


MITSUBISHI

MGF-1400
MGF-1402
MGF-1412

GaAs FETs

FROM STOCK



Aspen Electronics Limited

UK representative for Mitsubishi Electric

2/3 Kildare Close, Eastcote, Ruislip
Middlesex HA4 9UR
Tel: 01-868 1188 Tlx: 8812727

CIRCLE 015 FOR FURTHER DETAILS.

FILTERS

Custom-built to YOUR requirements

Solent Electronic Services Ltd specialize in the custom design and manufacture of L/C and crystal filters in the 0-40 MHz range (0-1000 MHz under development)

Filters are designed, built and tested to meet the highest specifications, including those for telecommunications and defence.

Production is specifically geared to small quantities - from single units to small batches - at relatively low cost.

Phone or write for further information:



Solent Electronic Services Ltd.

15 Abshot Close Titchfield Common

Fareham Hants PO14 4LZ

Tel. 04895-82094

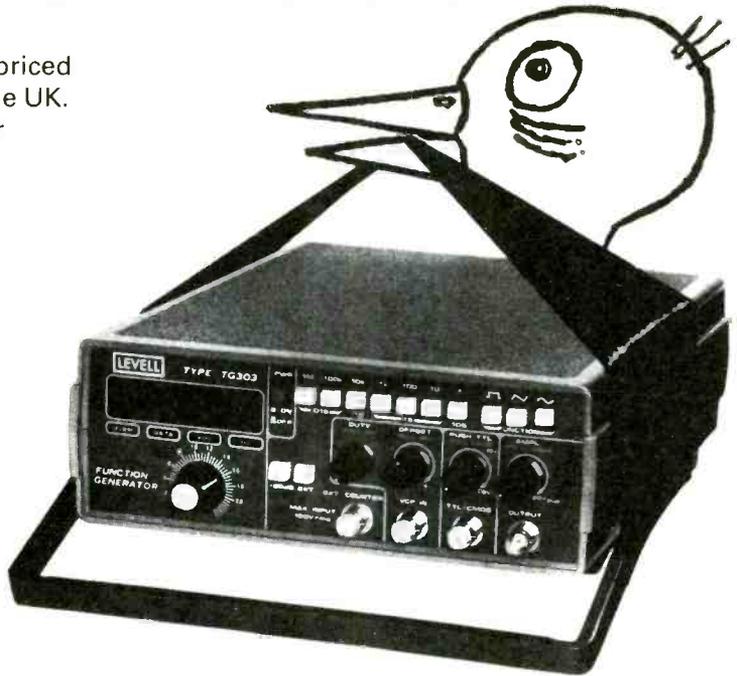
CIRCLE 013 FOR FURTHER DETAILS.

NEW

FUNCTION GENERATORS

The LEVELL TG302 is the lowest priced 2MHz function generator on sale in the UK.
The LEVELL TG303 is a function generator together with a frequency counter.

- * SINE, SQUARE, TRIANGLE, PULSE & RAMP
- * 0.02Hz to 2MHz in 7 RANGES
- * EXTERNAL SWEEP OVER 3 DECADES
- * 20Vp-p from 50ohm SOURCE
- * VARIABLE DC OFFSET
- * TTL OUTPUT
- * FREQUENCY COUNTER TO 10MHz (TG303)
- * CMOS OUTPUT (TG303)



TG302 - £135 ex. works + VAT
TG303 - £195 ex. works + VAT

We supply many other instruments including:
OSCILLATORS, COUNTERS, OSCILLOSCOPES, dB & MICROVOLTMETERS.

LEVELL ELECTRONICS LTD.

Moxon Street, Barnet, Herts. EN5 5SD, England.
Telephone: 01-4 40 8686/449 5028.

CIRCLE 022 FOR FURTHER DETAILS.

HOME CONTROL CENTRE

This kit enables you to control up to 16 different appliances by means of coded pulses in the mains wiring which may be decoded by special receivers anywhere in the house. The transmitter may be controlled manually or by the computer interface enabling your favourite micro to make your coffee in the morning, switch lights anywhere in the house, or your electric blanket in your bedroom. Just think of the possibilities - and no wiring!

The Kit comprises a transmitter with pre-drilled box and two receivers. **XK112 £42.00**

XK111 (additional receivers) **£10**

REMOTE CONTROL KITS

FOR A DETAILED BOOKLET ON REMOTE CONTROL - send 30p + 6" x 9" S.A.E.

These kits have been designed to enable infra-red remote control to be incorporated into virtually any application from switching carlocks or alarms to controlling Hi-Fi or TV. The exact application will determine the interface circuitry (not supplied) between the receiver and the device to be controlled. In many cases this could be a relay or triac. General instructions and applications are supplied with the kits. The kits are coded and provide a high degree of noise immunity and security.

MK16 Transmitter Kit For use with MK11/MK12 Receivers and MK3 10'15' keyboards. Requires PP3 battery. Size 8 x 2 x 1.3 cms. Range approximately 60ft. **£6.80**

MK11 Receiver Kit Mains powered. Provides 10 latched plus 3 analogue outputs. Ideal for controlling audio amplifiers, TV or lighting circuits where control of lamp brightness is required. **£13.50**

MK12 Transmitter Keyboard **£4.35**

MK19 DC Controlled Stereo Amplifier Kit If control of stereo amplifier is required the MK19 may be used providing for remote control of base treble and volume (or balance). This kit also includes a one of 10 decoder with LEDs for remote selection of programme or channel. May be connected between the pre-amp and power amp sections of almost any audio amplifier. **£10.70**

MK12 Receiver Kit **£13.50**

MK12 (state latched or momentary)

MK3 4-way Transmitter Keyboard **£1.90**

MK10 16-way Transmitter Keyboard **£5.40**

MK15 Dual Latched Solid State Relay **£4.50**

SEND SAE 9"x6" for FREE YELLOW CATALOGUE

MICROPROCESSOR CONTROLLED MULTI-PURPOSE TIMER

Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a seven day cycle, eg. to control your central heating (including different switching times for weekends), just connect it to your system programme and set and forget it - the clock will do the rest! **£39.00**

XK 114 OPTIONAL RELAY KIT £3.90

Kit includes one relay, PCB to accommodate up to four relays, terminal blocks, etc. to fit inside CT6000 box. Provides up to four 3amp 240V changeover contacts. Additional relays £1.65 each.

COMPUTER SHOWROOM TOP HARDWARE, LATEST SOFTWARE PERIPHERALS, ACCESSORIES AND MUCH, MUCH MORE!

Add 65p postage & packing + 15% VAT to total!

Overseas Customers: Add £2.50 (Europe), £6.00 (elsewhere) for p&pi

Send S.A.E. for further STOCK DETAILS

Goods by return subject to availability

OPEN 9am to 5pm (Mon to Fri) 10am to 4pm (Sat)

TK ELECTRONICS

11-13 Boston Road London W7 3SU

TEL: 01 567 8910 ORDERS
01 579 9794 ENQUIRIES
01 579 2842 TECHNICAL AFTER 3PM

Versatower:

A range of telescopic towers in static and mobile models from 7.5 to 36 metres with tilt-over facility enabling all maintenance to be at ground level.

Designed in accordance with CP3 Chapter V, part 2; 1972 for a minimum wind speed of 140 kph in conditions of maximum exposure and specified by professionals world-wide where hostile environments demand the ultimate in design, quality and reliability.

Suitable for mounting equipment in the fields of:

- Communications
- Security surveillance - CCTV
- Meteorology
- Environmental monitoring
- Geographical survey
- Defence range-finding
- Marine and aero navigation
- Floodlighting
- Airport approach lighting

Further details available on request.

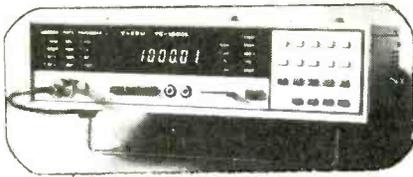
STRUMECH ENGINEERING LIMITED
Portland House, Coppice Side, Brownhills
Walsall, West Midlands WS8 7EX, England
Telephone: Brownhills (05433) 4321
Telex: 335243 SEL G.

CIRCLE 029 FOR FURTHER DETAILS.



SALE of TEST EQUIPMENT

1/2 PRICE!



YC1000L
DATA PROCESSOR
OBSERVE & RECORD
FREQUENCY PERIOD
PULSES
TEMPERATURE
VOLTAGES & TIMES
£365 +15% VAT
+£5 Securitor

The YC1000L is a laboratory grade instrument with versatile microprocessor control. It includes: a frequency (10Hz-600MHz, 0.02 ppm), a period (0.1S to 0.1uS), and a pulse counter (0-99,999,999, TTL level), a voltmeter (AC or DC to 999V, 3 ranges), a thermometer (remote sensor -29.0 to +99.9°C) plus a precision timer (24 hour clock providing: event or period, (local or remote) and alarm functions). Display is via 8 large fluorescent green digits and/or the inbuilt 5X7 (20 characters line 2 line second) Dot Matrix thermal printer.

You will wonder how your laboratory or workshops ever coped without



LCD MULTIMETER
3 1/2 DIGIT
HANDHELD
(Auto range/pol)
KD200
£25 +15% VAT
+£1 postage



VSWR-POWER METER
INTERNAL 50Ω
LOAD
2-150 MHz
6/30/150W
35 models stocked
FS800
£99 +15% VAT
+£3 postage



OSCILLOSCOPE 4"
20 MHz DUAL TRACE
DT420
£199 +15% VAT
+£5 Securitor

S.M. HOUSE, TOTTON, SOUTHAMPTON SO4 4DP, ENGLAND
Tel: SOUTHAMPTON [+44] (0)703 867333. Telex: 477351 SMCOMM G

CIRCLE 056 FOR FURTHER DETAILS.

pantechnic

THE POWERFET SPECIALISTS

OEM USERS

Pantechnic present the most adaptable high-powered amplifier ever.

FET SYSTEM AMP

Features:

- HIGH POWER up to 1.2kW (single ended)
 - LOW VOLUME. 1/4s Cubic foot inc. Heatsink
 - VERSATILE. Delivers more than 1kW into 1/2 to 8 ohms
- OR 2 x 600W into 2 to 8Ω
OR 4 x 300W into 2 to 4Ω (200W into 8Ω)
OR { 1 x 600W into 2 to 8Ω
1 x 300W into 2 to 4Ω
1 x 150W into 4 to 8Ω
- etc., etc.

Having been closely involved in a wide variety of OEM applications of their amp boards, Pantechnic became aware of numerous implementation problems often left unattended by other amp board manufacturers. These problems specifically of size and thermal efficiency became particularly aggravated at high powers and considerably lengthened OEM product development time.

By including thermal design in the totality of board design it has been possible to reduce the size of the electronics, and increase the efficiency of the transistor to heatsink thermal circuit. The combined effect of this has been to dramatically increase the volumetric efficiency of the amplifier/heatsink assembly. The SYSTEM Amp offers 1.2kW of power in a space of 180mm x 102mm x 77mm, excluding PSU and Fan.

The basis of this considerable advance is the PANTECH 74 Heat Exchanger, designed and manufactured by us. By eliminating the laminar air flow found in conventional, extruded heatsinks, heat transfer to the environment is greatly enhanced.

The flexibility of the 1.2kW amp stems from its division into 4 potentially separate amplifiers of 300W each (downrateable with cost savings to 150W). These can be paralleled, increasing current capability or seriesed (bridged in pairs) doubling voltage capability. In consequence a large variety of amplifier/load strategies can be implemented.

As ever Pantechnic offer a full range of customising options including DC coupling, ultra-high slew, etc. Contact Phil Rimmer on 01-361 8715 with your particular application problem.

P.S. Specs, as ever, are exemplary.

A wide range of other amplifiers and other modules available.

Price and Delivery
PANTECHNIC (Dept. WW5)
132 HIGH ROAD,
NEW SOUTHGATE,
LONDON N11 1PG

Technical Enquiries.
contact
Phil Rimmer
on
01-361 8715

CIRCLE 066 FOR FURTHER DETAILS.



PM COMPONENTS LTD
VALVE & COMPONENTS SPECIALISTS

INTEGRATED CIRCUITS

AN124 2.50	MC1351P 1.50	STK015 7.95	TBA540 1.25	TD42523 1.95
AN214Q 2.50	MC1352P 1.25	STK415 7.95	TBA540Q 1.35	TD42524 1.95
AN240P 2.80	MC1357 2.35	STK433 7.95	TBA550Q 1.45	TD42530 1.95
AN612 2.15	MC1358 1.58	STK437 7.95	TBA560C 1.45	TD42532 1.95
AN7140 3.50	MC1495 1.58	TA7081AP 3.00	TBA560Q 1.45	TD42540 1.25
AN7145 3.50	MC1496 1.25	TA7108P 1.00	TBA570 1.00	TD42541 2.15
AN7150 2.95	MC145106P 7.95	TA7120P 1.65	TBA641A12 2.50	TD42560 2.15
BA521 3.35	MC1723 0.50	TA7130P 1.50	TBA651R 2.50	TD42571 2.95
CA1352E 1.75	MC3357 2.75	TA7176AP 2.95	TBA720A 2.45	TD42581 2.25
CA3086 0.46	ML231B 1.75	TA7203 2.95	TBA750Q 2.65	TD42600 5.95
ET16016 2.50	ML232B 2.50	TA7204P 2.15	TBA800 0.89	TD42610 2.50
HA1317 3.50	PMS5807 6.75	TA7205AP 1.50	TBA810AS 1.65	TD42611A 1.95
HA1156W 1.50	PL02A 5.75	TA7227P 1.80	TBA810P 1.65	TD42640 2.60
HA1339A 2.95	SAA500A 3.50	TA7272P 4.25	TBA820M 0.75	TD42680A 2.75
HA1551 2.95	SAA1025 7.25	TA7310P 1.80	TBA820Q 1.45	TD42690 2.45
LA1230 1.15	SAA5010 6.35	TA7321P 2.25	TBA890 2.50	TD42690 2.45
LA4102 2.95	SAS5605 1.75	TA7321P 2.25	TBA920 0.65	TD42690 2.45
LA4250 2.95	SAS570S 1.75	TA7609P 3.15	TBA950/2X 2.35	UPC575C2 2.75
LA4400 4.15	SAS580 2.85	TA7611AP 2.95	TBA970 2.95	UPC1025H 2.50
LA4420 1.95	SL901B 4.85	TAA550 0.25	TBA990 1.49	UPC1028H 1.95
LA4422 2.50	SL917B 6.65	TAA570 1.95	TBA1441 2.15	UPC1032H 1.50
LA4430 2.50	SL1312 1.10	TAA621AX1 1.50	TA270 1.10	UPC1156H 2.75
LC120 3.25	SL1327 1.10	TAA661B 3.20	TC2705Q 1.10	UPC1568H 0.92
LC130 3.25	SL1327 1.10	TAA700 1.70	TC4650 2.50	UPC1167C2 1.15
LC131 5.50	SN76003N 1.95	TAA700 1.70	TC4800 2.15	UPC1181H 2.25
LC137 5.50	SN76013N 1.95	TAA700 1.70	TC940 1.65	UPC1182H 2.95
LM324N 0.45	SN76023N 1.95	TAA700 1.70	TD440 2.20	UPC1182H 2.95
LM380N 0.95	SN76033N 1.95	TAA700 1.70	TD440 2.20	UPC1185H 2.95
LM383T 2.95	SN76110N 0.89	TAA700 1.70	TD440 2.20	UPC1191V 1.50
MS1513L 2.30	SN76115N 1.25	TAA700 1.70	TD440 2.20	UPC1350C 2.96
MS1515L 2.95	SN76131N 1.30	TAA700 1.70	TD440 2.20	UPC1353C 2.45
MS1521L 2.00	SN76226N 2.95	TAA700 1.70	TD440 2.20	UPC1356C 3.95
MC1307P 1.00	SN76227N 1.05	TAA700 1.70	TD440 2.20	UPC2002H 1.95
MC1310P 1.50	SN76233N 1.95	TAA700 1.70	TD440 2.20	555 0.35
MC1327 0.95	SN76544N 1.95	TAA700 1.70	TD440 2.20	25605 0.42
MC1327Q 0.95	SN76570N 1.00	TAA700 1.70	TD440 2.20	723 0.50
MC1330P 0.76	SN76650N 1.15	TAA700 1.70	TD440 2.20	741 0.25
MC1349P 1.20	SN76660N 0.80	TAA700 1.70	TD440 2.20	747 0.50
MC1350P 0.95	STK014 7.95	TAA700 1.70	TD440 2.20	748 0.35
		TAA700 1.70	TD440 2.20	7808 0.60

SEMICONDUCTORS

AA12 0.25	BC182LB 0.10	BD234 0.35	BFR81 0.25	TIP34B 0.75
AC127 0.20	BC183 0.10	BD236 0.45	BFR88 0.30	TIP41A 0.45
AC128 0.28	BC183L 0.09	BD237 0.40	BFR90 1.50	TIP41C 0.45
AC128K 0.32	BC184B 0.09	BD238 0.40	BFR91 1.75	TIP42C 0.47
AC141 0.28	BC204 0.10	BD240 0.50	BF42 0.28	TIP47 0.65
AC141K 0.34	BC207B 0.13	BD242 0.50	BF43 0.28	TIP120 0.60
AC142K 0.30	BC208B 0.13	BD246 0.60	BF44 0.28	TIP125 0.65
AC176 0.22	BC212 0.09	BD376 0.32	BF45 0.28	TIP142 1.75
AC176K 0.31	BC212L 0.09	BD410 0.55	BF46 0.28	TIP146 2.75
AC187 0.25	BC212LA 0.09	BD434 0.55	BF47 0.50	BFX85 0.30
AC187K 0.28	BC213 0.09	BD438 0.60	BF48 0.28	BFX86 0.30
AC188 0.25	BC213L 0.09	BD506 0.50	BF49 0.28	BFX88 0.25
AC188K 0.28	BC214 0.09	BD508 0.40	BF51 0.21	BFY51 0.21
AD142 0.79	BC214L 0.09	BD520 0.85	BF52 0.25	BFY52 0.25
AD143 1.82	BC214L 0.09	BD538 0.65	BF53 0.25	BFY90 0.77
AD149 0.70	BC237B 0.09	BD697 0.75	BF54 0.25	BFY98 0.75
AD161 0.39	BC238 0.09	BD697 1.10	BF55 0.25	BR100 0.26
AD162 0.39	BC239 0.12	BD698 1.10	BF56 0.25	BR101 0.49
AD161/2 0.90	BC251A 0.12	BD707 1.80	BF57 0.25	BRC4443 0.85
AF114 1.50	BC252A 0.15	BDX32 1.50	BF58 0.25	BT100A/02 0.75
AF124 0.65	BC256 0.25	BDY57 1.65	BF59 0.25	BT100A/02 0.75
AF125 0.35	BC258A 0.39	BF115 0.35	BF60 0.25	BT106 1.49
AF126 0.32	BC284 0.30	BF119 0.65	BF61 0.25	BT116 1.20
AF127 0.40	BC300 0.30	BF127 0.24	BF62 0.25	BT119 2.35
AF139 0.40	BC301 0.30	BF154 0.12	BF63 0.25	BT120 1.65
AF178 1.95	BC303 0.26	BF158 0.22	BF64 0.25	BT121 2.22
AF239 0.42	BC307B 0.09	BF160 0.24	BF65 0.25	BU105 1.59
AU106 3.25	BC327 0.10	BF167 0.24	BF66 0.25	BU108 1.69
AU110 2.00	BC328 0.10	BF173 0.22	BF67 0.25	BU124 1.25
BC107A 0.11	BC337 0.10	BF178 0.26	BF68 0.25	BU125 1.25
BC107B 0.11	BC338 0.09	BF179 0.24	BF69 0.25	BU126 1.60
BC108 0.11	BC347A 0.13	BF180 0.29	BF70 0.25	BU204 1.55
BC108A 0.11	BC461 0.35	BF181 0.29	BF71 0.25	BU205 1.30
BC108B 0.12	BC478 0.20	BF182 0.29	BF72 0.25	BU208 1.99
BC109 0.10	BC527 0.20	BF183 0.29	BF73 0.25	BU208A 1.52
BC109B 0.12	BC547 0.10	BF184 0.28	BF74 0.25	BU208D 1.85
BC109C 0.12	BC548 0.12	BF185 0.28	BF75 0.25	BU326 1.20
BC114 0.11	BC549A 0.08	BF186 0.28	BF76 0.25	BU407 1.24
BC116A 0.15	BC550 0.08	BF187 0.28	BF77 0.25	BU500 2.75
BC117 0.19	BC557 0.08	BF188 0.28	BF78 0.25	BU526 1.90
BC119 0.24	BC557B 0.08	BF189 0.11	BF79 0.25	BUY698B 1.70
BC125 0.25	BC558 0.10	BF190 0.16	BF80 0.25	MJ3000 1.98
BC129 0.20	BC593A 1.60	BF191 0.14	BF81 0.25	MJE340 0.90
BC140 0.31	BD115 0.30	BF192 0.14	BF82 0.25	MJE520 0.68
BC141 0.25	BD116 0.60	BF193 0.14	BF83 0.25	MPSA13 0.29
BC142 0.21	BD124P 0.59	BF194 0.11	BF84 0.25	MPSA92 0.30
BC143 0.24	BD131 0.32	BF195 0.11	BF85 0.25	MR450A 12.50
BC147 0.09	BD132 0.35	BF196 0.11	BF86 0.25	MR453 17.50
BC147B 0.09	BD133 0.40	BF197 0.11	BF87 0.25	MR454 23.50
BC148A 0.09	BD135 0.30	BF198 0.11	BF88 0.25	MR475 0.28
BC148B 0.09	BD136 0.30	BF199 0.11	BF89 0.25	MR477 10.00
BC149 0.09	BD137 0.32	BF200 0.14	BF90 0.25	OC23 1.55
BC157 0.12	BD138 0.30	BF201 0.15	BF91 0.25	OC42 0.50
BC158 0.09	BD139 0.32	BF202 0.15	BF92 0.25	OC44 0.75
BC159 0.09	BD140 0.30	BF203 0.15	BF93 0.25	OC45 0.55
BC160 0.28	BD144 1.10	BF204 0.15	BF94 0.25	OC70 0.55
BC161 0.28	BD159 0.65	BF205 0.15	BF95 0.25	OC71 0.55
BC170B 0.15	BD160 1.50	BF206 0.15	BF96 0.25	OC81 0.50
BC171 0.09	BD166 0.55	BF207 0.15	BF97 0.25	R2008B 1.70
BC171A 0.10	BD179 0.72	BF208 0.15	BF98 0.25	R2010B 1.70
BC171B 0.10	BD182 0.70	BF209 0.15	BF99 0.25	R2322 0.58
BC172 0.10	BD201 0.83	BF210 0.15	BF100 0.25	R2323 0.66
BC172B 0.10	BD202 0.65	BF211 0.15	BF101 0.25	R2540 2.48
BC172C 0.10	BD203 0.78	BF212 0.15	BF102 0.25	RCA16334 0.90
BC173B 0.10	BD204 0.70	BF213 0.15	BF103 0.25	RCA16335 0.80
BC174 0.09	BD222 1.46	BF214 0.15	BF104 0.25	SKE5F 1.45
BC174A 0.09	BD223 0.48	BF215 0.15	BF105 0.25	TIP29 0.40
BC177 0.15	BD225 0.48	BF216 0.15	BF106 0.25	TIP29C 0.42
BC178 0.15	BC232 0.35	BF217 0.15	BF107 0.25	TIP30C 0.43
BC182 0.10	BD233 0.35	BF218 0.15	BF108 0.25	TIP31C 0.42
		BF219 0.15	BF109 0.25	TIP32C 0.42
		BF220 0.15	BF110 0.25	TIP33B 0.75

DIODES

AA119 0.08	BY199 0.40	IN4004 0.05
BA115 0.13	BY206 0.14	IN4005 0.05
BA145 0.16	BY208-800 0.33	IN4006 0.06
BA148 0.17	BY210-800 0.33	

PHONE
0474 813225
3 LINES

P. M. COMPONENTS LTD
SELECTRON HOUSE, WROTHAM ROAD
MEOPHAM GREEN, MEOPHAM, KENT DA30QY

TELEX
966371
PM COMP

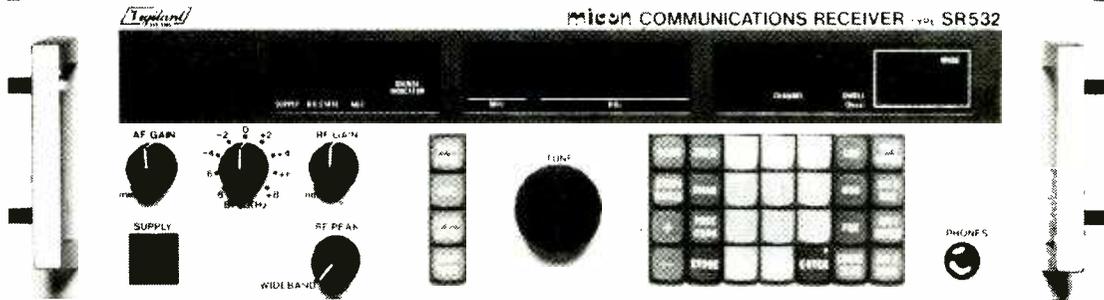


A SELECTION FROM OUR STOCK OF BRANDED VALVES

A1714 18.50	EAAG1 0.60	EF8065 14.50	HL90 0.70	PCL85 0.80	RG4-1000 10.00	VU29 4.50	3CX3 2.50	6BW4 1.50	7Y4 1.95	95A1 6.50
A1998 11.50	EACB80 0.70	EF812 0.65	HL92 1.50	PCL86 0.85	RK-29A 12.00	VU39 1.50	3CY5 1.50	6BW6 5.35	888 2.50	108C1 1.50
A2067 11.50	EAC91 2.50	EL1830 1.50	HL133/DD 3.00	PCL200 1.60	RL16 1.50	W77 5.00	3D6 4.50	6BW7 1.50	8F07 1.95	150B2 6.95
A2134 14.95	EAF42 1.20	EH90 0.72	HR 4.00	PC.800 0.80	RL16 12.00	W729 1.00	3D21A 29.50	6BW8 4.00	10D2 1.25	150C2 1.50
A2293 6.50	EAF801 3.50	EK90 0.72	HY90 1.00	PCL805 0.90	RPY13 2.50	W739 1.50	3D22 19.50	6BX6 0.48	10G1 0.75	150C4 2.15
A2521 21.00	EB34 1.50	EL32 0.95	HVR2 3.00	PDS500 3.50	RPY43 2.50	X24 1.00	3W4GT 2.50	6BX7GT 3.00	10G6 1.00	155UG 25.00
A2599 37.50	EB41 3.95	EL33 4.00	K39A 95.00	PDS10 3.65	RPY82 2.50	X66L 4.95	4B55B 115.00	6BZ 2.50	10P14 2.50	158B1 1.50
A2900 11.50	EB91 0.60	EL34 2.25	K318 85.00	PEN40D 2.00	RR3-250 37.00	X68 1.95	4-65A 59.00	6BZ7 2.95	10P18 0.78	274A 15.00
A3042 24.00	EC941 1.95	EL34 Philips 3.50	K33C 3.50	PEN45 3.00	RR3 1250 65.00	X74M 1.95	4250A 65.00	6C4 1.10	10L1D1 1.00	307 5.00
A3283 24.00	EBC31 2.50	EL36 3.50	K39C 7.00	PEN45DD 3.00	RS613 45.00	XC24 1.50	4B07A 1.75	6C5 1.95	10LD12 0.85	328A 17.50
AC/HL/DD 4.00	EBC81 1.50	EL36 1.50	KT44 4.00	PEN46 2.00	RS617 5.95	XW47 1.50	4C27 25.00	6C6 2.50	10L1E3 55.00	47U 35.00
AC/THI 4.00	EBC90 0.90	EL37 9.00	KT45 4.00	PEN45DD 3.00	RS688 52.15	XW50 1.50	4C28 25.00	6C8G 1.50	12AG8 1.50	507A 5.00
AC/T22 59.75	EBC91 0.90	EL38 3.50	KT66 OSRAM 9.50	PL21 2.50	S6F17 5.95	XF50-6400 35.00	4CX250B1 T 37.50	6C11 2.50	12AL5 1.00	742U 2.50
AC/VP2 4.00	EBC92 1.10	EL41 3.50	KT66 USA 7.15	PL21 2.50	S6F17 5.95	XG5-50 22.50	4CX250B 37.50	6C15 2.50	12AL6 0.65	705A 8.00
AC/VP2 4.00	EBC93 2.50	EL42 2.00	KT66 GEC 14.95	PL3 0.60	S11E12 38.00	XL1-5V 1.50	EIMAC 58.00	6C18 2.50	12A17 1.15	708A 8.00
AC/VP2 4.00	EBC94 1.95	EL43 2.00	KT77 Gold Lion 14.95	PL3 0.60	S130 5.95	XL628FT 7.50	4CX250B 37.50	6C24 4.50	12A17WA 2.50	715A 6.00
AH221 39.00	EBF80 0.65	EL41 6.95	KT77 Gold Lion 14.95	PL3 0.60	S130P 5.95	XNP12 2.50	surplus ex government 12.50	6C26 1.95	12A1U 1.50	715C 45.00
AH238 39.00	EBF85 0.95	EL82 0.58	KT77 Gold Lion 14.95	PL8 0.78	SC1/800 5.00	XP1002 29.00	4CX250B 37.50	6C28 1.50	12A1U7 0.55	725A 275.00
AL60 6.00	EBF89 0.70	EL84 0.75	KT77 Gold Lion 14.95	PL8 0.78	SC1/1200 5.00	XRI-1600A 49.50	tested ex-equipment 79.50	6C28 1.50	12A1X7 0.65	803 14.95
AN1 14.00	EBF93 0.95	EL85 4.50	KT81 7.00	PL8 0.78	SC1/2000 9.00	XRI-3200A 79.50	6C28 1.50	6C61 2.00	12A1Y7 3.95	805 39.00
ARP12 0.70	EBL1 2.50	EL86 0.85	KT88 USA 9.00	PL9 1.75	SD6000M 45.00	XR1-6400A 99.50	6C61 2.00	6C65 1.60	12A27A 1.95	810 55.00
ARP34 1.75	EBL21 2.00	EN91 1.10	KT88 Gold Lion 9.50	PL302 1.00	SP2 45.00	Y63 1.50	4CX350A 71.50	6C65 1.60	12B24A 3.50	811A 12.95
ARPS5 2.00	EC52 0.75	EL91 6.00	KT88 Gold Lion 9.50	PL345 12.50	SP4 5.00	Y65 6.95	4G57 2.25	6C75 1.00	12B26 1.50	813 18.50
BL63 2.00	EC70 1.75	EL95 0.70	KT67 15.95	PL504 1.15	SP42 3.00	Y602 12.00	4G7 2.25	6C86 2.95	12B26 1.05	866A 3.50
BS450 67.00	EC80 9.50	EL153 12.15	KTW61 2.50	PL508 1.95	SS501 35.00	YD1100 75.00	4J52 75.00	6D06 1.15	12B16 1.75	872A 19.00
BS810 55.00	EC81 7.95	EL183E 3.50	KTW62 2.50	PL509 4.85	ST11 1.50	YJ1060 265.00	4J52 75.00	6D05 3.35	12B16 1.75	874 60.00
BS814 55.00	EC86 1.00	EL360 7.95	KTW63 2.50	PL519 4.95	STV280/40 11.95	YL1070 115.00	4X150A 25.00	6D07 2.50	12B7A 2.75	882A 19.00
BS814 55.00	EC88 1.00	EL360 7.95	KTW63 2.50	PL519 4.95	STV280/40 11.95	YL1070 115.00	4X150A 25.00	6D07 2.50	12B7A 2.75	882A 19.00
C3JA 16.00	EC90 1.10	EL500 1.40	L63 1.50	PL820 2.95	SU42 4.95	YL1071 109.00	5A163K 10.00	6E88 1.75	12C16 1.75	930 9.95
C1108 54.95	EC91 5.50	EL504 1.40	L102/2K 12.00	P.825 2.95	SU42 4.95	Z77 1.20	5A170K 6.25	6E88 1.75	12C16 1.75	930 9.95
C1122G 70.00	EC92 1.25	EL509 5.25	LS98 6.95	PY32 0.60	T82 5/3000 60.00	Z302C 12.00	5A-180M 9.00	6E88 1.75	12C16 1.75	930 9.95
C1134 32.00	EC93 1.50	EL519 6.95	LS98 6.95	PY32 0.60	T82 5/3000 60.00	Z302C 12.00	5A-180M 9.00	6E88 1.75	12C16 1.75	930 9.95
C1148A 115.00	EC95 7.00	EN91 1.10	M502A 60.00	PY33 0.50	T82 300 45.00	Z389 9.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
C1149/130 10.00	EN91 1.10	EL821 3.50	M502A 60.00	PY33 0.50	T82 300 45.00	Z520M 4.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
C1150/135 0.00	ECB010 12.00	EL822 12.95	M508 85.00	PY82 0.70	TD1-100A 25.00	Z521M 8.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
C1534 32.00	EC32 3.50	EM1 9.00	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
CCA 2.60	EC33 3.50	EM4 9.00	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
CC3L 0.90	EC35 3.50	EM80 0.70	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
CC3L 2.00	EC38 1.15	EM84 1.65	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
CV Nos Prices on request	EC38 0.55	EM85 3.95	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
D63 1.20	EC38 1.15	EM85 3.95	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DAF91 0.70	EC38 0.65	EN10 8.00	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DAF96 0.65	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DAF96 0.65	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DC90 1.20	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DCX4-1200 10.00	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DCX4-5000 25.00	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DE116 28.50	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DE118 28.50	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DE124 39.00	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DE125 22.00	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DE129 0.70	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DE191 0.60	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DF92 0.65	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DF96 1.00	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DH63 1.20	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DH77 0.90	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DH79 0.56	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DH149 2.00	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DK91 0.90	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DK92 1.20	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DK96 2.50	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DL35 1.00	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DL63 1.00	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DL70 2.50	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DL73 2.50	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DL91 1.50	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DL92 1.50	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70	TD03-10D 35.00	Z700U 3.00	5A-206K 10.00	6F1 2.00	12C16 1.75	930 9.95
DL93 1.10	EC38 0.65	EN32 13.50	MS37A 60.00	PY83 0.70						

Vigilant **micon** HF Communications Receivers MICROPROCESSOR CONTROLLED RECEIVERS

Type SR 530 USB/CW/AM/Telex – 10 Hz Steps (Marine)
Type SR 532 USB/LSB/AM/CW – 10 Hz Steps (Static/Transportable)
Type SR 531 USB/LSB/AM/CW – 100 Hz Steps (Static/Transportable)



DESIGNED AND MANUFACTURED TO HIGHEST INTERNATIONAL SPECS

Freq. Range : 50 KHz to 30 MHz
Increments : 10 Hz or 100 Hz Steps
Stability : ± 1 Part in $10^7/^\circ\text{C}$
Tuning : Keypad and Spin Wheel
Power Supplies : 110/240V AC and 24V DC
FULLY MODULAR 'PLUG IN' CONSTRUCTION

Memory : 200 Channels Freq/Mode/Filter
Scanning : Full memory or discreet parts
Automatic or Manual Stop
Manual step on or Reverse
Dwell : Variable from Keypad 1 to 9 seconds
KEYPAD FUNCTIONS INDICATED BY DISPLAYS

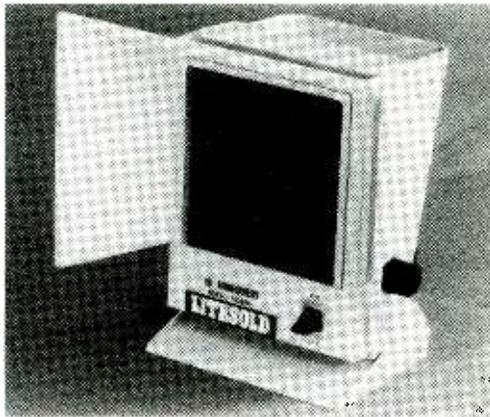
NOW AVAILABLE AT HIGHLY COMPETITIVE PRICES

Send for Technical Brochure to:
Vigilant Communications Ltd.
Unit 5, Pontiac Works, Fernbank Road, Ascot, Berks SL5 8JH, England

Tel: (0344) 885656
Telex: 849769 Vigcom G

CIRCLE 027 FOR FURTHER DETAILS.

LIFESOLD



SOLDER FUME ABSORBER

Removes smoke and fumes from soldering area and absorbs harmful components, using activated carbon filter. Free standing unit, adjustable for angle, with removable hood. Supplied with 3 spare filters. Price only **£58.04**.

Light Soldering
Developments Ltd
97/99 Gloucester Road
Croydon CR0 2DN 01-689 0574

CIRCLE 045 FOR FURTHER DETAILS.

WRONG TIME?

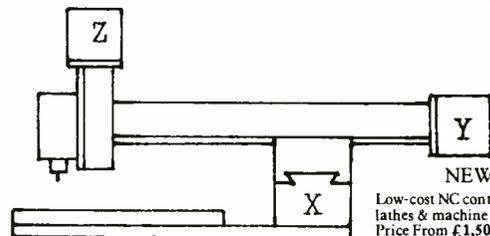
MSF CLOCK is ALWAYS CORRECT — never gains or loses, SELF SETTING at switch-on, 8 digits show Date, Hours, Minutes and Seconds, 24 hour format, larger digit Hours and Minutes for easy QUICK—GLANCE time, auto GMT/BST and leap year, can expand to Years, Months, Weekday and Milliseconds, with parallel BCD output for computer and audio to record with commentary and show time on playback, receives Rugby 60KHz atomic time signals, only 15x5x8cm, superhet receiver, built-in antenna, 1000KHz range, GET the RIGHT TIME, £72.70. Fun-to-build kit (ready-made to order) includes all parts, printed circuit, case, instructions, by-return postage etc, list of all kits, SEND away NOW.

CAMBRIDGE KITS

45 (WE) Old School Lane, Milton, Cambridge. Tel. 860150

MICRO ENGRAVER

MICROPROCESSOR-CONTROLLED ENGRAVING MACHINE



STEPPING MOTOR XYZ MACHINE. Complete with microprocessor controller and software programmed to engrave alphabet and numbers. Also features easy operator-programmable XYZ sequences to engrave, drill or cut out special shapes and logos. XY axis travel 200/170mm, Z 20mm. Mixed character sizes on a label from 1-99mm high. Qwerty keyboard, 24 character liquid crystal display. Machine supplied complete and ready to manufacture labels. PRICE £2650.00

J.A.F. GRAPHICS
70 Leek Road, Congleton, Cheshire CW12 3HU - 02602 5127

CIRCLE 017 FOR FURTHER DETAILS.

Appointments

Advertisements accepted up to 12 noon Tuesday, April 3, for May issue subject to space available.

DISPLAYED APPOINTMENTS VACANT: £17 per single col. centimetre (min. 3cm).
LINE advertisements (run on): £3.50 per line, minimum £25 (prepayable).
BOX NUMBERS: £5 extra. (Replies should be addressed to the Box Number in the advertisement, c/o Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS).
PHONE: IAN FAUX, 01-661 3033 (DIRECT LINE)

Cheques and Postal Orders payable to **BUSINESS PRESS INTERNATIONAL LTD.** and crossed.



ECM

ALWAYS AHEAD WITH THE BEST!

£7,000-£22,000

- ★ **Where does your interest lie:** Graphics; Comms; Robotics; Simulation; Image and Signal Processing; Medical Automation; Avionics; Acoustics; Weapons; Radar; Opto and Laser?
- ★ **Experienced in:** Microprocessor Hardware or Software; Digital and Analogue circuitry; RF and Microwave techniques?
- ★ **There are hundreds of opportunities in:** Design; Test; Sales and Service for Engineers and Managers
- ★ **For free professional guidance:** Call 076 384 676 (till 8pm most evenings) or send your C.V. (no stamp needed) to:

ELECTRONIC COMPUTER AND MANAGEMENT SERVICES LIMITED
 Freepost, Barkway, Royston, Herts SG8 8BR

1926

RESEARCH INSTITUTE University of Petroleum and Minerals DHAHRAN, SAUDI ARABIA

Needs Digital Electronics Repair Technicians for expansion of the facility for instrument repair, maintenance and calibration.

Candidates' background should include:-

- ★ Bachelors or associate degree or equivalent military/Technical training.
- ★ Minimum 4 years' hands-on digital experience on micro-mini computers, peripherals, data acquisition systems, micro-processor controlled test instruments.
- ★ Trouble-shooting and repair capability to component level (experience with current model minis, micros and GPIB a big advantage).

Salary is competitive, benefits include annual repatriation, housing and transportation allowances.

Candidates possessing the above requirements should only apply to the following address within one week of the release of this advertisement furnishing details resume of their educational qualifications and experience, attaching copies of their degrees and transcripts, giving names and addresses of four referees, including their present employer, if possible, and the present position held.



Mr. Ali A. Jaman, Director General,
 Financial and Admin. Affairs,
 Research Institute - University
 of Petroleum and Minerals, P.O.
 Box 7177, Dammam - 31462,
 Saudi Arabia.

2546

BRIGHTON POLYTECHNIC LEARNING RESOURCES

Senior Audio-Visual
 Technician
 £6,264 - £7,896

To be responsible for the organisation and operation of the audio-visual equipment loans service which supports teaching at the Moulsecoomb site of the Polytechnic. Equipment includes production standard colour video cameras, 3/4" and 1/2" video recorders and multi-standard video replay; production quality sound equipment, including Revox and Uher recorders, along with film and slide projectors. Candidates must have experience of the operation and maintenance of equipment of this kind, and be able to work with a wide range of academic, media production and engineering staff. Candidates must also have good organisational skills. City and Guilds Final Certificate or TEC qualifications in a relevant area of electronics an advantage.

Further details and application forms available from the Personnel Officer,
 Brighton Polytechnic, Mithras House,
 Moulsecoomb, Brighton BN2 4AT.
 Tel (0273) 693655 Ext 2536.

Closing Date: 4 May 1984 (2560)

LOGEX ELECTRONICS RECRUITMENT

Specialists in Field & Customer Engineering appointments, all locations and disciplines.

Logex House, Burleigh, Stroud
 Gloucestershire GL5 2PW
 0453 883264 & 01-290 0267

(24 hours) 321

BRIGHTON POLYTECHNIC COMPUTER CENTRE

TECHNICIAN

(DATA
 COMMUNICATIONS)
 Salary up to £8,712

To help maintain an extensive communications, terminals and microprocessor service comprising 350 terminals, and well over 50 microprocessors.

There is a small team dedicated to this task. Additional development activities are undertaken, improving the network by designing, building and servicing various system components.

A progression scheme is provided for accelerated remuneration commensurate with the applicant's development skills.

Application forms and Job description can be obtained from the Personnel Officer,
 Brighton Polytechnic,
 Moulsecoomb, Brighton BN2
 4AT. Telephone Brighton
 (0273) 693655 Ext 2537.
 Closing date 4 May 1984. (2544)

Appointments

CUT THIS OUT!

Clip this advert and you can stop hunting for your next appointment. We have a wide selection of the best appointments in Digital, Analogue, RF, Microwave, Micro processor, Computer, Data Comms and Medical Electronics and we're here to serve *your* interests.

Call us now for posts in Design, Sales, Applications or Field Service, at all levels from £6,000-£16,000.



Technomark
Engineering & Technical Recruitment

11 Westbourne Grove, London W2 Tel: 01 229 9239

(1935)

GENIUS WANTED

To join our technical department at **Utopia recording Studios**, SSL, Studer, Neumann and Neve experience an asset, to work with our young and enthusiastic team of Utopians.

Call Phil Wairman now on 01 586 3434.

(2567)

Test and Service Technician required for Electronics Company to undertake the running of a small service department.

Duties would include test and repair of electromechanical devices and associated microprocessor based electronics along with the administration of spare parts stock control.

Although formal qualifications would be recognised, mechanical aptitude and a working knowledge of microprocessors and digital circuitry are considered more essential.

Good conditions of employment, BUPA participation etc.

Apply in writing to:

Personnel Manager
Roxburgh Electronics Ltd., 22 Winchelsea Road,
Rye, East Sussex TN31 2BR

(2548)

BORED ?

Then change your job!

1) VDU and Peripherals

Senior service engineer required to support and liaise with O.E.M. sales orientated personality required — Middx. To £11.5K + car.

2) Data Communications

1 years experience in servicing PW Telex or message switching equipment for customer support — Berks c. £9K + car.

3) Naval Weapons/Communications

Support Engineer for managing logistics of installation and maintenance — Berks £9K

4) Service Personnel

(RAF, RN, ARMY)
We have many clients interested in employing ex-Service fitters and technicians at sites throughout the U.K. Phone for details

5) £600 per week

We are paying very high rates for contract design and test engineers who have a background in RF, Microwave, Digital, Analogue or Software, at sites throughout the U.K.

Hundreds of other Electronic and Computer vacancies to £12,500

Phone or write:

Roger Howard, C.Eng., M.I.E.E., M.I.E.R.E.

CLIVEDEN CONSULTANTS

92 The Broadway, Bracknell, Berkshire

Tel: 0344 483489

(1640)

CLIVEDEN

University of Leeds

Applications are invited for the post of Senior Technician (Grade 5) in the Electronics Workshop of the Department of Electrical and Electronic Engineering. The workshop staff are responsible for the maintenance of electronic instruments and for the development and construction of electronic equipment for both teaching and research.

Applicants are expected to have an appropriate qualification (minimum ONC) and considerable experience of electronic engineering, preferably including computers. The salary scale is currently £6279 - £7332 pa. Applications giving full details of age, qualifications and experience, together with the names and addresses of 2 referees, should be sent to Mr W G Black, Department of Electrical and Electronic Engineering, Leeds University, Leeds LS2 9JT.

(2566)

MID—WARWICKSHIRE COLLEGE OF FURTHER EDUCATION

Faculty of Technology

LII IN ELECTRONICS/MICROELECTRONICS

Applications are invited for the above post for appointment from 1st September 1984.

Applicants should possess a relevant degree or professional qualification with some relevant industrial experience and will be required to teach on a range of Technician and Craft courses, with particular responsibility for the organisation and development of courses relating to Electronics/Microelectronics.

Application forms and further details may be obtained from the Principal's secretary (s.a.e. please). Completed application forms to be returned to the Principal within two weeks of the date of this advertisement.

(2562)

PLYMOUTH GENERAL HOSPITAL

DEPARTMENT OF MEDICAL PHYSICS AND BIOMEDICAL ENGINEERING

Applications are invited for two posts at Greenbank Hospital

Post A Technician (electronics)

Post B Technician (mechanical)

The person appointed to Post A will be a member of a team of eleven in a well-equipped and expanding unit offering support services in the various aspects of the management of clinical electronic equipment in hospitals and health centres throughout the Plymouth Health District.

The person appointed to Post B will be a member of a team of five in a well-equipped and expanding unit dealing with the maintenance and development of a wide range of non-electronic clinical equipment (mainly in theatres and special care units) in hospitals throughout the Plymouth Health District.

Hospital experience is not essential as further training will be given. HNC/ONC/City and Guilds Final certificate or equivalent qualification is required. The work involves occasional travel and necessitates a current driving licence. There is a requirement to be prepared to participate in a scheme to provide out-of-hours emergency cover.

Posts are offered in one of the following grades according to relevant experience. MPT IV £5171 - £6,798 per annum or MPT III £6,132 - £7,926.

For further information

Post A Contact Mr A Dawson 0752 834276

Post B Contact Mr Bartrip 0752 834279

Applications forms available from and returnable to:-

Unit Personnel Officer
1 Belvedere, Greenbank Rd., Plymouth

Please enclose a s.a.e. Closing date: 4th May 1984.

(2556)

SATELLITE RECEPTION RESEARCH ASSISTANTS

For the BBC's Monitoring Service at Caversham, near Reading, Berkshire.

With the advent of satellite communications, broadcasting and news agency organisations are switching from conventional means to satellites for their transmissions. Satellite Reception Research Assistants will be involved in the Monitoring Service's work in this field.

Duties include frequency scanning and the compilation of transmission schedules. Extensive experience in communications with C and G Intermediate Telecommunications Technicians Certificate or equivalent qualification and a thorough grasp of satellite communications are essential. Knowledge of major broadcasting systems, familiarity with news agency transmissions and the ability to recognise a range of languages an advantage.

Applicants will be required to take written tests and appointment will be subject to satisfactory hearing tests. Shift working involved.

Salary £7,867 - £9,761 plus a 10% shift allowance.

Relocation expenses considered.

Write or telephone immediately for application form (quote ref. 3222/WW and enclose stamped, addressed foolscap envelope) to Senior Personnel Officer, BBC Monitoring Service, Caversham Park, Reading, Berks., RG4 8TZ. Tel. (0734) 472742 Ext. 212.

We are an Equal Opportunities employer

BBC

2552

Appointments

Design Engineers & Materials Supply Control

Farnell Instruments and the Electronic Engineering Department at Huddersfield Polytechnic have together established a Teaching Company Scheme.

This has provided a rare opportunity for Associates to work on industrial projects in:

- 1] Test and measurement instruments design
Digital signal processing
Digital storage oscilloscopes
- 2] Materials supply and control

Applications are invited from Honours graduates in an appropriate discipline and ideally with some industrial experience. Associates have the opportunity to register for a higher degree. Three posts are based at Wetherby and are initially for a two year period. Salary range £6516-£7692

Find out more by ringing Andy Lamming on Wetherby 61961 or Harrogate 870643 after 7.00pm

Further details also available from Personnel, Farnell Instruments Ltd., Wetherby LS22 4DH



Farnell



2535



CAPITAL APPOINTMENTS LTD

THE UK'S No. 1 ELECTRONICS AGENCY

If you have HNC/TEC or higher qualifications and are looking for a job in design, test, customer service, technical sales or similar fields:

**Telephone now for our free jobs list
We have vacancies in all areas of the UK
Salaries to £15,000 pa**

01-637 5551 or 01-636 9659
(24 hours)

**CAPITAL APPOINTMENTS LTD
29-30 WINDMILL STREET, LONDON W1P 1HG**

2450

CHELSEA COLLEGE UNIVERSITY OF LONDON

Electronics workshop technician required for interesting work for electronics and physics research and teaching. Includes prototype instrument design, development and construction and the servicing and repair of commercial electronic equipment.

Experience and qualifications in electronics (particularly digital) at an appropriate level are essential. Inclusive salary Grade 5 — £7529 to £8582 p.a.

Further details and application forms from Mr M E Cane,
Chelsea College Department of Electronics, Pulton Place,
London SW6 5PR.

(2563)

Careers in Electronics Research

The Laboratories at Redhill, Surrey, are the UK research centre of the international Philips Group of Companies. The facilities and resources rank alongside the most technically advanced in the world today. The total environment is completely conducive to the wide range of research projects which continue to achieve the successes for which we carry world recognition.

There are vacancies in two teams for people qualified at least to HNC or HTEC level and having relevant experience in:

DIGITAL TELECOMMUNICATIONS

This team is involved in an advanced Integrated Services Digital Network embracing subscriber access through digital transmission. The task will involve exploitation of both Digital and Analogue Signal Processing.

As a key member of this team you will be directly concerned with construction, testing and evaluation of hardware systems.

If you believe that your experience and qualifications would equip you for either of these positions we would be pleased to hear from you. Conditions of service and rewards reflect those of the parent group, renowned for their forward thinking and enlightened policies. Assistance with relocation is available if required.

FLAT CATHODE RAY TUBES

An opportunity to join a team working on Advanced Vacuum Tubes, building and testing sub-assemblies through to complete units, using a wide variety of mechanical and physical techniques and processes.

**PHILIPS RESEARCH
LABORATORIES**



Please apply to: Chris Nye,
Appointments Co-ordinator, Personnel Department,
Philips Research Laboratories, Cross Oak Lane,
Redhill, Surrey RH1 5HA. Tel: Horley 5544.

Together we can shape the future

2559

Appointments

Electronics Engineers £9561 Communications Design in High Tech Country

At H.M. Government Communications Centre we're using the very latest ideas in electronics technology to design and develop sophisticated communications systems and installations for special Government needs at home and overseas.

With full technical support facilities on hand, it's an environment where you can see your ideas progress from initial concepts through prototype construction, tests and evaluation, to the pre-production phase, with a chance to influence every stage. Working conditions are pleasant, the surroundings are attractive, and the career prospects are excellent.

Ideally we're looking for men and women who have studied electronics to degree level or equivalent and have had some experience of design, whether obtained at work or through hobby activities. Appointments will be made as Higher Scientific Officer (£7149-£9561) or Scientific Officer (£5682-£7765) according to qualifications and experience.

For further details please write to the address given below. As our careful selection process takes some time, it would be particularly helpful if you could detail your qualifications, your personal fields of interest and practical experience, and describe the type of working environment most suited to your career plans.

The Recruitment Officer, HMGCC, Hanslope Park, Buckinghamshire MK19 7BH.

(2448)

COMMUNICATION ENGINEERS TECHNICIANS

* Short or Long Term

* Installation

* UK or Overseas

* Maintenance

Marconi Communication Systems, world leaders in the design, manufacture and installation of advanced electronic communications equipment and systems require experienced field staff.

Contract employment

North Africa and Middle East

Maintenance of HF or Tropo, LOS, MUX and associated equipment.

Demanding assignments await adventurous Engineers/Technicians with an electronics qualification or HM Forces training and a minimum of three years' relevant experience (current UK driving licence required) as follows:-

Permanent employment

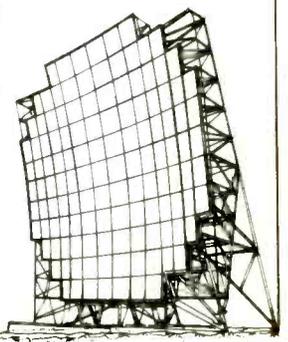
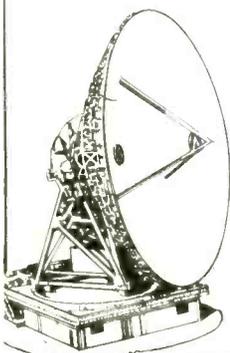
Worldwide

Installation and Maintenance of satellite earth stations or broadcast transmitters or Tropo, LOS, MUX or PCM and digital or HF equipments.

We offer excellent salaries, living allowances and overseas benefits where applicable. Skilled and dedicated Engineers and Technicians seeking permanent employment will find excellent scope for career advancement within our highly successful company.

Please telephone for an application form or send a full c.v. to Gordon Short, Marconi Communication Systems Limited, New Street, Chelmsford, Essex, CM1 1PL. Telephone: Chelmsford (0245) 353221, extension 498.

Marconi
Communication Systems



2533

COMMUNICATIONS ENGINEERING

- WIDE-RANGING OPPORTUNITIES IN THE DEVELOPMENT AND MAINTENANCE OF ADVANCED VOICE AND DATA SYSTEMS.

In every sphere of its operations, Aramco relies heavily on the most sophisticated communications links. The following appointments offer invaluable experience of advanced data and voice networks, together with all the tangible rewards of working for the world's largest oil producing company:

PROJECT PLANNING/ CO-ORDINATING ENGINEERS

(3 posts) Circa £19,500-£25,500 net

Will be involved in the planning and coordination of all types of telecommunications projects. One post requires at least 10 years' experience covering Transmission Systems Engineering, Systems Design and UHF/VHF Radio Networks, and Microwave and Multiplex Applications. The other 2 posts require at least 7 years in the planning, engineering and implementation of telecommunications projects. Experience of drawing up engineering standards and of technical writing would be advantageous for one of these posts. Ref: PPE/139.

DOCUMENTATION ENGINEER

Circa £19,500-£22,500 net

Will head the technical writing group and must have experience in the development, preparation and editing of communications-related standards, specifications, procedures etc. Ref: DOCE/140.

STANDARDISATION ENGINEER

Circa £19,500-£22,500 net

Will determine specifications etc and technical acceptability of substitutions. Must have in-depth knowledge of communications materials, equipment and spare parts. 8 years' experience is required in design, research, maintenance or a related area. Ref: STE/141.

SAUDI ARABIA
£15,000-£25,500 net

SENIOR COMMUNICATIONS TECHNICIANS

(6 posts) Circa £15-17,000

Will carry out the maintenance and repair of a variety of communications and electronic equipment, including UHF/VHF radio-systems and radio-data systems. One post will include the monitoring of the quality of the technical and administrative performance of contractors plus cost verifications for statistical purposes. Candidates should have a minimum of 10 years' post apprenticeship experience in the maintenance and repair of communications and electronic equipment. Ref: COMT/142.

For the Engineering posts a relevant degree, HNC or equivalent is required and for the Technician posts an apprenticeship, plus the experience specified above.

These single status appointments offer open-ended contracts with the usual tax advantages. The excellent range of benefits include low-rental accommodation (fully furnished and air-conditioned), regular UK leave with company paid air fares, free medical care and good sports and recreational facilities.

Please write with full career details quoting relevant ref. no. to: Webb Whitley Associates Limited, International Recruitment Consultants, 45 Kensington High Street, London W8 5ED.



ARAMCO



Webb Whitley
Associates Ltd.

partners in progress

Appointments

MAXELL (UK) LTD SALES ENGINEER

FOR PROFESSIONAL AND INDUSTRIAL VIDEO PRODUCTS

Maxell (UK) Ltd is a subsidiary of one of the world's largest and most respected tape companies. Maxell's research and development efforts have brought very high performance tapes to both the amateur and professional user and to supply the European market for video tape. Maxell have recently completed construction of a video tape factory in Telford, Shropshire. The company has achieved considerable success as a supplier to broadcast duplication and video facilities companies and to support these clients Maxell now wish to appoint a Sales Engineer. The products mainly involved will be VHS, Beta and U-matic video cassettes and the position will involve sales and technical liaison with existing and potential users of these products.

The successful candidate will ideally be educated to degree standard and have experience in consumer and professional video systems.

The company offers a secure future in an industry which is developing rapidly and which will present an interesting and challenging working environment.

The position is based in Harrow, Middlesex and benefits include free membership of the company BUPA scheme and a company car.

If this position would interest you please send a CV and any additional information you feel relevant to:

maxell®

Maxell (UK) Ltd, 1 Tyburn Lane, Harrow, Middx HA1 3AF.

(2542)

Senior Technical Assistant

from £9,300 p.a.

The Purchasing and Supply Department of the Independent Broadcasting Authority, based at Harrow, now has an opportunity for a Senior Technical Assistant to lead its small Technical Services Group.

Provision of technical services includes goods inwards inspection, storage environment, component testing, repairs to electrical equipment and maintenance of office equipment held at Harrow.

Candidates require a good secondary education to 'O' level standard and TEC or City and Guilds in Electrical/Electronic Engineering or equivalent knowledge and experience at a similar level. Considerable experience in a technical stores environment of a large organisation dealing with a wide range of complex technical equipment, will not only have furthered technical knowledge of electronic components and equipment, but brought an appreciation of stock control, purchasing systems and procedures, and of computer usage in stores and stock control.

An excellent working environment and conditions of employment are offered.



INDEPENDENT
BROADCASTING
AUTHORITY

* An Equal Opportunities Employer *

For further details of the vacancy and an application form, please telephone 01-584 7011 ext 390 (9am to 5pm weekdays).

2545



ADVANCE YOUR CAREER IN FUTURE PRODUCT DEVELOPMENT

Project Managers C£18K Technical Managers C£16K

HIGH TECHNOLOGY EQUIPMENT

S.E. ENGLAND

Several unique opportunities affording excellent career prospects with a large, expanding, performance orientated company exist for engineers with a degree or HNC in Physics or Engineering (preferably Electronics or Systems Engineering, but possibly Mechanical Engineering). Candidates should have acquired good systems experience whilst working in the Electronics or Defence Industries as a team leader or group leader and ideally will have acquired practical knowledge of prototype production or trials.

Your task will be to assist our client, who has developed an enviably secure base in the development and manufacture of complex weapons systems, to develop new business areas for high technology systems in both the defence and commercial sectors. The number of persons ultimately involved in a project will vary from 20 to 750 and the development costs will range from £20M to £200M and consequently there will be tremendous opportunities for you to progress to the control of the running of very large projects as well as to higher levels of management. By proposing, developing and evaluating systems and design options, producing prototypes and arranging for all necessary trials and tests, your team's objective will be to produce complete technical and cost proposals for complex, state-of-the-art systems whose technical excellence and competitiveness will ensure that large contracts are

secured. To have acquired the necessary skills and experience to meet this formidable challenge you will probably be at least 30 to 35 years old; have management experience especially of dealing with people outside your direct control; have experience of customer liaison and project planning; and will have developed commercial and business awareness.

These important new positions offer excellent rewards and conditions with first class future prospects in the thriving division of a leading company in the High-Technology and Defence Industries that is part of a highly successful, major international group. The division has an order book which takes them potentially beyond the year 2000, is committed to developing several new business areas, and is poised to move into the world market in a big way.

TO FIND OUT MORE and to obtain an early interview, please telephone FRED JEFFRIES C.Eng., MIERE in complete confidence on HEMEL HEMPSTEAD (0442) 212655 during office hours or one of our duty consultants on HEMEL HEMPSTEAD (0442) 212650 evenings or weekends (not an answering machine). Alternatively write to him at the address below.



Executive Recruitment Services

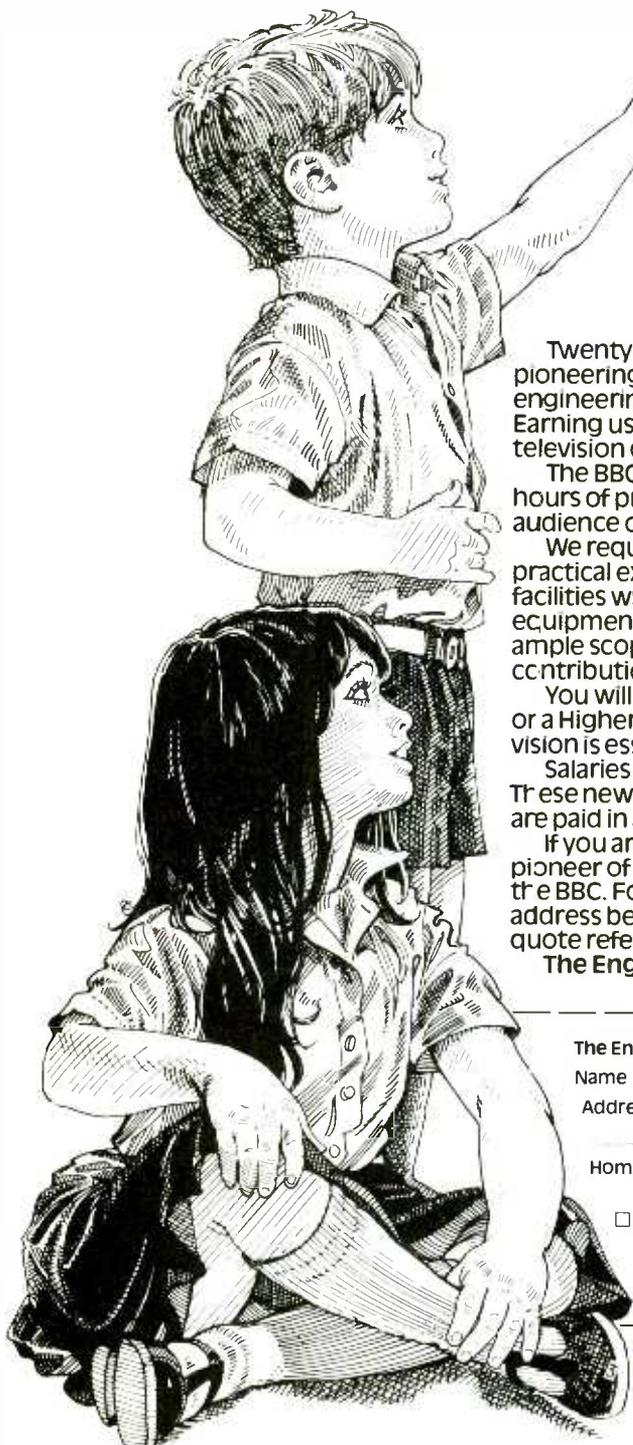
THE INTERNATIONAL SPECIALISTS IN RECRUITMENT FOR THE ELECTRONICS, COMPUTING AND DEFENCE INDUSTRIES

29-33 Bridge Street, Hemel Hempstead, Herts., HP1 1EG.

2543

Experienced Graduate Engineers Children of the 60's

On April 20th, 1964, BBC viewers were given a choice of channels: BBC2 was born.



Twenty years of achievement onward, the BBC shows the same pioneering spirit. Our approach to programming and broadcast engineering is as youthful, enthusiastic, and progressive as ever. Earning us international respect as the world's foremost radio and television organisation.

The BBC's world is still growing. We broadcast several thousand hours of programmes weekly to a national and international audience of millions.

We require qualified Electronics Engineers with several years' practical experience, to support the state-of-the-art technical facilities which make our programmes possible. Much of the equipment has been developed by in-house experts and there is ample scope for the innovative engineer to make a genuine contribution to broadcast technology.

You will need to have a Degree/HND/HNC in Electrical Engineering or a Higher BTEC Diploma in Electronics. Normal hearing and colour vision is essential.

Salaries are now on a scale from £8094 rising to £9791 in London. These new pay scales apply from 1st April. Allowances of about £1000 are paid in addition to these salaries, to cover irregular hours of work.

If you are a child of the 60's, an Engineer of the 80's and a potential pioneer of broadcast technology, you have much in common with the BBC. For further details, complete and send the coupon to the address below enclosing a large self-addressed envelope. Please quote reference 84E/4041.

The Engineering Recruitment Officer, BBC, PO Box 2BL, London W1A 2BL.

The Engineering Recruitment Officer, BBC, PO Box 2BL, London W1A 2BL.

Name _____

Address _____

Home tel. no. _____ Age _____

My qualifications are:- (please tick as appropriate).

- HND/HNC Electrical Engineering Higher BTEC Diploma Electronics
 Electrical/Electronics Degree C & G FTC 271

Please quote ref 84.E.4041 in any covering correspondence.

We are an equal opportunities employer.

BBC engineering
Making an Art of Technology

Pioneers of the 80's

2550

Appointments

Advanced telecommunications:

careers with extensive scope at Cheltenham

Join the Government Communications Headquarters, one of the world's foremost centres for R & D and production in voice/data communications ranging from HF to satellite — and their security. Some of GCHQ's facilities are unique and there is substantial emphasis on creative solutions for solving complex communications problems using state-of-the-art techniques including computer/microprocessor applications. Current opportunities are for:

Telecommunication Technical Officers

Two levels of entry providing two salary scales: £6262-£8580 & £8420-£9522

Minimum qualifications are TEC/SCOTEC in Electronics/Telecommunications or a similar discipline or C & G Part II Telecommunications Technicians Certificate or Part I plus Maths B, Telecommunication Principles B and either Radio Line Transmission B or Computers B or equivalent: ONC in Electrical, Electronics or Telecommunications Engineering or a CIE Part I Pass, or formal approved Service technical training. Additionally, at least four years' (lower level) or seven years' (higher level) appropriate experience is essential in either radio communications or radar, data, computer or similar electronic systems. At the lower entry level first line technical/supervisory control of technicians involves "hands-on" participation and may involve individual work of a highly technical nature. The higher level involves application of technical knowledge and experience to work planning including implementation of medium to large scale projects.

Radio Technicians — £5485-£7818

To provide all aspects of technical support. Promotion prospects are good and linked with active encouragement to acquire further skills and experience. Minimum qualifications are a TEC Certificate in Telecommunications or equivalent plus two or more years' practical experience.

Cheltenham, a handsome Regency town, is finely endowed with cultural, sports and other facilities which are equally available in nearby Gloucester. Close to some of Britain's most magnificent countryside, the area also offers reasonably priced housing. Relocation assistance may be available.

For further information and your application form, please telephone Cheltenham (0242) 32912/3 or write to:



Recruitment Office, Government Communications Headquarters, Oakley, Priors Road, Cheltenham, Gloucestershire, GL52 5AJ. (2452)

Cameron Communications, an expanding division of C W Cameron Ltd, is a well established leader in the Visual Communications market, with high quality products for the professional and industrial users, including — Colour Graphic Displays — Interactive Video Systems — Video Projection — Videotex Terminals — Broadcast and Industrial Video Equipment — Touch Screen Displays — Computer Graphics Projectors.

The continuing growth and success of the company has resulted in the creation of further career opportunities based in our new Reading Office.

SENIOR ENGINEER Video/Computer Products (Ref. RE1)

Salary: £ Negotiable Based: Reading Plus: Car

A Senior Engineer is required to head a team of engineers operating in a modern well equipped department providing technical assistance to the Sales Group, OEM Customers, Dealer Network and End Users. Key activities will include the organisation of documentation system to cope with the expanding product line and installed equipment base. Provide and maintain a technical interface with the company's suppliers and its customers and introduce equipment training and acceptance facilities.

EUROPEAN SERVICE ENGINEER (Ref. RE2)

Interactive Video — Computer Products

Salary: £ Negotiable Based: Reading Plus: Car

An adaptable and self motivated person is required to provide service support and practical training on the above display systems at our distributors and customers premises in the UK, Europe and certain other countries.

Formal qualifications in electronics are required and service experience on video displays and some knowledge of personal computers or microprocessor based equipment would be a distinct advantage as would a foreign language.

TEST/SERVICE TECHNICIAN (Ref. RE3)

Interactive Video — Computer Products

Salary: £ Negotiable Based: Reading Plus: Car

An interesting position is offered which will involve carrying out regular quality control checks on pre-manufactured 'Interact' systems passing through our Reading distribution and service depot. The post will also involve service and update of display units returned from the field and the preparation of fault investigation reports. Formal qualifications in electronics would be an advantage.

A small amount of UK and overseas travel may also be required.

We offer an attractive remuneration package with competitive salaries and company profit sharing scheme. All replies will be dealt with in the strictest confidence.



Cameron
Communications

Write for an Application Form quoting the position reference number to: —
Mr J F Cowan
Personnel Department at
Company Head Office
C W Cameron Ltd
Communications Division
Burnfield Road
Glasgow G46 7TH
Tel: 041-633 0077 (2460)

ARTICLES FOR SALE

TO MANUFACTURERS, WHOLESALERS BULK BUYERS, ETC. LARGE QUANTITIES OF RADIO, TV AND ELECTRONIC COMPONENTS FOR DISPOSAL

SEMICONDUCTORS, all types, INTEGRATED CIRCUITS, TRANSISTORS, DIODES, RECTIFIERS, THYRISTORS, etc. RESISTORS, C/F, M/F, W/W, etc. CAPACITORS, SILVER MICA, POLYSTYRENE, C280, C296, DISC CERAMICS, PLATE CERAMICS, etc.

ELECTROLYTIC CONDENSERS, SPEAKERS, CONNECTING WIRE, CABLES, SCREENED WIRE, SCREWS, NUTS, CHOKES, TRANSFORMERS, etc.

ALL AT KNOCKOUT PRICES — Come and pay us a visit ALADDIN'S CAVE
TELEPHONE: 445 0749/445 2713

R. HENSON LTD.
21 Lodge Lane, North Finchley, London, N.12
(5 minutes from Tolly Ho Corner) (1613)

2764 EPROM 250NS £5.65

FD1771 FDC £17.50

+ 75p P&P + VAT

MICROSYSTEMS LTD.

208 CROYDON RD
LONDON SE20 7YX
01-659 7131 (2538)

ENCAPSULATING EQUIPMENT FOR coils, transformers, components, degassing silicone rubber, resin, epoxy. Lost wax casting for brass, bronze, silver, etc. Impregnating coils, transformers, components. Vacuum equipment, low cost, used and new. Also for CRT regunning metallising. Research & Development. Barratts, Mayo Road, Croydon CR0 2QP. 01-684 9917. (9678)

AMP terminals type 152387/2 - 90,000 half price. Automatic coil winder Blume and £450. Also equipment and stock for loud speaker manufacturing — cheap for clearance. 0924 470757. (2540)

FERROGRAPH CONTINUOUS loop cassette £10. BSC Type Garrard 301 £29. Low ohms resistance bridge metre £29. Single to three phase converter. Binocular prismatic lab microscope £145. Fibreoptic light source £35. Semi conductor tungsten to white light correction mirror £2.50. Carbon filter inserts £8. Ten KT 66 and two KT88 valves £48. Monocular microscope. Experimental laser mirror pairs £5.75 pair. New microscope lenses. Pipe bender with four sets of dies £55. Flexible pipes with BSF couplings and adaptor £3.50 ea. (air etc). Advance cable test set, 0-6000v £59. Lightfast screen inks for semiconductor/IC design and production. Nerve & mustard gas detection equipment £20. Quantity of items used in semiconductor design and manufacture. PCM equipment. FM/AM generator £89. Sweep & RF generators. 040-376236. (1627)

WIRELESS WORLD MAY 1984

Electronic Test Engineers/Technicians

Racal Radar Defence Systems part of the Racal Electronics Group is undergoing a period of rapid growth. To meet our increasing production demands, we need to recruit a number of Test Technicians and Test Engineers at the following locations in Surrey - New Malden, Chessington and Hersham, and at Leicester.

The Company manufactures a wide range of products aimed principally at the Defence Industry including radar early warning and guidance systems, military displays and ECM and ESM systems.

The Test Department is responsible for the test and diagnostic functions on a wide range of complex radar equipment using high quality manual and automatic test equipment.

Applicants should be educated to HNC/HTC standard and have practical knowledge or experience of radar and/or microwave systems.

Conditions of employment are excellent including a competitive salary, five weeks holiday, and company pension and life assurance scheme.

Interested? Then phone me on: 01-397 5281 or alternatively write with brief details of qualification experience and current salary to:

Mr P N Willis,
Senior Personnel Officer,
Racal Radar Defence Systems Ltd.,
Davis Road, Chessington, Surrey.

Racal's people are Racal's success

RACAL

(2188)

BRITISH ANTARCTIC SURVEY

Electronics Technicians

Applications are invited from suitably qualified and experienced persons to work as part of a team working on the design, construction and maintenance of a wide range of electronic equipment.

The successful applicants must be able to build electronic circuits and systems which will be used for scientific research in the Antarctic at the Survey's Stations, in remote field sites, aboard their ships and in their aircraft. They will be required to spend periods in Antarctica, sometimes working from tents, operating, maintaining and installing electronic equipment. resourcefulness and initiative are essential as much of the field work will be unsupervised.

Qualifications: ONC/HNC or equivalent technical training combined with a sound practical electronics background in digital and/or analogue circuiting. The understanding of microprocessor systems with the ability to maintain low level software is an advantage. Academically well qualified younger applicants, but with limited practical experience will be considered and relevant necessary training will be given.

Salary: Dependant on qualifications and experience in the scale £6483 - £7552 p.a. (Professional and Technology Officer Grade IV).

The vacancies are at Professional and Technology Officer grade IV for period appointments of 3 years.

Applicants should be physically fit and must be male as field work requires successful candidates to share tented accommodation and to live in premises provided by the British Antarctic Survey which are only equipped for male accommodation.

For further details and an application form please write to:

The Establishment Officer
British Antarctic Survey
High Cross
Madingley Road
Cambridge CB3 0ET

Please quote Ref: BAS 14
Closing date: 9 May 1984.

(2558)

Electronic Opportunities

£6,000 - £18,000 p.a.

- ★ Microwave Design
- ★ Sales
- ★ Test and Commissioning
- ★ ATE Applications
- ★ Field Service

Many of our clients in the S.E. can offer excellent prospects in the above disciplines.

Technical Services (London) Ltd.
13 Station Approach,
Northwood HA6 2XN
STD: 09274 21622 (Agy)
Eves. & weekends
St. Albans (0727) 30602 (2534)

GRADUATE DESIGNERS wanted to join videotex specialist firm based at Whitechapel Technology centre. Must be versatile, experienced and familiar with the viewdata system. Call John Barton on (01) 377 1982 (2561)

ARTICLES FOR SALE

SPEAKERS

MOSTLY UNDER HALF PRICE.

PEERLESS

TWEETER 94mm DIAM 1" SOFT DOME
50 watts £4.65 PP 50p

SEAS

12" 40 watts £7.65 PP £1.67

AUDAX

8" 25 watts £2.85. 40 watts £5.50 PP 65p.

TRADE ENQUIRIES VERY WELCOME.

Celestion 15" 50 watt 15Ω £20. 10"×6 1/2" £5.50.
Audax 30 watt mid £3.80 3" 10w 4Ω £2.50. 10 watt
tweeter £1.60. Elac 7"×3 3/4" £1.60. Shadow 6"×4"
4Ω £1.85. 6" £2. 1" T.T. 6"×4" 4Ω 10 watts £5.
Peerless 5" mid £1.75. Eagle 2 1/4" tweeter 95p
40ohm tweeter 65p. Audax 2 way 30 watt. Crossover
70p. All items 65p PP.

STUART SPARES
HIGH ST. SOUTH RUSHDEN, NORTHANTS
0933-312352. CLOSED MON/TUES (2553)

ARTICLES FOR SALE

BBC MICROCOMPUTER "GENLOCK" ROAD

This card, type 630B enables the RGB and monochrome video outputs of the computer to be locked to an external video or sync signal. The card is supplied complete, ready to fit inside the computer with full installation instructions. For further details send s.a.e. to:

ABBEY AUDIO, PO BOX 2
STAINES, MIDDX TW18 2NH
Tel: Staines (0784) 63319 (2547)



Private enquiries send 13p in stamps for brochure

THE QUARTZ CRYSTAL CO. LTD.

Q.C.C. WORKS, WELLINGTON CRESCENT
NEW MALDEN, SURREY 01-942 0334 & 2988

ARTICLES FOR SALE

FERROGRAPH RECORDER test set RTS2 and auxiliary test units ATU1 for sale. As new. Tel: (0385) 882678. (2565)

FOR SALE IBM Electric Golfball Printer. Letter quality with centronics parallel interface. In very good condition. £160. Tel: East Grinstead 25759. (2551)

FOR SALE: MARCONI spacial purpose HF radio station type HS27/HR28. (Military type D11). Complete with all manuals. Tel: Royston 71825. (2554)

RACAL COMMUNICATION RECEIVERS

500Kc s to 30Mc s IN 30 BANDS 1Mc s WIDE RA17 MK11
 (100 RA17L E150 RA17IE E275 NEW METAL LOU-
 VERED CASES FOR ABOVE E25 E26 AIR RECEIVERS AIR
 TESTED AND CALIBRATED IN OUR WORKSHOP. SUPPLIED
 WITH MANUAL AND DUST COVER IN FAIR USED CONDITION
RACAL SYNTHESISERS (DECADE FREQUENCY GENERATOR)
 MA3500 SOLID STATE FOR USE WITH MA79 RA111
 RA171 RA1717 ETC (E100 to E150 MA250G 16Mc s TO
 316Mc s E100 to E150 MA250G PRECISION FRE-
 QUENCY STANDARD 5Mc s TO 100KHz E100 to E150
EDDYSTONE RECEIVER TYPE C3847 SOLID STATE
 SINGLE CHANNEL SSB MAINS OR BATTERY POWERED
 1.6 to 27.5Mc s AND 400 535KHz E100 WITH MANUAL
REDIFON SSB RECEIVER TYPE R499 SOLID STATE 10
 FIXED CHANNELS RANGE 1.5 TO 30Mc s AND 355KHz TO
 525KHz POWER MAINS OR BATTERY COMPLETE WITH
 SB ADAPTOR ARU10A E100 WITH MANUAL REDIFON TT10
 OR TT11 AUDIO TELEPRINTER CONVERTOR SOLID STATE
 TESTED WITH CIRCUIT 11 C25 CRED TYPE 75 TELEPRINTER
 50 AND 75 BAUDS FOR USE WITH ABOVE CONVERTOR E25

OSCILLOSCOPES

CT436 DUAL BEAM OSCILLOSCOPE 5Mc s E45
 TEKTRONIX 6A7A 100Mc s DUAL TRACE SOLID STATE
 E350 WITH MANUAL MARCONI TP995 SIGNAL GENER-
 ATORS FROM 2Mc s OR 1.5Mc s TO 220Mc s AM FM AZM
 E80 E20 E80 E25 E100 WITH MANUALS TP7605 DIF-
 FERENTIAL DC VOLT METER 0 TO 1100 volts (E100 TP2002
 AM SIGNAL GENERATOR 10Kc s TO 72Mc s E300
 TP2002AS FM AND AM SIGNAL GENERATOR 10Kc s TO
 72Mc s E300 TP21700 DIGITAL SYNCHRONIZER FOR ABOVE
 E350 TP10666 G FM AM SIGNAL GENERATOR
 10Mc s TO 420Mc s E300 TP1245 CIRCUIT MAGNIFICATION
 METER AND TP1246 OSCILLATOR E200 HP SIGNAL GENER-
 ATORS E208 E150 E150 E150 E150 E150 E150
 E70 E12A 450 1200Mc s E200 MARCONI AF WATT
 METER CT44 NOT ABSORPTION 200 MICROWATTS TO 25
 WATTS IN 10 RANGES SWITCHED 2150 Ohms E45
 TROBIA AF WATT METER 1 MILLIWATT TO 10 WATTS
 25 Ohms TO 20K Ohms IN 48 STEPS E65 THYRISTOR TEST
 SET CT156 VOLTAGES UP TO 2KV E100 TEKTRONIX
 4002A GRAPHIC COMPUTER TERMINAL WITH JOYSTICK
 E400 TEKTRONIX 4001 HARD COPY UNIT FOR USE WITH
 ABOVE E150 BOTH UNITS FOR E500 RACAL DIGITAL
 COUNTERS TYPE R610 125Mc s E50 RACAL R36 CDUM
 TER 35Mc s E50

V A T AND CARRIAGE ON ABOVE ITEMS EXTRA
 ALL ITEMS ARE BOUGHT DIRECT FROM H.M. GOVERNMENT
 BEING SURPLUS EQUIPMENT PRICE SEE WORKS S.A.E FOR
 ALL ENQUIRIES PHONE FOR APPOINTMENT FOR DEMON-
 STRATION OF ANY ITEM

JOHN'S RADIO
 WHITEHALL WORKS, 84 WHITEHALL ROAD EAST
 BIRKENHEAD, CH40 1DQ 021 2ER
 TEL (0274) 684007

WANTED REDUNDANT TEST EQUIPMENT RECEIVING
 AND TRANSMITTING EQUIPMENT VALVES PLUGS AND
 SOCKETS SYNCHROS, ETC (1848)

LINSLEY HOOD DESIGNS

75Watt and 100W amps
 Audio Signal Generators

75Watt amp p.c.b. £2.30
 100Watt Mosfet p.c.b. £4.00

p&p 50p
 S.A.E. for leaflets
TELERADIO ELECTRONICS
 325 Fore Street, London N9 0PE
 (1762)

SURPLUS STOCK COMPONENTS

We import and export all types of electronics
 components. Monthly stocklists are available on
 request. We also export various quality German
 products. Enquiries are always welcome.

Agents wanted for our hobby kits. Contact us at:
 Resco Electronic,
 Hessenbachstr. 35,
 8900 Augsburg, W. Germany.
 Tel: 0821 524033. Tx: 53776 RESCO D
 (2564)

7-track portable recorder, four head
 blocks £65. Car/van/lorry gas conversion
 kit £89. Flann microwave attenuator £35.
 50kV regulated, variable EHT supply
 (Brandenburg) £89. Microgen laboratory
 projector £59. Binocular, prismatic
 laboratory microscope £145 (mechanical
 stage). Fibreoptic laboratory light source
 £35. Braun Hobby professional
 electronic flash (rechargeable batteries)
 £39. Heavy duty multiple output power
 supplies. Star-Delta starter box £25. Al-
 ternator control unit £35. Single to three
 phase converter. Vacuum pump and
 motor £35. Compressor £39. Standard
 Reference Inductors £7.50 ea. Variac
 20A £49. 2KW 340/110 transformer,
 three outlets, £39. Rank wow/
 flutter meter £75. Polaroid back £15.
 Grunther CR1 servicing, testing and re-
 activating Unit £40. 20A variable resis-
 tance £20 (metal case). Mullard H.S.
 valve tester. Avo valve characteristic
 meter.

040-376236
 (2016)

FOR SALE — Marconi OE1761 Autotest computer
 controlled for automatic electrical inspection of
 PCB's Offers invited. Phone 01-223 2102 ext.
 211. Mr D. I. Fenton-Lewis. (2541)

SETTING UP A RADIO STATION?

Professional quality VHF/FM broadcast
 transmitters and repeater links available.
 25-250 watts, all solid state, continuously
 rated. Mono/Stereo versions. High sta-
 bility PLL/Xtal references. Competitively
 priced in 100 watt model, with integral
 mains power supply — £280. Fully
 guaranteed.

Cyberscan International,
 3 Eastcote View, Pinner,
 Middx HA5 1AT. Tel: 01-866 3300
 (2557)

COMPONENT SCOOP PURCHASE

ONE MILLION C280 MULLARD PHILIPS POLYESTER CA-
 PACITORS. Ideal for the trade or manufacturing. 0.01 to
 0.47 mid 100v wkg Assorted values E10 per 1,000 lot,
 p.p. E1 1,000 of one value E1250, p.p. E1 5,000 assorted
 E42, p.p. E2 Please add VAT. MAINS TRANSFORMERS
 Famous manufacturer TYPE 1 Midget clamped type
 Input 200-250V 250 c.s. Output 250-0-250 60 m a 6.3v at 2
 amps. E250 each, p.p. E150 Ten transformers E1750
 carriage E4 TYPE 2 Mains input Output 35V at 1 1/4 amp
 Price E2.25 each, carriage E150 Ten for E16, carriage E5
 Larger discounts for larger quantities Ten thousand
 valves, 1925 to 1975, modern and obsolete types. Send
 60p (refundable) VERSATILE BENCH POWER SUPPLY
 UNITS. Contains high quality transformer made to exacting
 specifications giving one 20v output and one 20-0-20v
 output D.C. output fused at 3 amps but will easily give 5
 amps Input AC 110 250v 50 c.s. Bridge rectification
 Contained on metal chassis with robust compact case
 size 75x54. Easily modified to give 40v and 50v. Makes
 ideal variable power supply. Usual cost around E60. Our
 price as new with circuit E850 each, p.p. E3 Two units
 E20 post free XENON FLASHER UNITS. Complete panel
 with dual flash rate (slow/fast) 12v to 18v D.C. includes
 tube, base, fuseholder, 10 metres of connecting wire. Full
 instructions and guarantee. As used on police vehicles
 ideal for boats and cars. Should be E40 each. Our price
 E12 each, p.p. E150 Two units E23 post free. Ideal emer-
 gency beacons for boats and cars

DEPT. W.W. MYERS ELECTRONIC DEVICES
 1214 Harper Street, Leeds LS2 7EA. Tel: 452045

WORLD RADIO TV HANDBOOK

1984 ed. £12
1984 THE RADIO AMATEUR'S
H/B by A.R.R.L. Price £12.50
BEGINNER'S GUIDE TO INTE-
GRATED CIRCUITS by I. R. Sin-
 clair Price £4.50
ELECTRONIC PROTOTYPE CON-
STRUCTION by S. D. Kasten
 Price £15.95
UNDERSTANDING ELECTRONIC
SECURITY SYSTEMS by M. D.
 Lamont Price £2.30
UNDERSTANDING DIGITAL
ELECTRONICS by G. McWhorter
 Price £4.30
INTRODUCTION TO
ELECTRONIC SPEECH SYNTH-
SIS by N. Sclater Price £8
ELECTRONICS FOR HIGHER
TECH by S. A. Knight Price £10
DOMESTIC VIDEO CASSETTE
RECORDERS. A SERVICING
GUIDE by S. Beeching
 Price £15.50
SEMICONDUCTOR DATA BOOK
 by A. M. Ball Price £7.50
 ★ ALL PRICES INCLUDE
 POSTAGE ★

THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKIST
 of British and American
 Technical Books
19-21 PRAED STREET
LONDON W2 1NP
 Telephone: 01-402 9176
 Closed Saturday 1 p.m.
 Please allow 14 days for
 reply or delivery
 (2245)

SATELLITE TELEVISION DISHES 1.2m
 diameter petal type for home construction from
 sheet aluminium. Suitable for 4GHz band detailed
 constructional diagrams and drawings £1.50
 including postage to all countries. W N Jones 2
 Ty'n Rhos, Gaerwen, Anglesey, Gwynedd, Wales
 LL60 6HL. (2549)

VALVES, PROJECTOR Lamps, 6000 types, list
 75p, world wide export. Cox Radio (Sussex) Ltd.,
 The Parade, East Wittering, Sussex. Phone (024
 366) 2023. (1991)

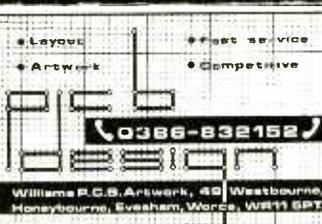
WAVEGUIDE, Flanges and Dishes. All stan-
 dard sizes and alloys (new material only) from
 stock. Special sizes to order. Call Earth Stations,
 01-228 7876, 22 Howie Street, London SW11
 4AR. (2099)

SERVICES

Thamescity Limited

Electronic (Analog and Digital), electro pneu-
 matic and control systems. R. & D. facilities for
 long or short run assembly and test to your
 design or ours at our new Maidstone facility.

48 Southwark Street
 London SE1 1UH
 Tel: 01-807 7441
 Telex: 8954865
 (2261)



DESIGN SERVICES. Electro design de-
 velopment and production service available for
 digital and analogue instruments. RF Transmis-
 sion and receivers, telemetry and con rol
 systems 20 years experience. R.C.S. Electronics,
 Wolvey Road, Ashford, Middlesex. Phone Mr
 Falkner 53661. (834)

SERVICES

FOR THE BEST PCB SERVICE AVAILABLE

★ **Circuit Design & Development**
 Digital and Analogue

★ **Artwork Layout**
 Work of the highest standard by experienced
 draughtsmen. No minimum charge.

★ **Board Manufacture**
 Prototype to semi-production, excellent rates,
 24-hour prototype service from filmwork.

★ **Wiring & Assembly**
 PCB assembly, wiring and cable forming by
 qualified staff

★ **Test**
 Full test facilities available.

One or all services avail-
 able, no order too small.
 Please telephone Chelms-
 ford (0245) 357935, or write
 to HCR Electronics, The In-
 dustrial Unit, Parker Road,
 Chelmsford. (1169)

ELECTRONIC SERVICES. Design and de-
 velopment. Repair, test, PCB assembly. Equip-
 ment prototypes and production. 14 years'
 experience since 1970. Young Electronics Ltd,
 Southgate, London N14. Tel: 01-886 6709.
 (2451)

PROFESSIONAL DESIGN SERVICE. Anal-
 ogue/RF circuit/system design. Specialising in
 microwave amplifier, oscillator and network
 design. MOTOROLA 6805/6809 series micropro-
 cessor design/development capability. All work
 carried out to a high standard by competent pro-
 fessional engineers. Trontect, electronics Design
 Services, 81 Finchampstead Rd., Wokingham,
 Berkshire. Tel: 0734 790103. (2439)

PROFESSIONAL MAST ERECTION
 SERVICE for mobile radio. Building mounted
 masts from only £5 per foot up to 60ft. 75ft or
 more — £7.50 per foot. Ground-standing masts
 may be extra for concrete base, etc. CTVR
 Comms, 1 Botesford Lang, Allington, Grantham,
 Lincs. Tel.: 0400 81296. (2539)

TURN YOUR SURPLUS transistors etc. into
 cash, immediate settlement. We also welcome the
 opportunity to quote for complete factory clear-
 ance. Contact COLES-HARDING & CO., 103
 South Brink, Wisbech, Cambs. 0945
 584188. (9509)

ASSEMBLY CAPACITY

PRINTED CIRCUIT BOARDS

A multi-product factory, part of a large Company, situated in
 East Lancashire, offers capacity for production of printed circuit
 board assemblies.

Production facilities include:—

- ★ **Automatic component insertion**
 - ★ **Flow soldering**
 - ★ **Automatic test equipment**
 - ★ **Well equipped laboratory**
 - ★ **Quality assurance Procedures**
 - ★ **A metrology department with British Calibration service approval**
 - ★ **Delivery performance**
 - ★ **Skilled labour force with the personal approach of a small highly technical unit.**
- The Company combines a high degree of commitment to meeting delivery schedules with an excellent reputation for quality which may be to British Defence Standards 05-21.**

RING IAN GREEN 0254 55241.
QUOTING REF. EWW

Crotech Oscilloscopes Nationwide availability local to You

London & Home Counties

Audio Electronics	London W2	01-724-3564
Carston Electronics	London N1	01-267-5311
Kentwood Electronics	Reading	0734-698040
Aughton Instruments	Strood	0634-724751

Wales & West

Glevum Instruments	Gloucester	0452-31620
--------------------	------------	------------

East Anglia
Electronic & Computer
Workshop Chelmsford 0245-62149
Maplin Electronics Rayleigh 0702-552911
Ambit International Brentwood 0277-230909

Midlands & North

Northern Instruments	Leeds	0532-791054
Universal Instruments	Leire (Leics)	0455-202391
Electronic Measurement Services	Manchester	061-273-4653
Radio Telephone Service	Derby	0332-41235

Scotland

RMR Measurements	Cumbernauld	02367-28170
------------------	-------------	-------------



Crotech Instruments Limited

5 Nimrod Way · Elgar Road · Reading · Berkshire · RG2 0EB
Telephone: (0734) 866945 Telex: 847073 POWLIN G

CIRCLE 073 FOR FURTHER DETAILS.

WIRELESS WORLD

INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 93-103

PAGE		PAGE	PAGE
AC/DC Electronics Corp	84	Global Specialities Corporation	5
Airlink Transformers	80	GP Industrial Electronics Inside Back Cover/Back Cover	
AM Electronics	84	Grandata Ltd	16
Armon Electronics	10	Greatch Electronics	19
Aspen Electronics Ltd	88		
Audio Electronics	22, 23		
		Happy Memories	73
Barrie Electronics Ltd	73	Harris Electronics (London)	14
B. Bamber	24	Harrison Bros	24
Barlec-Richfield Ltd	20	Hart Electronics Kits	85
Beckenham Peripherals	10	Henson, R. Ltd	20
Black Star Ltd	80	Hibmast	4
Binary Systems	76	House of Instruments	25
Cambridge Kits	92	ILP Electronics	25
Cambridge Micro Prossor's	21	Integrex Ltd	18
Carston Electronics	46		
Clark Masts Ltd	68	J. A. F. Graphics	92
Colomor Electronics	14	J.P.R. Electronics	85
Computer Appreciation	85		
Control Universal	12	Langrex Supplies Ltd	74
Crimson Elektrik Stoke	80	Levell Electronics	89
Crotech Instruments	104	Light Soldering Development	16, 92
Cynpex Ltd	9		
		Midwich Computer Co Ltd	9
Dataman Designs	26	Minim Electronics	22
Display Electronics	83		
		Olson Electronics	14
Electronics Brokers	13, 15, 11, 17	Opus Supplies	1, 75
Electronic Equipment Co	84	Orion Scientific Products	80
Ellmax Electronics Ltd	22		
EMS Manufacturing	4	Pantechinc	90
Essex Electronics	68	PM Components	90, 91
		Pye Unicam	79
Farnell Instruments	Inside Front Cover		
Future Film Development	24		
Fylde Electronics Lab	20		
		Radford Laboratory	10
		Radio Component Specialists	21
		Radiocode Clocks	12
		Ralfe PF	84
		Research Communication	11
		Reticon (EG&G)	16
		RST Valves	74
		Solent Electronic Services	88
		Service Trading Co Ltd	76
		South Midland Communication	90
		Sowter Ltd (EA)	18
		Special Product Distribution	17
		Stewart of Reading	76
		Strumech Engineering	89
		Surrey Electronics	14
		Taylor Bros	88
		Technomatic	86/87
		Tektronix	67
		Thacker AH	20
		Thanet Electronics	9
		Thomson CSF	45
		Thurlby Electronics	73
		Timebase Q Teq	88
		TK Electronics	89
		Triangle Digital Services	4
		Valradio Power	17
		Vellerman UK	18
		Vigilant Communications	92
		XTR Electronics	73

OVERSEAS ADVERTISEMENT AGENTS

France & Belgium: Norbert Hellin, 50 Rue de Chemin Veat, F-9100, Boulogne, Paris.

Hungary: Ms 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: Jay Feinnan, Business Press International Ltd, 205 East 42nd Street, New York, NY 10017 - Telephone (212) 867-2080 - Telex: 238327.

Jack Farley Jnr., The Farley Co., Suite 1584, 35 East Walker Drive, Chicago, Illinois 60601 - Telephone (312) 63074.
Victor A. Jauch, Elmatex International, P.O. Box 34607, Los Angeles, Calif. 90034, USA - Telephone (213) 821-8581 - Telex: 18-1059.

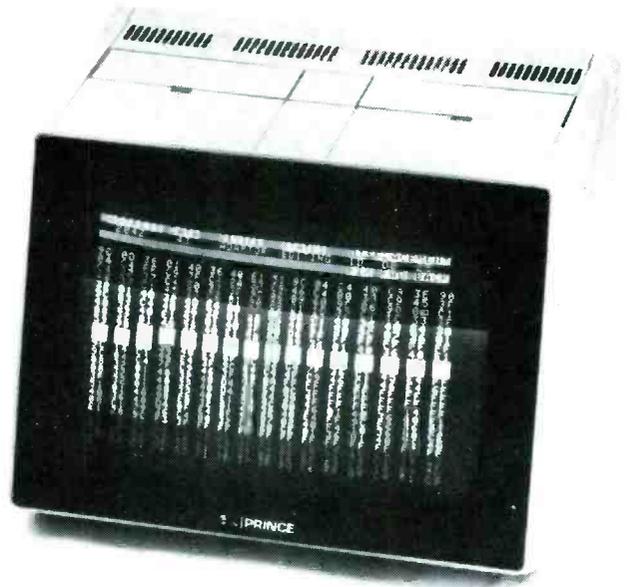
Jack Mantel, The Farley Co., Suite 650, Ranna Building, Cleveland, Ohio 4415 - Telephone (216) 621 1919.
Ray Rickles, Ray Rickles & Co., P.O. Box 2028, Miami Beach, Florida 33140 - Telephone (305) 532 7301.

Tim Parks, Ray Rickles & Co., 3116 Maple Drive N.E., Atlanta, Georgia 30305. Telephone (404) 237 7432.
Mike Loughlin, Business Press International, 15055, Memorial Ste 119, Houston, Texas 77079 - Telephone (713) 783 8673.

Canada: Colin H. MacCulloch, International Advertising Consultants Ltd., 915 Carlton Tower, 2 Carlton Street, Toronto 2 - Telephone (416) 364 2269.
* Also subscription agents.

EP8000 EPROM EMULATOR PROGRAMMER

**NEW
PRODUCT**



The new microprocessor controlled EP8000 Emulator Programmer will program and emulate all EPROMs up to 8k x 8 sizes, and can be extended to program other devices such as 16k x 8 EPROMs, Bipolar PROMs, single chip microprocessors with external modules.

Personality cards and hardware changes are not required as the machine configures itself for the different devices.

The EP4000 with 4k x 8 static RAM is still available with EPROM programming and emulation capacity up to 4k x 8 sizes.

● EP8000 8k x 8 Emulator Programmer – £695 + £12 delivery ● BSC8 Buffered emulation cable – £49 ● SA27128 Programming adaptor – £69 ● SA25128 Programming adaptor – £69 ● EP4000 4k x 8 Emulator Programmer – £545 + £12 de-

FEATURES

- Software personality programming/emulation of all EPROMs up to 8k x 8 bytes including 2704, 2708, 2716(3), 2508, 2758A, 2758B, 2516, 2716, 2532, 2732, 2732A, 68732-0, 68732-1, 68766, 68764, 2564, 2764. Programs 25128, 27128 with adaptors.
- No personality cards/characterisers required.
- Use as stand alone programmer, slave programmer, or EPROM development system.
- Checks for misplaced and reversed insertion, and shorts on data lines.
- Memory mapped video output allows full use of powerful editing facilities.
- Built-in LED display for field use.
- Powerful editing facilities include: Block/Byte move, insert, delete, match, highlight, etc.
- Comprehensive input/output – RS232C serial port, parallel port, cassette, printer O/P, DMA.
- Extra 1k x 8 scratchpad RAM for block moving.

livery ● BSC4 Buffered emulation cable – £39 ● BP4 (TEXAS) Bipolar PROM Module – £190 ● Prinz video monitor – £99 ● UV141 EPROM Eraser with timer – £78 ● GP100A 80 column printer – £225 ● GR1 Centronics interface – £65

VAT should be added to all prices

DISTRIBUTORS REQUIRED

EXPORT ENQUIRIES WELCOME

GP Industrial Electronics Ltd.

Tel: Plymouth (0752) 332961
Telex: 42513

Unit E, Huxley Close, Newnham Industrial Estate, Plymouth PL7 4JN

WW-002 FOR FURTHER DETAILS

P8000 — THE PRODUCTION PROGRAMMER THAT HANDLES ALL NMOS EPROMS



**NEW
PRODUCT**

- Checks, Programs, Compares up to 8 devices simultaneously
- Handles all NMOS EPROMS up to projected 128K designs with no personality modules or characterisers — See list
- Easy to use, menu driven operation for blankcheck, program, verify, illegal bit check, checksum, self-test
- Constant display of device type, mode and fault codings
- Individual socket LED indicators for EPROM status
- Comprehensive EPROM integrity checks — Illegal bit check, data and address shorts, constant power line monitoring
- Full safeguard protection on all sockets
- Automatic machine self-test routine
- RS232C interface supplied as standard
- Powered down sockets
- Cost effective price — £695 + VAT
- Available from stock

Write or phone for more details

2704
2708
2716(3)
2508
2758A
2758B
2516
2716
48016
2532
2732
2732A
68732-0
68732-1
68766
68764
2764
2564
MK2764
25128
27128

DISTRIBUTORS REQUIRED

EXPORT ENQUIRIES WELCOME

GP Industrial Electronics Ltd.

Tel: Plymouth (0752) 332961
Telex: 42513

Unit E, Huxley Close, Newnham Industrial Estate, Plymouth PL7 4JN

WW-003 FOR FURTHER DETAILS