ELECTRONICS &

Wireless world

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May 1984 85p.

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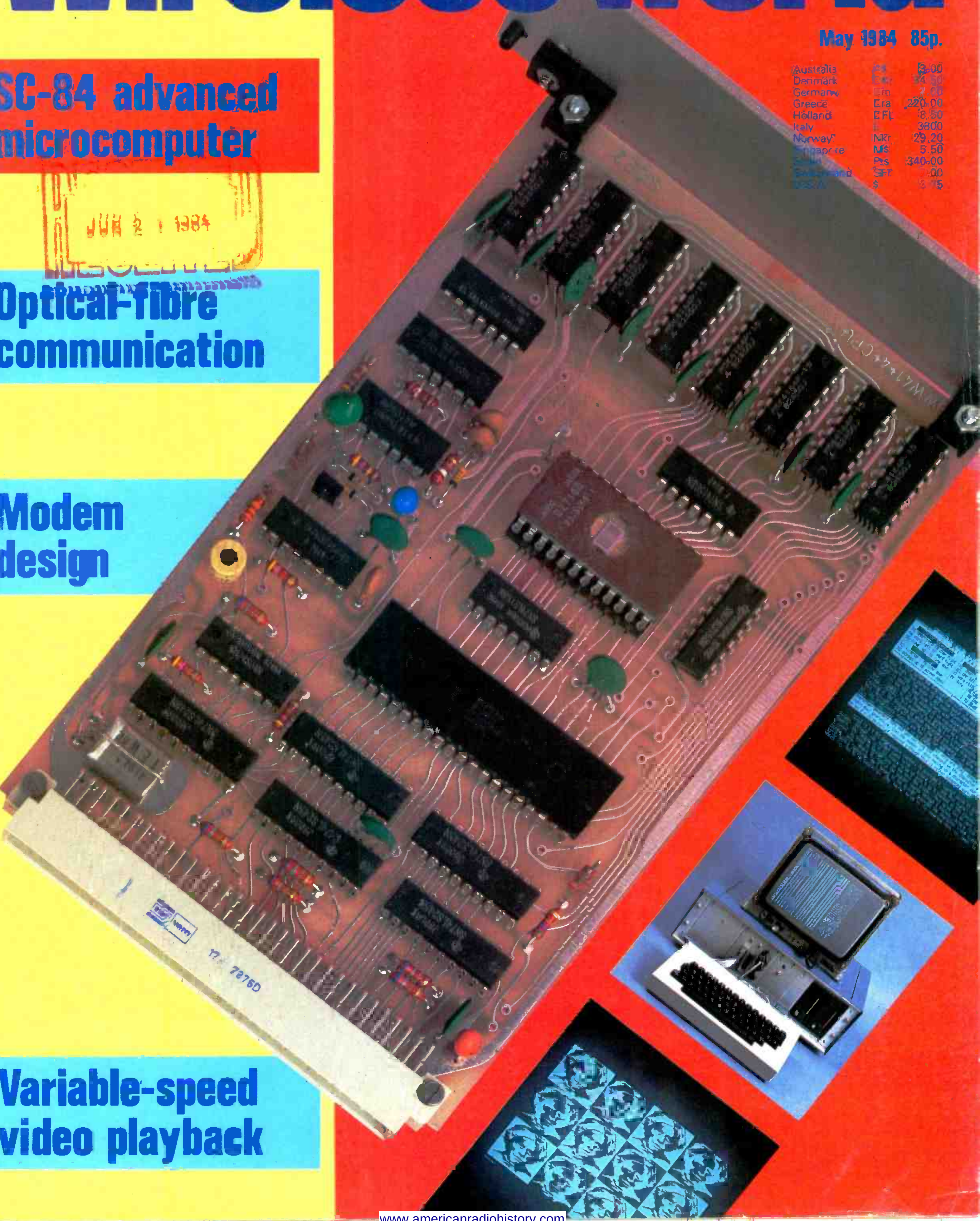
SC-84 advanced microcomputer

Optical-fibre communication

Modem design



Variable-speed video playback

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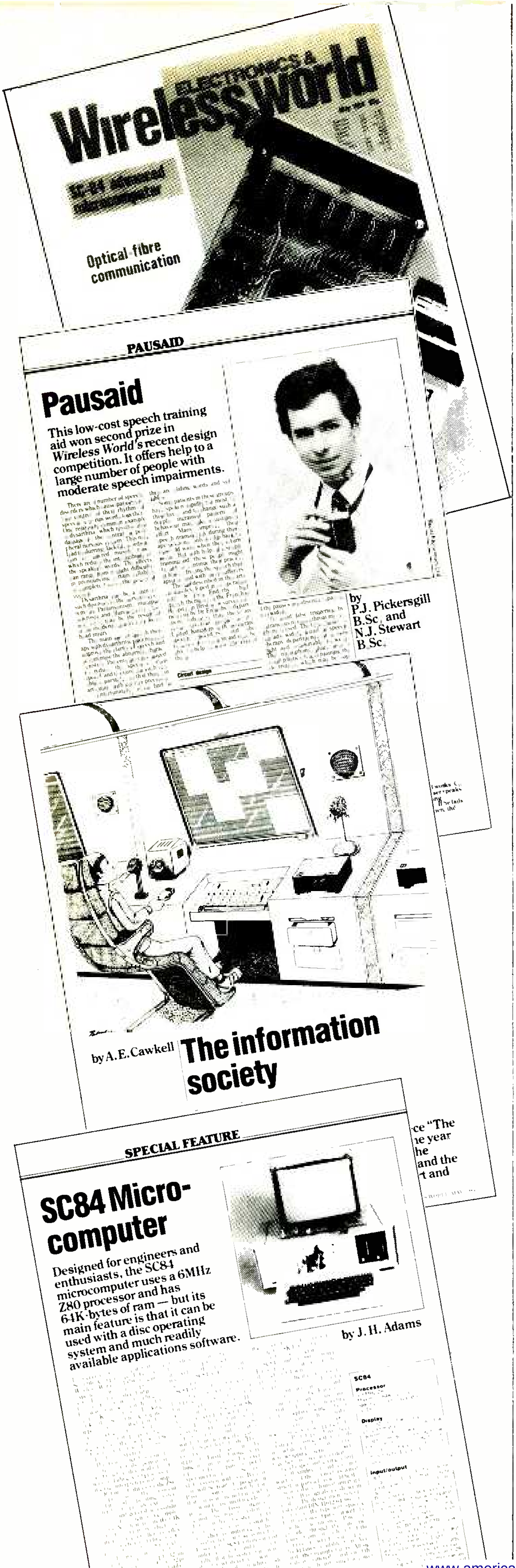
ELECTRONICS &
Wireless World
over 70 years in independent electronics publishing

FEATURES

REGULARS



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

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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 changes 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 eprom, 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 underpriviledged regions which don't at present have their own d.js, listeners would (for the price of an eprom) 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.

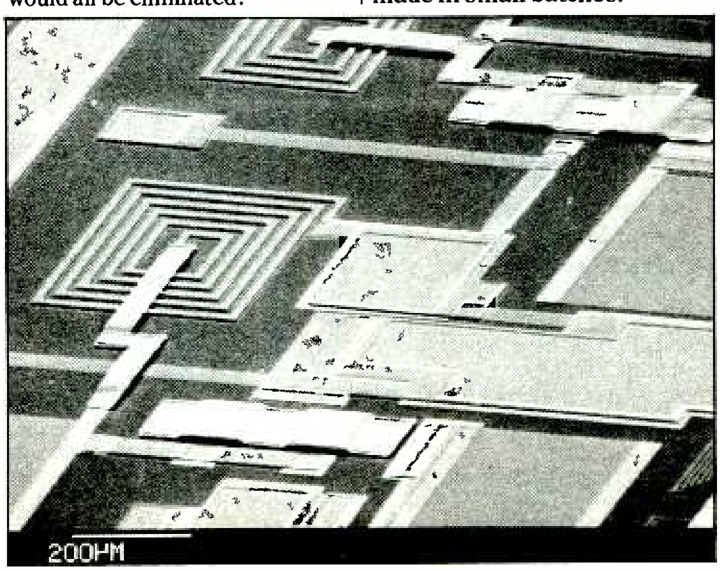
Laser etching — a path to bigger i.cs

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".

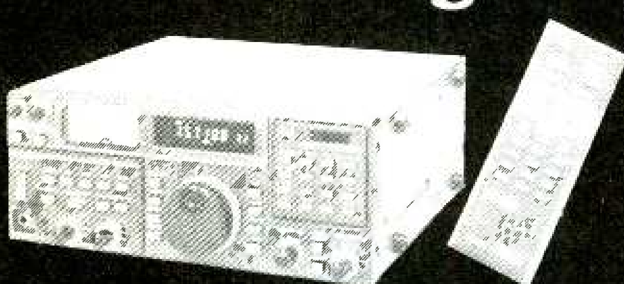
Frank Chapple, General Secretary of the Electrical, Electronic, Telecommunications and Plumbing Union, commented; "The EETPU is the only union to have its own training facility for running courses in new technology. Through this development the union has been able to offer a first class service that 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.

ICOM

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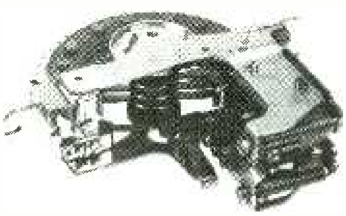

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4118-15	D1	3 75
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4164-20	D2	3 95
4416-20	D2	6 60
4564-15		5 25
5516-25		7 73
6116-3	D1	3 72
6116-LP3	D2	4 67
2532-45	D2	3 50
2708-45	D2	3 25
2716-35	D1	4 50
2716-45	D1	3 50
2716-3	D1	4 50
2732-35	D1	4 58
2732-45	D1	3 75
2764-30	D1	3 92
2764-250NS TI		3 92
2764-250NS BBC		5 95
2564-30	D2	6 00
27128-30	D2	24 50

Buffers

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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 Convertors

ZN435	D1	3 70
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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
ZN432CJ-10	D1	25 98
ZN432E-10	D1	10 88
ZN433CJ-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	1 00
A169A 3 6864MHz	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 35
FD1797	D6	24 35
WD1691	D2	12 00
WD2143 01	D2	7 90

Regulators

78L05	0 26
78L12	0 26
78L15	0 26
7805	0 33
7812	0 33
7815	0 33
7905	0 46
7912	0 46
7915	0 46
LM309K	0 98
LM317K	1 92
LM323K	4 58
LM338K	5 21
78HGASC	8 13
78H05SC	6 28
78H12ASC	7 40
78S40DM	6 28
78S40PC	2 50

6800 Family

6800	D7	2 87
6802	D5	2 61
6803C		5 83
6809	D6	7 13
6810	D1	1 25
6821	D3	1 31
6840	D4	3 92
6843L		20 88
6845	D5	5 88
6850	D2	1 31
6862		0 00
6871-Al		14 17
68488	D2	5 78
6875		7 13
68B00	D7	4 30
68B09	D6	9 96
68B21	D3	1 88
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68B50	D2	1 83
MC68B54P		7 75

Z80 Family

Z80A CPU	D2	2 42
Z80B CPU	D1	7 78
Z80A CTC	D1	2 20
Z80B CTC	D1	7 78
Z80A DART	D1	5 50
Z80A DMA	D2	6 95
Z80A P10	D1	2 20
Z80B P10	D1	7 78
Z80 SIO-0	D4	8 50
Z80A SIO-0	D4	9 00
Z80B SIO-0	D4	29 78
Z80 SIO-1	D4	8 50
Z80A SIO-1	D4	9 00
Z80B SIO-1	D4	29 78
Z80 SIO-2	D4	8 50
Z80A SIO-2	D4	9 00
Z80B SIO 2	D4	29 78
MK3886		7 00
MK3886-4		8 00

8080 Family

8085A	D4	3 07
8212		1 50
8216		1 37
8224		1 92
8228		3 25
8251A	D5	2 60
8253		3 33
8255A	D5	2 50

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

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6402		6 00
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AY5-3600	D2	7 37
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LM308AN		0 73
LM308N		0 47
LM311N		0 84
LM319		2 23
LM324N		0 32
LM339N		0 37
LM348N		0 53
LM358N		0 28
LM393N		0 34
LM725CN		1 33
LM741CP		0 18
LM747CP		0 48
LM748CP		0 22
MC1413P	D1	0 66
MC1416	D1	0.66
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MC1496P		0 65
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MC3242A		5 25
MC3302P		0 40
MC3340P		1 97
MC3357P		1 56
MC3423PL		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
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NE556CP		0 45
RO3 2513L	D1	7 82
RO3-2513U	D1	7 82
SN75107BN		0 58
SN75110AN		0 68
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SN75154N		0 87
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SN75160AN		2 15
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SN75162AN		3 31
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SN75189		0 44
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SN75452BP		0 24
SN75453BP		0 24
SN75454BP		0 24
SN75468N		1 08
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SN75492AN		0 61
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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
22	0 17	0 48	1 31
24	0 20	0 63	1 44
28	0 23	0 57	1 59
40	0 33	0 99	1 96

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

Data sheets are available on items marked D
Prices are as follows

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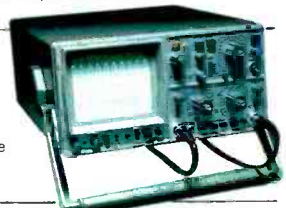

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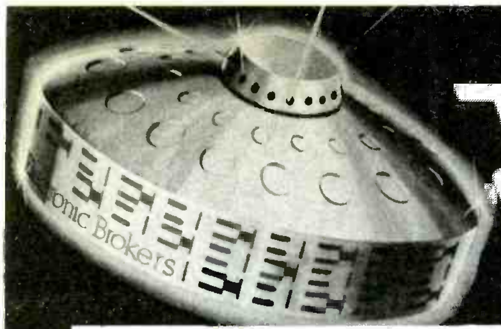

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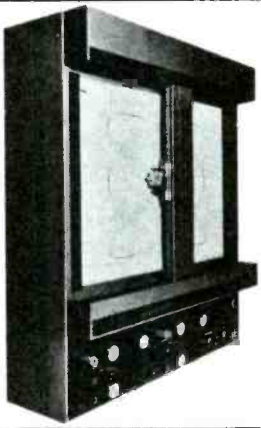

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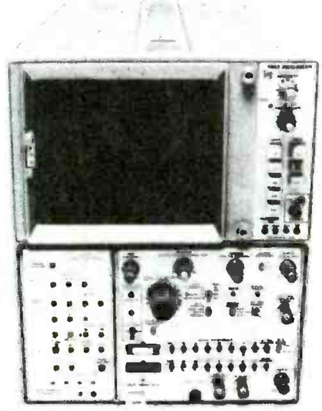

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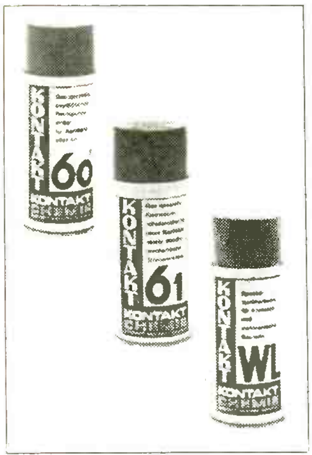

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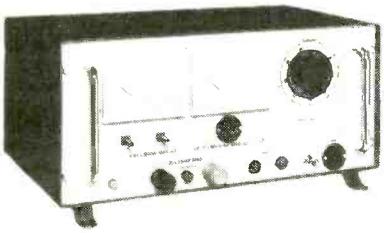

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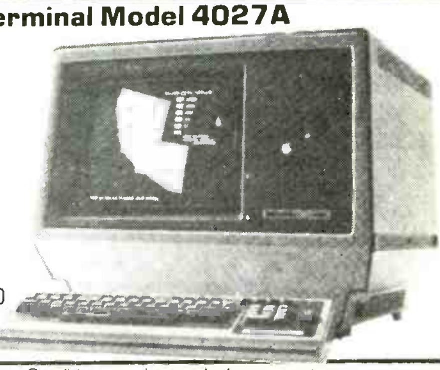

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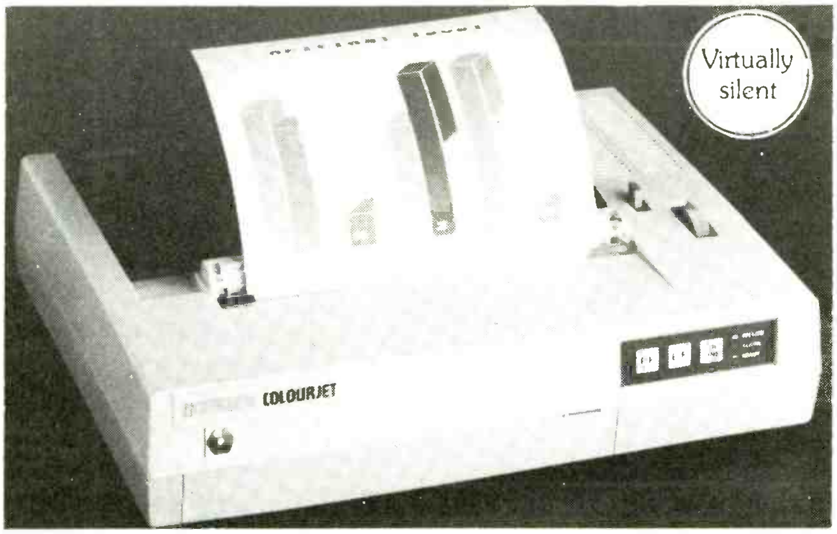

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32/350V		32+32+32/450V	95p	16+16/450V	£1
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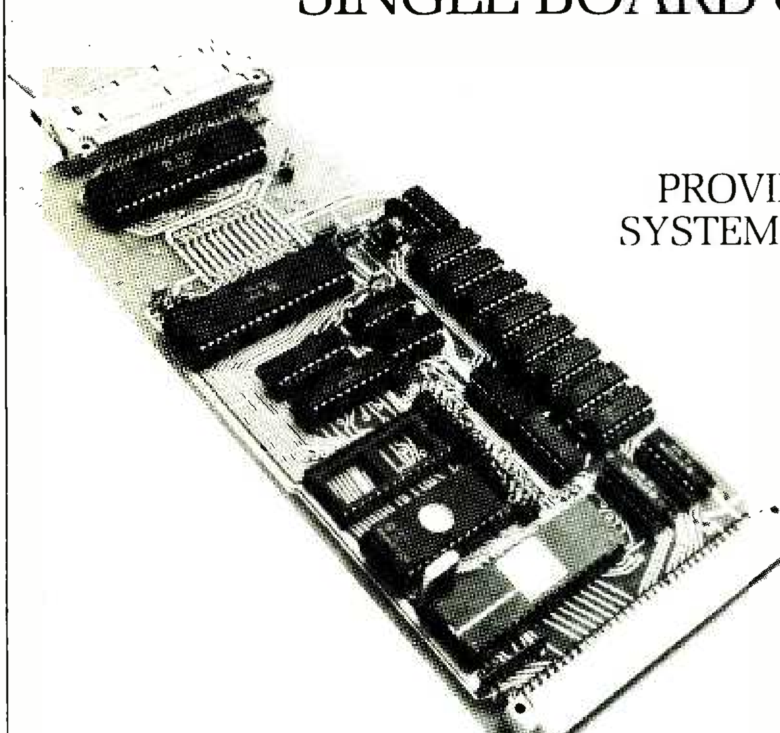

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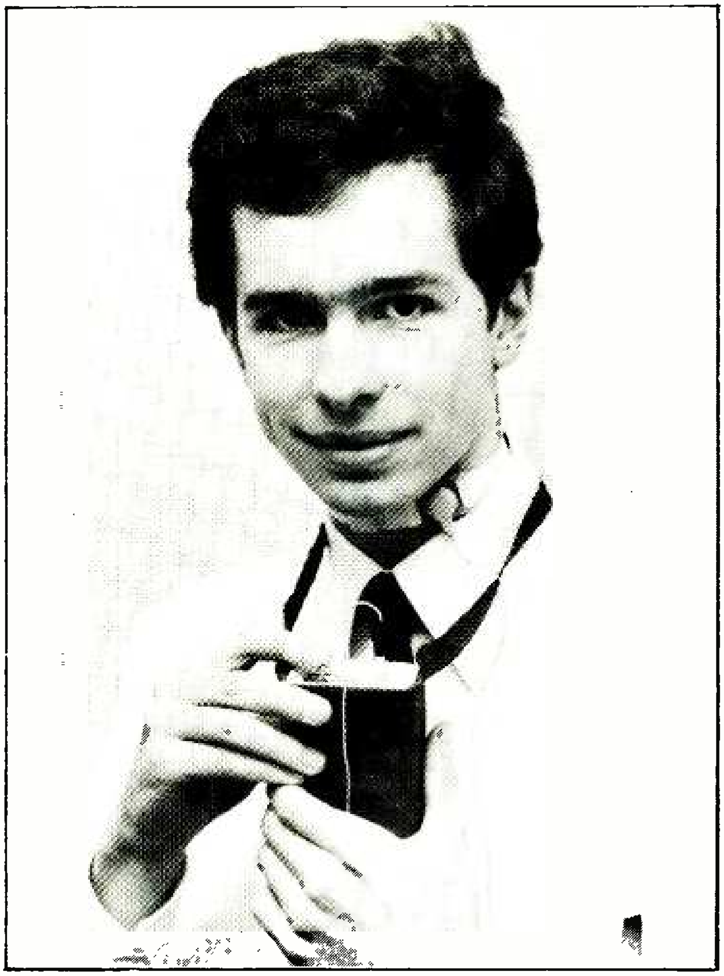
Pausaid

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.



Racal Electronics Ltd

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

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 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

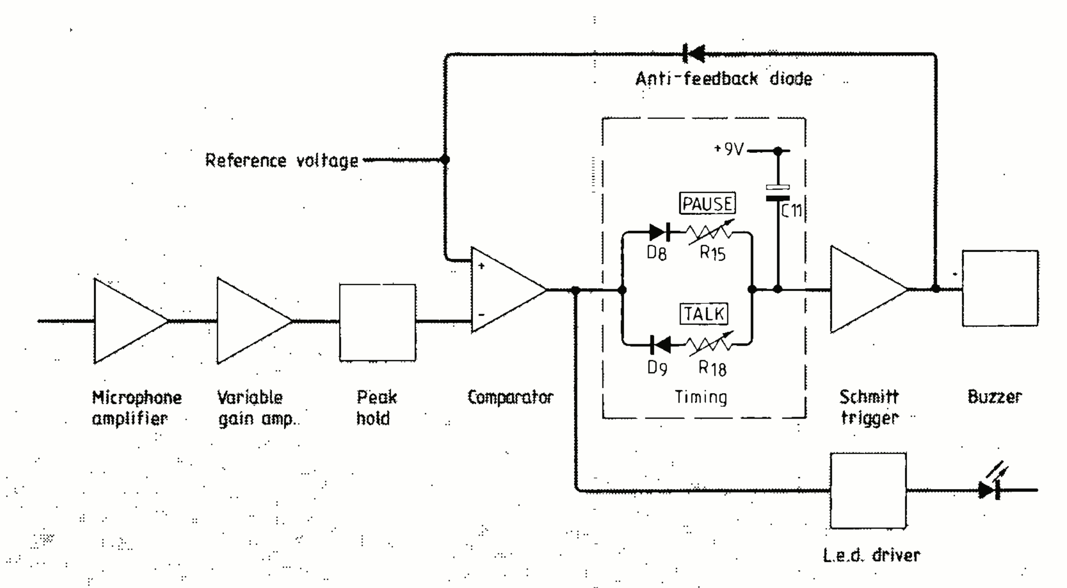


Fig. 1. **How Pausaid works: C_{11} charges when the user speaks and discharges during moments of silence. If he fails to pause now and then, the buzzer sounds.**

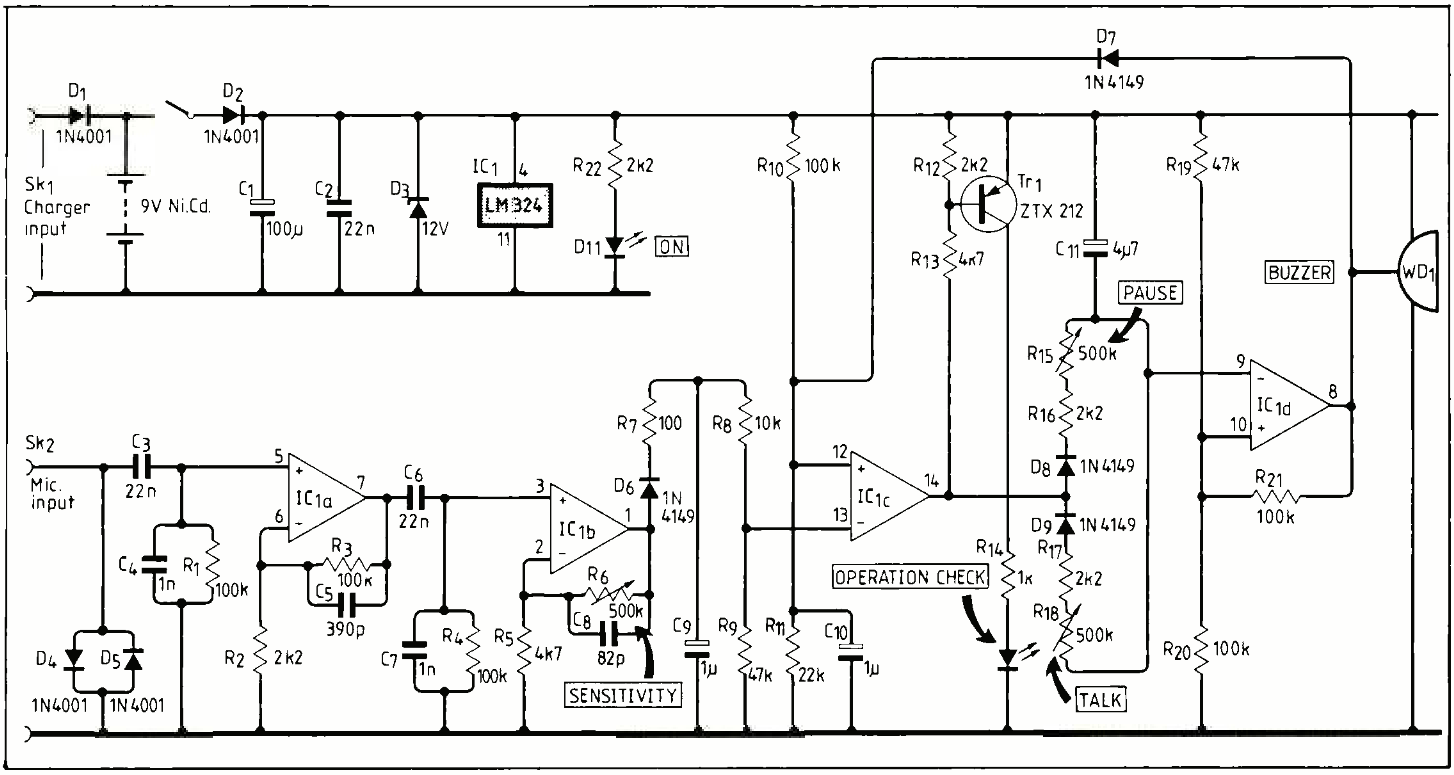


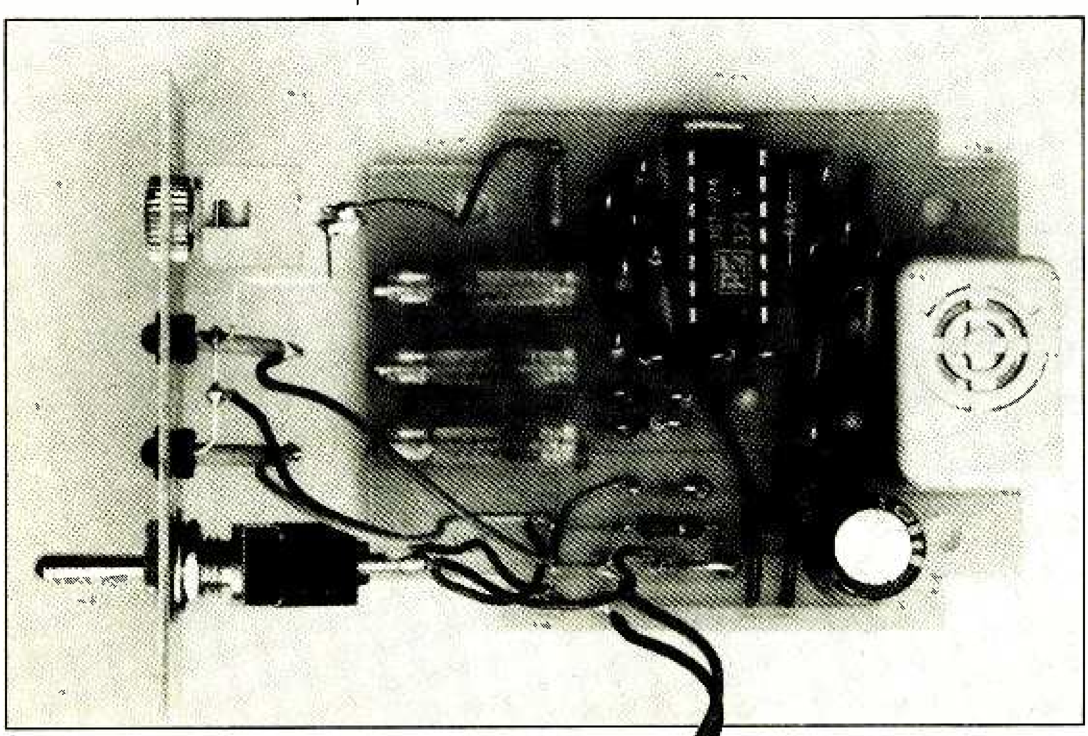
Fig. 2. **Complete circuit of Pausaid. R_{15} and R_{18} are miniature multi-turn presets. Sensitivity control R_6 should be adjusted so that the led flashes whenever the patient talks.**

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 D_4 and D_5 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 R_6. A peak-hold function is provided by D_6, R_7 and C_9. IC_{1c} is used as a comparator, its reference voltage supplied by R_{10} and R_{11}.

The talk without pause time limit is fixed by D_9, R_{17}, R_{18} and C_{11}; pauses necessary to prevent triggering of the buzzer are determined by D_9, R_{15}, R_{16} and C_{11}. R_{21} sets the hysteresis for the Schmitt trigger IC_{1d}, which drives the control input of the buzzer directly. D_7 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 reachargeable battery can be fitted if required: there is a charger socket on the front panel. The preset control 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 microcomputers 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 connected to the computer input changes state. On detecting this change of state the computer halts ramp generation and so holds the digital equivalent of the unkown 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 stabiltiy. This design provides accurate programmable square and pulse signals and — with some limitations — synthesized waveforms. Synthesized wave-

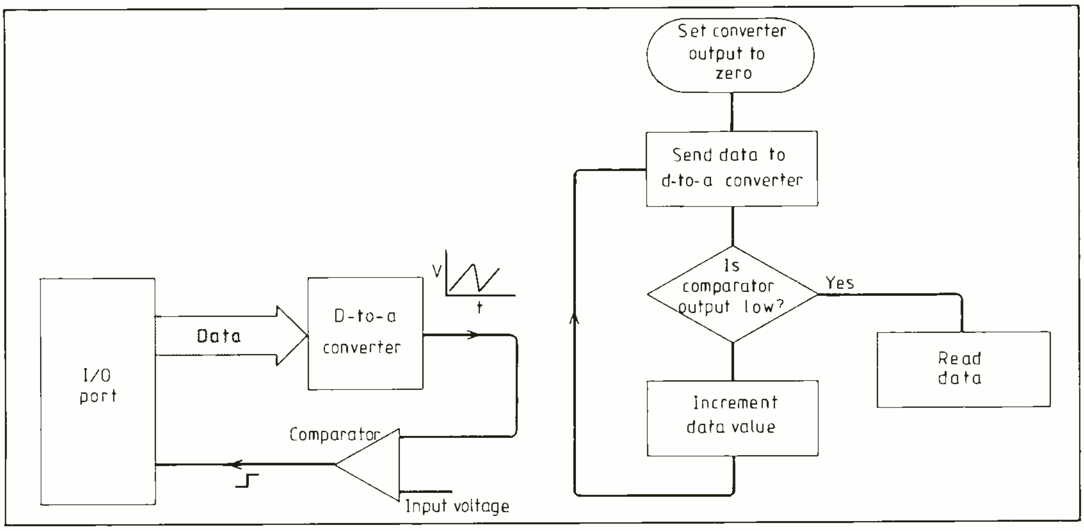


Fig.1. For analogue-to-digital conversion, used to measure voltages, the computer feeds a digital-to-analogue converter with digital values starting at zero and incrementing to form a voltage ramp at the converter output. Unknown input voltage is compared with the steadily rising ramp and when the two 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 form 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 alternateley 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 frequencies 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 samll, 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

Most-significant byte = 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

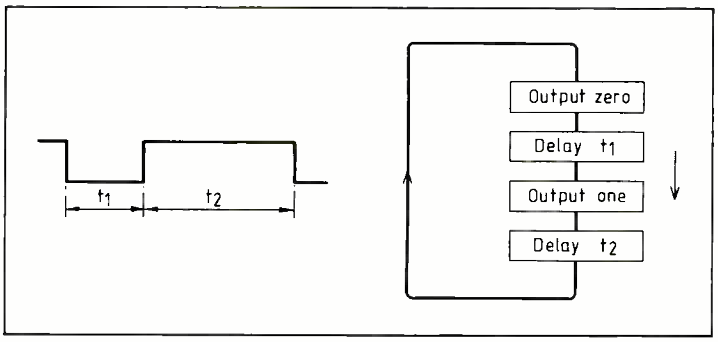


Fig. 2. **Pulse generation by software is simply a matter of writing a program which loops round, switching a digital output line on and off on each cycle. Mark/space ratio of the output signal is determined by proportions of delays x and z. Varying these delays for each loop can produce frequency and/or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

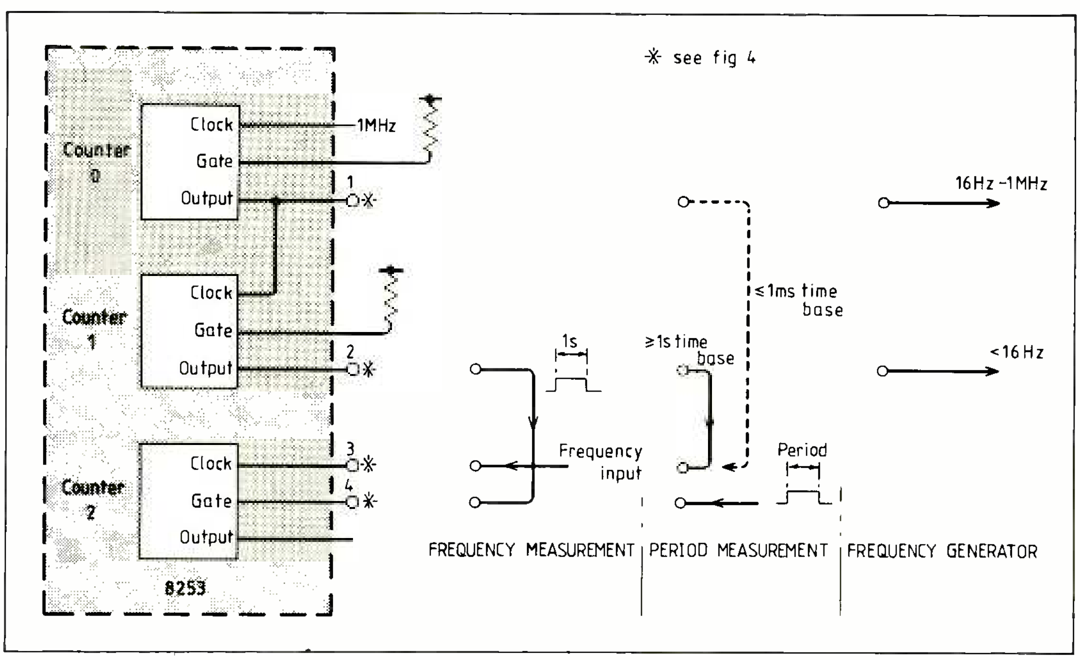


Fig. 3. **Timer/counter connections. For frequency measurement, input pulses are counted during a period of known length and conversely for period/interval measurement, pulses of known frequency are counted during a period determined by the input signal. Frequency generation is simply a matter of sending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

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 $C000_{16}$ to $FFFF_{16}$ 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 $A_{5\text{-}15}$ are decoded by gates, output of which enables the 74LS138 data-selector circuit. This in turn selects the 8255 for A_2 and the 8253 for A_2. 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)
    THEN GOTO 70            Read value D0, jump if 1
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.

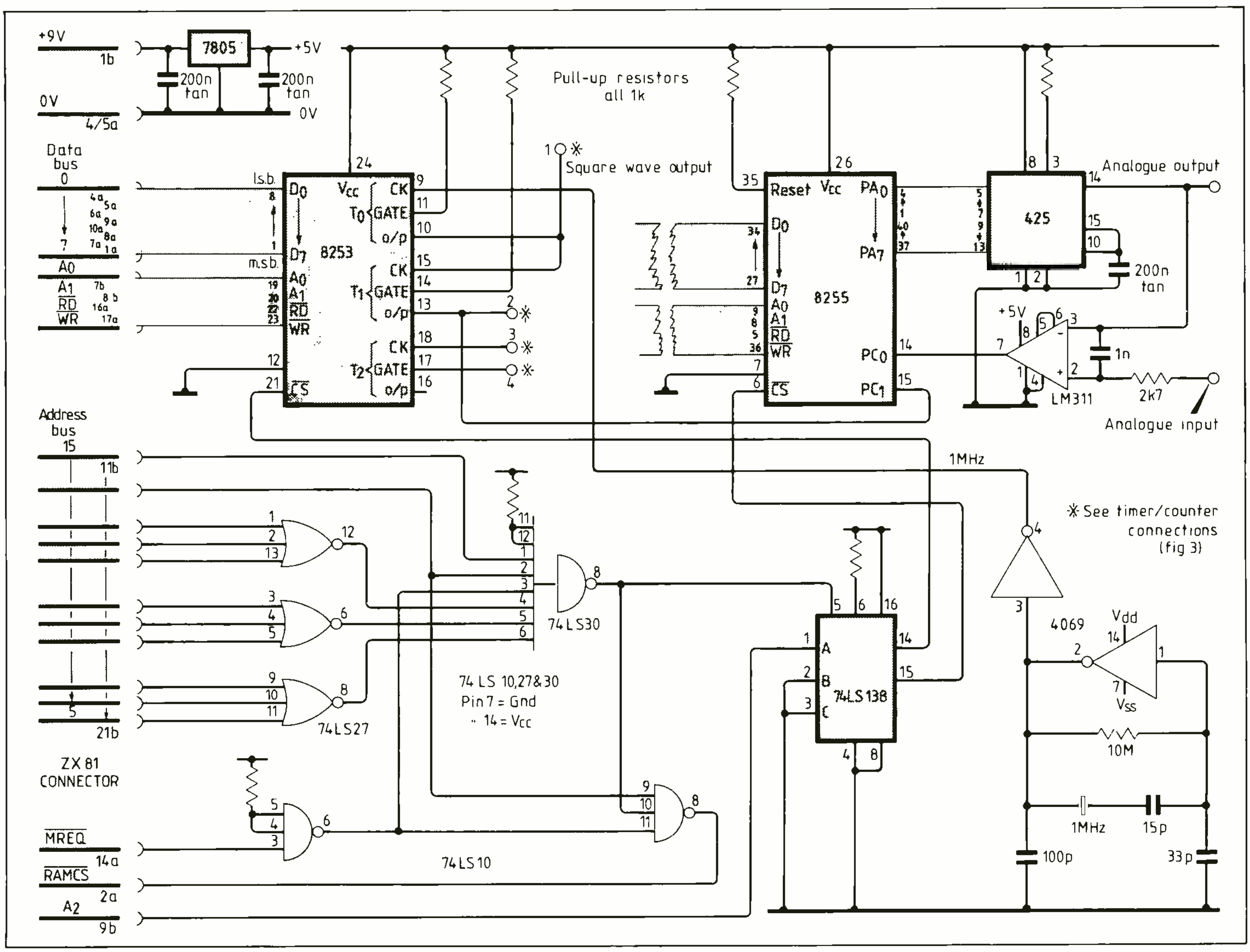


Fig. 4. **Measurement and signal-generation interface for the ZX81 provides voltage, period/interval and frequency measurement, accurate and programmable pulse/squarewave signals and low-frequency synthesized waveforms through software. Spare digital i/o lines are available on the 8255 i.c.**

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		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           T0=1kHz
40  POKE 49156,3
50  POKE 49159,118
60  POKE 49157,208           T0+T1=1s
70  POKE 49157,7
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)
    THEN GOTO 110            wait for D1=0
125 LET A=(PEEK 49154)/2     read port C, D1
130 IF NOT (A-2×INT(A/2)
    THEN GOTO 125            wait for D1=1
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.cs; 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 A_2 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 if 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

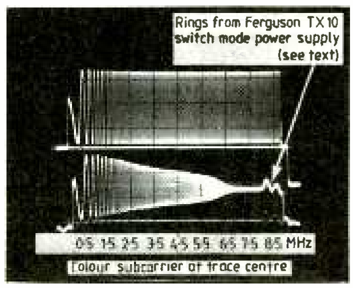


Fig. 39. **Top trace is the luminance sweep 0.5 to 8.5MHz applied to pin 10 of the TDA3561A decoder chip. Lower trace is the signal at the tube cathode (pin 2) showing loss in response at high frequencies in the decoder chip and the video output drive circuit.**

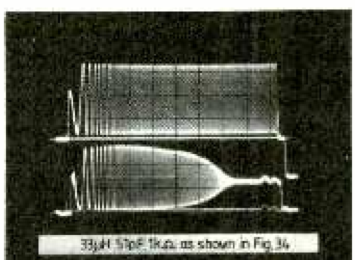


Fig. 42. **Typical frequency response of TDA3561A colour demodulator chip through to the RGB output stage. This was the green drive to the c.r.t. cathode.**

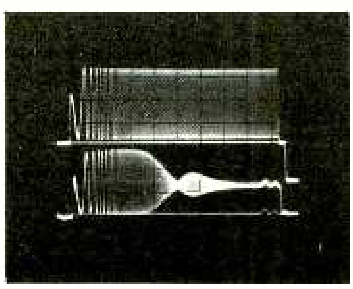


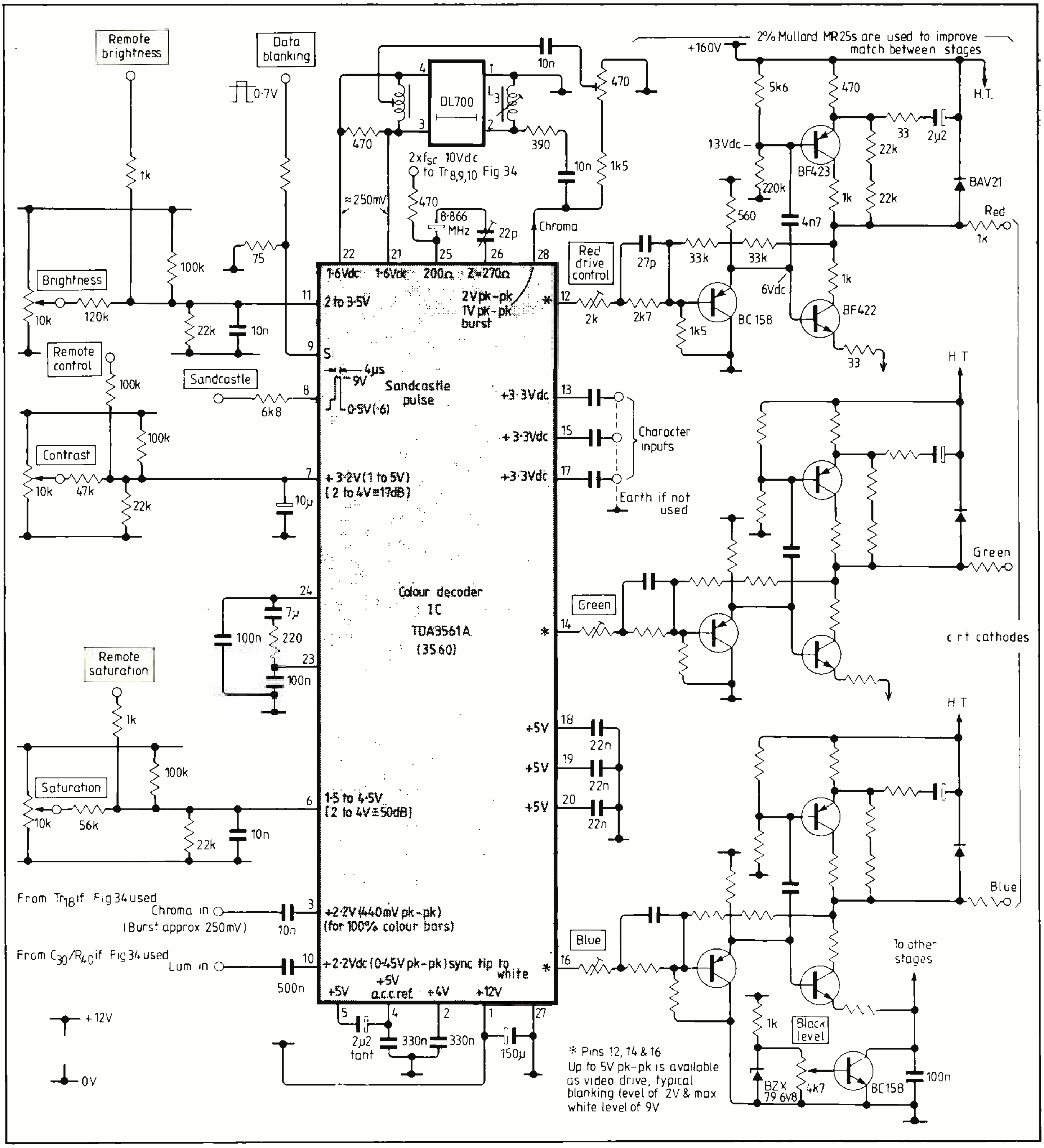
Fig. 43. **Video sweep showing output of modifier comb board with the subcarrier notch retained by the f.e.t. gate connected to ±12V rail; modifier turned off.**

Fig. 40. **Colour decoder chip and surrounding components. The chroma and luminance inputs are taken from the additional board, Fig. 34.**

response. The capacitor and the inductor resonate so that the lift does not continue beyond subcarrier frequency. Figure 42 shows the typical overall frequency response of the TDA3561A colour demodulator chip through the RGB output stages; in practice, Fig. 42 was the output response of the green drive to the tube cathode.

From a comparison of Fig. 39 with Fig. 42 it is apparent that there is some ringing at the beginning and end of each line. On investigation, it was found that the leads carrying RGB signals between the decoder chip and the tube base board (which contains the RGB output video drives transistors) must be carefully positioned. In the circuit condition shown in Fig. 39, the rings were at a high amplitude because these leads were passing near the switched mode power supply. Since the power supply chopping rate is line-locked (operating at 15.625kHz), magnetic field 'rings' from the transformer can readily be picked up by the wires. Figure 42 shows that, with careful positioning, 'rings' at the end of the active line are greatly reduced and can be made virtually invisible on the final display picture.

The response trace shown in Fig. 43 was taken with the notch



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 flatness 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 ± 1dB 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

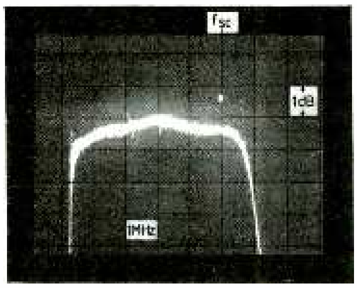


Fig. 44. Figure shows amplitude response of the test modulator and demodulator connected back-to-back (1dB/cm).

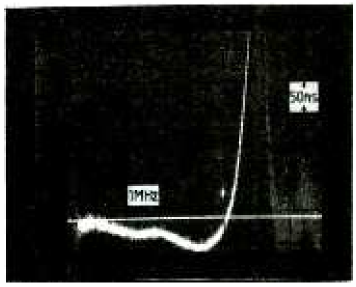


Fig. 45. Trace shows the group delay response of the modulator and demodulator (50ns/cm).

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

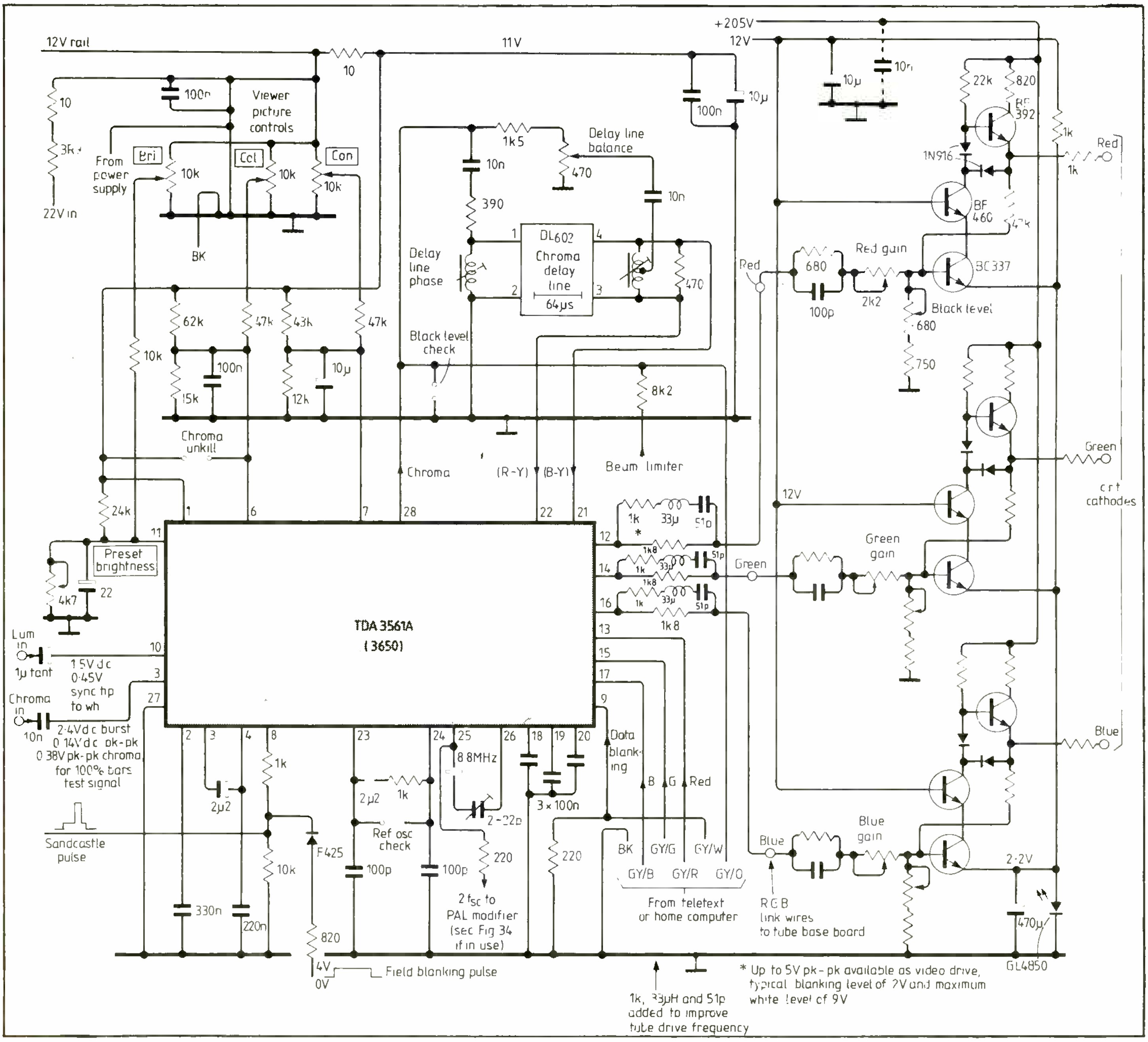
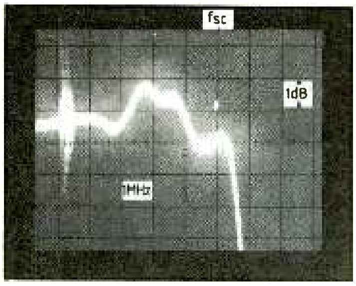


Fig. 46. A BBC 1 transmitter in the south of England. Figures show the amplitude response (right), group delay characteristic (Fig. 47, middle) and i.t.s. test signal performance (Fig. 51, below)



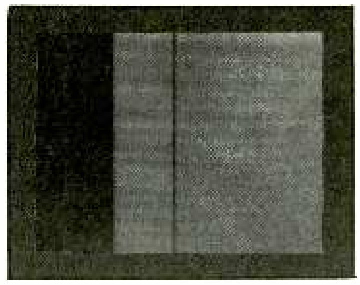
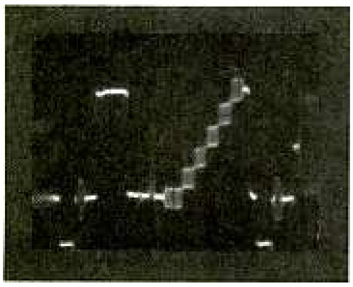
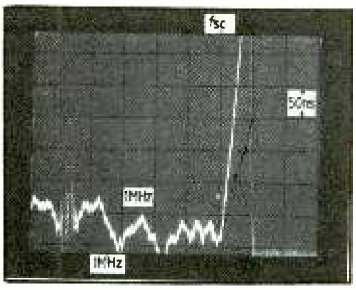


Fig. 48. Television screen photograph showing similar effects of residual 7.8kHz at colour transitions caused by lack of amplitude and/or phase symmetry in chroma path. Such symmetry should be maintained because the V-spectrum shifts on alternate lines, see Fig. 4 Dec 1983 issue; also Fig. 72.





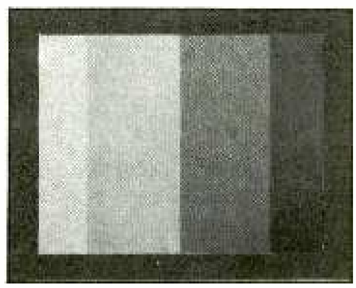


Fig. 49. With an input of 100% colour bars, photograph shows screen with a minimum of cross-luminance at colour transitions. Colour bar generator was fed directly to the comb filter (Fig. 34 circuit).

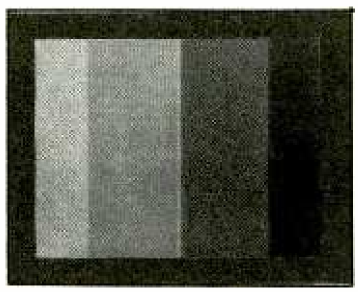
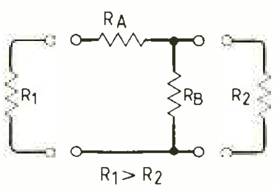


Fig. 50. Conditions as for Fig. 49 but with inclusion of the transmitter and receiver tuner plus i.f. section in the signal path. Results are still better than a luminance notch decoder only, but the possible improvement compared with Fig. 49 conditions is about half.

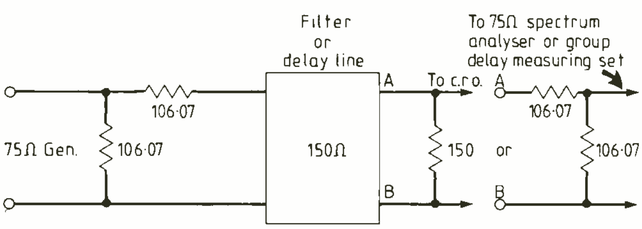
Impedance matching for measurement

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.



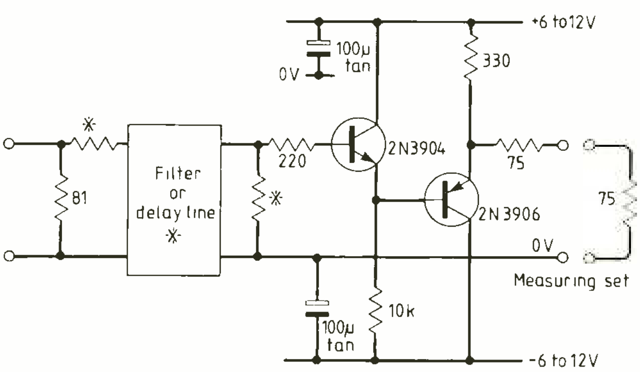
R_1 is 510Ω the characteristic impedance of gaussian band-pass filter used for chroma filtering, Fig. 34 March, R_2 is 75Ω. Calculated values:

R_A 471.01Ω
R_B 81.21
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.

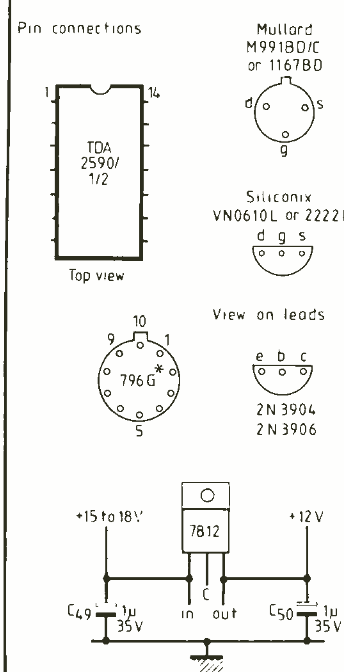
The diagonal-to-vertical chroma transition will also have an upward moving Hanover bar disturbance visible at each colour change, in a manner similar to the black and white photograph of Fig. 48. Also the modified performance will certainly be marred by cross-luminance returning to the luminance channel, 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_{51} 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 $Tr_{8,9,10}$.



* 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.)

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.

by J. H. Adams

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 Computer 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 programming; 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

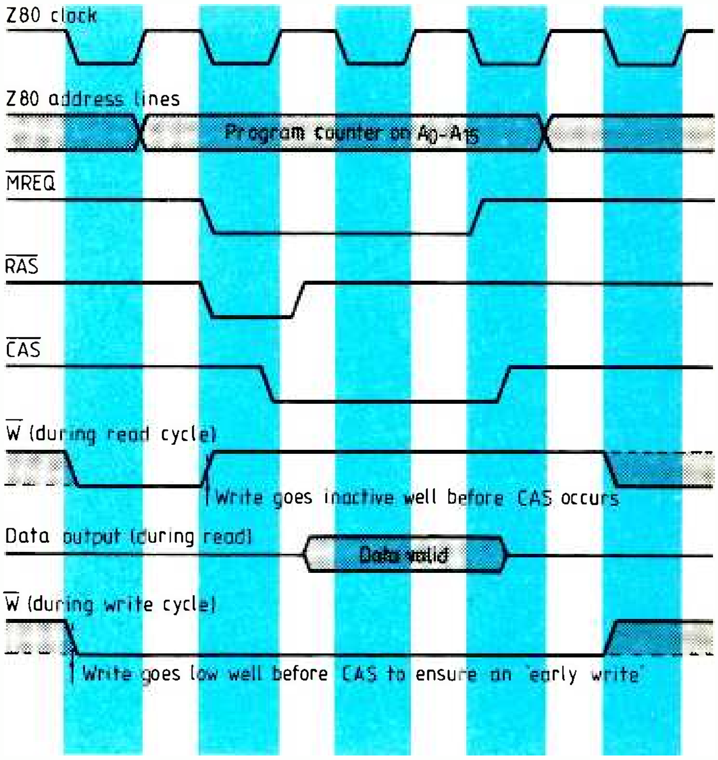
SC84

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.



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 eprom 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.

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.

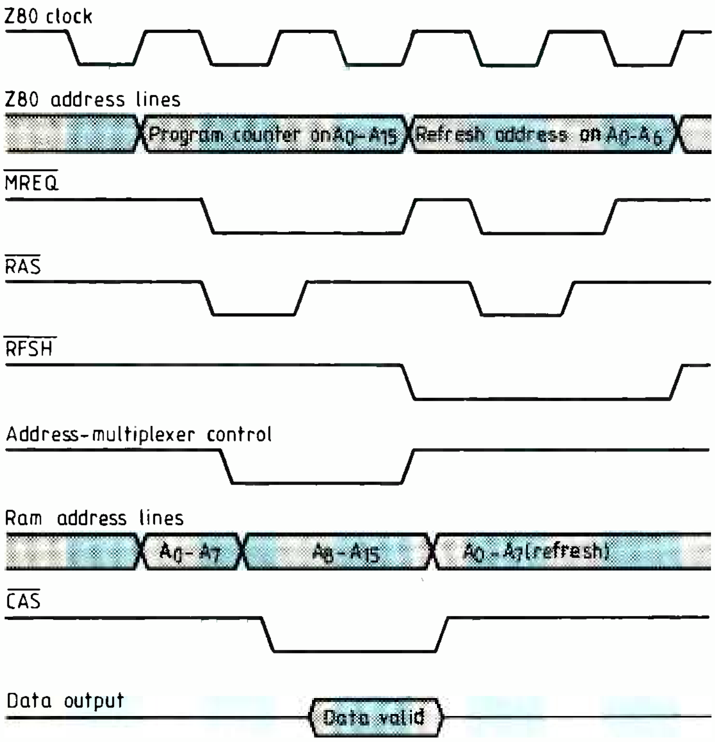
There are three types of memory cycle that the Z80 can execute. Fetching of an instruction or 'op-code' from memory is illustrated in the first diagram. The second is a composite diagram illustrating the writing or reading of data to or from memory. The difference between fetching an op-code and fetching 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 $\overline{MREQ}$ indicating that the current cycle is a memory cycle, $\overline{RFSH}$ indicating that memory refresh can now take place and $\overline{RD}$ which indicates that the current cycle will involve data passing into the Z80. There is also a signal called $\overline{M1}$ which becomes active during op-code fetches and interrupt acknowledge periods, and a $\overline{WR}$ signal which indicates that data is to pass from the Z80 to the system. Neither signal is used in memory access although $\overline{M1}$ 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 (IC_{118}). 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 IC_{118}, direction line $\overline{IN}$ becomes active when *($\overline{M1}$ and $\overline{IORQ}$) or $\overline{RD}$ and not ($\overline{MREQ}$ and not $\overline{MEMDIS}$)* 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 $\overline{M1}$ and $\overline{IORQ}$ 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

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.



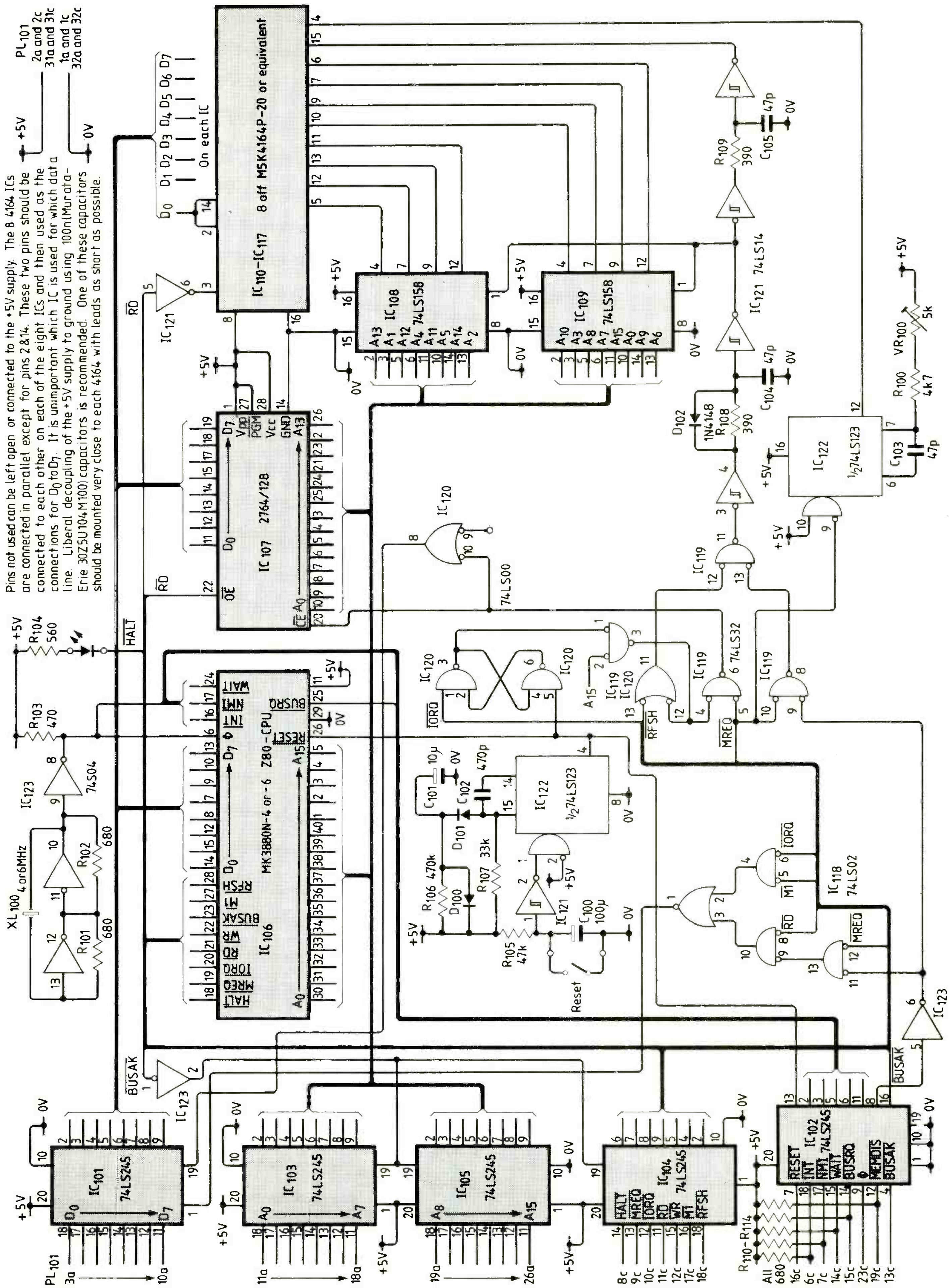

Pins not used can be left open or connected to the +5V supply. The 8 4164 ICs are connected in parallel except for pins 2&14. These two pins should be connected to each other on each of the eight ICs and then used as the connections for D0 to D7. It is unimportant which IC is used for which data line. Liberal decoupling of the +5V supply to ground using 100n (Murata-Erie 30Z5U104M100) capacitors is recommended. One of these capacitors should be mounted very close to each 4164 with leads as short as possible.
PL101
2a and 2c
31a and 31c
1a and 1c
32a and 32c
IC110–IC117 8 off MSK4164P-20 or equivalent
On each IC
IC107 2764/128
IC106 MK3880N-4 or -6 Z80-CPU
IC108 74LS158
IC109 74LS158
IC121 74LS14
IC122 1/2 74LS123
IC120 74LS00
IC119 74LS32
IC118 74LS02
IC123 74S04
IC101 74LS245
IC103 74LS245
IC105 74LS245
IC104 74LS245
IC102 74LS245
XL100 4 or 6MHz
Reset
R110–R114 All 680

Table 1. Bus connections

Row A	Pin	Row C	Function
GND	1	GND	
+5V	2	+5	
D0	3		
D1	4		
D2	5		
D3	6	$\overline{INT}$	Z80 maskable interrupt line*
D4	7	$\overline{NMI}$	Z80 non-maskable interrupt line*
D5	8	$\overline{HALT}$	Z80 has executed a HALT instruction
D6	9	$\overline{MREQ}$	Z80 is performing a memory operation
D7	10	$\overline{IORQ}$	Z80 is performing an input/output operation†
A0	11	$\overline{RD}$	Z80 is requesting data from the bus
A1	12	$\overline{WR}$	Z80 is writing data to the bus
A2	13	$\overline{BUSAK}$	Z80 has relinquished control of the system
A3	14	WAIT	Z80 is being asked to extend the current instruction*
A4	15	$\overline{BUSRQ}$	Z80 is being asked to relinquish system control*
A5	16	$\overline{RESET}$	20µs pulse generated when RESET is operated
A6	17	$\overline{M1}$	Z80 is fetching an op-code†
A7	18	$\overline{RFSH}$	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 $\overline{M1}$ and $\overline{IORQ}$ 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 'strobes' 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 ($\overline{RAS}$) 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 $\overline{RAS}$ 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 $\overline{RAS}$ 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 $\overline{RAS}$ as the sense amplifier is brought back into a state of balance. These conditions are paramount and to meet them $\overline{RAS}$ 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 $\overline{RAS}$ period and thus by definition the minimum inactive.

Once the leading edge of the $\overline{RAS}$ pulse has latched the first address byte into the memory i.cs., 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 ($\overline{CAS}$) 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, $\overline{RAS}$ 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. $\overline{CAS}$ also controls the state of the memory-output driver. While it is active the output is enabled and the selected data bit held there. $\overline{CAS}$ 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 $\overline{RAS}$ signal connects cells to buses and releases sense amplifiers and then the $\overline{CAS}$ 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 $\overline{CAS}$ 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 $\overline{CAS}$ goes active by arranging for the $\overline{write}$ signal to go active before $\overline{CAS}$ 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 $\overline{WR}$ 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 $\overline{RD}$ as a write strobe to the memory. Whenever $\overline{RD}$ 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 $\overline{RAS}$ will be over long before $\overline{RD}$ 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 $\overline{RD}$ going active low at the beginning of the cycle, well before $\overline{CAS}$ is applied. Except for a slight increase in current consumption during the write-line strobe, the effect is unnoticable.

The sequence of pulses for the dynamic memory is generated by a series of Schmitt buffers (IC_{121}). $\overline{RAS}$ is generated by the leading edge of memory-request signal $\overline{MREQ}$ which triggers monostable IC_{122}. A potentiometer sets the $\overline{RAS}$ pulse length. For the devices specified in the diagram $\overline{RAS}$ 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 $\overline{RAS}$ 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

Fibre optic communications

by Brett Wilson

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 50µm and a cladding diameter of 100µm.

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:

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

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

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 $\theta_{int\,max} = 5.5°$, corresponding to $\theta_{ext\,max} = 8.1°$. An equivalent way of describing a fibre is by way of its numerical aperture (NA), defined as $\sin\theta_{int\,max}$; in this example NA ≈ 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-

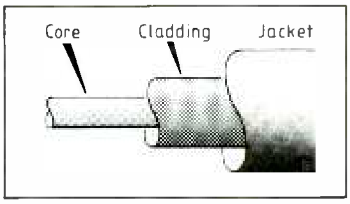


Fig.1. An optical fibre consists simply of an inner flexible rod of very pure glass surrounded by a cladding layer of slightly lower refractive index.

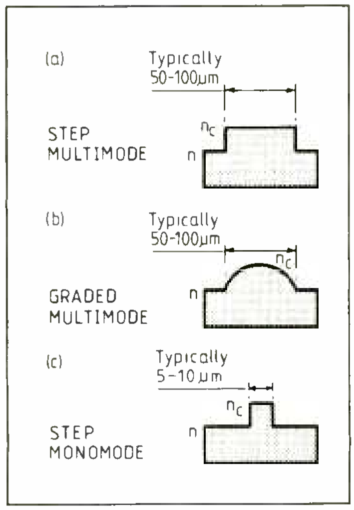
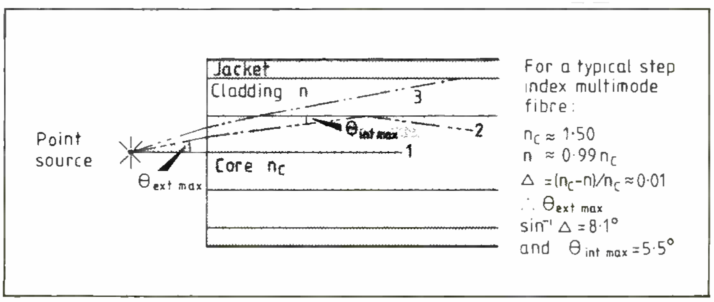


Fig.2. Choice of refractive index profile determines the propagation characteristics of the fibre.

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.



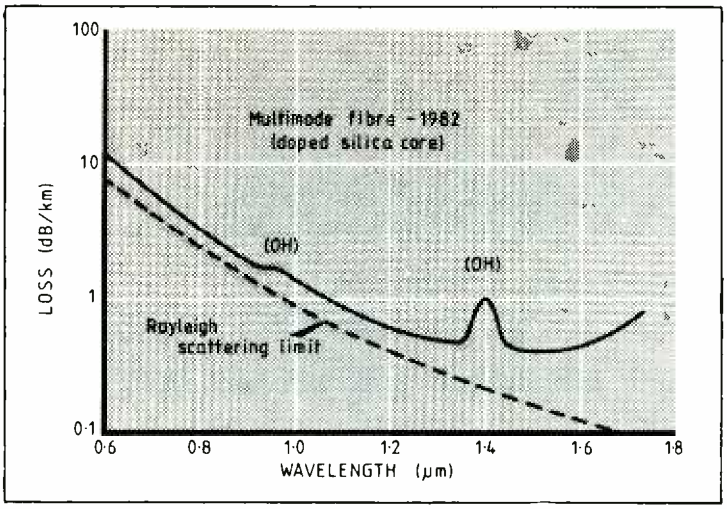


Fig. 4. Light loss in a multimode fibre approaches the theoretical minimum except at the wavelengths associated with water impurities.

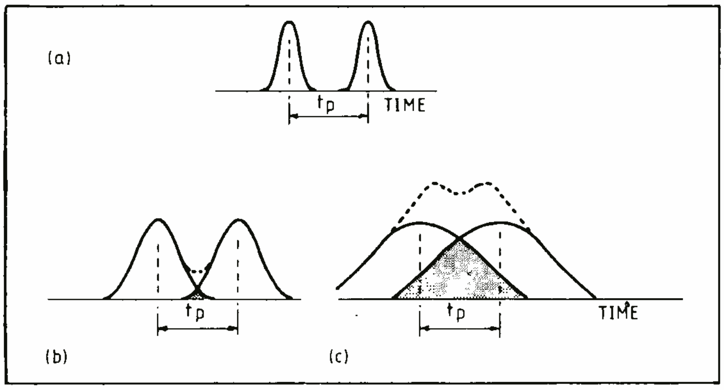


Fig. 5. If the bandwidth of the fibre is insufficient then adjacent data pulses can be spread out to the extent of becoming indistinguishable.

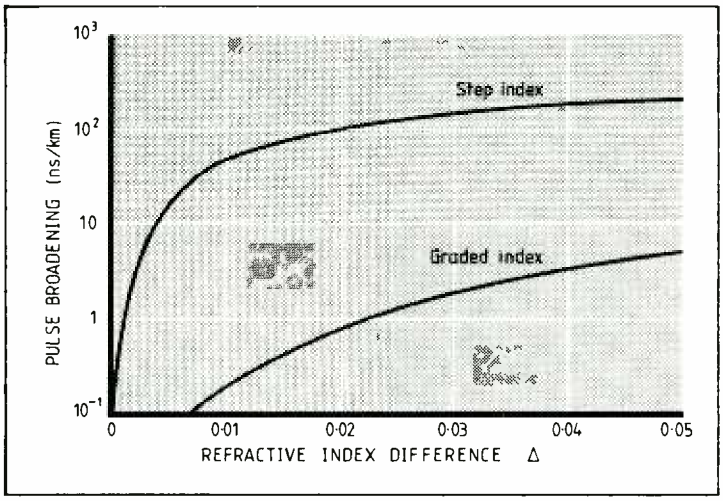


Fig. 6. Pulse spreading is much less noticeable with graded index fibres than with step index multimode fibres.

nications 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 0.85µm (low-cost high-lifetime aluminium-gallium arsenide l.e.ds the Rayleigh scattering limit is about 2dB/km; at a wavelength of 1.3µm the limit is around 0.3dB/km; whilst at 1.55µm the limit is as low as 0.15dB/km, Fig. 4. Presently available commercial 'premium' fibres exhibit losses of around 2.5 to 3dB/km at 0.85µm and 0.7 to 1.5dB/km at a wavelength of 1.3µm [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 1.4µm wavelength of OH excitation. Optical sources such as l.e.ds and injection laser diodes i.l.ds 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 0.65mm wires has a typical attenuation of 15 to 20dB/km at 1MHz 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 75dB/km being common at 100MHz. 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).

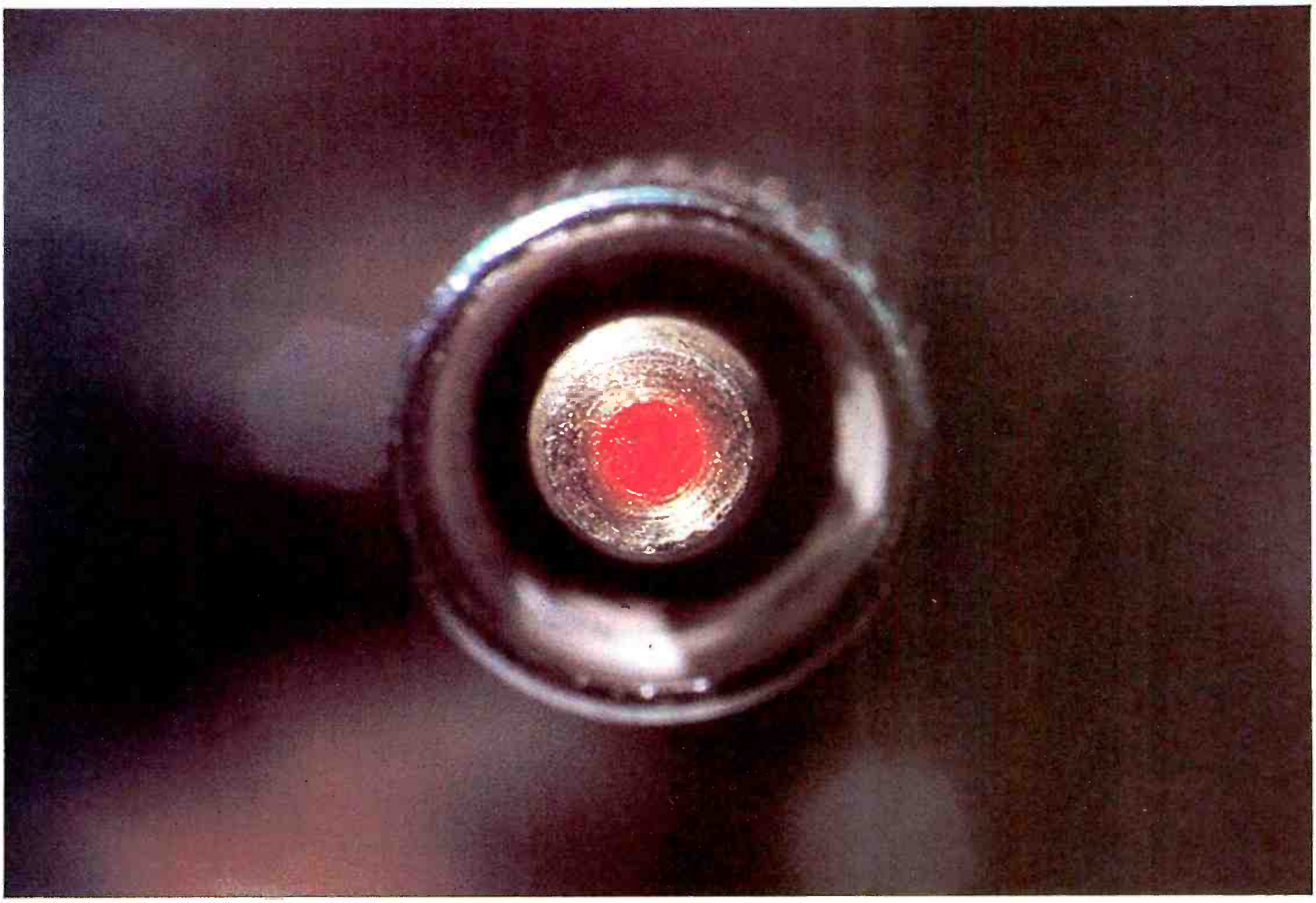
In a multimode fibre the bandwidth is primarily determined by two mechanisms: modal delay spread and material dispersion coupled to the source spectral bandwidth. As the amount of pulse-spreading depends on the length of the fibre it is most useful to quote the performance of a fibre as the product of 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 difference[2] 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 $\delta T_{max} \approx 50$ns/km. The pulse-smearing caused by this delay spread is equivalent to a modulation bandwidth-length product of around 5 to 10MHz 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 0.85μm. 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 respectively[3]. This corresponds to a fibre bandwidth-length product of approximately 1 to 5GHz km at 0.85μm 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 3μm) and so usually diameters in the range 5 to 10μm are used and a few low-order propagation modes tolerated[4]. (In contrast, a typical multimode step-index 50μm fibre may support several thousand porpagation 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 0.85μm l.e.d. exhibits a spectral width of around 0.05μm (50nm) in contrast to an injection laser diode whose spectral width is typically 0.002μm (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.

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 Step index	MULTIMODE FIBRE Graded index	MONOMODE Step index
l.e.d. $\lambda 0.85\mu m$ $\delta\lambda 50nm$	10 MHzkm / 500 MHzkm / 3dB/km	1-5 GHzkm / 500 MHzkm / 3dB/km	>100 GHzkm / 500 MHzkm / 2·5dB/km
l.e.d. $\lambda 1.3\mu$ $\delta\lambda 2nm$	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. $\lambda 0.85\mu m$ $\delta\lambda 2nm$	10 MHzkm / 25 GHzkm / 3dB/km	1-5 GHzkm / 25 GHzkm / 3dB/km	>100 GHzkm / 25 GHzkm / 2·5dB/km
i.l.d. $\lambda 1.3\mu m$ $\delta\lambda 2nm$	10 MHzkm / ≈100 GHzkm / 1dB/km	1-5 GHzkm / ≈100 GHzkm / 1dB/km	>100 GHzkm / ≈100 GHzkm / 0·7dB/km

KEY: Modal delay spread / Material wavelength dispertion / Attenuation

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

i.l.ds respectively at 0.85μm.

Fortunately a material dispersion minimum has been discovered at 1.3μm which allows for wide bandwidth transmission over distances, >100GHz km, even with an l.e.d[5]. Combined with the generally lower losses at 1.3μm, 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 l.e.ds and i.l.ds. 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 0.85μm l.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 1.3μm, probably using an i.l.d. source for faster modulation. Monomode fibres operating at 1.3μm 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 l.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 ratios[6]. 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 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.

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

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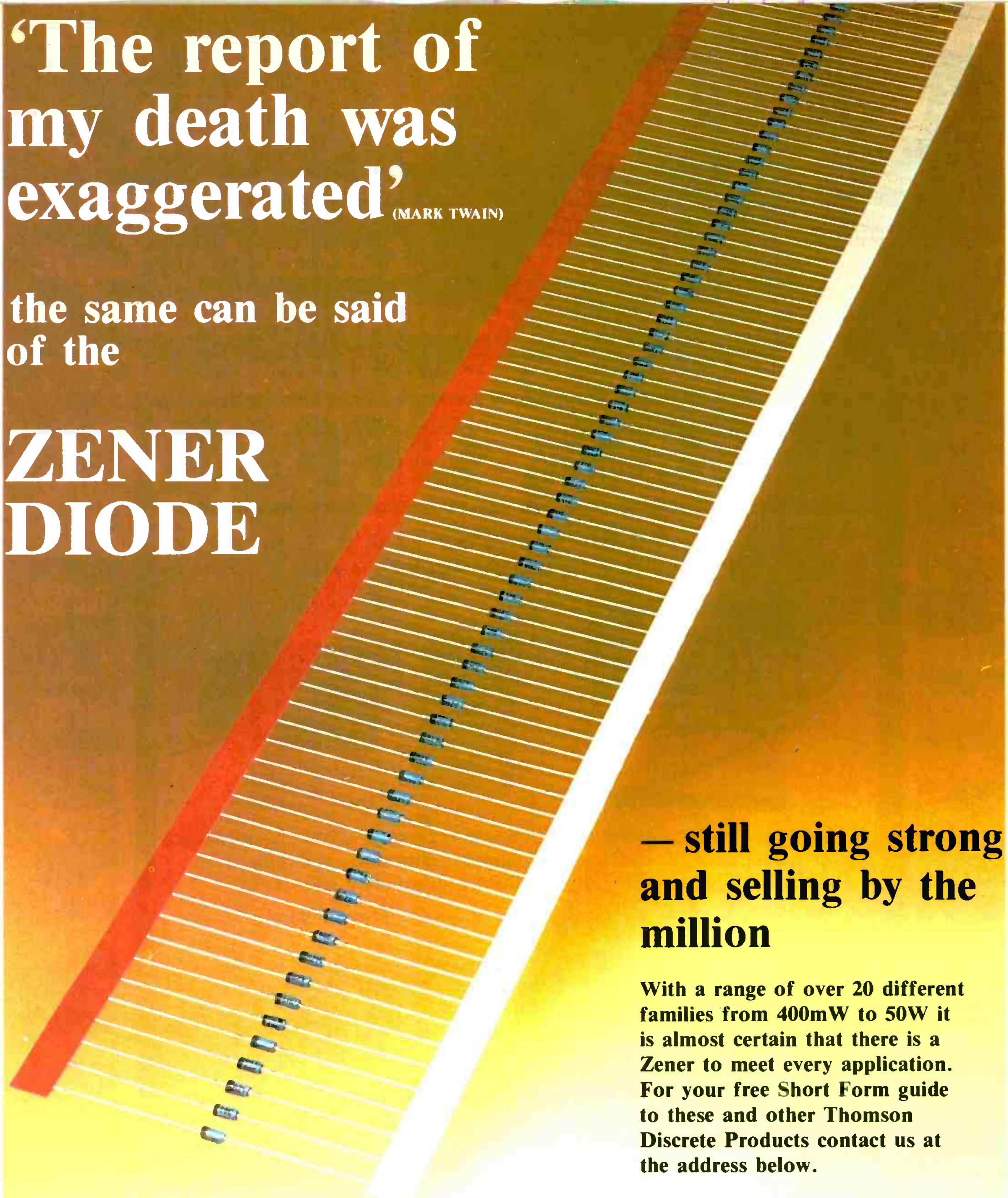

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Tv hazards

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 Durris, 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, suprisingly 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 acepting 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 ±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 $C \doteq 1/2\pi f_c R$, 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 clambers 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

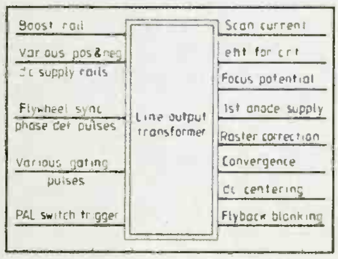
I think it is time something was done about Television. It has become rather nasty. I am referring not to video vice and violence, but to circuit technology. The whole science has, like Topsy in Uncle Tom's Cabin, "just growed". Well, what of it? one might ask, it works well enough, doesn't it?

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

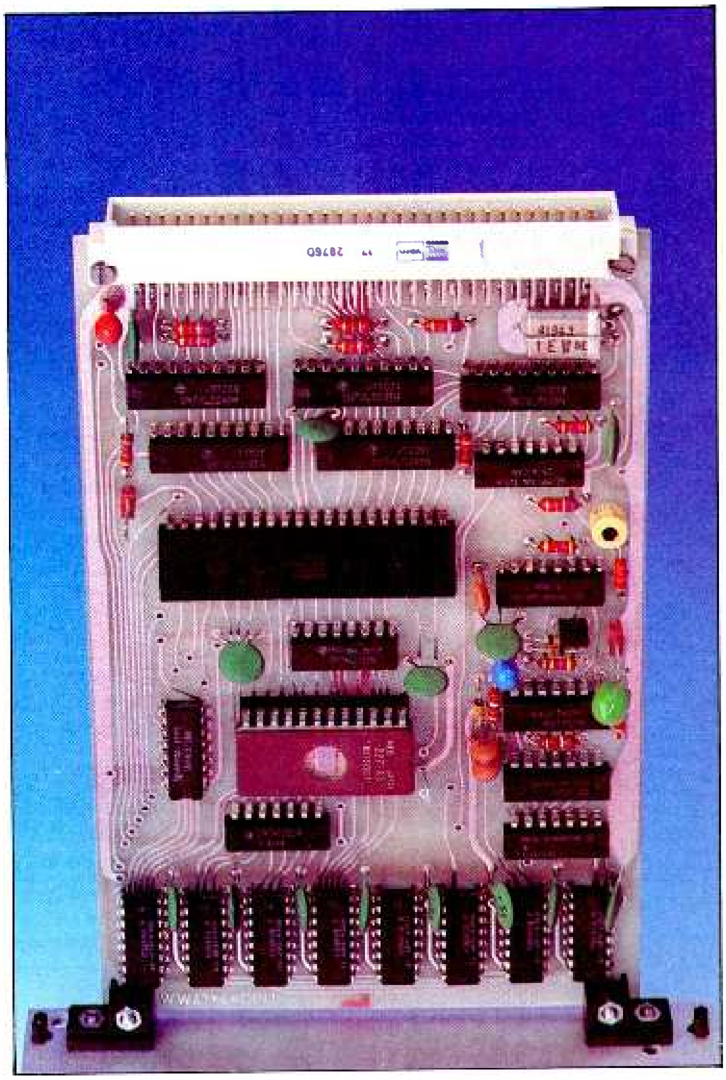
The signal at the start of the Schmitt buffers is (MREQ *and not* MEMDIS) *and not* (RFSH *or* ROMEN), i.e. unless MEMDIS, RFSH or ROMEN is active it is MREQ delayed by a couple of gates. The starting (falling) edge of MREQ becomes a rising edge at the output of the first Schmitt gate. This rising edge 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 IC_{120}. The output of this bistable device gates with A_{15} to produce ROMEN, a signal which follows A_{15} while the bistable i.c. is set and enables rom whenever A_{15} is low, i.e. during access at any address from zero to $7FFF_{16}$. 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 IC_{107} 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.cs 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.cs 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.

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.

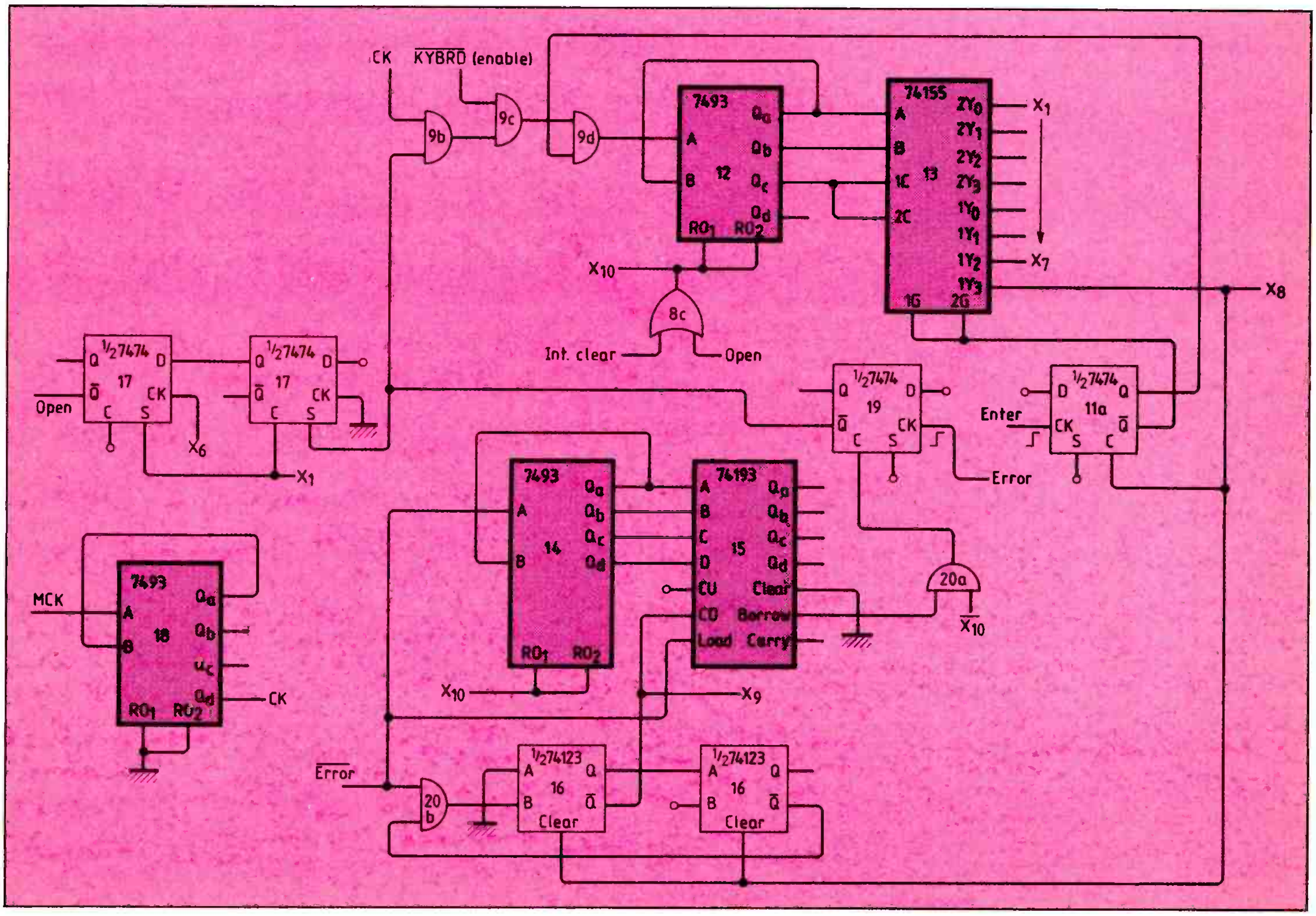
Inputs A-H of shift registers $IC_{21,22}$ are used to set the combination and A-D inputs of counter IC_5 set the combination size (four in this case). Pressing the internal clear key resets the control-sequence counter IC_{12} and control-pulse generator IC_{13}. On pressing the enter key, positioned externally on the keypad, outputs of decoder IC_{13} and counter IC_{12} are enabled through bistable IC_{11a}.

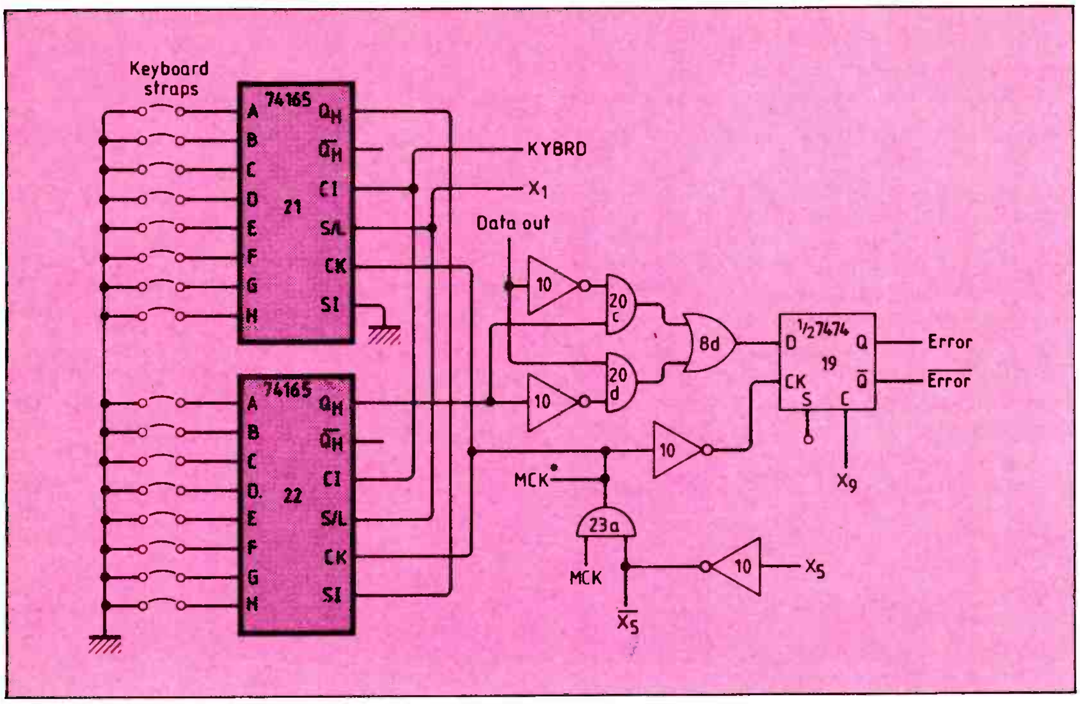
Activating X_1 loads the combination size into counter IC_5, loads the keyword into shift registers $IC_{21,22}$, clears previously entered trials in registers $IC_{3,4}$ and resets the open signal of bistable IC_{17}. Activating X_2 sets bistable IC_{11b}, which was reset when the internal clear key 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 IC_6 generates a pulse which decrements counter IC_5 by one. Following entry of the four-digit combination, the borrow output of IC_5 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 X_5 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 IC_{22} to one of the inputs of the exclusive-Or circuit comprising $IC_{10,20c,20d,8d}$. Also, activating X_5 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 X_6, the 'open' line will go high and open the lock. Otherwise, IC_{19} will be set on the first low-to-high transition of Error, setting IC_{17b} and clearing the open line on X_6 activation to keep the lock engaged. The change of state in Error inhibits the sequence counter IC_{12}, through setting of IC_{19}, and activates a $^1/_{60}$ Hz multivibrator IC_{16} with a duty cycle of 30s. Also, the delay counter is incremented by one and its contents loaded into counter IC_{15} which holds the control sequence for the specified delay steps; after this the borrow output goes low clearing IC_{19} and allowing sequence counter IC_{12} to continue.

At the end of each control sequence, mutlivibrator IC_{16} is





disabled and IC_{11} clears, inhibiting sequence decoder IC_{13} and the sequence counter IC_{12}. A further Enter signal restarts the control sequencer, permitting another trial entry. Upon activation of Open, delay counter IC_{14} and the sequence counter IC_{12} resets. Note that the MCK generator, not shown, can be realized with a 74123 (as shown in the delay section) or with an NE555 timer

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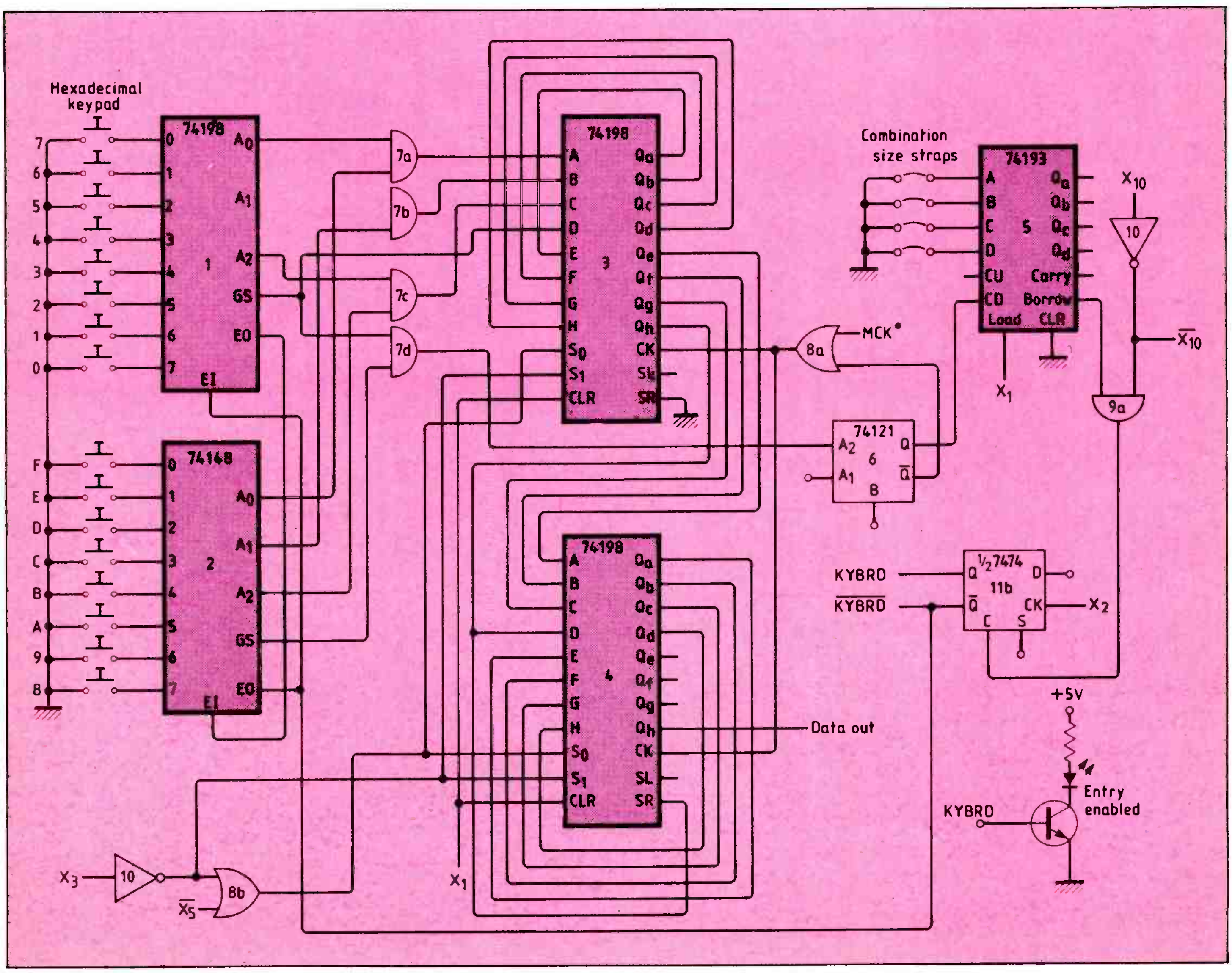
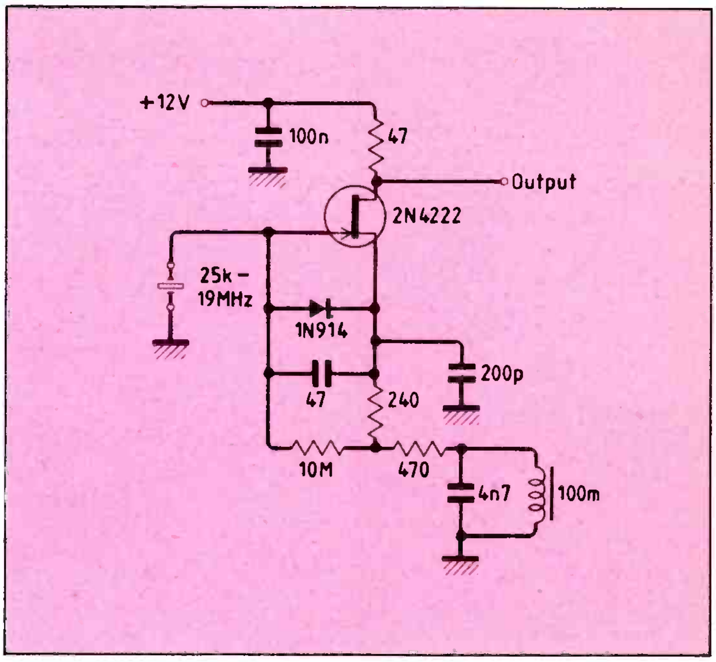


Universal crystal oscillator



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 frequnecy 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.

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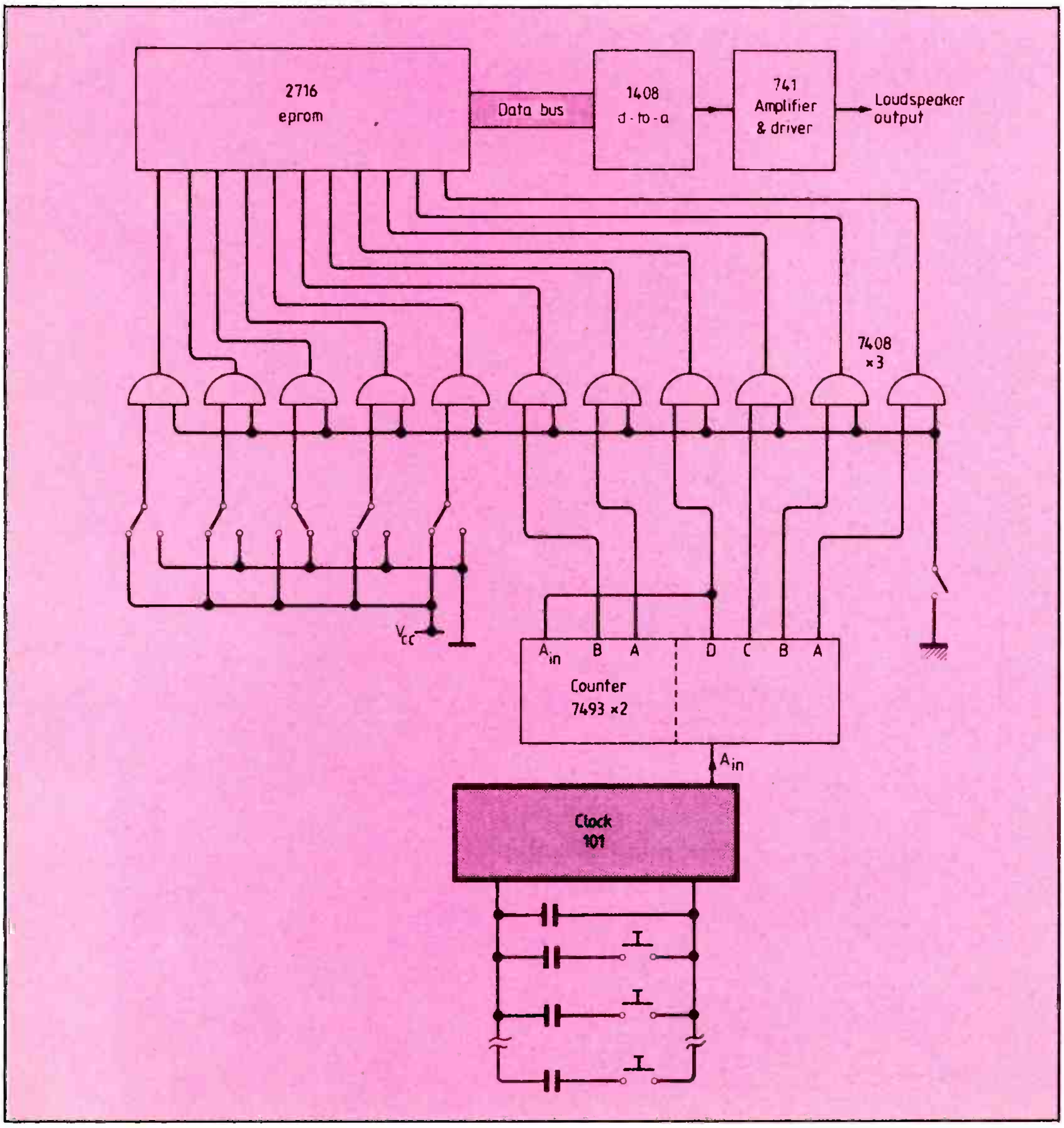
Simple digital music synthesizer



Musical notes of 32 instruments can be generated using this circuit. Basic sound patterns of the 32 intruments contained in a 2716 eprom 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 eprom address lines to select one of 32 memory blocks containing instrument patterns. Eprom data outputs feed a digital-to-analogue converter and loudspeaker amplifier.

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Variable-speed video playback

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

The C-format broadcast video recorder uses helical scan on 1in 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-sync. 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:

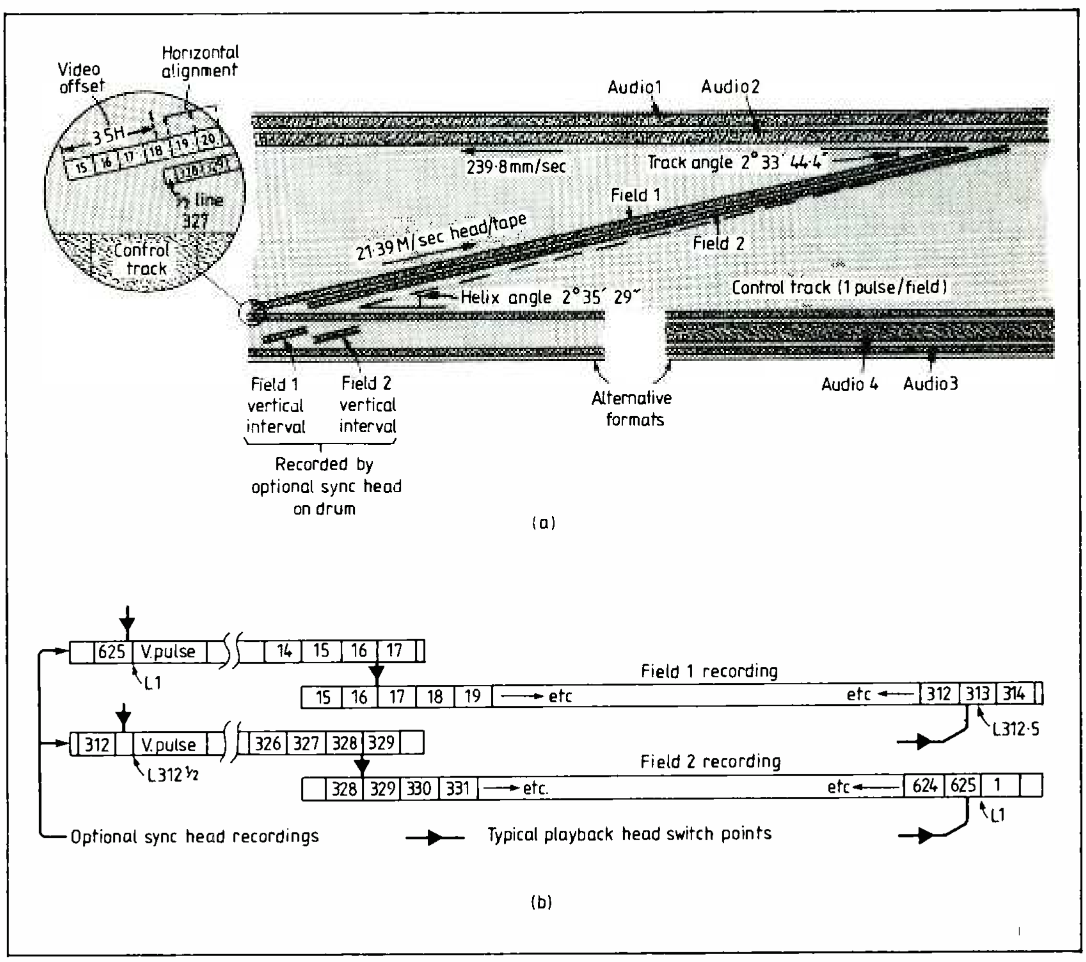


Fig 1(a) shows essentials of PAL C-format. Tape is guided round drum at helix angle, but movement of tape agains drum rotation causes track angle to be slightly smaller than helix angle. Tape speed is chosen to give video offset of 3.5 lines, which gives horizontal alignment condition (inset). Vertical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

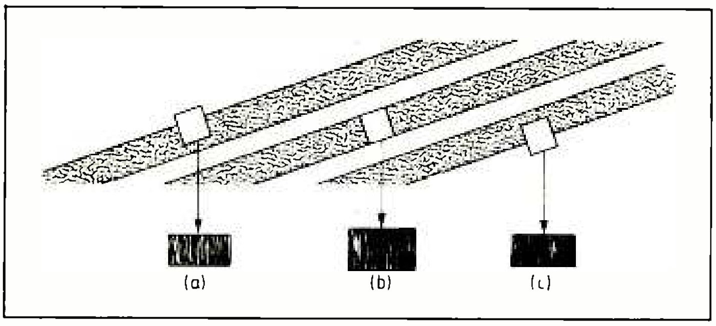


Fig. 2. **Effect of tracking error on playback signal. Signal amplitude in (a) and (c) is identical, despite sense of tracking error. Maximum signal occurs with correct alignment as in (b).**

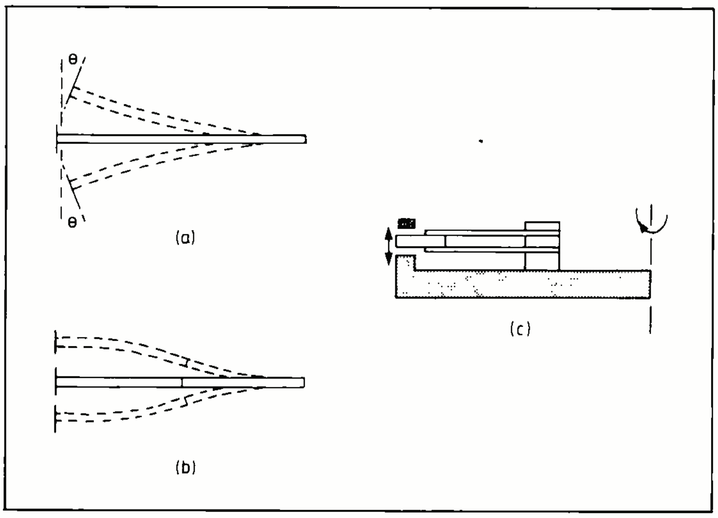


Fig 3. **Simple single bimorph at (a) changes head contact angle. At (b) compound bimorph closely approximates parallel action. Tracking head mounted in video drum is shown at (c).**

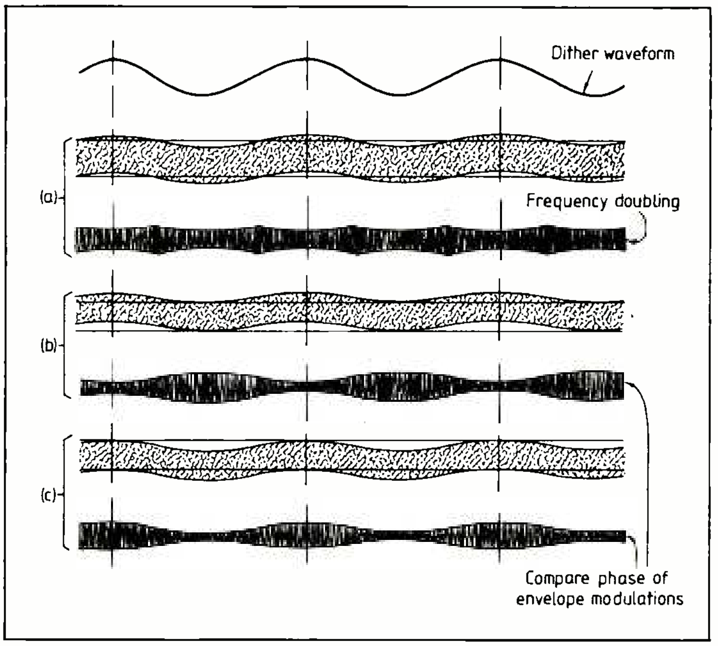


Fig. 4. **Top, dither waveform which causes head to oscillate across track. At (a) is optimum alignment, showing frequency doubling in r.f. envelope. With head above track centre, as in (b), r.f. amplitude increases as head reaches lowest point, whereas reverse applies in case (c).**

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 signal, 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 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 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 delfection, 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 dipulses which are needed to accelerate and decelerate the tracking head during the jump.

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× and +3× speeds are the inverse of one another. This is because the +1× speed is obtained by drum geometry, and the -1× and +3× 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-tape speed slightly. Similarly, doubling or tripling the linear tape speed only slightly increases the head-to-tape speed. Note that in C-format, the drum turns against tape travel. In some formats, the drum turns with the tape travel, and many of the effects described here will be in the opposite sense.

When the tape speed exceeds certain limits, the bimorph does not have enough physical travel to stay on one track for a complete revolution of the drum. In this case jumping has to take place on the visible part of the scan, and guard band noise between tracks will be played back during the jump. There is no disturbance to H sync. phase caused by in-field track switching because the C-format, like most other video tape formats, is designed such that H pulses on adjacent tracks are aligned. This is achieved by choosing a linear tape speed which causes a 3.5 line shift between tracks. The half-line component removes the effects of interlace on the H/V sync. relationship, permitting the horizontal alignment condition. It is this constraint that results in video recorders having rather strange linear tape speeds. One revolution of the drum now plays back segments of various tracks to build up a field. the circumstances under which this happens are beyond the speed range where a broadcast quality signal is required, and the jumping within the field permits a picture to be seen which is not perfect but is of much more practical use than no picture at all.

The track-following head is in a drum which is of 67.31mm radius, and turning at 3000r.p.m., which means that it is experiencing a pull of about 700 times the force of gravity, which tends to keep the bimorph straight! Large excursions needed for variable-speed operation mean that an appreciable drive (several hundred volts) is needed to overcome the overall stiffness of the bimorph. As drive in a conventional feedback servo is proportional to the loop error, the tracking error would be greater at the excursion limits. This problem can be eliminated by using a feedforward technique. For any linear tape speed, it is possible to calculate the slope of the voltage ramp needed to keep the head on track by geometry. Figures 6, 7 and 8 show that the slope is proportional to the deviation from normal speed, i.e. slope is zero at +1×, and the slope at +3× is equal and opposite to the slope at -1×. The capstan drive circuit can determine the speed deviation, and if this is fed into an integrator which resets once per drum revolution, a predicted deflection signal can be

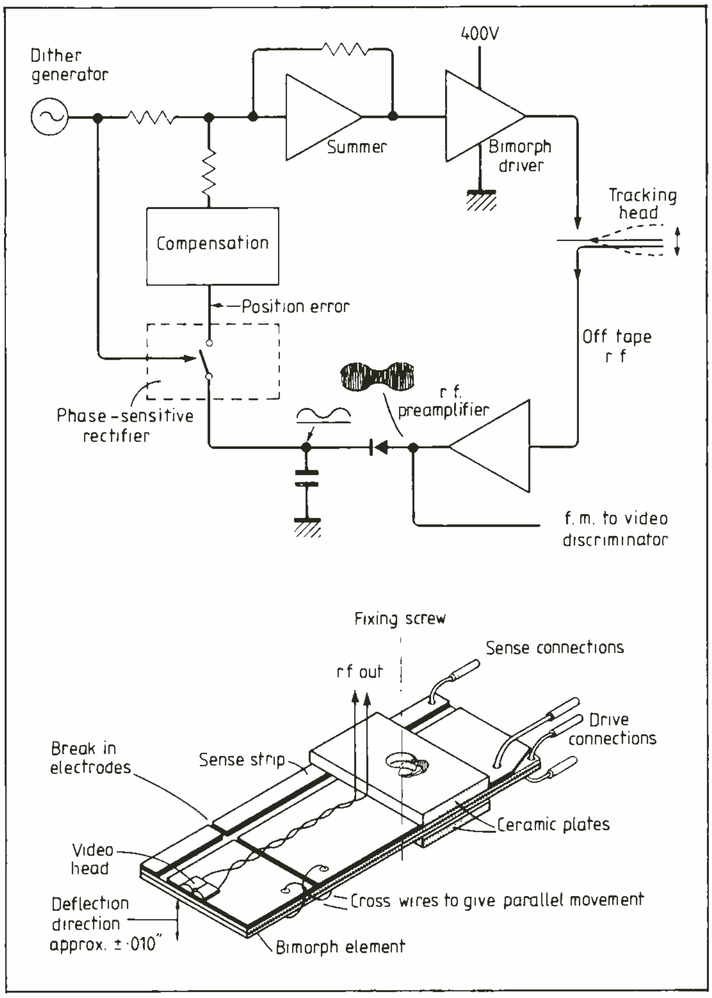


Fig. 5. **Phase-sensitive rectifier in (a) extracts tracking error from r.f. envelope. Position feedback from sense strip provides damping. At (b), break in electrode plating isolates sense strip on bimorph, isolating two sections of element which bend in opposition due to cross wire connections.**

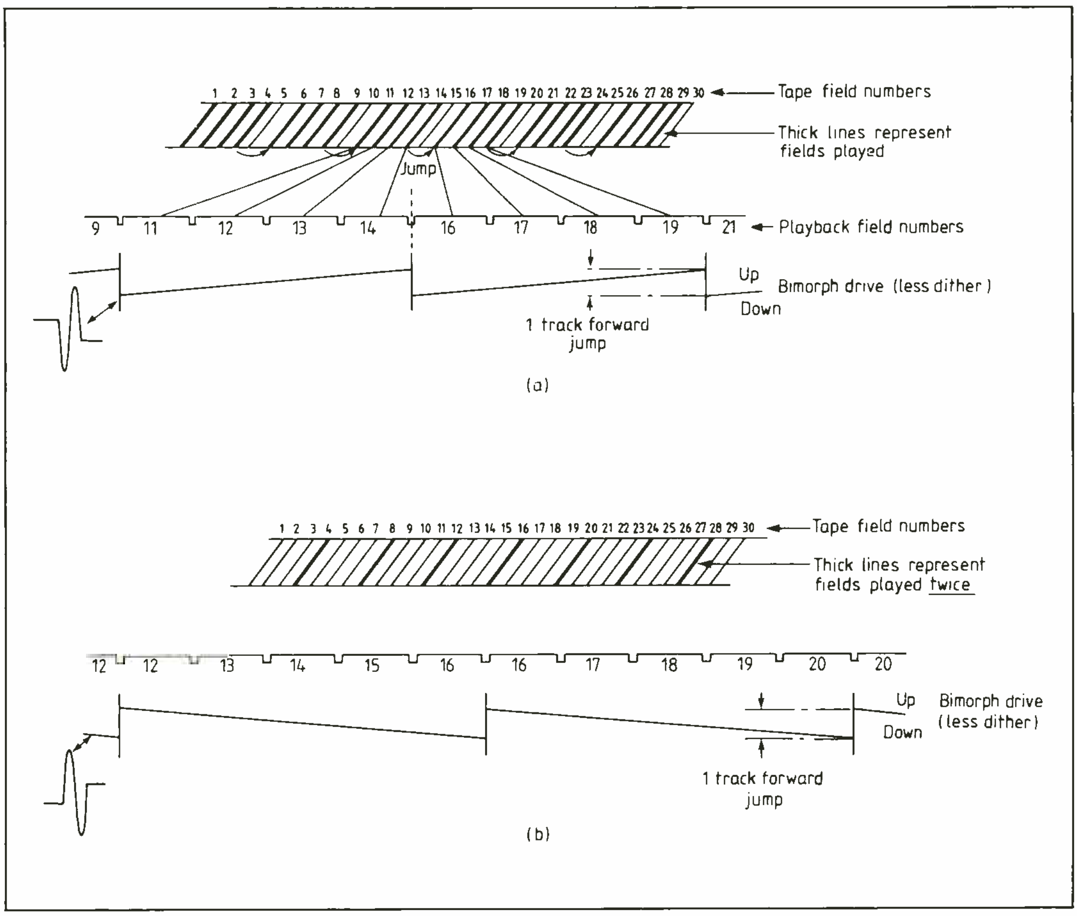


Fig. 6. **Tape at (a) moving at 125% normal speed: to maintain field rate, four out of every five tracks are played, with single-track jump every four. Slope of bimorph drive signal is positive: negative steps are where head jumps down to skip one track. At (b), tape moves at 80% of forward speed: every fourth track played twice using single-track reverse jump. Slope of bimorph drive is negative, with positive jumps to repeat one track.**

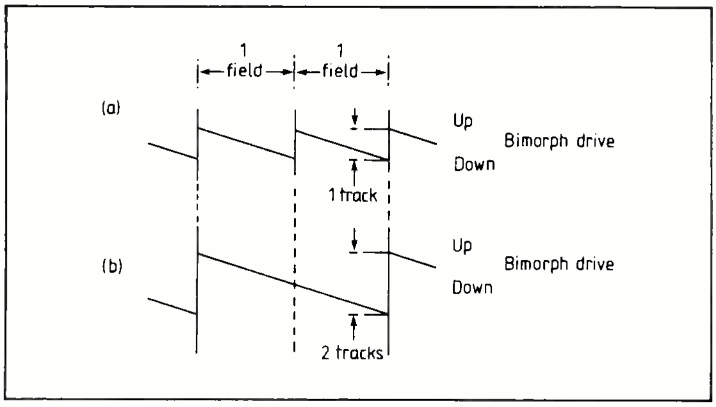


Fig. 7. **Still-field mode at (a) repeats one field endlessly. With tape stationary, one-track reverse jump is needed once per field. Still-frame mode at (b) repeats two fields endlessly. Two-track reverse jump once per frame. Depending on where tape stops, d.c. component may be needed.**

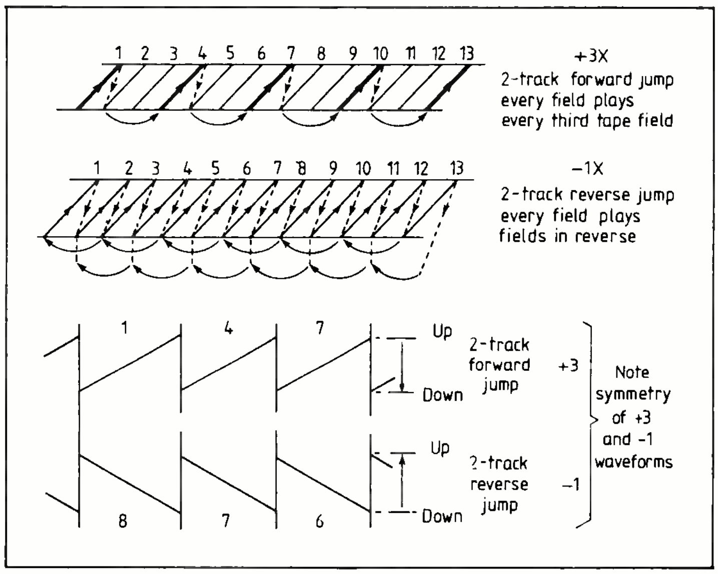


Fig. 8. **Single-track advance is obtained by normal tape movement. Two-track jump forwards adds to give ×3 speed: two-track backwards subtracts to give -1 speed.**

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×, single-track jumps are sufficient, their frequency varying from never at +1× to once per rev. at +2× 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×, 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.

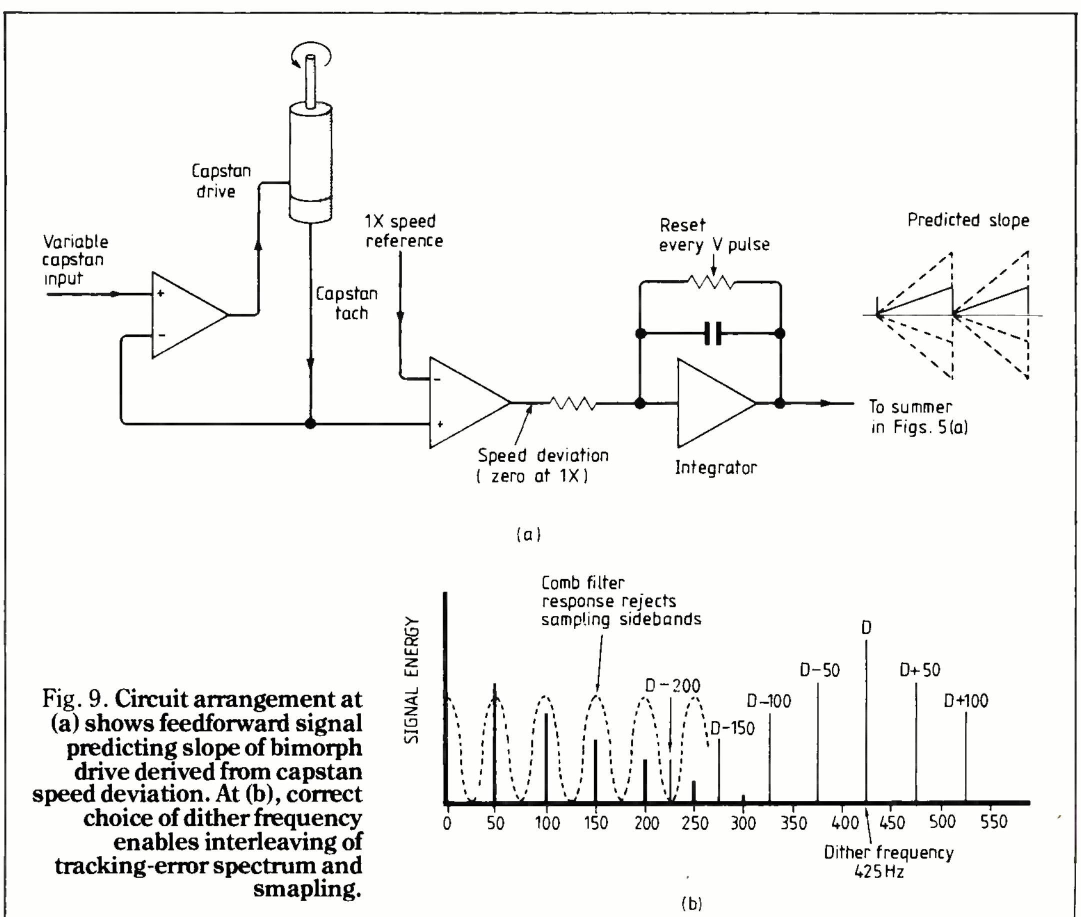


Fig. 9. **Circuit arrangement at (a) shows feedforward signal predicting slope of bimorph drive derived from capstan speed deviation. At (b), correct choice of dither frequency enables interleaving of tracking-error spectrum and smapling.**

To be continued

Multi-standard modem

by Richard Lambley

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 throughout. 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

A Wireless World Design

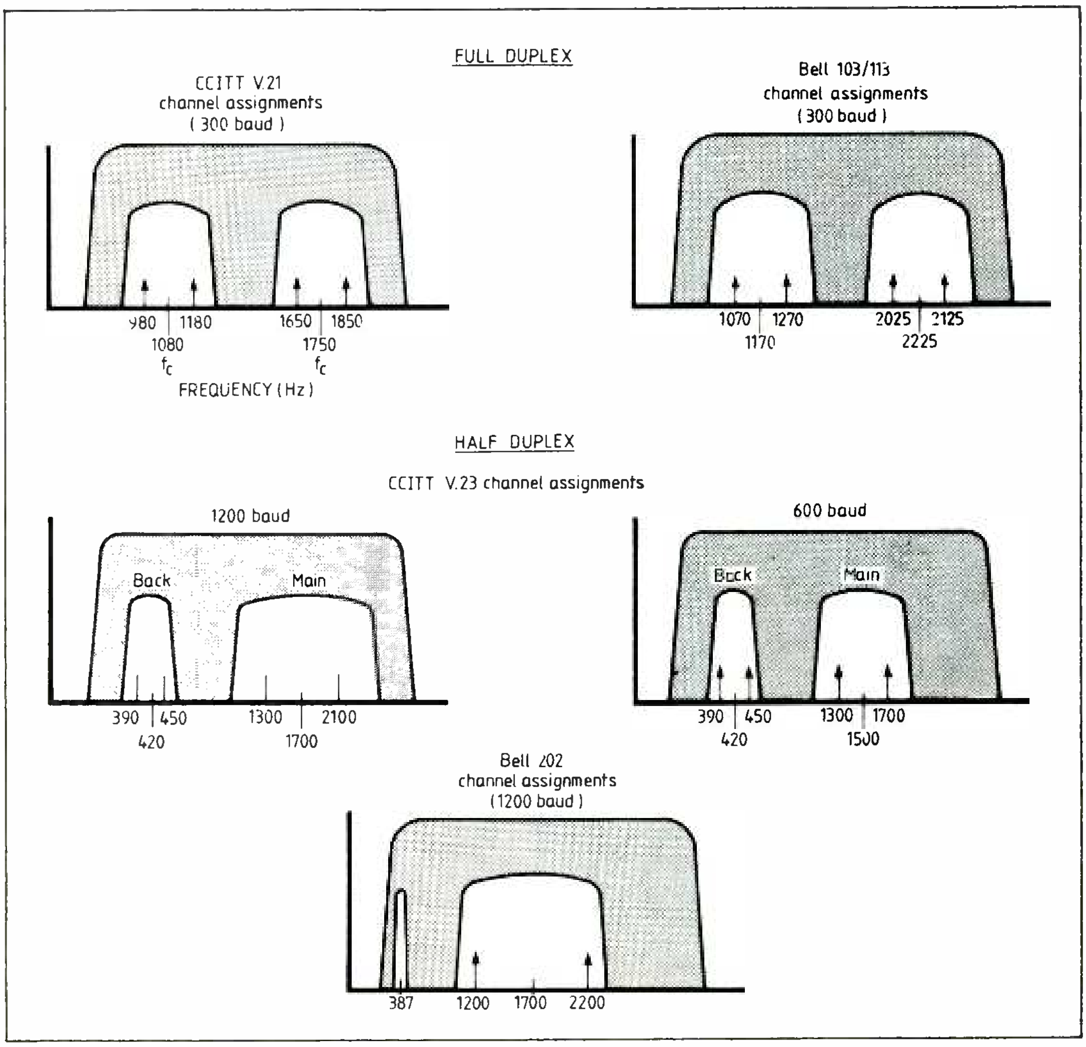


Fig. 1. **Full duplex modes allow simultaneous 300baud transmission in both directions. In the half-duplex modes, the return channel is of limited bandwidth.**

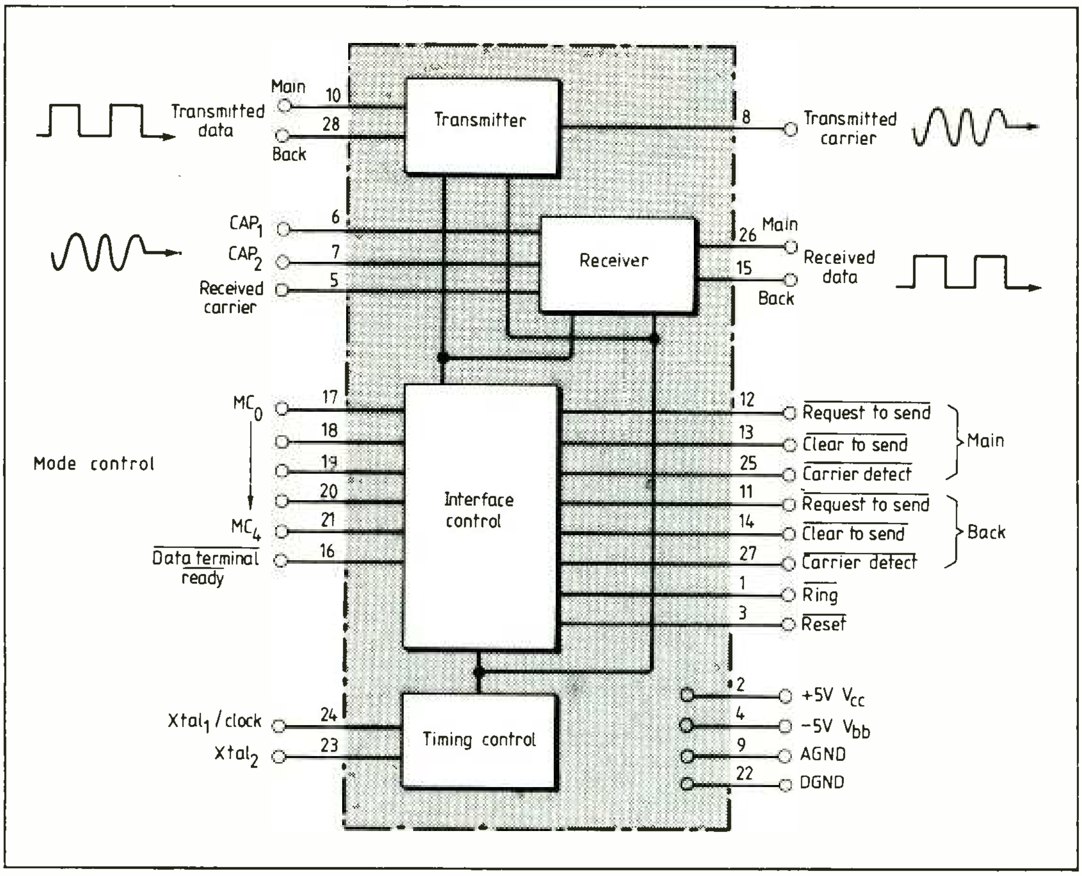
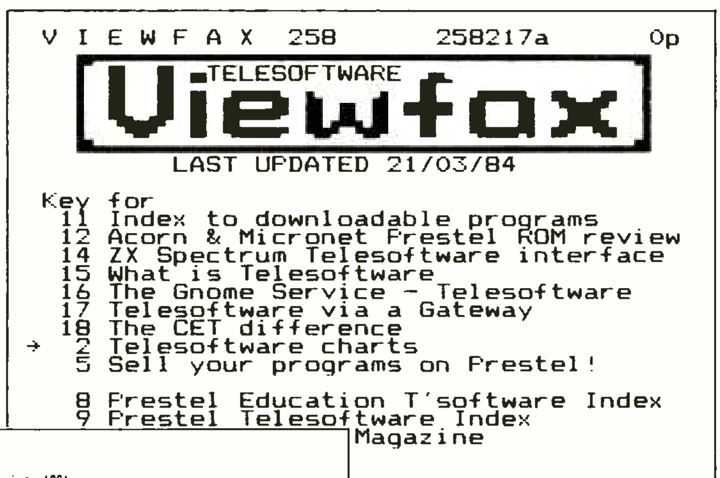


Fig. 2. **Block diagram of the AM7910. The mode control pins provide selection of a variety of common European and American standards. No external filters are required.**

Viewfax 258 (right) is available through Prestel.



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

```
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 FEWER 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 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 $\overline{CTS}$ and $\overline{RTS}$. 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 $\overline{RTS}$ and $\overline{CTS}$, or $\overline{BRTS}$ and $\overline{BCTS}$ 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 $\overline{CD}$ (carrier detect) pin or, for the back channel, its $\overline{BCD}$ 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. $\overline{BCTS}$ and BRD are not used at all; and on the transmit side keying is applied to the $\overline{BRTS}$ line while BTD is held at +5V.

To complete the RS232 interface, the Am7910 has a $\overline{DTR}$ pin ('data terminal ready'), which acts as a sort of chip select line. Held at +5V, the $\overline{DTR}$ 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 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.

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.

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						

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

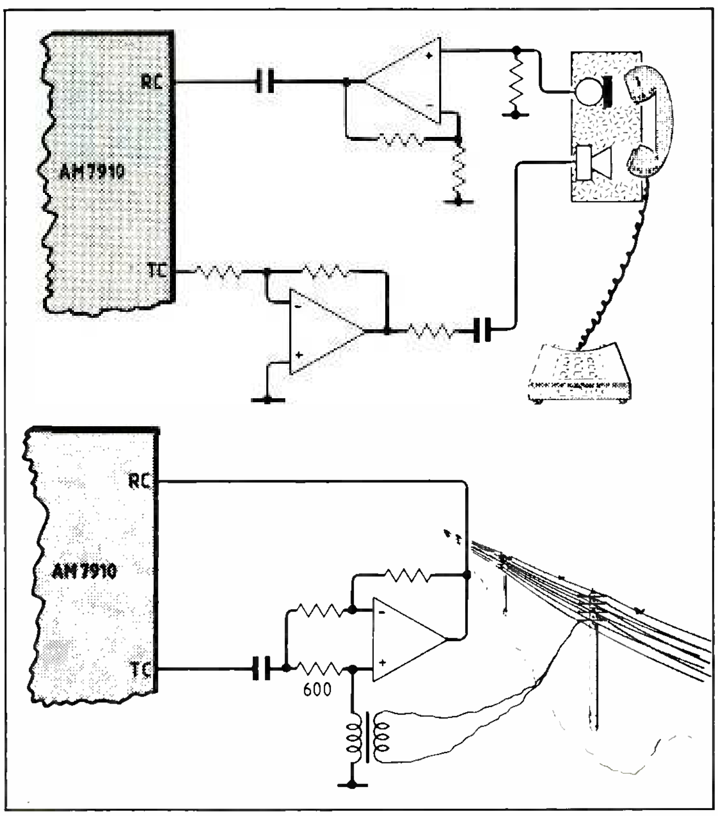
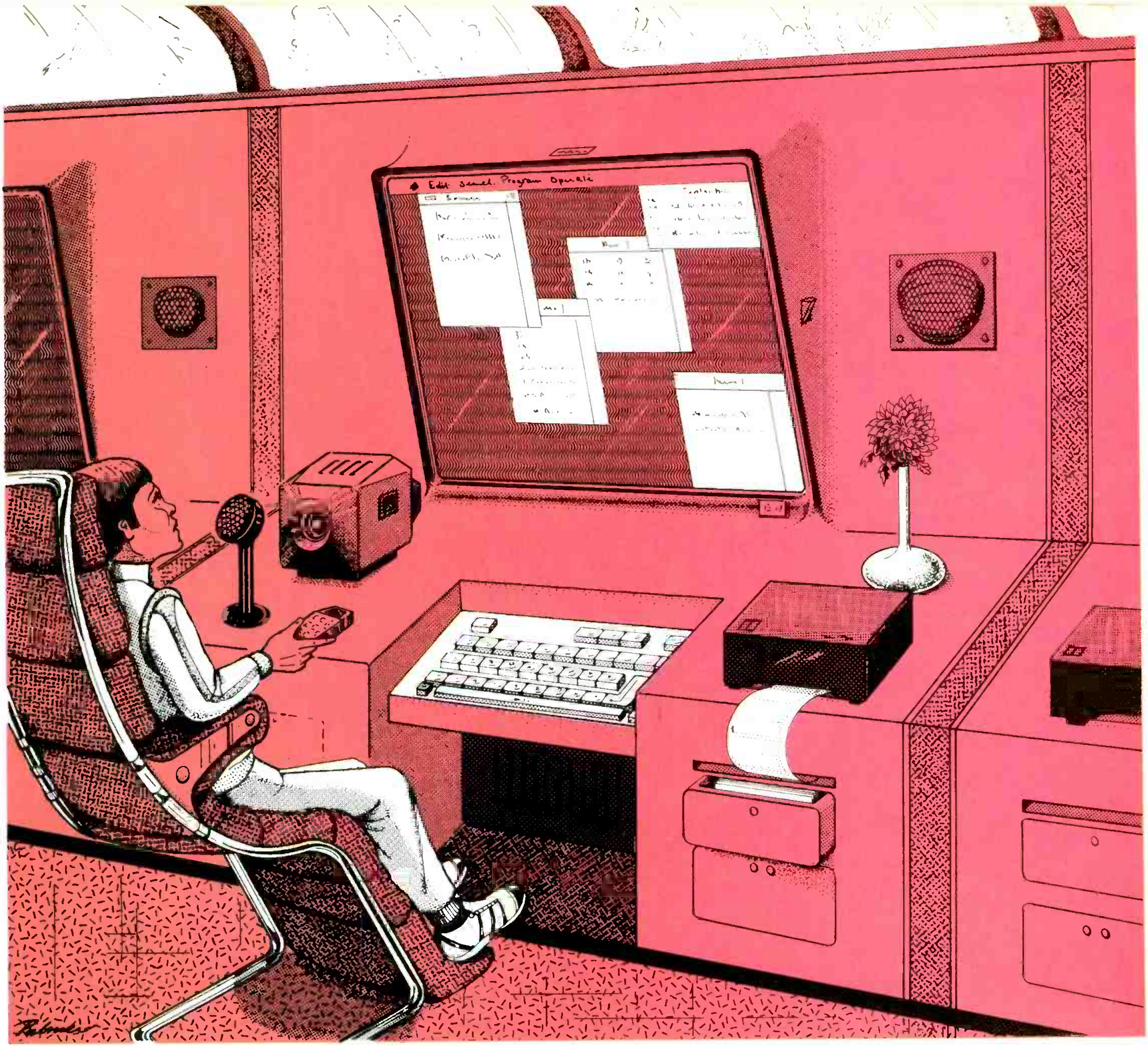


Fig. 3. Connection to the telephone line can be via an acoustic coupler, or (below) through an op-amp duplexer and an isolating transformer.



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 technology[1]. 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 1962[2]. 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 telecommunications 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 considerable 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 network[5].

The next transatlantic cable will be the optical-fibre type. The idea of optical-fibre communications was first mooted in 1966[6] 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 satellites[7] 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 1976[8], pioneered with mixed results in 1979-1982[9], and is the subject of further experiments today[10]. 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 article[11] 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 systems[12] 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.

One longs, indeed, for a unit of knowledge which might be called perhaps a 'wit', analogous to the 'bit'.

K. E. Boulding

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 accouncement 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 1975[13]. 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 microinches 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 $400[14], 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

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 teleconferencing[18]. 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 on 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 underveloped 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.

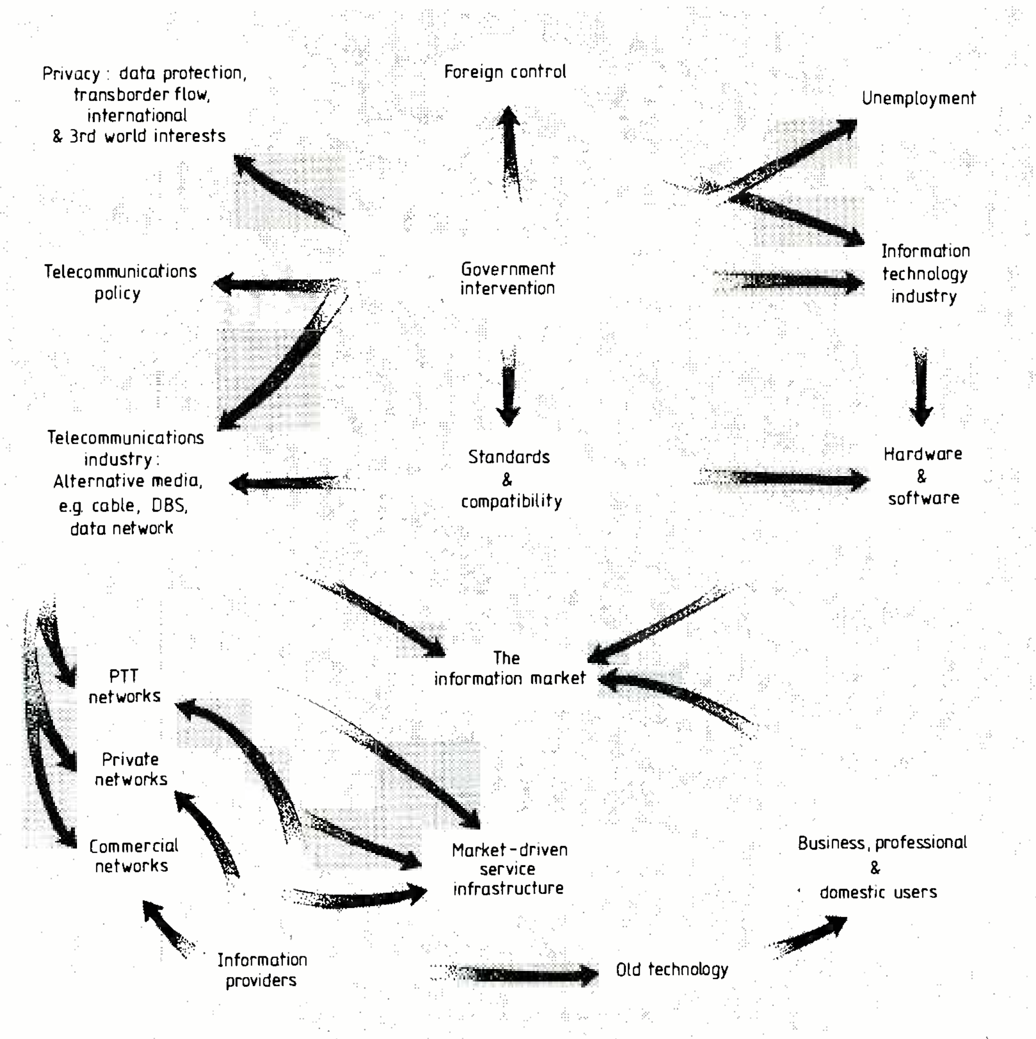


Fig. 1. **The information infrastructure and the forces which influence it.**

I am not referring to "service" in the "maintenance" sence (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 nth 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 users[19].

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 Unilever[20], airlines[21] 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 carrriers', 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" carrier[22]. 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 compromise[23] 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

The roots of relativity

by W A Scott Murray B.Sc., Ph. D.

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.

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 Realtivity 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 preamble[1] 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 plaintively[2] (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]."

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'.

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 retrospectively[3] 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 *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.

* '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.)

Einsteins'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 nautral 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 excercise (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 assumed to be true becasue 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?

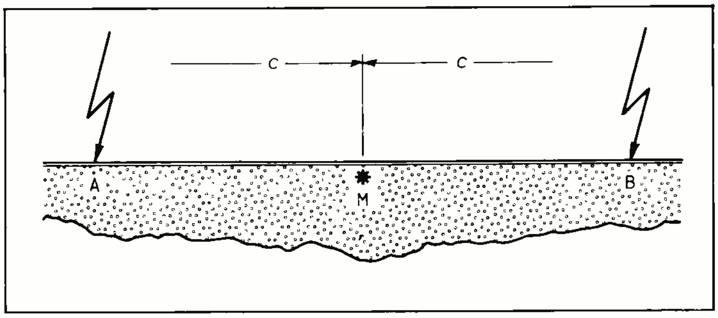
Signal error at the trackside

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 simultaniety. 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]

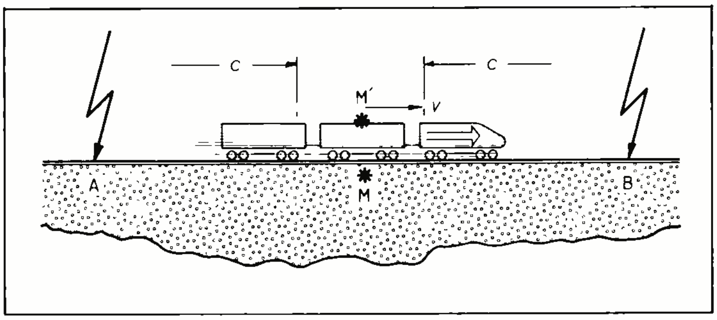
> "If the observer [at M] perceives the two flashes of lightning at the same time, then they are simultaneous."

This is Einstein's *definition* of what he means by simultaniety, 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 → M and M ← 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 → M as for the path B → 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 simultaniety."



Situation at the trackside, Fig. 1.



Situation deduced by observer M, Fig. 2.

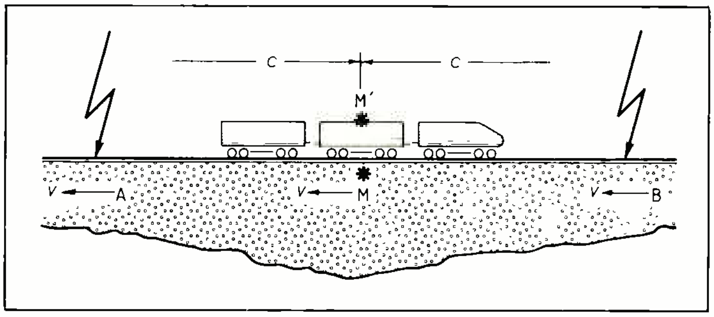
Now a 'stipulation' — arbitrary and subject to one's own free will 'in order to arrive at a definition' — does not seem quite the same thing as a universal natural law. Is he not still talking about the velocity of light *in vacuo*? And incidentally, why should the definition (or fact) of simultaniety 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 simultaniety that he proposes, *pro tem*.

Einstein next puts a train onto his railway embankment, travelling in the direction A → 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 simultaniety). 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 → M′ is equal to the distance B → M′, in exactly the same way that the distance A → M is equal to the distance B → 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 as seen by observer M[1], 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* 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 simultaniety' or the universal constancy of c, but not both.

* 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.

"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 may 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.

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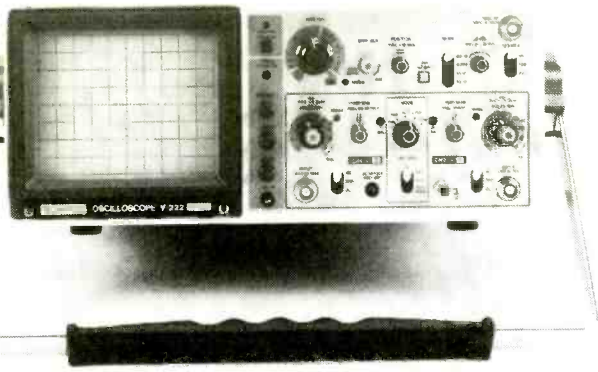

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VA	Price	P&P
*20	5.82	1.60
60	9.49	1.80
100	11.08	2.00
200	15.69	2.25
250	18.97	2.64
350	23.47	2.70
500	29.23	2.95
750	41.28	3.70
1000	53.00	4.00
1500	68.37	4.70
2000	82.27	5.10
3000	115.35	OA
6000	203.65	OA

*115 or 240V sec only.

400/440V ISOLATORS
400/440 to 200/240V CT

VA	Price	P&P
60	9.50	1.80
100	11.08	2.00
200	15.68	2.25
250	18.97	2.40
350	23.47	2.70
500	29.23	2.95
1000	52.98	4.00
2000	82.27	5.00
3000	115.37	OA
6000	228.75	OA

24/12V or 12-0-12V
2×12V Secs. Pri. 240V

12V		24V	Price	P&P
0.3A		.15	2.41	.90
1		.5	3.19	1.20
2		1	4.25	1.20
4		2	4.91	1.60
6		3	7.69	1.60
8	A	4	8.98	1.60
10	M	5	9.82	1.80
12	P	6	10.89	1.90
16	S	8	12.97	2.12
20		10	17.46	2.44
30		15	21.69	2.64
60		30	44.45	OA
83		41	51.20	4.50

96/48V. Pri 2×120V
Secs 2×36/48V

72/96-V		36/48V	Price	P&P
0.5A		1	5.37	1.20
2	A	4	14.69	2.20
3	M	6	17.79	2.40
5	P	10	32.23	3.20
6	S	12	40.36	3.50
8		16	44.03	3.75

50/25V or 25-0-25V
2×25V Tap Secs. 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40, 20-0-20 or 25-0-25V

50V		25V	Price	P&P
0.5		1	4.13	1.40
2	A	4	8.69	1.84
3	M	6	10.36	1.90
4	P	8	14.10	2.12
6	S	12	18.01	2.20
8		16	24.52	2.70
10		20	30.23	3.00
12		24	36.18	3.20

60/30V or 30-0-30V
Pri 2x120V. 2×30V Tap Secs 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60, 24-0-24 or 30-0-30V.

60V		30V	Price	P&P
0.5		1	4.70	1.50
1		2	7.15	1.50
2		4	9.20	1.90
3	A	6	13.31	2.00
4	M	8	15.15	2.20
5	P	10	19.16	2.20
6	S	12	21.86	2.65
8		16	30.72	3.00
10		20	35.76	3.30
12		24	41.22	3.50

MINIATURES

Sec V	A	Pri	P&P
3-0-3	.2A	3.11	.90
6×2	1A×2	3.45	1.20
9-0-9	.1	2.59	.90
9×2	.33×2	2.41	.90
8,9×2	.5×2	3.36	1.20
8.9×2	1A×2	4.27	1.40
15×2	.2A×2	2.41	.90
12-0-12	.05	3.11	.90
20×2	.3×2	3.39	1.20
20,12,0			
12,20	.9	4.13	1.30
15,20-2	1A×2	5.60	1.60
15,27×2	.5×2	4.83	1.40
15,27×2	1A×2	7.30	1.60

SPLIT BOBBIN
PC or CLAMP 15 & 3VA Sec V 2×3V 2×4 5V 2×6V 2×7.5V 2×9V 2×12V 2×15V 2×20V, 6, 9, 12 20VA.

EXPORT ENQUIRIES WELCOMEO

30/15V or 15-0-15V
2×15V Tap Sec. Volts 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30 or 15-0-15V

30V		15V	Price	P&P
0.5A		1	3.19	1.20
1		2	4.32	1.40
2	A	4	6.99	1.60
3	M	6	8.10	1.85
4	P	8	9.67	1.90
5	S	10	11.95	2.00
6		12	13.52	2.00
8		16	18.10	2.26
10		20	20.88	2.26
12		24	23.20	2.50
15		30	26.60	3.00
20		40	35.64	4.83

AUTOS
105, 115, 220, 230, 240V
For step-up or down

VA	Price	P&P
80	4.84	1.40
150	6.48	1.60
350	11.84	2.00
500	13.30	2.24
1000	22.70	2.80
1500	28.17	3.20
2000	42.14	4.00
3000	71.64	4.80
5000	108.30	OA

CASED AUTOS
240V to 115V USA skts.

VA	Price	P&P
20	7.21	1.50
80	9.35	1.60
150	12.10	1.90
250	14.73	2.00
500	22.14	2.20
1000	33.74	2.80
2000	60.47	4.50

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Spike-free stable mains

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MM5 Minor	£52.00
DA212 LCD	£98.60
DA116 LCD	£154.50
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Megger Gen	£116.40
Batt Megger	£85.50
AVO 2001	£91.60

P&P £2 VAT 15%

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400V1A	.32
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Unit 211, Stratford Workshops
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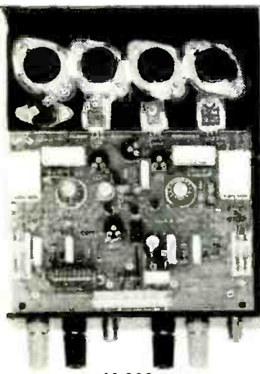
WW-6

CIRCLE 058 FOR FURTHER DETAILS.



— M.300 —

MONO 300 WATTS

MAIN FEATURES:- INCLUDE

1. SUPER SOUND
2. FREE STANDING
3. OPEN FRAME
4. VARIABLE GAIN
5. PRECISION PARTS

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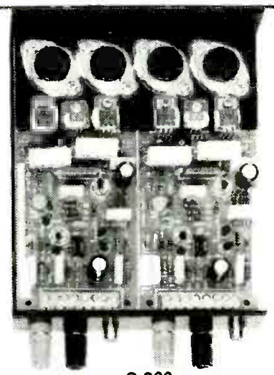

— S.200 —

STEREO 200 WATTS

(2 × 100 WATTS/CH.)
MAIN FEATURES:— INCLUDE

1. COMPLETE 2CH. CHASSIS
2. OPEN FRAME DESIGN
3. VARIABLE POWER 60-100w
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WW MAY 84

CIRCLE 068 FOR FURTHER DETAILS.

CIRCLE 047 FOR FURTHER DETAILS.

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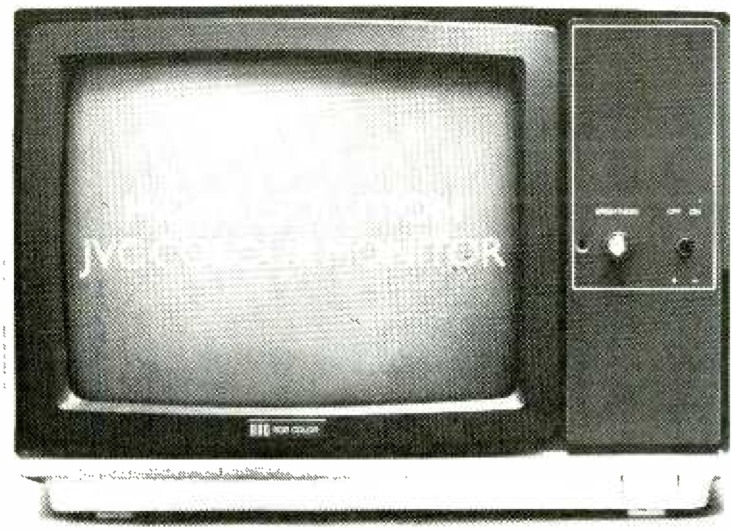

Our RGB high resolution colour monitors (580 × 470 pixels) sell for £229.95 (excluding VAT)–a saving of over £100 compared to other leading monitors of similar specifications.

That's a bargain we guarantee you won't see from any other micro retailer.

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"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 most other leading micros.

MODEL REFERENCE	1302-2 High Resolution	1302-1 Medium Resolution
RESOLUTION	580 x 470 Pixels	370 x 470 Pixels
C.R.T	14"	14"
SUPPLY	220-240v 50/60Hz	220-240v 50/60Hz
E.H.T	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

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I understand carriage per monitor will cost an extra £7.00. (N.B. A High Resolution Monitor including VAT, lead, and carriage costs £279.39. A Medium Resolution Monitor including VAT, lead and carriage costs £221.89).

I enclose a cheque for £_______ Or please debit my credit card account with the amount of £_______ My Access/Barclaycard (please tick) no. is_______

Please state the make of your computer_______

Name_______

Address_______

____

Telephone:_______

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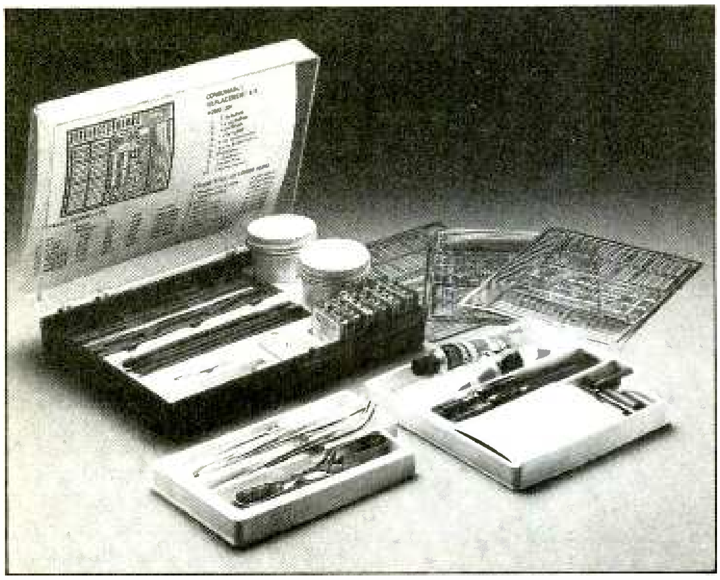
WW11

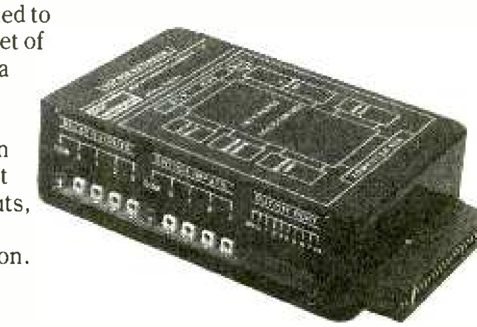
CIRCLE 037 FOR FURTHER DETAILS.



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.

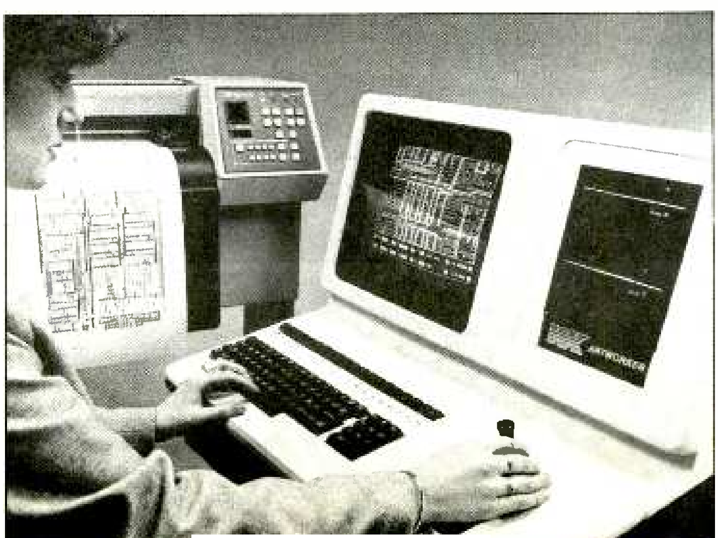
The a-to-d converter is a single-chip device with a separate 2.45V precision voltage reference i.c. it gives 256-step resolution on all eight channels. A 5V regulator provides the supply for all the internal circuitry with a spare capacity of 80mA for external circuitry. Up to four switches can be connected 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, Artwork 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



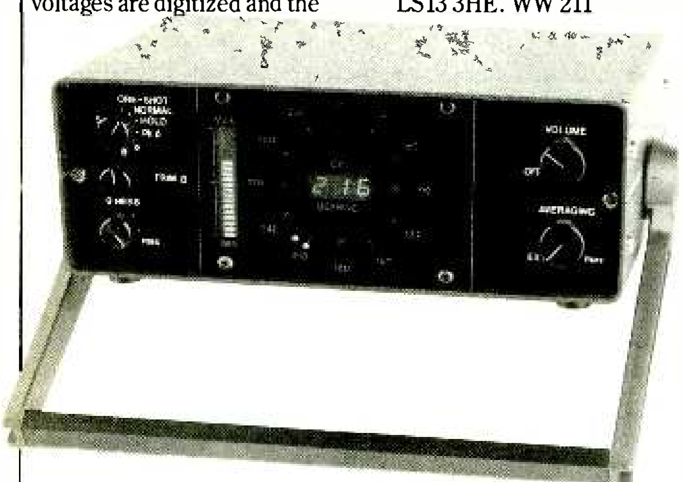
MORSE RECEIVER FOR ZX81

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

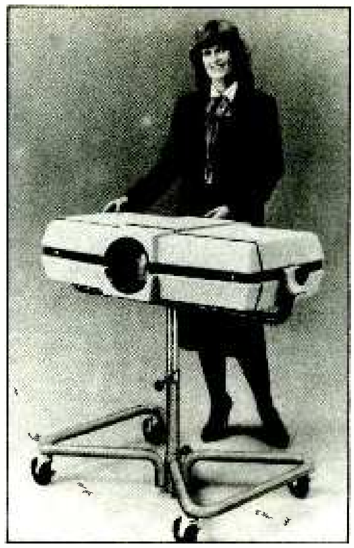
A radio direction finding system, the DF2, gives an instant readout of the direction of a signal both as a digital display and as points around a compass. The signals are collected from four identical antennae mounted in a square array. These are combined in a head unit which phase-modulates the signal 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 calculation to the bearing is handled by a Z80 processor, which is also used to drive the display. The phase-shift cause 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 act as a d.c. power cable to 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



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 cost £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.ts 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.ts. This ensures that the brightest image is available for projection. The c.r.ts. 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

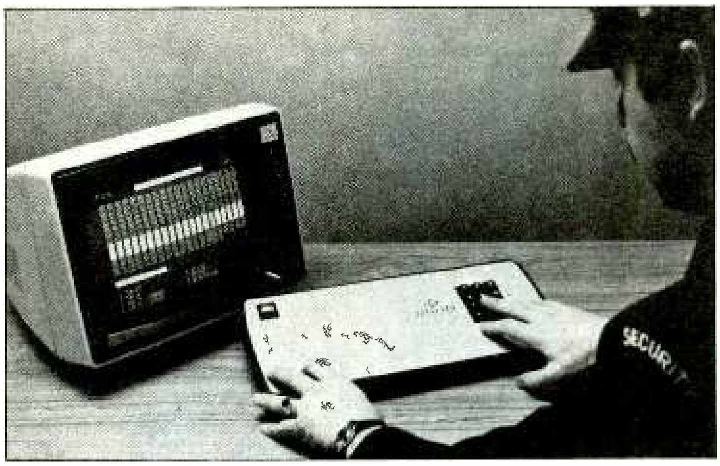
A different approach is taken by Phi Mag Systems, who have produced Phloopy, which uses a continuous loop of tape about three meters long in an interchangeable cartridge. Tape speed is 15in/s and 0.25in instrumentation tape is used. Each cartridge offers a capacity of 100Kbytes and a transfer rate of 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

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/µs. 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 nuber 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 porposed 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 insturment, 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. modualted 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

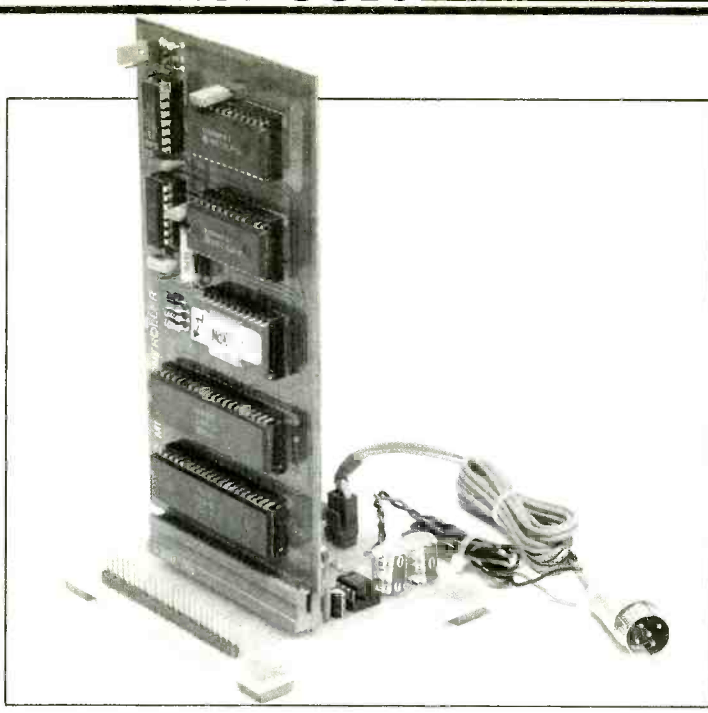
A module is produced which can be added to a forward power meter to convert it to read peak envelope.

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 cascasded 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

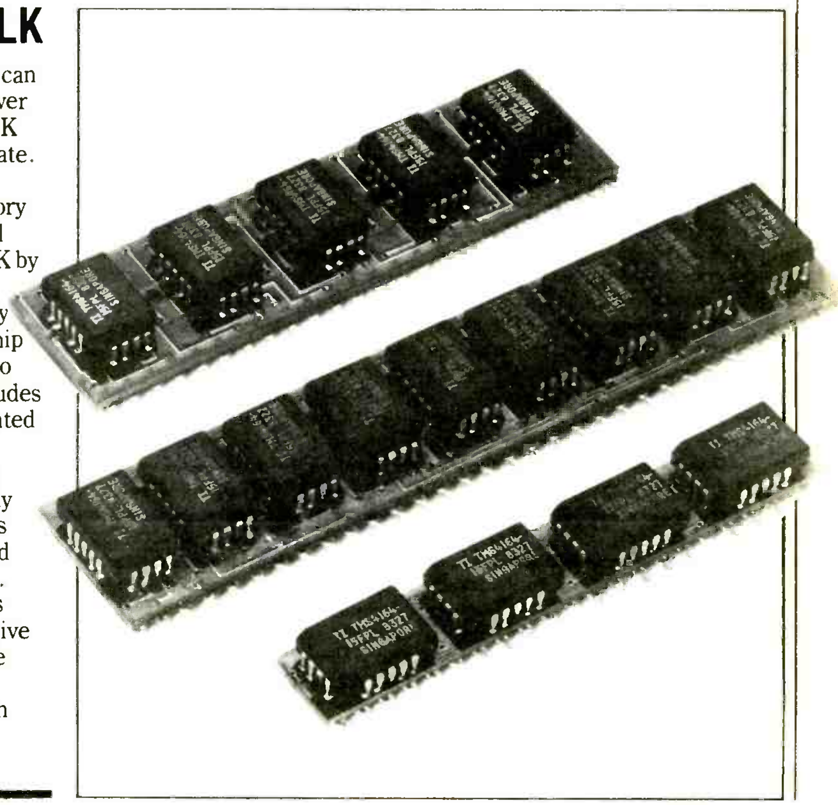


MICRO CONTROLLER

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 eprom 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 eprom 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

★ MARCONI SIGNAL GENERATORS ★

TF2002A/S (illustrated) 10kHz-72MHz AM/FM. **£750**
TF2002. As above but AM only. **£450**

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TELONIC SM2000 with 500-900MHz plug-in £175
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WW10

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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.).

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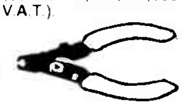

HIGH-POWER SILICON BRIDGE RECTIFIERS, 25 amp 600v. Single-hole fixing 250 (1/4in.), push-on connector terminals, manufactured by IR. £20 for 10, £90 for 50, £175 for 100, £800 for 500, £1,450 for 1,000. Special quotation for larger quantities. Sample sent for £2.50 + 25p P&P (£3.16 inc. V.A.T.).

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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 1rev. 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.).

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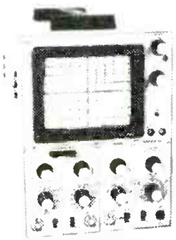

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OR { 1 × 600W into 2 to 8Ω
1 × 300W into 2 to 4Ω
1 × 150W into 4 to 8Ω }
Etc., etc.

Having been closely involved in a wide variety of OEM applications of their amp boards, Pantechnic became aware of numerous implementation problems often left untackled 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.

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SN76013N	1.95
SN76023N	1.95
SN76033N	1.95
SN76110N	0.89
SN76115N	1.25
SN76131N	1.30
SN76226DN	2.95
SN76227N	1.05
SN76533N	1.65
SN76544N	1.95
SN76570N	1.00
SN76650N	1.15
SN76660N	0.80
STK014	7.95

STK015	7.95
STK415	7.95
STK433	7.95
STK437	7.95
STK439	7.95
TA7061AP	3.95
TA7108P	1.00
TA7120P	1.65
TA7130P	1.50
TA7146	2.95
TA7176AP	2.95
TA7203	2.95
TA7204P	2.15
TA7205AP	1.50
TA7222AP	1.80
TA7227P	4.25
TA7310P	1.80
TA7313AP	2.95
TA7321P	2.25
TA7609P	3.15
TA7611AP	2.95
TAA550	0.25
TAA570	1.95
TAA621AXI	3.50
TAA661B	1.20
TAA700	1.70
TBA120B	0.95
TBA120C	1.15
TBA120T	1.05
TBA120U	1.00
TBA231	1.25
TBA395	1.50
TBA396	0.75
TBA440N	2.55
TBA480Q	1.25
TBA510	2.50
TBA510Q	2.50
TBA520	1.10
TBA520Q	1.10
TBA530	1.10
TBA530Q	1.10

TBA540	1.25
TBA540Q	1.35
TBA550Q	1.45
TBA560C	1.45
TBA560CQ	1.45
TBA570	1.00
TBA641A12	2.50
TBA651R	2.50
TBA720A	2.45
TBA750Q	2.65
TBA800	0.89
TBA810AS	1.65
TBA810P	1.65
TBA820M	0.75
TBA820Q	1.45
TBA890	2.50
TBA920	1.65
TBA950/2X	2.35
TBA970	2.95
TBA990	1.49
TBA1441	2.15
TCA270	1.10
TCA270SQ	1.10
TCA650	2.50
TCA800	2.15
TCA940	1.65
TDA440	2.20
TDA1001	1.95
TDA1004A	3.25
TDA1006A	2.50
TDA1010	2.15
TDA1035	2.50
TDA1037	1.95
TDA1170	1.95
TDA1190	2.15
TDA1270Q	3.95
TDA1327	1.70
TDA2002	1.95
TDA2020	2.45
TDA2030	2.80
TDA2522	1.95

TDA2523	1.95
TDA2524	1.95
TDA2530	1.95
TDA2532	1.95
TDA2540	1.25
TDA2541	2.15
TDA2560	2.15
TDA2571	2.95
TDA2581	2.25
TDA2593	2.95
TDA2600	5.50
TDA2610	2.50
TDA2611A	1.95
TDA2640	2.60
TDA2680A	2.75
TDA2690	2.45
TDA3560	5.50
UPC566H	2.95
UPC575C2	2.75
UPC1025H	2.50
UPC1028H	1.95
UPC1032H	1.50
UPC1156H	2.75
UPC1158H	0.75
UPC1167C2	1.15
UPC1181H	1.25
UPC1182H	2.95
UPC1185H	3.95
UPC1191V	1.50
UPC1350C	2.95
UPC1353C	2.45
UPC1365C	3.95
UPC2002H	1.95
555	0.35
556	0.42
723	0.50
741	0.25
747	0.50
748	0.35
7808	0.60

SEMICONDUCTORS

AAY12	0.25
AC127	0.20
AC128	0.28
AC128K	0.32
AC141	0.28
AC141K	0.34
AC142K	0.30
AC176	0.22
AC176K	0.31
AC187	0.25
AC187K	0.28
AC188	0.25
AC188K	0.37
AD142	0.79
AD143	0.82
AD149	0.70
AD161	0.39
AD162	0.39
AD161/2	0.90
AF114	1.50
AF124	0.65
AF125	0.35
AF126	0.32
AF127	0.40
AF139	0.40
AF178	1.95
AF239	0.42
AU106	3.25
AU110	2.00
BC107A	0.11
BC107B	0.11
BC108	0.10
BC108A	0.11
BC108B	0.12
BC109	0.10
BC109B	0.12
BC109C	0.12
BC114	0.11
BC116A	0.15
BC117	0.19
BC119	0.24
BC125	0.25
BC139	0.20
BC140	0.31
BC141	0.25
BC142	0.21
BC143	0.24
BC147	0.09
BC147B	0.09
BC148A	0.09
BC148B	0.09
BC149	0.09
BC157	0.12
BC158	0.09
BC159	0.09
BC160	0.28
BC161	0.28
BC170B	0.15
BC171	0.09
BC171A	0.10
BC171B	0.10
BC172	0.10
BC172B	0.10
BC172C	0.10
BC173B	0.10
BC174	0.09
BC174A	0.09
BC177	0.15
BC178	0.15
BC182	0.10

BC182LB	0.10
BC183	0.10
BC183L	0.09
BC184LB	0.09
BC204	0.10
BC207B	0.13
BC208B	0.13
BC212	0.09
BC212L	0.09
BC212LA	0.09
BC213	0.09
BC213L	0.09
BC214	0.09
BC214C	0.09
BC214L	0.09
BC237B	0.09
BC238	0.09
BC239	0.12
BC251A	0.12
BC252A	0.15
BC258	0.25
BC258A	0.39
BC284	0.30
BC300	0.30
BC301	0.30
BC303	0.26
BC307B	0.09
BC327	0.10
BC328	0.10
BC337	0.10
BC338	0.09
BC347A	0.13
BC461	0.35
BC478	0.20
BC527	0.20
BC547	0.10
BC548	0.10
BC549A	0.08
BC550	0.08
BC557	0.08
BC557B	0.08
BC558	0.10
BCY33A	1.60
BD115	0.30
BD116	0.60
BD124P	0.59
BD131	0.32
BD132	0.35
BD133	0.40
BD135	0.30
BD136	0.30
BD137	0.32
BD138	0.30
BD139	0.32
BD140	0.30
BD144	1.10
BD159	0.65
BD160	1.50
BD166	0.55
BD179	0.72
BD182	0.70
BD201	0.83
BD202	0.65
BD203	0.78
BD204	0.70
BD222	0.46
BD223	0.48
BD225	0.48
BC232	0.35
BD233	0.35

BD234	0.35
BD236	0.45
BD237	0.40
BD238	0.40
BD241	0.40
BD242	0.50
BD246	0.60
BD376	0.32
BD410	0.55
BD434	0.55
BD437	0.50
BD438	0.60
BD506	0.50
BD508	0.40
BD520	0.65
BD538	0.65
BD597	0.75
BD697	1.10
BD698	1.10
BD707	0.80
BDX32	1.50
BDY57	1.65
BF115	0.35
BF119	0.65
BF127	0.24
BF154	0.12
BF158	0.22
BF160	0.27
BF167	0.24
BF173	0.22
BF177	0.38
BF178	0.26
BF179	0.34
BF180	0.29
BF181	0.29
BF182	0.29
BF183	0.29
BF184	0.28
BF185	0.28
BF194	0.11
BF195	0.11
BF196	0.11
BF197	0.11
BF198	0.16
BF199	0.14
BF200	0.40
BF241	0.15
BF245	0.30
BF256/LC	0.28
BF257	0.28
BF258	0.28
BF259	0.28
BF271	0.26
BF273	0.13
BF336	0.34
BF337	0.29
BF338	0.32
BF355	0.37
BF362	0.38
BF363	0.38
BF371	0.20
BF394	0.19
BF422	0.32
BF457	0.32
BF458	0.36
BF459	0.36
BF467	0.68
BF595	0.23
BF597	0.25
BFR39	0.23
BFR40	0.23
BFR41	0.28

BFR81	0.25
BFR88	0.30
BFR90	1.50
BFR91	1.75
BFT42	0.28
BFT43	0.28
BFW92	0.85
BFX29	0.30
BFX84	0.26
BFX85	0.32
BFX86	0.30
BFX88	0.25
BFY50	0.21
BFY51	0.21
BFY52	0.25
BFY90	0.77
BLY48	1.75
BR100	0.26
BR101	0.49
BRC4443	0.85
BT100A/02	0.75
BT106	1.49
BT116	1.20
BT119	2.35
BT120	1.65
BU105	1.22
BU108	1.69
BU124	1.25
BU125	1.25
BU126	1.60
BU204	1.55
BU205	1.30
BU208	1.39
BU208A	1.52
BU208D	1.85
BU326	1.20
BU407	1.24
BU500	2.25
BU526	1.90
BUY69B	1.70
MJ3000	1.98
MJE340	0.40
MJE520	0.48
MPSA13	0.29
MPSA92	0.30
MRF450A	12.50
MRF453	17.50
MRF454	23.50
MRF475	2.50
MRF477	10.00
OC23	1.50
OC42	0.55
OC44	0.75
OC45	0.55
OC70	0.45
OC71	0.55
OC81	0.50
R2008B	1.70
R2010B	1.70
R2322	0.58
R2323	0.66
R2540	2.48
RCA16334	0.90
RCA16335	0.80
SKE5F	1.45
TIP29	0.40
TIP29C	0.42
TIP30C	0.43
TIP31C	0.42
TIP32C	0.42
TIP33B	0.75

TIP34B	0.75
TIP41A	0.45
TIP41C	0.45
TIP42C	0.47
TIP47	0.65
TIP120	0.60
TIP125	0.65
TIP142	1.75
TIP146	2.75
TIP161	2.95
TIP2955	0.80
TIP3055	0.55
TIS91	0.20
TV106/2	1.50
2N2219	0.28
2N2905	0.40
2N3053	0.40
2N3054	0.59
2N3055	0.52
2N3702	0.12
2N3703	0.12
2N3704	0.12
2N3705	0.12
2N3706	0.12
2N3708	0.12
2N3773	1.95
2N3792	1.35
2N4427	1.50
2N4444	1.15
2N5294	0.42
2N5296	0.48
2N5298	0.60
2N5496	0.65
2SA715	0.60
2SC495	0.80
2SC496	0.80
2SC1096	0.80
2SC1106	2.50
2SC1172Y	2.20
2SC1173	1.15
2SC1306	1.00
2SC1307	1.50
2SC1364	0.50
2SC1449	0.80
2SC1678	1.25
2SC1909	1.95
2SC1945	2.65
2SC1953	0.95
2SC1957	0.80
2SC1969	1.95
2SC2028	1.15
2SC2029	1.95
2SC2078	1.45
2SC2091	0.85
2SC2098	2.50
2SC2166	1.95
2SC2314	0.80
2SC2371	0.36
2SD234	0.50
3N211	1.95
3SK45	0.70
3SK88	0.55

DIODES

AA119	0.08
BA115	0.13
BA145	0.16
BA148	0.17
BA154	0.06
BA155	0.13
BA156	0.15
BA157	0.30
BAX13	0.04
BAX16	0.06
BB105B	0.30
BT151	0.79
BY126	0.10
BY127	0.11
BY133	0.15
BY164	0.45
BY176	1.20
BY179	0.63
BY182	0.55
BY184	0.35

BY199	0.40
BY206	0.14
BY208-800	0.33
BY210-800	0.33
BY223	0.90
BY298-400	0.22
BY299-800	0.22
BYX10	0.20
BYX36-150R	0.20
BYX38-600R	0.60
BYX55-600	0.30
BYX71-600	1.10
BZY95C30	0.35
OA47	0.09
OA90	0.05
OA91	0.06
OA95	0.06
OA202	0.10
IN914	0.04
IN4001	0.04
IN4002	0.04
IN4003	0.04

IN4004	0.05
IN4005	0.05
IN4006	0.06
IN4007	0.06
IN4148	0.02
IN4448	0.10
IN5401	0.12
IN5402	0.14
IN5403	0.12
IN5404	0.12
IN5405	0.13
IN5406	0.13
IN5407	0.16
IN5408	0.16
ITT44	0.04
ITT923	0.15
ITT2002	0.10

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A selection available.
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3BPI	£13.50	D10-210GH	£45
DG7-32	£42	DH7-91	£59
DP7-6	£35	DP7-11	£35
SE4DP7	£45	95447	£135
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We now have available from stock a range of popular TV spares including: line output transformers, tuners, triplers, etc
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Appointments

Advertisements accepted up to 12 noon Tuesday, April 3, for May issue subject to space available.

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1926

RESEARCH INSTITUTE
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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 Mouslecoomb 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 acedemic, 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.

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0453 883264 & 01-290 0267
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(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 accellerated 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

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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.

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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 7BR

(2548)

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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.

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1 years experience in servicing PW Telex or message switching equipment for customer support — Berks c. £9K + car.

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Support Engineer for managing logistics of installation and maintenance — Berks £9K

4) Service Personnel
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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.

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(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.

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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

THE POLYTECHNIC Huddersfield

2535

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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.

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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.

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.

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Please apply to: Chris Nye,
Appointments Co-ordinator, Personnel Department,
Philips Research Laboratories, Cross Oak Lane,
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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 of working environment most suited to your career plans.

The Recruitment Officer, HMGCC, Hanslope Park, Buckinghamshire MK19 7BH.

(2448)

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*Maintenance

Marconi Communication Systems, world leaders in the design, manufacture and installation of advanced electronic communications equipment and systems require experienced field staff.

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:-

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Maintenance of HF or Tropo, LOS, MUX and associated equipment.

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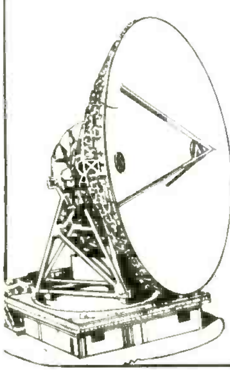
Installation and Maintenance of satellite earth stations or broadcast transmitters or Tropo, LOS, MUX or PCM and digital or HF equipments.



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.

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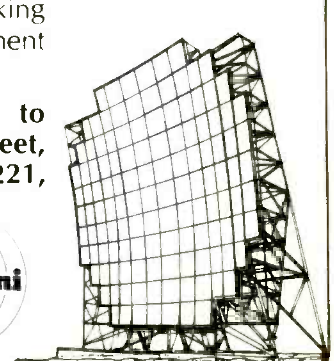

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Appointments

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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:

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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.

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For further details of the vacancy and an application form, please telephone 01-584 7011 ext 390 (9am to 5pm weekdays).

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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.

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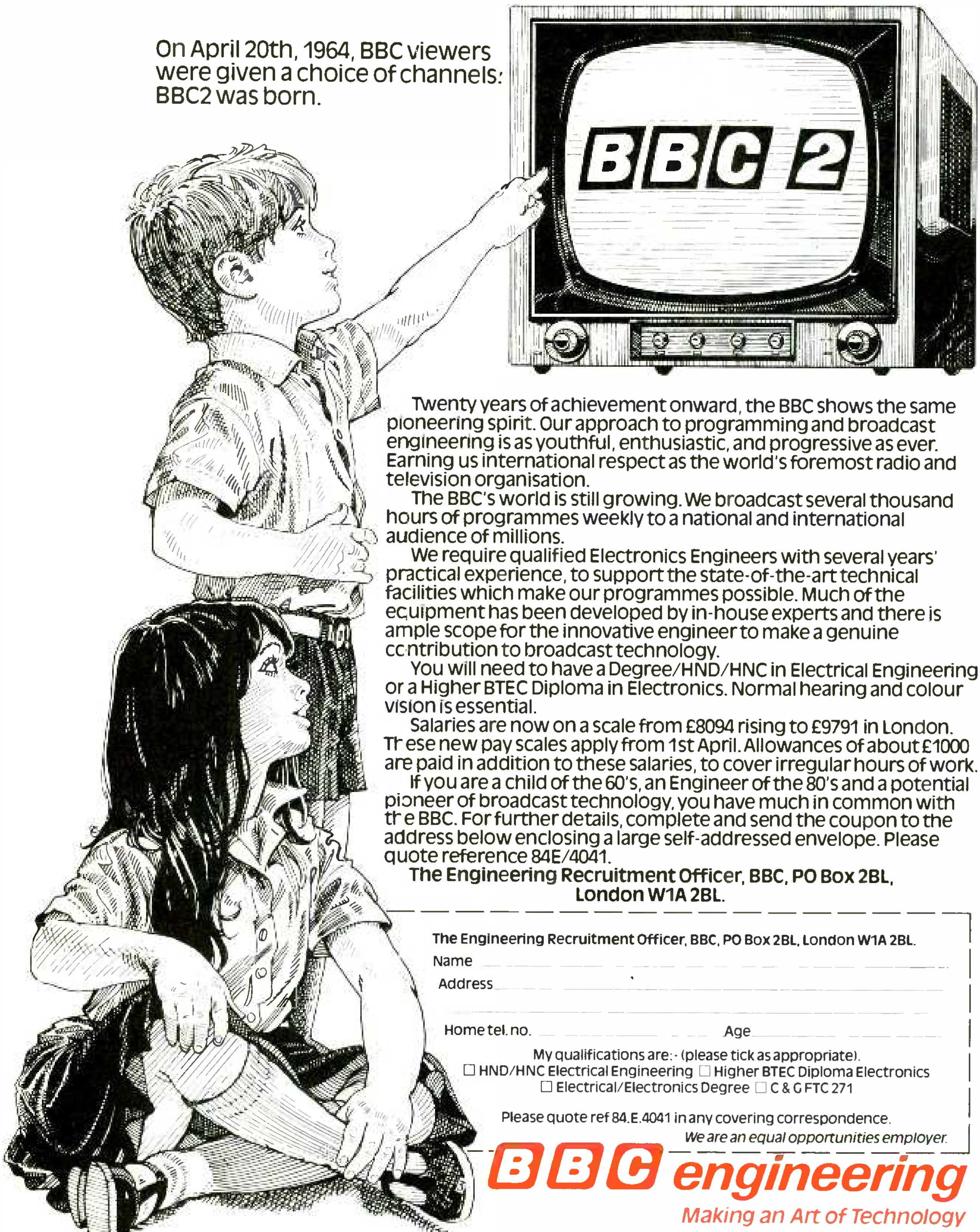

Twenty years of achievement onward, the BBC shows the same pioneering spirit. Our approach to programming and broadcast engineering is as youthful, enthusiastic, and progressive as ever. Earning us international respect as the world's foremost radio and television organisation.

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.

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Appointments

Advanced telecommunications:

careers with extensive scope at Cheltenham

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Two levels of entry providing two salary scales:
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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:

GCHQ

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.

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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:–
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Personnel Department at
Company Head Office
C W Cameron Ltd
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Burnfield Road
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Tel: 041-633 0077 (2460)

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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)

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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 succesfull 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 aricraft. 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)

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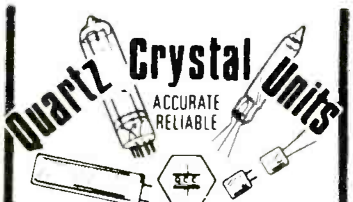

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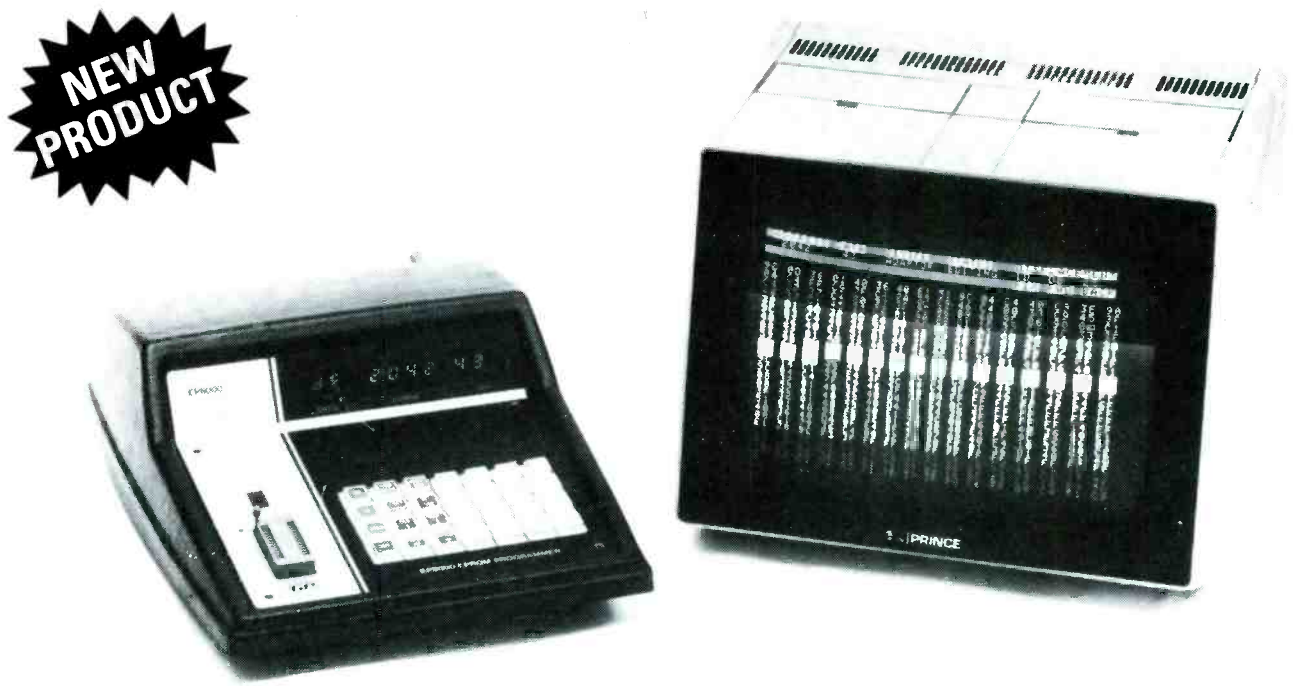
EP8000 EPROM EMULATOR PROGRAMMER



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FEATURES

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2532
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