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February 1985

Volume 91 1588

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FEATURES

REGULARS

Front cover, designed by Richard Newport and photographed by Chris Stevens, illustrates Leycester Whewell's Microspeedo.

NEXT MONTH

Invention is the theme of a new series from R.E. Young, who argues that not only are the British good at invention but can, in spite of widespread belief to the contrary, develop and apply.

Logic symbols will soon change to conform to the new international standard. Ian Kampel explains the new symbols, which take a new approach to logic representation.

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Editor
PHILIP DARRINGTON
01-661 3128

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

Technical Editor
MARTIN ECCLES
01-661 8638

Projects Editor
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Classified Manager
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IAN FAUX
01-661 3033

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

Publishing Director
DAVID MONTGOMERY
01-661 3241

International Agents and the Advertisers Index appear at the back of this issue.

Causality in energy transfer

A contributor to our December 1984 letters is right to criticise naive ideas of causality in energy transfer processes. N.C. Hawkes says it is meaningless to ask whether the field causes the current, or vice versa: they just happen together and "are related by the physics of the situation."

Any engineer who is stoutly confident he knows what is a cause and what is an effect should read David Hume's famous and penetrating study of causality published as long ago as 1739 (in *A Treatise of Human Nature*). If the engineer is honest he will certainly end up much less sure of himself.

Hume rigorously analyses examples of causality and comes to the conclusion that the only certain thing relating causes and effects is their "constant conjunction" in all past observations: objects or events "always existing in like relations of contiguity and succession." This is what the modern scientist would describe as observed regularities. We also nowadays tend to think in terms of correlations between variable quantities, but are careful to distinguish between those correlations which are just statistical and seem to have no plausible explanation and those which seem to indicate a casual relationship.

In fact Hume points out that we strongly feel in many instances there must be something more than just "constant conjunction": that there is a "necessary connexion" between causes and effects. But he concludes that the "necessity" here exists only in the human mind (e.g. as in laws of logic) and that there is nothing inherent in the objects or events themselves to account for it.

Time has not weakened Hume's philosophical analysis, and today there are scientific theorists who still firmly hold this empiricist view, that we can only be sure of the observed regularities in nature. The contemporary philosopher A.J. Ayer also agrees with Hume and says: "In nature one thing just happens after another. Cause and effect have their place only in our imaginative arrangements and extensions of these primary facts." (In *The Central Questions of Philosophy*.)

Of course, one must be careful to distinguish between causality in natural phenomena and causality in man-made devices. The engineer has no difficulty in thinking about causes and effects in the systems he or other engineers create because he is like God in deciding what is what. The input to a device is implicitly the cause and the resulting output implicitly the effect. Mere definition prevents it from being the other way round. And, of course, a definition is purely a mental thing.

It would be interesting to know if there are readers of this journal who can see a way round the strongly held view that the "necessary connexion" exists only in the human mind. As a concrete example to work on, take the simple instance that for a current to flow in a circuit there must be some kind of force present (field or e.m.f.). Here the concept behind "must" is necessity. If one puts it in a different way, that the current would not flow if the force were not present, this entails the same necessity in its negative form.

It would seem that, to be truly objective, one cannot go beyond the observed fact that the flow of current and the presence of the force are a "constant conjunction."

Information tax

Any attempt to guess what the Chancellor will announce in his Budget is a fairly forlorn pastime, but those versed in the semantics of parliamentary language are not encouraged by recent replies on the possibility of VAT being imposed on periodicals. Far from giving a direct statement, the Government "has no plans at the moment" to do so and "has not ruled out" the tax.

In 1855 the last tax on newspapers and journals was repealed by Palmerston's government: since that time each government coming to power has set its face against taxes on publications — taxes on knowledge. Indeed, a Tory government, on introducing VAT in 1973, declared "On the general principle of avoiding a tax on knowledge, we intend that books, journals, newspapers and broadcasting shall be at a zero rate". High-sounding words, but it now seems at least possible that they are about to be made nonsense.

On a purely practical note, such a move would almost certainly reduce the choice of periodicals open to readers. Many of the smaller, specialised journals exist on a tiny profit margin, and a 15% increase in their cover price would probably cut their circulation below a realistic level.

If VAT is imposed, it will quite definitely be a 'tax on knowledge', will restrict the flow of information, and is to be deplored.

Philips joins sub-micron race

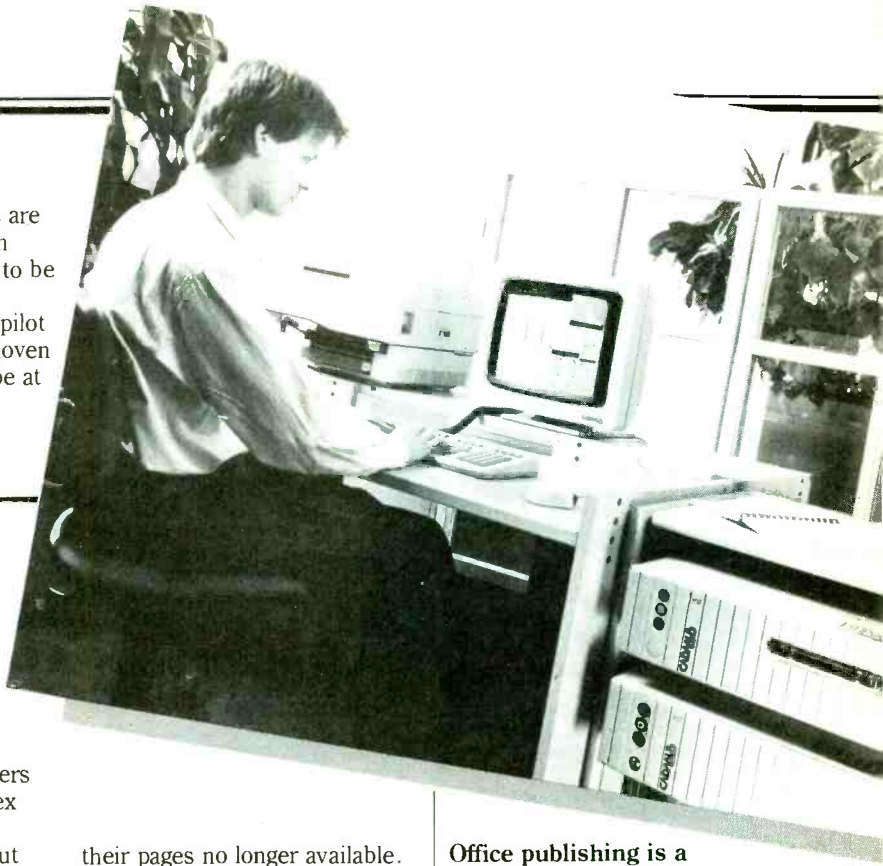
Several companies have announced recently their research projects into producing integrated circuits with internal structures smaller than one micron, in order to produce i.cs that are more complex but also smaller and cheaper. Philips is to set up a new centre at Eindhoven for fundamental and applied research. Philips, Valvo, their German subsidiary and Siemens are to cooperate in the research with financial backing from the Dutch and West German Governments.

A one megabit static ram will be used by Philips as a carrier for the new technology, Siemens are to concentrate on a 4Mbit dynamic ram. These are to be developed by intensive use of computers in c.a.d. and in manufacturing techniques. The project is expected to have a knock-on effect in promoting related developments in other areas.

Some bottlenecks to the production of such i.cs have already been identified; it is not known whether the local oxidisation of silicon, used to isolate elements will work in conditions of such fine detail; the structure of the transistor itself will need to be altered in order to fit into such a small space. Electrical magnitudes are very dependent on the geometry of the device; as elements get smaller the electrical field become proportionally larger and it is possible for high-energy electrons to be formed which endanger the stability of the circuit. As conductors get thinner, their resistance increases proportionally. It is possible that the use of metal silicides may be a solution to this problem. Yet another problem is the very hilly nature of the terrain to be connected. As with road planning a raised structure might offer a solution. Efforts will also be made to find a method of making the surface flatter.

At the design stage, computer facilities need to be able to cope with something in the order of 50 million geometric details which are incorporated in the drawings and in the masks. The masks need thorough checking to ensure that they are fault free. The programmes must also be capable of checking whether a long list of layout rules have been obeyed. The electrical performance of the chip is calculated in advance on a computer with a circuit-analysis program. It needs to be fed with a list of all the elements and interconnections and with the layout design. Present c.a.d.

tools are not sufficient to these tasks and so there is a need for advanced programming. Similar programs are needed for the automatic testing of the finished devices. The memory chips are to be designed with extra cells which can be connected with the aid of a laser, if any of the memory cells are found to be defective. Similar advances are needed in all the production equipment which will need to be operated in super clean, dust-free environments. A pilot plant is to be built in Eindhoven but production plants will be at Philips/Valvo and Siemens factories.



Today's hacker is tomorrow's expert

Breaking into computer data bases has become the hobby of those who, we suspect, have taken the place of the phone freaks of a few years ago. 'Hacker' was used to describe those who seemed to be permanently attached to their video screens, hacking away at a new program. The word is now used to describe people who 'break into' computers — when a system has been entered it is said to have been 'hacked'. There are also criminals who break software programs or find a way into databases for personal gain, but the majority of hackers do it for the fun of it; because it's there. Software manufacturers try more and more sophisticated methods to protect their precious programs and the hackers use equally clever methods to break into them. On the principle that if you can't beat them, join them, the manufacturers are now employing those same hackers to devise even more complex protection devices.

A row has now broken out between Timefame International and Prestel. Timefame operate a bulletin-board system for business information. Because of a major security alert at Prestel, when some important electronic mailboxes including that of the Duke of Edinburgh, had been hacked, there was a complete revision of the password codes. Very soon after, Timefame was hacked again and suggested that the only way it could have been done so rapidly was that some inside person from Prestel, a mole, must be divulging the passwords. Prestel say that they have evidence that this was not possible and have taken great exception to the accusation. Consequently, they slammed the door to Timefame and made their pages no longer available. We think that both sides are underestimating the ingenuity of the fanatical hacker, who will go to extraordinary lengths to take on the challenge of a seal to be broken. While we cannot condone their activities, we can admire the skills which they apply and hope that they will go on to use them productively. At a recent hackers' conference in California, a prominent participant was Steve Wozniak, the co-founder of Apple Computers, who still enjoys bending over a keyboard.

A further issue arises as to whether Prestel is a publisher and can exercise editorial rights, such as denying access to a major information provider like Timefame, or is purely a medium for use by anyone.

Office publishing is a new concept. With the development of high-quality laser printers it is possible to combine the facilities of a word processor with those of a typesetting machine and provide camera-ready copy of both text and graphics. Such a system has been launched by a German company, PCS Cadmus. It incorporates a 32-bit computer, 80Mbytes of Winchester storage. Prices start at £40,000 which includes a very high-resolution display, laser printer and a mouse. It is thought to be especially useful to those users who produce documentation and manuals needing regular up-dating and rapid printing in smaller batches.

Buzby buzzed! Whether there really *is* a mole in Prestel's headquarters we may never know. But the network's security is plainly less than perfect, as the small intrusion shown here demonstrates. The letter z, we're informed, is not a misprint but the visiting card of a hacker — though evidently one who bore no real ill will towards British Telecom or the railways.

The incident occurred in December soon after Prestel's precipitate excommunication of Timefame International, said to have been the system's second most popular information provider. Timefame had accused Prestel of leaking its passwords.

The page has since been corrected.

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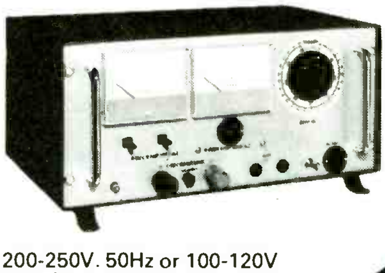

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ELECTRONICS & Wireless World

EDITORIAL FEATURES 1985

ISSUE DATE	PUBLICATION DATE	FEATURE
Mar. 1985	Feb. 16th	IEEE Instruments
May. 1985	April. 19th	Power Supplies
July. 1985	June. 21st	VDU's
Sept. 1985	Aug. 16th	Communication Receivers

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Admiral of the high-speed network

Research into advanced data communications is being set up in a three-year, £5M joint venture, sponsored by the Alvey Directorate and to be carried out by the GEC Research Laboratories. The plan is to provide instant and direct communication between computers, work stations and other peripherals, regardless of location and type, for applications such as computer-aided design, software engineering and office automation.

ADMIRAL (Advanced Mega Internet Research for Alvey) will be a joint effort between GEC/Marconi, BT Research Laboratories, University College, London and the University of London Computer Centre. A high-speed wide area network is already being set up using the BT MegaStream service, with 2Mbit/s links. Admiral will use this network to link together a number of l.a.ns. UCL has been recognised as one of the leading research centres for computer networks and their protocols. ULCC has had considerable experience in in providing large-scale computer facilities accessible from all over the country through communications networks. Special attention is to be paid to the protocol system to enable high-performance interconnection between heterogeneous devices. Aspects of network management will be looked into as multiple administrations need both automony and coordination. Another field for attention is distributed computing, including the use of remote workstations, program structuring tools such as remote procedure calls are important in this aspect. Although based around the BT/Alvey high-speed w.a.n., the aim of the research is that the results should be generally applicable to any large network. The first stage will be the linking together of all the participant in the research on five sites UCL, ULCC, BTRL at Martlesham, Marconi Research Centre at Baddow and the GEC RL Hirst Research Centre in Wembley. As the network progresses, other types of l.a.n. and local switched networks are to be included. Wherever it is possible without affecting the performance of the system, OSI standard protocol will be used. Devices connected to the network will include Unix-based systems, workstations and a Cray-1S computer.

India PM radio ham

Rajiv Gandhi, who succeeded his mother as Prime Minister of India, is a keen radio amateur and home electronics enthusiast. He passed the radio amateurs' exam over ten years ago and has the call sign VU2RG. He built his own h.f. ssb/cw transceiver and a two-element cubical quad antenna. He is installing the first amateur relay station in his country as well as looking at amateur radio computer networking and digitally coded squelch systems.

Since being elected to Parliament in 1981, he has constantly worked for the development of electronics and aviation in his country. There have been a number of concessions to the electronics trade and industry and the Government of India is easing the import restrictions on computers. Rajiv Gandhi is keen to have computer training taught in school. As an amateur he participated in, and organised, emergency communications when all civil communications had failed during cyclone and flood emergencies on the west coast of India. He persuaded the government to allow the duty-free importation of amateur equipment, accessories and components. This concession will last until the end of March.

Mr Gandhi retained the post of Minister for the Department of Electronics when he became Prime Minister. His enthusiasm has been transmitted to other members of the family. Mrs Sonia Gandhi is also a licenced amateur. His 14-year-old son, Rahul and his 12-year-old daughter, Priyanka, are studying for the radio amateurs' exams.

In brief

Free software packs are to be made available by the Department of Education for use with children who have special educational needs, particularly those with learning difficulties. The packs are aimed at 14 to 16-year-olds and as the programs can be altered to meet individual needs, they can also be used with younger children and with the physically handicapped. 25 programs in each pack were developed by the Scottish Council for Educational Technology. The programme focus mainly on life and social skills such as managing money, a healthy diet and achieving independance by, for example being able to read a railway timetable and planning a route. The pack has versions to run of the Acorn/BBC and RML computers.

- Impartial advice and training on the purchase of computers and software is available from the Federation of Microsystem Centres. They have come to an agreement with the Computer Retailers Association to provide a full service to computer users. The agreement was implemented on a pilot basis at a meeting in Sheffield with representatives of both parties and the DTI IT coordinator. The centres will undertake training the CRA members may be unable to handle themselves and care has been taken to preserve the impartiality of the centres.
- The Maritime Rescue Coordination Centre at Falmouth, Cornwall has installed a satellite earth station so that it can communicate directly with other rescue organisations and with ships at sea. They will be able to pass on emergency information to the nearest agency or ship. Two other coordination centres in Argentina and Bulgaria are also equipped to communicate through the Inmarsat satellite communication system. Others are expected to get similar facilities soon.

Welsh Basic

As a pilot for translating Basic into a number of different tongues, Xitan have developed their XBasic in Welsh. The version is sytactically the same as in English but all the keyboards and messages are in Welsh. For example the equivalent of 'Load' and 'Llwyth' and 'Run' is 'Rhedeg'. One of the main reasons for choosing Welsh was that the product could be tested locally and there was a potential for high levels of real use in the Welsh academic community. XBasic was developed specifically for scientific and educational applications and runs on CP/M and MP/M systems. It is described as a semi-compiler and incorporates syntax checking and error trapping before a program is run — sorry, rhedeg.

Pirate navigation interference overcome

Helicopter pilots flying to the North Sea oil rigs have found it increasingly difficult to use their navigational aids to locate the rigs. This is caused by pirate radio stations operating at frequencies in the medium waveband used by standard non-directional beacons. Racal Avionics have solved the problem by designing (within a month) a new non-directional beacon with a much increased frequency range. The new beacon conforms to the new CAA frequency allocation for such devices and has already been installed on one rig. The transmitters are used as landing site locators or as route markers and the new design incorporates power semiconductor circuits which allow adjustable, reduced power outputs to be used from 100W stepping down to 20W. Because of the reduced power consumption, the beacon can be operated by solar, gas or wind generators at remote locations.

TV network for medical school

Eight lecture theatres are linked by a tv network covering the six capitals in the Charing Cross and Westminster Medical School Group in West London. The system is, to use this year's current *in* word, interactive. This means that any of the hospitals can put out the teaching session to all or any of the others and that students at the distant sites can ask questions or make contributions and may be seen and heard at all the other sites.

Most of the system is connected through fibre-optic cables though one site is joined up by a microwave link. The cables are routed through London underground railway tunnels, Electricity Board ducts and disused tramway channels.

Fibre-optic cable was chosen as the medium for the transmission of video and audio signal as this was considered to offer the best fidelity for the transmission of, for example, microscope images and the audio signals used in aural diagnosis. In addition to live images there will be slides, recorded video and direct microscope and radiographic images. A microwave link was used between Charing Cross Hospital and St. Mary's Hospital, Roehampton. This was the only site south of the Thames and ducting was not available.

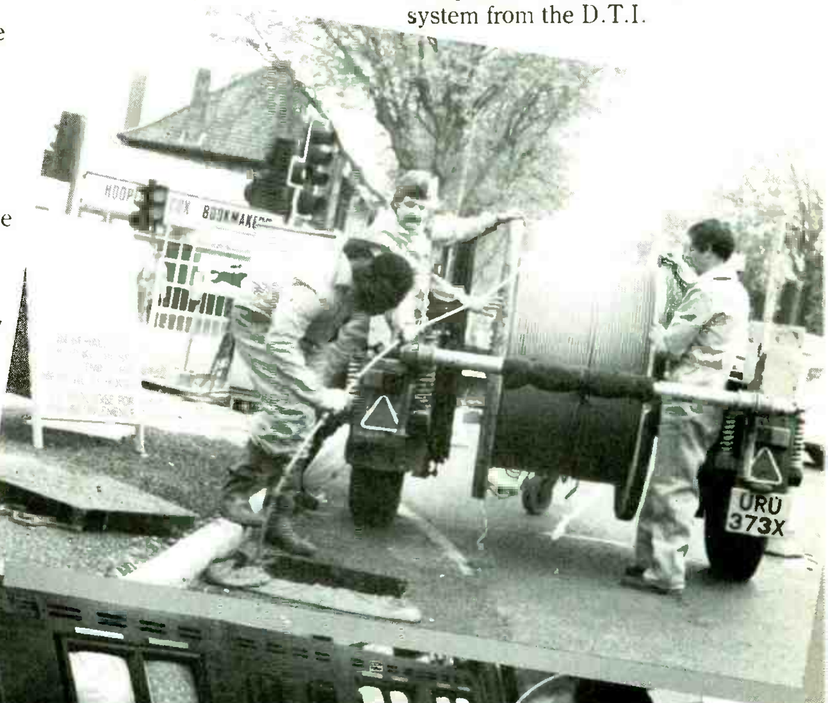
The main control room and switching centre is at the Charing Cross Hospital. Lecturers at the main lecture theatres of the two principal hospitals will have electronic consoles to control the use of the audio-visual facilities incorporated into the system. All proceedings can be recorded for subsequent editing and re-use but the real value of the system, as seen by the teaching staff, is the 'real time' contact between teacher and student. The teachers have been given familiarisation courses by staff from the Open University, who are also undertaking the adjudication of overall effectiveness of the system.

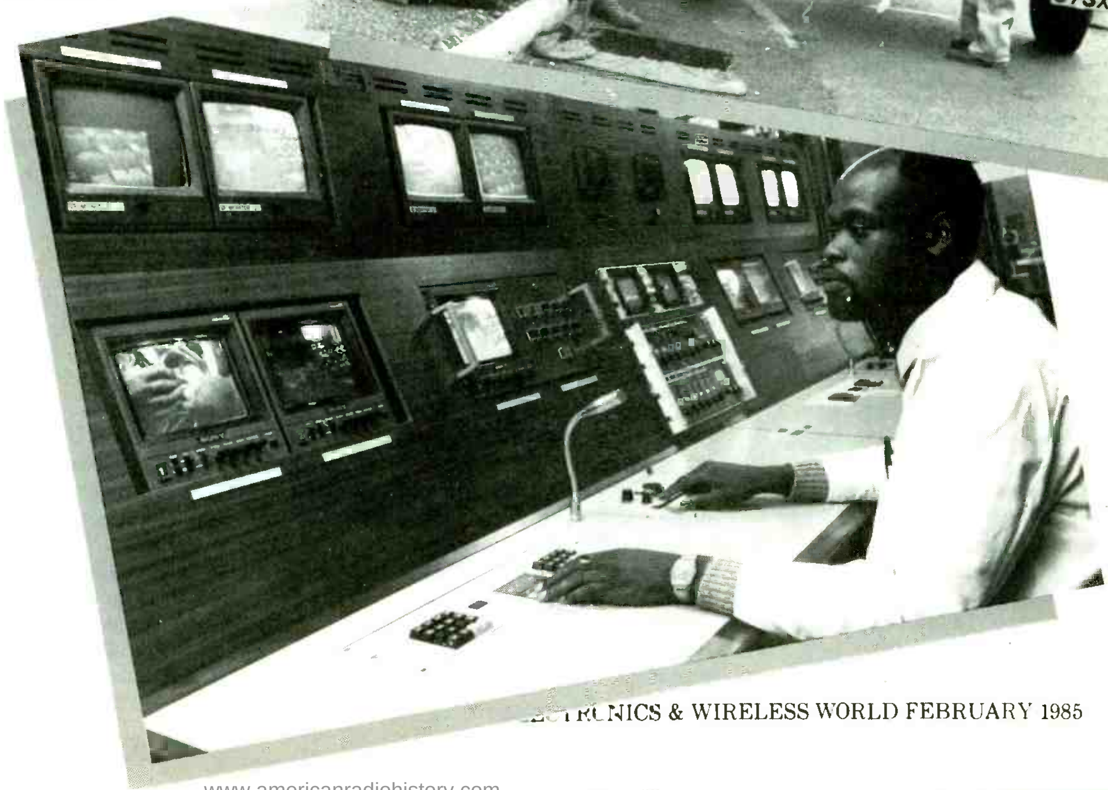
The list of credits is almost as long as those in Hollywood movies. Telefusion were the main contractors and were responsible for coordinating the whole project, as well as providing the video equipment and the main switching/editing centre. The 22km of fibre-optic cable was manufactured and installed by Pirelli General. Some individual lengths were over 2km. The London Transport tramway ducts, originally used to carry power and signals to the trams were found to be in a relatively good condition although they had not been used for thirty years or more. The London Electricity Board's ducts presented more of a problem as they were frequently interrupted to supply power to individual properties along the route. Considerable engineering work had to be undertaken to by-pass these blockages. Work carried out by Pirelli and the L.E.B. was completed on schedule and the L.E.B. are now considering the possibility of using their ducts in other similar projects. The central 10km section of cable was laid in the tunnels of the District Line of London's Underground by London Transport engineers. Multi-core cables were used, each circuit capable of carrying two tv channels and two sound/signalling channels without any intermediate amplification.

The microwave link was installed by Mercury Communications. Small dish antennae, mounted on the roofs of the two hospitals provided a direct line-of-sight link operating at 22 to 23GHz. Plessey are responsible for the video transmission system. The optical signal is transmitted using a high radiance led operating nominally at 1300nm, in the near infra-red region. This was selected in preference to laser as it offered more reliability, eliminated the need for complex control circuitry, was easy to modulate and could operate over a wide temperature range. To receive, a p-i-n diode is used in conjunction with an f.e.t. amplifier both incorporated into an i.c. package. F.m. is used and the system conforms to the CCIR recommended standards for broadcast quality signals. Each transmitter consumes only two watts and the receiver eight watts.

The sound system comes from Audix and consists of a amplifier/conference system for each site along with all the associated mixers, microphones and loudspeakers. At two of the sites separate smaller conferencing rooms are fitted with table-top microphone/loudspeaker units to add versatility to the conference facilities.

The project has been paid for by the Department of Trade and Industry and is intended as a showcase for British advanced technology. The Government has made a virtue out of necessity as the original medical schools of Charing Cross and Westminster hospitals were merged, following education and health service cuts. The school is expected to buy the £940 000 system from the D.T.I.





Background to MLS

A reader, with vivid memories of the bitter struggle in the 1970s that preceded the selection by the International Civil Aviation Organization of the microwave landing system TRSB, is not altogether surprised that the Americans are reluctant to credit the Australians for their part in its development (see December 'Communications Commentary'). The whole selection process, he recalls, was conducted in a manner that threw great doubt on whether or not TRSB had any, or at most marginal, technical advantages over the rival microwave Doppler system, supported by the UK, or even the West German DLS system. Study work on these and other systems was contracted to American industry but once they had decided to back TRSB, what amounted to a "dirty tricks" campaign was launched against Doppler, reminiscent of the campaign waged 25 years earlier to back VOR against Decca.

This reader points out that international electronics standardization, not only in the aviation field, often has less to do with technical merit than with short-term commercial interests. In international aviation, the record of some of the large American corporations has demonstrably included bribery, corruption and deliberate misdirection. International standardization is frequently a battleground for vested interests and it is not always the technically superior system that wins. Doppler m.l.s. was installed and tested successfully at Brussels, Stansted, Gatwick, Manchester and in Norway.

Nevertheless, the introduction of the TRSB (which started life as Interscan) microwave landing system will bring significant advantages. Existing i.l.s. systems are capable of handling more than one aircraft at a time, though constrained by aircraft separation of the order of three miles, and the speed of clearing the runways. The main advantages of m.l.s., in the view of this reader, are: fewer site restrictions, choice of glide-slope angle and choice of approach path within a $\pm 40°$ sector. Despite his misgivings about the way TRSB was selected, the new system is capable of giving very impressive results as he found during recent flights in the UK.

Jaw, Jaw

Sir Frank Cooper, formerly Permanent Secretary of the Ministry of Defence, in the 1984 annual lecture of the Royal Signals Institution advocated an approach to the management of international crises in which strategic communications would play a central role.

He believes that communications technology has far outstripped the ability of governments, politicians and military planners to comprehend and control crises and prevent them from escalating into both nuclear and conventional warfare.

Instead of the usual assumption that a first military aim should be to disrupt both strategic and tactical communications of an enemy, Sir Frank believes that maintenance of effective strategic communications should be given high priority, including, for example, clear agreement not to disrupt satellite communications.

West and East each need to understand the security policies of the other, and European countries should recognise more fully that the nuclear threat may not arise from direct confrontation along the East-West boundaries.

He dismissed the "controlled escalation" theories of the 1960s as "nonsense"; even greater nonsense was that politicians could sit down and take finely tuned decisions. His experience suggested that crises were times of confusion and uncertainty.

The dual capability of weapons such as Cruise that can carry either nuclear or non-nuclear warheads makes it impossible for the remote sensors and defence radars to determine the form of an attack unless some trusted and pre-arranged procedures and effective communications exist.

The greatest progress in the concept of keeping communications open has been made in the management of terrorist and hostage crises, while "war games" have increased understanding of tactical C^3I. It is recognised that electronic communication systems have a high degree of vulnerability. Nobody is sure of the secondary effects of nuclear weapons, including the nuclear electromagnetic pulse. The aim is to make tactical communications "survivable", yet, Sir Frank stressed, tactical systems are not central to crisis management.

The vast growth and increase in speed of communications and information technology has not been matched by the ability of humans to communicate in a real sense. The social divisions between East and West are substantial, with very different life styles. It was not a question of making judgements between these but recognising the differences in attitudes, and developing the "hot line" concepts beyond the stage of technical agreements. Improved communications between European capitals were needed: the setting up of crisis control centres; advance notification of ballistic tests; treaties to protect strategic communications, including space communications; agreement not to deploy weapons in space.

Political barriers to change were great. Science and technology are not answers in themselves. NATO channels of real communication are getting slower. In any reorganisation of information technology, it was important to eliminate the need to have graduate engineers pressing the buttons, but to allow the "managers" to "talk" from their desks via v.d.us. Since going into industry he had begun using his own word processor and office copying machines. Nobody spends eight hours a day thinking. The real crux of any IT system was to make people do their own thing.

Sir Frank's lecture underlined Churchill's dictum: "Jaw, jaw is better than war, war," while in discussion it was suggested that C.C.I.S. (Control & Command Information Systems) might be redesignated: "Control and Cooling of Imminent Scares".

Although Sir Frank did not refer to the Falkland Campaign of 1982, the evidence to the Parliamentary Select Committee has made clear that Northwood was bringing this to the boil while Downing Street was still committed to negotiation. A crisis in crisis management that was jaw, jaw *and* war, war, not helped by delayed communications.

Space sale

The two communications satellites recovered by the shuttle on behalf of insurers are not the only satellites going for a song. Telesat of Canada is trying to find a buyer for Anik C1, a 16-transponder Ku-band bird, due for launching this February. With two other Anik-C birds still singing, and demand for leased transponders slowing down, on to the market goes C1 (a Hughes HS376 design) priced at about $65-million, which includes cost of launch and launch insurance. If no buyers turn up, Telesat plan to keep C1 as an in-orbit spare, representing a lot of capital tied up in a non-revenue producing spare.

Time-dispersal

Considerable attention has been paid recently to the use of radio links within buildings for the short-distance transmission of speech and data. During the past two years, British Telecom Research engineers have published a number of reports on their investigations into radio propagation at 900MHz within buildings for cordless telephones. They have also shown their work on leaky co-axial cable systems as a means of distributing longer-range v.h.f. signals within a building to provide higher levels of field strength to reduce the aerial requirement on cordless telephones.

American firms have similarly developed short-range 900MHz radio-links as an integral part of computer systems. This, however, poses the question of how well or how badly 900MHz propagation within buildings or building-complexes behaves at high digital data rates.

Recent work by Bell Communications Research at Holmdel (*Electronics Letters*, November 8, 1965, pp.950-1) at 850MHz shows that multiple reflections tend to result in significant time-dispersal of the signals and hence severe intersymbol distortion at high data rates. In many cases the strongest transmission path occurred up to almost one microsecond after the first arrival. No significant

differences were noted between vertically and horizontally polarized signals. The BCR engineers conclude that the detailed measurements made at Holmdel indicate that signalling rates in excess of 400 kilobits/second may not be feasible for an error probability of 0.001 or less, and that the multipath characteristics of u.h.f. signals within buildings are a major factor to be considered in wideband systems design.

From all over

Engineering "Emmy" awards of the National Academy of Television Arts and Sciences, presented in New York, included a posthumous "Trustees Award" to the late Vladimir Zworykin, inventor of the iconoscope electronic camera, and "Emmys" to Stefan Kudelski for the Swiss firm's development of the portable C-format video tape recorder and to Ampex who distribute it; to Sony for their work on single-frame recording on stationary videotape (BVH2500); RCA for work on circularly polarized television aerials; Lexicon for the firm's 1200 audio time compressor/expander; and to Tektronix for continued work on television test and measuring standards.

A recent survey of world colour television standards listed 59 using PAL, 36 using SECAM, 32 with NTSC and 3 with both PAL and SECAM. But one suspects that in terms of receivers. NTSC would go to the top of the table.

A planned replacement for the unhappy Yuri 2 (BS-2A) Japanese direct broadcasting satellite, which has malfunctions on two of its three 100-watt transponders planned for summer 1985 may be delayed. The world still awaits its first operational high-power DBS service at Ku-band (12GHz) and the chances of one arriving in 1985 seem slim.

I have yet to puzzle out the logic behind a recent job advert for telecommunications engineers: "The day of the 'old fashioned' phone and exchange is over. The communications era is with us . . . to discover the full extent of these opportunities contact Mr. X on 01-XXX XXX or write."

Amateur Radio

Although for h.f. high-power amplification, either linear or Class C, thermionic valves continue to be the most cost-effective, often with improved linearity compared with transistors, it is becoming possible to put together 50—100-watt solid-state amplifiers at relatively low cost, based on "surplus" transistors available from component firms. But a key factor is the use of devices intended for operation from 25—30volt, or more, supplies.

Most amateur transceivers, h.f. and v.h.f., are intended to work directly from 12V car batteries, yet linearity performance is improved and very high peak currents reduced by using high-voltage devices such as those produced for airborne equipment used on 28V supplies. Power mosfet devices are available for use on 150V supplies, but these still tend to be much more costly than surplus 30V bipolar transistors selling at under £5.

I was reminded of this recently during a 3.5MHz contact with Art Radcliffe, GD3FXN, on the Isle of Man who has an 80-watt all-band, all-solid state h.f. transceiver partly, based on a Plessey design by James Bryant, G4CLF, but with 30V across the final amplifier and using power transistors that he bought for £3, and with no requirement for 30 ampere supplies!

Modern high-power valves now being used in amateur linear amplifiers can cost several hundred pounds, although many make do with ex-equipment or consumer type devices costing less than £10, but components for high-voltage, 1000-2000V, power units are becoming scarce and expensive at the 400-watt p.e.p. output level.

The use of tunable or broad-band solid-state amplifiers incorporating protection against mismatched loads has brought about an increased requirement for aerial tuning units. Output power now often begins to be reduced at an s.w.r. of about 1.8 or more. Few resonant aerials present such a low s.w.r. throughout an h.f. band without the use of an a.t.u.

Space packet

The FCC has recently granted permission, for a limited period, for a small number of American amateurs to engage in "Teleport" operation, acting as automatic relay stations between terrestrial amateur stations transmitting "packet" data and the amateur satellites. The Russian amateur satellite RS6 ceased operation during October 1984, possibly due to battery failure. This leaves three Russian satellites carrying transponders still active: RS5, RS7 and RS8 with beacon transmissions still occasionally received from early satellites, where the beacon transmitter is powered directly from solar cells. AMSAT-UK has circulated a questionnaire to members seeking views on whether an attempt should be made to set up another UK satellite project.

R.A.E. decline

The next two dates for the Radio Amateur's Examination are Monday, March 18 and Monday, May 13. The examination can be taken at any of about 400 centres recognized by the City & Guilds of London Institute. Closing date for applications January 15 and February 15, or possibly earlier at some local centres. Figures issued by CG&I show that the number of candidates completing the examination dropped from the peak figure of 8176 in 1982 to 7542 in 1983 and 5922 in 1984. Percentage of candidates qualifying for the RAE certificate dropped to 66.3 in 1984 from 70.5 in 1983 and 67.0 in 1982. The very high number of candidates in 1982 is thought to reflect the interest surrounding the introduction into the UK of legalized Citizen's Band operation, now largely evaporated.

City & Guilds have installed a computer system that enables a multichoice examination paper to be quickly assembled from a bank of questions. While this system should reduce the possibility of the printing errors, etc. the occurred a few years ago, one can hope that before putting them into the bank, the questions are carefully screened and brought up to date. It would also seem sensible for candidates to be given the choice of five rather than the present four answers, two of which including the "correct" one are usually deliberately ambiguous.

60 additional experimental 50MHz permits have now been issued to British amateurs, plus another five to fill gaps in the ranks of the original 40. Of these, five are in Scotland, two in Northern Ireland, one each in Guernsey and Wales and 56 in England.

The closing of v.h.f. television at the beginning of January has removed the "out of television hours" restriction. Norwegian authorities are issuing 25 experimental 50 MHz permits for use in non-tv hours. Norway is likely to discontinue the use of Band 1 for tv in 1985-86.

British amateurs have already found that 50MHz is particularly suitable for meteor-scatter communications.

In brief

Amateur radio operation under the callsign GB4DIS/MM is expected during some stages of current voyage of the RRS "Discovery" to the Scotia and Weddell Seas in the Antarctic. Three amateur operators, GW4SBB, GW4JAD and GW3RNP, are joining the ship at Punta Arenas and are expected to be active until the Discovery returns to Brazil next April, mainly on the 14 and 21MHz bands. The ship is carrying a geophysical research team from the University of Birmingham.

The RSGB's committee on electromagnetic compatibility has been co-operating with the Consumers' Association in an effort to determine vulnerability to radio-frequency interference of current television receivers. Radio-frequency interference to video cassette recorders and some of electronic telephones that incorporate amplifiers and electronic memory is proving an unwelcome e.m.c. problem, not only in the UK.

The Wireless Institute of Australia, doyen of the national amateur radio societies, founded in 1910, reaches its 75th anniversary during 1985.

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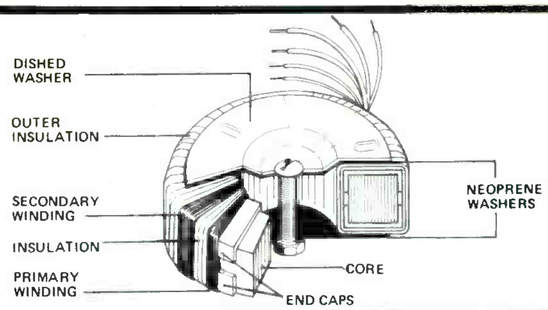

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0x011	9+9	0 83
0x012	12+12	0 63
0x013	15+15	0 50
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1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
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2x014	18+18	1 38
2x015	22+22	1 13
2x016	25+25	1 00
2x017	30+30	0 83
2x028	110	0 45
2x029	220	0 22
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3x010	6+6	6 64
3x011	9+9	4 44
3x012	12+12	3 33
3x013	15+15	2 66
3x014	18+18	2 22
3x015	22+22	1 81
3x016	25+25	1 60
3x017	30+30	1 33
3x028	110	0 72
3x029	220	0 36
3x030	240	0 33

120 VA 90 x 40mm 1.2Kg Regulation 11%

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4x010	6+6	10 00
4x011	9-9	6 66
4x012	12+12	5 00
4x013	15+15	4 00
4x014	18+18	3 33
4x015	22+22	2 72
4x016	25+25	2 40
4x017	30+30	2.00
4x018	35+35	1 71
4x028	110	1 09
4x029	220	0 54
4x030	240	0.50

160 VA 110 x 40mm 1.8Kg Regulation 8%

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5x011	9+9	8 89
5x012	12+12	6 66
5x013	15+15	5 33
5x014	18+18	4 44
5x015	22+22	3 63
5x016	25+25	3 20
5x017	30+30	2 66
5x018	35+35	2 28
5x026	40+40	2 00
5x028	110	1 45
5x029	220	0 72
5x030	240	0 66

225 VA 110 x 45mm 2.2Kg Regulation 7%

SERIES No	SECONDARY Volts	RMS Current
6x012	12+12	9 38
6x013	15+15	7 50
6x014	18+18	6 25
6x015	22+22	5 11
6x016	25+25	4 50
6x017	30+30	3 75
6x018	35+35	3 21
6x026	40+40	2 81
6x025	45+45	2 50
6x033	50+50	2 25
6x028	110	2 04
6x029	220	1 02
6x030	240	0 93

300 VA 110 x 50mm 2.6Kg Regulation 6%

SERIES No	SECONDARY Volts	RMS Current
7x013	15+15	10 00
7x014	18+18	8 33
7x015	22+22	6 82
7x016	25+25	6 00
7x017	30-30	5 00
7x018	35+35	4 28
7x026	40+40	3 75
7x025	45+45	3 33
7x033	50+50	3 00
7x028	110	2 72
7x029	220	1 36
7x030	240	1 25

500 VA 140 x 60mm 4Kg Regulation 4%

SERIES No	SECONDARY Volts	RMS Current
8x016	25+25	10 00
8x017	30+30	8 33
8x018	35+35	7 14
8x026	40+40	6 25
8x025	45+45	5 55
8x033	50+50	5 00
8x042	55+55	4 54
8x028	110	4 54
8x029	220	2 27
8x030	240	2 08

625 VA 140 x 75mm 5Kg Regulation 4%

SERIES No	SECONDARY Volts	RMS Current
9x017	30+30	10 41
9x018	35+35	8 92
9x026	40+40	7 81
9x025	45+45	6 94
9x033	50+50	6 25
9x042	55+55	5 68
9x028	110	5 68
9x029	220	2 84
9x030	240	2 60

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CIRCLE 52 FOR FURTHER DETAILS.

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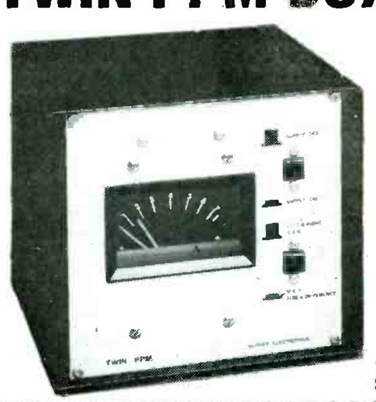

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Cable and satellite tv come together

Nigel Cawthorne reports from Catcom 84 in Switzerland

Organised by the Swiss Cable-TV association, the catcom '84 conference and exhibition held in Luzern in November 1984, brought together international experts in the fields of cable and satellite TV.

Switzerland, with its mountainous terrain, is one of the most "cabled" countries in the world. Over 50% of Swiss households are connected to cable tv and there are over 110 independent cable operators in this, one of Europe's smaller countries. Luzern, right in the centre of Switzerland was thus an appropriate location for the first "Catcom" cable tv and communications exhibition and conference.

Cable television is both a new science and an old one. Originally cable tv was the means of bringing pictures to viewers who were unable to receive signals directly from the broadcasters own transmitters. Cable tv in its early days was a "fill-in" service and was very limited in its objectives and services, whereas the cable tv systems being planned today are a major component of the communications and information revolution.

In the UK, the arrival of new franchise cable tv companies, such as Swindon Cable which in September 1984 was the first to come on-air, brings the possibility of a completely new range of services into the home which will soon go far beyond the retransmission of a handful of tv signals.

The cable that carries tv pictures into the home will also be the means by which the viewer receives a wide range of information services and through which he will be able to communicate out from his home and procure services. Interactive services will allow the viewer to do shopping, banking, obtain information as well as receive large numbers of TV and radio programmes all from his armchair.

Cable bandwidths

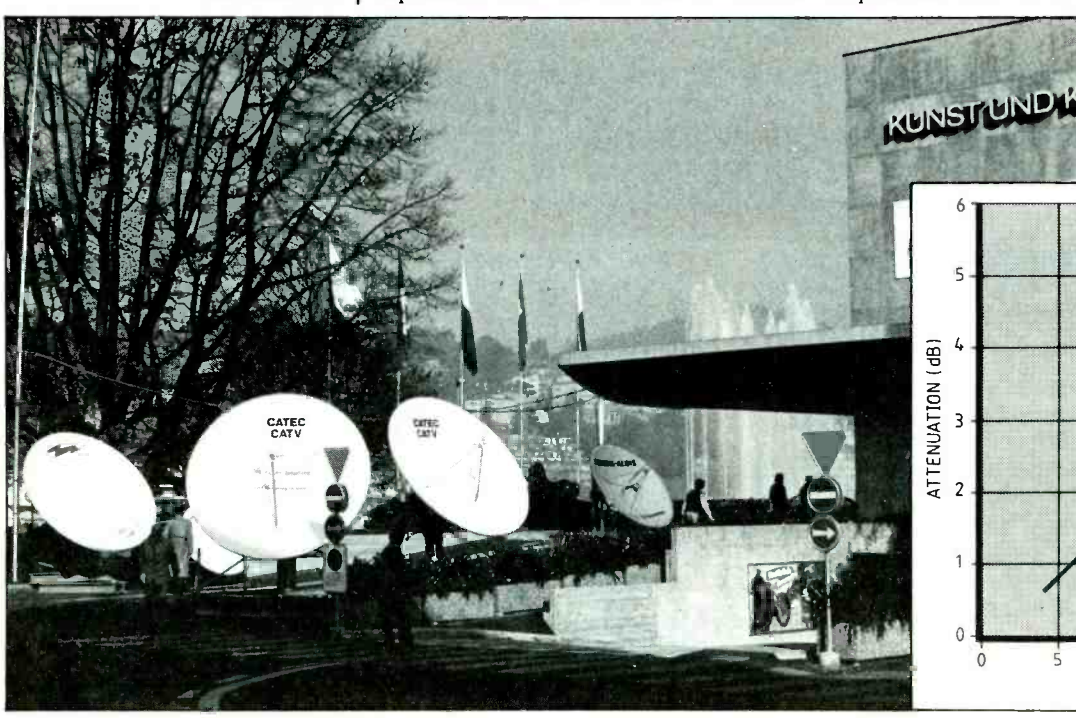
In modern cable tv systems, coaxial cable is used to bring the signals from the head-end into the viewers home. The bandwidth of current systems extends up to 450 or 500MHz. The lower frequency end of the new cable tv systems for outward transmission is around 50MHz. In the UK, certain frequencies have to be avoided within this bandwidth as part of the cable regulations. Also cable companies are advised to avoid the amateur band frequencies as both leakage out from the cable and leakage into the cable of signals create mutual problems for the cable company and for the amateur radio operator.

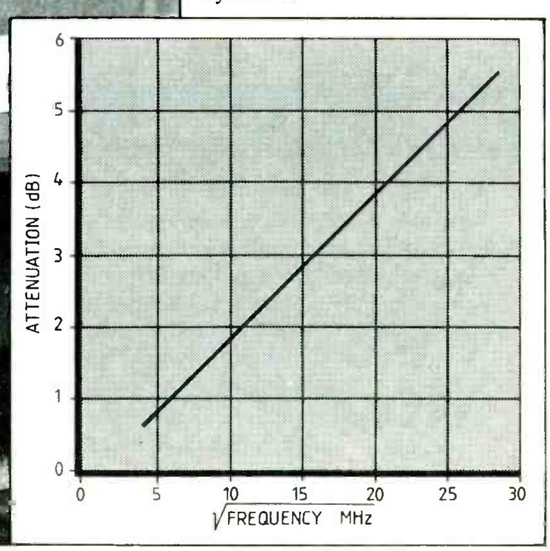
Amplifiers and corrector circuits are required to ensure that the signal delivered to the tv viewer is at the correct level. The attenuation characteristics of the cable used change with frequency. The higher the frequency of the signal within the cable the greater the attenuation. The numbers of channels available in a cable system is proportional to the bandwidth, whereas the attenuation of signals is approximately proportional to the square root of the frequency, see graph.

Feedforward amplifier techniques with their significantly reduced third-order harmonic distortion, and other techniques are used to extend the range of existing cables. Although traditionally the coaxial cable has been the main bearer in cable tv systems, the advent of optical fibre cables will lead in the long term to coaxial cable being used less. However before optical fibre cables are brought into common use, a few problems remain to be solved.

Optical fibre cables

The immediate attraction of optical fibre cables are their bandwidth capabilities and the relative cheapness of the fibres themselves. Also, they are totally immune from interference problems due to signal leakage. Signal leakages in both directions can be a major problem in coaxial cable systems.





Using analogue modulation techniques, today's fibre optics are yielding impressive results. Using an f.m. tv carrier, one channel has been transmitted repeaterless over 90 km. However in the future, it is p.c.m. that is likely to become the preferred mode for transmission of tv signals through fibre optics.

Low cost digital v.l.s.i. codecs, which code and decode the video signal into p.c.m. format, are the key to this important next step in cable television transmission. Developments in this field are currently taking place in several companies.

Digitally modulated video requires a comparatively large bandwidth, but yields a high picture quality which is practically uneffected by the use of successive repeaters, provided that sufficient levels of quantization steps are used in the codecs.

New monomode fibres as described at Catcom '84 by speakers from the Institute for Applied Physics in Zurich, would have a capacity of 1 to 2Gbit/s, and be capable of repeaterless operation over tens of kilometres. Such capacity would be enough to accommodate several tv signals per fibre.

Although coaxial cable will undoubtedly be used for many years to come in cable tv and communications networks, the potential of fibre optics as a distortionless trunk carrier of several broadband tv signals will begin to be fully realised just as soon as low-cost codecs become readily available.

Satellite signals

The first satellite television channels are currently operating on the ECS and Intelsat communication satellites, transmitting signals towards the Earth which need relatively large dishes (e.g. about 3m or 4m) for reception. By the end of 1985 there will be several dozen television programmes available for the cable tv operator to provide to his subscribers. This number will increase further as direct broadcasting satellites are introduced. DBS transmissions will be higher powered than those coming from the communications satellites and they will be receivable with smaller dishes (less than 1m).

3SAT comes on air

Hailed as a new concept in satellite broadcasting, the German speaking 3SAT programme started transmissions on December 1, 1984 and carries a combined programming from Austria, Switzerland and West Germany.

Programmes are prepared in a central studio complex in Mainz, and are transmitted up to the ECS-1 satellite from the West German earth station at Usingen. Transmission of 3SAT programmes is made on ECS1's East Spotbeam. As well as covering the three programme supplying countries, the East Spot footprint also covers large parts of Yugoslavia, Hungary, and Czechoslovakia. Where cable tv systems exist in these eastern countries, 3SAT organisers believe that there may be a demand for their programming. The main purpose of the programming is to cover Austria, West Germany and the German speaking parts of Switzerland. The three broadcasting authorities: Germany's ZDF, Austria ORF and Switzerland's SRG will each be providing about equal amounts of programme material.

Leo Schurmann, Director General of the Swiss Broadcasting Corporation, used the occasion of Catcom '84 to introduce the 3SAT project to both the Swiss and international cable tv professionals attending the conference. Catcom '84 also brought together specialists from the fields of both cable tv and satellite communications. The papers presented at the conference were divided into two streams: media-political and technical. There were a total of over 40 papers presented by speakers from Europe as well as the US and Canada.

North American cable tv

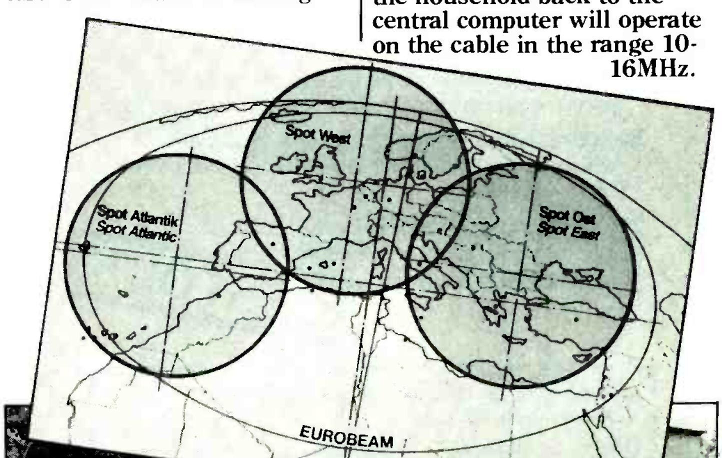
North American cable tv is now described as a "mature industry" whereas for most European countries cable tv is still relatively new. New European cable operations need to look at the experience gained in North America in cable tv to avoid possibly making some of the same mistakes.

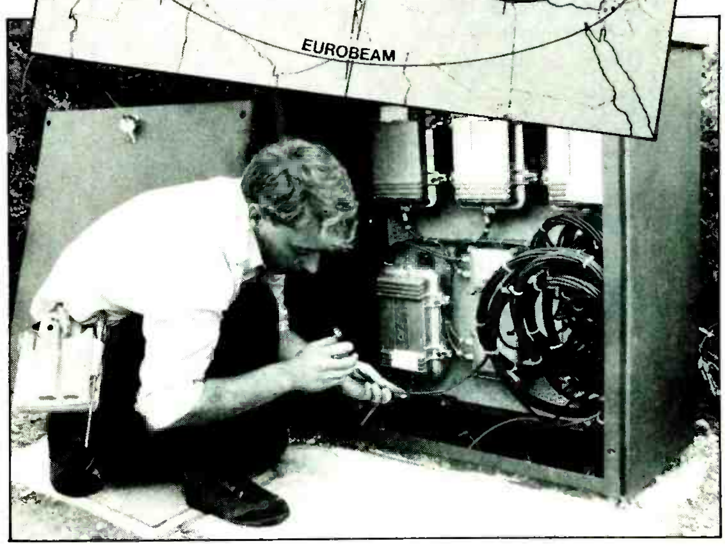
One area where direct comparisons cannot be made between North American and European cable tv relates to picture quality. The North American viewer suffers from a poor off-air picture quality, which cable operators seek to improve. Cable operators also offer additional programming. Because colour tv in Europe started later than in North America and could therefore take advantage of improvements in techniques over the NTSC colour coding system, picture quality, or lack of it, has never been such a critical problem in Europe as in North America.

As described by one Catcom '84 speaker: "The American cable systems business has evolved in a market environment in which variety, i.e. the number of signals, is more important than the image quality." Unlike in the UK where alternate channels are commonly used for the transmission of tv through cables, US cable systems operate with adjacent channels to pack the most signals into the least bandwidth.

Canadian catv consultant Israel Switzer proposed that a higher quality picture service be made available on North American cable networks for premium programming by using three 6MHz channels together to transmit frequency modulated tv signals requiring a bandwidth of 18MHz. Higher quality tv receivers would be used to demodulate the f.m. signal directly.

FM tv signals would be transmitted on channels within the normal 5-500MHz range of US cable tv systems. This would be a method of bringing a professional grade of broadcast tv picture to the viewer on existing 525-line standards, before high definition tv is introduced. The same modulation techniques would be used to obtain professional grade transmission as is used for the transmission of tv signals from satellites. The tv receiver in the home would be receiving at cable tv frequencies rather than at the 12GHz used in satellite transmissions. Switzer described this as a method of bringing the tvro into the living room!





The four foot-prints (Spot West, Spot Atlantic, Spot East and Eurobeam) of the ECS-1 communications satellite that is also used for the transmission of television signals to cable head-ends. 3SAT, the new German language satellite based programme that started transmissions on 1 December 1984 using the East Spotbeam, is produced as a cooperative venture between German ZDF, Australian ORF and Swiss SRG.

Bottom: Wiring up the first of the UK's new franchise cable-TV networks, Swindon Cable. From the kiosk, the 50-440MHz bandwidth signals are distributed to households. Interactive services, that will eventually need to return a signal from the household back to the central computer will operate on the cable in the range 10-16MHz.

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Mini Horiz 16p
Standard Vert 19p
Standard Horiz 19p
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CERAMIC 100V DISC (PLATE) E12 MICRO MINI TYPICALLY ±5%
1pF to 10nF 6p
POLYCARB 5% SIEMENS 7.5mm MINI BLOC E12
250V
1nF to 6n8 8p
8n2 to 47nF 9p
56nF to 150nF 12p
100V
100nF to 150nF 13p
180nF to 270nF 16p
330nF to 390nF 25p
470nF to 560nF 32p
680nF 38p
1µF (10mm) 40p
POLYESTER 250V RADIAL (C280)
10nF, 15nF, 22nF, 33nF, 47nF, 68nF, 100nF 7p
150nF, 200nF 10p
330nF, 470nF 13p
680nF 18p
1µF 22p
1.5µF 39p
2.2µF 39p
FEED-THROUGH
1nF 500V 35p
HIGH VOLTAGE Capacitors please enquire many types in stock
TANT BEADS
.1/35V 14p
.22/35V 14p
.33/35V 14p
.47/35V 14p
.68/35V 14p
1/35V 14p
2.2/35V 14p
3.3/35V 18p
4.7/35V 20p
6.8/35V 21p

10/16V 21p
10/35V 31p
15/16V 28p
15/25V 32p
22/6.3V 29p
22/16V 32p
33/10V 34p
47/3V 35p
47/6.3V 34p
47/16V 35p
100/3V 35p

ELECTROLYTICS Mainly Panasonic AXIALS (Wires each end)
uFd V
.47 63 9p
.47 100 10p
.47 350 35p
1 100 10p
1 500 46p
2.2 25 9p
2.2 63 10p
2.2 100 13p
2.2 350 34p
3.3 40 13p
3.3 63 14p
4.7 35 10p
4.7 50 13p
4.7 63 14p
4.7 100 16p
10 25 9p
10 50 14p
10 63 16p
10 100 18p
10 350 55p
22 25 13p
22 40 16p
22 63 18p
22 100 24p
47 25 16p
47 40 20p
47 63 30p
47 100 32p
100 16 16p
100 25 18p
100 50 25p
100 63 29p
100 100 34p
220 10 18p
220 16 19p
220 25 25p
220 40 29p
220 63 34p
220 100 46p
470 16 25p
470 25 32p
470 40 38p
470 63 50p
470 100 69p
1000 16 34p
1000 25 43p
1000 40 53p
1000 63 75p
2200 16 53p
2200 25 71p
2200 50 80p
2200 63 1.54p
4700 16 87p
4700 25 99p

RADIALS (Wires one end)
uFd V
10 35 7p
22 10 7p
22 16 8p
47 10 8p
47 16 9p
100 10 10p
100 16 11p
220 10 13p
220 16 13p
470 10 14p
1000 10 23p
1000 16 28p
2200 10 39p
2200 16 51p
3300 10 57p
3300 16 75p
4700 10 75p
4700 16 1.09p
4700 63 2.99p
10000 16 2.99p
10000 80 4.95p

TTL

7400 29p
7401 29p
7402 29p
7403 29p
7404 35p
7405 29p
7406 39p
7407 39p
7408 29p
7409 29p
7410 29p
7411 29p
7412 29p
7413 45p
7414 59p
7416 35p
7417 50p
7420 29p
7421 29p
7422 29p
7423 35p
7425 35p
7426 39p
7427 39p
7428 39p
7430 29p
7432 35p
7433 29p
7437 29p
7438 39p
7440 39p
7441 39p
7442 85p
7444 99p
7445 99p
7446 75p
7447 99p
7448 99p
7450 35p
7451 35p
7453 35p
7454 35p
7460 49p
7470 49p
7472 49p
7473 49p
7474 49p
7475 49p
7476 49p
7480 65p
7481 1.75p
7482 95p
7483 95p
7484 95p
7485 95p
7486 39p
7489 1.99p
7490 55p
7491 65p
7492 65p
7493 65p
7494 1.09p
7495 55p
7496 55p
7497 1.99p
74100 1.99p
74104 69p
74105 59p
74107 49p
74109 69p
74110 69p
74116 1.65p
74118 99p
74119 1.79p
74120 99p
74121 49p
74122 65p
74123 75p
74125 75p
74126 75p
74128 65p
74132 75p
74136 69p
74141 69p
74142 2.25p
74143 2.25p
74144 2.25p
74145 99p
74147 1.75p
74148 1.29p
74150 1.59p
74151 65p
74153 59p
74154 1.39p
74155 89p
74156 89p
74157 89p
74159 1.75p
74160 1.05p
74161 1.05p
74162 99p
74163 99p
74163 99p
74164 99p
74165 1.05p
74166 1.49p
74170 1.79p
74172 3.95p
74173 1.45p
74174 89p
74175 99p
74176 99p
74177 99p
74178 1.45p
74180 99p
74181 3.25p
74182 1.35p
74184 1.89p
74185 1.89p
74190 1.25p
74191 75p
74192 99p
74193 99p
74194 99p
74195 79p
74196 1.19p
74197 1.19p
74198 2.25p
74221 99p

74LS TTL

74LS00 28p
74LS01 28p
74LS02 28p
74LS03 28p
74LS04 28p
74LS05 28p
74LS08 28p
74LS09 28p
74LS10 28p
74LS11 28p
74LS12 28p
74LS13 32p
74LS14 49p
74LS20 28p
74LS21 28p
74LS22 28p
74LS27 28p
74LS28 28p
74LS30 28p
74LS32 28p
74LS33 28p
74LS37 28p
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74LS42 49p
74LS47 85p
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74LS74 35p
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74LS76 35p
74LS78 35p
74LS83 69p
74LS85 75p
74LS86 35p
74LS90 49p
74LS92 55p
74LS93 55p
74LS95 75p
74LS96 75p
74LS107 39p
74LS109 45p
74LS112 45p
74LS113 45p
74LS114 45p
74LS122 69p
74LS123 85p
74LS124 1.35p
74LS125 49p
74LS126 49p
74LS132 65p
74LS133 45p
74LS136 45p
74LS138 55p
74LS139 55p
74LS145 99p
74LS147 1.75p
74LS148 1.35p
74LS151 65p
74LS153 65p
74LS154 1.99p
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74LS161 75p
74LS162 75p
74LS163 75p
74LS164 75p
74LS165 1.09p
74LS166 1.95p
74LS169 99p
74LS170 1.65p
74LS173 99p
74LS174 99p
74LS175 75p
74LS181 1.99p
74LS183 1.99p
74LS190 85p
74LS191 75p
74LS192 85p
74LS193 65p
74LS194 75p
74LS195 75p
74LS196 89p
74LS197 89p
74LS221 99p
74LS240 85p
74LS241 85p
74LS242 85p
74LS243 85p
74LS244 79p
74LS245 99p
74LS247 99p
74LS248 99p
74LS249 99p
74LS251 75p
74LS253 75p
74LS257 75p
74LS258 65p
74LS259 1.19p
74LS261 1.19p
74LS266 55p
74LS273 1.22p
74LS275 3.49p
74LS279 75p
74LS280 1.89p
74LS283 79p
74LS290 79p
74LS293 79p
74LS295 1.35p
74LS298 99p
74LS299 2.25p
74LS323 3.09p
74LS324 3.25p
74LS325 1.65p
74LS326 2.89p
74LS327 2.89p
74LS347 1.35p
74LS348 1.95p
74LS352 1.19p
74LS353 1.19
74LS362 6.85p
74LS365 49p
74LS366 49p
74LS367 49p
74LS368 49p
74LS373 95p
74LS374 95p
74LS378 95p
74LS386 49p
74LS390 79p
74LS393 1.09p
74LS395 99p
74LS396 2.95p
74LS398 1.95p
74LS399 1.49p
74LS445 1.25p
74LS490 1.49p
74LS540 1.39p
74LS541 1.39p
74LS640 1.95p
74LS641 1.95p

CMOS

4000 19p
4001 19p
4002 22p
4006 68p
4007 25p
4008 89p
4009 55p
4010 29p
4011 19p
4012 25p
4013 25p
4015 55p
4016 35p
4017 52p
4018 55p
4019 55p
4020 75p
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4046 59p
4047 59p
4048 54p
4049 35p
4050 35p
4051 65p
4052 55p
4053 55p
4054 79p
4056 79p
4059 3.95p
4060 65p
4063 85p
4065 44p
4066 39p
4067 2.25p
4068 25p
4069 25p
4070 25p
4071 25p
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4076 65p
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4081 25p
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4103 1.95p
4502 55p
4503 35p
4505 3.50p
4507 35p
4508 1.19p
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4512 49p
4514 1.04p
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4555 35p
4556 49p
4560 1.45p
4566 1.39p
4569 1.65p
4584 55p
4585 59p

LOGIC

CPUs
6502 3.49p
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6809 6.49p
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8039 4.99p
8080A 3.55p
8085 on order
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Z80B CPU 7.95p
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2532-450n 3.45p
2564 7.74p
2708 2.99p
2716 3.45p
2732 4.35p
2764 5.19p
27128 19.95
4116 150n 1.25p
4118 4.65p
4164 4.99p
6116 4.95
6810 1.55p
MIS LOGIC IC's
ADC0804 5.85p
ADC0816 20.80p
ADC0817 12.54p
INS1771 pls ask
RO2513LC 7.50p
RO2513UC 7.50p
SAA5000 4.05p
SAA5010 7.81p
SAA5012 7.81p
SAA5020 5.95p
SAA5030 6.99p
SAA5040 15.95p
SAA5041 18.95p
SAA5050 8.95p
SAA5070 18.95p
8T26 1.09p
8T28 1.09p
8T95 1.09p
8T97 1.09p
81LS95 2.35p
81LS96 2.35p
81LS97 2.35p
81LS98 2.35p
6522 3.49p
6522A 5.45p
6532 5.25p
6821 1.55p
6840 3.75p
6845 6.49p
6847 6.49p
8154 on order
8155 on order
8212 4.85p
8216 on order
8224 on order
8226 on order
8255 13.95p
Z80ACTC 2.99p
Z80ADART 7.99p
Z80AP10 3.19p
ZN425E8 3.49p
ZN426E8 7.99p
ZN427E8 5.99p
ZN428E8 4.55p

V REGS

Positive 100mA
78L05A 29p
78L12A 29p
78L15A 29p
78L24A 29p
1 Amp TO202
7805T 55p
7812T 55p
7815T 55p
7824T 55p
Negative 100mA T092
79L05 49p
79L12 49p
79L15 49p
1Amp TO220
7905T 65p
7912T 65p
7915T 65p
7924T 65p

TRANSISTORS

2N2219 42p
2N2219A 45p
2N2222 40p
2N2222A 42p
2N2369 34p
2N2369A 35p
2N2904A 44p
2N2905 44p
2N2905A 48p
2N3053 45p
2N3054 98p
2N3055 65p
2N3055H 1.84p
2N3439 1.44p
2N3440 99p
2N3441 1.55p
2N3442 2.05p
2N3553 2.95p
2N3702 16p
2N3703 16p
2N3704 16p
2N3705 16p
2N3706 16p
2N3707 16p
2N3819 35p
2N3820 69p
2N3866 1.20p
2N3903 13p
2N3904 16p
2N3905 17p
2N3906 15p
2N4037 1.04p
1.06p
2N4240 2.78p
2N4400 21p
2N4401 27p
2N4402 26p
2N4427 1.34p
2N4870 99p
2N4871 75p
2N5245 59p
2N5246 68p
2N5247 75p
2N5248 66p
2N5249 67p
2N5296 93p
2N5298 98p
2N5401 45p
2N5415 1.67p
2N5416 1.97p
2N5447 36p
2N5448 36p
2N5449 36p
2N5450 63p
2N5451 66p
2N5457 63p
2N5458 57p
2N5459 63p
2N5460 63p
2N5551 26p
2N5657 2.25p
2N5684 15.10p
2N5884 4.60p
2N5886 4.60p
2N6027 60p
2N6030 9.70p
2N6031 10.90p
2N6058 3.85p
2N6059 3.86p
2N6121 1.28p
2N6122 1.49p
2N6123 1.54p
2N6124 1.35p
2N6125 1.55p
2N6126 1.72p
2N6129 1.57p
2N6130 1.88p
2N6131 1.88p
2N6132 1.66p
2N6133 1.89p
2N6134 1.93p
2N6212 2.96p
2N6254 2.90p
2N6387 1.95p
2N6676 11.45p
2SC1306 1.99p
2SC2978 1.65p
2SD313 86p
2SJ49 5.99p
2SJ50 6.49p
2SK134 5.99p
2SK135 6.49p
3N201 1.10p
40250 1.95p
40361 75p
40362 75p
40363 3.99p
40406 1.75p
40408 1.75p
40410 1.99p
40411 4.29p
40594 1.40p
40595 1.40p
40673 1.49p
40822 1.99p
40871 1.15p
40872 1.15p
AC125 99p
AC126 35p
AC127 35p
AC128 39p
AC141K 39p
AC142K 39p
AC176 39p
AC176K 49p
AC187 39p
AC188 39p
AC187K 49p
AC188K 49p
AD161 55p
AD162 55p
BC107 16p
BC107A 17p
BC107B 19p
BC108 16p
BC108A 17p
BC108B 18p
BC108C 20p
BC109 17p
BC109B 18p
BC109C 21p
BC140 38p
BC141 43p
BC147 15p
BC148 15p
BC149 16p
BC157 39p
BC158 37p
BC159 44p
BC160 55p
BC161 59p
BC169 19p
BC169C 23p
BC177 27p
BC178 29p
BC179 31p
BC182 15p
BC182L 15p
BC183 15p
BC183L 15p
BC184 16p
BC212 16p
BC213 17p
BC213L 15p
BC214 18p
BC214L 19p
BC300 59p
BC301 59p
BC303 59p
BC327 16p
BC394 52p
BC440 35p
BC441 37p
BC447 33p
BC448 33p
BC449 39p
BC460 38p
BC461 42p
BC478 38p
BC479 38p
BC546 16p
BC547 19p
BC548 16p
BC549 17p
BC550C 29p
BC557 19p
BC559 18p
BC560C 29p
BC639 37p
BC640 37p
BC650 45p
BC651 47p
BCY70 31p
BCY71 33p
BCY72 25p
BD131 63p
BD132 63p
BD135 38p
BD136 38p
BD137 39p
BD138 39p
BD139 42p
BD140 42p
BD237 98p
BD238 98p
BD239A 65p
BD239C 69p
BD240A 68p
BD240C 79p
BD241A 72p
BD241C 79p
BD242A 75p
BD242C 79p
BD243A 85p
BD243C 89p
BD244A 88p
BD244C 1.15p
BD245C 1.19p
BD245C 1.49p
BD246C 1.67p
BD249A 2.30p
BD249C 2.57p
BD250A 2.48p
BD250C 2.75p
BD410 1.65p
BD419 1.45p
BD420 1.45p
BD433 69p
BD434 75p
BD435 81p
BD437 88p
BD438 88p
BD439 90p
BD440 91p
BD441 91p
BD442 93p
BD529 1.75p
BD530 1.95p
BD535 89p
BD536 89p
BD537 97p
BD538 97p
BD539 1.08p
BD540 1.04p
BD651 1.95p
BD652 1.95p
BD675 85p
BD676 87p
BD677 89p
BD678 99p
BD679 99p
BD680 1.35p
BD711 1.50p
BD712 1.50p
BDX32 3.90p
BDX33A 1.29p
BDX33C 1.59p
BDX34A 1.29p
BDX34C 1.59p
BDX66B 6.35p
BDX67B 6.35p
BDY54 2.28p
BDY55 2.39p
BDY56 2.23p
BDY57 6.38p
BDY58 8.97p
BF179 83p
BF180 46p
BF198 18p
BF199 18p
BF200 79p
BF244A 61p
BF245A 63p
BF245B 66p
BF246 77p
BF246A 79p
BF246B 79p
BF257A 79p
BF247B 79p
BF254 66p
BF255 68p
BF256A 59p
BF256B 59p
BF256C 69p
BF257 39p
BF258 41p
BF259 45p
BF457 48p
BF458 59p
BF459 65p
BF900 1.33p
BF961 2.10p
BFR90 2.25p
BFR91 2.75p
BFS61 65p
BFS98 27p
BFT66 2.75p
BFX29 44p
BFX30 46p
BFY50 36p
BFY51 36p
BFY52 36p
BSV81 2.65p
BSX19 29p
BSX20 33p
BSX21 49p
BU104 2.32p
BU105 1.89p
BU108 2.49p
BU109 2.49p
BU126 1.55p
BU204 2.49p
BU205 1.99p
BU206 2.16p
BU208 1.93p
BU226 4.45p
BU326S 2.75p
BU406 1.58p
BU407 1.58p
BU408 1.49p
BU409 1.65p
BU500 5.01p
BUX48 6.75p
BUY18S 4.75p
E430 7.32p
IRF530 4.95p
J300 88p
J310 88p
MJ802 4.70p
MJ900 3.21p
MJ901 3.39p
MJ1000 1.78p
MJ1001 1.86p
MJ1800 3.79p
MJ2500 2.68p
MJ2501 3.08p
MJ3000 2.39p
MJ3001 2.63p
MJ4502 5.90p
MJE340 75p
MJE350 1.20p
MJE2955 2.52p
MJE2955T 95p
MJE3055 2.42p
MJE3055T 69p
MPSA05 17p
MPSA06 17p
MPSA12 29p
MPSA13 25p
MPSA14 25p
MPSA20 49p
MPSA42 29p
MPSA43 29p
MPSA55 17p
MPSA56 17p
MPSA92 27p
MPSA93 27p
MPSL01 29p
MPSL51 75p
MPSU05 1.24p
MPSU06 1.34p
MPSU07 1.64p
MPSU55 1.42p
MPSU56 1.72p
MPSU57 1.86p
TIP29A 35p
TIP29C 42p
TIP30A 37p
TIP30C 44p
TIP31A 39p
TIP31C 47p
TIP32A 46p
TIP32C 49p
TIP33A 1.22p
TIP33C 1.35p
TIP34A 1.27p
TIP34C 1.26p
TIP35A 1.87p
TIP35C 2.14p
TIP36A 1.94p
TIP36C 2.22p
TIP41A 47p
TIP41C 58p
TIP42A 62p
TIP42C 65p
TIP49 1.05p
TIP50 1.15p
TIP53 1.58p
TIP54 1.65p
TIP110 67p
TIP112 76p
TIP115 70p
TIP117 78p
TIP120 79p
TIP122 85p
TIP127 99p
TIP130 1.06p
TIP132 1.19p
TIP135 1.16p
TIP137 1.19p
TIP140 1.85p
TIP142 2.13p
TIP145 1.95p
TIP147 2.27p
TIP162 2.37p
TIP2955 95p
TIP3055 88p
TI543 61p
VN10KM 69p
VN46AF 1.46p
VN66AF 1.65p
ZTX107 16p
ZTX108 15p
ZTX109 18p
ZTX300 16p
ZTX301 17p
ZTX302 18p
ZTX303 19p
ZTX304 21p
ZTX310 22p
ZTX311 48p
ZTX313 23p
ZTX314 24p
ZTX320 27p
ZTX330 22p
ZTX341 26p
ZTX450 25p
ZTX500 22p
ZTX501 18p
ZTX502 19p
ZTX503 20p
ZTX504 21p
ZTX510 22p
ZTX531 22p
ZTX650 26p
ZTX651 36p
ZTX652 38p
ZTX653 42p
ZTX750 45p
ZTX751 37p
ZTX752 41p
ZTX753 45p 47p

DIODES

IN34A 52p
IN914 4p
IN916 6p
IN4001 4p
IN4002 4½p
IN4003 5p
IN4004 5½p
IN4005 6p
IN4006 6½p
IN4007 7p
IN4148 3p
IN5401 13p
IN5402 14p
IN5404 16p
IN5406 18p
IN5407 19p
IN5408 20p
BA102 49p
BA115 29p
BA133 51p
BA138 36p
BA155 18p
BA156 41p
BA157 28p
BA158 34p
BA159 38p
BA182 49p
BA201 23p
BA202 29p
BA316 27p
BA317 28p
BA318 31p
BAX13 21p
BB105 65p
BB109G 69p
BY126 12p
BY127 14p

25 amp type Metal clad with hole
KO1(100) 2.62p
KO2(200) 2.75p
KO4(400) 3.25p
KO6(600) 4.10p
BYW64 35A 400W 4.50p

SCR's TRIACS DIACS

THYRISTORS 4.8 & 12 Amps Texas TO220
Suffix A = 100V
Suffix B = 200V
Suffix C = 300V
Suffix D = 400V
Suffix M = 600V
4A
TIC106A 66p
TIC106B 67p
TIC106C 68p
TIC106D 69p
TIC106M 75p
8A
TIC116A 88p
TIC116B 89p
TIC116C 93p
TIC116D 97p
TIC116M 99p
12A
TIC126A 86p
TIC126B 90p
TIC126C 91p
TIC126D 92p
TIC126M 1.10p
TRIACS Texas 400V TO220 Case
TIC206D(4A) 79p
TIC225D(6A) 88p
TIC226D(8A) 89p
TIC236D(12A) 1.37p
TIC246D(16A) 1.40p
TIC253D(20A) 2.70p
TIC263D(25A) 2.91p
DIACS
BS100, DB3, ST2 29p

ZENER'S

Many specials in stock. Pls enquire.
400 to 500mW E24 Series 2.4 to 47V 7p
1.3 Watt E24 Series 3.3 to 82V 14p

BRIDGE

(PIV shown in brackets)
1½ amp type
W01(100) 28p
W02(200) 34p
W04(400) 33p
2 amp type Square with hole
SO1(100) 46p
SO2(200) 50p
SO4(400) 55p
6 amp type Square with hole
PW01(100) 95p
PW02(200) 99p
PW04(400) 1.30p
PW06(600) 1.39p

OPTO

Many weird & wonderful devices in stock, inc var. shapes & sizes of LEDS.
R = Red
G = Green
Y = Yellow
Large diffused 1 +
R5D 10p
G5D 16p
Y5D 15p
Small diffused
R3D 8p
G3D 13p
Y3D 13p
Micro 0.1"
RIM 27p
GIM 29p
YIM 29p
Large clear
R5C 12p
G5C 17p
Y5C 17p
Super bright high efficiency Large (100 times brighter)
R5U 53p
G5U 53p
Y5U 53p
Rectangular Stackable LEDS
R5R 19p
G5R 20p
Y5R 22p

LIN ICs

AY15050 99p
AY38910 3.99p
AY38912 4.95p
CA3048 5.54p
CA3059 3.33p
CA3090AQ 3.70p
CA3130E 87p
CA3130T 2.35p
CA3140E 54p
CA3140T 1.40p
HA1366W 2.40p
HA1388 2.54p
ICL7106 7.50p
ICL7107 9.50p
ICL7611 97p
ICL8038 3.50p
ICM7555 1.10p
ICM7556 1.49p
LF347 1.78p
LF351 75p
LF353 1.15p
LF355 1.25p
LF356 1.35p
LF357 1.65p
LF398 5.50p
LM301AN 45p
LM304H 1.75p
LM307N 45p
LM308N 99p
LM309K 1.99p
LM317T 1.75p
LM317K 1.45p
LM317HVK 10.80p
LM324 83p
LM335Z 1.60p
LM348N 99p
LM349N 1.09p
LM379S 5.50p
LM380N14 1.20p
LM380N8 pls ask
LM381AN 2.26p
LM318N 1.40p
LM382N 1.79p
LM383T 2.75p
LM384N 2.90p
LM386 1.25p
LM386N 1.20p
LM387 2.02p
LM388N 1.60p
LM391N60 1.55p
LM391N80 1.75p
LM392 99p
LM396K 22.29p
LM723CH 1.08p
LM723CN 1.05p
LM725CH 8.37p
LM725CN 5.93p
LM741CH 1.18p
LM741CN 28p
LM741CN14 1.20p
LM747CN 69p
LM748CH 1.46p
LM748CN 55p
LM1877 4.61p
LM1886 5.58p
LM1889 3.87p
LM2902 1.22p
LM2907N 3.47p
LM2907N8 3.34p
LM2917N 3.52p
LM2917N8 3.34p
LM3900 1.19p
LM3911 2.09p
LM3914 4.04p
LM3915 4.04p
LM4250 2.89p
LM13600 1.64p
LM13700 1.64p
MC1408 2.78p
MC1466L 16.50p
MC1468 4.30p
MC3340 2.66p
MC3446 3.95p
MC3357 2.11p
MC4044 6.60p
MF10 4.50p
NE529 2.25p
NE531N 1.99p
NE543N 2.75p
NE544N 2.31p
NE555 28p
NE556 69p
NE558 1.89p
NE560 3.25p
NE565 1.06p
NE566 95p
NE567 1.41p
NE570 3.14p
NE571 3.98p
NE5534A 2.08p
RC4194 2.60p
RC4195 2.06p
RC4558 99p
SN76477 7.95p
SN76003 3.50p
SN76013 3.50p
SN76023 3.50p
SN76033 3.50p
TA7204 1.99p
TA7205 1.20p
TA7222 1.75p
TA7227 5.82p
TBA500 2.97p
TBA520 2.57p
TBA530 2.55p
TBA540 2.72p
TBA550 3.25p
TBA560C 2.87p
TBA570 2.37p
TDA1002 4.35p
TDA1003 4.35p
TDA1010A 2.25p
TDA1022 4.95p
TDA1097 4.99p
TDA1151 1.95p
TDA2002 3.25p
TDA2003 3.25p
TDA2020 3.15p
TDA2030 2.85p
TDA2611 2.50p
TDA7000 3.45p
TL061 62p
TL062 99p
TL064 1.77p
TL071 57p
TL072 95p
TL074 1.50p
TL081 48p
TL082 75p
TL084 1.45p
TL494 3.99p
UAA170 2.49p
UAA180 2.49p
UA2240 1.25p
ULN2003 75p
UPC575C2 2.00p
UPC1156H 2.75p
UPC1182 3.75p
UPC1185 3.95p
UPC1185H 3.65p
UPC1212C 1.60p
UPC2002 3.25p
XR2206 3.95p
ZN409 2.25p
ZN414 1.00p
ZN1034 1.99p

TRANSFORMERS

Post inclusive prices cheaper to callers
All 240V Primary Split Bobbin
100mA
6-0-6 1.50p
9-0-9 1.70p
12-0-12 1.85p
15-0-15 1.95p
1A as above 3.75p
20-0-20V 0.125A 3.75p
12-0-12V 50VA 7.95p
12-0-12V 100VA 11.99p
0 + 6 + 6 + 9 + 9 1.25A 5.65p

VERO

0.1" COPPER TRACKS
2.5 x 3.75 95p
2.5 x 5 1.10p
3.75 x 3.75 1.10p
3.75 x 5 1.24p
2.5 x 17 3.27p
3.75 x 17 4.29p
4.79 x 17 5.56p
VQ Board 2.10p
DIP Board 3.95p
Track Cutter 1.63p
Pin Insertor 2.21p
100Pins 61p
Verobloc 4.66p
Vero Wiring Pen & Spool 3.39p
Spare Spool 75p
Combs 6p

PCB

FERRIC CHLORIDE Quick dissolving Enough to make over 1 litre 1.69p
ETCH RESIST TRANSFERS
1 Thin lines
2 Thick lines
3 Thin bends
4 Thick bends
5 DIL pads
6 Transistor pads
7 Dots & holes
8 0.1" edge connectors
9 Mixture
Any sheet of above 39p
GRADE ONE GLASS PCB SINGLE-SIDED
178x240mm 1.85p
420x195mm 2.55p
420x245mm 3.75p
DALO ETCH RESIST PEN + spare nib 1.29p
PHOTO SENSITIVE PCB
1st Class Epoxy Glass for better results than spraying expose to UV
Single sided
100 x 160 2.25p
100 x 220 2.65p
203 x 114 2.55p
233 x 220 5.75p
Double sided
100 x 160 2.35p
100 x 200 2.95p
203 x 114 3.05p
233 x 220 6.45p
Developer for above (do not use Sodium Hydroxide) 500ml 3.19p

WIRE

PRICES PER METRE
Solid connecting wire
MAINS SPEAKER
Twin 1 Amp 16p
Twin 2½ Amp 19p
3 Core 2½ Amp 21p
3 Core 13Amp 62p
SCREENED
Single 16p
Stereo 29p
Mini Single 13p
Mini Stereo 16p
4 Core 4 Screens 49p
4 Core Single Screen 62p
8 Core 73p
12 Core 88p
Heavy Duty Mike Guitar Lead 33p
AERIAL
50Ω RG58A 29p
75Ω UHF 31p
75Ω VHF 31p
300Ω Flat 16p
RAINBOW RIBBON
Prices per foot
10way 25p
16way 39p
20way 48p
24way 62p
30way 75p
34way 82p
40way 88p
64way 1.49p

SOLDER

ANTEX SOLDERING IRONS
C240(15W) 5.20p
XS240(25W) 5.40p
Iron Stand 1.75p
Elements (State Iron) 2.05p
C240 Bits
No 2 (Small) 85p
No 3 (Med) 85p
No 6 (Micro) 85p
XS240 x 25 Bits
No 50 (Small) 85p
No 51 (Med) 85p
No 52 (Lge) 85p
SOLDER 125gms
18swg 3.10p
22swg 3.35p

PLUGS & SOCKETS

'D' Connectors 25 Way
Solder
Male 1.60p
Female 2.09p
PCB Wire-Wrap
Male 1.60p
Female 2.09p
Covers 1.00p
Phono plugs Blk, Red, Grn, Wt or Yell 15p
Line Skts 15p
Chas Sktx1 16p
Dual Skt 30p
Quad Skt 40p

ZIF SOCKET

24pin 4.35p
28pin 5.00p
40pin 5.35p

SWITCHES

TOGGLE (MIN)
SPST 59p
SPDT 65p
DPDT 74p
DPDT C OFF 90p
4PDT 3.25p

CIRCLE 20 FOR FURTHER DETAILS.

by K.L. Smith,* Ph.D.

D.c. supplies from a.c. sources–3

Straighten out your power — rectifiers and smoothing

Straightening out a.c. back to d.c. is a requirement in every power supply for the applications I am discussing. The rectification of single-phase sinusoidal sources by diodes is rather poorly carried out from the point of view of efficiency of conversion to d.c.: the efficiency of half-wave rectification, defined as the amount of the power in the load dissipated by the d.c. component, is only 40.6%. The rest is dissipated by the ripple current made up from remnants of the fundamental a.c. and its harmonics. The efficiency of single-phase full-wave rectification is better: 81.2% of the load power is now in the d.c. component. Because of this, you will hardly ever see half wave rectifiers in modern equipment.

If you rectify polyphase supplies, then as the number of phases increases, there is a large rise in efficiency of a.c. to d.c. conversion. That is why motor-car alternators are three-phase, full-wave rectified systems. For a three-phase, half-wave rectifier circuit, the efficiency of conversion is already 97%. For a full-wave rectifier circuit, it reaches 99.3% — without any smoothing! Your motor car battery is charged by virtually pure d.c. However, in the home there are not many of who would instal 440 volt three phase mains — just to save on smoothing capacitors in the hi-fi system! This means single-phase rectifier operation remains of interest, complete with the need for large smoothing or reservoir capacitors.

Eliminating the ripple

When the diodes have converted the a.c. line to pulsating d.c. the ripple component must be prevented from reaching the load. Traditionally this was done with bypass capacitors (smoothers) and a series choke, but in modern, low-voltage semiconductor supplies, the choke has all but disappeared. Only a single, large reservoir capacitor is used to do the job. This component must pass a considerable ripple current, so an important parameter is how it handles this.

The analysis of how a capacitor input filter operates remains quite complex and many authors have made attempts to reach some kind of approximation to reality in their calculations. The first use of the terms 'cut-in' and 'cut-out' for the moments when the rectifiers switch on and off, appears to have been made in the paper by M.B. Stout[1] who assumed that the diodes acted as perfect switches. By 1941 D.L. Waidelich[2] was writing a rather complicated analysis where he distinguished between a hard vacuum valve and a mercury-vapour rectifier. The hard valve had a high 'on' resistance, R_d and the mercury-vapour tube dropped a fairly large constant forward voltage, V_d, but had negligible resistance. But the article that has become the 'source paper' on this topic was written in 1943 by O.H. Schade[3]. He developed a large number of design curves and these continue to appear in contemporary literature when smoothing filters are discussed. Thomas Roddam used some of Schade's curves in his 'Battery charging..' article some time ago[4].

Subsequently, textbook writers and students' course notes settled down to a standard simplified 'model' which assumed a sawtooth ripple and peak value charging, as in Fig. 1. This not very good approximation was used, for example in Samuel Seely's book[5] after he outlined how a discussion of the full exponentially shaped discharge curve of the smoothing capacitor might be approached. Grey[6] gives a detailed analysis including an 'exponential' treatment, but assumes a charge to the peak value, i.e. no R_d. Parker[7] uses the same approach, but shows (with practical example using 'valve'-level voltages and typical component values) how the linear discharge assumption is a good approximation. His section on this is still worth reading, if you would like to follow how the assumption of a 'peak charging' circuit works.

I have not found that peak charging is necessarily the norm in high-current, low-voltage rectifiers with capacitor input filters. In practice, a peak current limiting resistor R_1, is often required to protect the diodes. This means that however large the reservoir capacitor, the circuit voltage does not reach charging peaks at the crest of the sine-wave input when supplying the rated load, as seen in Fig.2. It will do so, however, off load and the capacitor must be rated for voltage working accordingly. The old 'sawtooth wave approximation' (Fig.1) fails to give the conduction time, peak value of the (narrow) diode current pulses, or the r.m.s. value of these currents. Some kind of analysis that does, would be very useful. It would enable the VA ratings of the transformer windings to be estimated. These depend on the r.m.s. value of the winding current. The ratings of the diodes could also be estimated, since they are dependent on the peak value $\hat{I}$, of the current pulses, as well as on the mean current I.the mean current is of course, the value of the d.c. output, I_{dc}.

A search through the literature for the treatment of the 'non-peak' charging case, turned up an analysis by A. Lieders[8]. He assumed linear rises and falls of voltage during the capacitor charge and discharge periods. But as Parker had shown earlier, this assumption is alright for fairly well smoothed supplies. Yet Lieders' approach produced some terrible integrals — one requiring nearly two pages in an appendix to evaluate! His nomograms and graphs offered as design aids are

*University of Kent at Canterbury.

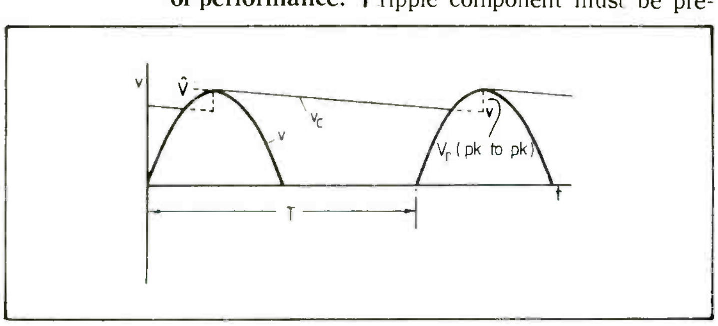


Fig. 1. The simple assumption of a sawtooth ripple in a smoothing filter is shown. The peak voltage change across the capacitor is a half-wave rectifier circuit has an amplitude of $V_{r(pk.\ to\ pk.)}$ equal to I_{dc}/fC. This leads to an r.m.s. ripple estimate given by $V_r = I_{dc}/2\sqrt{3}\,fC$. A rough value for the d.c. voltage output is given by the simple expression, $V_{dc} = \hat{V} - I_{dc}/2fC$. (For a full-wave circuit, '4' appears in place of the '2s'.) Although rough, these estimates give an idea of performance.

well up in quantity to Schades and the approach is daunting...

Developing a simpler model

As linear charge/discharge approximations had already been made by Lieders, et al., I considered there ought to be a more compact (simpler) approach that would still yield good design predictions. You might find the following treatment useful. It has been used to design a few low voltage supplies with considerable success and it helps explain some of the mystique in other articles on power supplies[9,10].

The symbols and geometry shown in Fig. 2 are drawn upon to build the model. From Fig. 2(a):

the d.c. output voltage,

$$V_{dc} = \frac{V_{c1} + V_{c2}}{2} = \hat{V}\cos\frac{\pi\tau_c}{T} \qquad \ldots 1$$

the instantaneous a.c. voltage,

$$v = \hat{V}\cos\omega t = \hat{V}\cos\frac{2\pi t}{T} \qquad \ldots 2$$

and the peak ripple voltage,

$$\hat{V}_r = \frac{V_{c2} - V_{c1}}{2} \qquad \ldots 3$$

The meaning of the load resistance R_L, and the total series resistance in the rectifier path R_i, ($R_i = R_s + R_d + R_t$) is shown in Fig. 2(b).

The current pulse through the rectifiers and therefore through the transformer secondary winding, flows in the interval between cut-in and cut-out, and this is labelled τ_c in Fig. 2(a). τ_c is the *conduction time*. The current pulse is very nearly given by $v - V_{dc}$ acting across R_i during the conduction time interval. The d.c. current i_{dc}, is the average of these charging pulses over the period T/p, where p is 1 for half-wave rectification and 2 for full-wave circuits.

$$I_{dc} = \frac{p}{TR_i}\int_{-\frac{\tau_c}{2}}^{\frac{\tau_c}{2}} (v - V_{dc})dt$$

and by substituting from eqns 1 and 2:

$$I_{dc} = \frac{p\hat{V}}{TR_i}\int_{-\frac{\tau_c}{2}}^{\frac{\tau_c}{2}} \left(\cos\frac{2\pi t}{T} - \cos\frac{\pi\tau_c}{T}\right) dt$$

Carrying out this simple integration, you can see that:

$$I_{dc} = \frac{p\hat{V}}{\pi R_i}\left(\sin\frac{\pi\tau_c}{T} - \frac{\pi\tau_c}{T}\cos\frac{\pi\tau_c}{T}\right)$$

But we have eqn. 1 again to enable substitution for $\hat{V}$:

$$I_{dc} = \frac{pV_{dc}}{\pi R_i}\left(\tan\frac{\pi\tau_c}{T} - \frac{\pi\tau_c}{T}\right)$$

Finally, by Ohm's Law:

$$\frac{I_{dc}}{V_{dc}} = \frac{1}{R_L}$$

$$\therefore \frac{\pi R_i}{p R_L} = \tan\frac{\pi\tau_c}{T} - \frac{\pi\tau_c}{T} \qquad \ldots 4$$

This is an interesting result. It gives the *conduction time* for half-wave (p = 1) or full-wave (p = 2) rectifiers, in terms of R_i and R_L. Notice that the value of the smoothing capacitor doesn't appear. The approximation must therefore breakdown somewhere. The answer is; for a sufficiently large capacitor, the value of τ_c on a pocket calculator and moving into an accurate solution by trial and error. Figure 3 is a useful curve giving τ_c/T as a function of R_i/pR_L.

The constancy of τ_c (but not with load current, as that implies a changing R_L) does not mean that the ripple amplitude is constant. With changing capacitance, the linear charge/discharge curves 'tilt' at different angles on Fig. 2a. There is also a 'phase shift' in the current pulse – as the capacitor is made smaller, the pulse moves to an earlier part of the half cycle. Even at high tilts on the charge curve approximation, the current pulse during this time is very close to a sine wave cap. This 'cap' has a time width of τ_c of course. It also has a peak value of $\hat{I}$, and an r.m.s. value I.

Another derivation for the mean current I_{dc}, can be argued from this sinusoidal cap comprising the current pulse. By averaging it over the time period $\frac{T}{p}$, we obtain:

$$I_{dc} = \frac{\hat{I}p}{T}\int_0^{\tau_c} \sin\frac{\pi t}{\tau_c}\, dt = \frac{2\hat{I}}{\pi}\frac{\tau_c}{T}\, p \ldots 5$$

Or transposing for $\hat{I}$:

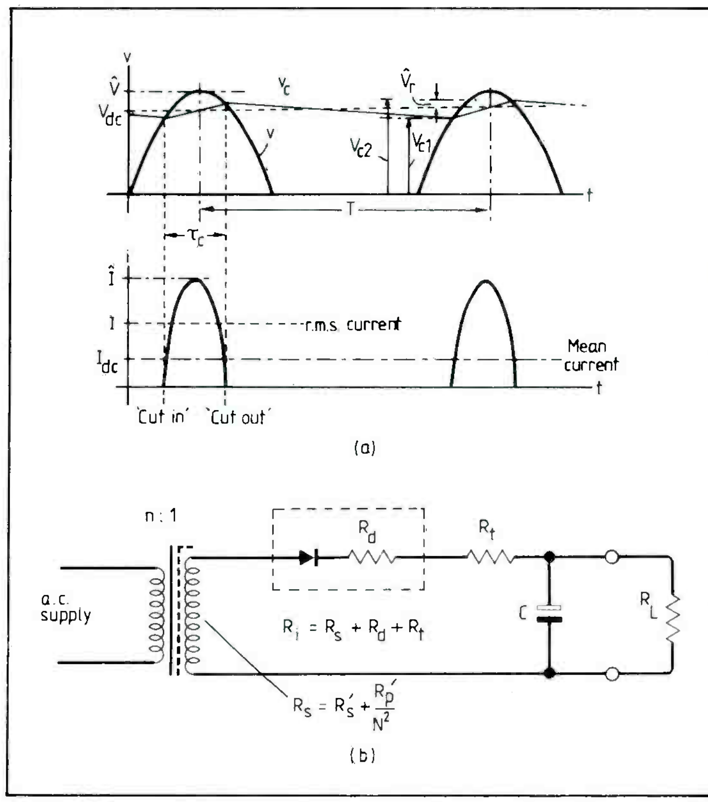


Fig. 2. **The voltage shown in (a) where the capacitor voltage ramps up and down in a charge period τ_c, and a discharge time of T - τ_c, more nearly models the actual variations observed across the smoothing capacitor in a practical circuit.**

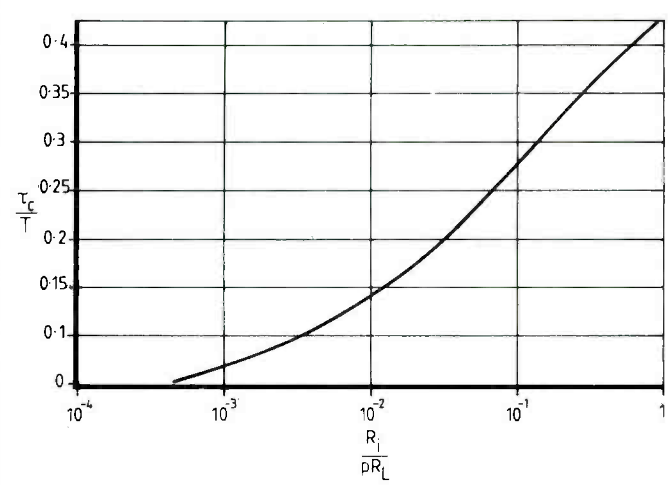
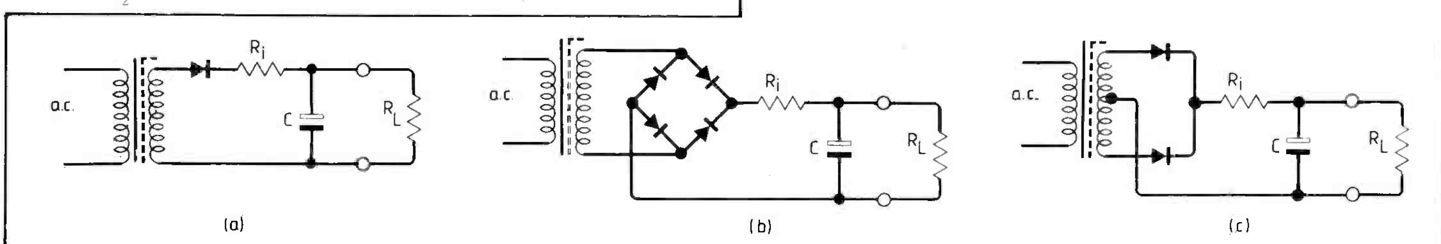
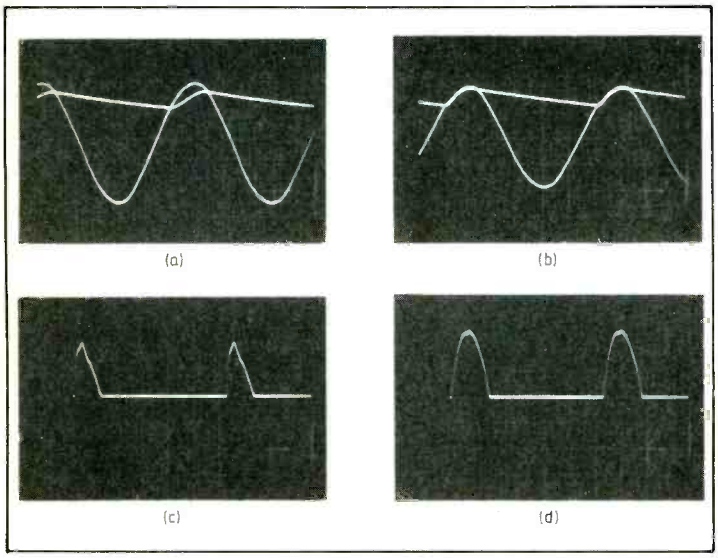


Fig. 3. **This curve is a plot of equation 4 in the text. It yeilds values of τ_c if the ratio of R_i to R_L is known.**

Fig. 4. **The r.m.s. currents in the transformer windings of (a) (half-wave), (b) (full-wave bridge), (c) (full-wave biphase) standard circuits can be calculated easily, using equations 9, 10 and 11.**





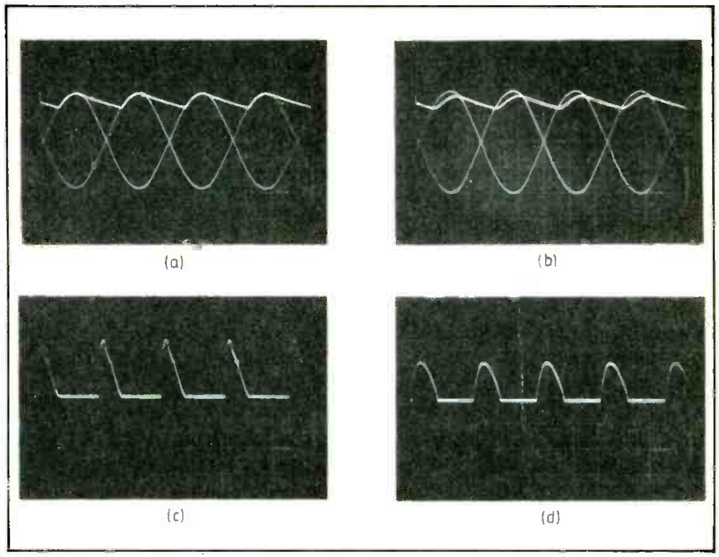


Fig. 5. **These oscillograms were taken with the circuuit conditions described in the text and in Table 1. The current waveforms especially show the degree of approximation assumed when taking the pulses in (c) and (d) as sine wave 'caps'.**

Fig. 6. **These results were taken exactly as in Fig. 5, but with a full-wave circuit.**

$$\hat{I} = I_{dc}\frac{\pi}{2p}\frac{T}{\tau_c} \qquad \ldots 6$$

The root mean square value of the current pulses *per diode*, is found as usual by intergrating the square of the pulse values, averaging, and taking the square root:

$$I = \hat{I}\sqrt{\frac{1}{T}\int_0^{\tau}\sin^2\frac{\pi t}{T}\,dt} = \hat{I}\sqrt{\frac{\tau_c}{2T}} \qquad \ldots 7$$

(As this value is *per diode*, p doesnot come into the picture at this stage.) On substituting for $\hat{I}$:

$$I = \frac{I_{dc}}{p}\sqrt{\frac{\pi^2}{8}\cdot\frac{T}{\tau c}} \qquad \ldots 8$$

This is the r.m.s. current in each diode arm, therefore we can find the r.m.s. currents in the transformer windings. For the circuits shown in Fig. 4:

a. half-wave:

$$I_{(h.w.)} = I_{dc}\sqrt{\frac{\pi^2 T}{8\,\tau_{c(h.w.)}}} \qquad \ldots 9$$

b. full-wave bridge:

$$I_{(bridge)} = \sqrt{I^2_{(r.m.s.\,1)} + I^2_{(r.m.s.\,2)}} = \frac{\sqrt{2}}{2}$$

$$I_{dc}\sqrt{\frac{\pi^2 T}{8\pi_{c(FW)}}} \qquad \ldots 10$$

c. full-wave, centre-tap (biphase rectifier):

$$I_{(centre\text{-}tap)} = \frac{I_{dc}}{2}\sqrt{\frac{\pi^2 T}{8\pi_{c(FW)}}} \qquad \ldots 11$$

(per half winding)

The electrical engineers define a *form factor* for a repetitive waveform as $k = \frac{I_{r.m.s.}}{I_{mean}}$.

$$k = \frac{1}{p}\sqrt{\frac{\pi^2 T}{8\tau_c}}$$

Smoothing capacitor

As we have seen, as long as the capacitor is large, the peak current, conduction time and the r.m.s. quantities are all independent of the actual capacitor value. But the ripple amplitude across the load is strongly dependent upon it.

The capacitor has a fraction of the peridic time interval to discharge given by $(T/p)-\tau_c$

$$\therefore\ \left(\frac{T}{p} - \tau_c\right) I_{dc} = 2\hat{V}_r C \qquad \ldots 12$$

where $\hat{V}_r$ is the *peak ripple voltage*.

For any sawtooth waveform, if $\hat{V}$ is the peak value, then the r.m.s. value is given by $V_r = \frac{\hat{V}_r}{\sqrt{3}}$.

$$C = \frac{I_{dc}\left(\frac{T}{p} - \tau_c\right)}{2\sqrt{3}.\,V_r} \qquad \ldots 13$$

Therefore if you know the type of rectifier (p), the d.c. load current (I_{dc}), the conduction time (τ_c), together with the maximum r.m.s. ripple voltage (V_r), the size of the required smoothing capacitor can be calculated.

You will come across a good deal of empirical comment regarding the smoothers required for this and that in power supplies. For example, E.J. Hatch[9] stated in his article that he had 'seen the rule of thumb, use 2000μF per amp of d.c. load — for a peak to peak ripple voltage of 3.5 volts'. How does this compare? Substituting 1 amp and 1.75 volts peak ripple into equation 13 with τ_c about 3 ms on 50 Hz mains (T = 20 ms) gives in a full-wave rectifier circuit:

$$C = \frac{1 \times (10 - 3) \times 10^{-3}}{2 \times 1.75} = 2000\mu F$$

A good approximation to the required r.m.s. secondary voltage on the transformer can be found from equation 1, taing account of the forward voltage drop across n diodes in the rectifier arm. This gives:

$$V_{r.m.s.} = \frac{V_{dc} + nV_d}{\sqrt{2\cos\pi\tau c/T}} \qquad \ldots 14$$

How accurate?

No model is worth much if the results are so wide of the mark that 'guessing' say, could do better! One check on these results was to use Lieders' practical measurements and his calculations, to compare results. Lieders used a full-wave bridge circuit with the following values

$R_i = 19.7\Omega$
$R_L = 497\Omega$
$C = 37.5\ \mu F$
Diodes BAX13 $V_d = 0.77$ V
$V_{dc} = 10$ V on load,
$I_{dc} = \frac{V_{dc}}{497} = 20.1$ mA

The measured and calculated values given by Lieders and the present results are:

measured	calculated	present results
$I = 91.6$ mA	90.5 mA	90.6 mA from 6
$I_{r.m.s.} = 26.7$ mA	26.3 mA	26.75 mA from 8
$V_{r.m.s.} = 9.5$ V	9.65 V	9.5 V from 14
$r = 0.0894$	0.086	0.084
$2\alpha = 68°$ (1.187 rad)	1.148 rad	1.096 rads via 4

(r is the ripple factor, 2α is the conduction angle used by Lieder and related by $\tau_c = \alpha T/\pi$

These results appear to be in good agreement. Not to be outdone, a colleague suggested, "It might be a coincidence!" As a final check, measurements on half-wave and full-wave bridge rectifier circuits using one of the toroidal mains transformers mentioned in part 2, gave further experimental results.

Practical rectifier

The 'peak charging' condition was attempted in both circuits, by minimising R_i. Another set of results was obtained for the 'sawtooth' approximation, by using a relatively large R_i. Figure 5(a) and (b) shows the voltages obtained in the half-wave examples, while the current pulses through the diode are shown in c and d. Figure 6(a) and (b,c) and (d) illustrate the corresponding results for the full-wave bridge circuit. The current pulse profiles can now be 'blown up' on squared paper, say, and the area under them calculated. This will give the mean current I_{dc}. The peak value $\hat{I}$, and 'on' time τ_c, can be read off the scales on the oscillograms. Squaring the ordinates yields data for the squared area value, and thus the r.m.s. current. Table 1 lists the various quantities I measured, together with the calculated values from the various formulae derived earlier. A reasonable result has been obtained.

	HALF WAVE RECTIFIER				FULL WAVE RECTIFIER			
	LOW R_i		HIGH R_i		LOW R_i		HIGH R_i	
Parameter	Measured	Calc.	Measured	Calc.	Measured	Calc.	Measured	Calc.
$\frac{\tau_c}{T}$	0·15	0·17	0·245	0·25	0·16	0·138	0·2	0·2
τ_c	3ms	3·38ms	4·9ms	5ms	3·2ms	2·75ms	4ms	4ms
$\hat{I}$	420mA	418·9mA	260mA	251mA	220mA	228·5mA	150mA	153mA
$I_{r.m.s.}$	114·3mA	114·7mA	101·3mA	97·2mA	88·3mA	84·7mA	72·9mA	69·4mA
$V_{r.m.s.}$	13·8V	13·2V	16·6V	17·3V	12·73V	12·9V	14·1V	14·7V
C	110µ	95µ	110µ	107·5µ	55µ	58µ	55µ	52µ
$\hat{V}_f$	3·5V		3V		2·5V		2·25V	
R_i	6Ω		24Ω		9Ω		27Ω	
$\hat{V}$	19V		24V		18V		20V	

Whatever the detailed results of the calculations we all attempt using our various approximate 'models' of the rectifier-smoother situation, one or two important generalisations emerge. One is the fact that because of the peaky nature of the current pulses, the r.m.s. values are rather greater than the average, or d.c. levels. The transformer rating is based on the r.m.s. currents in its windings because the heating effect rests on that. Most power supply transformers must, therefore be rated at a somewhat larger VA than the output power would seem to predict. A discussion of this point was offered by E.J. Hatch[9].

Taking just one example from the measurements reported in Table 1, for example the full-wave, low R_i case:

Power out $= i_{dc} \times V_{dc} = 40 \times 10^{-3} \times 15 = 600$ mW

VA (sec) $= i_{r.m.s.} \times V_{r.m.s.} = 12.73 \times 84.7 \times 10^{-3} = 1080$ mW

... a ratio of 1 : 1.8

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10. Voltage Regulator Handbook, National Semiconductor, Section 8, 1982

This list supplements last month's computer-board article. Addresses of microprocessor manufacturers, most of whom produce computer boards for evaluation and experimentation purposes, can be found in S.A. Money's Microprocessor Data Book published by Granada.

Aitek Microcomputers Ltd
22 Market Place
Wokingham
Berkshire RG11 1AP

Andelos Systems
Solina
Bucklebury Alley
Cold Ash
Newbury
Bershire RG18 9NN

Arcom Control Systems Ltd
Unit 8
Clifton Road
Cambridge CB1 4BW
(Dist. Dage)

CMS 44a Hobson Street
Cambridge CB1 1NL

Control Universal Ltd
Andersons Court
Newnham Road
Cambridge CB3 9EZ

Costgold Research Ltd
The Old School
Stretham
Cambs CB6 3LD

Country Computers Ltd
Pipers Road
1ark Farm Ind. Est.
Redditch B98 0HU

Crellon Microsystems (Motorola, Zilog)
380 Bath Road
Slough
Berkshire SL1 6JE

Ctronics
39 High Street
Cowbridge
South Glamorgan CF7 70E

Dage Eurosem
Rabans Lane
Aylesbury
Buckinghamshire HP19 3RG

Deephaven Ltd
9a High Street
Andover
Hampshire SP10 1LU

Deltak Electronics
Central High Street
Staplehurst
Kent TN12 0BH

Dicoll Electronics Ltd
Bond Close
Kingsland Estate
Basingstoke
Hampshire

Essex Electronics Centre (dist. RCS)
Wivenhoe Park
Colchester
Essex CO4 3SQ

Flight Electronics
Flight House
Quayside Road
Bitterne Manor
Southampton
Hampshire SO2 4AD

Fulcrum (Europe) Ltd
Valley House
Purleigh
Essex CM3 8BH

Gemini Microcumputers Ltd
18 Woodside Road
Amersham
Bucks HP7 0BH

GNC Electonics
Little Lodge
Hopton Road
Thelnetham
Diss
Norfolk IP22 1JN

IBS (Irvine Business Systems)
1 Montgomery Place
Irvine
Ayrshire KA12 8PN

Intel
MEDL Distribution (Marconi)
East Lane
Wembley
Middlesex HA9 7PP

L.J. Electronics Ltd
Francis Way
Bowthorpe Ind. Est.
Norwich NR5 9JA

Macro Marketing Ltd.
Burnham Lane
Slough SL1 6LN

Measurement Systems Ltd
7B Faraday Road
Newbury
Berkshire RG13 2AD

Mercatek Marketing
Springmead House
Bradcutts Lane
Cookham Dean
Berkshire SL6 9AA

Microkey Ltd
88a St James's Street
Brighton
East Sussex BN2 1TP

Micronix Computers Ltd
1 Grangeway
London NW6

National Semiconductor, See Macro Marketing

Pelco Electronics
London Road
Spring Gardens
Romford
Essex RM7 9LP

Pronto Electronic Systems Ltd
446-478 Cranbrook Road
Gants Hill
Ilford
Essex 1G2 6LE

Quant Systems
111 Thorpe Road
London E7 9DE

Rade Systems Ltd
209a High Road
London NW10 2EU

RCS Microsystems Ltd
141 Uxbridge Road
Hampton Hill
Middlesex TN12 1BL

Rockwell, see Pelco, RCS

SGS-ATES (UK) Ltd
Planier House
Walton Street
Aylesbury
Bucks HP21 7QJ

Sherwood Data Systems Ltd
Sherwood House
The Avenue
Farnham Common
Slough SL2 3JX

Slemens Ltd
Slemens House
Windmill Road
Sunbury-on-Thames
Middlesex TW16 7HS

Sirius Microtech Ltd
15 Alexandra Way
Ashchurch Ind. Est.
Tewkesbury GL20 8NB

Syntel Microsystems Ltd
Queens Mill Road
Huddersfield HD1 3PG

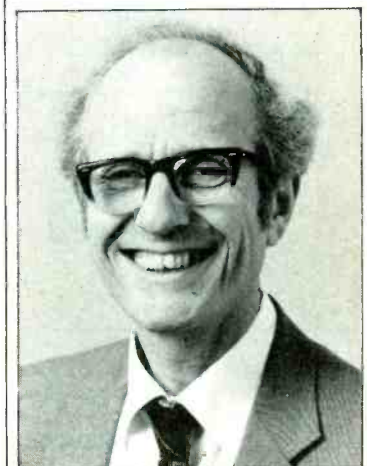
TDS (Triangle Digital Services Ltd)
100a Wood Street
London E17 3HX

Thomson-CSF Components
Ringway House
Bell Road
Daneshill
Basingstoke
Hampshire

Veraspeed
Stanstead Road
Boyatt Wood
Eastleigh
Hants SO5 4ZY

Sampled-data servos – a new analysis

By D.M. Taub



Since 1950, Matthew Taub has been continuously engaged in development work on digital electronics. After five years with Ericsson Telephones Ltd (now part of the Plessey Group), where he worked on electronic switching in telephone exchanges, he went to Leo Computers Ltd (now part of ICL), contributing to the development of the mercury delay-line store and input/output section of the LEO 2 computer. He joined IBM UK Laboratories Ltd in 1957 and is now a Senior Technical Staff Member. Areas of work at IBM included magnetic core logic circuits, computer architecture, read-only and magnetic disc storage, peripheral-device control using l.c.i. techniques, and circuits for c.r.t. displays. During the past two years he's been active on the working group developing Futurebus (IEEE P896) for use in high-performance multimicroprocessor systems.
He has 22 publications in journals, a further 26 in the IBM Technical Disclosure Bulletin, and is named as inventor or co-inventor on 27 patents. The published work earned him a PhD degree from Cambridge University in 1982. Previously, he'd studied electrical engineering at University College, Nottingham, gaining the B.Sc. (Eng) degree in 1945, and after a short period with Ferranti went on to carry out research into noise phenomena in electron tubes at the Cambridge University Engineering Laboratory, for which he received the M.Sc. degree in 1950.
He has served as joint honorary editor of the *IEE Proceedings on Computers and Digital Techniques* (1977-81), and is a Fellow of the IEE and the British Computer Society, and a Senior Member of the IEEE.

Sampled-data feedback control systems — frequently a topic many engineers find difficult — are analysed in a new way, specially suitable for use with computers

The subject of sampled-data servos is one that many engineers find difficult, and this series is offered in the hope that these difficulties will be lessened.

Sampled-data servos have been the subject of several textbooks over the past few decades, notably those by Ragazzini and Franklin, Kuo, Jury, and Franklin and Powell. This series therefore makes no claim to present new knowledge. What it sets out to do is to present existing knowledge in a new and simpler way; it is strongly computer-oriented, which has made it possible to avoid some of the complexities of the earlier presentations. Some of the features of this treatment are as follows:

- Instead of sampling with unit impulses, impulses of weight T (the sampling interval) are used. This simplifies many of the expressions by eliminating the factor T, but in particular it allows one to express simply in words the relationship between the gain of a network and the gain of the same network followed by a sampler (parts 4 and 5).
- For calculating the sampled gain of the continuous-signal portion of the servo loop, i.e. the portion from the hold circuit to the sampler at the plant output, an iterative procedure is used which avoids the use of z-transform tables. All time delays in the loop, whether in the sampler itself or in the sampled-data compensator are considered to lie in the continuous signal portion, and the procedure used allows them to be included without having to use modified z-transforms.
- Modified z-transforms, and the alternative of multiple-rate sampling, are also avoided in calculating the plant stimulus and output between sampling intervals. The calculation is done instead by straightforward application of the Laplace transform, using numerical integration in the complex-frequency plane.

As a background, the reader is assumed to be familiar with Fourier and Laplace transforms, and to have an elementary knowledge of z-transforms. Linear systems are assumed throughout, but they can have arbitrarily-high complexity.

Introduction to the series

Feedback control systems are an essential feature of animal and plant life. They have been used in engineering for at least two hundred years and are generally described today by the term 'servo-system' or simply 'servos'. Their objective is to keep the value of some variable in the system, representing perhaps the position or velocity of part of a mechanism, as close as possible to a reference value applied externally. In general, this reference value will vary with time.

The principle on which a servo works is shown in Fig. 1. The value of the variable being controlled, Y, is subtracted from the reference value R to produce an error signal V. This drives the system in such a sense that the error is reduced. Unfortunately the characteristics of most systems are such that if the error signal were used directly as the drive signal, instability would result. To avoid this, the error signal is first passed through a signal-processing network whose characteristics have to be carefully chosen. This network is generally known as the 'compensator', and the system being controlled, as the 'plant'.

In classical servos the various signals, including in particular the error signal, are continuous functions of time. Therefore, provided that the plant itself is linear, the compensator can be designed using the established theory of linear systems. Many books have been written explaining the procedure, for example references 1 and 2.

Today, however, there is increasing use of systems in which the error signal takes the form of a sampled-data signal; that is to say, its value is finite only at certain regularly-spaced instants of time called the sampling instants. At all other times it is zero. The difference between continuous and sampled-data signals is illustrated in Fig. 2.

There are two reasons for the development of sampled-data servos. One is that all but very simple compensators can be most cheaply built today as digital circuits, and these, by their very nature, handle signals in sampled-data form, i.e. as a succession of values. The other reason is that in some modern systems the error signal has to be a sampled-data signal because of the nature of the system.

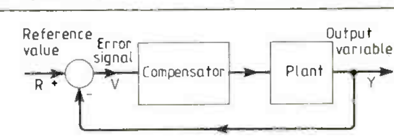


Fig. 1. Essential features of a feedback control system or 'servo'.

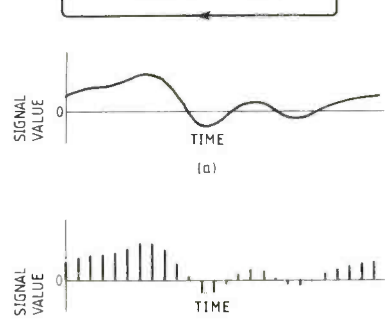


Fig. 2. Comparison between continuous and sampled-data signals. The sampled-data signal is zero except at regularly-spaced discrete instants of time. (a) continuous signal, (b) sampled-data signal corresponding to (a).

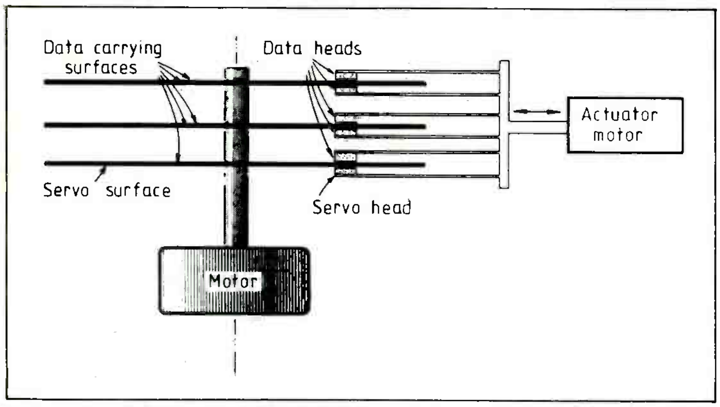


Fig. 3. **Low-density magnetic-disc store in which one disc surface carries only servo information.**

An example is the track-following servo in some recent magnetic-disc stores. As the name implies, its purpose is to keep the read/write head accurately centred over the desired track. In the stores being built up to a few years ago the track pitch was never less than about 250μm and so one could use the scheme shown in Fig. 3. In this, one of the disc surfaces carries only servo information, and the signal from the corresponding head, the servo head, gives a measure of how far it is displaced from the centre of its assigned track. The heads are rigidly joined to one another, and so as long as the servo head is correctly positioned, one can take it that the data heads are correctly positioned as well.

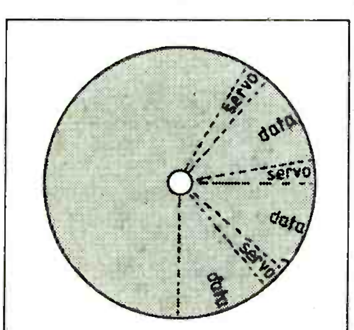
The trend today, however, is to use much smaller values of track pitch, 60μm or less, and it becomes difficult to avoid movement of the data heads relative to the servo head caused by vibration and differential thermal expansion. The way out of the difficulty is to combine servo information and data on the same track, and there are two ways of doing so. One, which has so far been used only experimentally, is to use frequency-division multiplexing: the servo information is confined to low frequencies and is separated from the data by means of frequency-selective filters 3,4.

The alternative is to use space-division multiplexing as shown in Fig. 4. Here each disc surface consists of a number of sectors for storing the data, and between data sectors there are narrow sectors containing servo information. As the disc rotates, the data sectors and servo sectors pass under the head alternately, and the servo information is extracted by straightforward strobing. The signal indicating the error in the head position thus exists only during the short intervals when the head is over the servo sectors; nowhere does it exist as a continuous signal.

The purpose of this series is to present the mathematics of sampled-data servos and show how their performance can be computed. Part 2 describes the sampling process and explains the phenomenon of 'aliasing'. Part 3 considers the reverse process, i.e. converting a signal back from sampled-data form to a continuous function of time. In part 4 the servo loop is examined in some detail; its response to a sinusoidal input is calculated and stability margins are determined. Following this, part 5 shows how to find the various signals in the loop for any arbitrary input. First, the various sampled-data signals are considered, and then the signals which are continuous functions of time. Examples are included at appropriate points. The mathematical methods developed are embodied in a set of programs presented in a companion paper[9].

To understand part 2, the only background needed is an understanding of Fourier series. Part 3 requires some familiarity with Laplace transforms, and part 4 brings in z-transforms, but only in a very elementary way. Both these transforms are used again in part 5. The necessary material is covered in many textbooks, but specially recommended is reference 5, in which the relevant material is to be found in chapters 2, 3, 4, 8 and 9.

Fig. 4. **In today's high-density disc stores servo information is interleaved with the data on every disc surface.**



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List of principal symbols

A,B,C,D	points in the servo loop at which signals are continuous functions of time (Fig. 21)
A(s) to D(s)	signals at points A, B, C and D respectively as functions of complex frequency
a(t) to d(t)	— ditto — as functions of time
f_s	sampling frequency
H	gain; subscripts indicate points between which the gain applies
j	$\sqrt{-1}$
K	multiplication constant in expressions where gain is expressed in terms of poles and zeros
k	integer
L	$H_{XY}(j\omega) \sum_{k=0}^{m} \zeta_k e^{jkT\omega}$
m	integer; also highest power in general polynominal expressions
M	highest power of z in numerator and denominator polynomials of $H_{UY}(z)$
n	sample number
p(t)	sampling waveform
s	complex frequency
T	sampling interval
t	time
U,V,X,Y	points in the servo loop carrying sampled-data signals (Fig. 21)
U(z) to Y(z)	z-transforms of signals at U, V, X and Y
u(n) to y(n)	sample values at U, V, X and Y
z	e^{Ts}
α	hold- circuit proportionality constant
β_k	coefficient of z^k in numerator polynomial of $H_{VX}(z)$
γ_k	coefficient of z^k in denominator polynomial of $H_{VX}(z)$
$\delta(t)$	Dirac function
$\Delta\tau$	time delay between A and B (Fig. 21)
ζ_k	coefficient of z^k in numerator polynomial of $H_{UY}(z)$
η_k	coefficient of z^k in denominator polynomial of $H_{UY}(z)$
$\lambda_1, \lambda_2, \ldots$	zeros of $H_{XD}(s)$
$\mu_1, \mu_2, \ldots$	poles of $H_{XD}(s)$
ν_k	coefficient of z^k in numerator polynomial of $H_{xy}(z)$
ξ_k	coefficient of z^k in denominator polynomial of $H_{XY}(z)$
$\psi_1, \psi_2, \ldots$	poles of $H_{XY}(z)$
ω	angular frequency
φ	phase angle

Improving colour television decoding

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

Guidance through the series, with some useful addresses.

A series of articles which started in December 1983 and ended in July 1984 investigated many of the problems associated with PAL decoding. The eight articles particularly contained many illustrations — a total of 102 drawings and photographs — which detailed suggested solutions to these problems. The series was, in effect, a fairly comprehensive survey of the subject, but judging from reader's response, some found the wide range of treatment confusing; the perspective of the various explanations was not fully appreciated. So to help pinpoint the many aspects covered, the following digest is offered.

The first article (*WW* Dec. 1983) explained the basics of the PAL coding system, considering how the luminance and chrominance components are spectrally interleaved. Methods of separating these components by comb filter were discussed and Fig. 11 on page 77 illustrated the principle of sum-and-difference filtering using the input and output of a delay (a form of transverse filter). The article described how the frequency spacing of the comb filter 'teeth' was determind by the delay value and gave examples of typical spacings ranging from 64 µs (15.625 kHz) for a 1-line delay up to 40 ms (25 Hz) for a two-field delay, i.e. picture store. Further explanation showed that, although this closer frequency spacing (of comb teeth) resulted in virtually perfect component separation, the temporal element of (moving) television pictures precludes the use of this degree of selection.

Part 2, in the January 1984 *WW* issue, explained the operation of the PAL modifier circuit, showing how the chrominance coding in adjacent (television) lines can be V axis switched so that lines can be electrically subtracted on to give chrominance cancellation and luminance enhancement. The description mentioned how this was a particularly suitable method for domestic television receivers which operate with only one (tv) line delay (64µs).

The distortions caused by the use of shadow-mask colour display tubes were discussed in Part 3 (February issue). This type of component was investigated and its particular form of operation analysed. The conclusion reached was that 25 in (standard receiver) tubes or small, high-resolution tubes were those most suitable for deriving benefits from the application of the extended-PAL decoding techniques explained in the preceeding two articles. With other types, the improvement to be gained from the modification would be limited such that, for example dot crawl on the display would be eliminated from vertical chroma transients but there would not be any evident increase of high—frequency luminance.

Part 4 of the series (March issue) described in detail the hardware required to realise the modifier and 1-line-delay circuits previously outlined and included typical waveforms illustrating the operation of these circuits. Some reservations as to the possible improvements to be derived were given. In particular, this section explained that any improvement had to be paid for by the need for better aerial provision, for better RGB drive amplifier performance (specifically, this was needed to reduce the visibility of slew-rate distortion) and the acceptance of an apparent increase in noise interference.

Two modern domestic receivers — the Ferguson/Thorn TX10 and the Phillips/Mullard circuits — were reviewed in Part 5 (May issue) with particular consideration given to the performance of those circuit elements most affected by application of the modifying techniques, and to how the alternative circuitry could noticeably improve on that performance.

Part 6 dealt with the operation of the comb-filter board in some detail. The amplitude and group-delay responses as well as the 'pulse-and-step' performance figures were compared with the same characteristic of the passive filters in the TX10 and Phillips receivers. This was done to show the degree of improvement which could be obtained from the modifications.

In the final article (Part 7, July 1984), additional help is offered to prospective builders of the comb-filter circuit by way of further description, parts list, location diagrams, photographs etc. One further point to be mentioned in respect of the picture improvement which may be gained from the modifications is that, when viewing good quality pictures, the sharpness and general 'cleanliness' (absence of luminance 'ringing' and chroma dot crawl) is particularly pleasing. But the observable fact is this improvement might be questioned when inspecting a Test Card F display because visible disturbances in the region of the 4, 4.5 and 5.25 MHz gratings show the very effects which the modifications are intended to overcome. This occurs because the high-band luminance passing through the PAL modifier produces aliasing and cross-colour components generated by the addition of the chrominance luminance. Also, with a test-card input, the adaptive notch will be operated — thus removing luminance in the frequency range sampled by the 4.5 MHz grating — and will leave only the spurious colour from the U and V channels. The immediate reaction to such a display is that the modifications seem to have produced very little improvement in performance. However, the test-card display is, in this instance, giving a false impression. With real pictures (i.e. television programmes), the chance of considerable luminance detail occuring at exactly 4.5MHz is statistically rare; the transients which would provide such picture detail would, in any event, contain only a small amount of energy and would not be sufficient to trigger the adaptive notch. Thus, although aliasing components from the modifier can sometimes produce some business around picture-edge detail, this would only be detected on close inspection and would not be visible at normal viewing distances. A/B comparison of the notch and comb decoder would indicate that with good signals, noise level low etc., the comb gives picture improvement especially on large screen and high resolution monitors.

Two corrections: on page 41 July issue the 500ms in the left column should be 500ns for the chroma. The top left figures on page 38 of the July issue is Fig.60. This is the correct figure for page 58 of the June issue.

Some extra useful addresses:

STP Video Ltd (for high-grade receiver IF/tuner)
Unit 1, Heybridge Industrial Estate
Holloway Road
Heybridge
Maldon
Essex CM9 7XS (Tel. 0621 54633)

'Television' Readers PCBs Services Ltd (for the board shown in Fig.91)
Fleet House
Welbeck Street
Whitwell
Worksop
Notts.
(Quote ref. D077 at £9.50. Includes P&P and VAT) or Manor Supplies (address shown in July issue page 40) for a small board only housing the TDA3561A and its components.

M.Sagin (for the comb filter board, shown on the cover July, Fig.34, 36 circuit)
Nancarras Mill
Constantine
Falmouth (Tel. 0326 40687/ 76007)

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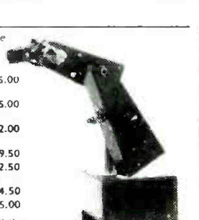

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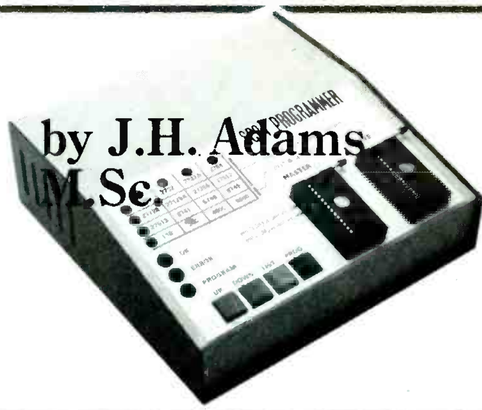
Intelligent eprom programmer



by J.H. Adams M.Sc.

These software notes are a guide for developing programming routines for eproms and single-chip microprocessors outside the current range.

Since the first article* I have improved the software so that it is now possible to produce a printed listing of 8741/8 and 8749 devices. Also, if the LIST key is pressed when no printer is connected, the programmer ignores the command. This eliminates the risk of the system freezing while high voltage is applied to an eprom in the slave socket.

Setting up for the high voltages is now slightly different. During adjustment of these voltages, a link should be fitted between pin 20 of the 25-pin D connector and pin 17 of IC_7. This convinces the programmer that a printer is connected and it switches on the high-voltage supply.

When setting and checking the slave socket V_{cc} supply to 6V, make sure that the ends of the wires of the 120Ω resistor fitted between pins 14 and 28 of the slave socket do not foul adjacent pins in the zif socket. Before taking any measurements, select 2764 and execute a PROG operation. There is no insulation between pin sockets within the zif socket body. For this reason the high-voltage supplies must be tested and calibrated as described with the 680Ω resistor connected across C_7.

Software controlling the programmer has been kept as general purpose as possible. Special software techniques are used to select device-specific routines for operations such as setting up the programmer, getting a byte from the master device and programming a byte in the slave device. Table 1 lists commands which the computer can give to the programmer and Fig. 1 charts the general-purpose algorithm used for all commands. During the algorithm the command, stored in register R2, is interrogated to see which sections should be skipped and which executed. Remaining flow diagrams illustrate the controlling program structure.

*The main eprom programmer circuit was detailed in last November's issue, pp. 43-46, and its power supply, an adaptor for programming single-chip microcomputers and 8048 characteristics in the December issue, pp. 51-55.

Device-specific routines

Within the programmer's operations some sections are specific to individual devices and others relate to groups of devices such as single-chip microcomputers. The key to selecting these functions within the overall structure of a device-independent algorithm is the content of register R3, the register pointing to the currently indicated device or baud setting.

In setting up initial conditions for the programmer once a device has been selected, the value in R3 is used as a pointer to one of a series of of consecutive three-byte entries at the beginning of the program-eprom data page, page three. The first of these three bytes, the number of pages to be programmed, is transferred to register R5 and used as an end-of-operation marker against the current address every time that address is incremented in the INCADD routine.

The remaining two bytes form 16 bits for sending to the four ports of EXP0 to set up V_{pp}, V_{cc}, the relay-selectable pins and control pins on both master and slave devices. Content of R3 is also

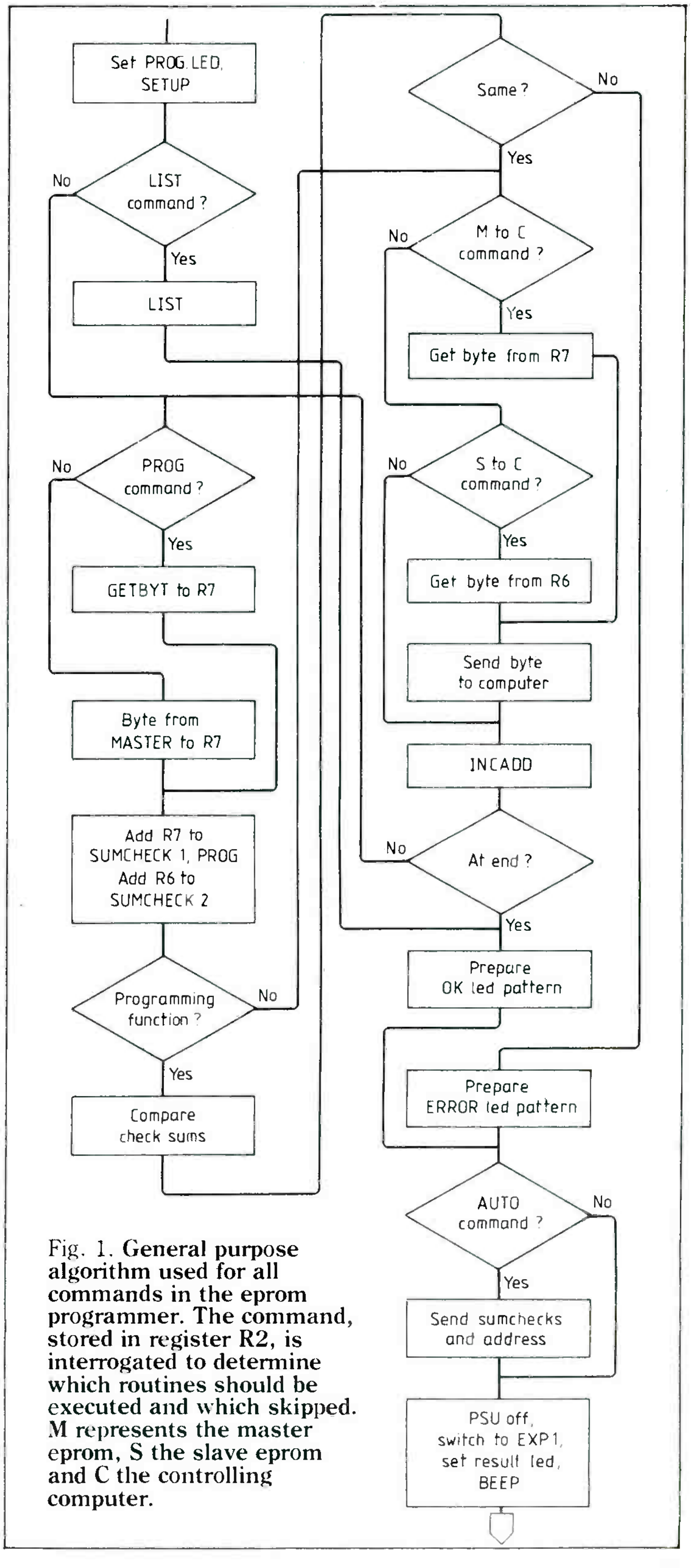


Fig. 1. **General purpose algorithm used for all commands in the eprom programmer. The command, stored in register R2, is interrogated to determine which routines should be executed and which skipped. M represents the master eprom, S the slave eprom and C the controlling computer.**

interrogated during setting up to see if extra initialization is required for pins associated with putting 8048 devices in program mode.

The general-purpose nature of register-conditional program execution is illustrated when it is time to program a device. Relevant extracts from the program source code are shown in List 1. Prior to programming, the master byte stored in register R7 is added to the master check sum referenced as SC1. After programming, the result is expected to be in R6 ready to be added to the slave check sum SC2 and possibly to be compared with the content of register R7 to establish whether or not programming was successful.

To execute the programming operation, a call is made to PROG. In this routine, the content of device-pointer register R3 is offset by the base address of a table of data bytes beginning at location PROGTAB in the same eprom page as the PROG routine. This A register will now contain a value equal to the lower eight bits of the eprom address PRGTAB plus a number in the range 0 to 11.

Operation JMPP @A is a single instruction It gets the byte from the PRGTAB table pointed to by the contents of the A register and uses it as the lower eight bits of the next instruction to be executed. In register terms, the instruction puts the byte extracted from the table into the

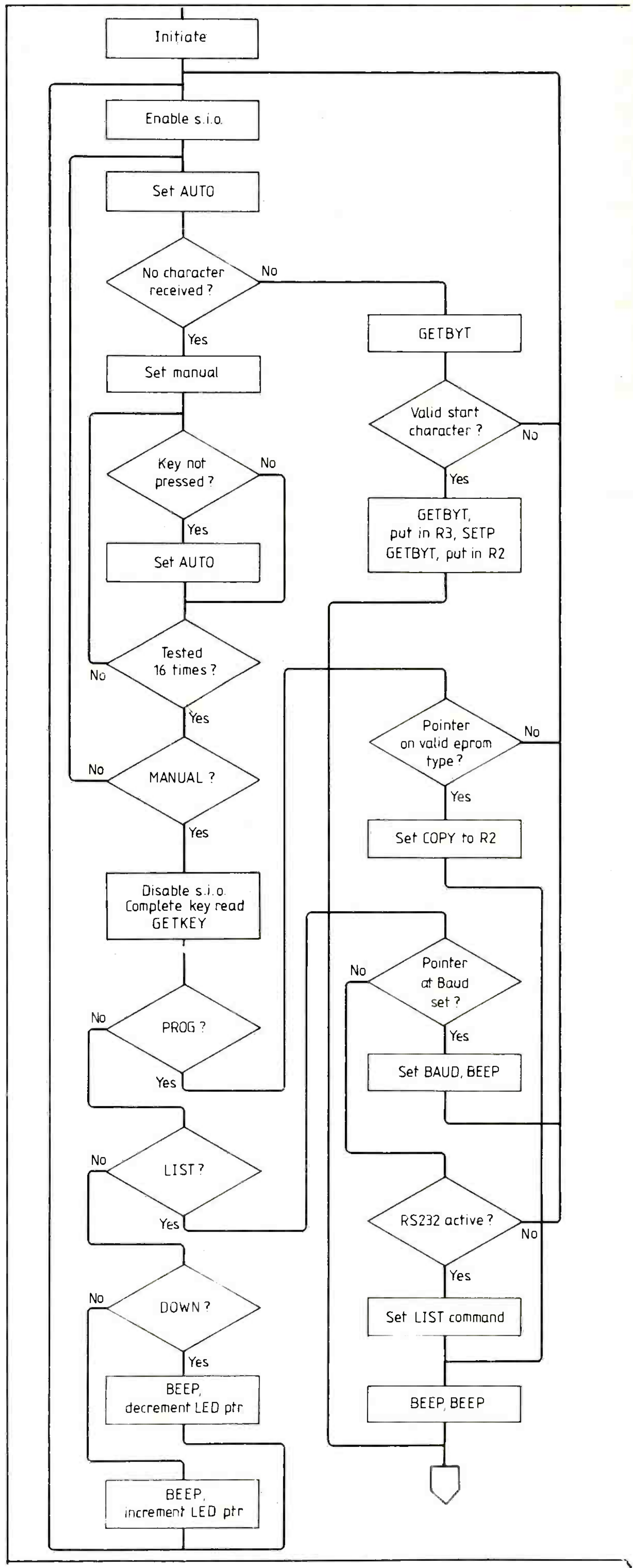
Table 1. **Commands and device-selection codes for a computer to the programmer.**

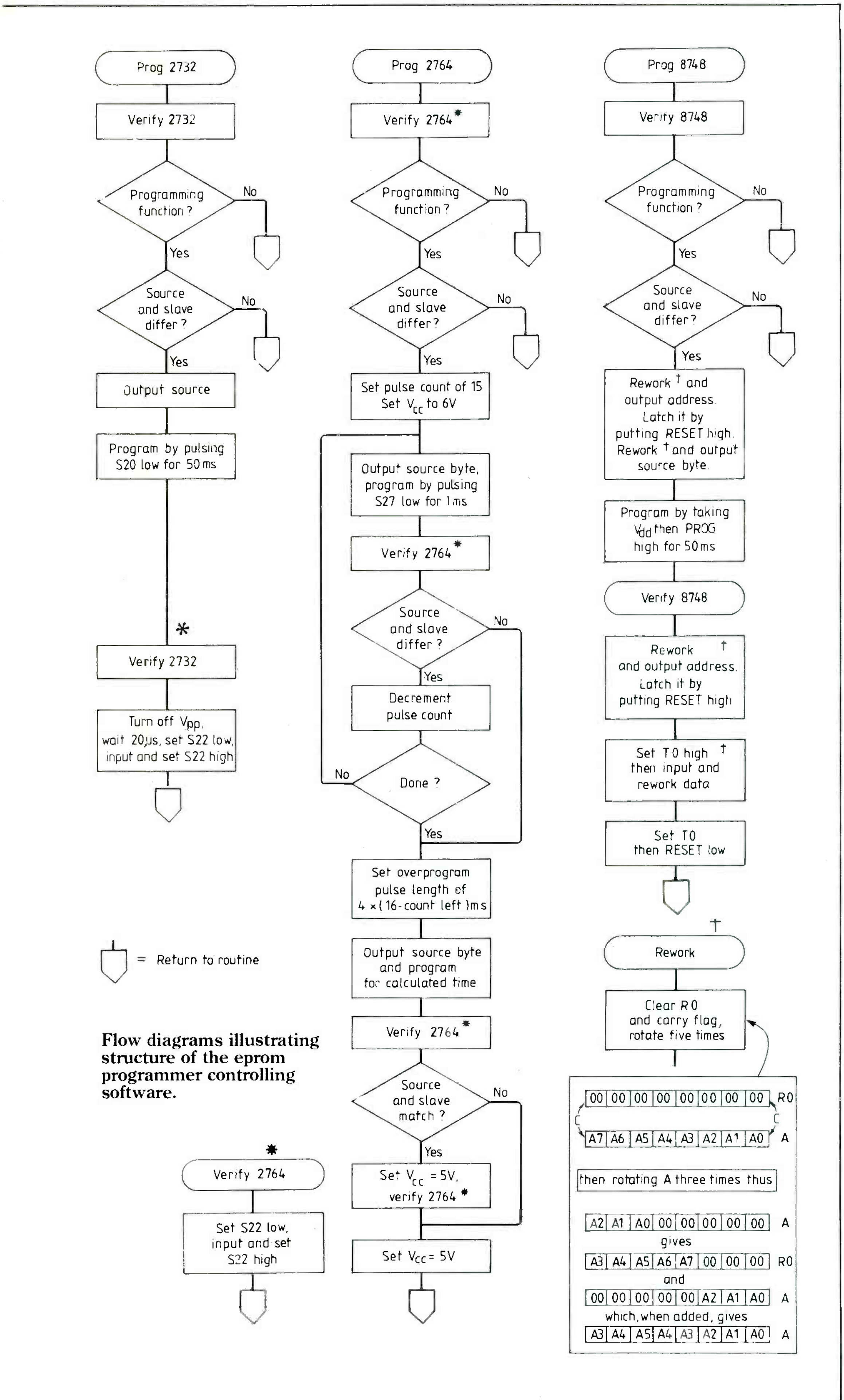
Code	Command	Device
0	LIST	2716
1	SUMCHK	2732
2	READ M	2732A
3	READ S	2764
4	COPY	2764A
5	PROG S	27128
6	–	27128A
7	–	27256
8	–	27512
10	–	8741/8
11	–	8742/9

Note: M represents master, S, slave.

```
MAIN30: MOV     A,R7
        MOV     R0,#SC1
        CALL    SUMCHK          ;add to SC1
        CALL    PROG            ;else possible prog, definite verify
        MOV     A,R6            ;slave byte to R6
        MOV     R0,#SC2         ;add to SC2
        CALL    SUMCHK
    .
    .
    .
    .
    .
PROG:   MOV     A,#LOW PRGTAB
        ADD     A,R3
        JMPP    @A
;
PRGTAB: DB      LOW J2716
        DB      LOW J2732
        DB      LOW J2732
        DB      LOW J2764
        DB      LOW J2764
        DB      LOW J27128
        DB      LOW J27128
        DB      LOW J27256
        DB      LOW J27512
        DB      LOW J27512
        DB      LOW J8748
        DB      LOW J8748
;
J2716:  JMP     P2716
J2732:  JMP     P2732
J2764:  JMP     P2764
J27128: JMP     P2764
J27256: JMP     P27256
J27512: JMP     P27512
J8748:  JMP     P8748
```

List 1. **Extracts from the eprom programmer source code to illustrate the general-purpose nature of register-conditional program execution.**



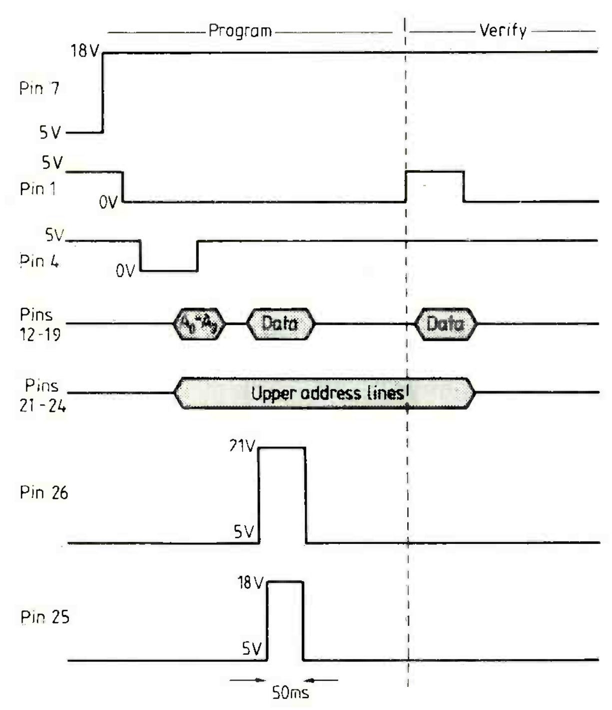


Flow diagrams illustrating structure of the eprom programmer controlling software.

A complete kit of parts for the eprom programmer including transformer, zif sockets, unpunched case, connectors, hardware and programmed eprom but not p.c.bs can be obtained by sending £89.50 inclusive to John Adams at 5 The Close, Radlett, Hertfordshire, telephone Radlett 5723. Parts for the single-chip microcomputer programming adaptor excluding p.c.b. but including sockets are an extra £17.25. A disc with the SC84 control program is £5.25 inclusive — please state disc size, etc.

Two silk-screened p.c.bs, a main plated-through-hole board for the programmer and single-sided one for the p.s.u., are £17 including UK/overseas postage and vat from Combe Martin Electronics, King Street, Combe Martin, North Devon EX34 0AD. The microcomputer programming board is an extra £4 including postage.

Our apologies to readers who received character-generator listings for the SC84 by mistake.



Programming/verify cycle for 8741/2/8/9.

lower eight bits of the program counter.

Now the 12 bytes in the PRGTAB table are each the lower eight bits of eprom address locations holding the starts of several jump instructions within the current page. One can see that the content of register R3 has been used to direct execution to the jump instruction selected by register R3 and thus on to the particular routine for the device to be programmed.

As the level of execution is already within a subroutine, each jumped-to routine needs only end with a return instruction, RET, to pass control back to the original calling program. There are 12 bytes defined in the PRGTAB table, each related to one of the twelve possible devices and thus twelve possible R3 register values, but there are only seven JMP instructions. This is because for several devices, e.g. 2732/32A, 2764/64A and 27128/128A, only the initial conditions vary and so the same programming algorithm may be used more than once.

Obtaining a byte from the master device during listing, copying or device reading is carried out in the same way. There are only two jumps, one representing a routine for all ordinary eproms and one returning the content of the 8048 device in the adaptor as though it were a master device (i.e. in register R7), even though it is in the slave socket. Note that this will not affect copy operations attempted on 8048 i.cs, nor will printer data rates cause erroneous JMPP executions as register R3 is strictly qualified during early sections of the main program to filter out illegal operations.

Programmer specification

Eprom types programmed
2716, 2732, 2732A, 2764, 2764A, 27128, 27128A, 27256, 27512, 8741, 8748, 8749, 8742.

Modes
Computer peripheral
Programmer-control functions and eprom data i/o through 9600 baud serial link. Eprom reading, copying and programming under computer control. Disc-file to eprom and *vice versa*, sum-check master or slave and copy master to slave using SC84 software. Manual controls are inhibited.

Stand alone
Manual controls verified by sounder for eprom copying, erasure verification and sending contents of eprom to a serial printer, etc. in formatted hexadecimal and ascii form at one of four data rates.

Interface
RS232C bidirectional with hardware handshake.
Eight-bit data, l.s.b. first, no parity, two stop bits send, one or two stop bits receive.

Printer data rates
9600, 2400, 1200 and 300 baud.

Controls
Four push controls,
PROG — programs selected master to slave eprom
LIST — lists master eprom via RS232 port
UP — increment selection pointer
DOWN — decrement selection pointer

Processor
8048 microprocessor with i/o extenders controls above functions and uses 'intelligent' programming algorithms where applicable to reduce programming time by at least 75%.

Table of device details
This table contains three-byte entries detailing each device. The first byte is the page count (zero means 256 pages) and the other two are set-up conditions of $P_{4\text{-}7}$ on the expander. For 874x devices, $A_{12\text{-}15}$ control RESET, V_{dd}, EA and T0 respectively; slave line S20 controls the PROG signal and S22 supplies V_{pp}. In these devices, a low on the control line activates the high-voltage supply.

		PSU				Control				Relay				Address line (1)				Device	
		+5	+21	+12	ON	RES	M22	S20	S22	26	1	22	23	15	14	13	12		
DB	8	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	2716	25V to S23 (2)
DB	16	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2732	25V to S22 (2)
DB	16	1	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2732A	21V to S22 (2)
DB	32	1	1	0	0	0	0	0	1	1	1	0	0	0	1	1	0	2764	21V to 1, S20 L, 26 & 27 H
DB	32	1	0	1	0	0	0	0	1	1	1	0	0	0	1	1	0	2764A	12V to 1, S20 L, 26 & 27 H
DB	64	1	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	27128	21V to 1, S20 L, 27 H
DB	64	1	0	1	0	0	0	0	1	1	1	0	0	0	1	0	0	27128A	12V to 1, S20 L, 27 H
DB	128	1	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	27256	12V to 1, S20 & S22 H
DB	0	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	27512	12V to S22, S20 H
DB	4	1	0	0	1	0	0	1	1	1	0	1	0	1	1	1	0	8748	25V to S22, T0 H, RES L (3)
DB	8	1	0	0	1	0	0	1	1	1	0	1	0	1	1	1	0	8749	25V to S22, T0 H, RES L (3)

Notes: (1) $A_{12\text{-}15}$ are pins 2, 26, 27 and 1 respectively. (2) $A_{12\text{-}15}$ irrelevant. (3) High-voltages on. Logical low and high are represented by L and H.

COLOURJET 132

132 Column Compressed Mode

36 COLOUR INK JET PRINTER.

Logic seeking in dot address mode

Cash price **£550** + VAT

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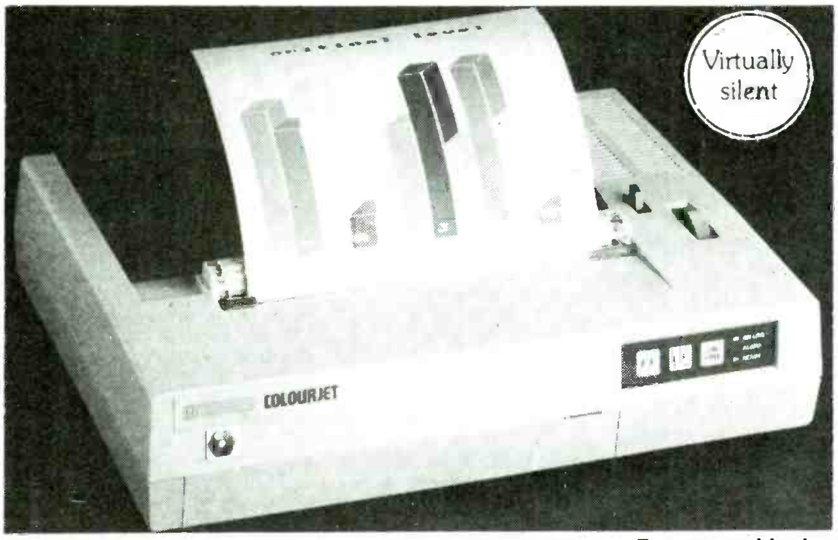

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CIRCLE 63 FOR FURTHER DETAILS.

AA117	0.09
AA119	0.09
AAY32	0.09
AC107	0.28
AC126	0.17
AC127	0.15
AC128	0.15
AC128K	0.23
AC141K	0.23
AC142K	0.22
AC153K	0.23
AC176	0.18
AC176K	0.20
AC187	0.15
AC187K	0.20
AC180	0.17
AC188K	0.23
ACY18	0.48
ACY19	0.48
AD142	0.60
AD149	0.45
AD161	0.22
AD162	0.22
AF124	0.25
AF125	0.25
AF126	0.25
AF127	0.25
AF139	0.22
AF239	0.22
AL112	0.70
AL113	0.80
ASZ15	1.00
ASZ17	1.00
AU110	1.10
AY102	1.80
AY106	1.80
BA145	0.10
BA148	0.10
BA154	0.06
BA157	0.12
BB101	0.13
BB103	0.16
BB105B	0.18
BB205B	0.24
BC107	0.07
BC108	0.07
BC109	0.07
BC115	0.10
BC118	0.11
BC140	0.19
BC141	0.19
BC142	0.19
BC143	0.19
BC147	0.05
BC148	0.05
BC149	0.05
BC157	0.05
BC159	0.05
BC182	0.06
BC182L	0.06
BC183	0.06
BC183L	0.06
BC184	0.06
BC184L	0.06
BC212	0.06
BC212L	0.06
BC213	0.06
BC213L	0.06
BC214	0.06
BC214L	0.06
BC237	0.07
BC238	0.07
BC300	0.18
BC301	0.18
BC302	0.18
BC303	0.18
BC327	0.06
BC382	0.06
BC337	0.06
BC328	0.06
BC557	0.06
BCY32	1.50
BCY33	1.50
BCY34	1.50
BCY42	0.20
BCY56	0.16

BCY70	0.16
BCY71	0.16
BCY72	0.16
BD115	0.26
BD124P	0.50
BD124	1.10
BD128	0.35
BD131	0.25
BD132	0.25
BD135	0.20
BD136	0.20
BD137	0.20
BD138	0.20
BD139	0.20
BD140	0.20
BD144	0.90
BD150	0.30
BD157	0.38
BD158	0.38
BD166	0.30
BD175	0.30
BD177	0.30
BD179	0.32
BD181	0.45
BD201	0.33
BD202	0.38
BD203	0.42
BD204	0.42
BD222	0.31
BD225	0.31
BD232	0.31
BD237	0.21
BD238	0.24
BD433	0.28
BD437	0.28
BD535	0.38
BD536	0.38
BD537	0.40
BD538	0.40
BDX32	1.00
BDX65	0.80
BF180	0.16
BF181	0.18
BF183	0.20
BF184	0.20
BF185	0.20
BF194	0.05
BF195	0.05
BF196	0.06
BF199	0.06
BF200	0.16
BF257	0.18
BF258	0.18
BF259	0.18
BF336	0.20
BF337	0.20
BF338	0.20
BF362	0.30
BF422	0.21
BF458	0.19
BF459	0.19
BFX29	0.20
BFX84	0.20
BFX85	0.20
BFX87	0.15
BFX88	0.15
BFY50	0.14
BFY51	0.14
BFY52	0.14
BFY56	0.25
BYF57	0.25
BFY64	0.25
BR100	0.14
BSX19	0.15
BSX20	0.15
BSX21	0.16
BSX26	0.16
BSX29	0.19
BZX76	0.18
BT106	0.90
BT109	0.90
BT116	0.80
BT119	1.00
BT120	1.00
BU104	1.00
BU106	0.80
BU108	1.00
BU110	1.10

BU111	1.40
BU126	0.70
BU204	0.75
BU205	0.70
BU208	0.75
BU208A	0.80
BU208D	1.20
BU326	0.85
BU406	0.85
BU407	0.75
BU408	1.00
BU500	1.10
BU526	0.80
BY126	0.06
BY127	0.08
BY133	0.08
BY164	0.22
BY176	0.85
BY179	0.35
BY182	0.32
BY184	0.32
BY187	0.32
BY196	0.20
BY206	0.11
BY207	0.11
BY223	0.72
BYX10	0.15
CA270	0.40
CA3086	0.25
CA3089	1.50
CA3240	0.90
C106D	0.23
MC1327	0.70
MJ2500	1.00
MJ2501	1.10
MJ2955	0.55
MJ3000	1.15
MJ3001	1.15
MJE29A	0.30
MJE30A	0.30
MJE340	0.25
MJE350	0.80
MJE520	0.30
MJE2955K	0.90
OA47	0.06
OA90	0.04
OA91	0.04
OA200	0.07
OA202	0.07
OC28	1.00
OC29	0.80
OC35	1.00
OC45	0.50
OC71	0.30
OC72	0.50
OC200	1.80
OCP71	1.00
ORP12	1.00
ORP60	1.00
ORP61	1.00
R2008B	0.80
R2010B	0.80
SAS560	1.10
SAS570	1.10
SN76003N	1.40
SN76013N	1.40
SN76023N	1.40
SN76033N	1.50
SN76110N	0.78
SN76115	0.70
SN76226	0.90
SN76227	0.80
T2800D	0.52
TAG06-60	0.42
TAG521-200	0.72
TAG4443	0.76
TAG4444	0.76
TAA550	0.16
TBA120S	0.45
TBA395	0.60
TBA396	0.60
TBA520	0.75

TBA530	0.75
TBA540	0.75
TBA560	0.70
TBA800	0.35
TBA810S	0.60
TBA820	0.75
TBA920	0.80
TBA950	0.80
TBA990	0.80
TCA800	0.80
TCA940	0.85
TDA1170	0.90
TDA1412	0.60
TDA2002	0.80
TDA2003	1.50
TDA2020	1.40
TDA2030	1.40
TDA2522	0.80
TDA2530	0.80
TDA2532	0.75
TDA2540	0.70
TDA2560	0.70
TDA2593	0.80
TDA2690	0.70
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TIP29A	0.22
TIP29C	0.25
TIP30	0.16
TIP31A	0.24
TIP32	0.24
TIP32A	0.24
TIP33	0.50
TIP34	0.50
TIP41A	0.22
TIP41C	0.25
TIP42A	0.22
TIP42C	0.25
TIP47	0.40
TIP48	0.40
TIP49	0.40
TIP110	0.47
TIP112	0.54
TIP115	0.45
TIP117	0.56
TIP120	0.43
TIP121	0.46
TIP122	0.47
TIP125	0.47
TIP126	0.56
TIP127	0.56
TIP2955	0.34
TIP3054	0.38
TIP3055	0.34
TIS61	0.15
TIS90	0.15
TIS91	0.18
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2N 2905	0.20
2N 2906	0.18
2N 2907	0.18
2N 2926	0.08
2N 3019	0.28
2N 3063	0.18
2N 3054	0.35
2N 3055	0.32
2N 3055H	0.38
2N 3440	0.58
2N 3442	0.85

2N 3771	0.85
2N 3772	0.90
2N 3773	1.00
2N 4031	0.25
2N 4036	0.25
2N 4037	0.25
2N 4443	0.76
2N 4444	0.76
2N 5061	0.20
2N 5294	0.30
2N 5296	0.30
2N 6106	0.40
2N 6107	0.40
2N 6109	0.40
3N 128	0.55
3N 143	0.65
IN 914	0.02
IN 4001	0.04
IN 4002	0.04
IN 4003	0.04
IN 4004	0.04
IN 4005	0.04
IN 4006	0.04
IN 4007	0.06
IN 4148	0.02
IN 5400	0.09
IN 5401	0.10
IN 5402	0.10
IN 5403	0.11
IN 5404	0.11
IN 5405	0.12
IN 5406	0.13
IN 5407	0.13
IN 5408	0.13
VOLTAGE REGULATORS	
7803	0.35
7812	0.35
7815	0.35
7818	0.35
7824	0.35
7905	0.35
7912	0.40
7915	0.40
7918	0.40
7924	0.40
78L05	0.28
78L12	0.28
78L15	0.28
74L18	0.28
74L24	0.35
LM309K	1.00
LM317K	2.20
LM317T	1.80
LM323K	4.20
LM723	0.32
78HGKC	5.70
78H05KC	5.20
78GU1C	1.90
79GU1C	2.15
79HGKC	6.70

JAPANESE TRANSISTORS	
2SA73	0.30
2SA104	0.32
2SA198	0.22
2SA203	0.30
2SA473	0.37
2SB54	0.25
2SB77	0.32
2SB337	1.20
2SB405	0.22
2SC460	0.21
2SC495	0.60
2SC733	0.40
2SC1161	1.10
2SC1172Y	1.50
2SC1279	0.24
2SC1306	1.00
2SC1307	1.00
2SC1520	0.25
2SC1969	1.30
2SC2029	1.20
2SC2078	1.20
2SC2122A	2.00
2SC2952	0.27
2SD234	0.37
2SK135	4.00
MB3712	1.50
TA7205	1.50
UPC575	1.00
ICS SOCKETS	
8 pin	0.06
14 pin	0.08
16 pin	0.09
18 pin	0.12
20 pin	0.14
22 pin	0.16
24 pin	0.18
28 pin	0.20
40 pin	0.25
VALVES	
DY87	0.53
DY802	0.45
ECC82	0.40
ECC83	0.43
ECC83	0.40
ECC85	0.40
ECH81	0.49
ECH84	0.52
ECL80	0.57
ECL82	0.25
ECL84	0.57
ECL85	0.57
ECL86	0.49
EF80	0.31
EF85	0.34
EF89	0.43
EF183	0.45
EF184	0.53
EL34	1.90
EY86	0.31
EY87	0.31
PC97	1.00

PCC85	0.42
PCF80	0.58
PCF200	1.35
PCF801	1.10
PCF802	0.57
PCF806	1.15
PCH200	1.00
PCL81	0.54
PL519	4.50
PCL82	0.63
PCL84	0.50
PCL85	0.55
PCL86	0.55
PCL805	0.55
PFL200	0.85
PL36	0.80
PL504	0.95
PL508	1.90
PY81	0.70
PY88	0.48
PY500A	1.60
ZENERS	
400MV	
BZY88 Range 2V7 to 39V0	060
13W Zeners	
BZX61 Range 2V7 to 39V0	120
MEMORIES	
2114	2.00
2716	3.00
2532	4.00
2732	4.00
2764	7.00
4116	0.75
6116	6.00
LM324	0.30
LM380	0.50
LM381	1.00
LM709 Dil	0.30
LM723	0.32
LM741 Cil	0.15
LM741 Met	0.45
LM3900	0.25
NE555	0.15
NE556	0.40
BYX55/350	0.30
BYX55/600	0.30
BYX55/600	0.30
BYX55/800	0.32
BYX70/500	0.29
BYX70/500	0.31
BYX70/800	0.36
BYX71/600	0.80

LED	
LED 3mm RED	0.05
LED 3mm YELLOW	0.10
LED 3mm GREEN	0.10
LED 5mm RED	0.05
LED 5mm YELLOW	0.10
LED 5mm GREEN	0.10
BRIDGE RECTIFIERS	
1A/50V	0.16
1A/100V	0.18
1A/200V	0.19
1A/400V	0.21
1A/600V	0.23
1A/800V	0.28
2A/100V	0.35
2A/200V	0.36
2A/400V	0.42
2A/600V	0.54
2A/800V	0.58
3A/200V	0.66
3A/400V	0.68
3A/600V	0.78
6A/200V	1.00
6A/400V	0.80
25A/100V	1.60
ELECTROLYTIC	
4700UF-16V CAN	0.20
TRIPLERS	
LP1195 (4000Ser)	2.25

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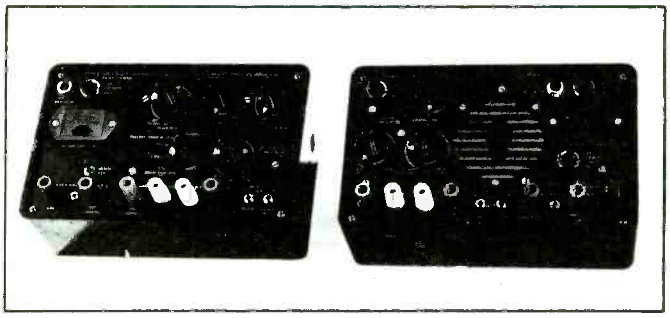
CIRCLE 45 FOR FURTHER DETAILS.

FIBRE-OPTICS EDUCATOR



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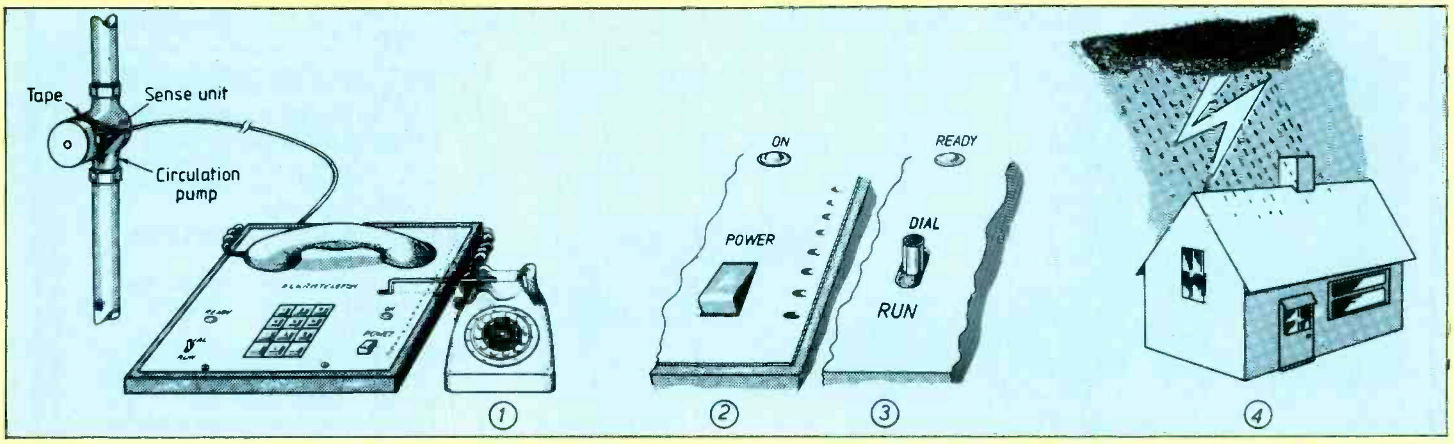
CIRCLE 33 FOR FURTHER DETAILS.

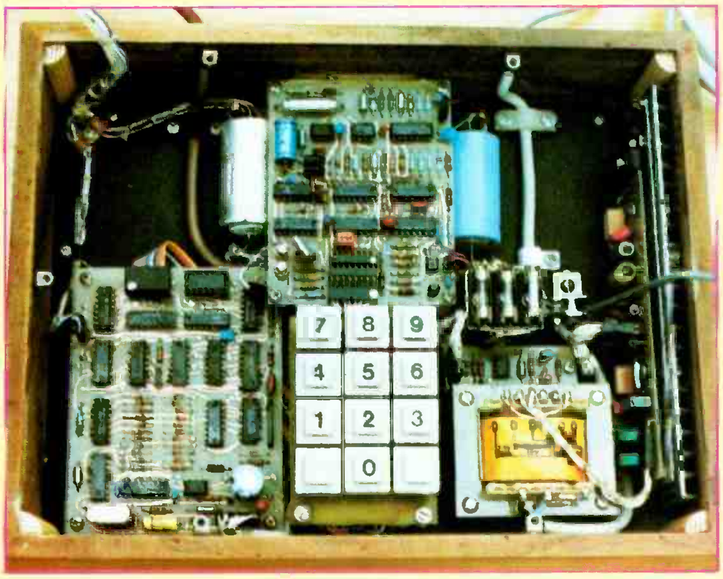


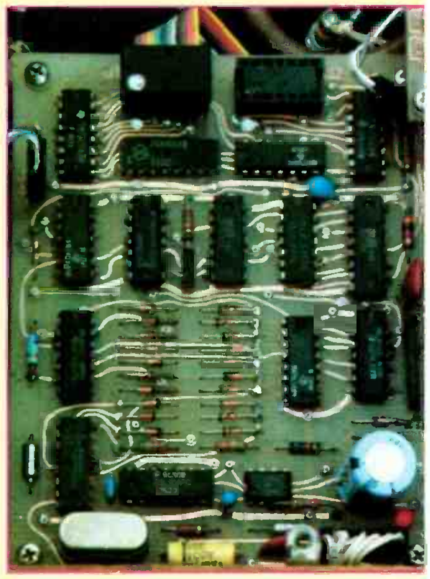
(1) Place telephone beneath the arm so that it holds down the hook switch. Then place the receiver in the two slots on top of the unit. Attach the sense unit to the warning machine.

(2) Turn on power, wait for the ready-lamp to go on, and then dial the number. Verify number if a display is provided.

(3) Switch from dial to run and initiation is completed. The machine now monitors the pump function and whatever other application is chosen.

(4) On failure the device lifts the arm providing the ready-tone from the telephone. The encoded number is now dialled and at the end the alarm tone is sent to inform of the failure.





Alarmphone

Automatic warning device uses telephone without direct connection

by Per Andersen

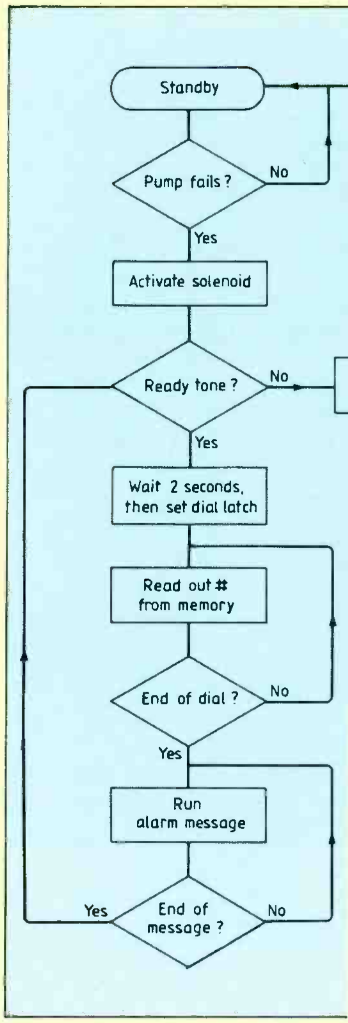
Living on a farm way out in the country, we are occasionally attacked by heavy thunderstorms, most at fall. And during almost every storm we have a breakdown of the electricity mains supply. This is caused by a huge charge of static electricity in the air, which somehow triggers our security relay to break the power, and refrigerators, aquarium pumps, heating units and so on stop working. If we are at home, we simply turn on the relay again and that's it, but if not the accident becomes a lot more serious because of the damage that could be done to food, aquaria, and other things needing a continuous mains supply for proper operation. In my place, our heating unit — a straw-burning type — could be very seriously damaged if the circulating pump fails or if the power is removed shortly after the unit has been loaded with a couple of strawbails. The water then boils in no time, and everyone knows what could happen to metal exposed to strong heat without the possibilit of being cooled.

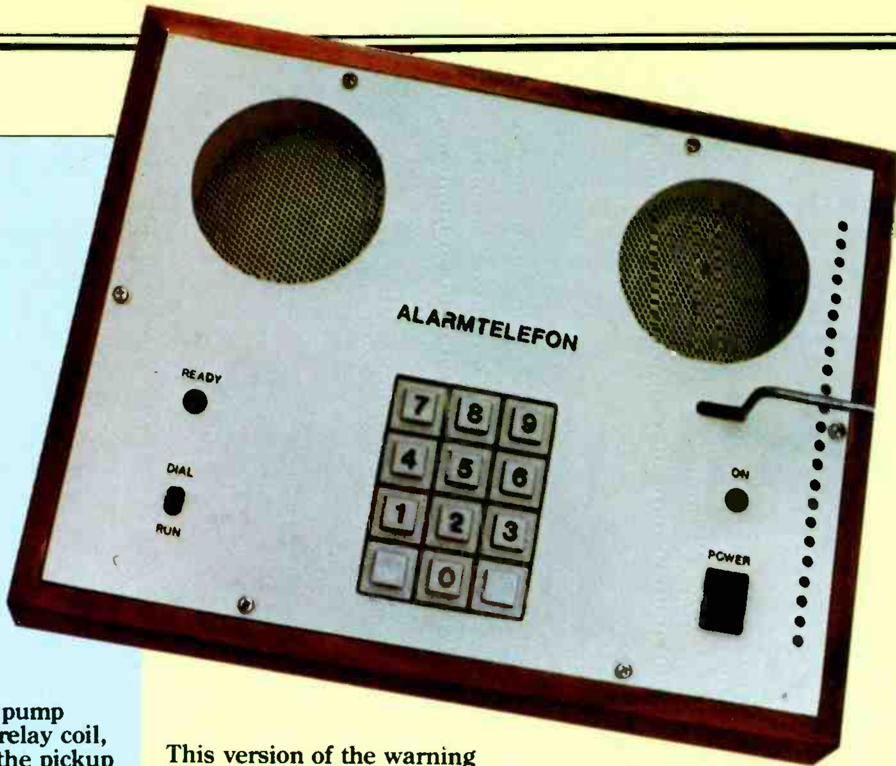
The present machine was designed to prevent such damage. Not that it is able to prevent the loss of power but when it happens it lets you know about it, giving you the chance to make the necessary decisions.

The machine monitors the rotation of the circulation pump by means of a sense coil mounted close to the motor. Any stop of the rotation is detected by appropriate circuitry in the device, which then dials a previously encoded telephone number, e.g. the place where you stay or at your neighbours. After dialling the number an alarm tone is sounded for some time, after which the machine returns to the stand-by mode. If the ready-tone does appear within six seconds, the machine hangs on again. The situation where the dialled number is busy is not considered in this version of the warning machine, although it is simple to extend the construction to be able to handle this too.

In my country one is not allowed to connect any device not sold by the telephone company to the telephone lines, so to avoid conflict the machine had to operate in a way that did not interfere with the law. The principle of the idea is therefore to avoid any galvanic contact with the telephone lines. The receiver is then placed on top of the warning machine, underneath which is located two

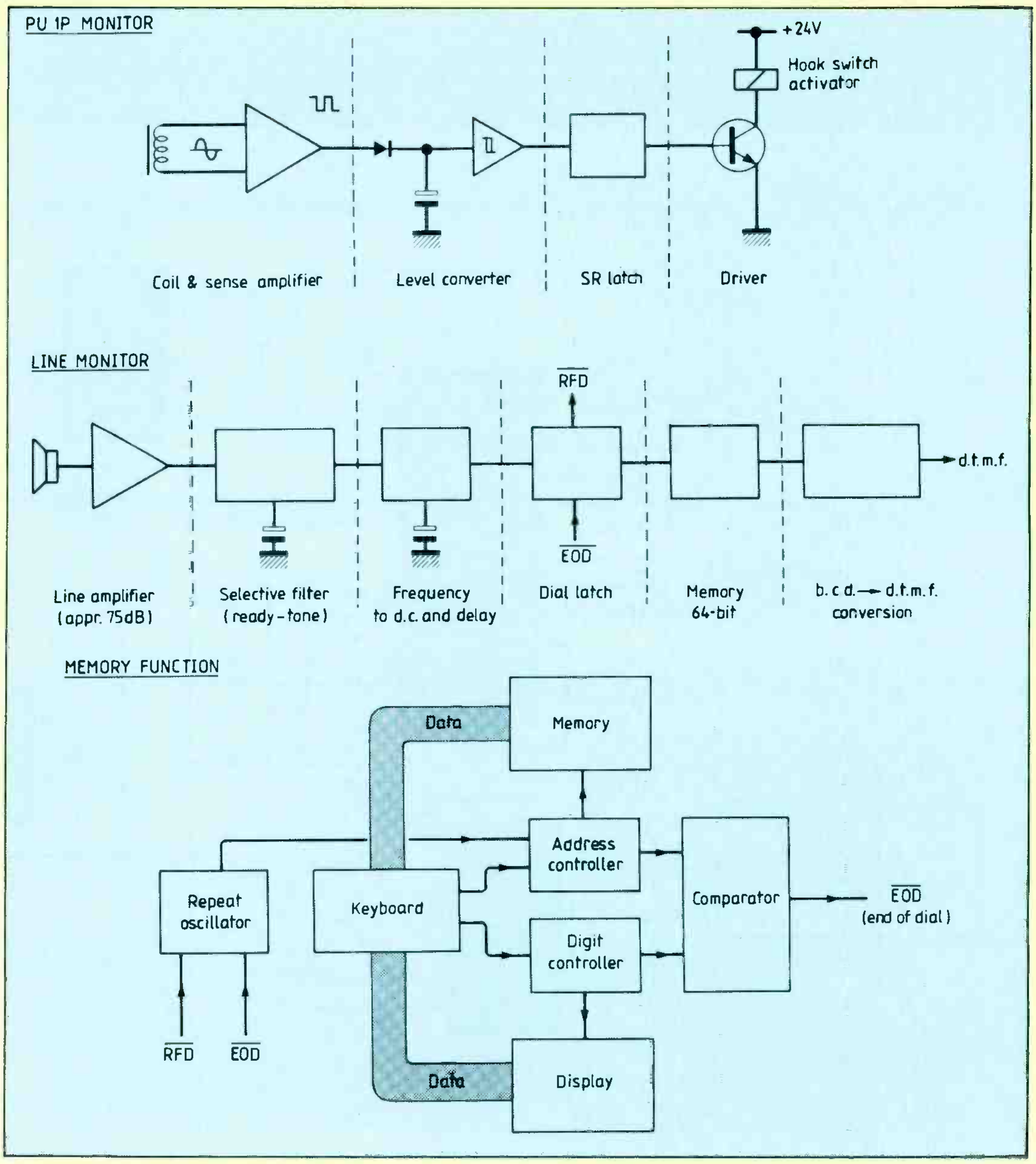
The second part of this article will include circuit details, for which a separate components list is available in advance from the editorial office.





Sense coil for the pump monitor is an old relay coil, but the nature of the pickup will depend on the application.

This version of the warning device doesn't have a display to verify the keyed in number on account of its expense (though a display circuit is available from the editorial office).



small loudspeakers one as the transmitter and one as the receiver. The machine is placed beside the telephone in such a way that permits the solenoid arm to hold the hook switch deactivated.

Upon a pump failure the solenoid arm lifts and activates the hook switch. The receiver/loudspeaker picks up the ready-tone, which is processed in the electronics, providing the memory to support the dial logic with the encoded telephone number. From the dial logic dual-tone multifrequency (d.t.m.f.) signals are sent to the transmitter/loudspeaker via the driver stage. When the number is completed, the alarm tone is sent to the transmitter for about 1½ minutes to let the person that answers the call know that it's from the automatic warning machine.

In my case the instrument is supported from a 24V battery, which is recharged every time the machine has been used, but any kind of power-supply can be used as long as the quality is reasonable. If a 12V battery is used the only thing to change is the type of solenoid.

DON'T WASTE GOOD IDEAS
We prefer circuit ideas with neat drawings and widely-spaced typescripts, but we would rather have scribbles on "the back of an envelope" than let good ideas be wasted. Submissions are judged on originality or usefulness — not excluding imaginative modifications to existing circuits so these points should be brought to the fore, preferably in the first sentence. Minimum payment of £30 is made for published circuits, normally early in the month following publication.

Printer port provides RS232 output

Use of a uart not specifically designed for microprocessor interfacing allows a computer's Centronics printer port to be adapted for RS232 serial data output. With this uart, a cmos Harris 6402, internal functions are selected by hardware rather than by programmable registers. Being cmos, the uart only requires about 1mA; current requirement of the whole circuit is 17mA at 5V so battery power may be used.

Parallel data from the Centronics interface connects directly to the 6402 uart through up to 0.6m of ribbon cable. This data is latched into the uart by the $\overline{\text{STROBE}}$ line and converted into serial form for output at pin 25. Serial data is fed to the 741 op-amp acting as an inverting comparator to give output levels of plus and minus 5V. Negative supply for the comparator is produced by a 7660 voltage converter; minimum RS232 levels are plus and minus 3V.

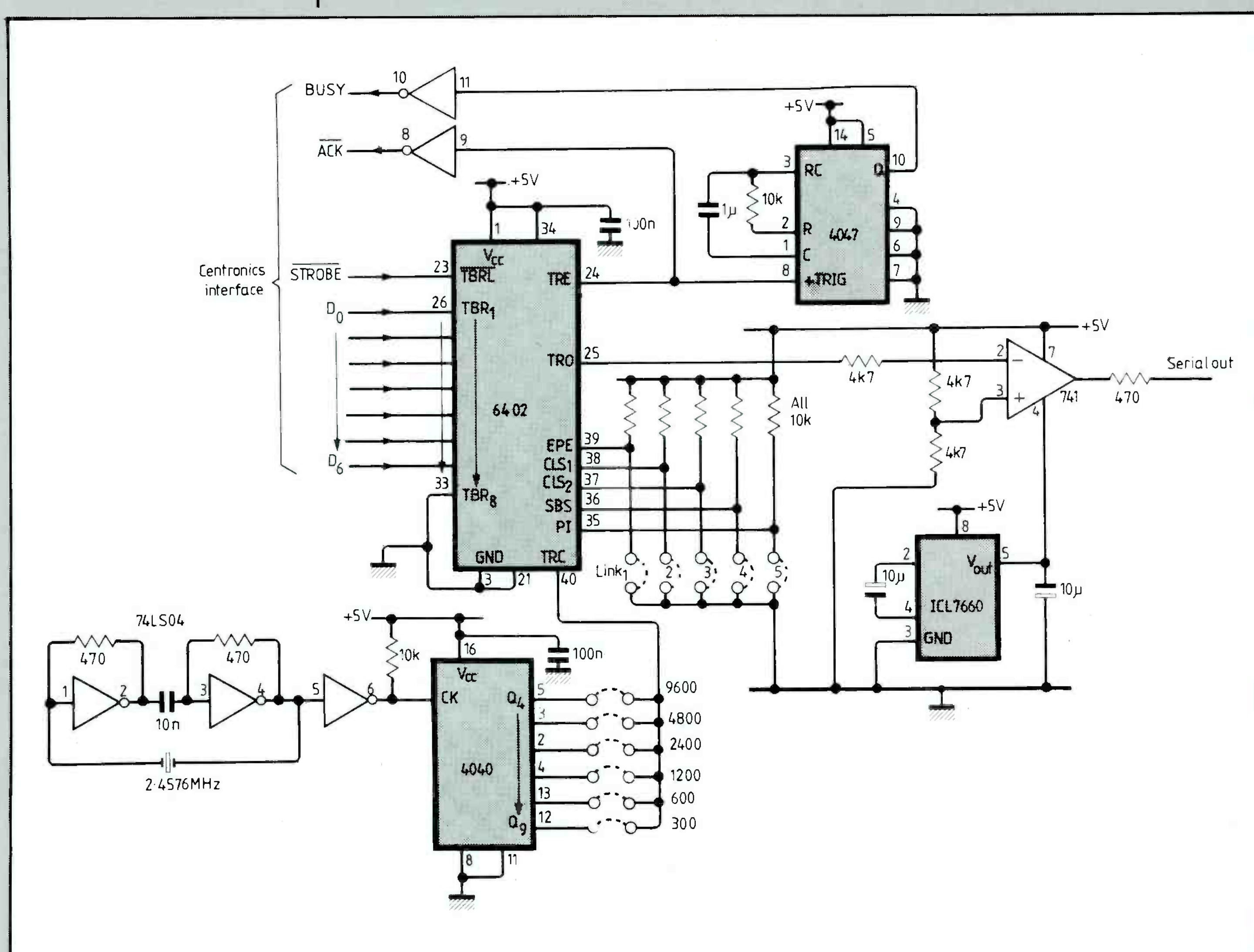
When output of serial data is completed, a low-to-high transition of the uart TRE (transmitter-register empty) output causes triggering of the 4047 monostable i.c. to produce an acknowledgement pulse, $\overline{\text{ACK}}$, indicating to the Centronics interface that the uart is ready to receive more data. An inverted TRE signal, high when data is being transmitted, provides the BUSY line, and inverter gates and a 4040 counter generate the uart ×16 transmit clock. The inverter i.c. is a t.t.l. device to provide correct levels for BUSY and $\overline{\text{ACK}}$ signals. Data rate selection is done by making one of the vertical row of links and data format selection by setting the horizontal row of links according to the tables.

Word length	Link 2	Link 3
5	made	made
6	open	made
7	made	open
8	open	open

Stop bits	Word length	Link 4
1	5,6,7,8	made
$1\frac{1}{2}$	5	open
2	6,7,8	open

Parity	Link 1	Link 5
Inhibit	—	open
On, even	open	made
On, odd	made	made

N. Burd
Department of Engineering
University of Lancaster

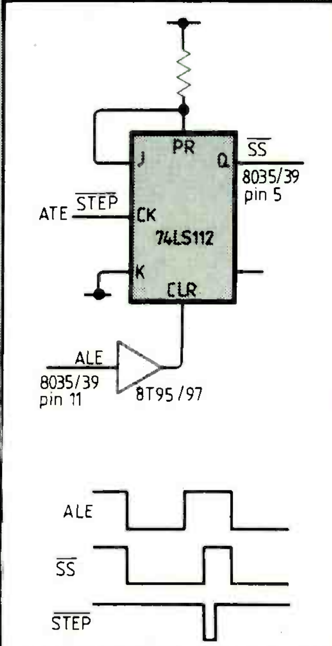


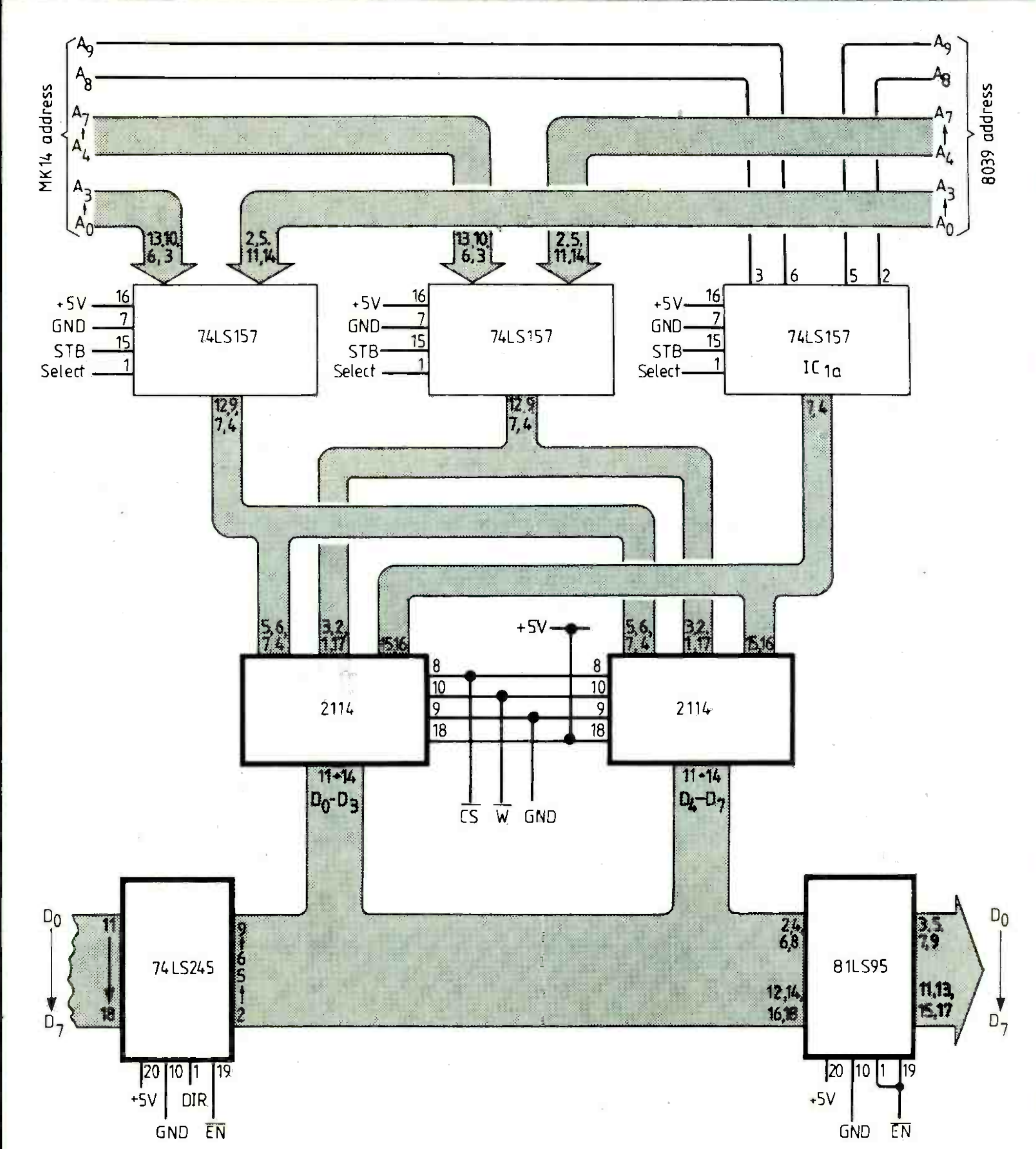
8035/39 single step

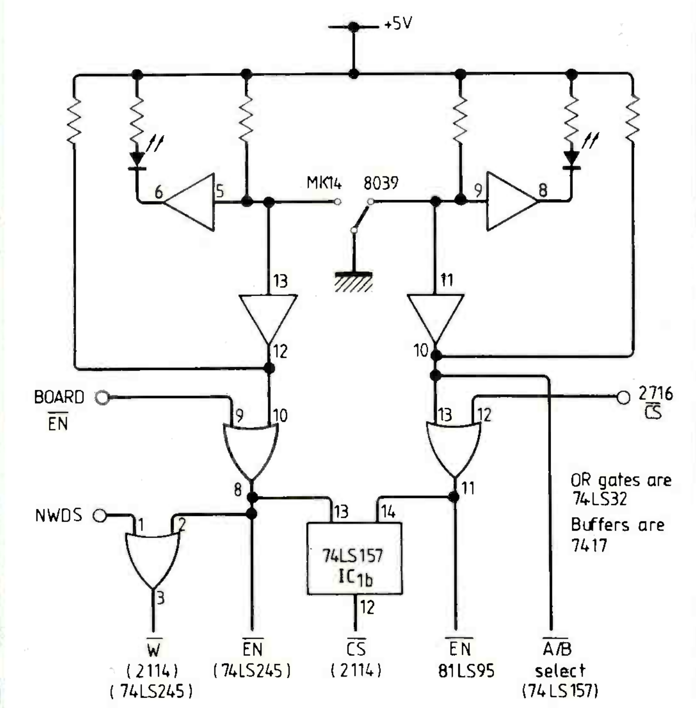
When testing 8035 microcomputer boards, single-stepping is useful for synchronizing the unit being checked with slower automatic test equipment. The test system can then check each program step for correct operation.

Typical 7474 D-type bistable circuits for this purpose can operate eratically due to delay between the falling of the 8035 address-latch enable, ALE, and single-step signals. Using the 74LS112 roughly halves this delay to produce trouble-free operation. Decoupling and p.c.b. layout are important.

J.J. Alexander
Dundee







Using the MK14 for development

This switch allows me to write programs for an 8039 microprocessor system using my SOC MK14 computer. It selects 1Kbyte of static ram as either program memory for the 8039 system or 'page one' memory for the MK14.

Cable to the 8039 system is terminated by a 24-pin dil plug which the 8039 processor sees as a 1Kbyte rom. Three 157 i.cs select which address bus goes to the ram, depending on the control-logic switch position, and a pair of three-state buffers select the data bus. Leds indicate which mode is selected.

I used a dip prototyping board and Verowire, so that changes could be made easily, and powered the board from the MK14 supply which had spare capacity. Decoupling capacitors should be used throughout.

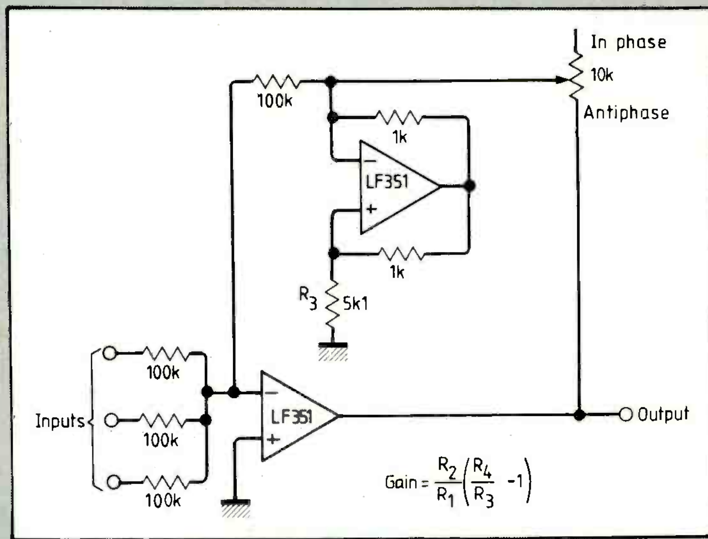
S.J. Churchman
7 Signal Regiment
BFPO 15

Keyboard encoder

In this circuit published in the February issue, bits 0-7 of the encoder i.c. were drawn in reverse order and segments f and g of the led and the function switch common line should be 5V. Also worthy of note is that the 74148 and 74154 alone encode the keyboard into seven bits and software could be used to provide shift and control functions.

Mixer with gain polarity control

A mixer whose overall gain can be varied continuously between +1 and −1 is invaluable for experimental work in multi-microphone stereo recording. Use of a negative impedance converter constructed around a second op-amp allows the familiar summing amplifier to be configured in a non-inverting form.
John Lawson
Cheltenham
Gloucestershire

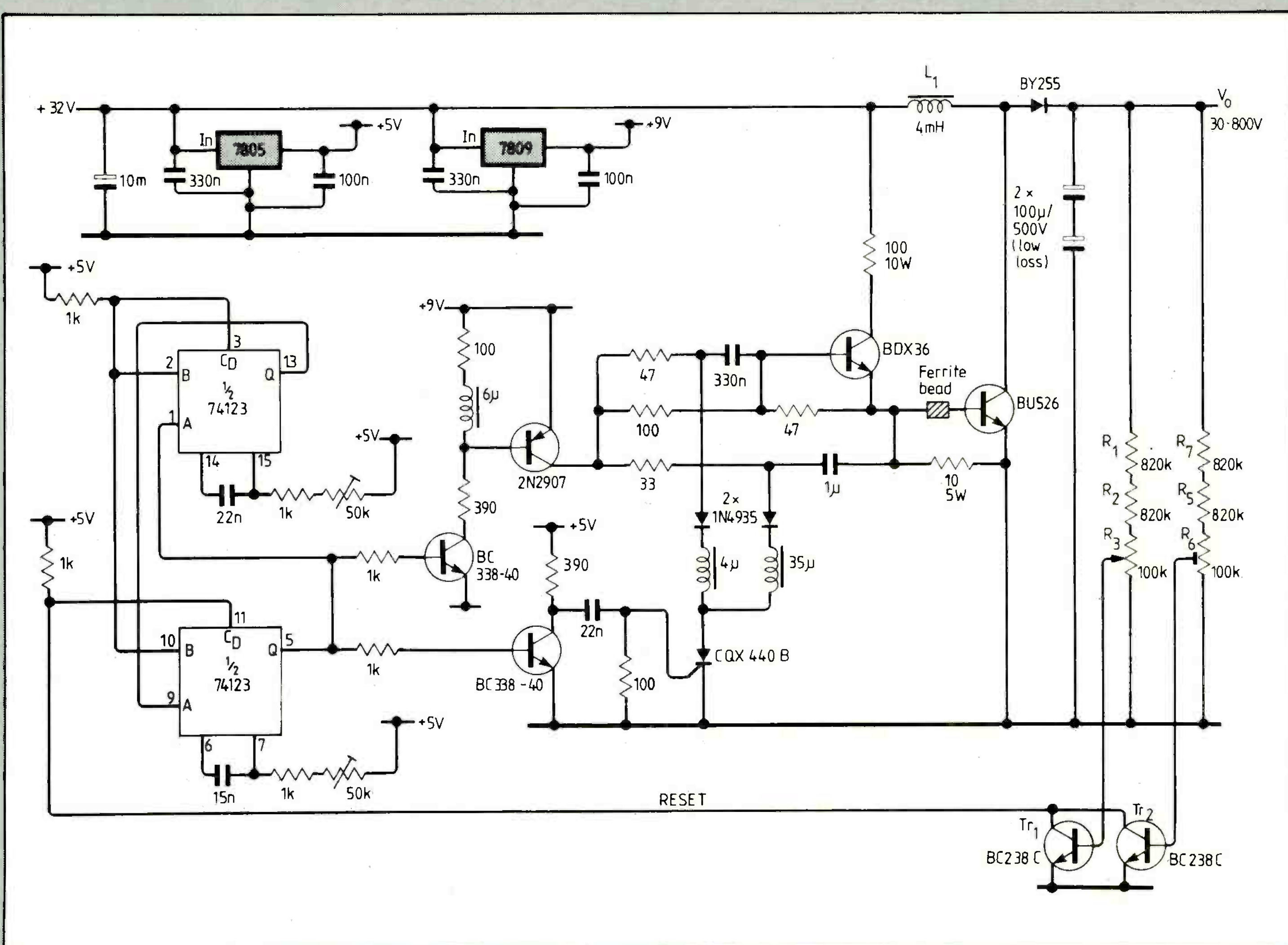


Adjustable switching supply

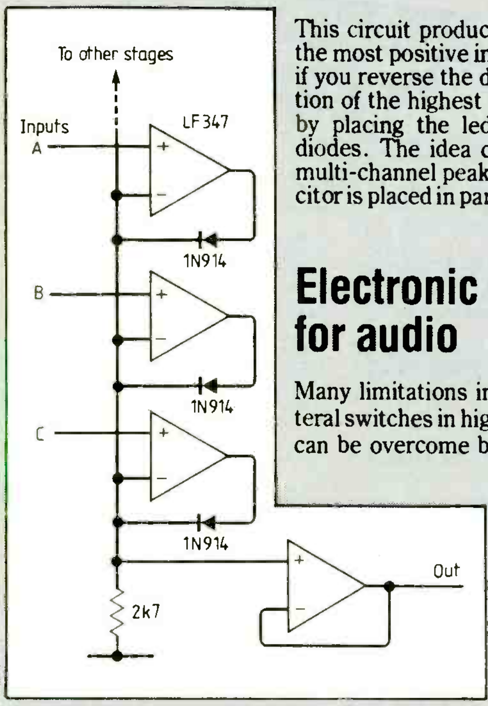
Simple additions to a power switching circuit shown in Leistungstransistoren im Schaltbetrieb (Thomson-CSF, Munich, includes detailed hints and equations) allow output to be varied between 31 to 800V.

Two separately adjustable monostable i.cs generate switching pulses and are set for optimum on/off times. Regulation is obtained by simply switching the generator on and off using the monostable i.c. reset input. To vary output voltage, the reset switching input is made adjustable, R_3. The whole adjusting and regulating circuit consists of just R_{1-3} and Tr_1. Under no-load conditions, output can be as high as 1500V so a second identical circuit around Tr_2 is included to protect against this. A third such circuit might be added for remote control.

My circuit is adjustable between 31 and 800V with a 47kΩ load or up to 560V with a 10kΩ load. Above about 200V, output varies less than 2V when a 10kΩload is removed. Output power depends on L_1 which should be kept as small as possible so as not to overload the power transistor.
H.P. Recktenwald
Berlin



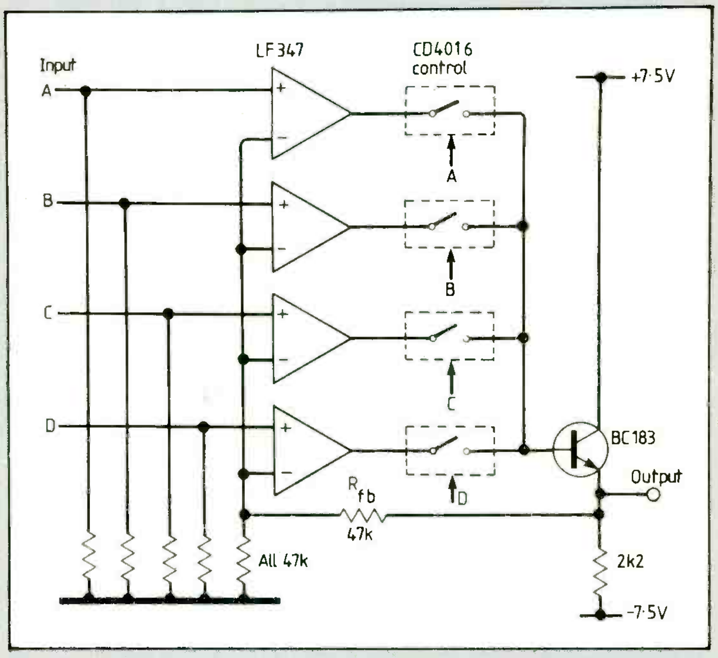
Peak indicator



This circuit produces an output equal to the most positive input (or most negative if you reverse the diodes). Visual indication of the highest input can be obtained by placing the leds in series with the diodes. The idea can also be used as a multi-channel peak-hold circuit if a capacitor is placed in parallel with the resistor.

Electronic switch for audio

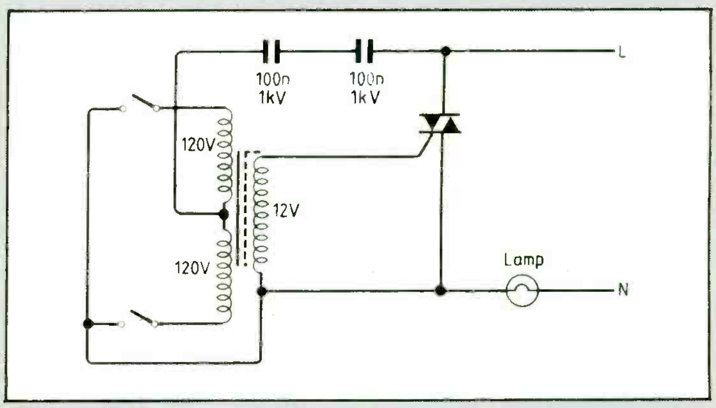
Many limitations imposed by cmos bilateral switches in high-fidelity applications can be overcome by this design. Break-through is reduced by the low impedance drive to the switches, and distortion is kept low by having the switch elements within the feedback loop. Gain of this circuit is two, but it can be increased by enlarging R_{fb}.
Steve Hutton
Wooron Bassett
Wiltshire



Two-wire extension switch

If an extra switch is required for an existing light whose two-conductor cable is difficult to replace with a three-conductor one, this circuit might be of use. When the switches are open, no current flows in the transformer and the light remains off. When one switch is closed, current flows through the capacitors, is stepped up by the transformer, and turns on the triac to light the lamp. When both switches are closed, there is no net flux in the transformer so the lamp is off.

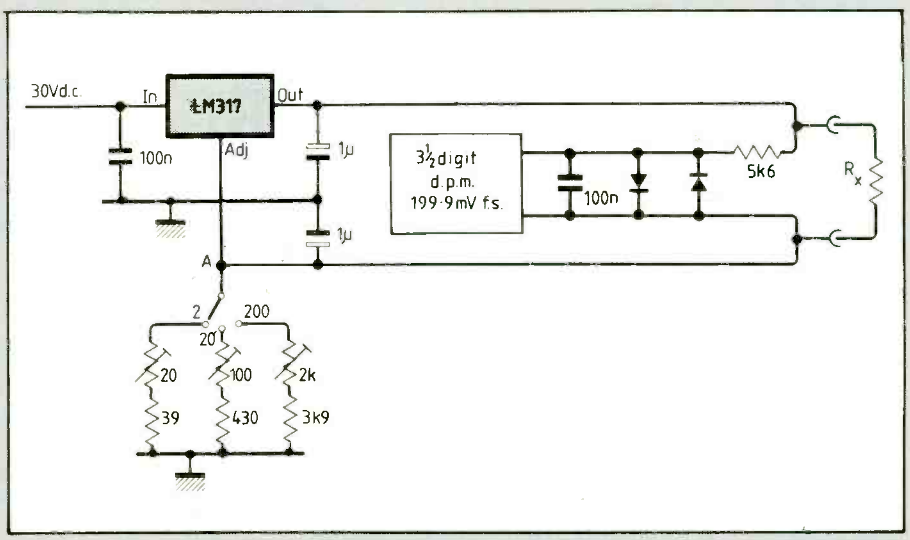
Transformer primary current is limited by the two capacitors, which should both be rated for mains use. Note that when both switches are closed, about 4mA flows through the lamp so care must be taken when changing it.
S.J. Kearley
Wirral
Merseyside



Measuring low resistance

Using a 199.9mV f.s. digital meter and a simple four-terminal circuit, low resistance can be measured accurately in 0-2, 2-20 or 20-200Ω ranges. Test currents are 100, 10 and 1mA respectively. At first glance these may appear high, but worst-case dissipation in the unknown resistor is 20mW (2Ω and 100mA).

Point A is kept at a constant voltage by the LM317 regulator i.c. therefore constant current flows through the resistor under test, R_x; voltage across this resistor is thus proportional to its resistance. Three pontentiometers set each scale using known values for R_x.
A.H. Howe
Bexleyheath
Kent



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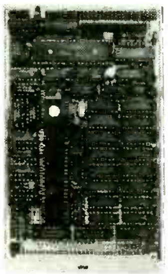

Z80 CPU, 4 or 6 MHz; 128 KByte RAM; 8KByte EPROM; memory management; sophisticated floppy interface for up to 4 drives (SS/DS; SD/DD; 3.5", 5.25", 8" mixed); buffered system bus (ECB standard); expanded addressing (A16-A19); real time clock; two V24/RS232 interface

GRAPHICS I/O PROCESSOR —
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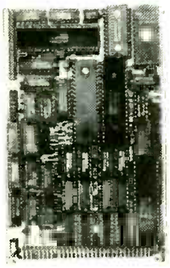

Graphics resolution 768 × 280 pixels; text format 80 x 25 or 96×33; 8 character sets; 6 attributes; subscript/ superscript; Z80A slave CPU; powerful command set; own 30 KByte printer spooler; sound generator; connections for system bus (ECB standard), V24/RS232, serial or parallel keyboard, graphics printer, light pen

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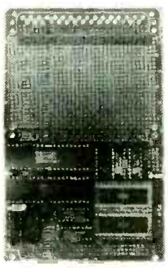

Z80 CPU, 2.5–6.0 MHz; 2 bidirectional ports with handshake (Z80 PIO); 16 latches, optionally with high current outputs (250 mA); 8 status inputs; watchdog timer; wire wrap field for additional hardware; two "bytewide" RAM/EPROM sockets (2-16 KByte); system bus connector (ECB standard)

CMOS SINGLE BOARD ALL PURPOSE COMPUTER —
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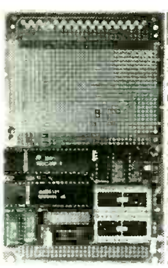

NSC800 CPU (Z80 — compatible), 1-4 MHz; 46 I/O-lines, 16 of them optionally with high current latches (250 mA); 5 interrupt inputs; two 16-Bit timer; 14-Bit watchdog timer; 128 Byte RAM; two "bytewide" RAM/ EPROM sockets (2-16 KByte); system bus connector (ECB standard)

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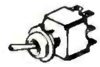

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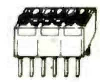

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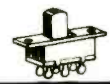

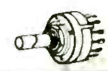

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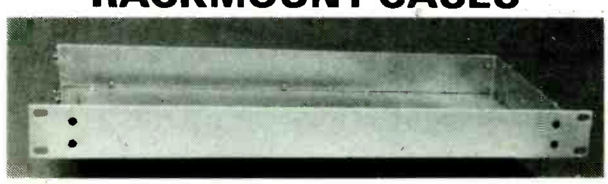

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Microprocessor speedometer

by Leycester Whewell

Home built design gives digital display of distance and time as well as speed

The concept for this speedometer design was originally based on a frequency counter using a set of discrete counters and a display. The sensor would have been an infra-red link periodically broken by a slotted disc mounted near the centre of the front wheel, but it was found to be too influenced by extraneous sunlight and dirt. It was abandoned in favour of a Hall-effect switch which could be toggled by a set of magnets mounted on the wheel. A low-powered c-mos micro processor was later found to be ideally suited to control application and was incorporated in subsequent versions. This gave the advantage of having more than one mode: three others were added — distance, top speed and time.

The 1802 microprocessor made by RCA uses standard eight-bit data bytes. The instruction set is oriented toward control application and as such has four parallel input lines to sense the state of the outside world, and three output lines which can be activated when writing data. Dynamic variables are held in sixteen 16-bit registers labelled R0 to R9, RA to RF, one of which is chosen as the program counter. There is also a programmable flip-flop, Q, which has an output that external devices can be strobed.

Clock rate may go up to about 3.2MHz on the 5V version and takes either 16 or 24 clock cycles to perform an instruction. Power consumption depends linearly on the clock frequency and is ≈2.5mA when running at 3.2MHz; about 1/50 of the amount used in home computer microprocessors. For further details see 'Programming the 1802' by Tom Swan (Hayden).

Hardware

The design needed to be economical on power and space and a 2kB read-only memory (a 2716) was all that was required.

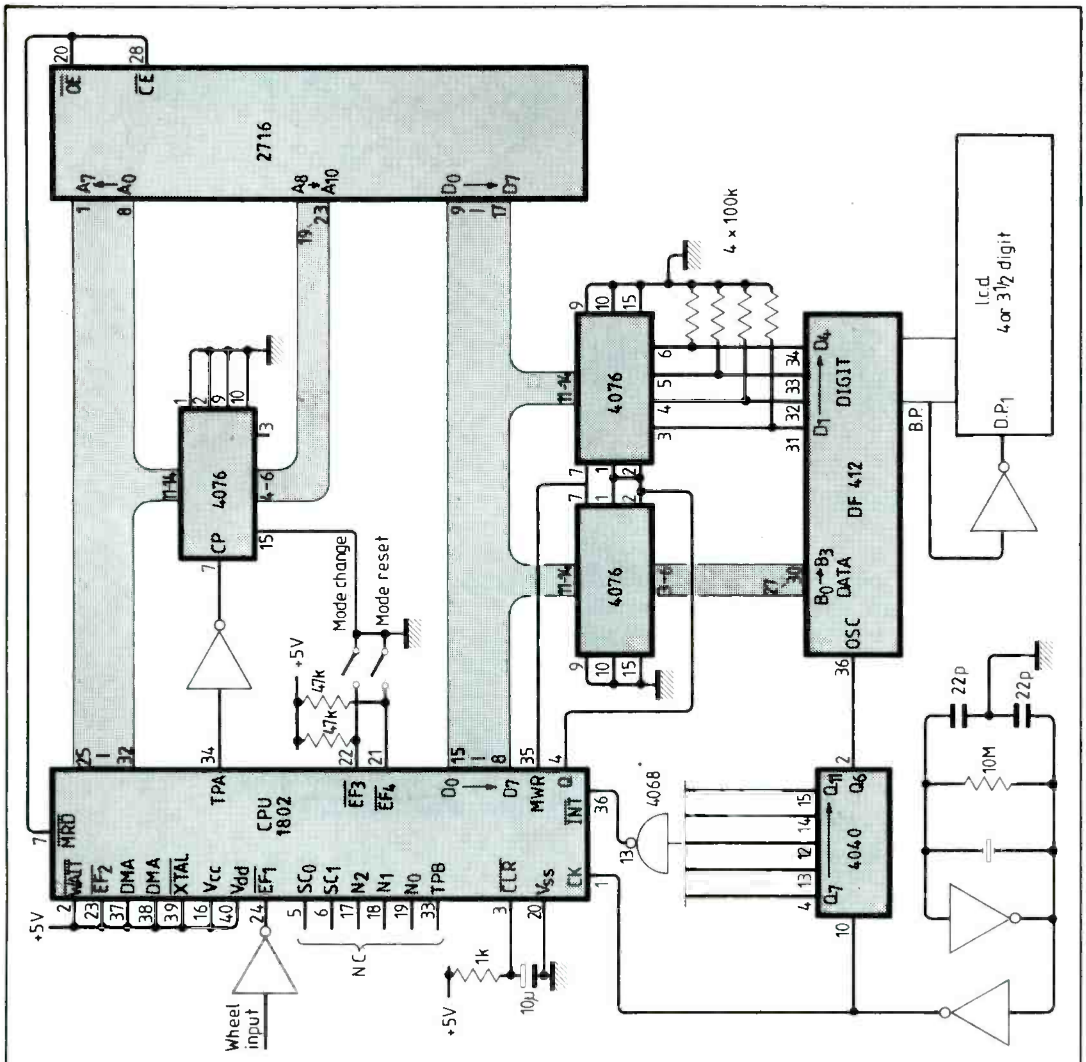
A clock frequency of 3.2768MHz is used since when divided by 2^{11} in a ripple counter a frequency of 1600Hz is produced, which is used to interrupt the main program and

REGISTER ALLOCATION. Each of the 16 bit registers is allocated as below. Only the upper and lower eight bits of each may be transferred to/from the accumlator at once.

- RF Distance counter arranged as four b.c.d. numbers, 100 miles:10 miles:1 mile:1/10 mile.
- RE Binary counter of wheel pulses, incrementing RF at a predetermined value.
- RD Time register as four b.c.d. numbers, hours:10min:1min:1/10min.
- RC Counter of interrupt at 1600Hz . ·. 9600 counter 0.1 min.
- RB Top speed as four b.c.d. digits, unused: 10mile/h:1mile/h:1/10mile/h.
- R9 Binary counter of interrupt since last wheel pulse was received.
- R8 Display register during output routine, otherwise a division routine work register.
- R7 Divisor } Registers for division routine.
- R6 Dividend }
- R5 Quotient }
- R4 Upper half: Accumulator storage during interrupt. Lower half: Mode (and carry flag during interrupt)
- R3 Program counter.
- R2 Address of byte containing register pointers used at the end of an interrupt.
- R1 Interrupt program counter.
- R0 Subtraction data table pointer.

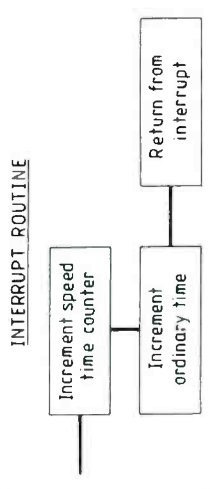
HEXADECIMAL DUMP The author is willing to program eproms sent to him at 93 Mawson Road, Cambridge.

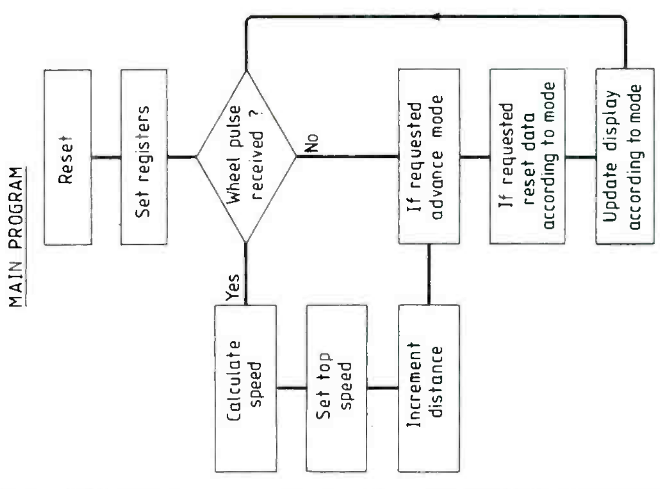
0000	E2	F8	70	A2	F8	02	B2	B1	F8	21	A1	F8	03	B0	F8	15
0010	A3	F8	00	B3	70	7B	AF	BF	AE	BE	AD	BD	AC	BC	AB	BB
0020	AA	BA	A9	B9	A8	B8	A7	B7	A6	B6	A4	B4	C4	C4	C4	34
0030	34	C0	01	C8	84	FA	08	CA	01	0E	84	F9	08	A4	00	99
0040	F6	B7	89	76	A7	F8	00	A9	B9	A5	B5	A8	B8	F8	96	B6
0050	F8	9C	A6	87	FE	A7	97	7E	B7	18	33	66	87	A0	86	F7
0060	97	A0	96	77	33	53	97	76	B7	87	76	A7	A0	86	F7	97
0070	A0	96	77	3B	7F	87	A0	86	F7	A6	97	A0	96	77	B6	85
0080	7E	A5	95	7E	B5	28	88	3A	66	85	A6	95	B6	F8	00	A5
0090	B5	C4	C4	B7	F8	0A	A7	87	FE	A7	97	7E	B7	18	33	AA
00A0	87	A0	86	F7	97	A0	96	77	33	97	97	76	B7	87	76	A7
00B0	A0	86	F7	97	A0	96	77	3B	C3	87	A0	86	F7	A6	97	A0
00C0	96	77	B6	85	7E	A5	95	7E	B5	28	88	3A	AA	98	3A	DB
00D0	86	AA	F8	01	B8	85	A6	95	B6	30	8D	FF	01	3A	F1	8A
00E0	A0	86	FE	FE	FE	FE	F4	AA	F8	02	B8	85	A6	95	B6	30
00F0	8D	86	BA	C0	01	00	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0100	8A	A0	8B	F7	9A	A0	9B	77	33	0E	8A	AB	9A	BB	36	19
0110	84	FA	EF	A4	F8	0F	B8	30	24	98	FF	01	C2	02	9F	B8
0120	C4	C4	C4	C4	37	2C	84	FA	DF	A4	30	50	84	FA	20	3A
0130	50	84	F9	20	A4	FA	03	3A	3F	AE	BE	AF	BF	30	50	FF
0140	02	3A	47	AB	BB	30	50	FF	01	3A	50	AC	BC	AD	BD	C4
0150	84	FA	03	3A	5B	8F	A6	9F	B6	30	73	FF	01	3A	65	8A
0160	A6	9A	B6	30	73	FF	01	3A	6F	8B	A6	9B	B6	30	73	8D
0170	A6	9D	B6	96	3A	7B	F8	FF	B6	30	83	FA	F0	3A	83	96
0180	F9	F0	B6	96	F6	F6	F6	F6	FC	80	5F	7A	F8	1F	FF	01
0190	3A	8E	7B	96	FA	0F	FC	40	5F	7A	F8	1F	FF	01	3A	9C
01A0	7B	86	F6	F6	F6	F6	FC	20	5F	7A	F8	1F	FF	01	3A	AC
01B0	7B	86	FA	0F	FC	10	5F	7A	F8	1F	FF	01	3A	BA	7B	C0
01C0	00	2F	FF	FF	FF	FF	FF	FF	84	FA	08	32	0E	84	FA	F7
01D0	A4	8E	FC	07	AE	3B	DB	9E	FC	01	BE	9E	FF	02	3A	0E
01E0	8E	FF	0B	3B	0E	AE	F8	00	BE	1F	8F	FA	0F	FF	0A	3A
01F0	0E	8F	FC	06	AF	FF	A0	3A	0E	AF	9F	FC	01	BF	FA	0F
0200	FF	0A	3A	0D	9F	FC	06	BF	FF	A0	3A	0D	BF	C0	01	0E
0210	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0220	70	E2	B4	84	7E	A4	19	99	FF	20	3B	33	F8	10	B9	F8
0230	00	AA	BA	1C	9C	FF	25	3A	65	8C	FF	80	3A	65	AC	BC
0240	1D	8D	FA	0F	FF	0A	3A	65	8D	FC	06	AD	FF	A0	3A	65
0250	AD	9D	FC	01	BD	FA	0F	FF	06	3A	65	9D	C4	FC	0A	BD
0260	FF	A0	3A	65	BD	F8	70	A2	84	76	A4	94	30	20	FF	FF
0270	03	03	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0280	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0290	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	F8
02A0	0F	B8	84	FA	10	3A	B0	84	F9	10	A4	14	84	FA	FB	A4
02B0	C0	01	24	FF	FF	FF	FF	FF	50	72	6F	6A	65	63	74	20
02C0	20	62	79	20	20	20	4C	2E	57	68	65	77	65	6C	6C	20
02D0	32	32	2F	31	32	2F	38	33	20	20	20	20	20	20	20	20
02E0	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
02F0	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0300	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
0310	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
0320	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
0330	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
0340	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
0350	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
0360	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
0370	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F
0380	80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
0390	90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
03A0	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF
03B0	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB	BC	BD	BE	BF
03C0	C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
03D0	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF
03E0	E0	E1	E2	E3	E4	E5	E6	E7	E8	E9	EA	EB	EC	ED	EE	EF
03F0	F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FB	FC	FD	FE	FF



Most of the useful c.p.u. time is spent check the time, sampling inputs, performing calculations based on their states and outputting information to the display. The nature of the design means that the time input changes far more rapidly than any of the others. The only way to avoid losing time counts due to slow polling is to use timed interrupts. This simplifies the rest of the program which, after initialization, continuously tests each input flag and acts accordingly. None of these inputs normally changes at more than 10Hz which gives ample time to look at each input in turn.

As only two out of the 64K bytes of available memory space are used, just three out of the eight high-order address lines (A8, A9 & A10) need to be latched from the multiplexed bus. The strobe for this is provided by the c.p.u. but it was originally designed for use with transparent latches. No memory decoding is required either; the only data read by the 1802 are from the eprom and all that are written go to the display.





ensure accurate timing.

The display, a four-digit ½in liquid crystal, is driven by a single-chip display drive connected to the data bus via a ripple interface. Together they consume less than ½mA which is miniscule relative to a l.e.d. display and offers far higher contrast in daylight hours.

Mode and reset are operate via two small push-to-make switches connected to two of the four parallel inputs. The Hall-effect sensor uses a third and its transistor shaped package is housed in a small plastic tube, weatherproofed with Araldite. A small metal plate supports the tube so that the two oppositely aligned magnets on the wheel pass closely to the sensor, thus changing its state. The wires from the sensor go to a three pin DIN pug which fits into a socket mounted in the speedometer case.

Software

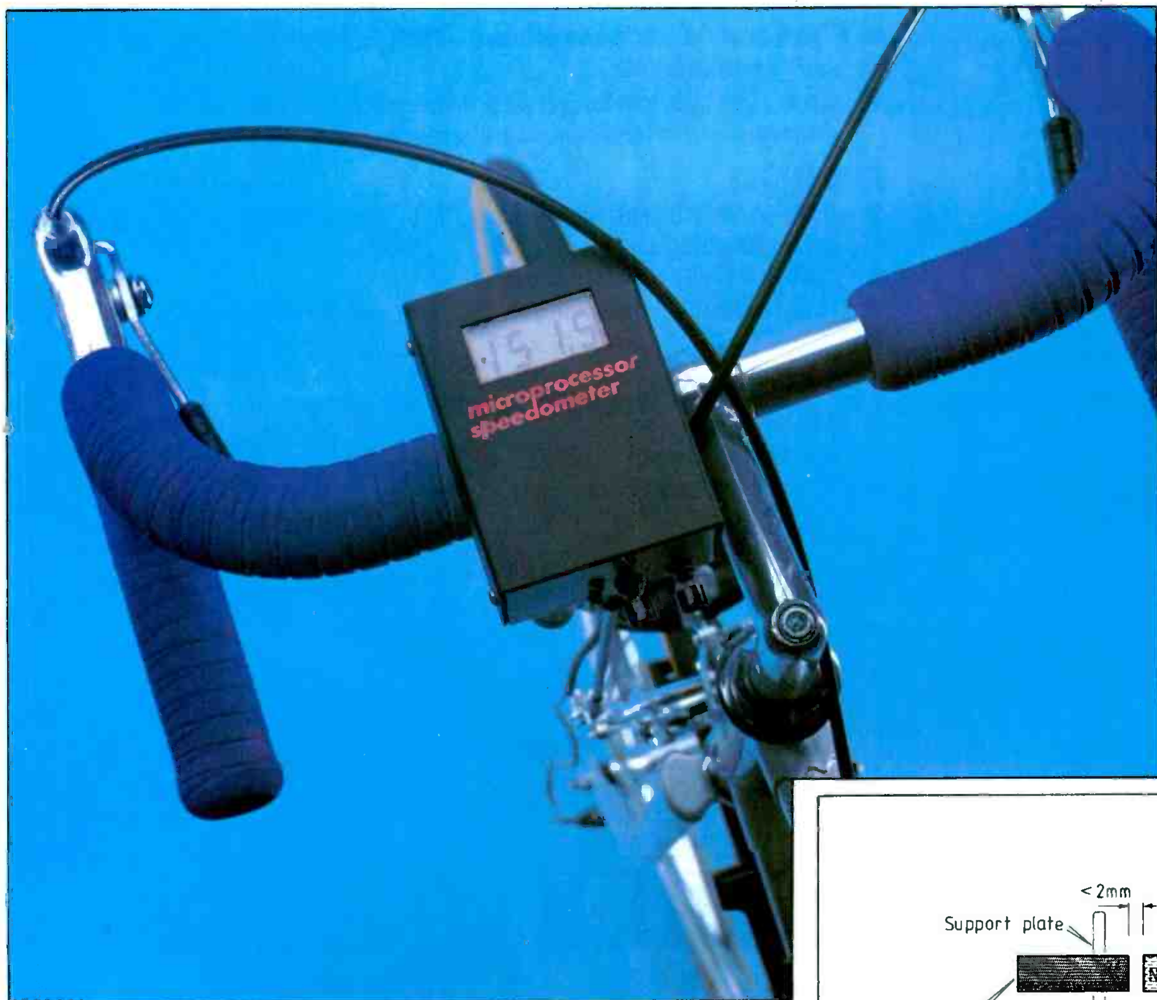
The main program is basically a loop which continually senses the input lines to see if a wheel pulse has been received or a mode advance or reset requested. On receipt of a new wheel pulse the speed is calculated by a constant (whose magnitude varies linearly with wheel diameter) being divided by the time since the last wheel pulse was received. This counter is then reset and the program searches for the top speed before incrementing the distance register.

By choosing suitable constants, the speed and distance may be produced in any set of units by changing the contents of a handful of bytes within the program. This also enables one to use different wheel sizes.

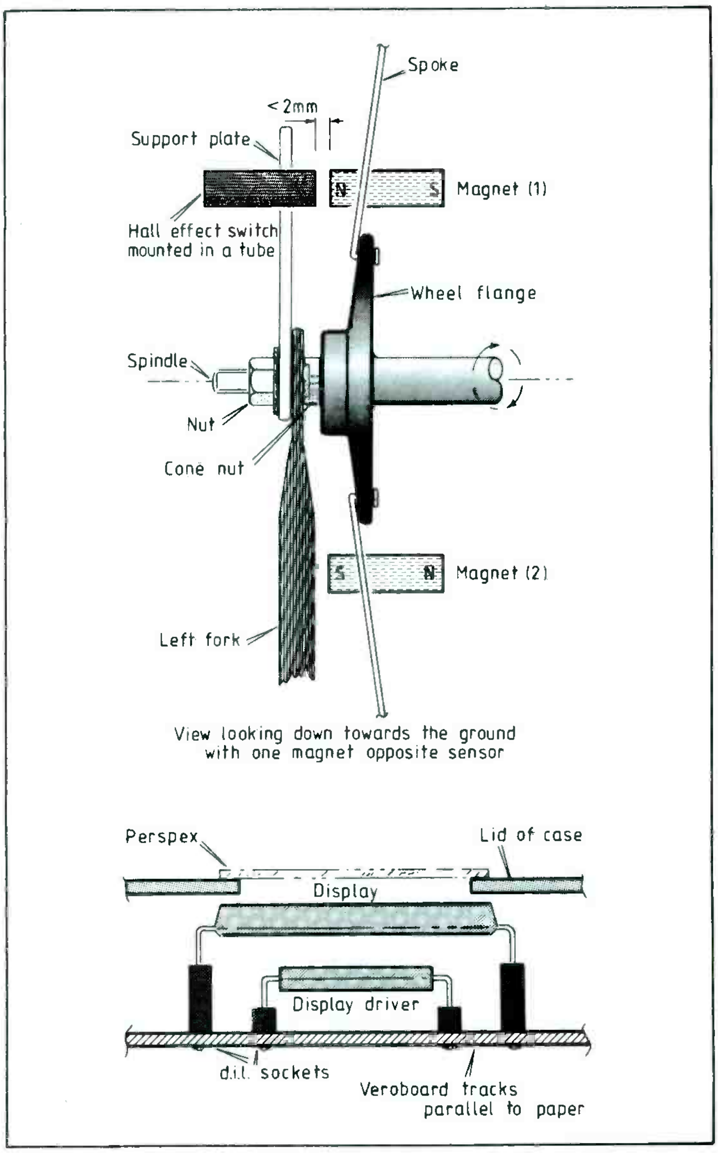
Ordinary lapse time and speed time counter are incremented by the interrupt routine- 1600Hz is required to produce sufficient accuracy in calculating the speed. A special routine looks after the case when one has stopped and automatically sets the speed to zero.

Accuracy

An error of about ¼in in the diameter of a 27in wheel may exist due to varying ages and hardness of the tyre and is



To keep all the components within a reasonably sized box, the display and its driver reside on a separate board, and electrical contact between them is through a series of soldered 5cm ling wires. For compactness, the display is mounted directly above its driver; the height gained as a result allows the display to be placed close to the transparent cover above the slot cut in the lid.



much greater than the 0.02% error generated when the distance register is incremented. Unadjusted crystal oscillators generally work within 1 part in 5000 of their cut frequency and this will produce an error of about 0.1 min over the ten-hour range of the lapse time. Combined distance and time errors are less than the resolution of the speed which is typically 0.1 at 20 and about half that at double the speed. This resolution is still much greater than given by conventional speedometers.

Construction

The case may be of grey ABS plastics as in the 'prototype', or of sheet aluminium as in the model illustrated and has external dimensions of 120 by 65 by 40mm and contains everything apart from the sensor. All the chips apart from the display drive are mounted on Veroboard at the bottom of the case. The battery is above it, being held in four trimmed cell compartments glued to the lid of the box. Trimming is necessary to allow enough space for the display, mounted as illustrated. Underneath it are the mode and reset switch bodies, the on/off switch and the three-pin DIN socket. The bracket to the bicycle has been 'cannibalized' from an old lamp support and in one version two of the four screws that fix the lid to the box.

Improvements

Four NiCd cells will provide power for about seven hours, of which two thirds is consumed by the rom. Hence a cmos version of the rom would greatly assist the longevity of the battery. An alternative would be to provide cmos ram (a 6116 which is 2Kbyte would be best) and boot up a the program from rom to ram on power-up. This way one could add extra modes at will for example average speed and actual travelling time. However, now the speedometer is operational, I will probably leave it alone and spend more time cycling.

Wireless World INDEX

Volume 89, January – December 1983

The General Index has direct references to all individual articles. Letters, News and Communications Commentary are indexed separately. Correspondence and corrections are included in the entries for articles to which they refer, as appropriate.

From October 1983, the words "Electronics &" appeared above "Wireless World" on our masthead. For convenience it is suggested that this be considered the last complete volume of *Wireless World* and 1984 be the first year of *Electronics & Wireless World.*

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NEWS of the MONTH

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COMMUNICATIONS COMMENTARY and AMATEUR RADIO by Pat Hawker

LETTERS to the EDITOR

An index to the authors contributing to this volume is available. Please send an s.a.e. to the editorial office, marked "Index".

Another 400 MHz for the hobbyist's spectrum analyser

By adding a mixer and filter, Roy Hartkopf doubles the analyser's range

By now, those who were interested will have completed the first section of the project (*Wireless World*, August 1983) and will have realised its potential as a piece of test equipment for the experimenter. The basic u.h.f. tuner covers 450 to 850 MHz, varying slightly with different makes. The oscillator and mixer described in this article provides coverage from 0 to 400MHz, giving, with a small gap in the middle, 0 to 850MHz.

The block diagram (Fig. 1) shows the two additional sections necessary. The incoming signal is mixed with the output from a 450MHz oscillator (the frequency is not critical) and the sum of the two frequencies is fed into the u.h.f. tuner. If the tuner will only go to, say, 470MHz then the oscillator can be set to 470MHz and so on.

The general principle is much the same as that of the normal superheterodyne receiver; but instead of a tunable oscillator and a fixed frequency output we have a fixed oscillator, which is much easier to build. The difficult job of sweeping the frequency band is done by the u.h.f. tuner.

Those who have not already attempted to build an oscillator working in the u.h.f. range will be surprised how easy it is. The requirements are some double sided glass-fibre circuit board, copper wire of about 14 gauge, a 2N5245 field effect transistor, trimmers and feedthrough capacitors.

Figure 2 shows a circuit diagram and physical layout of the complete unit. The dimensions are not critical. Because the fet requires no bias voltage between its source and the gate the respective leads can both be soldered to the wire which is in effect a shortened quarter-wave line. The electrical length is controlled by the trimmer capacitor at the end to which the fet is soldered.

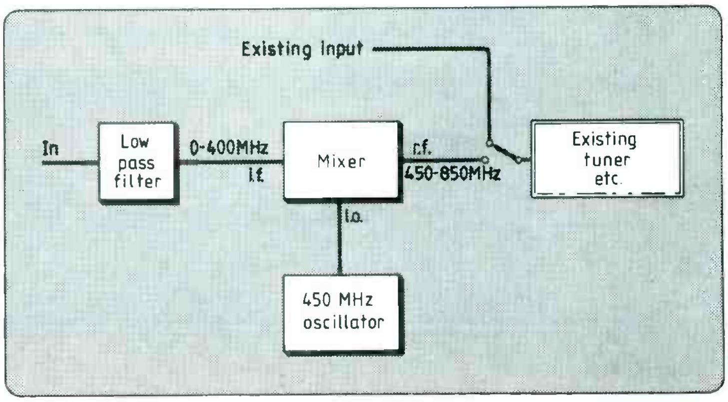
There is, however, one precaution which must be observed when working with u.h.f. Use the best quality components you can possibly get. At these frequencies an inch of wire becomes a tuned circuit, normal resistors often look like chokes, capacitors become inductors or worse still the electronic equivalent of blotting paper.

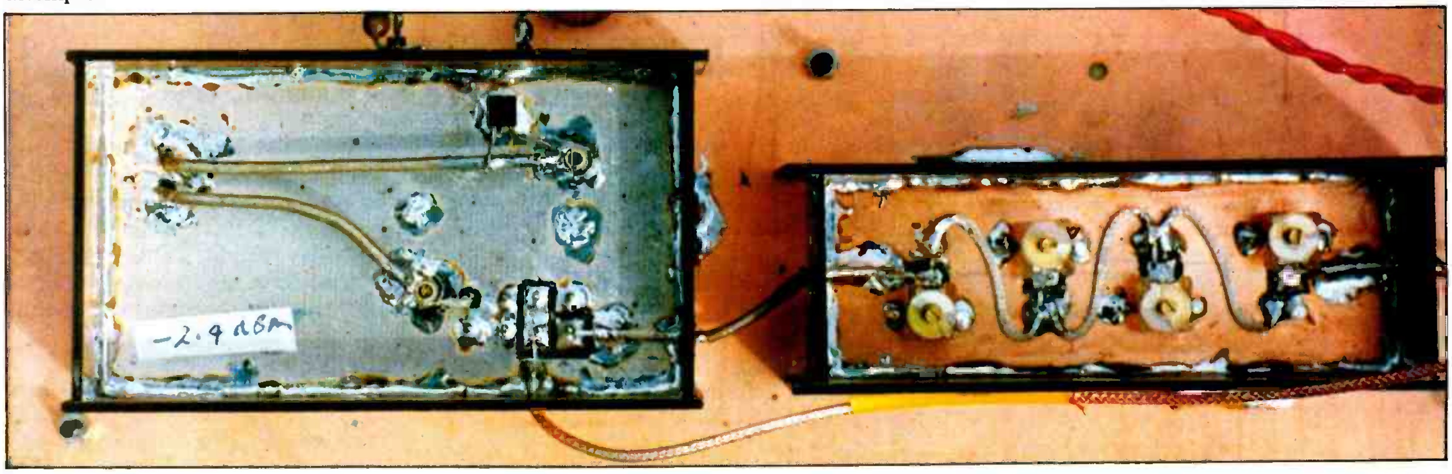
The capacitors used in the prototype were Triko u.h.f. piston trimmers and a Filtercon feedthrough capacitor. These components are useable well into the gigahertz range.

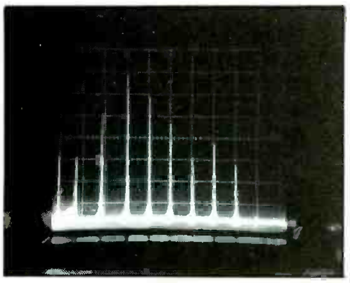
In the interests of stability it is a good idea to provide the oscillator with its own regulator (they are cheap enough) and mount it on the side of the box. A second feedthrough capacitor connected directly to the output and a capacitor on the input pin also will ensure the supply is clean and stable.

The only other component required is a double-balanced mixer. It is possible to build this but the ready built miniature modules are so much better than anything which can be made with discrete components that there is no practical alternative. As with the tuner there are several makes

Fig. 1. **With an additional oscillator-mixer unit, the spectrum analyser covers 0-850MHz with one small gap around 400MHz.**







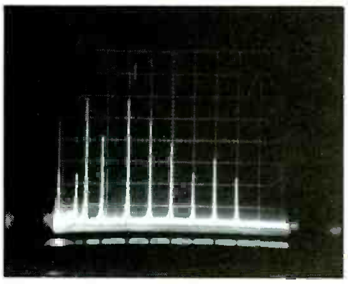
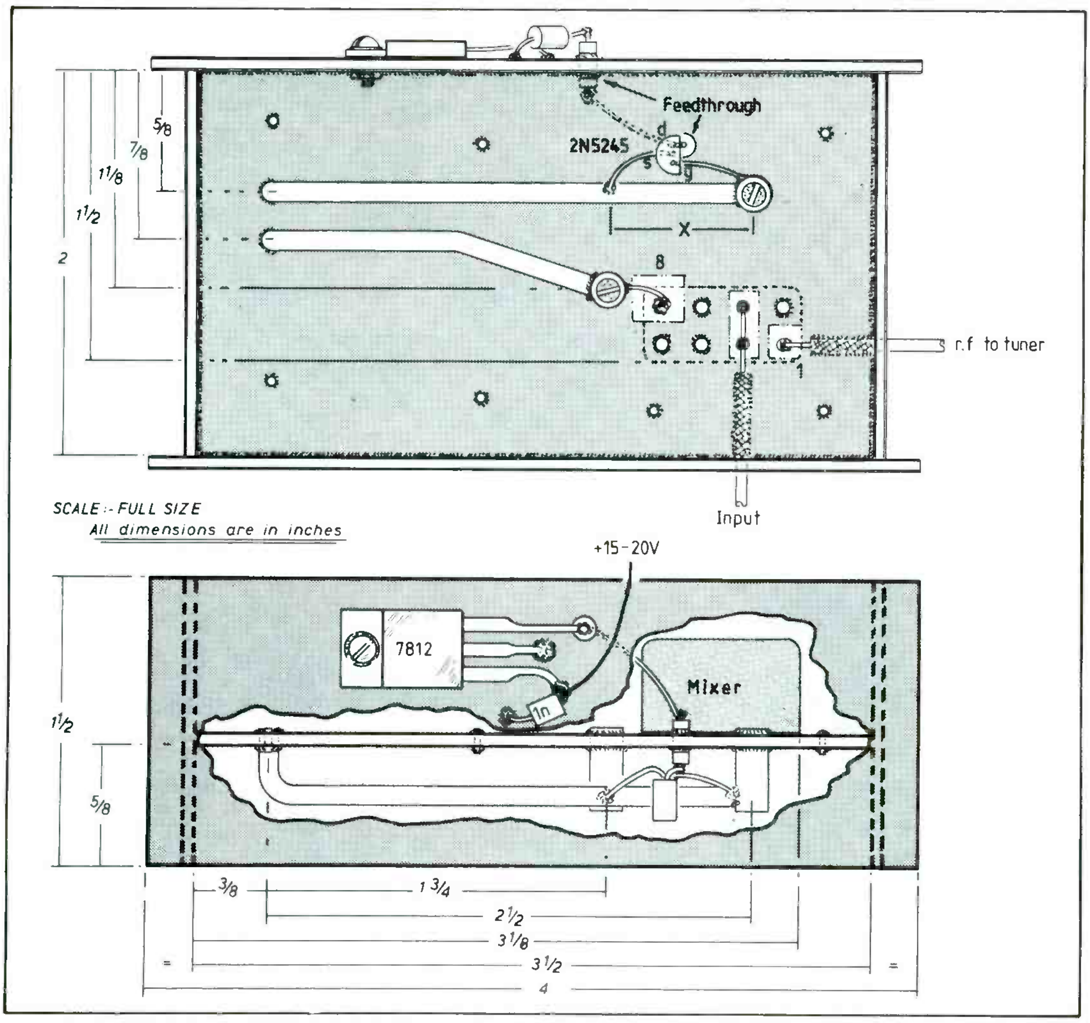


Fig. 4. (top) **50MHz comb generator pattern. This tuner had an unusual problem, a spread caused by changing voltage-frequency ratios at the low as well as the high frequency end.**

Fig. 5. (lower) **Same patter as Fig. 4 with the mixer oscillator placed a few inches away from the tuner.**

Fig. 3. (below) **parts layout.**



available and most of them have a standard eight pin case.

The Cimarron CM2 type I used has a bandwidth of 0 to 1000MHz and over. It also has excellent rejection of unwanted frequencies and can be used as a modulator, mixer, attenuator or phase detector.

In the present case the module is used to convert the input frequency (0-400MHz) upwards. For this reason the i.f. and r.f. ports are reversed and the signal is fed into the i.f. port (pins 3 and 4). The output is taken from the r.f. port (pin 1). The local oscillator port (pin 8) is supplied from a pick-up line (see Fig. 2). This line is tuned by a trimmer identical to that used in the oscillator line.

Construction

If the fibreglass board is cut by hand it is necessary to trim the pieces to their final size by careful rubbing with emery paper on a flat plate-glass sheet so that the edges are straight and square. Careful preparation will make it much easier to do a neat job of soldering the pieces together to make the box.

Holes for the feedthrough capacitors and trimmers and particularly the eight holes for the mixer module should be carefully marked and drilled. Holes can also be drilled for locating the grounded ends of the two lines, which can then be soldered to both sides of the board.

It can reduce the possibility of unwanted resonances if a few 1mm holes are drilled through the board (suggested positions are marked with an X on Fig. 2) and short lengths of hook-up wire pushed through and soldered to both sides of the board.

After the holes for the mixer module have been drilled the copper should be removed from pins 1, 8, and 3 and 4. All other pins will be soldered to the copper. On the underside it is necessary to countersink the holes to prevent the pins from accidental contact with the copper.

When the mixer module has finally been fitted, its case can be spot soldered in a couple of places to the underside of the circuit board. When all the components have been soldered in place the four sides should be spot soldered to the main board, and then a continuous solder run may be made along the edges. It helps if all the pieces are cleaned and sprayed with a flux before working on them.

A couple of holes can now be drilled to connect lengths of coaxial cable to the r.f. and i.f. pins. Again it is essential to use top quality miniature p.t.f.e. core cable. With the p.t.f.e. core, it is possible to solder the outer braid to the board without the core melting and causing distortion or short circuits.

The box and low-pass filter shown in the photograph have been soldered to a large piece of circuit board for convenience, but it is not essential to cover the top. If this *is* done it would be necessary to provide small holes to adjust the trimmers.

Adjustments

Once the oscillator-mixer unit is complete, it is necessary to adjust the frequency and the output level. The part of the spectrum analyser already built provides all the test equipment necessary.

Using a 50MHz comb generator as described in the earlier article, obtain a pattern on the oscilloscope similar to that shown in Fig. 4. Apply power to the oscillator-mixer module and place it close to the tuner. If the oscillator trimmer is adjusted a spike should appear — possible with others due to overload — near the left hand side of the screen, as shown in Fig. 5. If the spike caused by the oscillator is then shifted to coincide exactly with the first spike from the comb generator, the frequency sweep will be the same for both ranges.

At the same time, move the position of the fet's source lead along the oscillator line to obtain maximum output as indicated by the height of the spike. A fraction of an inch variation can often effect a considerable improvement.

Later on, connect the oscillator-mixer unit to the tuner and inject a signal of about 100-200MHz into the mixer. Keeping the level well below any overload point, adjust the trimmer on the end of the pick-up line for maximum output. This maximum should be maintained over a wide range. Set the trimmer to the centre of this range.

Those who have access to laboratory test equipment may prefer to use an alternative procedure. The Cimarron mixer, and most others, can be used as attenuators by putting a direct current into the i.f. port. With 10-20mA they give an attenuation of about 3dB. With an r.f. microwattmeter connected to the r.f. port the output from the oscillator shown can typically be adjusted to read between 0 and −5dBm (this includes the 3dB attenuation). Though most mixers specify about plus 5-8dBm for maximum conversion efficiency this lower input seems to give quite good results with all mixers so far tested.

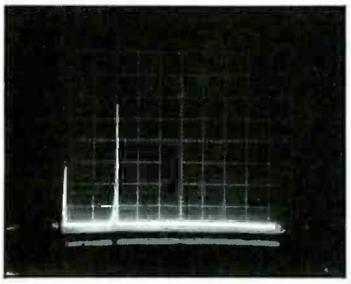
Figures 6 and 7 show the results obtained with the mixer-oscillator unit connected to the tuner when signals of 100MHz and 400MHz respectively were applied. The spike at the left-hand end is the zero-frequency beat marker.

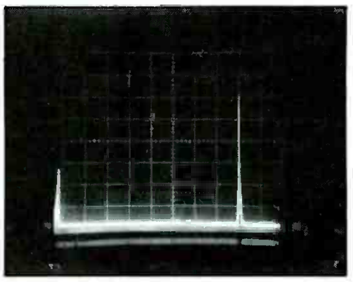
Although the double-balanced mixer modules appear symmetrical, the local oscillator should always be applied to the pin specified. As an experiment the module was reversed and a 100MHz signal exactly the same level as before was applied. Figure 8 shows the result. Although the 100MHz signal appeared as before there was also a spurious image 350MHz. When the input frequency was changed to 200MHz the image appeared at 250MHz and so on.

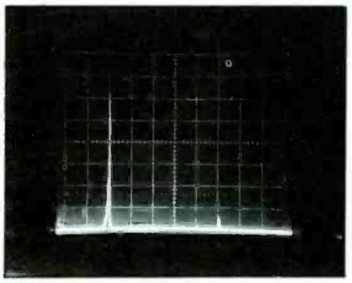
The tests were done with a laboratory-quality signal generator and a u.h.f. digital microwattmeter. The photographs were taken with the generator set to −30dBm and the tuner output, using germanium rectifiers, fed to an oscilloscope having a vertical sensitivity of 0.2V/cm. In other words the output from the tuner waa a little over half a volt peak.

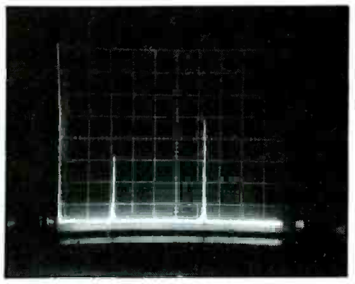
As a contrast Fig. 9 shows the output from a cheap commercial signal generator at a frequency of about 105MHz. The second harmonic at 315MHz is stronger than the fundamental, but at 90MHz this harmonic has disappeared. Without the spectrum analyser it would be almost impossible to discover the limitations of such equipment.

To avoid the possibility of breakthrough or intermodulation from signals above 400MHz, it is worth while putting a low pass filter in front of the oscillator-mixer unit. Figure 3 and the photographs show a simple layout. The trimmers are 0-15pF and each inductor consists of about 25mm of p.t.f.e. miniature cable, the outer braid soldered to the circuit board.









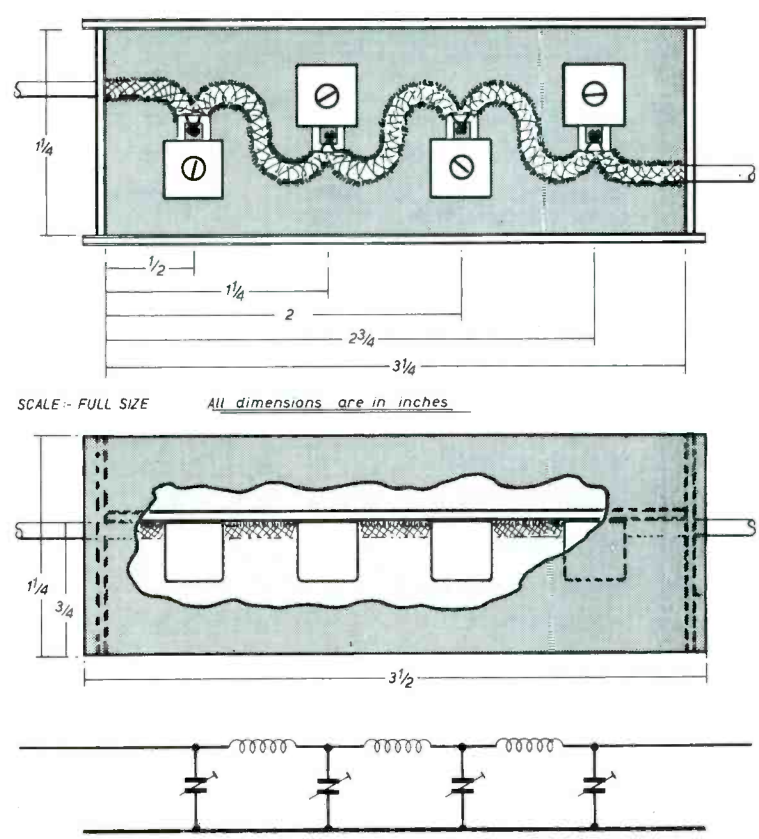
Adjust the filter by putting it in series with the comb generator and tuner, then try to reduce spikes in the 450-850MHz range as much as possible. Next put it in front of the oscillator mixer unit and make sure it is not also reducing the spikes in the top end of the 0-400MHz band. Keep on adjusting and altering the filter until it passes all frequencies up to 400MHz and attenuates anything over that frequency.

Fig 6. (top left) **A signal at 100MHz into the completed mixer-oscillator unit (see text).**

Fig 7. (top right) **Same as Fig. 6 but at 400MHz.**

Fig. 8. (lower left) **Same as Fig.6 but with mixer module inputs reversed.**

Fig. 9. (lower right) **Low-price signal generator at 115MHz. Note the harmonic at 315 MHz which disappears when the frequency is changed (see text).**



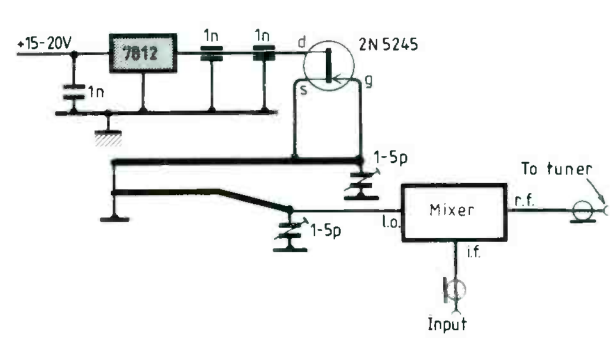


Fig. 2. **Circuit diagram of the u.h.f. oscillator and filter. Pin numbering of the mixer module may vary with different makes.**

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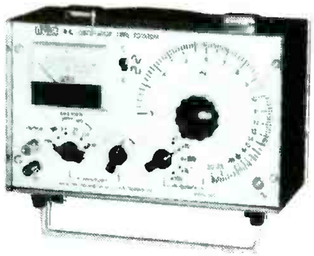

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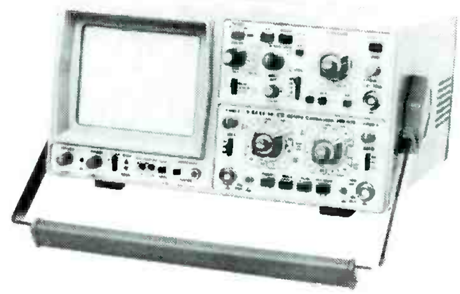

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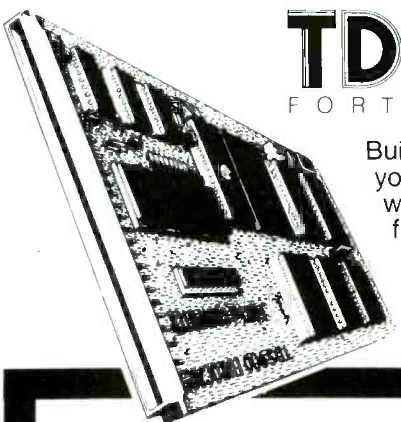

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CIRCLE 54 FOR FURTHER DETAILS.

Floppy discs

by David March

David March continues his survey of disc storage in microcomputers and looks at some practical disc operating systems

Table 1 shows the track structure of several different filing systems. Each column begins with padding bytes or index hole location. The padding bytes are FF in single density and 4E in double density. The numbers of padding bytes shown in some cases are uncertain because of limitations of my analysis technique.

Each sector is then defined. There are 10 sectors per track except with Philips and with Tandy's TRS-80 DD which have 18 sectors per track.

The remaining padding bytes are shown and finally the total number of bytes found on the track. Theoretically the total should be 3125 and 6250 for single density and double density respectively. The variations result from departures fromthe nominal 300 rev/min disc speed in the originating and analysing disc drives.

As sectors are being read or written, the disc rotates continuously and data bytes must be accepted (or made available) by the microcomputer at the rate determined by the combination of disc drives and f.d.c. Generally the time interval between adjacent sectors is inadequate for the microcomputer to process or prepare the next sector of information.

It follows that if the microcomputer is not ready when the start of a particular sector passes the read/write head, then a full revolution time must elapse before reading or writing can continue. With a 300 rev/min speed of the 5¼in. floppy disc this amounts to to 0.2 seconds.

Sector interlacing is a way of minimising this dead time. Sectors which are physically adjacent to each other on the disc are not addressed consecutively when sequential read/write operations take place. Thus more time is available to the microcomputer at the end of one sector before th next sectors is required. A typical arrangement is a follows:—

Physical position	0 1 2 3 4 5 6 7 8 9
Logical sector number	0 5 1 6 2 7 3 8 4 9

Here the microcomputer has one sector time (0.02 seconds) for processing/preparing each sector before the next is required.

If all sectors are to be accessed sequentially starting at sector 0, only two disc revolutions will be required (sectors 0-4 during the first revolution and sectors 5-9 during the second). This compares with the ten revolutions needed without interlacing. Although sector 9 is physically adjacent to sector 0 this is usually irrelevant as after sector 9 the file will probably continue on another track. The head movement time will then outweigh the processing time.

Sector interlacing can be achieved two ways. When the sectors are being laid out on the disc during formatting, the appropriate logical numbering can be applied. This has the advantage that subsequent file handling operations are not concerned with the interlacing. Alternatively the filing system may carry out a translation as each sector read/write is undertaken.

Disc filing systems

The function of a disc filing system is to protect the user from the intricacies of directly addressing the f.d.c. and to extend the capabilities of the f.d.c. by allowing the user to handle logically related sets of data in a convenient and secure manner.

Each logically related set of data is known as a **file** which the user accesses by its **file name** and which consists of a series of **records**. The size of each record is generally fixed by the filing system but the number of records in any file is determined by the needs of the user. Thus as the user writes information into a file, the number of records will be increased as necessary.

Individual filing systems will impose ultimate size limits but these are quite large: at best one file may occupy the whole disc.

The user generally needs to access information sequentially but may also wish to dip into a file at arbitary positions to read and possibly update the information. Most filing systems support this **random access** facility in varying degrees.

The filing system deals with the task of allocating physical space on the disc by establishing and maintaining tables of information defining the names of files, their sizes and where on the disc they are stored. These tables, known variously as the **directory** or **catalogue**, are specific to each disc filing system and frequently contain much more information about the files: for instance creation date, file types, load address, access restrictions etc.

Since the actual storage position of files on the disc is now hidden from the user, the filing system may optimise this allocation to speed up access and minimise unusable disc space.

Typically a filing system will partition the physical disc space into **granules** which are smaller than one track but larger than a

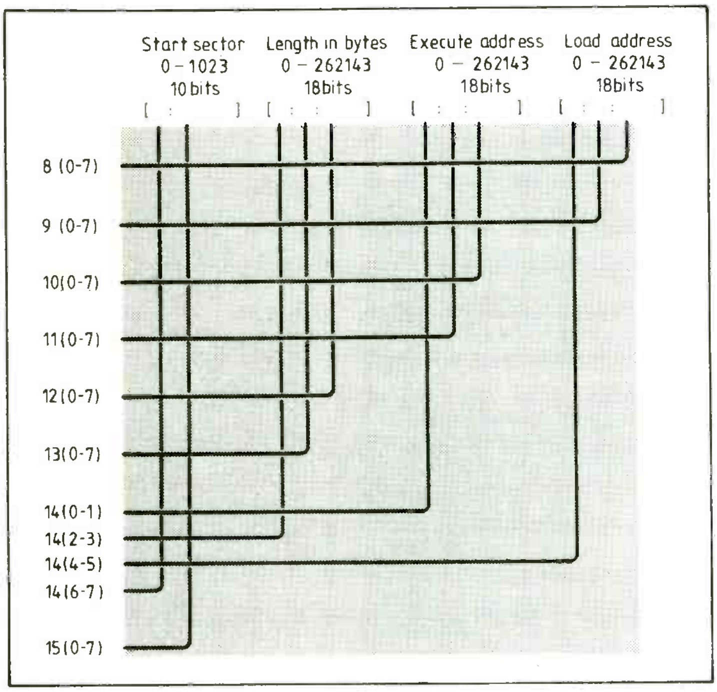
In his concluding article, David March will examine Tandy's TRS-DOS.

Table 1: track structures

	TRS-80 SD	TRS-80 DD	BBC 40T	Philips	S/Brain	S/Utility
Padding bytes	14×FF	72?×4E	19×FF	104?×4E	59?×4E	15?×FF 6×00 FC 12×FF
Sector details	6×00 FE track side sector size 2×c.r.c. 12×FF 6×00 FB/FA 256×data 2×c.r.c. 12×FF	12×00 3×A1 FE track side sector size 2×c.r.c. 22×4E 12×00 FB/F8 256×data 2×c.r.c. 24×4E	6×00 FE track side sector size 2×c.r.c. 11×FF 6×00 FB 256×data 2×c.r.c. 21×FF	12×00 3×A1 FE track side sector size 2×c.r.c. 22×4D 12×00 FB 256×data 2×c.r.c. 48?×4E	12×00 3×A1 FE track side sector size 2×c.r.c. 22×4E 12×00 FB 512×data 2×c.r.c. 15?×4E	6×00 FE track side sector size 2×c.r.c. 11×FF 6×00 FB 256×data 2×c.r.c. 9?×FF
Padding bytes	134×FF	128×4E	31?×FF	300?×4E	376?×4E	109?×FF
Total	3153	6264	3122	6210	6262	3113

Acorn DFS catalogue details

Bytes (bits)	Field name	Comments
0-6	File name	7 Ascii characters
7(0-6)	Directory character	Single Ascii character
7(7)	Lock bit	Set when file is protected



single sector. It will maintain a list of granules which are free.

When allocating space for a file, the filing system draws the next available granule from this list and maintains in the directory an ordered list of the granules assigned to each file. This permits individual files to change their sizes within the overall limit of the physical storage space of the disc.

Disc filing systems provide many facilities not directly related to the mechanism used for storing files on the disc. Some functions extend the way in which files are manipulated, e.g. changing files names, modifying access protection or concatenating multiple files; whilst others are quite unrelated to files, e.g. support for real-time clock, program debugging aids and so on.

The Acorn disc filing system

This filing system is installed in the BBC microcomputer in read-only memory. It has the advantage of speed but is more limited than other filing systems. It is thus a good place to start. The following description relates to Acorn's DFS; some variations of its derivatives are mentioned later.

The system supports up to four single-density disc surfaces, which may be in 40 or 80 track single or double-sided drives.

The catalogue occupies 512 bytes and resides on the first two sectors on track zero. The remainder of the disc is available for file storage.

The whole of each file is held in consecutive sectors. The first file written to the disc will occupy space from sector 2 upwards. Subsequent files will generally be placed immediately after previous ones, ensuring that no sectors are left unused initially. The granule concept is not implemented although the effect is of a variable granule size equal to the individual file lengths.

The gap left by deleting a file will be used subsequently when a file of length equal to or smaller than the gap is written to the disc. This will either use up the whole gap or leave a smaller one.

Eventually as files are written and deleted a time may arise when a file to be written is larger than any single gap although the sum of the gaps would be adequate. At this stage the user, who is warned of the problem, may choose to invoke a **Compact** command. This shuffles the files up to leave at the end of the disc a gap equal to the sum of previous gaps into which the required file may be written. The catalogue is adjusted to keep track of the files' new positions.

The catalogue contains 16 bytes describing the disc itself. It holds the disc name (13 characters), the number of files in the catalogue, the start-up option (used when rebooting the system) and the number of physical sectors on the disc. Each file entry in the catalogue also occupies 16 bytes, giving a maximum of 31 files per disc.

Each file name consists of up to seven characters. An additional character is available to allow the user to group files into a set known, confusingly, as a directory. DFS provides commands to allow the user to access files in a directory within the catalogue. Thus files may be grouped by type, e.g. Basic program files, or in whatever manner the user chooses. Individual files may be locked to inhibit the DFS from deleting or over-writing them. This information is carried in the catalogue as a single bit per file.

The remaining eight bytes in a file entry define the file's position on the disc, its size and its loading and execution addresses (if appropriate). The maximum size of a file is in theory 1023 sectors but in practice is limited by the physical size of the disc (398 sectors on a 40 track single-density disc).

DFS provides 28 user commands and seven entry-points to assembly-language routines giving some 24 additional disc facilities which are generally implemented via the resident high-level language processor.

Derivatives of Acorn's DFS seek to remove some of its limitations whilst retaining a degree of compatibility for file transfer. For example, the Watford DFS (Watford Electronics) extends support to a larger number of files by doubling the catalogue, which now occupies the first four sectors and allows a maximum of 62 files. This d.f.s. limits the disc name to 12 characters and uses one byte as a cyclic counter of the number of write commands issued to the disc. The counter is used to provide a measure of protection against writing to the wrong disc if the user changes discs in the drive whilst a file is being written.

CP/M and Superbrain

CP/M was developed by Digital Research Corporation as an environment for running application programs which would be independent of the actual microcomputer involved. This they achieved by incorporating all the software which deals directly with the peripheral hardware in CP/M itself and presenting a standard interface to the applications programs. Thus applications programs share the computer memory with the resident CP/M routines.

CP/M handles all the basic input/output messages via a set of predefined routines which are accessed through a fixed memory location. Each host microcomputer is supplied with its own version of CP/M which translates between the standard interface and the particular file structuring of the host system.

When CP/M is started up it loads the basic routines into high memory, then loads and executes a keyboard command processor. The bulk of the memory is available for whatever application program the user initiates from the keyboard.

It is a feature of CP/M that many of the facilities which an operating system typically supports are provided by application programs which are delivered with the host system but which are essentially separate from CP/M. Thus CP/M itself is very compact.

The disc tracks which CP/M occupies are predefined but the remaining formatting and structure is determined by the host system.

Superbrain is one of the many microcomputers which support CP/M. It incorporates two built-in 5¼in disc drives. These are 35-track double-density and may be single-sided or double-sided.

Tracks 0 and 1 of the system disc contain CP/M and the Directory resides on track 2. Each Directory entry is 32 bytes long and there is a maximum of 64 entries. Each entry comprises seven fields, some of which are not used by current versions of Superbrain.

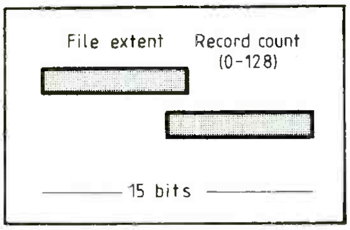
The name and extension (fields 2 and 3) form the full file-name. On keyboard input the fields are separated by a full stop. Conventionally the extension is used to define the type of file, for example

.BAS — Basic source file
.TXT — text file
.COM — executable program

The top bit of each byte of the extension has additional significance. For example, the top bit of byte 9 when set indicates read-only protection. In byte 10 it indicates a file which is normally invisible.

The granule allocation (field 7) in any directory entry is limited to 16 granules each of 2048 bytes, giving a total of 32 768 bytes. Should this be insufficient a second directory entry will be generated having the same file name and extension.

The file extent and record count (fields 4 and 6) together define the size of the file. CP/M treats files as a collection of fixed length records, each of 128 bytes. The highest numbered valid record addressed by any directory entry is held in these two bytes in a curious manner.



The length of the file is given loosely by

(file extent × 128) + record count

Loosely, because CP/M permits truly random file access, with only those records which are in use being allocated disc space in granule units. Thus it is perfectly possible to create a file with records 100-110 and no records numbered 0-99. The six granules which would have contained records 0-95 will not be allocated and only 2048 bytes will be used. The first twelve bytes in the granule allocation field will be left blank, ready for use if the lower numbered records are subsequently needed.

CP/M directory details

Field	Bytes	Field name	Comments
1	0	Entry type	Not used
2	1−8	Name	In Ascii and padded with spaces
3	9−11	Extension	In Ascii and padded with spaces
4	12	File extent	
5	13,14	—	Not used
6	15	Record count	
7	16−31	Granule allocation	Two bytes per granule

Granules are numbered from zero beginning after the two tracks reserved for CP/M itself. Thus the directory occupies the whole of granule zero (64 entries by 32 bytes).

Files are allocated the lowest available granule and may be extended following their creation. Files which become smaller or are deleted will leave gaps which subsequent files will use.

The directory mechanism is unable to access tracks zero and one, even if the particular disc does not contain a CP/M system; but any file can grow until the remainder of the disc is full.

Superbrain uses a Western Digital 1791 f.d.c. This chip supports both single and double-density, but in the Superbrain the f.d.c. is permanently selected to double-density mode.

One other curiosity of the Superbrain is its inversion of data bits between the microcomputer and the read/write head. This causes the magnetic encoding on the disc to be inverted with respect to other common microcomputers. Within the Superbrain itself no problems occur since inversion takes place both on reading and writing; but when a Superbrain disc is read on another microcomputer each data bit must be inverted to obtain the correct file data.

Superbrain uses sector interlacing to speed up sequential file access. The interlacing pattern follows the example given earlier. This is carried out in software and each physical sector is 512 bytes long. In other words, each sector contains four 128-byte CP/M records.

To be continued.

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The phone number for Active Electronics in the December issue should read: 0494 41414; Quarndon Electronics not only sell small quantities but also make no charge for post and packing. RS Components headquarters are at PO Box 99, Coby, Northants NN17 9RS, with the telephone number 0436 201234

Some manufacturers who did not get onto the chart, and their distributors. Addresses in the December 1984 issue.

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FD1795	25.00
FD1797	21.00
WD1691	14.00
WD2143	12.00

DATA CONVERTERS

ZN425E-8	3.76
ZN425J-8	8.00
ZN426E-8	1.90
ZN427E-8	6.68
ZN427J-8	12.50
ZN428E-8	5.10
ZN428J-8	9.70
ZN429E-8	1.60
ZN432CJ-10	20.79
ZN432E-10	13.00
ZN433CJ-10	25.00
ZN434	0.98
ZN435	4.38
ZN436E	1.26
ZN440	55.00
ZN441	46.80
ZN447	7.80
ZN448E	6.66
ZN448J	12.48
ZN449	2.72
ZNA134J	22.50
ZNA234E	9.40

VOLTAGE REF.

ZN404	0.50
ZN423	0.98
ZN458	0.92
ZN458A	0.92
ZN458B	1.12
ZNREF 025	1.90
ZNREF 040	1.90
ZNREF 050	1.90
ZNREF 062	1.90
ZNREF 100	3.05

BUFFERS

81LS96	0.80
81LS97	0.80
81LS98	0.80
8T26A	0.80
8T28	0.80
8T28A	0.80
8T95	0.80
8T97A	0.80
8T98	0.80

OPTOISOLATORS

4N25	0.75
4N26	0.75
4N33	0.90

UHF MODULATORS

UM1111	2.95
UM-1233	3.45

VOLTAGE REG.

7805	0.75
7812	0.75
7815	0.75
78H05SC	7.50
78H12ASC	8.95
78HGASC	9.95
78L05	0.30
78L12	0.30
78L15	0.30
78S40DM	7.50
78S40PC	3.00
7905	0.95
7912	0.95
7915	0.95
LM309K	0.95
LM317K	2.45
LN323K	4.95
LM338K	4.50

FAIRCHILD FAST

74F00PC	0.60
74F04PC	0.60
74F08PC	0.65
74F109PC	0.65
74F11PC	0.52
74F138PC	0.52
74F138PC	1.26
74F139PC	1.26
74F151	1.26
74F153	1.26
74F157	1.30
74F158	1.17
74F161	2.34
74F164	1.68
74F175	1.82
74F181	3.90
74F189	5.10
74F190	3.20
74F191	3.20
74F194	1.68
74F20PC	0.52
74F240	3.16
74F241	2.42
74F243	2.80
74F244	2.96
74F245	6.08
74F251	1.26
74F253	1.26
74F257	1.26
74F258	1.34
74F280	1.74
74F283	1.74
74F32PC	0.52
74F352	1.26
74F353	1.26
74F373	3.16
74F374	3.16
74F379	1.83
74F381	6.62
74F382	4.22
74F398	3.16
74F399	2.70
74F521	2.76
74F533	3.16
74F534	3.16
74F537	6.02
74F538	4.38
74F539	4.38
74F64PC	0.52
74F74PC	0.58
74F86PC	0.77

HIGH SPEED CMOS

74HC00N	0.42
74HC02N	0.42
74HC03N	0.64
74HC04N	0.44
74HC08N	0.42
74HC107N	0.78
74HC109N	0.50
74HC10N	0.64
74HC112N	0.86
74HC113N	0.86
74HC132N	1.28
74HC137N	1.81
74HC138N	1.20
74HC139N	0.78
74HC151N	1.16
74HC153N	0.90
74HC157N	1.02
74HC158N	1.02
74HC160N	0.90
74HC161N	0.90
74HC162N	1.51
74HC163N	1.51
74HC164N	0.95
74HC165N	2.24
74HC173N	1.35
74HC174N	0.80
74HC175N	0.78
74HC194N	1.28
74HC195N	1.28
74HC20N	0.40
74HC237N	1.80
74HC240N	1.38
74HC241N	1.34
74HC242N	2.24
74HC243N	2.24
74HC244N	1.32
74HC251N	1.03
74HC253N	1.03
74HC257N	1.03
74HC266N	0.92
74HC273N	2.24
74HC27N	0.80
74HC280N	3.26
74HC32	0.40
74HC373N	2.40
74HC374N	2.40
74HC393N	1.78
74HC4002	0.64
74HC4017	1.16
74HC4020	1.46
74HC4024	1.20
74HC4040	1.46
74HC4060	1.46
74HC4075	0.64
74HC42N	0.90
74HC4511	2.51
74HC4514	3.76
74HC4538	2.36
74HC4543	3.04
74HC51N	0.64
74HC533N	2.40
74HC534N	2.40
74HC589N	1.72
74HC58N	0.64
74HC595N	1.84
74HC597N	1.72
74HC73N	0.84
74HC74N	0.84
74HC75N	0.92
74HC76N	0.64
74HC85N	2.02
74HC86N	0.80
74HCU04N	0.80

TTL

74LS00	0.17
74LS01	0.17
74LS02	0.17
74LS03	0.17
74LS04	0.25
74LS05	0.25
74LS08	0.17
74LS09	0.25
74LS10	0.17
74LS109	0.27
74LS11	0.17
74LS112	0.54
74LS113	0.27
74LS114	0.44
74LS12	0.25
74LS122	0.42
74LS123	0.53
74LS124	2.30
74LS125	0.49
74LS126	0.29
74LS13	0.17
74LS132	0.73
74LS136	0.46
74LS138	0.77
74LS139	0.77
74LS14	0.28
74LS145	1.23
74LS148	1.50
74LS15	0.25
74LS151	0.36
74LS153	0.36
74LS155	0.24
74LS156	0.77
74LS157	0.24
74LS158	0.62
74LS160	0.80
74LS161	0.34
74LS162	0.80
74LS163	0.80
74LS164	1.10
74LS165	0.61
74LS166	1.95
74LS173	0.63
74LS174	1.30
74LS175	0.96
74LS181	2.09
74LS190	0.98
74LS191	0.75
74LS192	0.36
74LS193	1.10
74LS194	0.28
74LS195	0.78
74LS196	1.10
74LS197	1.10
74LS20	0.17
74LS21	0.17
74LS22	0.17
74LS221	0.62
74LS240	1.40
74LS241	0.48
74LS242	1.36
74LS243	1.36
74LS244	1.40
74LS245	1.95
74LS248	0.39
74LS249	1.16
74LS251	0.78
74LS253	0.25
74LS257	0.78
74LS258	0.27
74LS259	0.42
74LS26	0.30
74LS261	2.60
74LS266	0.19
74LS27	0.17
74LS273	1.35
74LS279	0.77
74LS28	0.17
74LS283	1.00
74LS290	0.29
74LS293	0.29
74LS30	0.17
74LS32	0.25
74LS33	0.17
74LS365	0.33
74LS366	0.33
74LS367	0.34
74LS368	0.36
74LS37	0.17
74LS373	1.50
74LS374	0.52
74LS375	0.26
74LS377	0.46
74LS378	1.22
74LS379	1.50
74LS38	0.25
74LS386	0.50
74LS390	1.10
74LS393	0.52
74LS40	0.25
74LS42	0.25
74LS47	0.30
74LS48	0.35
74LS49	0.34
74LS51	0.17
74LS54	0.17
74LS55	0.17
74LS670	2.30
74LS73	0.30
74LS74	0.35
74LS75	0.28
74LS76	0.17
74LS78	0.19
74LS83	0.28
74LS85	0.39
74LS86	0.42
74LS90	0.21
74LS91	1.30
74LS92	0.22
74LS93	0.21
74LS95	0.77

CMOS 4000 Series

4000	0.16
4001	0.15
4002	0.16
4006	0.55
4007	0.16
4008	0.50
4009	0.25
4010	0.25
4011	0.19
4012	0.16
4013	0.29
4014	0.40
4015	0.50
4016	0.29
4017	0.40
4018	0.40
4019	0.30
4020	0.41
4021	0.56
4022	0.42
4023	0.23
4024	0.40
4025	0.16
4026	0.74
4027	0.52
4028	0.34
4031	0.93
4033	2.40
4034	1.00
4035	0.54
4040	0.41
4041	0.36
4042	0.40
4043	0.41
4044	0.43
4045	2.00
4046	0.55
4047	0.50
4048	0.40
4049	0.50
4050	0.29
4051	0.40
4052	0.48
4053	0.50
4054	1.30
4055	0.72
4060	0.50
4063	0.60
4066	0.50
4068	0.16
4069	0.23
4070	0.23
4071	0.23
4072	0.23
4073	0.23
4075	0.46
4076	0.48
4077	0.23
4078	0.2[illegible]
4081	0.2[illegible]
4082	0.2[illegible]
4085	0.6[illegible]
4086	0.4[illegible]
4093	0.2[illegible]
4099	0.5[illegible]
4502	0.5[illegible]
4507	0.47
4508	0.96
4510	0.45
4511	0.50
4512	0.40
4514	1.00
4515	1.84
4516	0.45
4518	0.40
4519	0.25
4520	0.64
4521	1.32
4522	0.84
4526	0.52
4527	0.52
4528	0.48
4532	0.68
4541	0.82
4543	0.60
4553	2.00
4555	0.36
4556	0.44
4585	0.48

CRYSTALS

A111B	1MHz	4.50
A112A	1.008MHz	2.70
A113A	1.8432MHz	3.50
A116A	2.4576MHz	2.00
A120B	4MHz	1.25
A132A	6MHz	1.30
A140A	8MHz	1.25
A169A	3.6864MHz	2.00
A173A	9.8304MHz	2.75
A182A	19.6608MHz	2.50

DIL SKTS TIN

		1+	100+
07070802	8 PIN	0.07	0.05
07071402	14 PIN	0.09	0.07
07071602	16 PIN	0.09	0.07
07071802	18 PIN	0.15	0.10
07072002	20 PIN	0.19	0.14
07072202	22 PIN	0.21	0.15
07072402	24 PIN	0.24	0.16
07072802	28 PIN	0.26	0.17
07074002	40 PIN	0.29	0.18

DIL SKTS GOLD

06060802	8 PIN	0.16
06061402	14 PIN	0.20
06061602	16 PIN	0.21
06061802	18 PIN	0.22
06062002	20 PIN	0.28
06062202	22 PIN	0.32
06062402	24 PIN	0.42
06062802	28 PIN	0.46
06064002	40 PIN	0.66

DIL SKTS W/WRAP TURNED PIN

9090802	8 PIN	0.36
9091402	14 PIN	0.75
9091602	16 PIN	0.86
9091802	18 PIN	0.96
9092002	20 PIN	1.08
9092202	22 PIN	1.18
9092402	24 PIN	1.28
9092802	28 PIN	1.50
9094002	40 PIN	1.70

ZIF SOCKETS

08082402	24 PIN	5.70
08082802	28 PIN	6.90
08084002	40 PIN	8.25

components

GILRAY ROAD, DISS, NORFOLK. TEL: 0379 4131

NSULATION DISPLACEMENT ONNECTOR SYSTEM

IEADERS

	SHROUDED 90°	OPEN 90°	OPEN — STRAIGHT PINS
0 way	0.86	0.65	0.47
4 way	1.22	0.83	0.59
6 way	1.34	0.92	0.65
:0 way	1.36	1.13	0.77
:6 way	1.70	1.40	0.95
I4 way	2.04	1.78	1.19
I0 way	2.28	2.07	1.37
;0 way	2.70	2.54	1.67
;0 way	3.20	3.02	1.96

OCKETS

0 way	0.88
4 way	1.06
6 way	1.16
0 way	1.38
6 way	1.66
4 way	1.94
0 way	2.08
0 way	2.78
0 way	3.34

:ARD :DGE

0 way	1.84
:0 way	3.14
:6 way	3.80
I4 way	4.90
I0 way	5.52
;0 way	6.68
;0 way	8.06

DIP PLUGS

14 way	0.92
16 way	1.06
24 way	1.60
40 way	2.40

TRANS. CONNS.

10 way	0.86
16 way	1.17
20 way	1.37
26 way	1.67
34 way	1.87
40 way	2.23

D-TYPE SOCKETS

9 way	1.47
15 way	2.02
25 way	2.90
37 way	3.97

D-TYPE PLUGS

9 way	1.38
15 way	1.85
25 way	2.52
37 way	3.34

CABLE ASSEMBLIES

IDC JUMPERS SINGLE ENDED

36" cable	IDC socket
10 way	1.72
14 way	2.07
16 way	2.22
20 way	3.14
26 way	3.75
34 way	3.98
40 way	4.23
50 way	5.36
60 way	6.36

DIP JUMPERS

Single Ended

	— 24" cable
14 pin	1.73
16 pin	1.90
24 pin	2.73
40 pin	3.96

Double Ended

	6" cable	12" cable	18" cable
14	2.74	2.84	2.94
16	3.03	3.14	3.25
24	4.18	4.36	4.55
40	5.89	6.18	6.47

DISC DRIVE CONNECTING CABLES

34 way card edge to 34 way card edge 1M	11.30
34 way card edge to 2 × 34 way card edge 1.5M	18.00
34 way card edge to 34 way IDC SKT (BBC) 1M	8.50
34 way card edge to 2 × 34 way IDC KT (BBC) 1 5M	14.50
BBC Power Cable — Single Drive	3.50
BBC Power Cable — Dual Drive	4.75

RIBBON CABLE (PRICED PER FOOT)

	GREY	RAINBOW
9	0.16	0.25
10	0.16	0.25
14	0.21	0.35
15	0.22	0.37
16	0.23	0.39
20	0.28	0.48
25	0.34	0.60
26	0.35	0.62
34	0.45	0.80
40	0.52	0.92
50	0.64	1.14
60	0.76	1.35

BBC MICRO CONNECTORS

DIN PLUG 7 PIN	0.40
DIN PLUG 6 PIN	0.40
DIN PLUG 5 PIN 180°	0.40
DIN PLUG 5 PIN DOMINOE	0.40
POWER PLUG (36" CABLE)	3.00
ANALOGUE INPUT PLUG	2.25
5 WAY DIN SKT 180°	0.90
5 WAY DIN SKT DOMINOE	0.90
6 WAY DIN SKT	0.90
7 WAY DIN SKT	0.90
15 WAY DIN SKT	2.15

Connecting cables for personal computers

A comprehensive range of high quality interconnecting cables for popular micro computers. All cables utilise high quality connectors and are individually tested to ensure trouble free use.

Part number	Description	Computer	
Video cables			
CON100	Phono plug to phono plug (2M)		1.20
CON101	Phono plug to BNC plug (2M)		2.95
CON102	BNC plug to BNC plug (2M)		3.95
CON107	6 pin DIN to open end (1M)	BBC	1.05
CON108	6 pin DIN to 6 pin DIN (1M)	BBC	1.50
CON119	Phono plug to coax plug		1.35
CON160	DIN plug to 2 phono plugs	Dragon	1.20
Cassette recorder cables			
CON109	7 pin DIN to open end	BBC	1.25
CON110	7 pin DIN to 2 × 3 5mm + 1 × 2 5mm J/plug	BBC	2.50
CON111	7 pin DIN to 5 pin DIN + 2 5mm J/plug	BBC	2.50
CON118	5 pin DIN to 2 × 3 5mm J/plugs	Spectrum/ZX	2.50
CON117	5 pin DIN to 2 × 3 5mm + 1 × 2 5mm J/plug	Dragon	2.50
Parallel printer cables			
CON130	36 way plug to 36 way plug (2M)	Sirius/Apricot	18.00
CON131	36 way plug to 36 way plug (5M)	Sirius/Apricot	26.50
CON132	36 way plug to 36 way socket (2M)		18.00
CON133	36 way plug to 36 way socket (5M)		26.50
CON144	36 way plug to 25 way male D type (2M)	IBM/TI PC	19.00
CON145	36 way plug to 25 way male D type (5M)	IBM/TI PC	27.50
CON134	36 way plug to 25 way male D type (2M)	RML/Apple	19.00
CON135	36 way plug to 25 way Male D type (5M)	RML/Apple	27.50
CON142	36 way plug to 20 way IDC socket (2M)	Dragon	13.95
CON139	36 way plug to 26 way IDC socket (2M)	BBC	9.95
CON140	36 way plug to 26 way IDC socket (5M)	BBC	22.95
CON141	36 way plug to 34 way card edge (2M)	TRS80 Lev 1	18.50
CON143	36 way plug to 34 way IDC socket (2M)	TRS80 Lev 2/ Memotech	10.95
RS232 Cables			
CON106	25 way male D type to 5 pin DIN	BBC	5.85
CON128	'Universal' RS232 cable (pins 1-8, 20 connected and 20 jumpered as required) 2M		15.95
CON164	'Universal' RS232 cable as above but 5M		20.95
CON120	25 way male to male 1-25 connected (2M)		16.95
CON121	25 way male to male 1-25 connected (5M)		22.50
CON122	25 way male to male 1-25 connected (10M)		32.50
CON123	25 way male to male 1-25 connected (30M)		68.00
CON124	25 way male to female 1-25 connected (2M)		15.45
CON125	25 way male to female 1-25 connected (5M)		21.00
CON126	25 way male to female 1-25 connected (10M)		31.00
CON127	25 way male to female 1-25 connected (30M)		66.50
CON129	25 way male to 9 way male	Spectrum	15.95
CON162	25 way male to 9 way male	Mackintosh	15.95
CON163	25 way male to 5 pin DIN	RML 480Z	14.95

PART NO.	DESCRIPTION	MAIL ORDER PRICE
BBC MICROS AND ACCESSORIES		
ANB01	BBC Model B Micro	£325.00
ANB02	BBC Model B Micro with Econet I/F	£385.00
ANB03	BBC Model B Micro with Disc I/F	£406.00
ANB04	BBC Model B Micro with Disc & Econet	£445.00
ANB21	DNFS ROM	£17.91
ANB23	Disc Interface Kit (Excl DNFS ROM)	£84.00
ANB14	Speech Interface	£40.00
ANK01	IEEE488 Interface Adaptor	£283.00
ANB22	Econet I/F Kits	£35.00
BBC 45	2 BBC Joysticks	£8.00
STAND	Monitor Stand	£7.50
SRE1	Sideways ROM Expansion Board for BBC Micro	£25.95
BBC DISC DRIVES		
HC1	Single 100k 40 track single sided	£75.00
HC1S	Single 100k (expandable to dual) 40 track	£90.00
HC1D	Dual (2 × 100k) 40 track single sided	£160.00
BBC44	Single 400k 80 track double sided	£156.50
BBC44S	Single 400k (expandable to dual) 40/80 track switchable double sided	£180.00
BBC44SW	Single 400k 40/80 track switchable double sided	£159.00
BBC44D	Dual (2 × 400k) 40/80 track switchable double sided	£310.00
MECHANISMS		
	100k single sided Alps	£70.00
	400k double sided Epson	£140.00
FLOPPY DISCS		
MD-1C/B	Nashua single sided, single density 40 track (10 discs)	£12.00
MD-1DC/B	Nashua single sided, double density 40 track (10 discs)	£13.00
MD-2DC/B	Nashua double sided, double density 40 track (10 discs)	£15.50
MD-2FC/B	Nashua double sided, quad density 80 track (10 discs)	£17.85
SPECIAL OFFER		
BBC40TD	BASF double sided, double density 40 track (10 discs)	£14.00
DISC STORAGE BOXES		
MDT25/3	3½" Flip 'N' file Micro disc box (cap. 25)	£7.75
DT25/5	5¼" Flip 'N' file lockable disc box (cap. 25)	£18.77
DT60/5	5¼" Standard lockable disc box (cap. 60)	£10.65
MONITORS		
9MON	9 inch green screen high resolution NEC high quality monitor	£125.00
12MON	12 inch green screen high resolution NEC high quality monitor	£135.00
1431	Microvitec 14" RGB colour monitor	£175.00
1441	Microvitec 14" RGB colour monitor high resolution	£410.00
1451	Microvitec 14" RGB colour monitor medium resolution	£295.00
1431/AP/MS	Microvitec 1431 PAL & RGB inputs and sound facility	£225.00
EPSON COMPUTERS AND ACCESSORIES		
PX-8	Epson portable computer (incl. CP/M and s/w) 64k	£798.00
PX-8/120	120k RAM	£998.00
CX-21	Acoustic coupler	£160.00
PF/10	Disc drive for PX-8	£360.00
P40	Thermal printer for PX-8 and HX-20	£86.91
HX-20	Epson portable computer	£411.00
MATRIX PRINTERS		
RX80	Epson RX80 100cps matrix printer	£204.00
RX80F/T	Epson RX80F/T 100 cps matrix printer friction or tractor feed	£231.00
FX80	Epson FX80 150cps matrix printer	£328.50
MT80SP	Mannesmann Tally MT80 matrix printer friction or tractor feed with film ribbon and tear off facility	£217.00
LETTER QUALITY PRINTERS		
HR5	Brother HR5 Thermal printer A/C mains or battery	£130.00
HR15	Brother HR15 Daisy wheel printer (13cps)	£326.00
HR25	Brother HR25 Daisy wheel printer (23cps)	£550.00
UCHIDA	Uchida DWX305 Daisy wheel printer (20cps)	£227.00
PRINTER SUPPLIES		
11241P160	11×9½ 1 part plain listing paper (2,000)	£12.56
11241P2CI	11×9½ 2 part (otc) plain listing paper (1,000)	£15.93
11241P3CI	11×9½ 3 part (otc) plain listing paper (700)	£17.86
11370R160	11×14½ 1 part ruled listing paper (2,000)	£16.20
11370R2NC	11×14½ 2 part (ncr) ruled listing paper (1,000)	£22.50
11370R2CI	11×14½ 2 part (otc) ruled listing paper (1,000)	£15.00
12235P160S	12×9½ 1 part plain listing paper with side perfs. (2,000)	£12.00
HR1R	Brother HR1 ribbon	£2.20
RIB119	Diablo Hytype II Multistrike film ribbon	£1.75
GP205	Diablo Hytype II fabric ribbon	£2.50
MX80	Epson MX80, RX80, FX80, fabric ribbon	£3.00
MT80	Mannesmann Tally MT80 film ribbon	£6.50
RIB117	Uchida DWX305 multistrike film ribbon	£2.75
HR5R	Brother HR5 ribbon	£2.20
HR15R	Brother HR15 multistrike ribbon	£4.00
HR25R	Brother HR25 multistrike ribbon	£4.00
	Brother daisy wheels	£14.00
	Uchida/Qume daisywheels	£4.00
LAB089361C	3½×1 7/16 Labels — 1 wide (8,000)	£20.00
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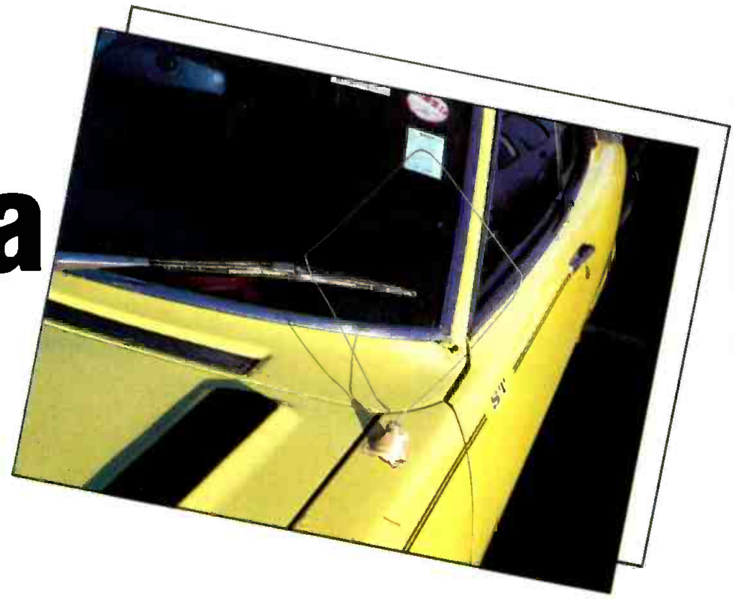
CIRCLE 36 FOR FURTHER DETAILS.

The end of the coat-hanger era



Vandal-proof demister aerials for m.f. and v.h.f. reception in cars

by J.D. Last and B. Easter

Brian Easter and Dr David Last of the University College of North Wales, Bangor, were consultants to Industrial Development Bangor (UCNW) Ltd.

Fig. 1. An early window aerial formed by conductors up the centre and along the edges of the glass of the windscreen, retaining good visibility.

Fig. 2. VHF/f.m. aerial and matching circuit printed in the narrow space above the heater conductors of the rear window.

Whip aerials of about 1m length have been the standard broadcast receiving aerials on cars for many years, yet they have a number of serious disadvantages. They are expensive to fit, requiring the metalwork to be drilled; they corrode so that their performance deteriorates; they injure pedestrians in accidents, and they cause significant aerodynamic drag increasing fuel consumption. From the owner's viewpoint they are a nuisance in garages and car-washes and they present an irresistible temptation to vandals — and a source of profit to coat-hanger manufacturers!

These snags have stimulated engineers into a long search for satisfactory alternatives. Short 40cm whips, mounted on the roof or boot, are now widely used in West Germany. Active aerial techniques, employing amplifiers in the base mouldings, compensate for the loss of signal due to their reduced length. But these aerials can still be damaged and corrode.

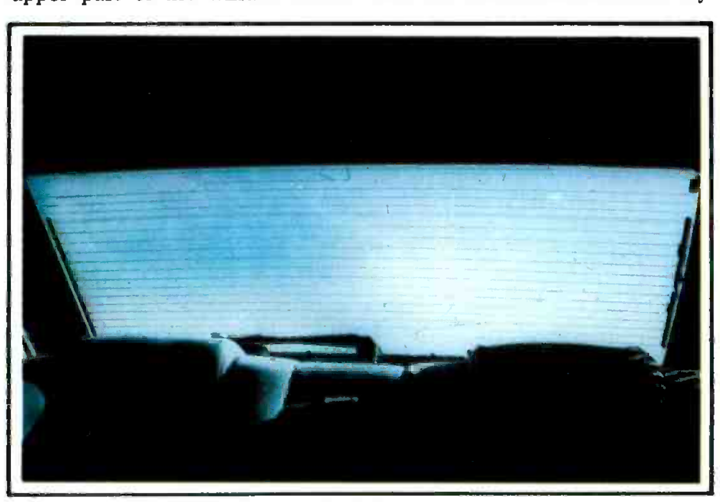
There has also been a major effort to develop windscreen aerials that are both vandal and corrosion-proof and which do not protrude from the vehicle[1]. Fine conductors are inserted between layers or deposited on the surface of the glass. However, any window aerial is limited in size and must be inconspicuous. Conductors are more intrusive on the windscreen than on any other window so designers have been obliged to concentrate them towards the edges of the glass, undesirably close to the metal bodywork, Fig. 1. The windscreen aerial is also adjacent to powerful sources of electrical interference — the engine, windscreen wipers and the many accessories concentrated on both sides of the firewall.

Why not put the aerial on the rear window instead of the windscreen where it is less intrusive and further from the engine? Unfortunately the demister has already claimed most of the area of the glass, though it is possible to reduce the size of the demister sufficiently to squeeze in an aerial for the v.h.f. f.m. band above it, Fig. 2. Again the aerial is close to the bodywork and prevents the upper part of the window from being demisted.

An attractive technique, which we have chosen, is to use a full-size, no-compromise demister and use it simultaneously as an aerial. This approach makes the most efficient use of the window aperture to provide an aerial of substantial size.

But, there is a major obstacle: signals received on the demister must be separated from the heater supply — a direct current of typically 15A which carries electrical interference. This is a difficult problem for medium and long-wave reception (155-1605kHz). The heater current may be passed through ferrite-cored chokes, Fig. 3(a), but the aerial is a voltage source of high capacitive reactance at these low frequencies so the chokes must be physically small, have high impedance, and also be able to pass heavy currents without saturating.

The solution to these conflicting requirements is to wind bifilar chokes, Fig. 3(b), in which the magnetic fields due to the currents flowing to and from the demister cancel one another[2]. By



maximizing winding efficiency, it is possible to manufacture chokes of 1mH inductance using ferrite pot-cores of only 25mm diameter. Their resistance must also be controlled so that they drop less than 500mV at 15A heater current.

Simply connecting the radio receiver to the aerial via a d.c.-blocking capacitor and a cable — as in Fig. 3(b) — is inefficient. Car radio receivers are designed to be used with conventional whip aerials fitted with low-capacitance coaxial feeders that offer a source capacitance of approximately 80pF. The tuning circuits of many radios will not track correctly if the aerial capacitance is outside the limited range of their adjustable compensating capacitors. When using a feeder of too great a capacitance — an extension lead from a rear-mounted aerial, for example — a small series capacitor is fitted which brings the source capacitance at the radio into range. Inevitably, this reduces the signal voltage at the aerial terminals of the radio by potential division.

Rear window demisters normally have capacitance to ground values in the range 75-400pF. With the series capacitor technique, Fig. 4, not only is the potential division between the source and the chokes-plus-series-capacitor substantial but the inductive susceptance of the chokes still leads to imperfect receiver tracking. This arrangement typically gives 20dB less sensitivity than a wing-mounted whip aerial.

The situation can be greatly improved by isolating the cable from the aerial using a buffer amplifier, even a simple voltage follower. A further improvement results from redesigning the conductor patterns of those demisters that have their terminal bus-bars buried under rubber mouldings; many of these mouldings are not made of rubber at all, but of plastics so loaded with carbon as to be electrically conductive! Adopting these techniques increases signals at the receiver to a level comparable with those from front-mounted whips — and typically 6dB stronger than rear-mounted ones.

VHF problems are quite different

Isolating the radio signals from the heater current simply requires small chokes and blocking capacitors. But at very high frequencies the performance of demister aerials is found to vary greatly from vehicle to vehicle. This variability occurs because the lengths of the heaters are of the order of half a wavelength so their performance as aerials depends on the details of the conductor patterns, the window aperture sizes and the connecting leads; a few centimetres can make a big difference.

Ideally the complex frequency-dependent impedance of each demister aerial should be matched to the input impedance of the radio across the v.h.f./f.m. broadcasting band — 88-108MHz. The input impedances of car radio receivers at v.h.f. are typically 100 ohms resistive (although often poorly defined) and the characteristic impedances of the feeder cables are similar. Repeatability of the demister impedance from vehicle to vehicle at v.h.f. can again be greatly improved — and the signal levels increased — by removing the bus-bars from the mouldings. All that remains is to match a complex aerial impedance to a badly-defined load across a broad bandwidth!

The problem is simplified by again interposing a buffer amplifier between the aerial and cable and then matching the aerial to the input impedance of the ampli-

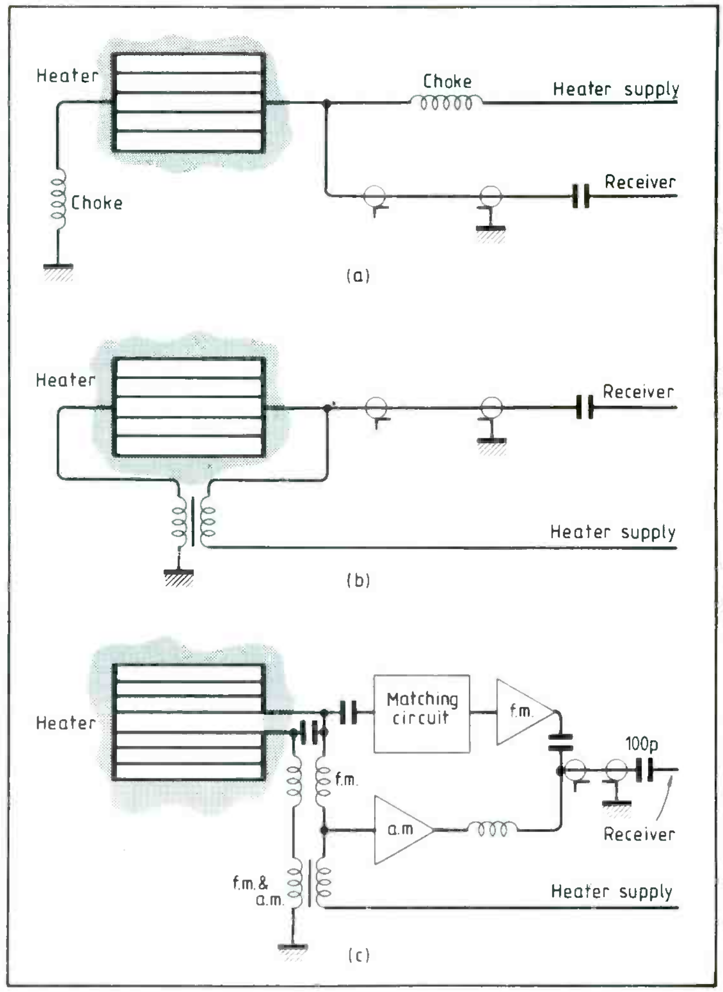


Fig. 3. **A demister may be used as an aerial, with the demister isolated from the heater supply circuit by simple chokes (a). In (b), a single bifilar-wound choke ensures that the d.c. magnetization is eliminated. (c) Shows the complete demister aerial system incorporating a vhf matching circuit and pre amplifiers for both a.m. and f.m. bands.**

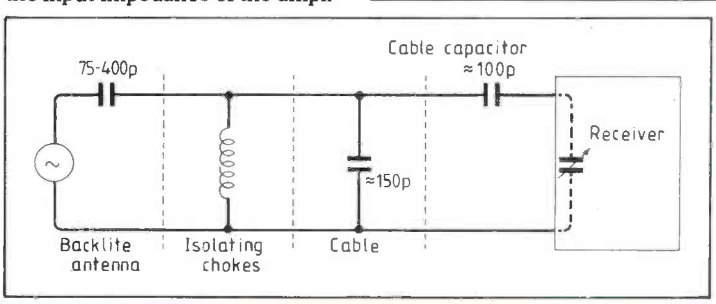


Fig. 4. **Equivalent circuit, for medium and long waves, of the demister aerial with isolating chokes and standard car-radio extension cable incorporating series capacitor. Aerial and cable capacitances form a potential divider which reduces the signal voltage at the receiver aerial terminals.**

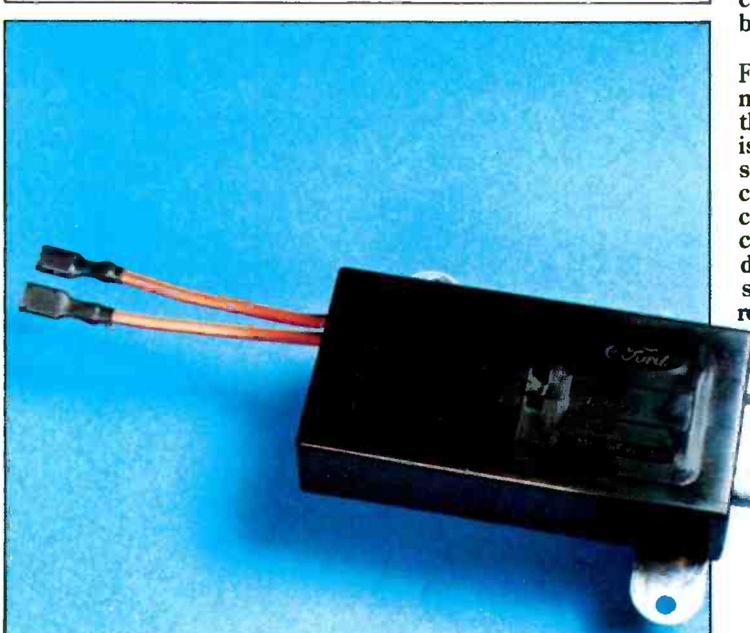


Fig. 5. **Ford Orion demister aerial. The folded heater pattern allows both heater connections to be made via a single isolator unit.**

fier. Choosing a low-noise amplifier and providing an approximately noise-optimal source impedance should enhance the sensitivity of the receiving system. It would be attractive to load each end of the demister with a susceptance making a symmetrical, resonant system with a current maximum in the centre — farthest from the bodywork. But this would mean fitting isolator units at each side of the window.

It is simpler, and very effective, to use a folded demister pattern with one end left open-circuit and the other end loaded and matched in a single unit, Figs 3(c) and 5.

The input impedance of a folded heater of this kind is shown in Fig. 6(a), two connections being common at r.f. Its Q-factor is approximately 20 (others are as high as 50) so the matching must be a compromise over the broad band. Fig. 6(b) shows the source impedance presented to the grounded-gate fet amplifier; a second-order matching network has been employed. Bode's integral indicates that the most complex possible matching network would give a mismatch loss only some 1dB less than this is so the circuit is a reasonable compromise between quality of match and complexity.

The f.m.-band isolating chokes separate the signals into the two

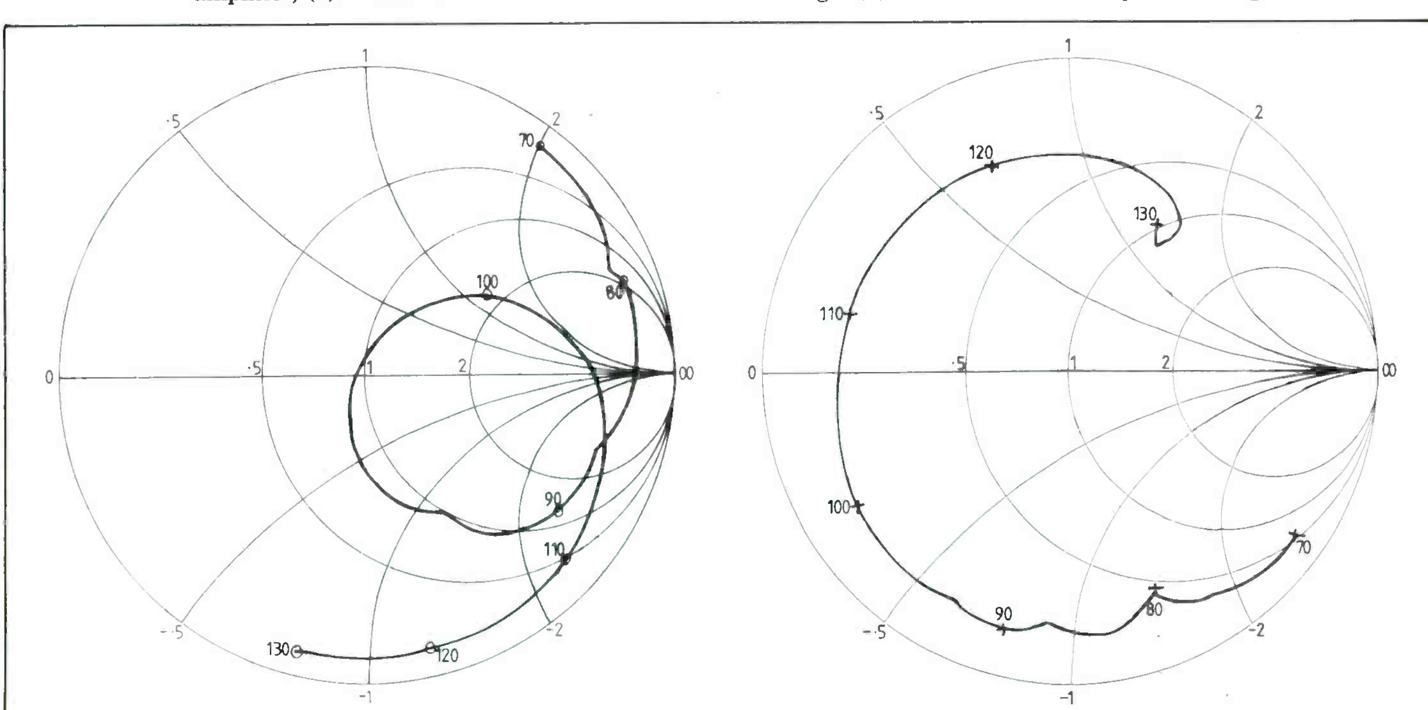


Fig. 6. **Smith chart shows feed-point impedance of the Ford Orion demister aerial (a), and impedance presented to the input of the v.h.f. amplifier, (b).**

amplifiers, see outline schematic of the whole demister aerial system, Fig. 3(c). At the output, the signals are recombined and fed from low-impedance sources via the cable to the receiver. The matching and isolating components are in a small unit which is mounted in the roof pillar adjacent to the demister terminals. It also contains protection against reversed and over-voltage supplies and static discharges to the aerial. An external choke and capacitor filter electrical noise from the demister supply.

The need for effective v.h.f. matching dictates that efficient demister aerials must be designed as original equipment and will differ in detail between vehicle models. Their performance will also depend on the design of the vehicle, as does that of a whip aerial. Fig. 7 compares the v.h.f-band sensitivity of the demister aerial system, fitted as original equipment on a Ford Orion saloon, with that of a quarter-wave whip aerial mounted in the centre of the roof. When receiving horizontally polarized signals at 98MHz the demister provides on average 20dB greater signal voltage at the input terminals of the radio than does the whip. Its sensitivity varies with direction by approximately 3dB r.m.s.

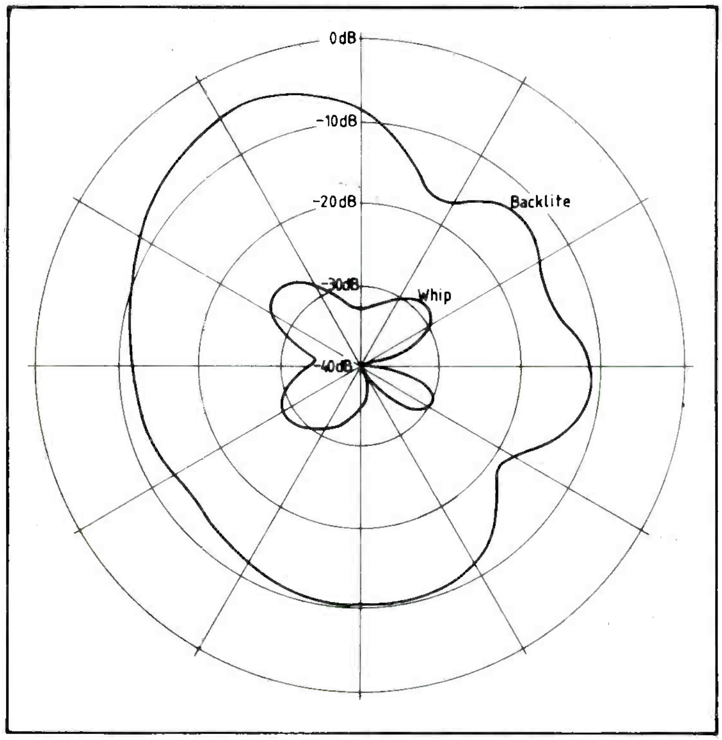


Fig. 7. **Horizontal polar diagram of Ford Orion demister aerial with horizontally-polarized signals — compared with a quarter-wave whip in the centre of the roof. The demister aerial gives substantially greater signal voltages and less variation with direction.**

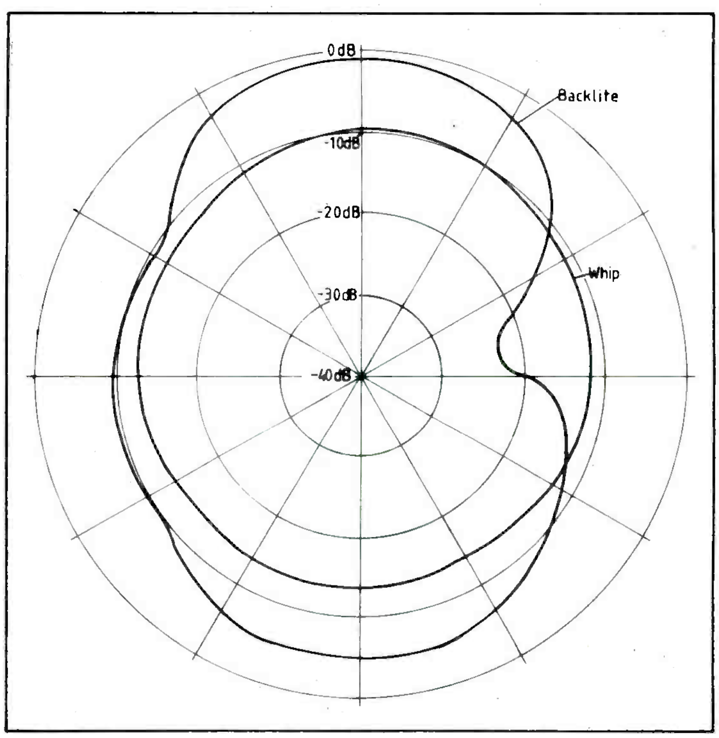
The whip, of course, is much more sensitive to vertically polarized signals, Fig. 8. The demister aerial still gives an average signal 4dB stronger than the whip although it is less-uniformly omni directional. Many UK v.h.f./f.m. broadcasting stations either already transmit mixed-polarized signals or are being converted to do so[3]. In many countries horizontal polarization is employed, so it is important that an car radio aerial is able to receive both planes of polarization effectively.

The gain of the v.h.f. amplifier has been kept low so as to avoid intermodulation problems; 1dB gain compression occurs at an input signal power of −5dBm, well below the signal received at the base of fairly high-powered transmitter masts[1]. Of course, in designing a complete receiving system for a vehicle the gain of the radio must be adjusted to allow for that of the amplifier if the dynamic range is to be optimized.

The level of medium-wave signals received on the demister is within 1dB of those from a wing-mounted whip and about 6dB greater than from a rear-mounted one. At the lowest frequency end of the long-wave band the performance of the demister aerial falls about 8dB below the whip's because of the limited size of the isolating chokes. To have made them larger however would not have increased the signal-to-ambient-noise ratio which is what generally controls the subjective acceptability of automobile long-wave reception.

In hatch-backs or estate cars there is no room to mount the isolator unit at the side of the window so the folded demister pattern shown in Fig. 5 cannot be used. Instead, the bus bars are extended down the sides and along the lower edge of the glass and the isolator is fitted inside the tailgate. This diameter arrangement performs as a radio aerial at least as well as the folded pattern and it can be used on vehicles of all types.

Fig. 8. **Horizontal polar diagram of Ford Orion demister aerial with vertically-polarized signals. The demister aerial provides a performance comparable to the roof-mounted quarter-wave whip which, in this case, is greatly superior to the standard wing-mounted car radio aerial.**



The demister aerial system is not only advantageous to the user but also to the vehicle manufacturer since both labour costs and numbers of parts are reduced. The principal advantage to both parties, however, is the reduction of aerial failures from whatever cause. It is interesting to calculate that the number of car radio aerials manufactured annually world-wide is nearly half the total number of cars in use — and that represents a new aerial for every vehicle each two or three years!

The development of the system described in this article has been the work of a number of people, at BSH Electronics Ltd and Salford Electrical Instruments Ltd, as well as at the Ford Motor Company.

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C3A	22.00
C3JA	22.00
DA41	25.00
DA42	18.70
DAF91	1.75
DAF96	1.75
DET22	35.00
DET24	49.00
DF91	1.75
DF96	1.75
DK91	1.75
DK92	2.00
DK96	1.75
DL92	2.00
DL94	1.75
DL96	1.75
DLS10	14.00
DLS15	12.50
DLS16	12.50
DLS19	12.50
DM70	2.00
DM71	2.00
DM160	4.75
DY87	1.50
DY802	1.50
E55L	45.00
E80CC	8.81
E80CF	11.27
E80F	14.19
E80L	13.73
E81CC	8.00
E81L	13.27
E810F	35.48
E82CC	8.10
E83CC	8.40
E86C	8.25
E88C	8.25
E88CC	8.42
E90CC	9.47
E90F	9.90
E91H	6.25
E92CC	8.75
E99F	9.10
E130L	18.50
E180CC	10.50
E180F	10.20
E182CC	13.25
E186F	11.50
E188CC	8.91
E280F	22.51
E283CC	12.00
E288CC	17.50
EA52	125.00
EA76	2.50
EABC80	1.25
EAC91	3.50
EAF42	2.50
EAF801	2.00
EB41	4.00
EB91	1.50
EBC33	2.50
EBC41	2.50
EBC81	1.50
EBC90	1.25
EBF80	1.50
EBF83	1.75
EBF89	1.50
EBL31	10.00
EC90	1.25
EC91	8.00
EC92	1.75
EC157	410.00
ECC33	4.50
ECC35	4.50
ECC40	4.50
ECC81	1.75
ECC82	1.75
ECC83	1.75
ECC84	1.75
ECC85	1.75
ECC86	2.50
ECC88	2.10
ECC89	2.00
ECC91	8.93
ECC189	2.10
ECC807	1.75
ECC808	3.00
ECF80	1.55
ECF82	1.50
ECF86	2.50
ECH35	3.00
ECH42	3.50
ECH81	3.00
ECH83	2.50
ECH84	2.50
ECL80	1.50
ECL81	1.75
ECL82	1.50
ECL83	3.00
ECL84	1.50
ECL85	1.50
ECL86	1.75
EF37A	5.00
EF39	2.75
EF40	5.00
EF41	3.50
EF42	4.50
EF50	2.50
EF54	5.00
EF55	3.50
EF80	1.75
EF83	4.00
EF85	1.75
EF86	3.50
EF89	2.50
EF91	2.95
EF92	6.37
EF93	1.50
EF94	2.50
EF95	5.99
EF98	2.00
EF183	2.00
EF184	2.00
EF804S	12.00
EF805S	15.00
EH90	1.75
EK90	1.50
EL32	2.50
EL33	4.00
EL34MUL	4.00
EL36	2.50
EL41	2.80
EL42	2.50
EL81	5.25
EL83	6.00
EL84	2.25
EL86	2.75
EL90	2.25
EL91	9.69
EL95	2.00
EL156	30.00
EL360	8.50
EL500/504	3.00
EL509	10.00
EL821	13.00
EL822	13.97
EM34	7.50
EM80	2.50
EM81	2.50
EM84	2.00
EM85	2.75
EM87	2.50
EN32	17.46
EN91	6.50
EN92	6.96
EY51	2.75
EY81	2.50
EY83	2.50
EY84	9.24
EY86	1.75
EY88	1.75
EY500A	3.00
EY802	1.75
EZ35	1.75
EZ40	2.50
EZ41	2.50
EZ80	1.50
EZ81	1.50
EZ90	2.00
FW4-500	3.50
FW4-800	3.50
G1.371K	35.00
G551K	12.00
G180.2M	17.50
G240.2D	12.00
G400.1K	17.50
GN4	9.00
GN4A	9.00
GS16	16.00
GT1C	15.00
GU50	20.00
GU51	20.00
GXU1	15.35
GXU2	30.00
GXU3	25.40
GXU4	44.50
GXU50	20.00
GY501	3.00
GZ32	4.00
GZ33	4.75
GZ34	3.00
GZ37	4.75
KT61	5.00
KT66	15.00
KT77 Gold Lion	12.00
KT88 Gold Lion	20.00
KTW61	2.50
KTW62	2.50
KTW63	2.50
M8079	12.34
M8080	8.25
M8081	9.82
M8082	9.69
M8083	8.58
M8091	10.43
M8096	6.80
M8097	8.10
M8098	8.15
M8099	8.00
M8100	9.52
M8136	10.23
M8137	10.23
M8140	6.00
M8141	6.50
M8142	8.75
M8144	7.50
M8149	6.50
M8161	9.35
M8162	10.40
M8163	8.25
M8190	5.00
M8195	10.85
M8196	7.50
M8204	7.05
M8212	11.37
M8223	6.00
M8224	6.30
M8225	4.50
M8248	14.03
MD2901	115.00
MU14	2.50
MX119	55.00
MX123	72.00
MX145	56.70
MX151	17.25
MX152	131.25
MX161	152.25
MX163	20.25
MX164	25.52
MX166	147.00
MX168	50.00
N78	15.00
OA2	3.25
OA3	2.50
OA4	6.00
OB2	4.35
OB3	2.50
OC2	4.35
OC3	2.50
OD3	2.50
OZ4	3.50
PC86	2.50
PC88	2.50
PC95	1.75
PC97	1.75
PC900	1.75
PCC84	1.50
PCC85	1.50
PCC88	2.00
PCC89	1.75
PCC189	2.50
PCC805	1.60
PCC806	1.60
PCE82	2.00
PCF80	2.00
PCF82	1.50
PCF86	2.50
PCF87	2.00
PCF200	3.25
PCF201	3.25
PCF801	2.50
PCF802	2.50
PCF805	1.70
PCF806	1.70
PCF808	1.70
PCL82	2.00
PCL83	3.00
PCL84	2.00
PCL85	2.50
PCL86	2.50
PCL805/85	2.50
PD500	6.00
PE06-40N	45.00
PFL200	2.50
PL36	2.50
PL81	1.75
PL81A	2.00
PL82	1.50
PL83	2.50
PL84	2.00
PL504/5	2.50
PL508	2.50
PL509	6.00
PL519	6.00
PL801	1.50
PL802	6.00
PY33	2.50
PY81	1.50
PY82	1.50
PY83	2.50
PY88	2.00
PY500A	4.00
PY800	1.50
PY801	1.50
QF451	82.50
QQV02-6	31.80
QQV03-10	23.50
QQV03-20A	48.38
QQV06-40A	75.00
QQV07-50	69.74
QQZ06-40A	75.00
QU37	12.50
QV03-12	6.80
QV04-7	3.50
QV08-100	171.20
QY3-65	63.24
QY3-125	68.64
QY4-250	70.14
QY4-400	76.20
QY5-500	190.00
QY5-3000A	450.00
QZ06-20	32.70
R10	6.00
R17	3.00
R18	3.00
R19	9.24
R20	2.50
RG3-250	32.68
RG3-250A	32.68
RG3-1250	59.50
RG4-1250	61.60
RG4-3000	99.45
RR3-250	40.00
RR3-1250	45.75
S11E12	65.00
S130	6.00
S130P	6.00
STV280-40	14.00
STV280-80	21.00
SU41	5.00
SU42	10.00
TD03-10	35.00
TD03-10F	35.00
TT15	50.00
TT21	30.00
TT22	37.50
TT100	60.00
TY2-125	65.00
TY4-400	80.00
TY4-500	105.00
TY5-500	214.00
TY6-800	210.00
TY6-5000A	490.00
TY6-5000B	395.00
TY6-5000W	425.00
TY7-6000A	525.00
TY7-6000W	525.00
TZ40	25.00
U18-20	3.50
U19	13.75
U25	2.50
U26	2.50
U37	12.00
UABC80	1.25
UAF42	2.50
UB41	3.00
UBC41	2.25
UBF89	1.50
UCC84	1.75
UCC85	1.85
UCF80	2.00
UCH42	2.50
UCH81	2.50
UCL82	1.75
UCL83	2.75
UF41	2.00
UF42	2.10
UF80	1.75
UF85	1.75
UF89	2.00
UL41	5.00
UL84	1.75
UM80	2.00
UY41	2.25
UY85	2.25
VLS631	15.00
XG1-2500	55.00
XG2-6400	141.90
XG5-500	26.60
XG2-6400	162.00
XR1-1600A	53.75
XR1-3200	81.97
XR1-3200A	
XR1-6400	165.00
YD1120	395.00
YD1240	490.00
Z759	25.00
ZM1000	8.00
ZM1001	8.00
ZM1020	9.00
ZM1021	9.00
ZM1022	9.00
ZM1023	9.00
ZM1040	19.36
ZM1041	16.66
ZM1042	17.77
1B3GT	3.00
1B24	25.00
1B35A	48.00
1B63	64.00
1R5	1.75
1S5	1.75
1T4	1.75
2AS15	11.50
2C39A	60.00
2C43	70.00
2D21	3.25
2E26	8.25
2J42	98.00
2J55	175.00
2J70A	383.00
2J70B	336.00
2K25	125.00
3-400Z	85.00
3-500Z	85.00
3A5	3.00
3B24	11.00
3B28	15.35
3B29	20.05
3B240M	17.50
3B241M	17.50
3C23	25.00
3C45	24.50
3CX100A5	47.00
3E29	45.00
3S4	2.00
3V4	1.75
465A	60.00
4-125A	60.00
4-250A	80.00
4-400A	87.00
4B32	20.00
4C35	78.00
4CX250B	45.00
4CX350A	80.00
4X150A	60.00
4X150D	56.00
5B254M	35.00
5B255M	35.00
5C22	160.00
5J180E	1650.00
5R4GY	3.50
5U4G	3.00
5U4GB	2.50
5V4G	2.50
5Y3GT	2.50
5Z3	4.00
5Z4G	2.50
5Z4GT	2.50
6-30L2	1.75
6AB4	1.75
6AB7	3.00
6AC7	3.00
6AF4A	4.25
6AG7	3.00
6AH6	5.00
6AK5	5.99
6AK6	2.50
6AL5	1.50
6AM4	4.00
6AM5	9.69
6AM6	6.02
6AN5	4.75
6AN8A	3.50
6AQ5	2.25
6AS6	8.66
6AS7G	8.75
6AT6	1.25
6AU5GT	5.00
6AU6	2.50
6AV5GA	4.50
6AV6	1.50
6AX5GT	3.00
6B7	3.25
6B8	3.25
6BA6	1.50
6BA7	5.00
6BA8A	4.00
6BC4	4.00
6BE6	1.50
6BH6	2.50
6BJ6	2.25
6BK4	4.50
6BL6	85.00
6BL7GT	4.50
6BM6	115.00
6BN6	2.00
6BQ7A	3.50
6BR7	6.00
6BR8A	3.50
6BS7	6.00
6BW6	6.00
6BW7	1.50
6BX7GT	5.00
6BZ6	2.75
6C4	1.25
6CB6A	2.50
6CD6GA	5.00
6CG7	2.50
6CH6	13.00
6CL6	3.75
6CW4	8.00
6D2	1.50
6DK6	3.00
6DQ6B	4.75
6EA8	3.00
6EB8	2.50
6EW6	2.25
6F6	3.00
6F23	1.60
6F28	1.60
6F33	33.50
6H1	14.00
6H2N	2.75
6H3N	2.75
6H6	3.00
6J4	5.50
6J6	8.93
6J7	4.75
6K4N	2.50
6K6GT	2.75
6K7	3.00
6K8	3.00
6KD6	7.00
6L6G	3.00
6L6GA	3.00
6L6GC	3.50
6L6GT	3.00
6L7	2.50
6N2P	2.50
6N3P	2.50
6N7	3.00
6P25	4.00
6Q7	3.75
6R7	3.25
6SA7	3.00
6SC7	2.75
6SF7	2.50
6SH7	3.00
6SJ7	3.25
6SK7	3.50
6SK7GT	3.00
6SN7GT	3.00
6SQ7	3.40
6SR7	4.00
6SS7	2.75
6U5G	3.50
6U8A	2.25
6V6GT	2.25
6X4	2.00
6X5GT	1.75
7B7	2.50
7C5	4.00
7C6	2.50
7H7	4.00
7R7	4.25
7S7	3.50
7Y4	2.25
7Z4	2.00
11E3	55.00
12AH8	5.00
12AT6	1.50
12AT7	1.75
12AU6	2.50
12AU7	1.75
12AV6	2.50
12AV7	3.50
12AX7	1.75
12AY7A	4.00
12B4A	3.50
12BA6	2.50
12BE6	2.50
12BH7	2.75
12BY7	3.00
12E1	20.00
12E11TT	28.00
12E14	65.00
13E1	170.00
19H4	27.50
19H5	47.50
24B9	67.25
30C15	2.00
30C17	2.00
30C18	2.00
30F5	1.60
30FL1/2	1.38
30FL12	1.80
30FL14	2.00
30L1	1.50
30L15	2.00
30L17	2.00
30P4	2.50
30P19	2.50
30PL1	3.00
30PL14	1.80
30PL15	1.80
35W4	1.00
50C5	1.50
75B1	6.05
75C1	4.50
85A1	7.50
85A2	6.45
90AG	12.96
90AV	12.96
90C1	6.00
90CG	14.54
90CV	15.45
92AG	20.00
92AV	20.00
95A1	8.45
150B2	6.50
150B3	8.35
150C2	3.25
150C4	6.00
211	35.00
723AB	125.00
803	25.00
805	45.00
807	3.75
811A	18.33
812A	29.50
813 valve	65.00
833A	193.16
866A	20.03
872A	20.00
922	6.00
931A	18.50
1624	4.00
1625	3.50
2050	7.50
4212E	300.00
4212H	300.00
5544	81.97
5545	165.00
5551A	114.90
5552A	155.35
5642	9.00
5654	3.00
5651	4.45
5670	4.50
5675	28.00
5687	6.00
5696	4.50
5718	7.50
5725	5.50
5726	11.37
5727	7.05
5749	2.50
5751	4.00
5763	4.50
5814A	4.00
5840	4.00
5842	12.00
5876A	31.50
5879	5.00
5886	17.50
5963	2.50
5965	3.50
6005	2.25
6021	4.50
6057	10.23
6058	12.34
6059	6.00
6061	6.00
6063	3.75
6064	8.58
6067	10.23
6072	6.00
6080	14.00
6097A	235.00
6097B	200.00
6146A	8.25
6146B	12.00
6159B	19.00
6189	9.50
6201	11.40
6442	20.00
6883B	8.25
6973	4.00
7025	3.00
7551	6.25
7586	15.00
7587	23.00
7609	56.00
7868	6.00
7895	12.00
8005	110.49
8068	14.00
8122	100.00
8136	2.50
8417	6.00
18042	11.53
18045	10.49

Tested
Ex-Equipment
4CX250B 6.50
CV Devices
Large stocks
Prices on application

BASES

Type	Price
B7G unskirted	0.25
B7G skirted	0.35
B9A unskirted	0.25
B9A skirted	0.35
Int Octal	0.35
Loctal	0.55
Nuvistor base	2.00
Valve screening cans all sizes	0.40

CRTs

Type	Price
2AP1	8.50
2BP1	9.00
3BP1	12.00
3DP1	5.00
3EG1	10.00
3FP7	6.00
3GP1	6.00
3JP1	8.00
3JP2	8.00
3JP7	10.00
3KP1	15.00
3RP1	35.00
3WP1	20.00
5ADP1	55.00
5CP1	10.00
5CP1A	40.00
5FP15A	15.00
5UP7	25.00
DG7-5	63.32
DG7-31	58.07
DG7-32	58.07
DG7-36	65.00
DH3-91	56.83
DH7-11	113.12
VCR97	12.00
VCR138	12.00
VCR138A	12.50
VCR139A	8.00
VCR517B	10.00
VCR517C	10.00

CRT sockets,
Prices on application

I/C sockets
Texas
low profile

Type	Price
8 pin	10p
14 pin	10p
16 pin	10p

INTEGRATED CIRCUITS

Type	Price
7400	0.16
7401	0.17
7402	0.17
7403	0.17
7404	0.18
7405	0.18
7406	0.43
7407	0.43
7408	0.20
7409	0.20
7410	0.17
7412	0.29
7413	0.32
7416	0.32
7417	0.32
7420	0.18
7422	0.20
7423	0.33
7425	0.30
7427	0.30
7428	0.43
7430	0.17
7432	0.30
7433	0.40
7437	0.32
7438	0.32
7440	0.32
7441	0.90
7442	0.72
7447AN	1.17
7450	0.18
7451	0.18
7453	0.18
7454	0.18
7460	0.18
7470	0.38
7472	0.33
7473	0.38
7474	0.38
7475	0.54
7476	0.42
7480	0.56
7482	0.75
7483	1.00
7484	1.05
7486	0.39
7490	0.60
7491	0.82
7492	0.60
7493	0.60
7494	0.82
7495	0.73
7496	0.82
7497	3.15
74100	1.54
74107	0.45
74109	0.73
74110	0.51
74111	0.71
74116	1.85
74118	1.00
74119	1.54
74120	0.83
74121	0.43
74122	0.62
74123	1.18
74125	0.58
74126	0.58
74128	0.63
74132	0.72
74136	0.51
74141	0.89
74142	2.30
74143	2.60
74144	2.60
74145	1.00
74147	2.00
74148	1.76
74150	1.80
74151	0.94
74154	1.80
74155	0.90
74156	0.90
74157	0.75
74159	2.20
74170	2.40
74172	4.40
74173	1.42
74174	1.60
74175	1.02
74176	1.16
74178	1.36
74179	1.36
74180	1.20
74190	1.90
74191	1.90
74192	1.90
74193	1.90
74194	1.25
74195	1.20
74196	1.35
74197	1.35
74198	2.70
74199	2.30
TAA570	2.30
TAA630S	3.50
TAA700	3.90
TBA480Q	1.84
TBA520Q	2.30
TBA530	1.98
TBA540Q	2.30
TBA550Q	3.22
TBA560CQ	3.22
TBA673	2.20
TBA700	1.52
TBA720Q	2.30
TBA750Q	2.07
TBA800	1.20
TBA920	2.90
TBA920Q	2.90
TBA990Q	2.90
TCA270Q	2.90
TCA760A	1.38

Terms of business: CWO. Postage and packing valves and semiconductors 50p per order. CRTs £1.50. Prices excluding VAT, add 15%. Price ruling at time of despatch.
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CIRCLE 23 FOR FURTHER DETAILS.

Variable-speed video playback

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

D-a conversion, colour processing and dropout compensation

Most TBC d-to-a convertors follow a conventional layout where switched current sources, one for each bit, feed a resistor ladder. In discrete component d-to-as the current sources will be factory adjusted by presets to the correct binary weighting. A benefit of the adoption of monolithic d.a.cs will be the elimination of these adjustments. Figure 1 shows the essentials of a video d.a.c. Note that all of the current sources are programmed by a single reference, which can be used to set the gain. The current switches are differential, which means that current is either fed into the ladder or sunk. The current sources thus see a more constant load than would be the case with single-pole switching.

The d.a.c. proper is immediately followed by a resampling gate. The function of this gate is twofold. Firstly, skew between data bits will cause transients from the d.a.c., and the gate will be arranged to be open circuit until the d.a.c. settles. This however is not the prime function of resampling. In the absence of resampling, the d.a.c. output frequency response would be that of a zero-order hold sampling system, i.e. the aperture ratio is 100%, which causes the output level to roll off to 64% of maximum at half sampling rate. The resampling process reduces the aperture ratio to the duty cycle of the gate, yielding a corresponding improvement in frequency response. The effect of resampling at various apertures is shown in Fig. 2. The chosen aperture ratio reflects a compromise between the perfect frequency response of an impossible zero aperture, and the reasonable output signal level from a large aperture. A common figure is 50% since this permits the drive to the switch to be transformer coupled. An aperture-effect equalising circuit will be necessary following resampling. Since the aperture effect causes a sin x/x response, the natural choice is a cosine filter, but tuned circuits can also be found. A reconstruction filter returns the output of the resampler to a continuous analogue waveform. The frequency response of an ideal filter would be linear up to half the sampling rate, and have infinite attenuation thereafter. However, the use of 3× or 4× subcarrier sampling rates allow the use of filters with finite slope, as was the case for the antialiasing filters described earlier in the series.

Following restoration to the analogue domain, the signal now has reference-derived syncs and bursts added. The usual video processes of dark clipping, differential gain and phase compensation and chroma level adjustment can then be carried out before the signal is finally available for output. Figure 3 shows the overall subsystem. The d.a.c. completes the description of the simple TBC block diagram shown in Part 2. Dropout compensation and colour processing were omitted from this block diagram both for clarity and because there are a number of possible configurations.

Colour processing and dropout compensation

These two TBC subsystems have completely different functions, but are usually found together since common circuitry can be used for both. The necessity for dropout compensation (hereafter abbreviated to DOC) is self evident, and although it has nothing to do with timebase correction per se, it is implemented in TBCs

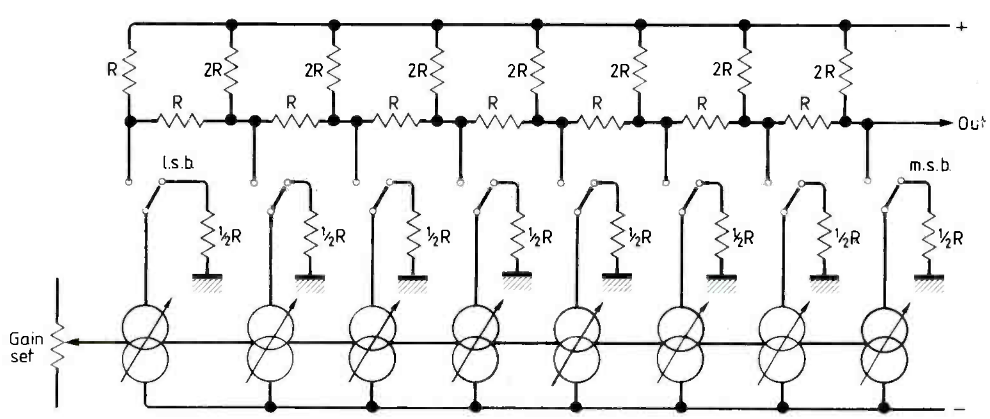


Fig. 1. **Typical video d-to-a convertor. Programmed current sources feed resistor ladder. Alternatively, current sorces in power ratios can be summed, or a combination of both used.**

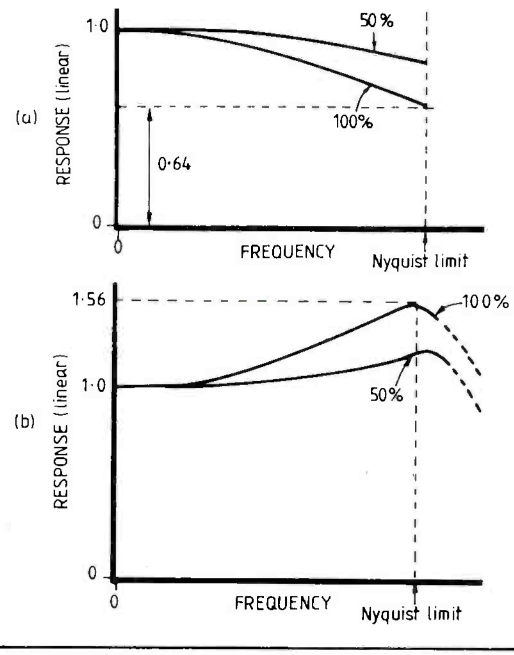


Fig. 2. **Aperture effect in resampling shown at (a) causes h.f. loss dependent on aperture ratio. In (b) the aperture correction required is less for 50% aperture ratio.**

*Ampex (GB) Ltd.

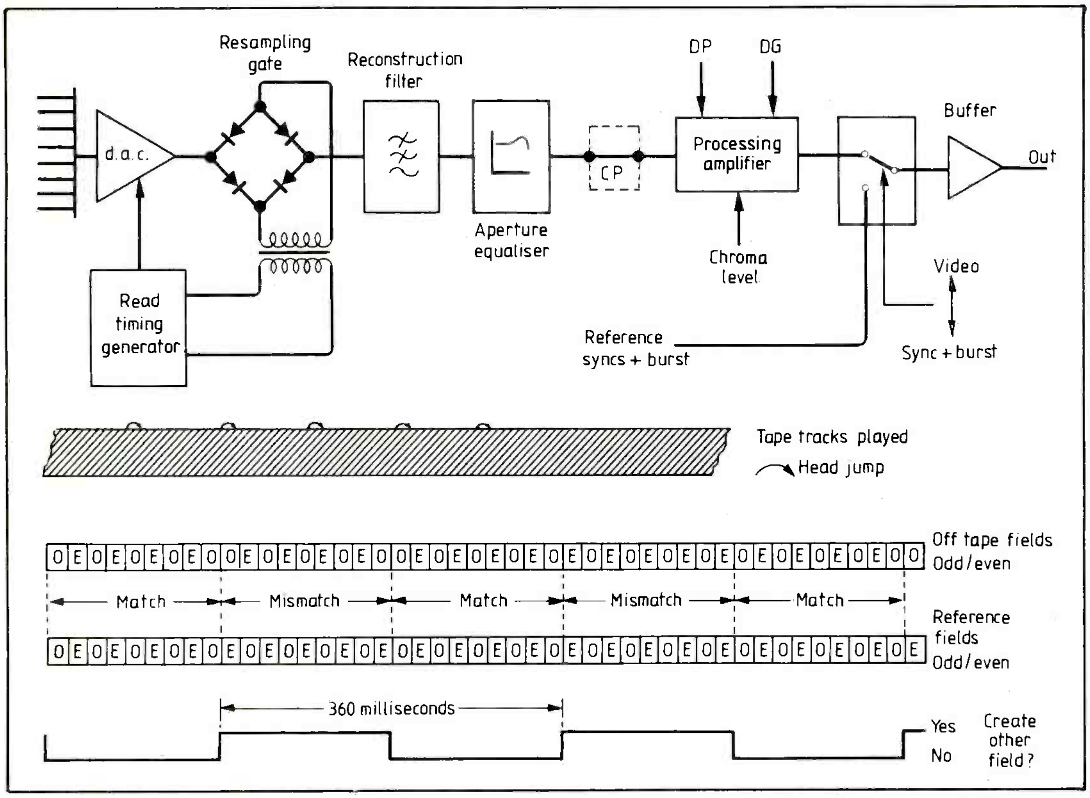


Fig.3. **Simplified d-to-a and output subsystem converts memory samples to analogue video and adds reference sync pulses and bursts. For varispeed a colour processor is necessary and this is connected at 'CP' if colour processing follows timebase correction.**

Fig.4. **Variable-speed operation causes infrequent jumps at near-writing speed. This causes a low-frequency alternation between full interlace and field mismatches. In this example, at approx. 10% above normal speed, the head traces nine tracks and then jumps one, giving a match/mismatch period of 360ms. At 1% above normal speed, the period is about four seconds.**

because it is conveniently done in the digital domain.

Dropout compensation depends on the substitution of information from previous lines, which on typical programme will correlate reasonably well. Owing to the PAL four-line sequence, unaltered video from the previous line would be useless since it would have the wrong V-switch sense and Sc-H phase. Video from four lines back would not correlate well with the missing information. The solution is to separate luminance and chrominance. Luminance from the previous line is used to give good subjective correlation, and inverted chrominance from two lines back is added to it. Chrominance separation and inversion are relatively simple in digital circuits.

The use of variable speed means that fields are repeated or skipped, and the eight-field sequence of broadcastable PAL is broken. The most obvious difficulty is that the odd-even field sequence necessary for interlace will be broken, and the TBC may have to generate an even field from an odd field or vice versa. The greatest problem is, however, the effect of track jumps on Sc-H phase.

At normal speed, a TBC locks to offtape bursts to write the memory and to reference bursts to read it. The TBC is essentially using its variable delay to line up offtape subcarrier to reference. If an out-of-sequence field is presented to a TBC operating in this mode, it will still line up the offtape bursts to reference, but it will do so at the expense of a horizontal picture shift which will be plus or minus 56 or 112 ns, depending upon the way in which the sequence is broken. Variable-speed operation would result in random picture shifts making the programme unviewable.

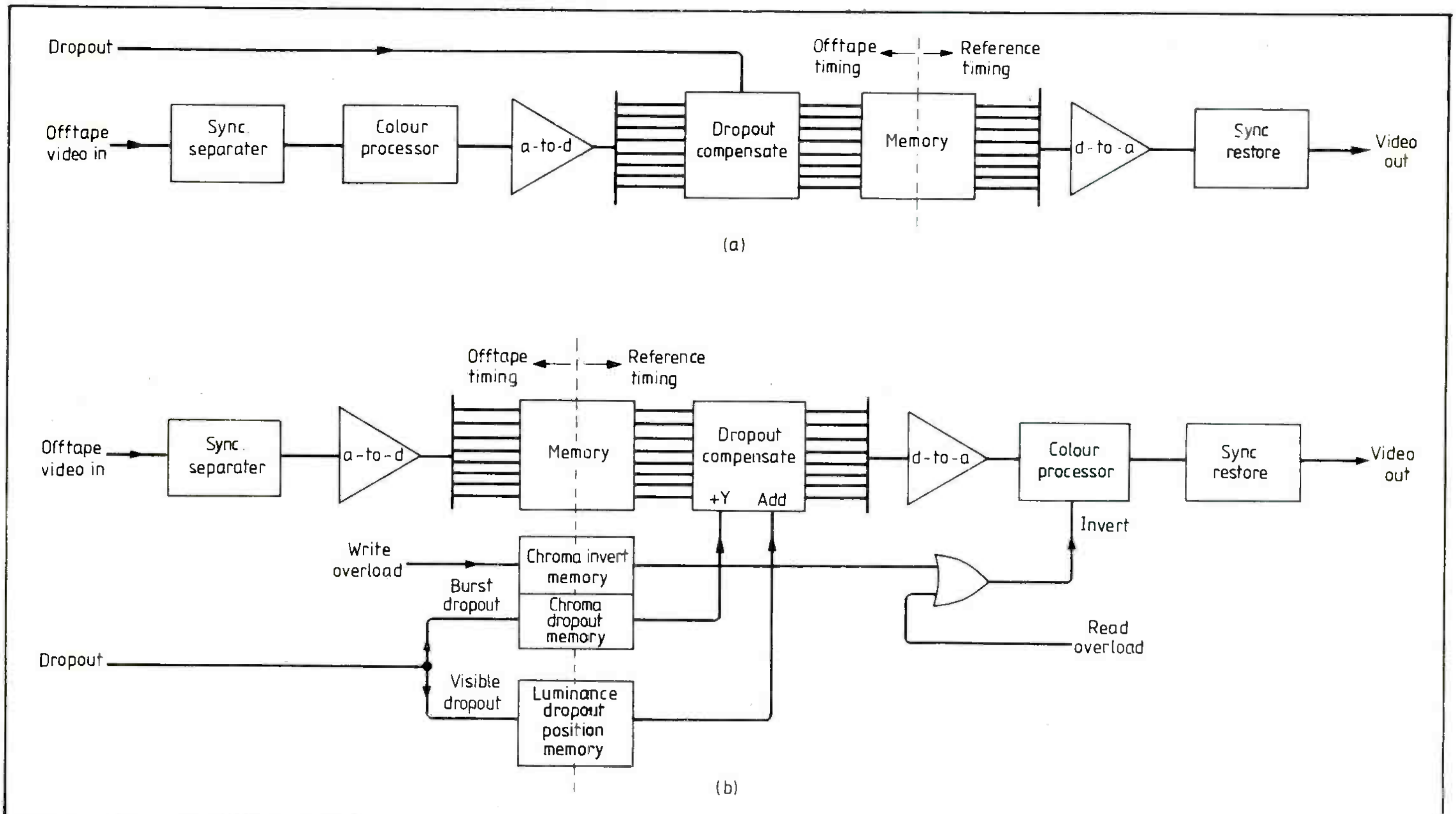
The only solution to picture shift is to decode the PAL waveform back to Y, U and V using offtape subcarrier, and re-encode using reference subcarrier. This is the function of the colour processor. Further colour processing in some TBCs consists of chroma noise reduction by line averaging, and the provision for use with colour-under-type video cassette recorders.

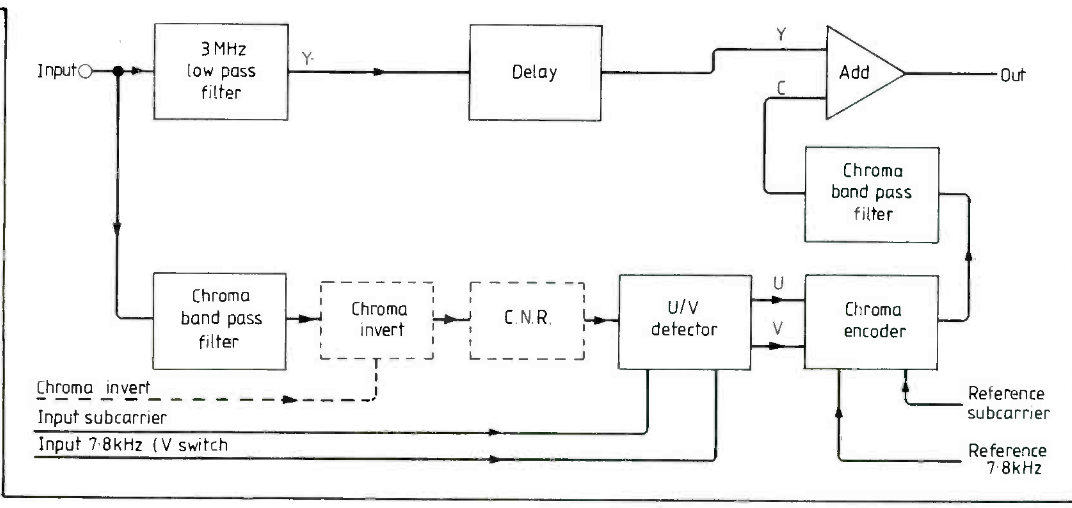
The creation of odd fields from even and vice versa can be achieved in two different ways. Since the TBC line addressing system is locked to H-pulses, the $\frac{1}{2}$H shift relative to vertical timing will be removed by default when the memory is read. An alternative is to interpolate the luminance for one field from adjacent lines above and below in the other field. The lower resolution of chroma renders chroma interpolation superfluous. The process requires Y/C separation, which is also a requirement of the DOC circuit. The luminance interpolator can thus be a part of the dropout compensator, which is why the two are associated in this description and in real hardware. Furthermore, similar timing signals are required by both, making for a more elegant design if both subsystems are on the same side of the memory.

It is interesting to compare the subjective results with and without interpolation. At a speed close to normal, track jumps will be of one track only, and may be several seconds apart. Figure 4 shows that offtape odd-even timing will change at each jump, spending a roughly equal amount of time matched and mismatched with respect to reference. The default approach simply moves an odd field down the screen by one line to create an even field up a line to create an odd field. The critical eye can perceive these vertical shifts at each track jump. The process of interpolation eliminates the vertical movement, but when there are slowly alternating matches and mismatches, the interpolator can be seen to turn on and off, causing a focus popping effect. One or other of these phenomena has to be accepted due to the fundamental field-per-track layout of C-format.

To overcome these problems in stop motion, most v.t.rs offer the stop-frame facility, where two fields are repeatedly scanned (see Part 1). This gives better results on slowly moving scenes, whereas still-field is to be preferred for rapid movement since adjacent fields will not then correlate well. Some top-of-the-range broadcast recorders offer a tape speed offset facility, where the capstan is driven at a small but very precise offset from unity speed. This allows slightly overlength programmes to be squeezed into scheduled times. In this mode the v.t.r. can be set up to lock offtape odd-even fields to reference, and maintain that lock by using only two track jumps. The picture jerks due to two track jumps are clearly twice as great as with single track jumps, but they are infrequent in t.s.o. mode, and the provision of full interlace is to be preferred.

Clearly the combined effects of odd-even field restoration and colour processing must result in a reduction in the resolution of the picture. The colour processor usually restricts luminance bandwidth deliberately, to match horiztonal resolution to the degraded vertical resolution, since anisotropic resolution looks odd. The softness of a varispeed picture





can be discerned, but at low speeds it is masked by blur due to subject movement, and at high speeds the eye is distracted by the rapidly changing scene.

Varispeed operation causes changes in offtape subcarrier frequency, but the colour processor depends upon fixed delays and filters for its operation. Where a colour signal is only necessary over the broadcast speed range (typically $-1\times$ to $+3\times$) the change in subcarrier frequency is relatively small, and the colour processor can be installed before the a-to-d convertor. The DOC will then be fitted between the a-to-d and the memory. Such a TBC will resort to monochrome operation in shuttle. Where colour in shuttle is provided, colour processing can only take place after timebase correction, and DOC will then be between memory and the d.a.c. Figure 5 compares these configurations.

Colour processor

Figure 6 shows the block diagram of a typical colour processor. Luminance is separated by a low-pass filter of about 3MHz to give isotropic resolution. Chrominance is separated by a bandpass filter. Input burst drives a v.c.o. which provides the reference for the U and V detectors. The U and V baseband signals are now re-encoded at the desired Sc-H relationship, and the resulting chroma is added to the luminance. A small delay in the luminance path compensates for the chroma delay due to decode-encode.

If the colour processor precedes the memory, then this is all that is necessary. The input will be offtape video, and the reference will be advanced to compensate for the TBC delay. Data entering the memory in such a system will therefore be in an eight-fold sequence even in varispeed. Reading the memory is quite straightforward.

If the colour processor follows timebase correction to provide colour in shuttle, there are a number of additional problems. Memory overloads are a normal event in shuttle, and to reduce the effect on the picture, they are achieved with two-line address jumps. However, in colour, a two-line address jump causes a chroma inversion, and the colour processor needs a compensating inversion circuit and control logic.

Overloads can occur on read or write, but both need compensation. The memory thus has to store a data bit for each line to indicate if a write overload took place until the line is read. The chroma invert memory is used for this purpose. The invertor is driven by an Or function of chroma-invert memory output and read overload. Since write overloads only occur in forward shuttle and read overloads only occur in reverse, simultaneous

Fig.5. **Simplest approach to varispeed TBC is at (a). Colour processor and DOC precede the memory. Since colour processor precedes timebase correction, colour is only available over the broadcast speed range. System reverts to monochrome in shuttle.**

Fig.6. **Colour processor block diagram. Following Y/C separation, optional chroma inversion (for colour shuttle TBCs) and chroma noise reduction, chroma signal is detected input burst derived reference, back to baseband U and V signals. These feed encoder which produces chroma relative to reference Sc and V switch.**

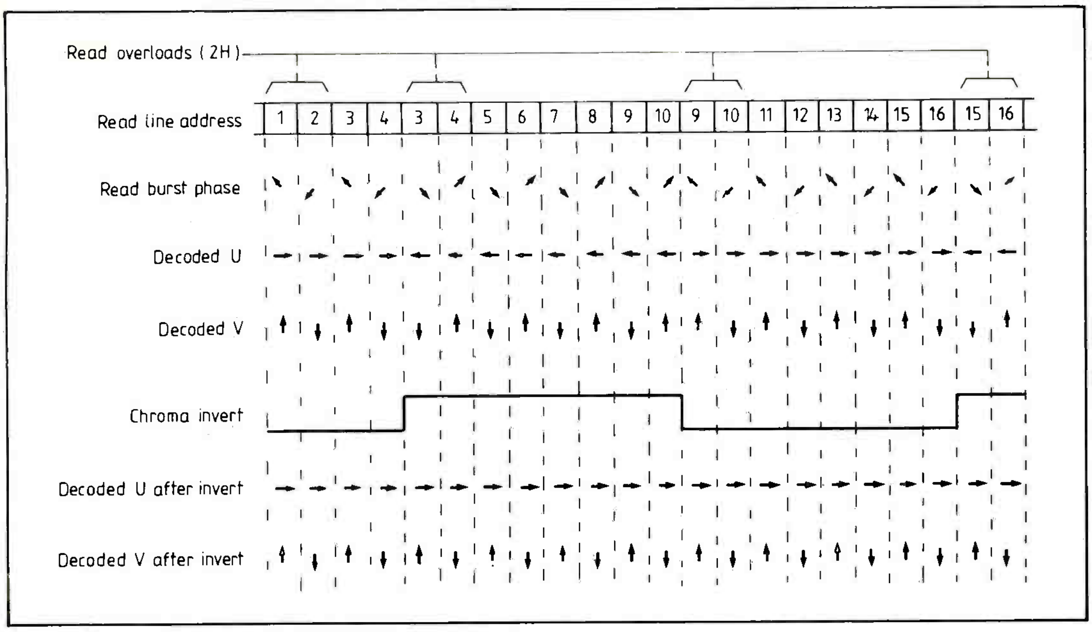


Fig.7. Example of chroma inversion. In reverse shuttle, read overloads occur periodically, causing two memory lines to be re-read (3,4:9,10:15,16). Owing to the PAL four-line sequence, this causes chroma inversion, decodes of U and V being in error. Chroma invert signal, effectively Overload/2, compensates for overload by inverting chroma before decoder. In forward shuttle, write overloads have similar effect except that overload is stored in chroma invert memory until line is read.

write and read overloads, which would mutually cancel, do not occur. Figure 7 shows the timing of a chroma inversion sequence. Optional extras shown in Fig. 6 are now described.

Since the presence of V-switch spectrally separates U and V energy by half-line-rate spectral steps, it follows that a 1H delay comb filter will separate U and V and line average them. Line averaging degrades vertical chroma resolution by a factor of two to give a 3dB improvement in chroma s/n. Owing to the fixed 1H delay, CNR is only possible after timebase correction.

Most C-format TBCs also support the use of ¾in U-matic cassette recorders. Since these machines do not have ful bandwidth, chroma is down converted to a subcarrier of about 1MHz which can be accommodated below the f.m. luminance carrier spectrum. On playback this so-called colour-under signal is heterodyned with a local oscillator to return the subcarrier to the correct frequency. However, if the oscillator frequency is fixed, timebase correction becomes impossible because the upconverted chroma in the presence of jitter will be at a difference frequency which is not proportional to head-to-tape speed. The solution is to use a heterodyne frequency which is locked to playback H-rate, which will follow playback instabilities to produce an upconverted signal, whose instabilities are proportional to head-to-tape speed and can be corrected. The TBC takes offtape H and sends back to the v.c.r. a reference subcarrier with the same instabilities. The v.c.r. controls the local oscillator to make the upconverted chroma the same frequency as the reference. Standard PAL subcarrier frequency is not used, since the relationship to H is so complex: a frequency of 282fH is commonly used. The v.c.r. chroma will now have the same instabilities as the luminance, but the wrong subcarrier frequency. This is easily solved since the decode/encode in the colour processor can be used to change subcarrier frequency for U-matic playback just as easily as to change subcarrier phase for varispeed C-format playback. This frequency-changing facility will be built into the colour processor, whereas the 282fH generator will generally be an option, since it is not needed for C-format only. Figure 8 shows the essentials of a colour-under heterodyne configuration.

Dropout compensation

When the v.t.r. plays over a tape defect, the r.f. level falls, and the signal will be noisy. The v.t.r. detects the loss of r.f. and replaces the noise with black level: a logic level dropout signal is sent to the TBC. An alternative is to send an analogue r.f. level signal so that the TBC can detect dropouts for itself. The use of prior line luminance replacement implies Y/C separation, and this is most conveniently achieved with digital filters, the advantages being that no setting up or tuning is necessary in manufacture, and there is no response drift due to component ageing. The accuracy of Y/C separation for DOC does not have to be very high, since the transient nature of dropouts prevents critical appraisal of the substitution. Provided the replacement video has reasonably well matched luminance, and is roughly the right colour, dropouts will go unnoticed.

The series will conclude with a piece on digital filtering.

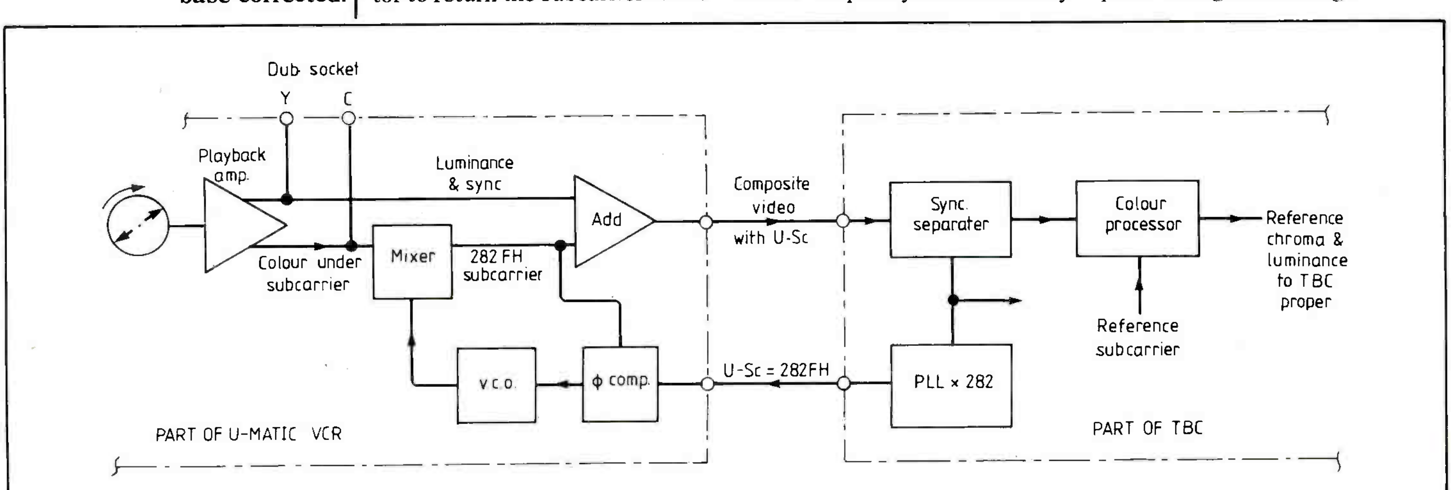
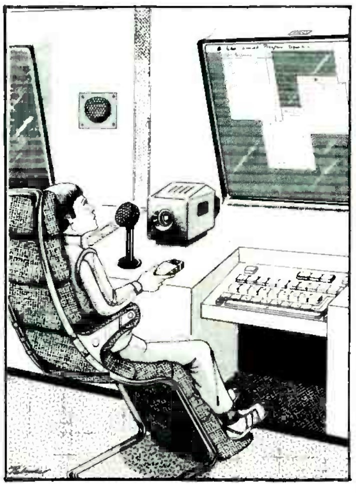


Fig.8. With U-matic type v.c.rs, offtape unstable line rate is multiplied by 282 to give head-to-tape speed proportional to frequency. Colour-under offtape signal is heterodyned with a v.c.o. whose frequency is controlled to make output heterodyne frequency equal to V-Sc input. Up-converted chroma now has same instabilities as luminance, and can be time-base corrected.

by A.E.Cawkell

The information society

How society is changing . . . or is it?



By focusing on information, we force ourselves to consider the route along a thorny track towards an inevitable outcome — a world where the production of goods and many services are performed by machines provided with the necessary information. The claim has already been made, as stated earlier, that 50% of the US labour force (and by implication a substantial percentage in other countries) is engaged in information processing. What does that imply?

The figures originally generated by Porat, and discussed by Parker & Porat[3,23], encourage the belief that a very large number of people are generating information, a resource having very different properties from the goods and services on which the economics of many countries are based, with the result that there may be a dramatic change of some kind which justifies the claim that we are moving into an Information Society. The figures were based on 1967 data. They have recently been up-dated to 1972 and give similar results — there was little change in that period in the percentage of US labour in information processing[73].

About 29.5 million people were engaged in information processing according to Porat. Nearly 80% of this total can be aggregated into the following general occupations from the detailed categories given in the original table:

Table 2. Information processing occupations in the USA

Occupation	Number (Millions)
office workers	8.52
managers	5.57
teachers	3.1
professions	2.94
communication & computer people	1.76
engineers & draughtsmen	1.42
	23.31

The other, smaller groups include people like buyers, public administration officials, sales representatives, etc. We can immediately see that nothing dramatic can be expected. This is simply another way of recognising long-term trends in the official records of many countries showing a decline in agricultural employment to about 8%, industrial employment to 40%, and an increase in service employment to over 50%.

What is new is the splitting of services into those with low and high information-processing content. For example, services with a low content include truck drivers (1.4), waiters (1.1) and, oddly, janitors and sextons (1.2). Figures in brackets are millions of US employees: these are not in the above table. It is not clear why retail sales clerks (2.2M) and miscellaneous sales clerks (1.2M), are excluded from the table. Nothing unexpected is likely to happen because teachers, managers, etc., are now seen to be generating information — a hard-to-evaluate resource which is difficult to handle for economists. There may be more of them but their activities haven't changed much.

The reason why there are no serious evaluation problems is because these people provide labour-intensive *information services* evidently of determinable value — there seems to be no great difficulty in deciding what the level of their salaries should be.

In this area, the concern of Parker, and Stigler[74] and other economists, over problems of evaluation seem unfounded. They bring the "problem" with them from economic theory where there is much discussion about demand and price-setting for products in a market where consumers possess imperfect information.

There are, however, other factors to be discussed. First, when the information sector was small, growth in the productivity of other sectors was achieved by more information. But if now higher wages and salaries can be justified by higher productivity in a relatively small industry and other relatively small sectors, and salaries in the much larger information sector follow, the improvements in the smaller sectors will be nullified. In many cases, of course, the "information sector" is an artificial division, previously considered to be part of the overhead. For example, the largest "information sector" in a plastics company would be its office staff. What is needed is a *productivity increase* in the information sector.

Information per se — demand and value

Alternatively, or as well, there needs to be an increase in the *consumption of information per se* — and this is where evaluating information may present problems and the current buzzwords "The Information Industry" or "The Knowledge Industry" must be introduced. Relatively few people in the Porat table are recognisably a part of this industry; about 400,000 — people like authors, editors, librarians, and some computer people — and many of these are working in other "industries". Products of this industry include home computers and software, books and magazines, advisory and consulting services, television and radio programmers, private educational services and "electronic publishing" such as information provided via databases, computer networks, videotex, videotape, television, radio, and cable.

The difficulty here is drawing a line between entertainment and information. Entertainment must be valued highly — witness the popularity of tv and videotape machines, but the evaluation of information is much more difficult for the reasons stated earlier.

The value of timely, relevant information to people with obvious occupational need of it — for example the money market people — can be expressed in monetary terms. At the other end of the scale is the domestic market. People will pay for a daily paper and may subscribe to a magazine — partly, at least, for their information content. They receive a good deal of information without paying for it — for instance magazines and newspapers supported by advertising, train and flight times, citizen's advice bureaux and library services etc. They do not seem to want to pay for very much other information.

In between these extremes lies a grey area composed of professional and business people who may need information but may not want it enough to pay much for it. Evidently the intangibility of the information makes it hard to evaluate. You would imagine that doctors would be prepared to pay for medical information; however physicians in the US, who are certainly not short of money, were provided with a free online computer-based information for six years which was quite widely used. The introduction of a $5 charge caused demand to fall by 77%[75].

I conclude that the information society's demand for information can be summarised in this way. Many people in industry, commerce, and services are now seen as "information workers" — they always have been. There are now more of them and information technology provides them with better tools. They are demanding better communications and machines and use external information services. They mainly handle internally generated and transactional information, and are striving for better productivity. Additionally the information society will consume information and information products, often hard to distinguish from entertainment. The demand will be variable with business information predominating. There is little evidence to suggest that the general public wants more information for which it is prepared to pay.

Social aspects

The many aspects of the widespread dissemination of information by telecommunication and display as it gradually replaces paper-based information may be grouped under the following headings:

- the man-machine mismatch
- the effects on people's behaviour at work and at home
- privacy, secrecy, security, and freedom
- work, leisure, and unemployment
- the differential distribution of information — the "information rich" and the "information poor"
- the generation and distribution of wealth from information
- philosophical implications — McLuhan

The effects of technological change on people's lives is much more frequently discussed than the changes bought about by different ways of generating, distributing, and using information, enabled by new technology. It seems to me that information is at the heart of the matter more often than not.

Consider the man who loses his job on a car production line because painting is done by a jet-spraying machine controlled by a program on tape. In machine-efficiency terms the correctness of the decision to change cannot be challenged. Why use an incredibly powerful multi-task information-processing machine which can do a million other things and is expensive to maintain, when you can use a single-task machine which simply requires an occasional squirt of oil? Simply represent the information possessed by the man about manipulating the jet as electrical impulses on tape instead of in his brain, thereby releasing a powerful multi-task machine to do a job that really needs that power — in other words match information processing capacity to the job requirement.

One problem which arises when a policy of information transfer from man to machine is widely implemented was succinctly expressed over a century ago by Robert Owen's son "If we can imagine a point at which all the necessaries and comforts of life shall be produced without human labour, are we to suppose that the human labourer is then to be dismissed to be told that he is now a useless encumbrance that we cannot afford to hire?".

The question of unemployment has received very wide discussion. Trends are hard to discern firstly, because the net medium-term change in consequence of technology introduction is hard to measure in the face of shorter term changes as people are displaced from a job and then, possibly following re-training, settle down in another job, or remain unemployed. Secondly, changes in growth rate, economic conditions generally, import-export policies etc., mask the effects of technology.

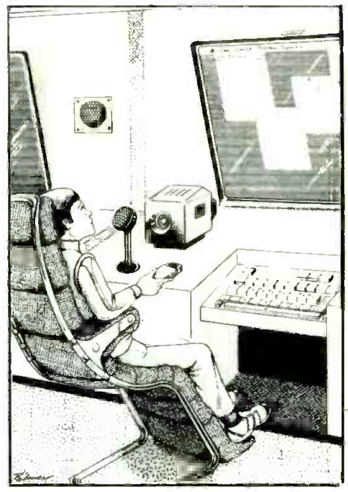
What *is* known is that increasing productivity may not be accompanied by a decrease in unemployment. During the period 1950-1965, an average annual increase of 7% in the industrial output of EEC countries was accompanied by a 1% job increase, but during 1973-1978 industrial output increased by 1% annually while jobs decreased by 1.8%[76].

Unquestionably new technology creates new jobs as anyone who has been to the area between San Jose and San Francisco along the Bay can see, but it seems unlikely that they are enough to balance job losses in other areas. The consensus of opinion seems to be rather pessimistic. A call is made in a well argued article[77] for far-reaching changes . . .

"We perhaps need to prepare for the coming of a societal structure in which only part of the working population will be needed at any given point in time, to produce all the goods and marketed services — an extension to the entire economy of a phenomenon which already exists in agriculture. In this light, is it possible that we would accept a dual or a single society structure in which a minority would be at work and the majority condemned to idleness? Or must we learn to share out available work in a different way? Would it not be better to use productivity as a lever to free time and to reduce the working week with a view to enlarging free-time activities? Our answer is clear: we must do away with the single, salaried and full-time job syndrome and promote a society based on a pluriactivity for those involved".

This proposal must be countered with the remark "Is it politically possible to carry through such ideas, and what would be the effects on a particular country if it is out of phase with the others during this period?"

The same counter could be used in response to the answer provided by another author in response to his own very interesting question[78]. "A society which relies so heavily on employment as a means of distributing material and moral resources (respect, prestige, etc.) is gravely shaken by the impact of too little employment. The microprocessor is feared not because it will lead to the production of less wealth but because it will enable wealth to be produced with less employment. Of course that wealth has to be distributed but why do people need to be



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McLuhan as rhetorical theorist.

"employed" for that purpose? At once the litany of objections is recited. "Somebody will have to work: if people can get what they want without working who will want to work? Without everybody at work *how is the wealth to be created?"* . . . "the creation of goods and services will never again require 65,000 hours of everyone's life; we shall need to acquire the values that go with the sequestration of a mere 35,000 or 25,000 hours".

The social pros and cons of advancing technology on people's lives generally are well put by two well known protagonists[79,80]. On the one hand we are told that "computer technology can show man how to live in harmony with nature"; on the other "The use of large-scale computer based information systems induces an extremely poverty-stricken notion of knowledge and fact . . . such systems necessarily induce recoding of data into information-rich chunks denuding the original data of the subtleties which accompanied them and determined their meaning while still in ordinary language".

The wider use of communications and information distribution may produce various effects according to your viewpoint — it may bring with it a Utopian home of the future or widen the knowledge gap between the information rich and the information poor. The author of ref. 81 becomes almost poetic "a home once more will be a place to live, not just a place to stay. The communications revolution will make it increasingly easy to perform many kinds of work from remote locations — including home — rather than requiring people to work at a central office or plant. The addition of telecomputing capabilities to radio, tv, photograph, and other home entertainment devices will transform today's family room into a media room. A home computer will tie separate systems together and provide the central focus or "electronic hearth" around which the family will gather for work, play, and fellowship". But more than that, sensors will recognise the mood of the occupants, leading to the introduction of "white noise to mask out street sounds or relaxing raindrop or soft wind noises".

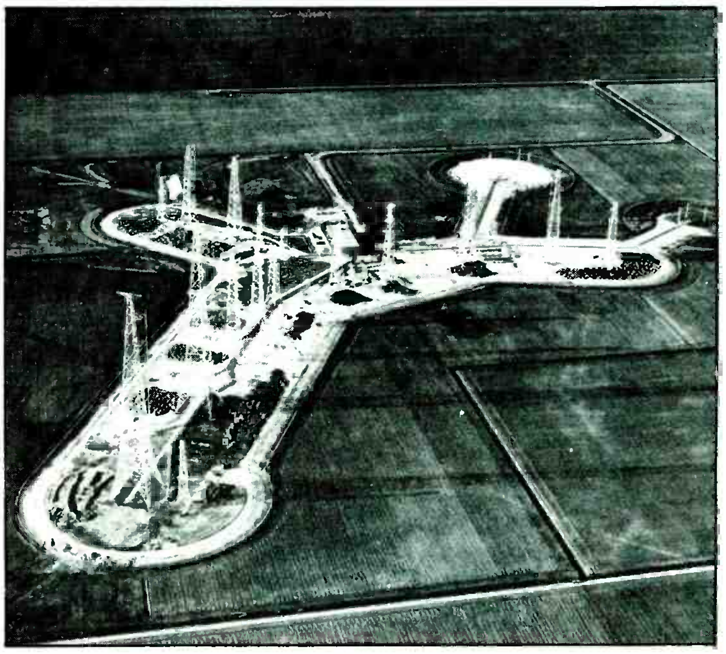
But according to ref. 82, "The popular mythology that sees the avalanche of new information technologies as heralding a new democratic, egalitarian, age, is little more than a cruel hoax — the product of marketing hype or self-delusion . . . the distribution of benefits flowing from the new technologies will widen the information gap between the rich and poor . . . the transformation of information into a commodity traded in an unregulated marketplace will mean that the poor will simply not be able to afford access to most of the new technologies or their software".

Finally, perhaps McLuhan will come into his own. He is remembered primarily for his comment that media are messages in the sense that they determine and embody what is to be considered appropriate social organisation at any time[83]. Media are not simply shapers of content; a new media provides human beings with new psychological-structural equipment. In succeeding years the community may "judge him harshly although it never in all probability will be able to forget "the medium is the message" . . . it is perhaps typical of very creative minds that they hit very large nails not quite on the head"[84].

The biggest amateur station in the World

Radio Netherlands World Service is commissioning a new shortwave transmitting centre in Flevoland, a reclaimed polder. Before it starts official transmission on March 31, there is to be an interesting experiment. On the third weekend in February (16th and 17th) two amateur radio transmitters are connected to the vast directional shortwave antennae, using amateur frequencies. There is to be a continuous period of operation from 0600 UTC on Saturday the 16th to 1800 UTC on Sundayy the 17th. One transmitter will operate on the non-directional antenna, intended for European reception. The second will make full use of the curtain arrays and will be following the beam pattern of the regular English-language transmissions from Radio Netherlands; for example, at 0703 UTC, when Radio Netherlands is on the air to Australia and New Zealand, the amateur station will beam in that direction too, though on a different frequency. The station will be operating in SSB and CW (morse) modes. The sign PA6FLD will be used, and a special QSL card is to be printed. Radio amateurs are encouraged to make contact with the station but all shortwave listeners are invited to look for the station.

Frequency details will be broadcast on the Media Network programme of Radio Netherlands, on Thursdays, or may be obtained from Radio Nederland Wereldomroep, PO Box 222, 1200 JG Hilversum, The Netherlands.



FUNDAMENTALS OF ENERGY TRANSFER

I agree with Chris Parton's attack on the definition of electric current, *Wireless World,* December, 1984, page 65.

Parton discusses "Forces on conductors guiding a TEM wave." I have a chapter with that title in vol. 2 of my book, Electromagnetic Theory. I feel that these strange forces may guide us to a unified field theory.

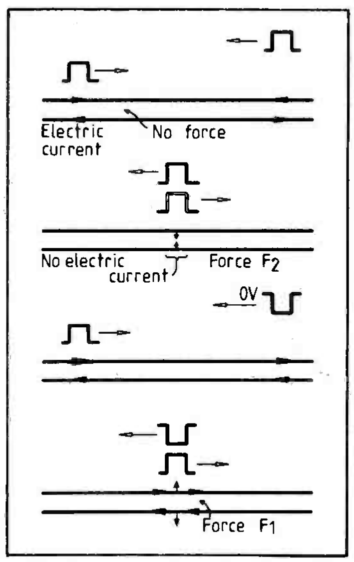
Force on conductors guiding a TEM wave

After a TEM wave step has passed by, guided by two parallel conductors, there remain two steady state "fields":

(1) Electric current flows down the wires, and a B field exists in the dielectric right next to the surface of the conductor.

(2) Electric charge remains on the surface of the conductors, and an E field exists in the dielectric right next to the conductor.

The magnetic field exerts a force into the conductor; that is, a force which tends to drive the conductors apart. The electric field exerts a force out of the conductor; that is, a force which tends to pull the two conductors together.



The forces are $F_1 = iB$, $F_2 = qE$. Now the electric current in the surface of the conductor i and the electric charge in the surface of the conductor q are related by the equation i = q ©. That is, the current is equal to the speed with which the charge density travels along the surface of the conductor. Dividing, we find that numerically:

$$\frac{F_1}{F_2} = \frac{iB}{qE} = \frac{©B}{E} = \frac{1(\mu H)}{\sqrt{\mu . E}} = \sqrt{\frac{\mu}{E}}\,\frac{H}{E}$$

But we know that in a TEM wave, at every point $E/H = \sqrt{\mu / E}\ \mu$

Therefore $F_1 = F_2$ numerically.

We conclude that when a TEM wave (which we call a Heaviside signal) glides along between two conductors at the speed of light, there is no force on the conductors guiding the signal. This very interesting feature of a Heaviside signal was first pointed out by David Walton, and is here proved.

(For the equations giving F_1 and F_2, see for instance P. Hammond, "Electromagnetism for Engineers", Pergamon, 1978, pages 107 and 55.)

It is generally thought that if an electromagnetic wave travels down a coax cable from left to right and passes through another such wave travelling from right to left, then superposition applies. However, this is not true in the very important matter of the forces on the conductors. Where each wave on its own exerts no force, (the electric force and magnetic force cancelling,) when two waves are passing through each other one of the "fields" E or B — cancels, and we are left with a net force resulting from the non-cancelling "field". So superposition does not strictly apply, because when we superpose two TEM waves, something new suddenly appears, a physical force. If the two pulses passing in opposite directions are of the same polarity, another strange thing happens for the short time during which they overlap. That is, there is no electric current in the surface of the conductors. So if the conductors are imperfect, there is no resistive loss during that short period of time. (Similarly, if the pulses have opposite polarity, then if the dielectric is imperfect, there will be no losses due to leakage during the short period of pulse overlap.)

Ivor Catt
St. Albans
Hertfordshire

I am not very surprised to notice that many readers of *Wireless World* (e.g. N.C. Hawkes, December, 1984) have been finding difficulty in appreciating the contradiction implicit in classical electromagnetic theory pointed out by Ivor Catt (September, 1984).

A slow drift of electrons along a wire may well account for a "steady state" movement of charge, and until recently it seems that this was all that was required.

However, with the growing importance of high-speed logical signals, new problems have been brought into the limelight which are inexplicable purely in terms of classical "electron drift".

I will attempt to explain the "Catt anomaly" from a slightly different angle in the hope that this may serve to shed more light on the contradiction.

(i) Experiment shows that a voltage "step" travels at the speed of light (of the dielectric between the wires).

(ii) Classical theory tells us that electrons cannot travel at the speed of light because they have a finite rest mass. (At normal temperatures the average speed of the free electrons is of the order of 1/1000 of the speed of light). In fact the "drift velocity" of the free electrons turns out be much smaller, (of the order of 1cm/second).

(iii) Electrons in a given section of wire will not start to "drift" until they have received the message to do so.

(iv) The signal which tells the electrons to move is the electric field caused by the charge on the electrons which have drifted in another section of the wire. Thus the signal resulting from the change in electric field (the voltage step) travels at the drift velocity of the electrons.

The contradiction and resulting inadequacy of the theory is clear to see.

This, the "Catt anomaly", seems to have fallen on many deaf ears. I am interested to see how the scientific community continues to react to this vitally important breakthrough, which could lead to a revolution in electromagnetic theory.

F.U. Weaver-Mowes
Sutton
Surrey

With reference to the correspondence concerning the physical mechanism of energy transfer along transmission lines. I believe that Catt is correct in insisting that something much faster than electrons is involved. It seems reasonable to assume that as the electrons in the wires would be continuously entering and leaving the conduction band, there would be a corresponding traffic of the associated quanta, at the velocity of light, and that it is the existence of these quanta that constitutes the basis of the energy transfer mechanism. By considering all the quanta that at any given time travel in one direction along a wire as one energy current, and the contrary travelling quanta as an opposite current, Catt could justifiably speak of two superimposed slabs of energy and explain the experimental facts in connection with 1 metre long transmission line reported on page 80 of the December, 1980 issue.

I expect that the above suggestion, if correct, will lead to revised understanding of conduction phenomena generally, including such topics as superconductivity and the action of thermocouples.

G. Berzins
Camberley
Surrey

RELATIVITY

Modern physics assumes Einstein's Special Relativity true. S.R. is based on three postulates, two of which are well known and the third (the unmentionable) ignored. These three postulates are:

(1) Laws observed by an observer, A, who resides solely in an inertial frame, A_0, are the same as those observed by B who resides solely in an inertial frame, B_0, both of the observers using the same units.

(2) The speed of light produced in an inertial frame, A_0, is constant relative to A_0 and is equal to c. Likewise, the speed of light produced in an inertial frame, B_0, is constant relative to B_0 and is equal to c, the same units being used in both frames.

(3) Before landing on a moving object (in any inertial frame) light magically adjusts its own speed to make its reception speed relative to that object, equal to c.

Postulate (1) is called, "the principle of relativity". Postulate (2) is called, "the constancy of the speed of light". Postulate (3) is, of course, never mentioned, but it is often combined with postulate (2). The resulting, mixed-up postulate, (2/3), is called, "the invariance of the speed of light".

Most physicists today, accept postulates (1) and (2) because experiments confirm both postulates. It is the unmentionable (3) or the mixed-up, unmentionable (2/3) that produces intellectual indigestion.

Your contributor, Roy Hodges, (*Wireless World,* December, 1984) has obviously given much thought to the unmentionable and has produced a hypothesis in which photons are pulled by matter into an invariant, reception speed. However, to even think up such an explanation assumes that postulate (3) is true! But no-one has bothered to measure the reception speed of light from a radially-moving star to discover if the unmentionable is true or not!

With today's technology, it should be possible to measure the reception speed of light from a radially-moving star to see if it is c (as invariance dictates) or (c—v) (as constancy dictates).

A.H. Winterflood
London N10

With reference to C.F. Coleman's comments on Scott Murray's article "The Roots of Relativity", it seems to me that the situation with regard to Einstein's 1905 'thought experiment' is as follows:

Light from the two flashes A and B arrives at M, the stationary observer, simultaneously. M′, on the train, arrives at M at the same time. It therefore seems inescapable to me that the two rays of light, M and M′ are all together at the same place and at the same time. Hence M′ must judge the two light flashes to be simultaneous, as does observer M.

D. Marquis
Cudham
Kent

See also page 93

DIFFERENTIAL LINE DRIVER

Since taking up an interest again in electronics, after a lapse of some 20 years, I find so much has changed and I do try to look at the new ideas and designs for positive advantages, rather than just accepting the flavour of the month, as it were. For example, I have been prototyping a balanced line system, using an NE5534, driving a Sowter line output audio transformer type 4652 into a line terminated by a 3678 screened input transformer. The design and layout are perfectly straightforward and hardly worth setting down.

What is interesting is that switching the signal from direct input, to the alternative path via the NE5534, two transformers and about 10 metres of unscreened figure-of-eight, produces no audible difference when levels are adjusted. My original comparison, between two channels of a stereo pair, one with and one without the extra link, did give significant differences at the top end, which was a bit puzzling, because transformers are supposed to start losing performance at lower frequencies. Which does rather prove that one should compare like with like absolutely.

Your contributor makes the point that transformers are expensive and suffer from limited bandwidth and stray magnetic fields; true up to a point, but the extra cost of an NE5532 dual op-amp, associated components and p.c. board must be getting on towards that of a 4652, and whether a pair of 5534s driving a 600Ω line in push-pull are a good enough match is debatable. At 0dBm, normal care with layout will eliminate hum pick-up even in an unscreened line-output transformer; dramatic overload capability is not normally needed in a complete balanced line system because somewhere or other in the system there are going to be greater constraints, as for bandwidth, the 4652 is only 0.8dB down at 100kHz, and at +20dBm low frequency distortion at, say, 30Hz is only 0.25%.

So all in all I am not convinced that the basic simplicity of a transformer is worth sacrificing — and I do hear tell that you can achieve perfectly satisfactory results driving the output transformer with something a lot less expensive than an NE5534.

B.A.L. Morgan
Ledbury
Herefordshire

VELOCITY OF LIGHT

Roy Hodges (December, 1984) made some good arguments in favour of the proposition that the velocity of light c must be always referred to the rest frame of nearby matter, and to this frame only. Mr Hodges and those readers who thought that this hypothesis is sound, promising, and more reasonable than the incredible relativistic postulate, namely that c can be referred to *any* frame, might be interested to read further arguments supporting various refinements of the former hypothesis, as well as proposals for experimental tests, in the following works:

H. Aspden, Physics Unified (Sabberton Publications, Southampton) 1980; Chapter 3, pp.47-69.
Z.L. Bourdikis, "Ritz's Electrodynamics as a Microscopic Basis for Maxwell-Lorentz Electromagnetism", *Proc. IREE Australia 29,* pp.343-358, 1968.
"Might Electrical Earthing Affect Convention of Light?", *Spec. Sci. Techn. 5,* pp.171-187, 1982.
T. Theocharis, "On Maxwell's Ether", *Lett. Nuovo Cimento 36,* pp.325-332, 1983.
C.A. Zapffe, A Reminder on $E = mc^2$, $m = m_0\,(1 - v^2/c^2)^{-1/2}$, & $N = N.\exp(-t'/\gamma\tau_0)$, (Lakeland Color Press, Brainerd, Minnesota) 1982.

T. Theocharis
Blackett Laboratory
Imperial College

BAIRD TELEVISION

Referring to the response by Doug Pitt in the November issue to Pat Hawker's comments in the June 'Communications' column, the closest analogy that I can find to the everlasting Baird controversy is a Wimbledon tennis match that has overrun by 50 years. Every so often some pro- or anti-Baird person makes some badly-worded or ill-informed comments about Baird and suddenly we have a rather pathetic slanging match.

With due respect to both factions, I would like to make some comments from the relatively unbiased position of having studied one of Baird's achievements from a purely engineering standpoint.

J.L. Baird is considered to be the first of many independent inventors to demonstrate electrical transmission and reception/display of moving pictures with grey tones. At the time this was considered to constitute a demonstration of 'television' (which literally means 'seeing at a distance'). He also explored the engineering possibilities of television which resulted in demonstrations of colour and stereoscopic moving pictures. His electrical recordings of the vision signal in the late 1920's — the first in the world — have been the subject of my researches in the past few years (the results of which can be studied in the references).

The main problem for the would-be researcher in assessing Baird's achievements is sifting through the over-enthusiastic claims which resulted both from the media's excitement at Baird's tv demonstrations and from an efficient p.r. department. Today it is clear that these claims exceeded the capabilities of Baird's 30-line tv system.

To put the situation into context, this over-enthusiasm is reminiscent of the claims (such as control of power stations . . .) surrounding the appearance of the first Sinclair home computer — the ZX80 — in the late 1970's. In comparison with home computers today, the best use for the ZX80 (with apologies to Sinclair) is for propping up the leg of a wonky table.

Although we can study the operation and performance of Sinclair's first home computers in detail, Baird's 30-line system cannot be so appraised since actual performance measurements of the broadcast chain are not available and probably were never made. From this lack of hard evidence, the distinction between myth and truth becomes difficult and therefore is subject to the individual bias of the person intending to 'put the record straight'.

Out of this analogy between Baird and Sinclair comes an interesting point: if Baird had not suffered the business failure in the mid-thirties and had been as successful as Sinclair is now, would he still be the subject of this everlasting tennis match?

References

Wireless World, October, 1983 — Using a Micro to process Baird tv recordings.
Royal Television Society Journal. Article to be published in 1st quarter 1985.

Donald F. McLean
Edgware
Middlesex

XY PLOTTER

Having constructed several digital plotters, I read with interest P.N.C. Hill's article in the December issue of your magazine. If I may I would like to comment on the algorithm used to determine the best 'straight line' between two pairs of coordinates.

The statement that: "The staircase route for the pen is the best approximation", and "at any point there are only two directions in which the pen can be stepped", are not necessarily true. If one includes the condition that the X and Y motors are stepped simultaneously, then a third elemental vector can be drawn at 45° (diagonal). A line can then be drawn so that:
(1) Gradient = 45° composed wholly of diagonals
(2) Gradient <45° mixture of diagonals/horizontals
(3) Gradient >45° mixture of diagonals/verticals
In many cases this will result in a better approximation to the straight line. The required ratio of diagonals to horizontals/verticals for any line can be calculated using a digital differential analyser algorithm[1]. A suitable implementation of this algorithm appeared in *Practical Computing,* May, 1979. Since the method only requires simple arithmetic (+/−) it can readily be implemented in machine code, dramatically reducing the computational time.

At this point I must admit to not having read the original article, and if I am covering old ground I beg your indulgence.

C.E. Turner
Department of Physics
Portsmouth Polytechnic

Reference

1. Newman and Sproull — Principles of Interacture Computer Graphics — McGraw Hill.

ELECTRIC CHARGE FROM A RADIO WAVE

Professor Jennison's demonstration of the production of equal quantities of positive and negative electricity whose sum is always zero seems to be refuted by experiments in rarefied gases. Both positive and negative electricity have the two mutual and reciprocal powers to repel like quanta and attract unlike quanta at one and the same time. The sum of these symmetrical powers is also zero.

In a rarefied gas, negative electricity is transferred from a negatively charged cathode to a positively charged anode by the normal forces of electrical attraction and repulsion. Apparently positive electricity is attracted by a positively charged cathode and repelled by a negatively charged anode, preventing the transfer of positive electricity from cathode to anode. The strange power of a rarefied gas to reverse the actions of electricity is the source of the many action at a distance theories of the electron. If a rarefied gas has the power to reverse one of the symmetrical forces of mutual attraction and repulsion and make their unit sum equal two, the forces of positive electricity must differ in some way from those of negative electricity. The photoelectric effect of negative electricity is probably due to the same cause.

Poynting's Theorem and Hertz's experiments with electric waves of alternate half cycles of positive and negative electricity separated by a node, suggest electricity is transferred in the field and therefore enters and heats a wire from without. It is difficult to reconcile this suggestion with the skin effect of wave electricity. The heating power of a steady current is disproportionately greater than that of a wave current. Tesla's a.c. mains supply to New York proved far superior to Edison's planned d.c. supply for this very reason.

Maxwell defined his displacement current in Art. III of his Treatise. "Any increase in this displacement is equivalent, during the time of increase, to a current of positive electricity from within outwards, and any diminution of the displacement is equivalent to a current in the opposite direction."

In Art. 799 he commented on the inability of his light wave of displacement electricity to decompose a transparent electrolyte. ". . . the electromotive intensity acts for so short a time in one direction that it is unable to effect a complete separation between the combined molecules. When, during the other half of the vibration, the electromotive intensity acts in the opposite direction it simply reverses what it did during the first half (cycle)."

The success of Jennison's experiment is due to his ingenious use of leds to observe the velocities of closed current wave electricity relative to conducting matter, and also to the close analogy between the symmetrical configurations and actions of the capacitors and coils of the apparatus and those of electricity. The experiment would not take too kindly to a disfiguring modification.

There is, however, a partial analogy between a coaxial capacitor, its rarefied gas equivalent — a thermionic diode valve — and a length of coaxial cable. It may be possible to induce one cycle of a standing wave to fit into one half-cycle length of open circuit coax. By forcing the wave to reflect back on itself at its crest and trough. The temperature difference may reach a maximum at the open ends of the cable. A modification to the experiment of Chute and Vermeulen (August, 1982) using heat sensitive liquid crystal paint might illuminate the reason why the sum of all symmetrical electric actions is always zero, and why the currents of Maxwell's mandatory closed circuits are the sum of the conduction and displacement currents of the same kind of electricity.

One serious reservation. When standing waves are formed by the reflection of water waves from the sides of a ripple tank, the standing waves collapse when the last cycle passes across the tank. A constant passage and constructive interference of two trains of equally spaced crests and troughs moving in opposite directions is the cause of the formation of standing waves. The energy of the crests moving one way must frequently coincide with the equal and opposite energy of the troughs moving the other way without neutralising each other. The sum of their energy at the instant of coincidence is a zero of annihilation to a mere mathematician. This very odd behaviour of interfering waves actuates the mathematical creation and annihilation of virtual electron-positron pairs and virtual photons.

The closed wave current of a continuous non-annihilating interaction between the equal and opposite energy of crests and troughs is also necessary to maintain a standing electric wave caused by reflection from the open ends of a length of coax. The non-neutralising action of moving electric potentials or pressures is the reason why the suggested temperature difference may not occur, although one may be detected by using a very low frequency wave of say one hertz. The inner and outer conductors of one end of the cable may both be charged with stationary positive wave electricity and those at the other end charged with stationary negative wave electricity, apparently reversing the symmetrical force acting between the inner and outer conductors of the cable's partial analogy, a coaxial capacitor.

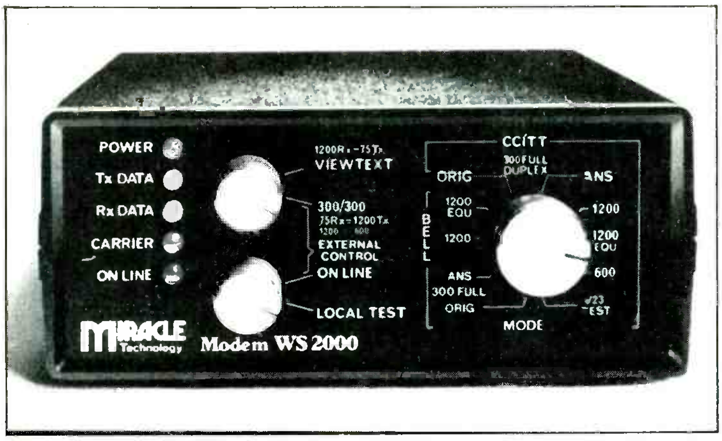
The rarefied gas of an unheated diode valve is an open circuit non-conductor of Ohm's conduction current electricity. When a diode's cathode is heated the open circuit is closed by the rarefied gas's conduction of a rectified wave of displacement current electricity in the heat or infra-red spectrum radiated by the cathode.

If one of the suggested effects does occur, the experiment will identify the first half cycle of one full cycle of an electromagnetic wave as a region of negative electricity, confirm Ivor Catt's revised theory, and give some impetus to A.H. Winterflood's scheme (December Letters), although I would question the location of his school. This is a wireless world in more ways than one.

M.G. Wellard
Kenley
Surrey

Letters

Letters for publication are always welcome. Those that are short and to the point stand the best chance of publication since space for these columns is limited.

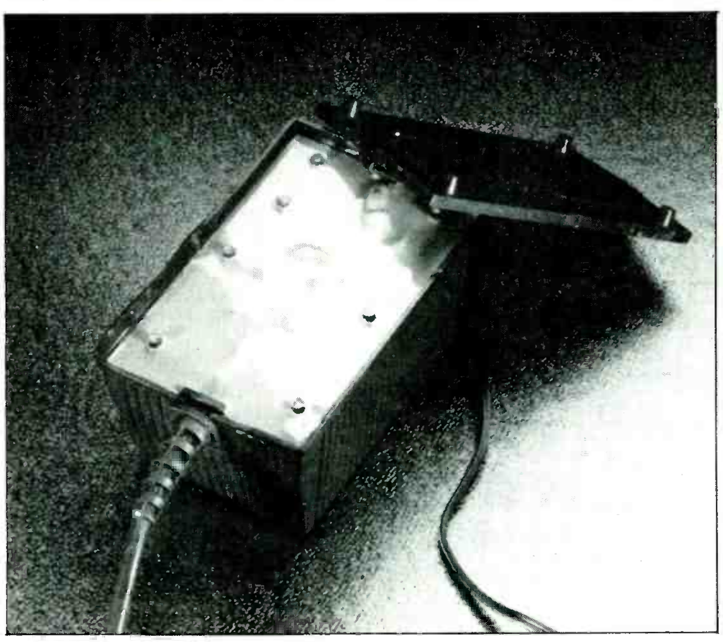


APPROVED MODEM

BATB approval has been granted to the Miracle WS2000 modem. The multi standard unit can cope with both Bell and CCITT systems at 75, 300, 600 and 1200 baud. Full telex facilities, through the Easylink system of Cable & Wireless/ Western Union, are available at a cost well below that of setting up a conventional telex system. Public services, such as Prestel, Micronet, Telecom Gold and private bulletin boards are available to the user as well as inter-computer communications. Expansion accessories include auto-dial and auto-answer, an added chip-set to provide full computer software control of the modem, battery power, acoustic coupling and t.t.l. RS232 interfacing. The unit costs £150. Miracle Technology (UK) Ltd, 10 St Peter Street, Ipswich IP1 1XB. EWW 216

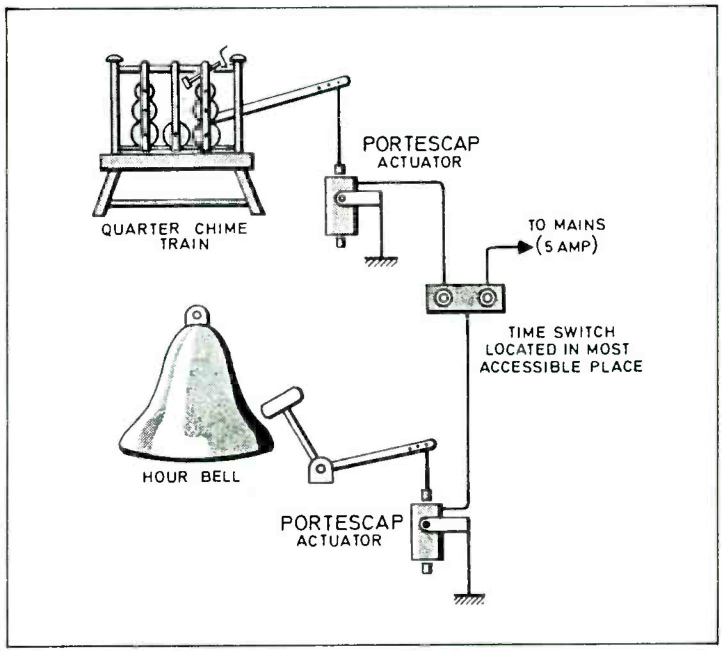
POTTING PLASTIC RESISTS FLAMES

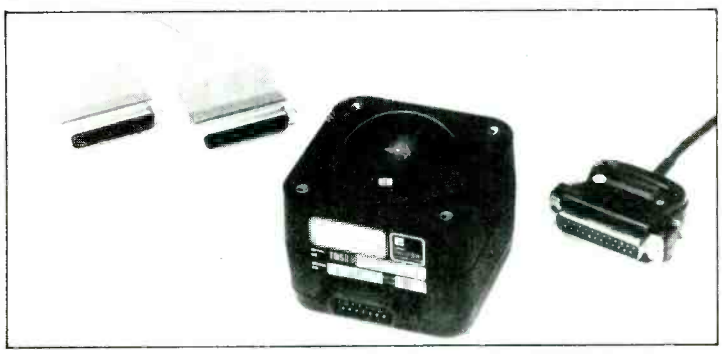
A flame retardant polyurethane resin is suitable for potting and encapsulation of electronic components. Dobeckan IF400/052/FR was orginally developed for encapsulation of transformers used in home computers but because of its flame-retardant property it is suitable for a wide range of other applications. Of low viscosity, the material takes only 17 minutes to gel and may be used for high-volume production with metered dispensing equipment. The cured system is self-extinguishing and offers a high degree of insulation. The makers claim that it is cheaper and easier to use than epoxy compounds as its quick setting time is combined with a low exotherm. Glasurit Beck Ltd, Slinfold, Horsham, W Sussex RH13 75H. EWW 217



SILENT NIGHT

Although pleasant at times, it can be very annoying to live near to a striking clock especially at night. Now Public Clocks have come to the rescue with a device that will silence the chimes during the night. The clock mechanism need not be altered in any way. The silencer consists of two pre-set electric timers and an industrial electric actuator from Portescap, who told us about it. In operation, one timer energises the actuator and pulls the hammer off the bell. The electric supply is cut off after half an hour. The second timer comes into operation after the pre-determined time lapse and allows the actuator to lower the hammer gently on to the bell. The supply is again cut after 30 minutes. This saves power and also increases the working life of the unit. If the clock also chimes quarters, a second set of timers and actuators would be needed. Public Clocks, 1 Prideaux Place, Lloyd Square, London WC1X 9PR. EWW 229



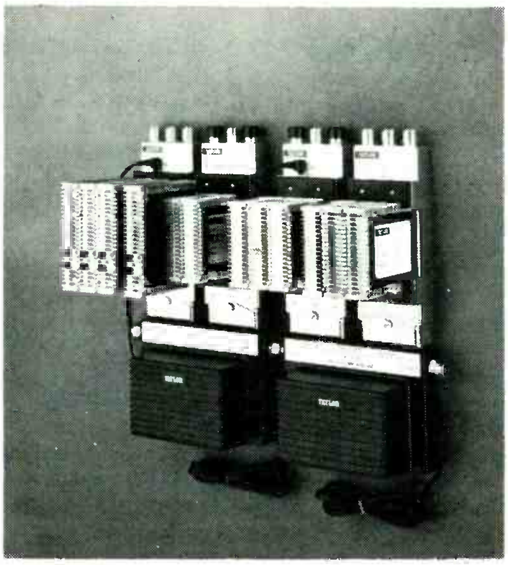


RS232 TRACKBALL

A new option has been added to the Litton TBSII trackball, an RS232 interface which allows it to be used in a variety of applications. As well as with computers, it may be used in a wide range of medical electronics systems, flight (and other) training simulators and arcade electronics games.

Custom i.cs are used to implement the RS232 function and the interface is contained within the trackball package, eliminating the need for any other interface in most instances. This can also be provided in non-standard configurations for any special requirements. The TBSII is available for console mounting or as a hand-held unit. The ball diameter is 2.25in. Litton Precision Products International, 6 First Avenue, Globe Park, Industrial Estate, Marlow, Bucks. EWW 221

CABLE T.V. HEAD END AND REPEATER AMPLIFIERS



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TAG4863	Gain 48dB, maximum output 63dBmV. Regulator + or − 8dB. Power requirement 14V 210mA.
TAG4063	Gain 40dB, maximum output 64dBmV. Regulator + or − 16dB. Power requirement 14V 210mA.

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TSS4663	Gain 28-46dB adjustable. Maximum output 63dBmV. Power requirement 14V 170mA.
TSS3062	Gain 12-30dB adjustable. Maximum output 62dBmV. Power requirement 14V 26mA.

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TS1030FM	FM driver amplifier. 10dB Gain. Maximum output 30dBmV. Power requirement 14V 10mA.
TS1030B3	Band III driver amplfier. 10dB gain. Maximum output 30dBmV. Power requirement 14V 10mA.
TS1030UHF	UHF driver amplifier. 10dB gain. Maximum output 30dBmV. Power requirement 14V 10mA.
TS1040S	Single channel UHF driver amplifier. 10dB gain. Maximum output 40dBmV. Power requirement 14V 10mA. (Quote channel required).

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TE1638	Domestic distribution amplifier. 1 input, 2 outputs. Gain 16dB. Maximum output: 2 at 38dBmV.
TS2046	40-860MHz. Gain 20dB UHF, 18dB VHF. Maximum output 46dBmV.
TS2846	40-860MHz. Gain 28dB UHF, 22dB VHF. Maximum output 46dBmV.
TS2845	Separate UHF/UHF inputs. Gain 28dB UHF, 22dB VHF. Maximum output 46dBmV.
TS2054	40-860MHz. Gain 20dB UHF, 18dB VHF. Maximum output 54dBmV.
TS2060	40-860MHz. Gain 20dB UHF, 18dB VHF. Maximum output 60dBmV.
TS5565	Gain 55dB UHF, 55dB VHF, 42dB FM. Maximum output 65dBmV.

CHANNEL CONVERTERS

TCUU	UHF-UHF Single channel converter. Gain adjustable +2dB−16dB. Maximum output +26dBmV. Crystal controlled oscillator. Power requirement 14V 25mA. (Quote Channels required).
TCUV	As TCUU except UHF to VHF converter. (Quote Channels required).
TCVU	As TCUU except VHF to UHF converter. (Quote Channels required).

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TSC3660	Repeater. Gain 16-36dB UHF, 10-30dB VHF. Maximum output 60dBmV.
TSC3665	Repeater. Gain 16-36dB UHF, 10-30dB VHF. Maximum output 65dBmV.
TSC3060	Repeater. Gain 10-30dB VHF. Maximum output 60dBmV.

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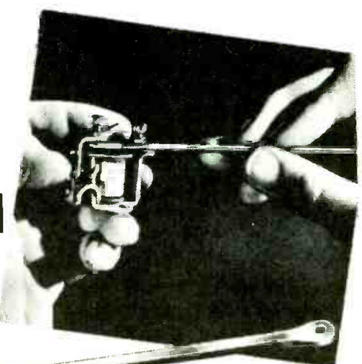

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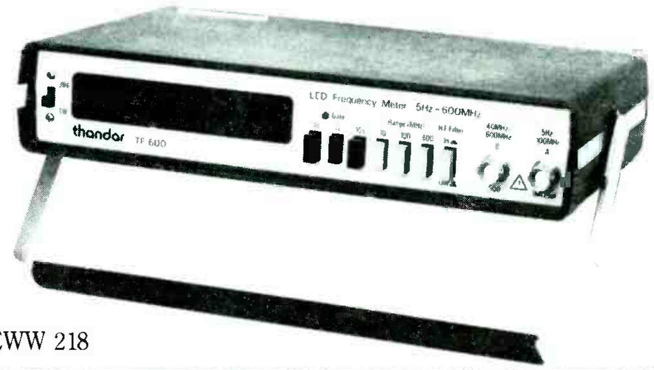
CIRCLE 11 FOR FURTHER DETAILS.

FREQUENCY METER

A frequency-measuring range from 5Hz to 600MHz with a sensitivity of better than 10mV is provided by the Thandar TF600. It is mains or battery operated and has an 8-digit display. There are two inputs; input A has 1MΩ input impedance and is used for frequencies up to 100MHz, it may be used with the low pass (40kHz) filter provided; input B is a 50Ω input for the 40Mhz to 600MHz range. The display reads out directly in kHz and has indicators to show overflow, time gate and low battery. The decimal point is positioned automatically on all ranges. Thandar Electronics Ltd, London Road, St Ives, Huntingdon, Cambs PE17 4HJ.



EWW 218

MULTIPURPOSE MUART

Five different microprocessor peripheral functions are combined in one chip in the Intel 8265. Designed to interface with any of the Intel-type processors, for example 8048, 8085, 8086 and 8088, the multifunction universal asynchronous receiver/transmitter provides serial communications, parallel i/o, timing, event counting and priority interrupt functions. All of these are fully programmable through nine integral registers.

The five timer/counters and the two paralle i/o ports can be accessed directly by the processor. Four of the 8-bit counters may be cascaded to provide two 16-bit timer/counters. A prescaler provides for system clocks of 1,2,3 or 5 times the basic 1.024 MHz clock rate.

The serial asynchronous communications interface is programmable for various bit-length characters, a variable number of stop bits and parity generation. Thirteen different data rates are catered for up to 17.2Kbit/s and an external clock may be used to give 1Mbit/s. Parallel i/o consists of two 8-bit programmable ports of which port 1 is bit programmable and can be set up to provide handshake control for port 2 as well as inputs for event counting.

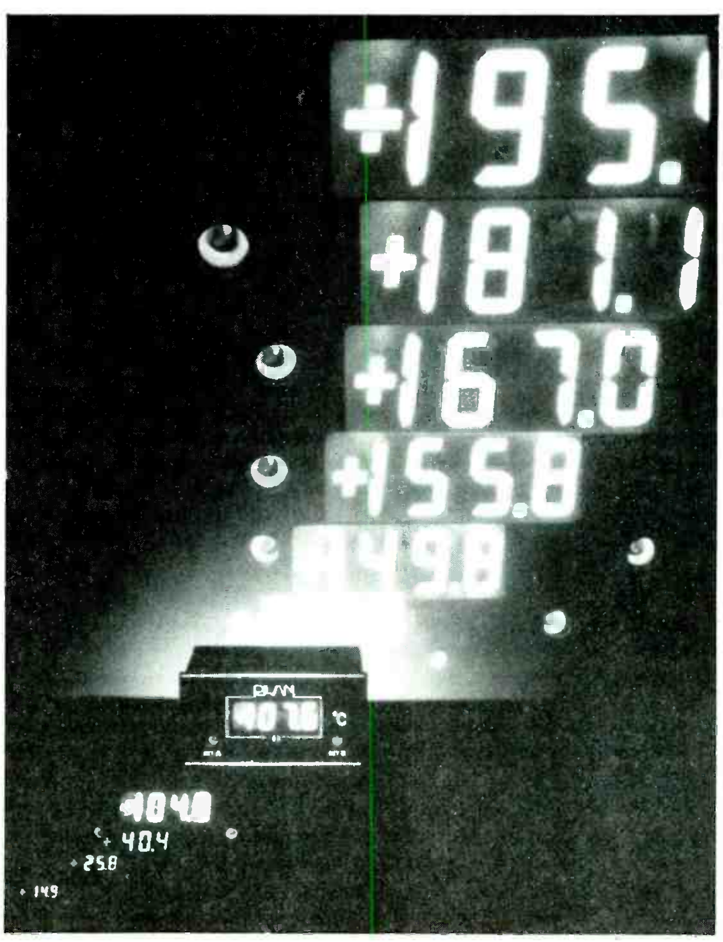
Interrupts are controlled at eight nested levels with programmable priority. Seven of them deal with the muarts own internal operation but the eighth can be used for a specific external function or for chaining with other interrupt controllers. Futher details from Jermyn Distribution, Vestry Estate, Sevenoaks, Kent. EWW 220

MOUSE CONTROLLER

Not a pesticide but an i.c. from Sanyo which will accept a signal from a two-wire input as provided by one axis of a computer input mouse and provide 13 control outputs. Comparator output levels range from 1.6V at output 1 to 6.4V at output 13 in 0.4V steps. The device includes a one-shot multivibrator for chatter [squeak?] rejection and requires supply voltage between 8 and 16V. A sequential latching circuit avoids ambiguous inputs. The LB1475 operates over a wide temperature range, has a maximum output current of 30mA and a maximum disipation of 250mW. Edicron Ltd, 1-7 Wesley Avenue, London NW10 7BZ. EWW 222

COLOUR-CHANGE DISPLAY

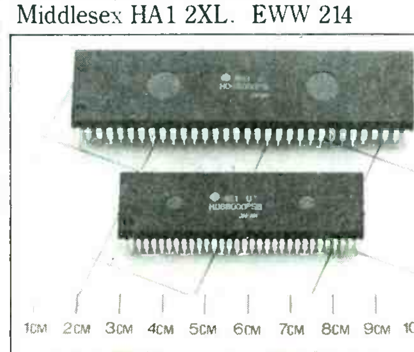
A three-colour digital display may be used to give eye-catching monitor and alarm warnings. The Digiplan 500, with a 12.5mm high, $3\frac{1}{2}$-digit liquid crystal display may be used to monitor temperature, pressure, flow, force, current or voltage with a colour sequence, red, yellow and green that changes instantly when preset limits are reached. Accuracy is claimed to be 0.05%, ±1 digit. The input range and signal conditioning circuit is selected by the insertion of a plug in card. Displays are supplied with marked units and symbols according to the user's needs. However, by changing the plug-in card the unit may be re-scaled almost instantly. Supply voltage, colour change sequence and decimal point position are all selected on internal switches and the alarm limits are set by simple screwdriver adjustment. TC Ltd, PO Box 130, Uxbridge, Middlesex UBO 2YG. EWW 211



LOW-POWER 68000

A new version of the 68000 32/16-bit processor reduces the power consumption from 1.5 to 0.7W at the normal operating frequency of 8MHz. The Hitachi design, manufactured by their nMOS process, is a direct equivalent of previous versions of the device and is packaged in plastic, without the need for any special heat-dispersing baseplate.

The full-size 64-pin version is a plug-in replacement for earlier types but the lower power consumption has made it possible to produce another version the same size as a conventional 40-pin d.i.p. with a pin spacing of 1.78mm (0.7in) Hitachi Electronic Components (UK) Ltd, Station Road, Harrow, Middlesex HA1 2XL. EWW 214



LITTLE WINNIE

Actually its not called Winnie at all but Penny, but it is a miniature (3.5in) Winchester disc drive with capacity of 50MByte. It is planned to go into full production in spring and its makers, Newbury Data, expect it to find a market in original equipment manufacturers of personal and mini-computers. The drive uses four platters stacked to achieve its capacity and offers an access time of 40ms and a data rate of 5MBits/s. In addition, Newbury Data are making a two-platter version (half-Penny?) with half the capacity which will be compatible with current software and allow the time for suitable modifications to driver software to cope with the 50MByte drive. surface-mounted electroncis help to save space and offer better reliability. The drive uses the standard ST506/412 interface. Formatted capacity is 40 (or 20) MBytes. Penny uses a closed loop, adaptive, digital servo driving a brushless d.c. motor. Recording densities of 12685 bits/in. and 980 tracks/in. are achieved through the use of Whitney head technology in conjunction with plated discs. Newbury Data Recording Ltd, Hawthorne Road, Staines, Middlesex TW18 3BJ. EWW226

LCR BRIDGES

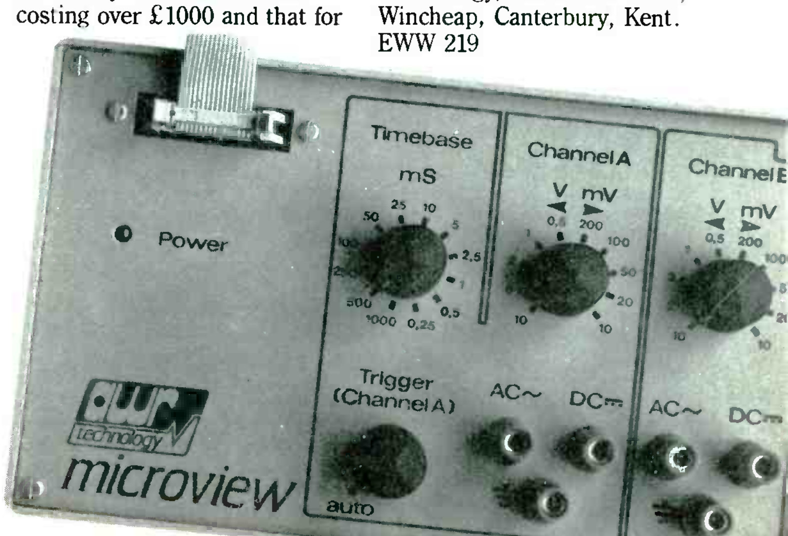
Resistance, inductance and capacitance meters from Wayne Kerr are microprocessor-based to enable a rapid automatic quality assurance check on components. Bridge parameters can also be set manually for more diverse test applications. As well as displaying component values, D or Q terms can be displayed at the touch of a button. The 4225 is an a.c. component bridge with a basic accuracy of 0.25%. It uses three test frequencies. In the limits measurement mode a hi-low-pass statement is displayed when the component is compared to preset limits entered at the keypad.

The 4210 (illustrated) offers an accuracy of 0.1% and is programmable through an IEEE488 bus. In addition to the features of the 4225, it has percentage deviation and can indicate into which bin the component should go, sorting the component in absolute or comparative percentage terms. Auto-trim compensation and bin values are stored in non-volatile memory during power off. The IEEE interface gives automatic output of data to a printer for example, and allows full remote control of all functions. Electroplan Ltd, PO Box 19, Orchard Road, Rovston, Herts 598 5HH.
EWW 224

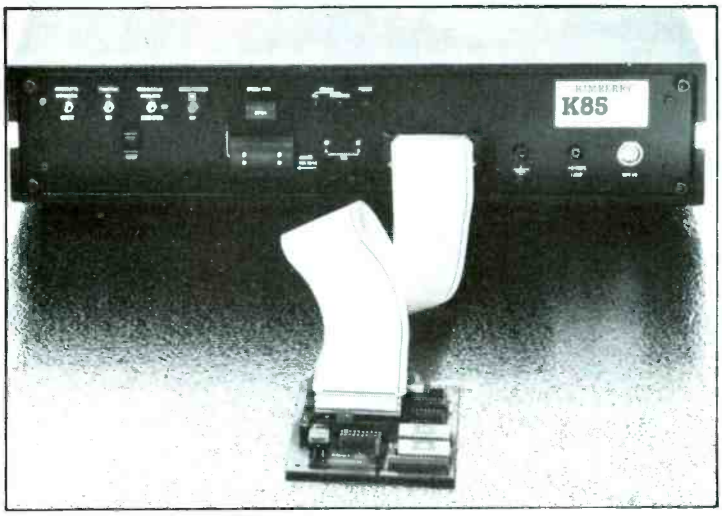
SPECTRUM OSCILLOSCOPE

The first product of a new company, AWR Technology, the Microview is a digital storage oscilloscope and spectrum analyser used in conjunction with the ZX Spectrum computer. The dual-trace instrument with a maximum sampling rate of 100kHz is plugged into the Spectrums edge connector and is programmed through the computer. The gain of each channel is independently controlled with displays of from 10mV to 10V per division. The timebase is selected by a 12-position switch giving values from 1s to 250µs per division. It is possible to analyse the spectrum of either channel using Fourier transformation. The output is displayed on a tv screen on a video-generated graticule and it is possible to display either or both channels, to add them together or to subtract them. X and Y cursor movements permit the reading of amplitude and timing of a waveform. Selected areas of a waveform may be magnified. The signal may be triggered automatically or manually and waveforms can be stored on cassette and played back when required. Output can also be printed on a ZX printer.

The Microview uses machine-code routines to enable fast plotting of data and there are comprehensive menu options to allow extensive analysis of the waveforms. Aimed at the amateur electronics enthusiast and for use in the schoolroom, the Microview costs £140 inclusive. AWR Technology claim that its features compare favourably with instruments costing over £1000 and that for those who do not have a Spectrum computer the cost is still low enough to make it worth getting one. Other versions of the instrument are being prepared for the BBC Micro and the Apple. AWR Technology, Simmonds Road, Wincheap, Canterbury, Kent.
EWW 219



MICROPROCESSOR DEVELOPMENT



A system for the development of microprocessor control boards is provided by the K85 from Kimberry. In-circuit emulation, eprom programming, text editing, assembler language programming, disassembling and debugging are all available in the one unit. The system is itself based on a 8085 processor and is used to develop target circuits which also use the same chip. The target board is connected to the K85 through the in-circuit emulator cable. Any user-designed board can be emulated provided they conform to certain common design rules. Kimberry can also supply a target board, the MTB85-1 which has an 8085, i/o ports, 4K eprom or 2K eprom and 2K ram, and a programmable timer.

The K85 assembler is fully symbolic and very fast. Assembling a 1500-line source program takes about 15 seconds. Any error causes the assembler to stop, pass the control back to the text editor and display the error line on the screen. Thus corrections can be made very quickly and the assembler can go back into action. This eliminates the frustration of having a long list of errors at the end of an assembly and makes editing very easy.

Programs can be stored directly on cassette through the port provided, or downloaded to another computer through the RS232 link. Text files produced by the K85 are Wordstar compatible and editing may be carried out on the second computer if the K85 is in use for emulation.

The zif socket on the front panel has two uses; to read-in programs or regularly used routines kept on a 'library' eproms. A directory listing the stored files can be produced much as in a disc system and such files can be retrieved virtually instantly by name. The other use for the socket is to program 2, 4, 8 or 16Kbyte eproms, all memory mapped. Programs can be assembled into an eprom and then 'run' from the same socket. Additional test and utilities programs are provided for this purpose.

The debug monitor makes development and testing very easy. Amongst its facilities are the ability to inspect and change memory; write to or read from an i/o port; set, clear and list breakpoints; set interrupt status; start a program; inspect and alter 8085 registers. The single-step mode disassembles the object code and displays all registers; a trace mode displays the progress of a program on a screen or outputs it to a printer.

Also provided is an output power supply for the target system, a parallel printer interface, video output, cassette interface at 1200baud and a fully buffered interface bus configurable to STD or Euro buses.

The K85 development system cost £1995 and Kimberry point out that the alternative is a full-scale microprocessor development system costing upwards of £7000. The price includes an 8085 target board. Additional target boards are £65.
Kimberry, 29 Thorney Hedge Road, Chiswick, London W4 5SB.
EWW 207

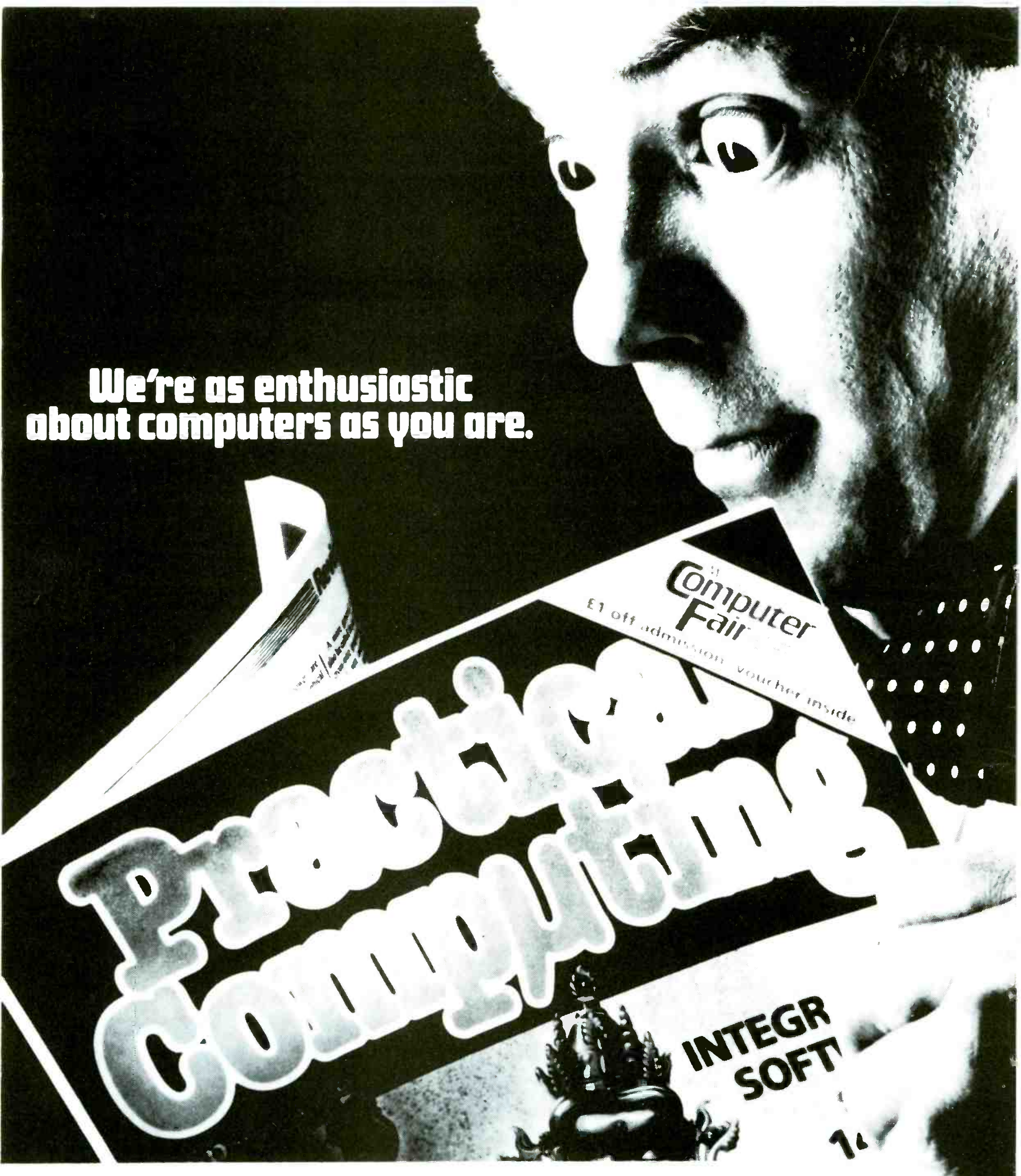
To get further information on any of the products mentioned in these columns, circle the appropriate number on the reply card.

GPIB FOR QL

A full implementation of the international IEEE-488 protocol is available in a plug-in package which fits the expansion slot on the Sinclair QL computer. The device allows the computer to be connected to, and obtain data from a wide range of scientific and laboratory instruments and such peripherals as printers, plotters and disc drives. The Q-488, as it is known, responds to commands from any high-level language installed in the QL, such as QL SuperBasic, Pascal, C, Forth and also assembly or machine-code instructions. It incorporates an interface with the QDOS operating system and can cope with up to 16 devices connected at the same time. Data can be transferred between devices at a rate of up to 70Kbytes. It has been designed to be easy to use and incorporates a number of user advice facilities, error checking and a comprehensive user manual. The Q-400 is the second of a number of devices designed to make the QL suitable for serious industrial and research work. The first was a Centronics parallel interface. Cambridge Systems Technology, 30 Regent Street, Cambridge CB2 1DB.
EWW 205

FLAT CONVERTERS

A range of six d.c.-to-d.c. are designed with a low profile for p.c.b. mounting. With inputs of 5 and 12V they have outputs of 5, 12 and 15V, fully regulated with isolation up to 500V, short-circuit and thermal overload protection. A pi input filter reduces the ripple feedback current to the supply. Fully enclosed aluminium cases allow for a wide operating temperature range. £35 each from K.E. Developments Ltd, The Mount, Tolt, Cambridge CB3 7RL.
EWW 210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PCB DESIGN ON A PC

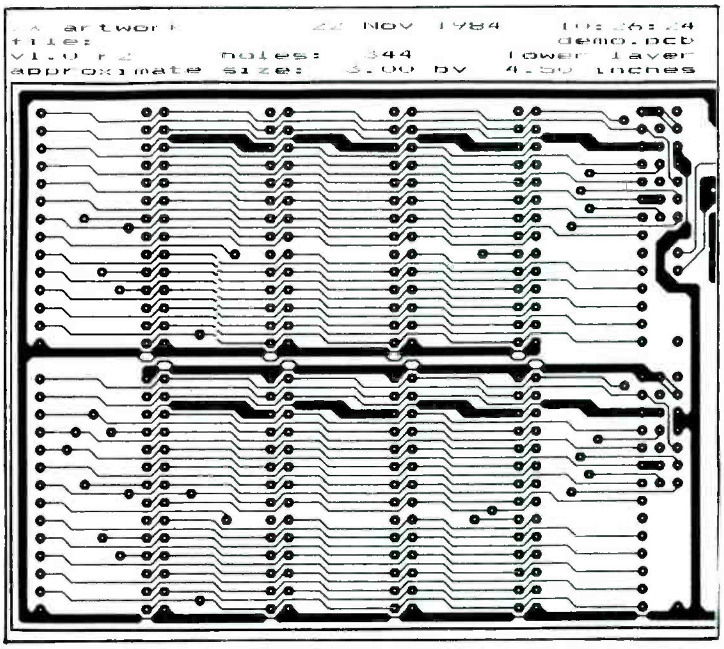
A complete system for designing p.c.bs is available for running on an IBM-compatible desk-top commputer.

Camera-ready artwork is produced on an ordinary Epson dot-matrix printer although it is possible to get higher precision by using a plotter. The disc-and-handbook combination of the smArtwork (sic) software makes it very easy to position connector pads and join them with traces. Either or both sides of a p.c.b. may be viewed on a screen and there are many options to zoom into an area for precision work and to select contrasting colours on the screen display.

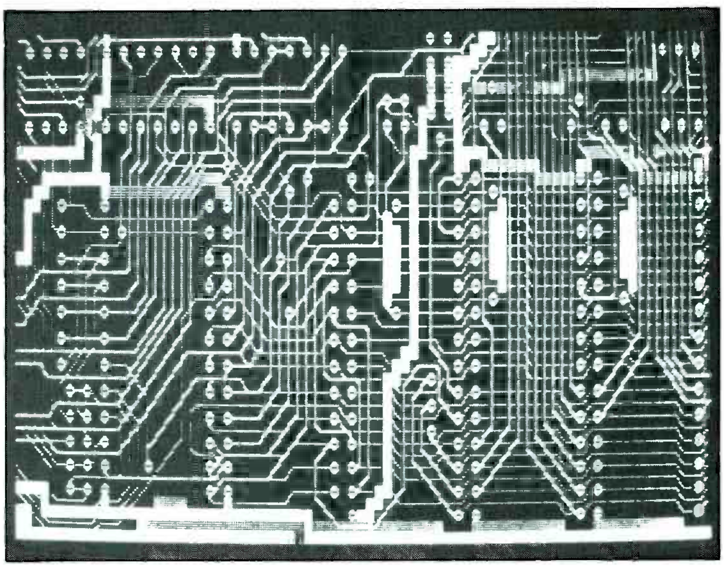
There is a library of standard connector pads for, e.g. dil or sil devices and a single push button will position them at a chosen direction from the cursor. When used with a mouse, the system can be used very quickly to indicate the start and end pads of a connection and the computer will automatically find a route, avoiding other connections and providing sufficient width for reproduction (and for connection). All conductors are automatically made vertical, horizontal or at 45°. It is also possible to specify a specific route and to remove or reposition all or part of a trace. Repetitive traces, when the connections on one dil package are all connected to similar pads on another, can be produced automatically just by a single depression of the mouse button.

The maximum board size is determined in part by the printer or plotter in use, but the program can handle double-sided boards of any complexity up to 10 by 16in. Conductor size and spacing has been chosen to give optimum results. Thicker traces for power or ground tracks may be chosen as required.

The twice-sized artwork produced by a dot-matrix printer is perfectly acceptable for prototyping or small quantities but a plotter is recommended for printing the masters for production runs. A normal sized output is also possible and may be used for checking and for reference purposes.



Artwork produced on an Epson dot-matrix printer. The X2 printout is here reduced to approximate board size.



Complete systems start at £3600. Software for £895. EuroMicro Ltd, Coleridge Lane, London N8 8ED. EWW 208

Also from Conguin Software, 14 Goodwin Close, Morden, Surrey SM4 5AW, who offer a 10% discount on orders received before 28th February. EWW 249

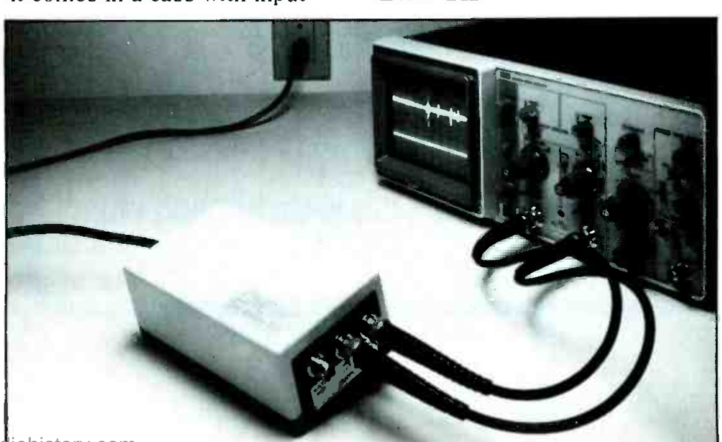
TUBE RESTORER

The quality of any television picture tube can be rapidly analysed and restored by using the B&K Model 467. Digital multiplexing circuits are used to provide many testing capabilities. The test procedure is all laid out on the control panel which guides the user through the sequence. Three meters display the emission from the three guns in a colour tube; they are also used to show the heater, G1 and line voltages. Leakage between all important elements can be checked instantaneously. The heater voltage is continuously variable with all commonly used voltages marked on the meter scale; G1 and G2 voltages are also variable to simulate the use of a tube in a receiver. Colour tracking test circuits allow the easy checking of gun tracking.

Rejuvenation of a tube is carried out simply by pressing the Restore button; each gun is restored independently and a special technique (patent applied for) is employed to ensure the maximum cathode current without damaging the cathode. This involves pre-heating the cathode and then applying the high rejuvenating voltage between G1 and the cathode while at the same time removing the heater current. Function switching between restoring and emission test permits instant evaluation of the effectiveness of the restoration. The removal of a short between the grid and cathode is indicated instantly by a lamp. B&K Precision, PO Box 27, 39 Whitby Street, Hartlepool, Cleveland TS24 7BR.
EWW 209

POWER LINE EXAMINER

It is easy and safe to view a.c. power line waveform on an oscilloscope if you use the Line Viewer 103, says its manufacturer. It is an interface between a power line and the oscilloscope which may be used by a service engineer for the analysis of power problems. Normal-mode or common-mode noise and low-frequency distortion may be seen easily. A power conditioner can be easily checked to test its effectiveness. The Line Viewer 103 operates on all standard mains voltages, it comes in a case with input and output leads at a one-off price of £525. Oneac Ltd, 6 Eyston Way, Abingdon, Oxon OX14 1TR.
EWW 212



EINSTEIN'S TRAINS

From W.A. Scott Murray

Consider the situation described by Einstein in his book — *"Relativity — the Special and the General Theory"*, dated 1916/1952. Lighting strikes a railway track at two separated points A and B, while an observer M sits at the trackside half-way between these points. The light signals due to the strikes, travelling from A to B, at velocity *c*, reach M at the same time. Since the distances AM and MB are equal (by measurement), M concludes that the strikes at A and B were simultaneous (Fig.1); we shall designate their common time (instant) of occurrence, as deduced by M, as $t = 0$. this is Einstein,s *new definition* of simultaneity, superseding the previous conventional definition:

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

Einstein next introduces a train, running along this track in the direction A → B at velocity v. The train carries another observer M′, and it happens that just when the lightning strikes the rails at A and B (that is, at $t = 0$ as judged by M), M′ is located exactly opposite M. What does M′ observe? The quotation is Einstein's version, verbatim:

> "Just when the flashes of lightning occur (as judged from the embankment), this point M′ naturally coincides with the point M, but it moves towards the right in the diagram with the velocity *v* of the train. If an observer sitting in the position M′ in the train did not possess this velocity, then he would remain permanently at M, and the light rays emitted by the flashes of lightning A and B would reach him simultaneously, i.e. they would meet where he is situated. Now in reality (considered with reference to the railway embankment) he 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."

He then goes on to declare as a Principle the "relativity of simultaneity", saying,

> "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."

Einstein's description of M′ "hastening towards the light coming from B while riding on ahead of the light coming from A, so that he will see the light coming from B earlier than he will see that coming from A", is as depicted in Fig.2. That is what the "fixed" observer M would deduce *(by common sense)* that M′ would see. However, Einstein's own "second postulate" denies that the velocity of M′ relative to A or B can have any relevance: the velocity of light approaching M′ is to be c always, irrespective of the motion of its source. If so, then the situation observed by M′ in his own coordinates must be as shown in Fig. 3. where the two flashes arrive at the same instant — by Einstein's own definition, "simultaneously".

Einstein's argument *as quoted* is therefore inconsistent with his own, new postulate of the invariance of c.It is, however, com-

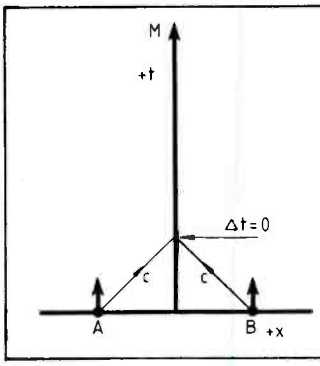


Fig.1. **Coordinates of M. Flashes arrive simultaneously**

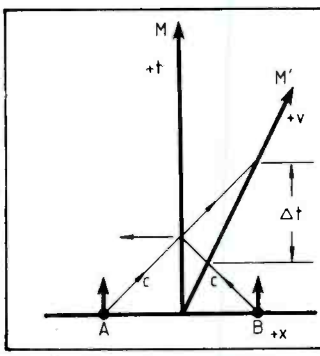


Fig.2. **Coordinates of M. Newtonian mechanics: what M deduces that M′ will observe**

pletely consistent with Newtonian mechanics and Galilean transformations between the two coordinate systems,

$$x' = x - vt,$$
$$t' = t \text{ (of course)}, \quad \ldots(1)$$

which would apply to a ballistic theory of light (in which the photons were radiated at velocity c relative to their source and retained that same velocity indefinitely thereafter whilst in transit *in vacuo*, in accord with Newton's first law). This situation, which is shown at Fig.4, is that which is actually described by Einstein, and there can be no doubt but that his description is in conflict with his own theory on this point.

In order to view the situation "properly" from the stand-point of Special Relativity theory it is necessary to resort to the non-Newtonian or Minkowski mechanics which corresponds to the Lorentz transformations,

$$x' = \beta(x - vt),$$
$$t' = \beta(t - vx/c^2), \quad \ldots(2)$$
$$\text{where } \beta = 1/\sqrt{1 - v^2/c^2}.$$

Thus numerically, if we choose scales such that, in the coordinate system of M, the point A is at $x = -1$, B is at $X = +1$, $c = 1$, and $v = 0.5c$ (for demonstration) so that $\beta = 1.1547$, then by equations 2 we have, for the coordinates (x', t') of A and B in the system of M′,

$$\text{A}: x = -1,\ t = 0, \quad \rightarrow x' = -1.1547, \quad t' = +0.57735$$
$$\text{B}: x = +1,\ t = 0, \quad \rightarrow x' = +1.1547, \quad t' = -0.57735 \quad \ldots(3)$$

These results are plotted in Fig.5. According to Special Relativity, the coordinates (places and times) of the lightning strikes at A and B *are not the same* for the "moving observer" M′ as they are for his "fixed" colleague M. To maintain the theory's postulate — or fiction — of the invariance of c, M′ must calculate — and perhaps even believe? — that A and B are really located at (x', t') rather than at (x, t). the only justification for adopting this complicated metaphysic is that some (but not all) of the experimentally-observed failures of Maxwell's electromagnetic theory are automatically compensated if one does so. Such compensation is achieved at the cost of believing the coordinates of time and space to be distorted, to a different extent for every observer, in accordance with the transformations proposed at equations 2. Is it worth it?

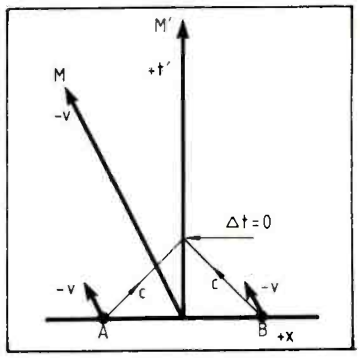


Fig.3. **Coordinates of M′. Newtonian mechanics: effect if c were simply invariant**

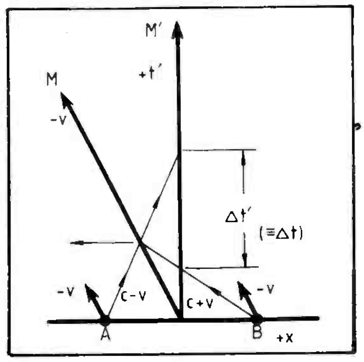


Fig.4. **Coordinates of M′. Newtonian mechanics: effect of c dependent on its source**

If M′ opts to adopt this "relativistic" procedure he will indeed generate that time difference $\Delta t' \neq 0$, for the arrival of the two light signals, which Einstein was seeking to induce by his earlier, erroneous argument. By Special Relativity theory proper the time difference in Fig.5 (a Minkowski diagram) is

$$_{\text{MINK}} = \frac{2vx}{c^2} \cdot \frac{1}{\sqrt{1 - v^2/c^2}} \quad \ldots(4)$$

On the other hand, if the speed of light should be finite but not *invariant*, the common-sense condition $\Delta t' \neq 0$ *required by a ballistic theory is provided with much less complication by Newtonian mechanics; by inspection of Fig.4 it is, simply,*

$$\Delta t'_{\text{NEWT}} = \frac{2vx}{c^2} \cdot \frac{1}{(1 - v^2/c^2)} \quad \ldots(5)$$

Needless to say, this $\Delta t'$ is identical to the Δt in Fig.2. Thus on this hypothesis the two observers remain in complete agreement concerning what each observes and how it should be interpreted; the obvious non-simultaniety of arrival of the light signals at M′ does not suggest to either of them that the lightning strikes at A and B were not simultaneous.

What are the prospects of putting this issue to practical test? In

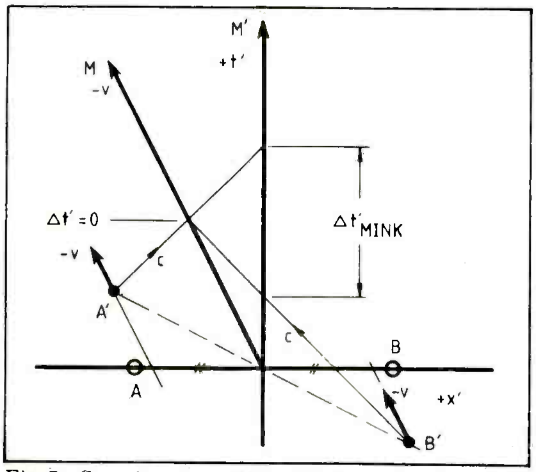


Fig.5. Coordinates of M'. Minkowski diagram: situation in accord with Special Relativity theory

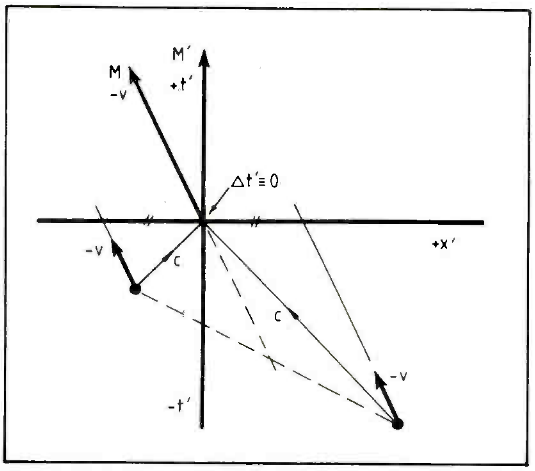


Fig.6. Coordinates of M'. Minkowski diagram: plot of N.B. Taylor's equations in Wireless World

the orbits of low-level earth satellites one has, typically, $v/c = 2\times10^{-5}$, $x/c = 5$ ms, and the term $2vx/c^2$ is consequently of order 0.2μs. Thus to dertermine that Δt does in truth differ from zero in our physical world lies well within the capability of today's technology. Most unfortunately, this "failure of simultaneity" (by Einstein's definition of simultaneity) is insufficient either to confirm or deny Einstein's theory: the difference between equations 4 and 5 amounts, to only one part in 2×10^{-10} in the present case, so that an empirical decision between Sir Isaac Newton's mechanics and that of Professor Minkowski continues to elude us.

One's personal decision about whether or not to accept the mystique of Special Relativity (which in its turn demands personal belief in the *actual* distortions of space and time that are proclaimed in the Lorentz transformations, not just that they *seem* to be distorted) should not depend solely on faith in one's teacher, nor yet on the internal self-consistency of the theory's mathematical arguments (which are entirely circular), but on firm, physical observations of its correspondence to the workings of the world as it is.

Direct demonstrations of such correspondence remain conspicuously non-existent. The fact that it may make the predictions of *another theory* (the electromagnetic theory) "come right" — for example, in the design of a particle-accelerator such as the synchrotron — concerns only the credibility of the other theory, which has failed already on separate grounds; it can in no way be relevant to the credibility of *this* theory, and there is no other reason why one should believe in it.

Einstein's argument as quoted here achieved the result he desired by the device of changing over from Galilean rules of light propagation to speed-invariant rules halfway through, which is scarcely a legitimate procedure. Nevertheless, and surprisingly, very many intelligent people have been deceived by it. Indeed there are some who are quite content to remain deceived! Einstein's proposed "relativity of simultaneity" relies on the relevance of the physical world of those same Lorentz transformations, a question that we are at present unable to resolve by physical measurement. The credibility or otherwise of his celebrated "trains" argument is a separate issue, much less difficult for us to judge.

Kippford, Galloway
November 1984

Addendum in reply to NB Taylor

It is instructive to change the zero of coordinates so that the instant $t = 0$ is defined not by the simultaneous events of the lightning strikes at A and B, but as the time at which, the ensuing light signals simultaneously reach the observer M. Since this is the only time which is actually observed in this thought-experiment, it is perhaps the more natural event to choose for time zero. As far as M is concerned it involves no more than correcting a fixed setting error ($\delta t = AM/c = BM/c$) in his observatory clock, and it is clear that it cannot affect his observations of the relative times of events. However, in this system the events A and B, although simultaneous for M, occur for him not at $t = 0$ but at $t = -1$ (units of x/c). Thus in the coordinates of M' we now have, by equations 2

$$\begin{aligned} A &: x = -1, t = -1 \\ &\rightarrow x' = -0.57735, \\ &\quad t' = -0.57735 \\ B &: x = +1, t = -1, \\ &\rightarrow x' = +1.73205, \\ &\quad t' = -1.73205 \qquad \ldots(6) \end{aligned}$$

The outcome of this transformation is plotted in Fig.6. Apparently light leaving points A and B (as defined in these particular space-time coordinates), travelling at invariant velocity c, does indeed reach the observer M' simultaneously. The change, from $\Delta t' \neq 0$ to $\Delta t' = 0$, seems to have been achieved by observer M by the simple process of resetting his watch before the experiment began!

One need look no further than that last sentence tolocate the fallacy in that argument. The assumption underlying Fig.5 and its predecessors was that M' was coincident with M at the time $t = 0$, which was the instant of the strikes as "judged" (not as "observed", see p.93) in the coordinates of M. But M' is not coincident with M at the instant newly defined by M as $t = 0$. If the world-line of M is backtracked in Fig.6 it will be found to pass through the *mid-point* of the line AB. Both the length and the slope of AB are unchanged as between Figs 5 & 6-M cannot modify the physical events simply by resetting his watch. The mid-point of AB was the origin of coordinates in Fig.5, and it remains (by Einstein's initial choice) the only location at which M and M' can be coincident. Thus in Fig.6 the world-line of M' is incorrectly plotted, and the apparent "simultaneity" is false.

LITERATURE RECEIVED

The latest products from Advanced Micro Devices are all described in a Hot New Products catalogue. Included are programmable array logic i.cs, the iAPX 80186 which provides a second source for the Intel device. A number of other microprocessor peripheral chips, including display controllers, non-volatile memory devices, and telecommunications interfaces. Available through their distributors, Hawke Electronics, 45 Hanworth Road, Sunbury-on-Thames, Middlesex. EWW 250

Power linear actuators interface micros to a variety of external devices such as stepper motors, power supplies, tachometers etc. SGS-Ates make a variety of such i.cs which can handle voltages up to 100V or currents up to 4A. These are detailed in a catalogue with full data and application details. SGS Semicondictor Ltd, Planar House, Walton Street, Aylesbury, Bucks. EWW 251

Although Ambit retail outlets have been absorbed into the Cirkit organization, they are continuing to offer a service to industry through mail-order with trade counters at Brentwood, Essex, Boxbourne, Herts and Portsmouth, Hants. The catalogue, is available through Ambit Industrial Sales, 200 North Service Road, Brentwood, Essex. CM14 %SG. EWW 252

A high-speed information stystem, based on teletext, is described in a folder-full of brochures from MRG Systems. The equipment is compatible with a wide range of main-frame, mini and microcomputers. It acts as a 'page' store and converts the information into a teletext broadcast signal which can be received by standard teletext tvs or through special terminals. The system can support an unlimited number of terminals and, using a whole-channel transmission, can maintain a constant response time of between 0.2 and 3s. MGR Systems Ltd., Calf-way House, The Camp, Miserden, Glos GL6 7HN. EWW 253

A number of dictionaries of electronics and computer terminology are very useful to technical translators as they are published in multi-language editions. Typical is a Dictionary of Microprocessor Systems in English, German, French and Russian.

All detailed in a brochure from Elsevier Science Publishers, PO Box 211, 1000 AE Amsterdam, The Netherlands. EWW 256

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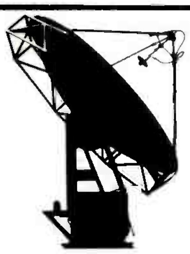

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