Microprocessor speedometer

Auto telephone dialler alarm

Developments in cable television

Sampled data servo analysis

Demister aerial for car radios
**SCOPES**

- UK C/P £30.00
- UK P & D £33.00
- P/C £64.50
- P/D £65.00

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**DIGITAL MULTIMETERS**

- Handheld models
  - Controls: 50kV/20g/2p-p
  - FS: 6 to 12 diode
  - All feature AC/DC volts
  - AC/DC current (with AC adapter
  - extra £2.50)
  - All AC/DC inputs
- Hameg 2020 (10MHz)
- £69.50
- £125.00

**LCD COUNTERS**

- $200.00
- $215.00
- $60.00
- $45.00

- Hameg 2010 (10MHz)
- £45.00
- £60.00

**GENERATORS**

- Function and pulse (UK C/P £65.00)
- AT840E: £65.00
- £45.00
- £55.00
- £30.00

**COUPLERS**

- £9.00
- £10.00
- £15.00
- £20.00

**AMPLIFIERS**

- £5.00
- £6.00
- £8.00
- £10.00

**DIGITAL CAPACITANCE METER**

- £100.00
- £120.00
- £140.00
- £160.00

**LEADERS**

- £25.00
- £35.00
- £45.00
- £55.00

**ADAPTERS**

- £10.00
- £20.00
- £30.00
- £40.00

**TROJAN DIPOD METER**

- £25.00
- £35.00
- £45.00
- £55.00

**ASZ UNIVERSITY**

- £40.00
- £50.00
- £60.00
- £70.00

**PROJECTS**

- £10.00
- £15.00
- £20.00
- £25.00
COUNTERS

TF600
Bench/Portable: large 8-digit LED display. Frequency range 5Hz to 600MHz. Resolution 0.1Hz. Sensitivity 10mV rms. Timebase accuracy ±2ppm. Battery or mains. Complete with mains adaptor.

TF200
Bench/Portable: 8-digit Liquid Crystal Display. Frequency range 10Hz-200MHz. Resolution better than ±1ppm. Sensitivity typically 10mV rms. Timebase accuracy ±0.5ppm. Battery life 200 hours. Frequency, time average period, totalize & reset: 2 ranges. 5 gate times. External clock facility. Complete with batteries.

TF040
Bench/Portable: 8-digit Liquid Crystal Display. Frequency range 10Hz-40MHz. Resolution 1Hz. Sensitivity 40mV rms. Timebase accuracy ±0.5ppm. Battery life 80 hours. Frequency, totalize and reset: 2 gate times. Complete with batteries.

PFM200A
Pocket size: 8-digit LED display. Frequency range 20Hz-200MHz. Resolution 0.1Hz. Sensitivity typically 10mV rms. Timebase accuracy ±2ppm. Battery life 10 hours. Frequency: 2 ranges. 4 gate times. Complete with batteries.

TP600 PRESCALER
Frequency range 40MHz-600MHz. Sensitivity 10mV rms. Powered direct by TF200 or TF040 (leads supplied).

TP1000 PRESCALER
Frequency range 100MHz-1000MHz. Sensitivity 25mV rms. Will extend TF200 and PFM200A capability beyond 1GHz.

For further information contact:
Thandar Electronics Ltd.
London Road. St Ives. Huntingdon Cambs PE17 4HJ
Telephone (0480) 64646. Telex 32250 thondar

ELECTRONICS & WIRELESS WORLD FEBRUARY 1985

METER PROBLEMS?

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Bucks
Tel: (0494) 448484

R. Henson Ltd.
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Telephone 01445 2713/0749
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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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ISSN 0043 6062.
### INTEGRATED CIRCUITS

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### ELECTRICAL COMPONENTS

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### ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
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**Note:** The above list is not exhaustive and prices are subject to change.
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 vigorously 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 causal 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 govern-ment: since that time each government coming to power has set its face against taxes on publications - taxes on knowledge. Indeed, a Tory govern-ment, 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 cer-tainly reduce the choice of peri-odicals open to readers. Many of the smaller, specialised journ-als exist on a tiny profit mar-gin, 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.c.s 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 also have a 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.c.s have already been identified; it is not known whether the local oxidation 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 becomes 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 databases 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 updating and rapid printing in smaller batches.

Buzzsy 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 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 and least popular information provider. Timefame had accused Prestel of leaking its passwords. The page has since been corrected.
The PC-16 16-bit computer provides PERFECT COMPATIBILITY with the IBM PC/XT range. The motherboard can be supplied in two versions for stereoscopic convenience. The "N" version has no memory on board and the "B" version with space for 64 to 256K RAM. Addition of the Memory Expansion Card provides a further 64 to 512K of RAM. BASIC FEATURES INCLUDE:

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**Electronics & Wireless World** FEBRUARY 1985
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 voice 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.n.s. 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 autonomy 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 in on five sites UCL, ULCC, BTRL at Martlesham, Marconi Research Centre at Baddow and the GEC RL First 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.

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 independence 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 Microcomputers 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 syntactically 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 output 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.

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 licensed amateur. His 14-year-old son, Rahul and his 12-year-old daughter, Priyanka, are studying for the radio amateurs' exams.
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 trains 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 bypass 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 antenna, 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-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 CCH 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 an 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 civil aviation 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 demonstrated 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 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 ±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 control of both strategic communications open has been made in the management of terrorist and hostage crises, while "war games" have increased understanding of tactical CI. 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.u.s.

Sir Frank's lecture underlined Churchill's dictum: "Jaw, jaw is better than war, war," while in discussion it was suggested that C.G.I.S. (Control & Guidance 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 Norwood 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. 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 $60 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 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, 1985, 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. The strongest transmission path occurred up to almost one microsecond after the first arrival. No significant...
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Amateur Radio

Although for h.f. high-power amplification, either linear or Class C, the accomplishers 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 15V 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, G6EPX, on the Isle of Man who has an 80-watt all-band, all-solid state h.f. transceiver partly, based on a Passley design by James Bryant, G4CLF, but with 30V across the final amplifier and using power transistors that he bought for £12, and with no requirement for 30V 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, March 25. 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 2000 in 1976 to 750 in 1982 and 500 in 1984. Percentage of candidates qualifying for the RAE certificate dropped to 66.3 in 1984 from 70.5 in 1983 and 76.0 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 can be 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 50MHz permits for use in non-television hours. Norway is likely to discontinue the use of Band 1 for v.h.f. 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, GW4SHB, GW4JAD and GW4KVPN, 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.

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CIRCLE 40 FOR FURTHER DETAILS.
Cable and satellite tv come together
Nigel Cawthorne reports from Catcom 84 in Switzerland

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.

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.
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 unaffected by the use of successive repeaters, provided that sufficient levels of quantization steps are used in the codes. The first digital fibre optics as described at Catcom '84 by speakers from the Institute for Applied Physics in Zurich, would have a capacity of 1 to 2Gb/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 these 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 ECS-1'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 organises 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 operators 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 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 12 GHz used in satellite transmissions. Switzer described this as a method of bringing the two into the living room!

The four footprints (Spot West, Spot Atlantic, Spot East and Eurobeam) of the ECS-1 communication 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 50-440 MHz 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 10-16 MHz.

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 6 MHz channels together to transmit frequency modulated tv signals requiring a bandwidth of 18 MHz. 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 5-500 MHz 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 materials.
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CIRCLE 62 FOR FURTHER DETAILS.

ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
**BBC Micro Computer System**

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**ELECTRONICS & WIRELESS WORLD FEBRUARY 1985**
D.C. SUPPLIES

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 load voltage that does not get dissipated by the d.c. component, is only 40.6%. The rest is dissipated by the ripple current made up from remnants of the fundamentals of 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 sources, then as the number of phases increases, there is a large increase in efficiency of a.c. to d.c. conversion. That is why motorcar 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 install 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 and its value, i.e. $R_f$, Parker 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 $R_p$ 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, therefore, 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 of the current pulses, as well as on the mean current. The mean current is of course, the value of the d.c. output, $I_p$.

A search through the literature for the treatment of the non-peak charging case, turned up an analysis by A. Lieders. 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 produces some terrible integrals — one requiring nearly two pages in an appendix to evaluate! His nomograms and graphs offered as design aids are...
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. The symbols and geometry shown in Fig. 2 are drawn upon to build the model. From Fig. 2(a):

the d.c. output voltage,
\[ V_o = \frac{V \sin \omega t - V_c}{2} \]  

the instantaneous a.c. voltage,
\[ v = V \cos \omega t - V_c \]  

and the peak ripple voltage,
\[ \Delta v = \frac{V_c}{2} \]  

The meaning of the load resistance \( R_L \), and the total series resistance in the rectifier path \( R \) 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 \( \tau \) in Fig. 2(a). \( \tau \) is the conduction time. The current pulse is very nearly given by \( v - V_k \) acting across \( R \) during the conduction time interval. The d.c. current \( I_{\text{dc}} \) is the average of these charging pulses over the period \( T/\pi \), where \( p \) is 1 for half-wave rectification and 2 for full-wave circuits.

\[ I_{\text{dc}} = \frac{p V}{2 \pi R} \int_{\tau}^{\pi - \tau} (v - V_k) \, dt \]

and by substituting from eqns 1 and 2:

\[ I_{\text{dc}} = \frac{p V}{2 \pi R} \int_{\tau}^{\pi - \tau} \left( \cos \frac{2 \pi t}{T} - \cos \frac{\pi t}{T} \right) \, dt \]

Carrying out this simple integration, you can see that:

\[ I_{\text{dc}} = \frac{p V}{2 \pi R} \left( \frac{\sin \frac{\pi t}{T} - \frac{\pi t}{T} \cos \frac{\pi t}{T} - \frac{\pi t}{T} \cos \frac{\pi t}{T}}{T} \right) \]

But we have eqn. 1 again to enable substitution for \( V \):

\[ I_{\text{dc}} = \frac{p V_0}{2 \pi R} \left( \frac{\sin \frac{\pi t}{T} - \frac{\pi t}{T} \cos \frac{\pi t}{T} - \frac{\pi t}{T} \cos \frac{\pi t}{T}}{T} \right) \]

Finally, by Ohm's Law:

\[ I_{\text{dc}} = \frac{1}{V_{\text{cc}}} \frac{R}{R_L} \]

This is an interesting result. It gives the conduction time for half-wave (\( p = 1 \)) or full-wave (\( p = 2 \)) rectifiers, in terms of \( R \) 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 \( \tau \), on a pocket calculator and moving into an accurate solution by trial and error. Figure 3 is a useful curve giving \( \tau \) as a function of \( R/L \).

The constancy of \( \tau \), (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 \( \tau \), of course. It also has a peak value of \( \Delta V \) and an r.m.s. value \( I \).

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

\[ I_{\text{dc}} = \frac{p V}{2 \pi} \int_{\tau}^{\pi - \tau} \frac{\sin \frac{\pi t}{T}}{T} \, dt \]

Or transposing for \( I \):

\[ I_{\text{dc}} = \frac{p V}{2 \pi} \int_{\tau}^{\pi - \tau} \frac{\sin \frac{\pi t}{T}}{T} \, dt \]

Fig. 3. This curve is a plot of equation 4 in the text. It yields values of \( \tau \) if the ratio of \( R \) 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 circuit 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.

\[ 1 - I_{av} = \frac{\pi T}{2p \tau} \ldots 6 \]

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

\[ I = 1 - \frac{1}{T} \int_0^T \sin^2 \frac{\pi t}{T} \, dt = \frac{\tau}{2T} \ldots 7 \]

(As this value is per diode, it doesn't come into the picture at this stage.) On substituting for \( I \):

\[ I = 1 - \frac{I_{av}}{\frac{\pi T}{2p \tau}} \ldots 8 \]

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:

\[ I_{(t. \, m. \, w.)} = \frac{\pi T}{8 \tau} \ldots 9 \]

b. full-wave bridge:

\[ I_{(t. \, m. \, b.)} = \frac{\pi T}{8 \tau} \ldots 10 \]

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

\[ I_{(t. \, m. \, c. \, t.)} = \frac{\pi T}{8 \tau} \ldots 11 \]

(per half winding)

The electrical engineers define a form factor for a repetitive waveform as

\[ k = \frac{I_{rms}}{I_{av}} \ldots \]

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. Therefore the ripple amplitude across the load is strongly dependent upon it.

The capacitor has a fraction of the periodic time interval to discharge given by \( T(1 - \tau) \ldots 12 \)

where \( V_r \) is the peak ripple voltage.

For any sawtooth waveform, if \( V \) is the peak value, then the r.m.s. value is given by \( V_r = \frac{V}{\sqrt{2}} \ldots 13 \)

Therefore if you know the type of rectifier (p), the d.c. load current \( I_{dc} \), the conduction time \( \tau \), 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 smoothing required for this and in power supplies. For example, E.J. Hatch\(^7\) stated in his article that he had 'seen the rule of thumb, use 2000\text{\mu}F\text{ 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 \( \tau \) about 3 ms on 50 Hz mains (\( T = 20 \text{ ms} \)) gives in a full-wave rectifier circuit:

\[ C = \frac{1 \times (10 - 3) \times 10^{-3}}{2 \times 1.75} = 2000 \text{\mu}F \ldots 14 \]

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

\[ V_{r.m.s.} = \frac{V_r + nV}{V} \ldots 15 \]

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:

\[ R_1 = 19.7 \Omega \]
\[ R_2 = 497 \Omega \]
\[ C = 37.5 \text{\mu}F \]

Diodes BAX13 \( V_r = 0.77 \text{ V} \)
\[ V_1 = 10 \text{ V} \text{ on load.} \]
\[ I_{dc} = 20.1 \text{ mA} \]

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

<table>
<thead>
<tr>
<th>measured</th>
<th>calculated</th>
<th>present results</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I = 9.16 \text{ mA} )</td>
<td>( 9.06 \text{ mA} ) from 6</td>
<td>( 9.06 \text{ mA} ) from 6</td>
</tr>
<tr>
<td>( I_{dc} = 20.1 \text{ mA} )</td>
<td>( 20.3 \text{ mA} )</td>
<td>( 20.3 \text{ mA} )</td>
</tr>
<tr>
<td>( V_1 = 9.5 \text{ V} )</td>
<td>( 9.5 \text{ V} \text{ from 14} )</td>
<td>( 9.5 \text{ V} \text{ from 14} )</td>
</tr>
<tr>
<td>( r = 0.086 )</td>
<td>( 0.086 )</td>
<td>( 0.086 )</td>
</tr>
<tr>
<td>( 2a = 60° \text{ (1.187 rad/1.08 rad)} )</td>
<td>( 1.086 \text{ rad} \text{ vs } t )</td>
<td>( 1.086 \text{ rad} \text{ vs } t )</td>
</tr>
</tbody>
</table>

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 changing' condition was attempted in both circuits, by minimising \( R_1 \). Another set of results was obtained for the 'sawtooth' approximation, by using a relatively large \( R_1 \). Figure 5(a) and (b) shows the voltage obtained in the half-wave examples, while the current pulses through the...
diode are shown in a,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 opted-up on squared paper, and then the area under the calculations. This will give the mean current $I_m$. The peak value $I_p$ and, on time $t_r$, 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.

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 peaked 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$^6$.

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

Power out $= I_p \times V_{dc} = 40 \times 10^{-2} \times 15 - 600$ mW

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

... a ratio of 1 : 1.8

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

Andeols Systems
Solina
Buckleyville Alley
Cold Ash
Newbury
Berkshire RG18 9NN

Arcom Control Systems Ltd
Unit 6
Clifton Road
Cambridge CB1 4BW
(Dist: Dage)

CMS 44a Hobson Street
Cambridge CB1 1NL

Control Universal Ltd
Anderssons Court
Newham Road
Cambridge CB3 9EZ

Costgold Research Ltd
The Old School
Streatham
Cambs CB6 3LD

Country Computers Ltd
Pipers Road
1ark Farm Ind. Est. Reddish B96 8HU

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

Cronics
39 High Street
Cowbridge
South Glamorgan CF7 7OE

Dage Eurosem
Rabans Lane
Aylesbury
Buckinghamshire HP19 3RG

Deephaven Ltd
5a High Street
Andover
Hampshire SP10 1LU

Deltak Electronics
Central High Street
Staplehurst
Kent TN12 0BH

Dixit Electronics Ltd
Bond Close
King's Langley Estate
Basingstoke
Hampshire

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

Flight Electronics
Quayside Road
Bittern Manor
Southampton
Hampshire SO2 4AD

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

Gemini Microcomputers Ltd
18 Woodside Road
Amerham

Bucks HP7 0BH

GNC Electronics
Little Lodge
Hopton Road
Thetford
Diss

Norfolk IP2 1JN

IBS (Irving 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
Bowlthorpe Ind. Est.
Norwich NR5 5JA

Macro Marketing Ltd.
Burnham Lane
Slough SL1 8LN

Measurement Systems Ltd
78 Faraday Road
Newbury
Berkshire RG13 2AD

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

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

Microxon Computers Ltd
1 Grangeway
London NW6

National Semiconductor, See Macro Marketing

Pelco Electronics
London Road
Spring Gardens
Romford

Essex RM7 9LP

Pronto Electronics Systems Ltd
454-476 Cranbrook Road
Gants Hill
Ilford

Essex IG1 6LE

Quant Systems
111 Thorpe Road
London E7 9OE

Rade Systems Ltd
20a High Road
London W3 5EJ

RC Microsystems Ltd
141 Uxbridge Road
Hampshire

Middlesex TN12 1BL

Rockwell, see Pelco, RCS

SGS-ATES (UK) Ltd
Planer House
Walton Street
Aylesbury

Bucks HP2 1TQ

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

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

Sirius Microtech Ltd
15 Alexandra Way
Ashchurch Ind. Est.
Tewkesbury GL2 8BN

Syanl Microsystems Ltd
Queens Mill Road
Huddersfield HD1 3PG

TDS (Triangular Digital Services Ltd)
100a Wood Street
London E7 9XW

Thomson-CSF Components
Ringway House
Bell Road
Daneshill
Meadaston
Hampshire

Versaphase
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Eastleigh

Hants SO5 4ZY

References
7. P. Parker, Electronics, Edward Arnold, 1956, Chapter 14

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ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
Sampled-data servos
- a new analysis

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-transforms.
- 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 times other than 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.

By D.M. Taub

Since 1937, D.M. Taub has been continuously engaged in development work on digital electronics. After five years withEricsson Telephones Ltd, he moved to the Plecas Group, where he was involved in electronic switching in telephone exchanges, he went on to contribute to the development of the mercury -data line gate and improved section of the LEO 2 computer. He joined IBM E.A. as a Senior Laboratories Ltd in 1957 and is now a Senior Staff Member. Areas of work at IBM include magnetic -disk data storage, digital -device techniques, and error correction devices. During the past two decades he has been involved on the working group developing Functional (IEEE 1985 D4) for use in high-performance multiprocessor computer designs.

In 1952 D.M. Taub completed a B.Sc. degree at Cambridge University in mathematics, a further 26 in the IBM Technical Disclosure Bulletin, and is named as co-inventor of the 27 -device of 1985. The published work carried him a Ph.D. from the Cambridge University in 1962.

Previously, he had studied electrical engineering at University College, Nottingham, gaining the B.Sc. (Eng) degree in 1948, and after a short period with Ferranti, spent some time carrying out research into new phenomena in electronic devices at the Cambridge University Engineering Laboratory, for which he received the B.Sc. degree in 1950.

He has served as joint secretary editor of the IEE Proceedings on Computers and Digital Techniques (1974-75), and is a Fellow of the IEEE and the British Computer Society, and a Senior Member of the IEEE.

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).

ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
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 every point. The mathematical methods developed are embodied in a set of programs presented in a companion paper.

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.

REFERENCES

List of principal symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tr>
<td>T</td>
<td>sampling interval</td>
</tr>
<tr>
<td>t</td>
<td>time</td>
</tr>
<tr>
<td>U,V,X,Y</td>
<td>points in the servo loop carrying sampled-data signals</td>
</tr>
<tr>
<td>z</td>
<td>z-transforms of signals at U, V, X and Y</td>
</tr>
<tr>
<td>u(n)</td>
<td>sample values at U, V, X and Y</td>
</tr>
<tr>
<td>y(n)</td>
<td>z-transforms of U, V, X and Y</td>
</tr>
<tr>
<td>x(n)</td>
<td>z-transforms of U, V, X and Y</td>
</tr>
<tr>
<td>α</td>
<td>hold-circuit proportionality constant</td>
</tr>
<tr>
<td>β</td>
<td>coefficient of $z^k$ in numerator polynomial of $H_u(z)$</td>
</tr>
<tr>
<td>γ</td>
<td>coefficient of $z^k$ in denominator polynomial of $H_u(z)$</td>
</tr>
<tr>
<td>δ(t)</td>
<td>Dirac function time delay between A and B (Fig. 21)</td>
</tr>
<tr>
<td>Δz</td>
<td>coefficient of $z^k$ in numerator polynomial of $H_u(z)$</td>
</tr>
<tr>
<td>ξ</td>
<td>coefficient of $z^k$ in denominator polynomial of $H_u(z)$</td>
</tr>
<tr>
<td>η</td>
<td>coefficient of $z^k$ in numerator polynomial of $H_u(z)$</td>
</tr>
<tr>
<td>ι</td>
<td>coefficient of $z^k$ in denominator polynomial of $H_u(z)$</td>
</tr>
<tr>
<td>m</td>
<td>integer; also highest power in general polynomial expressions</td>
</tr>
<tr>
<td>L</td>
<td>highest power of $z$ in numerator and denominator polynomials of $H_u(z)$</td>
</tr>
<tr>
<td>M</td>
<td>poles of $H_u(z)$</td>
</tr>
<tr>
<td>n</td>
<td>poles of $H_u(z)$</td>
</tr>
<tr>
<td>p(t)</td>
<td>sampling waveform</td>
</tr>
<tr>
<td>ω</td>
<td>angular frequency</td>
</tr>
<tr>
<td>φ</td>
<td>phase angle</td>
</tr>
</tbody>
</table>

TUTORIAL SERIES

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

Fig. 4. In today's high-density disc store servo information is interleaved with the data on every disc surface.
Improving colour television decoding

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 pin-point the many aspects covered, the following digest is offered.

The first article (WW Dec. 1983) explained the basics of the PAL colour 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 determined by the delay chosen and gave examples of typical spacings ranging from 64 µs (15.625 kHz) for a 1-line delay up to 40 ns (25 kHz) 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 separation.

Part 2, in the January 1984 WW issue, explained the operation of the PAL comb filter, 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 preceding two articles. With other types, the improvement to be gained from the modifications 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 modified 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 R/G 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 that 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 decoder 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 occurring at exactly 4.5 MHz 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 comb filter 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.

Electronics & Wireless World February 1985

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

Two corrections: on page 41 July issue the 500ns 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:
Stereovision Ltd
(tel: 0233/7901)
Unit 1, Heybridge Industrial Estate
Holloway Road
Heybridge
Maldon
Essex CM9 7XS (Tel. 0621 54633)

'Television' Readers ICBs Services
Ltd (for the board shown in Fig.51)
Fleet House
Welbeck Street
Whitehall
Westminster

Notts.
(Quote ref. D077 at £9.50)
Includes P&P and VAT)

Manor Supplies (addressed in July issue page 40) for small board only housing the TDA3560A 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)

www.americanradiohistory.com
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MULTI-FORTH 83 FOR THE BBC MICRO

CIRCLE 41 FOR FURTHER DETAILS.
Intelligent eprom programmer

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. This convinces the programmer that a printer is connected and it switches on the high-voltage supply.

When setting and checking the slave socket Vcc 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.

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.

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 microprocessors. 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 Vee, Vcc, 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.

<table>
<thead>
<tr>
<th>Code</th>
<th>Command</th>
<th>Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>LIST</td>
<td>2716</td>
</tr>
<tr>
<td>1</td>
<td>SUMCHK</td>
<td>2732</td>
</tr>
<tr>
<td>2</td>
<td>READ M</td>
<td>2732A</td>
</tr>
<tr>
<td>3</td>
<td>READ S</td>
<td>2734</td>
</tr>
<tr>
<td>4</td>
<td>COPY</td>
<td>2734A</td>
</tr>
<tr>
<td>5</td>
<td>PROG</td>
<td>2764</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>27128</td>
</tr>
<tr>
<td>7</td>
<td>-</td>
<td>27256</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>27512</td>
</tr>
<tr>
<td>10</td>
<td>-</td>
<td>8741/8</td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td>8742/9</td>
</tr>
</tbody>
</table>

Note: M represents master, S, slave.

List 1. Extracts from the eprom programmer source code to illustrate the general-purpose nature of register-conditional program execution.
A complete kit of parts for the eprom programmer including transformer, zif sockets, unpunched case, connectors, hardware and programmed eprom but not p.c.b.s 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.b.s, 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 9AD. The microcomputer programming board is an extra £4 including postage.

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

---

Flow diagrams illustrating structure of the eprom programmer controlling software.

- Prog 2732
  - Verify 2732
  - Programming function?
    - Yes
      - Source and slave differ?
        - Yes
          - Output source
            - Program by pulsing S20 low for 50 ms
          - * Verify 2732
        - No
          - Source and slave differ?
            - Yes
              - Output source byte, program by pulsing S27 low for 1 ms
              - * Verify 2764
            - No
              - Decrement pulse count
              - Done?
                - Yes
                  - Clear R0 and carry flag, rotate five times
                - No
                  - Output source byte and program for calculated time
                  - Verify 2764
        - No
          - Output source
          - Program by pulsing S20 low for 50 ms
          - * Verify 2732
          - Turn off Vpp, wait 20 us, set S22 low, input and set S22 high

- Prog 2764
  - Verify 2764*
  - Programming function?
    - Yes
      - Source and slave differ?
        - Yes
          - Output source byte, program by pulsing S27 low for 1 ms
          - * Verify 2764
        - No
          - Decrement pulse count
          - Done?
            - Yes
              - Clear R0 and carry flag, rotate five times
            - No
              - Output source byte and program for calculated time
              - Verify 2764*
        - No
          - Output source
          - Program by pulsing S20 low for 50 ms
          - * Verify 2732
          - Turn off Vpp, wait 20 us, set S22 low, input and set S22 high

- Prog 8748
  - Verify 8748
  - Programming function?
    - Yes
      - Source and slave differ?
        - Yes
          - Re-work ? and output address
          - Latch it by putting RESET high
        - No
          - Set T0 high, then input and rework data
          - Set T0 then RESET low

- Verify 8748
  - Source and slave match?
    - Yes
      - * Verify 2764
      - Set S22 low, input and set S22 high
      - Set Vcc = 5 V, verify 2764
      - Set Vcc = 5 V
    - No
      - Re-work?

---

ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
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 12 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.c.s, nor will printer data rates cause erroneous JMP executions as register R3 is strictly qualified during early sections of the main program to filter out illegal operations.

---

**Table of device details**

This table contains three-byte entries detailing each device. The first byte is the page count (zeros means 256 pages) and the other two are set-up conditions of P7 on the expander. For 874x devices, A12-A15 control RESET, Vpp, EA and TO respectively; slave line S20 controls the PROG signal and S22 supplies Vpp. In these devices, a low on the control line activates the high-voltage supply.

**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, i.e. 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

**Notes**: (1) A12-A15 are pins 2, 26, 27 and 1 respectively. (2) A15-relevant, (3) High-voltages on. Logical low and high are represented by L and H.

---

**Pinout diagram**

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

---

**Specifications**

<table>
<thead>
<tr>
<th>Control</th>
<th>Address line (1)</th>
<th>Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>+5</td>
<td>+21 +12 ON</td>
<td></td>
</tr>
<tr>
<td>RES</td>
<td>S22 S20 S22</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>21 22 23 15 14 13 12</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>10 11 12 13 14 15 16 17</td>
<td>DB</td>
</tr>
<tr>
<td>0</td>
<td>1 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>2716 27512 2764A 2764A 27128 27128A, 27256 27512 8741 8748 8749 8742</td>
</tr>
<tr>
<td>1</td>
<td>1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0</td>
<td>2732 2732A 27256 2764A 27128 27128A, 27256 27512 8741 8748 8749 8742</td>
</tr>
<tr>
<td>2</td>
<td>1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0</td>
<td>2764 2764 2764A 2764A 27128 27128A, 27256 27512 8741 8748 8749 8742</td>
</tr>
<tr>
<td>3</td>
<td>1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0</td>
<td>27512 27512 2764A 2764A 27128 27128A, 27256 27512 8741 8748 8749 8742</td>
</tr>
<tr>
<td>4</td>
<td>1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0</td>
<td>27512 27512 2764A 2764A 27128 27128A, 27256 27512 8741 8748 8749 8742</td>
</tr>
<tr>
<td>5</td>
<td>1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0</td>
<td>27512 27512 2764A 2764A 27128 27128A, 27256 27512 8741 8748 8749 8742</td>
</tr>
<tr>
<td>6</td>
<td>1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0</td>
<td>27512 27512 2764A 2764A 27128 27128A, 27256 27512 8741 8748 8749 8742</td>
</tr>
<tr>
<td>7</td>
<td>1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0</td>
<td>27512 27512 2764A 2764A 27128 27128A, 27256 27512 8741 8748 8749 8742</td>
</tr>
</tbody>
</table>
COLOURIET 132

36 COLOUR INK JET PRINTER.

Logic seeking in dot address mode

ELECTRONICS

8C1831
8C149
80144
6C147
BC143
8C142
00115
B13101
08151
BBM4
010
81113
A9139
A1I21
49124
00162
40161
AC119
ACYIB
AC787X
AC128
ACI26
ACI07
84132
A4119
BCY32
5C324
BG302
BC238
BC213L
55761105
1:550
N
0.90
1.18
1.00
0.19
0.13
0.20
0.31
0.31
0.42
0.39
0.30
0.30
0.31
0.11
0.16
BCY71
BCY70.
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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.

Alarophone

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 thunders-torms, 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 straw-bails. The water then boils in no time, and everyone knows what could happen to metal exposed to strong heat without the possibility 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...
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 1 minute 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.

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).
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 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, 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

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<tr>
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Parity

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<td>On, even</td>
<td>open made</td>
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<tr>
<td>On, odd</td>
<td>made made</td>
</tr>
</tbody>
</table>

×16 transmit clock. The inverter i.c. is a t.t.l. device to provide correct levels for BUSY and 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.

N. Burd
Department of Engineering
University of Lancaster

WASTE GOOD IDEAS

Andrew Harris

ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
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 74517 i.c.s 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

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 erratically 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

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 471454 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.c.s 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, R3. The whole adjusting and regulating circuit consists of just R1,3 and Tr1. Under no-load conditions, output can be as high as 1500V so a second identical circuit around Tr3 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 10kΩ load is removed. Output power depends on L1 which should be kept as small as possible so as not to overload the power transistor.

H.F. 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. Breakout 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 $R_e$.

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.e. therefore constant current flows through the resistor under test, $R_x$; voltage across this resistor is thus proportional to its resistance. Three potentiometers set each scale using known values for $R_x$.

A.H. Howe
Bexleyheath
Kent

ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
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ELECTRONICS & WIRELESS WORLD FEBRUARY 1985

www.americanradiohistory.com
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 8082 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 3.2 MHz 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 ~2.5 mA when running at 3.2 MHz, about 1/50 of the amount used in home computer microprocessors. For further details see 'Programming the 8082' by Tom Swan (Hayden).

Hardware

The design needed to be economical on power and space and a 2 kilo-byte read-only memory (a 2716) was all that was required. A clock frequency of 3.2768 MHz is used once when divided by 2^11 in a ripple counter a frequency of 1600 Hz is produced, which is used to interrupt the main program and

**HEXADECIMAL DUMP**

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

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**REGISTRATION 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 accumulator at once.

- **RF Distance counter arranged as four b.c.d. counters, 100 miles:10 miles:1/10 mile.**
- **RE Binary counter of wheel pulses, incrementing RF at a programmed interval.**
- **RD Time register as four b.c.d. counters, hours:10 minutes:1 minute:1/10 minute.**
- **RC Counter of interrupt, at 1600 Hz, ~9600 counter 0.1 min.**
- **RB Top speed as four b.c.d. digits, unused: 10 miles/h:1 mile/h:1/10 mile/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 Divider.**
- **R6 Dividend.**
- **R5 Quotient.**
- **R4 Upper half: Accumulator storage 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.**

**ELECTRONICS & WIRELESS WORLD FEBRUARY 1985**

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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.

The main program is basically a loop which continually senses the input lines to see if wheel pulse has been received or a mode advance or reset pulse has been received. If not, and if wheel pulse has been received or a mode advance or reset pulse has been received, the program searches the counter since the last wheel pulse was received. If not, and if wheel pulse has been received or a mode advance or reset pulse has been received, the program searches the counter since the last wheel pulse was received. If not, and if wheel pulse has been received or a mode advance or reset pulse has been received, the program searches the counter since the last wheel pulse was received.

By choosing suitable constants, the speed can be produced in any set of units, by changing the outputs to sense the distance at which the wheel rotated by a constant (wheel pulse distance divided by wheel pulse rate) when the speed is calculated by a constant (wheel pulse rate divided by wheel pulse distance). By choosing suitable constants, the speed can be produced in any set of units, by changing the outputs to sense the distance at which the wheel rotated by a constant (wheel pulse distance divided by wheel pulse rate) when the speed is calculated by a constant (wheel pulse rate divided by wheel pulse distance).

The four parallel inputs of the Hall-effect sensor uses a third switch to sense the sensor, thus changing its state. The wires from the sensor go to a third package in a small transistor. The sensor is housed in a small package in a small transistor. The sensor is housed in a small package in a small transistor. The sensor is housed in a small package in a small transistor.
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 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.
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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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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 400 MHz, giving, with a small gap in the middle, 0 to 850 MHz.

The block diagram (Fig. 1) shows the two additional sections necessary. The incoming signal is mixed with the output from a 450 MHz 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, 470 MHz then the oscillator can be set to 470 MHz 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 usable 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 0-850 MHz with one small gap around 400 MHz.
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. micro-wattmeter 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.

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 micro-wattmeter. 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 was 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 each 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.f.e. miniature cable, the outer braid soldered to the circuit board.

Adjust the filter by putting it in series with each oscillator and tuner, then try to reduce the spikes in the 450–850MHz range as much as possible. Next put it in front of each 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.

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**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).

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**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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ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
Floppy discs

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 from the 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 5½in. floppy disc this amounts to 0.2 seconds.

Sector interleaving 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 the next sectors is required. A typical arrangement is a follows:

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

Floppy discs

by David March

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 arbitrary 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 spread 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 longer than a

Table 1: track structures

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<th>Logical sector number</th>
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Acorn's DFS was developed by Digital Research Corporation as an environment for running application programs which would be independent of the actual microcomputer involved. They achieved this by incorporating 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 supp.
ports 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 5in. 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 space. 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 an 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.

<table>
<thead>
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<th>Field</th>
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<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0-8</td>
<td>Entry type</td>
<td>name</td>
</tr>
<tr>
<td>3</td>
<td>9-11</td>
<td>Extension</td>
<td>not used</td>
</tr>
<tr>
<td>12</td>
<td>File extent</td>
<td>in ascii and padded with spaces</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Record count</td>
<td>in ascii and padded with spaces</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Granule allocation</td>
<td>Two bytes per granule</td>
<td></td>
</tr>
</tbody>
</table>

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.

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 interleaving to speed up sequential file access. The interleaving pattern follows the example given earlier. This is carried 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 number for Active Electronics in the December issue should read: 0494 41414; Quadrond 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.

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

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. 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. 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 amplifier. This may be done by the chokes-plus-series-capacitor technique, Fig. 3(b), or by using matching sections, not shown in detail, as in Fig. 3(c). By means of such matching sections, the complex impedances of the aerial and chokes are made to match the input impedance of the radio receiver in the frequency range 500MHz.

**Fig. 3** A demister may be used as an aerial, with the demister isolated from the heater supply circuit by simple chokes (a). (b) 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.
CAR AERIAL

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

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).

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 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
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 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.

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. In many countries horizontal polarization is employed, so it is important that a 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. 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 wire-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-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.

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.

References
## SEMICONDUCTORS

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Variable-speed video playback
D-a conversion, colour processing and dropout compensation

Most TBC d-to-a converters 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 discrete approach is that the d-a-c 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 3X or 4X subcarrier sampling rates allow the use of filters with finite slope, as was the case for the anti-aliasing 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 combinations.

*Amplex (GB) Ltd.

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

Fig. 1. Typical video d-to-a convertor. Programmed current sources feed resistor ladder. Alternatively, current sources 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.

Fig. 3. Overall video subsystem. The d-a-c completes the description of the simple TBC block diagram shown in Part 2. Click to enlarge.
Fig. 3. Simplified output approx. 0 giving video E alternation pulses and bursts. The solution to picture shift is to decode the PAL waveform back to Y, U and V using off-tape 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 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. r. s offer the stop-frame facility, where two fields are repeatedly scanned (see Part 1). This gives better results on slowly moving scenes, whereas odd-fields 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. Resolution looks odd for length 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 jumps to the odd field and looks odd for 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 interface is to be preferred. Clearly the combined effects of odd-even field restoration and colour processing must be taken into account when considering the reduction in the resolution of the picture. The colour processor usually restricts luminance bandwidth deliberately, to match horizontal resolution to the degraded vertical resolution, since antinoise processing adds 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× to +3×) the change in subcarrier frequency is relatively small, and the colour processor can be installed before the a-to-d converter. The TBC 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 and write 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 signals 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.

Fig 8. With U-matic type v.c.r.s, off-tape unstable line rate is multiplied by 282 to give head-to-tape speed proportional to frequency. Colour-under off-tape 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 has same instabilities as luminance, and can be time-base corrected.

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 an 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 error 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 off-tape 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 282Hz 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 282Hz 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.
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, 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.

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

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Number (Millions)</th>
</tr>
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<tbody>
<tr>
<td>office workers</td>
<td>8.52</td>
</tr>
<tr>
<td>managers</td>
<td>5.57</td>
</tr>
<tr>
<td>teachers</td>
<td>3.1</td>
</tr>
<tr>
<td>professions</td>
<td>2.94</td>
</tr>
<tr>
<td>communication &amp; computer people</td>
<td>1.76</td>
</tr>
<tr>
<td>engineers &amp; draughtsmen</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td>23.31</td>
</tr>
</tbody>
</table>

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, juniorants 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 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 evaluations has been that in the US 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 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%.

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. 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 necessities 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, but 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, re-trained, 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%.

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 for far-reaching change.

"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 pluractivity 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. "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
“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 protagonists79-80. 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 recording of data into information-rich chunks, encoding the original data of the subleties 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 homes 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 be 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 time83. 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 Sunday 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.

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

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THANK YOU.

CIRCLE 13 FOR FURTHER DETAILS.
FUNDAMENTALS OF ENERGY TRANSFER


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 direction 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.

\[
\mathbf{F}_1 = \mathbf{E}\times\mathbf{B}
\]

The forces are \( \mathbf{F}_1 = -iB \), \( \mathbf{F}_2 = -qE \).

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 \( i = qE \). 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:

\[
F_1 = \frac{iB}{\varepsilon_0} \frac{\mu H}{\mu E} \frac{\mu E}{\mu E} = \frac{iB}{\varepsilon_0}
\]

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

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 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 coaxial 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 "fields". 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 are of 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. T. 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 movement of the associated charge, 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 an assumed conduction mechanism 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
Cambrelery

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, but \( A \) and \( B \) are equal to c. Likewise, the speed of light produced in an inertial frame, \( c \), is constant relative to \( A_0 \) and \( B_0 \), both of the observers using the same units.

2. The speed of light produced in an inertial frame, \( c \), is constant relative to \( A_0 \) and \( B_0 \), both of the observers using the same units.

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 on 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 a 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 6000 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. 57-69.


C.A. Zapfle, A Reminder on E = mc^2, p = m, (1 - v^2/c^2)^1/2, & N = N. exp (-t'/r'), (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 and I for putting 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
Donald F. McLean
Edgeware
Middlesex

ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
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/horizontal.

(3) Gradient > 45° mixture of diagonals/vertical.

In many cases this will result in a better approximation to the straight line. The required ratio of diagonals to horizontal/vertical for any line can be calculated using a digital differential analyser algorithm.

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


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 across the cathode to anode. The strange power of a rarefied gas to reverse the actions of electricity is the source of the many actions 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, then 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 leads 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 actsuates 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. Winterfold'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.

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Other features include
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CIRCLE 44 FOR FURTHER DETAILS.
NEW PRODUCTS

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.

POTTING PLASTIC RESISTS FLAMES

A flame retardant polyurethane resin is suitable for potting and encapsulation of electronic components. Dobeckan IF400/052/FR was originally 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 7SH. EWW 217

SILENT NIGHT

Although pleasant at times, it can be very annoying to live near 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 ICs 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

SINGLE CHANNEL AUTOMATIC GAIN CONTROL AMPLIFIERS
TAC4063 Gain 48dB, maximum output 63dBmV. Regulator + or - 9dB. Power requirement 14V 21mA
TAC4064 Gain 40dB, maximum output 64dBmV. Regulator + or - 16dB. Power requirement 14V 21mA

SINGLE CHANNEL AMPLIFIERS
TSS4065 Gain 28-46dB adjustable. Maximum output 63dBmV. Power requirement 14V 10mA
TSS3062 Gain 12-30dB adjustable. Maximum output 62dBmV. Power requirement 14V 2mA

DRIVER AMPLIFIERS
TS1038M FM driver amplifier. 10dB Gain. Maximum output 30dBmV. Power requirement 14V 10mA
TS2038E Band III driver amplifier. 10dB gain. Maximum output 30dBmV. Power requirement 14V 10mA
TS3030UHF 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 channels required).

DISTRIBUTION AMPLIFIERS
TE2042 Domestic distribution amplifier. 1 input, 1 output. Gain 20dB. Maximum output 43dBmV
TE1638 Domestic distribution amplifier. 1 input, 2 outputs. Gain 16dB. Maximum output 2 at 30dBmV
TS2046 40-85MHz. Gain 20dB. UHF. Maximum output 46dBmV
TS2047 40-85MHz. Gain 30dB. UHF. Maximum output 46dBmV
TS2845 Separate UHF/UHF inputs. Gain 20dB UHF, 22dB VHF. Maximum output 46dBmV
TS2654 40-85MHz. Gain 20dB UHF, 18dB VHF. Maximum output 54dBmV
TS2655 Gain 18dB UHF, 16dB VHF. Maximum output 60dBmV
TSS3065 Single channel UHF, 18dB VHF. Maximum output 60dBmV
TSS3066 Single channel UHF, 18dB VHF. Maximum output 54dBmV
TSS505 Gain 50dB UHF, 55dB VHF. 42dB FM. Maximum output 65dBmV

REPEATER AMPLIFIERS
TSC1660 Repeater. Gain 16-36dB. UHF. Maximum output 62dBmV
TSC1665 Repeater. Gain 16-36dB. UHF. Maximum output 62dBmV
TSC1660 Repeater. Gain 16-36dB. UHF. Maximum output 62dBmV
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CIRCLE 11 FOR FURTHER DETAILS.

ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
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 8285. 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

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 dissipation of 250mW. Edicron Ltd, 17 Wesley Avenue, London NW3 7BZ. EWW 220

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-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 330, Uxbridge, Middlesex UB8 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 any 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

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CIRCLE 32 FOR FURTHER DETAILS.

ELECTRONICS & WIRELESS WORLD FEBRUARY 1985
**NEW PRODUCTS**

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**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 5MBytes/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 electronics 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

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**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 Spectrum's 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. EWW219

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**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 high-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 5HI. EWW 224

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**ELECTRONICS & WIRELESS WORLD FEBRUARY 1985**
DEWSBURY ELECTRONICS

Efficient monitoring of the complete SW range calls for the use of modern receivers offering operational ease. Recently, good receivers such as the ICOM R-70 and JRC NR-515 have come onto the market, but they lack optimal microprocessor support. Operating categories 240VA-500VA are satisfied by the intelligent POCOM PFC-100 programmable frequency controller.

The basic idea behind this development was got from the analysis of practical experience with different SW receivers. Utilizing this experience with technically sophisticated microcomputer hardware gave birth to this versatile frequency controller, indispensable to all ICOM or JRC owners.

Advanced circuit technology contributes to the high-quality level of this innovation, thus meeting the most stringent demands of all active SW-listeners. Together with either the ICOM or JRC, the PFC-100 permits an unsurpassed degree of operational ease due to the use of a microprocessor and manageable software.

Transformers offer a range of 15-0-15, 18-0-18, and a competitive price. We also stockists of DAIWA WELTZ-DAVETRENS-TASC TELEREADERS-MICROWAVE MODULES.

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ELECTRONICS & WIRELESS WORLD FEBRUARY 1985

www.americanradiohistory.com
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 and disassembler, 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 MT85-1 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 correct 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 on any of the products mentioned in these columns, circle the appropriate number on the reply card.

FLAT CONVERTERS

A range of six d.c.-to-d.c. converters are designed with 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, Tolp, Cambridge CB3 7RL.

EWW 210

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 peripherals as printers, plotter 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, Fortran and 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 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
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If you use computers at work or at home, Practical Computing magazine is essential reading. Every month it takes a long hard look at the most important issues in computing. It's informative, very useful and immensely readable.

It reviews both hardware and software, discusses the latest innovations and helps you get the most out of all the popular computers.

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PCB DESIGN ON A PC
A complete system for designing p.c.b.s is available for running on an IBM-compatible desk-top computer.
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 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 sl 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.

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 1LR.

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. Leaping 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 available 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 rejuvenation 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 Whitley Street, Hartlepool, Cleveland TS24 7BR.

Complete systems start at £3600. Software for £895.
EuroMicro Ltd, Coleridge Lane, London N8 8ED. EWW 208
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Goodwin Close, Morden, Surrey SM4 5AW, who offer a 10% discount on orders received before 28th February.
EWW 249

EWW 209

Artwork produced on an Epson dot-matrix printer. The X2 printout is here reduced to approximate board size.
LINSLEY-HOOD 100-watt Mosfet Power Amplifier

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92
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 appear to him later, and 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 a constant, 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, completely consistent with Newtonian mechanics and Galilean transformations between the two coordinate systems,

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

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 standpoint of Special Relativity theory it is necessary to resort to the non-Newtonian or Minkowski mechanics which corresponds to the Lorentz transformations,

$$x' = \beta(x-vt), \quad t' = \beta(t-vx/c^2), \quad \ldots \quad (2)$$

where $\beta = 1/\sqrt{1-v^2/c^2}$.

Thus numerically, if we choose scales such that, in the coordinate system of the train, 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',

At $A: x = -1, t = 0$,

- $x' = -1 - 0.57735 = -0.57735$,

At $B: x = +1, t = 0$,

- $x' = +1 + 0.57735 = +1.57735$.

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?

If M' opts to adopt this "relativistic" proposition 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

$$\Delta t' = \frac{2vx}{c^2} \sqrt{1-v^2/c^2} \quad (4)$$

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

$$\Delta t' = \frac{2vx}{c^2} \quad (\Delta t' \neq 0) \quad (5)$$

Needless to say, this $\Delta t'$ is identical to the $\Delta t$ 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-simultaneity 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
the orbits of low-level earth satel-
lites one has, typically, vi/c = 2×10⁻⁵, x/c = 5 ms, and
the term 2vx/c² is consequently of
order 0.2µs. Thus to determine
that Δt does in truth differ from
zero in our physical world lies
well within the capability of
today's technology. Most unfor-
tunately, this "failure of simulta-
neity" (by Einstein's definition of
simultaneity) is insufficient
either to confirm or deny Ein-
stein'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 mys-
tique of Special Relativity (which
in its turn demands personal
belief in the actual distortions of
space and time that are pro-
claimed in the Lorentz transfor-
mations, 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 form,
physical observations of its cor-
spondence to the workings of
the world as it is.

Direct demonstrations of such
correspondence remain consci-
ously non-existent. The fact
that it may make the predictions
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agnetic theory) "come right" —
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particle-accelerator such as the
synchrotron — concerns only the
credibility of the other theory,
which has failed already on sepa-
rate grounds; it can in no way be
relevant to the credibility of this

The orbits of low-level earth satel-
lites one has, typically, \( \frac{v_i}{c} = 2 \times 10^{-5}, \) \( \frac{x}{c} = 5 \text{ ms}, \) and
the term \( 2vx/c^2 \) is consequently of
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which has failed already on sepa-
rate grounds; it can in no way be
relevant to the credibility of this

 theory, and there is no other rea-
son 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,
many very 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 phy-
sical world of those same Lorentz
transformations, a question that
we are at present unable to
resolve by physical measure-
ment. The credibility or other-
wise of his celebrated "trains"
argument is a separate issue,
much less difficult for us to judge.

Kiplford, Galloway
November 1984

Addendum to 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 light-
ning 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 \( (t - AM/c = BM/c) \) in
his observatory clock, and it is
clear that it cannot affect his observ-
ations of the relative times of
events. However, in this system
the events A and B, although
simultaneous for M, occur for him
at \( t = 0 \) but at \( t = 1 \) units of
\( x/c \), thus in the coordinates of
M' we have, by equations 2

\[
A' : x = -1, t = -1 \\
B' : x = +1, t = -1 \\
- x' = -0.57735 \\
+ t' = -0.57735 \\
- x' = +1, t' = +1.73205 \\
+ t' = -1.73205 \quad \ldots \ (6)
\]

The outcome of this transforma-
tion is plotted in Fig. 6. Appar-
ently light leaving points A and B
(as defined in these particular
space-time coordinates), travell-
ing at invariant velocity \( c \), does
indeed reach the observer M'
simultaneously. The change,
from \( \Delta t' = 010 \Delta t' = 0 \), seems
to have been achieved by observing
M by the simple process of reset-
ing his watch before the experi-
ment began!

One need look no further than
that last sentence tocolocate the fal-
acy 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
strike as "judged" (not as "observed",
see p.93) in the coordinates of M. But M'
is not coincident with M at the instant
defined by M as \( t = 0 \). If the
world-line of M is backtracked in
Fig. 5, 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 reset-
ing his watch. The mid-point
of AB was the origin of coordinates
in Fig. 5, and it remained frozen 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 reset-
ing his watch. The mid-point
of AB was the origin of coordinates
in Fig. 5, and it remained frozen

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store and converts the information
into a teletext broadcast signal

which can be received by standard
teletext ts or through special
terminals. The system can support
an unlimited number of terminals
and, using a whole-channel (by Ein-
stein's special theory) 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 "simul-
taneity" is false.

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world-line of M' is incorrectly
plotted, and the apparent "simul-
taneity" is false.
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<td>Gas Relays</td>
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<td>Klystrons</td>
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<td>Klytron Amplifiers</td>
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<td>Silicon Controlled Rectifiers</td>
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<tr>
<td>X-Ray Tubes</td>
<td>$0.00</td>
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<th>CHIMNEYS</th>
<th>CONNECTORS</th>
<th>FINGER STOCK</th>
<th>SOCKETS</th>
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**PRODUCTS**

- Backward Wave Oscillators
- Cathode Ray Tubes
- Cold Cathode Tubes
- Domes
- Display Devices
- Duplexers
- Electro-Optical Devices
- Gas Relays
- Ignitrons
- Image Intensifiers
- Integrated Circuits
- Klystrons
- Klytron Amplifiers
- Silicon Controlled Rectifiers
- X-Ray Tubes

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<th>DESCRIPTION</th>
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MICRODOCTOR is for DIAGNOSIS, finding troubles in microsystems. You just plug into the microprocessor socket, READ and WRITE to the MEMORY and I/O. MD does CHECKSUMS, RAMTESTs on memory, checks for SHORTS on the bus, and prints memory in HEX or ASCII. You can also DISASSEMBLE and print the SOURCECODE in 280, 6502, 6800 or 8085 mnemonics. When your SCOPE or MULTIMETER can't find the problem — consult the MD. When you order say wish processor or ask about multiprocessor MD £295

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