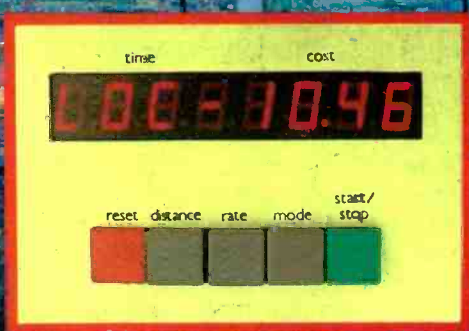
ELECTRONICS &
Wireless world
JULY 1985 85p

Video displays surveyed

Telephone charge indicator

Enlarger lamp power controller

Electronics for young people



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July 1985

Volume 91 number 1593

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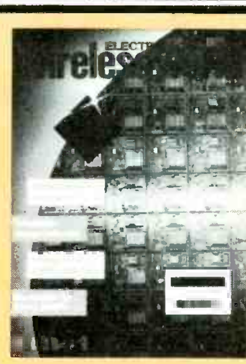

Front cover illustrates our feature on video display units, which starts on page 17. Insert at lower right is the call-cost calculator on page 50. Cover design by Philip Brooker.

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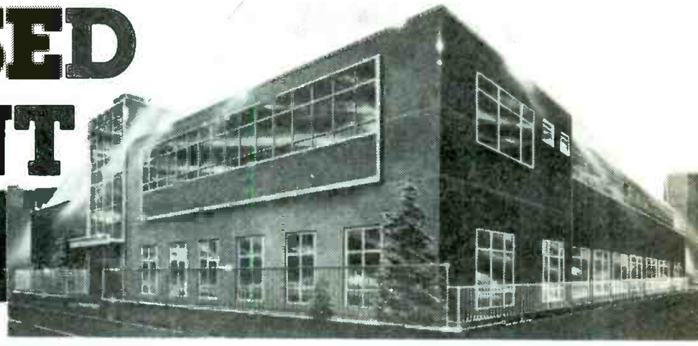

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Another good use has been found for a cordless 'phone. This one is carried around by the warden of sheltered housing for the elderly. The handset is linked to a system that provides immediate alarm calls, can act as a vandal-proof door entry phone and offers speech communication wherever the warden may happen to be at the time. This one comes from Wolsey Electronics, in Pontypridd.

Pirate satellites?

Luxembourg may tire of the dithering over satellite broadcasting in Western Europe and launch a 'pirate' d.b.s. tv service covering several countries and financed by advertising. This comes from a report by a US firm of market researchers, International Resource Development Inc.

IRD has analysed the European d.b.s. scene. They reject two 'pirate' possiblities but feel that a third is likely. Those rejected are that an individual satellite owner capable of offering a form of d.b.s. could start transmissions or an entrepreneur could buy a satellite and launch it for the purpose. IRD's view is that a country ready to start national coverage or even a wider service may jump the gun on overspill and copyright arguments. It could then, they say, argue from a strong position and it could, if forced to withdraw, simply re-focus on a tighter beam to stay within its own borders or, alternatively, avoid contentious programming. IRD sees Luxembourg as the most likely contender. One consequence of the 'he who dares, wins' scenario not covered by IRD is the possible effect on technical standards. It could be the end of MAC, catering for future improvements in picture quality, so opponents of MAC might well covertly back a pirate.

Hitech at the union

It seemed inappropriate for a high technology training scheme, organized by a trades union, to be launched by a Tory minister. However this is what happened when Norman Tebbit, Secretary for Trade and Industry, launched two systems for training members of the Electrical, Electronic, Telecommunications and Plumbing Union (EETPU) in microelectronics and robotics. Development of the training package was supported by grants from his Department.

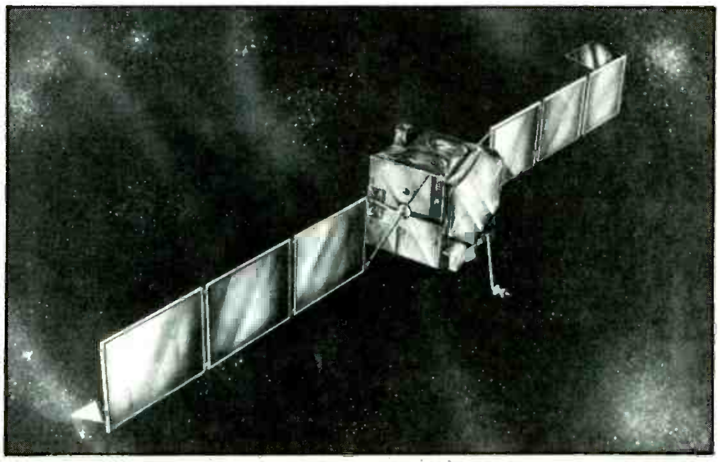
Much of the training is carried out through the use of an interactive videodisc learning package. Mr Tebbit pointed out that the system was developed from a programme begun by his Department; "to stimulate development and growth of a UK interactive video disc industry. The EETPU project is a clear example of cooperation at its best; between a forward looking trade union, an enterprising and expanding small British firm, Epic; and the Government."

He went on to praise the union's involvement with advanced technology and its contribution to the forthcoming report of the National Economic Development Office on advances manufacturing systems.

"We all depend for our well-being ultimately on the performance of British industry. Two vital ingredients of that performance are the skills of our workpeople and the new technology being put at their fingertips."

New Beeb

Without much advance publicity Acorn have launched the BBC B+ computer. Externally this is extactly the same as its predecessor. Internally it uses a completely redesigned circuit board, developed for the Acorn Business Computer. This incorporates 32K more ram, making the B+ a 64K computer. The extra memory is divided between 20K screen memory, freeing that amount for program development, and 12K of 'sideways' ram. This occupies the same area in the memory map as roms and may be used to download rom utilities. The other major difference is the provision of six sockets for roms which can now be up to 32K each. One 32K rom is installed. It combines the operating system with BBC Basic. The computer is fitted with a disc interface as standard and as a departure from their stubborn adherence to the outdated 8271 single-density, limited file-number system, they have now opted for the 1770, but in order to keep as compatible as possible with the old system the DFS incorporates all the same restrictions! Acorn see the computer as a continuation of their role in education and 'serious' home computing and it costs £499 inclusive. This compares unfavourably with many other 64K computers and general opinion is that it is overpriced and unlikely to sell well. One would have thought that it could have been possible for Acorn to reduce the price of the BBC B to about £300 and then sell the B+, with its enhancements, for the same £400 of its predecessor.



British Aerospace have been given a $150M contract to build three new Inmarsat-2 satellites, expected to go into service during 1988/89. The satellites will be the first to be owned and operated by Inmarsat themselves; all the previous ones have been leased. There are now 3300 vessels equipped to operate with the Inmarsat system and 10 countries operate a total of 13 earth stations. Services are to include aeronautical communications including a telephone service for airline passengers!

Substitute satellite

Meteosat-1, the ESA weather satellite, five years older than its original planned mission, is drifting out of orbit and has come to the end of its useful life. However, the USA is to lend a spare, standby, satellite already in orbit which is to be repositioned from its present position of 140°W, over the Pacific to 10°W by being moved by 4° a day. The GOES-4 satellite, launched in 1980, lost its imaging capability in 1982 and has been used as a standby transponder, relaying meteorological data. After its temporary service in Europe, it will be boosted up, out of the geostationary orbit to make room for other spacecraft.

CLAUDIVS (Calling Line Announcer Using Digitally Integrated Voice Synthesis), enables Beattie Brooks, who lost her voice after a throat operation, to 'speak' on the Telephone. Words and phrases are selected by the push button keyboard. A total of 64 phrases are chosen by the customer and then coded into a rom. Developed by BT.

America and China have teleconference

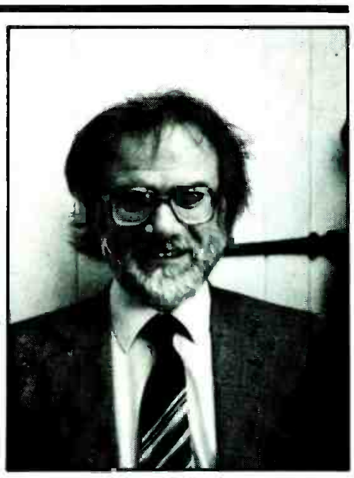
The successful exchange of slow-scan video images between the USA and the Peoples' Republic of China opened a new channel of communications between these countries. The exchange took place between two medical facilities; the University of Cincinnati Medical Centre and Zhejiang Medical university in Hangzhou. Two seperate test periods were used at the end of 1984 and in April this year. Pictures of people, charts, graphs, printed matter and the local skyline were sent. The picture quality of the transmissions, which spanned half the globe, was considered to be good to excellent. Further tests were carried out between China and Boulder, Colorado where Colorado Video manufactured the teleconferencing equipment. Test are to continue throughout the year.

Satellite docking system

A precision navigational system for the automatic docking of spacecraft and load carriers is being developed by a Swedish Electronics company and the Saab Space corporation, which may be used on the European and American orbiting space stations now being planned.

The system is based on the invention of Dr Lars-Erik Lindholm, who developed an optical system for detecting the reflexes and movements in handicapped people. The detector used in the system was refined until an accuracy of 0.01% could be achieved, the standard required by NASA for precise navigation in space. Dr Lindholm has also developed a photodetector process using electronic pulses from an l.e.d. The photodetector has proved to have a wide range of applications including guidance for robots and in the manufacturing industries. It's success has led to Dr Lindholm setting up his own company, SiTek. Saab Space is evaluating how the system could be used in the ESA Columbus space platform project, scheduled for 1990 to 1995, and NASA are said to be very interested.

During the All-Electronic/ ECIF Show, at the ECIF banquet at the Grosvenor House Hotel, Tony Wilson, of Electronics for Peace was given the Tobie Award as Electronic Personality of the Year. The Award was for his efforts in promoting Electronics for Peace and for drawing attention to the issues of the dominatation of the electronics and computing industries by military research, procurement, secrecy and waste.



Pocket phones on the way

A low-cost, lightweight, portable telephone, the size of a pocket diary, will be commonplace by the end of the century, according to John Carrington of BT Mobile Systems. He was speaking at the Asia Telecom Forum in Singapore. The biggest stumbling-block is the need for high-capacity small batteries and Mr Carington believes that a 'major breakthrough' in battery technology is needed. The development of low-cost large-scale i.cs will speed the fall iin prices for mobile phones as will the adoption of international standards for cellular systems.

In brief

The BBC has brought into use a system, developed by them, to protect headphone users against excessive levels. The device is smaller than a matchbox and needs no external power supply, being driven by the signal that it is monitoring and may be incorporated into the headphone lead. It offers no distortion to the sound until the limiting level is reached. That level is preset on manufacture to a value between 95 and 110dBA. An averaging network prevents the protector from operation on short-term peaks. Similarly another network prevents the limiter from acting on less-harmful low-frequency sounds. The circuit is available to UK firms to manufacture and market under licence.

• British Telecom's CARE system is to be expanded. It provides continuous alarm monitoring of a customer's premises using signals transmitted over the telephone lines with interrupting telephone usage. The second phase of the scheme is to cover one hundred telephone exchange areas in London. This follows a pilot scheme of ten exchanges last September. The equipment, manufactured by Base Ten includes local exchange scanners which are connected to the BT host computer. The subscriber terminal unit is microprocessor based and is available through Ademco-Sontrix in Reading. The system offers high security, and low cost as no extra exchange lines are required and the subscribers receive full line monitoring through the central station, with continuous interrogation and verification of the alarm system. Signalling is encrypted and modulated whether the phone is on or off the cradle.

• *Morsum Magnificat* is the magnificent title of a quarterly magazine devoted to Morse telegraphy. The first international edition (in English) is a compilation from the two years of its existance in Holland and has nostalgic tales written by professional and amateur operators as well as photos of all kinds of telegraph equipment. Copies may be obtained for £1 inclusive from the Editor; M. Hellemons, PA0 BFNBFN, Hollweg 187, 4623-XD, Bergen op Zoom, The Netherlands.

• *VHF Communications* is the English language edition of *UKW-Berichte*, a prominent German quarterly for the radio amateur.

The magazine specializes in advanced construction projects for the v.h.f., u.h.f. and microwave bands: recent issues describe a 10GHz f.m. transceiver with dielectrically-stabilized oscillator, a solid-state linear amplifier for 1.3GHz, an r.f. power meter and a receiver for the standard frequency and time signals of DCF77. Printed circuit boards and parts kits are available for most designs.

Other articles have covered coherent c.w. telegraphy, spread-spectrum techniques, weather satellites and theuse of Smith charts.

Through the loss of its British distributors the magazine is less easy for U.K. radio amateurs to find; however, it remains available direct from publishers in West Germany. An annual subscription now costs DM24.00, but back issues are offered at reduced prices. The publishers prefer a signed order quoting Visa card number and expiry date. Their address is Verlag UKW-Berichte, Postfach 80, Jahnstrasse 14, D-8523 Baiersdorf, F.R. Germany.

Trouble for d.b.s.

Will direct satellite broadcasting ever come? All the signs are that the starting dates, for the home-grown variety at least, have receded far into the future.

The BBC cannot afford d.b.s. and has the more pressing matter of its own future to worry about. The independent broadcasters, if they go ahead, will have to carry the huge cost of a spacecraft which is already looking outdated. Receivers for 12GHz have improved so much that it is doubtful whether Unisat's expensive high-power transponders are still needed.

Direct reception of existing satellite channels is already possible with dishes only a little larger than were promised for Unisat. The Government has at last announced, after much pressure from the industry, that blocks of flats and even individuals will now be allowed to receive these programmes. But this change of policy, long overdue though it is, is certain to spoil Unisat's prospects still further.

The 11GHz band, in which Sky Channel and the others are to be found, is a broadcast band in all but name. Any individual with £1500 to spend on it can now receive six extra English-language programmes, most of them in plain ordinary PAL, plus a growing number of foreign stations.

Yet as more stations arrive on the scene, so their value to the viewer, now spoiled for choice, inevitably diminishes. So how will the viewer feel about true high-power d.b.s. tv when it arrives?

Already it can be argued that western Europe has some of the least fertile soil in the world for d.b.s. tv. Viewers can enjoy a great diversity of programmes from national broadcasters and in many cases from private stations too. New d.b.s. channels could undoubtedly fill gaps in the present services.

But to receive them, it will be necessary to have a special decoder for C-MAC, plus as many of its variants as may eventually be adopted. As engineers, whether amateur or professional, we may well relish the prospect of more 12GHz plumbing and more boxes full of black plastic beetles. For most people, though, the decision to buy the new equipment will depend, as such decisions always have, on the programmes it will bring. And the programmes provided by d.b.s. will need to be outstandingly attractive if they are to interest a public already reaching saturation point with other satellite or cable-borne material.

The voice (and ears) of Alvey

The latest announcement from the Alvey Directorate is about the backing of several inter-related projects on voice synthesis and voice recognition by computers. This is part of the Man-Machine Interface aspect of the Alvey programme which is looking into alternatives to the keyboard.

Central to the scheme is to be a large scale demonstration of a Machine Assisted Speech Transcription (MAST) project, also called a speech-operated word processor. This is to be undertaken by Plessey, with assistance from Shell (UK), Edinburgh University, Loughborough University and Imperial College. The problem is not so much the ability to hear and transliterate spoken words, but to put them into context so that the computer will be able to distinguish between 'eight' and 'ate' by reference to the words on either side. This involves the use of expert systems and artificial intelligence and another project between STL and Cambridge University is working on this. They expect to produce a system that can recognise over 25,000 words.

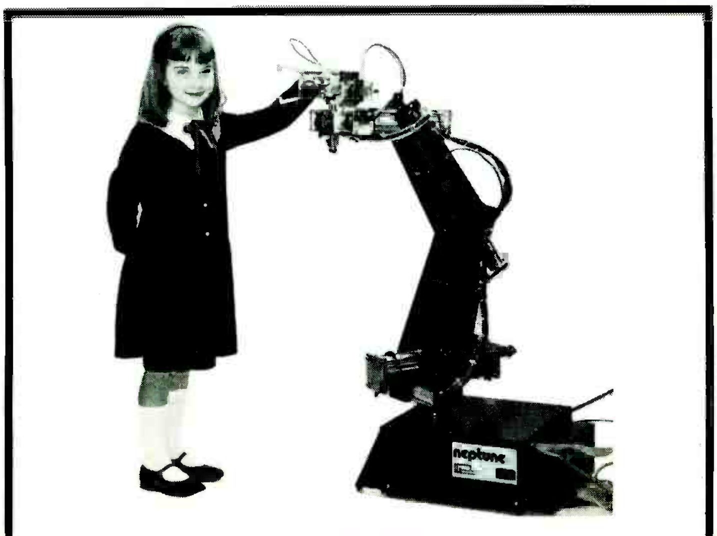
Other projects include intonation in sythesized speech so that stress may be added as well as regional accent and male and female voices.

Sindex, a company who have developed a Chinese word editor are working on Chinese speech input/output along with the School of Oriental and African Studies, University College and the RSRE.

One project which it is hoped to reach fruition early is the use of a voice-operated enquiry systems. British Telecom, Logica and Cambridge University are working on such a system and as a demonstration, developing a railway timetable enquiry service. Much work will go into the study of algorithms for the analysis of speech and phonetics as a path to better reproduction by the synthesized voice.

All participating bodies and other interested parties will get together in one of the interest 'clubs' which form an integral part of the whole project.

This touch sensitive robot from Cybernetic Applications, in Andover, can be guided into position by fingertip control and then programmed to find the same spot again. Sequences of movements can be easily programmed by this method although the arm uses a powerful hydraulic system.



'Don't commercialize the BBC'

Lord Hill, who has been in turn Chairman of both ITA and the BBC, warns that the idea of advertising on BBC tv "spells disaster to programme standards."

"Today British broadcasting is undeniably the best in the world. But that supremacy of standard is now in danger." Lord Hill, writing in the IBA journal *Airwaves*, pointed out that the IBA has had to offer equal service as the BBC and the BBC responded to greater effort to give the public what it wanted as well as what it ought to want. The conversion of the BBC to a commercial service would "injure both and do irreparable damage..."

Lord Hill referred specifically to the committee to be chaired by Professor Alan Peacock which is to assess the effects of the BBC taking advertising. He urges all those who believe that the British system, of a public service competing with a commercial service, is best should "raise their voices; and prepare their evidence; to persuade Peacock to accept the basic truth."

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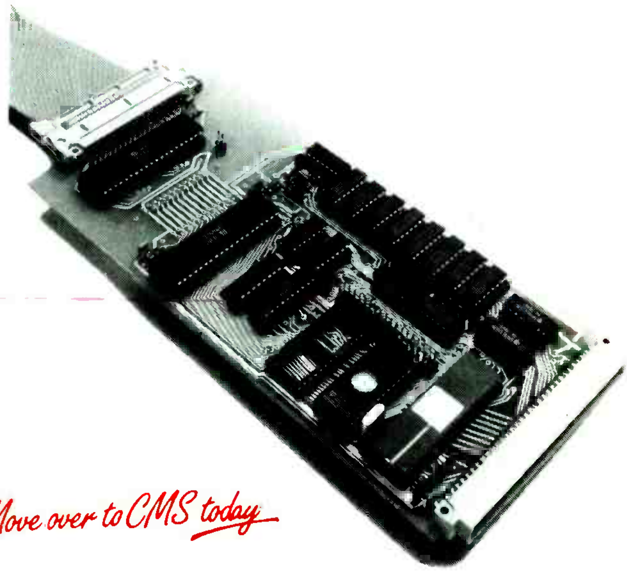

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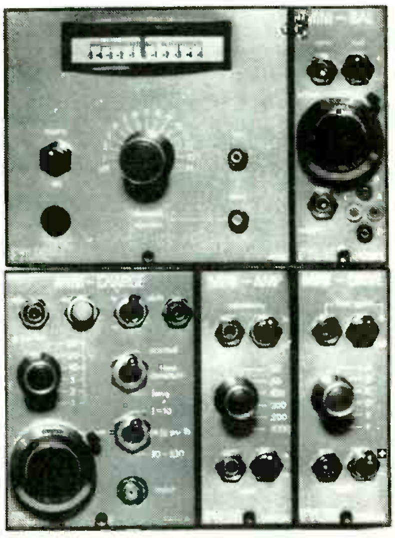

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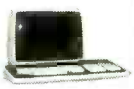

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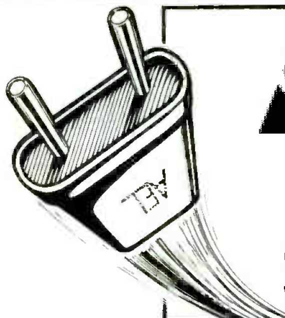

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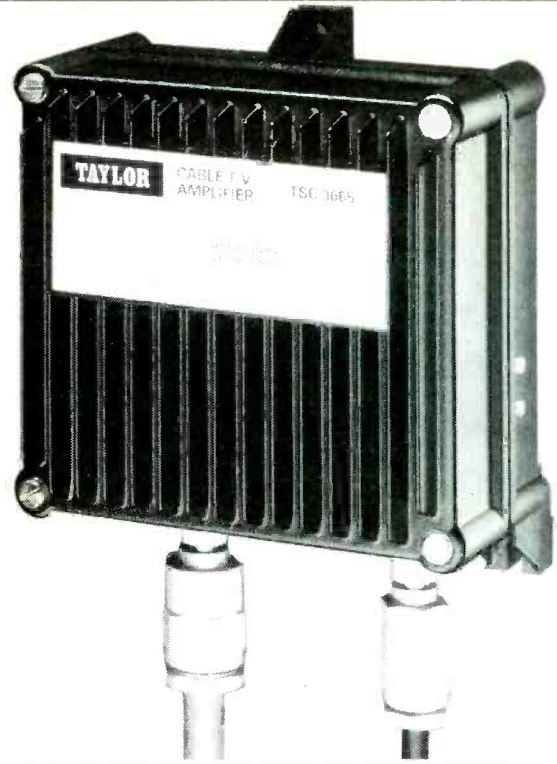

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EZV9	40-300	9dB	1dB	EZU9	470-860	9dB	1dB
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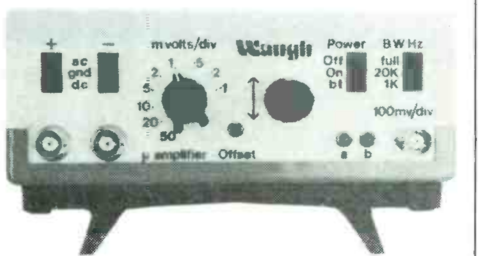

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Disco/Group	12	4-8-16	45	PA	£18
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Video displays

Low cost per character will ensure that the cathode ray tube remains the dominant display technology this decade, despite advances in flat-panel displays.

Way back in the early seventies, nearly all data display units were hardwired. The main functions of computer intercommunication, screen display and editing, and print handling were organised by fixed logic elements that couldn't do anything else, which meant the user was stuck with a rigid set of protocols, editing facilities and formatting rules. Next came the independent-maker ascii terminal of the mid-seventies that were programmable only to a limited extent but could emulate the earlier hard types, as well as handling peripheral devices. Then Televideo introduced the microprocessor to the terminal, which then became 'smart' and reduced costs as well as increased flexibility.

But nowadays, the difference between smart and dumb terminals is fast dissappearing as it now becomes difficult to find them without microprocessors: characteristics are more and more determined by firmware rather than hardware.

Nevertheless, what might be called a classically-intelligent terminal is one that communicates with a mini or mainframe or other multiuser computer and can be used as an editing terminal to download, modify and possibly upload data. At the top end of this bracket is the multiple-emulation graphics terminal that can serve as a stand-alone workstation with bit-mapped graphics, modem and word processor.

More humble are the standard terminal displays that have come to feature 12 or 14in screens, holding 24 lines of 80 or 132 characters, line and character editing, smooth scrolling, a basic set of attributes plus variants, a matrix of 7 by 9 dots (being displaced by 7 by 14, 8 by 16, 9 by 12, 10 by 12, or most recently 13 by 18 dots), together with a gradual trend to the more visible amber phosphor, now standard in Sweden. Ergonomic design is almost mandatory, with swivel, tilt and the low-profile keyboard being the most obvious elements.

There are so many models on the market (over 400 in the US alone) that we leave the market researchers to collate and classify (e.g. SRI* in the US and *Systems International* here).

Visual display unit, the term more often used in Europe, has taken on a rather different meaning for users of microcomputers. Screen actions of character and window generation, editing, attribute and cursor handling are all done within the microcomputer and do not have to be separately generated. So the term v.d.u. has also come to mean simply a monitor screen, with its power supply and deflection circuitry, contrasting with the word 'terminals', which implies keyboard editing or entry.

Current demand for c.r.t. monitors with higher bandwidth, increased colour options, and higher resolution is a reflection of the host-equipment manufacturer's demands for sharper and flicker-free monitors with improved text and graphics presentation features, according to a recent survey of the c.r.t. monitor market. But the main impetus for technical improvements and innovation, the report says, has and will come from the graphics terminal manufacturers.

The survey*, published earlier this year by Stanford Resources Inc, says that though flat-panel display technolgies will make their presence known in the marketplace in the next few years, the c.r.t. will continue to be the dominant display device because of its low cost per picture element. SRI forecast that the (US) flat panel market value will increase from nearly 50 million this year to $340 million in five years time, while the non-tv c.r.t. market for 2,000-characters tubes or more will increase from 800 million to $2 billion over the same period.

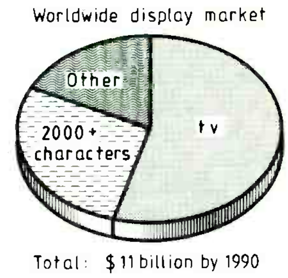
The high resolution 1,280 by 1,024 colour format will evolve to higher resolution, stretching the capability of the shadow-mask tube to its limits, and monochrome picture element count will increase to 8-10 million elements with a resolution in the range 350 to 400 elements per inch by 1992.

*The SRI study, which analyses market by application, details product specifications, assesses technology trends and profiles major suppliers, costs $1950 in Europe from International Planning Information, Nodre Ringvej 201, 2600 Glostrup, Copenhagen. It forecasts an average annual growth in 'shipments' of non-tv c.r.t. monitors of 23% — from 3.7 million in 1983 to 16 million by 1990. Another report, from Venture Development Corp. in Wellesley, Ma, gives a rate of 17%, from 8 to 25 million units over the same period, but VDC wouldn't let us see their $7500 report so there's a bit of a mystery in this large disparity.

'Virtual micros'

People at Rank Xerox have recently centralized the intelligence in a new network for communicating with about a thousand terminals. Instead of using PCs at around £3000 each they have substituted dumb terminals, and collected together the processors, with hardware and software specially developed for the system. In this 'virtual PC' or 'virtual micro' method, both processors and disc drives are taken away from the terminals and centralized in such a way that as network users log on each is allocated the use of a microprocessor housed in central rack-mounted module. An initial study estimated that the average information user requires much less that 30 minutes microcomputer time a day, and that only 10 to 15 centralized microprocessors are required for every 100 dumb terminals printers reduced with to one per floor.

The project started three years ago when Stephen Shiu, manager of information technology at Rank Xerox (UK), was asked to find a way of speeding informa-



Though the flat-panel display market will grow from $48 million worldwide this year to $340 in 1990, the c.r.t. monitor market will grow from $800 million to over $2 billion in the same period. Source: SRI.

Display price per character
For displays with more than 2000 characters:

Monochrome c.r.t.	2
Monochrome flat c.r.t.	3
Colour c.r.t.	8
Multiplexed fluid crystal	8
Active matrix fluid crystal	17
Electroluminescent	20
Plasma	20
Vacuum flourescent	30

Price per character in 1984 cents projected to 1990. Source: Monitor Market Trends, SRI.

To meet the competitive demands of today's markets, 'state-of-the-art' terminals require a multiplicity of facilities — flexible attribute handling, proportional spacing, split screens and multiple windows with soft scrolling of windows, variable height and width, and full-page 132 by 60 screen format — all featured in AMD's 8052, the subject of this issue's front cover. Of 1983 vintage, it was the first to support flicker-free unrestricted (split-screen) smooth scrolling by using three row buffers. The 8052/8152 set can handle the Japanese Kanji character set by using two 12 by 24 characters side by side and redefining one of the attribute bits. Normally only four of the 12 attribute bits are user-redefinable but by programming a special register eight of the attributes can be redefined — especially useful for the Kanji set, which requires 2500 to 4000 unique characters or 12 bits of addressing.

tion to the company's UK front-line managers. His initial approach was the development of a conventional multi-function micro with mainframe link, electronic mail and file transfer capabilities that would have cost £4 million for the thousand users envisaged. But Shiu wanted terminals at £1,000: "It seemed illogical to install £3000 PCs simply to turn them into dumb terminals for much of the time to talk to the mainframes and minis." It was then that he saw a better solution was to use a dumb terminal that would not only communicate with IBMs, DECs and Xerox 8000 Network Systems but also with the modular micros. One then virtually has a PC, he says, but with the advantage that maintenance and up-grading become easier because all the processors are in one location, and data back-up can be carried out automatically. The disciplined 'housekeeping' and big savings on software licences were also important to Rank Xerox.

CRT controllers

There were only a handful of c.r.t. controllers on the market at the time of our last review of v.d.us*. Designed to replace the t.t.l. control gates and counters, these l.s.i. chips were of two kinds — the early fixed screen format type and the programmable type that can run at non-standard scan rates, such as Motorla's 6845. Then, there was a firm upward trend in scan rates. Horizontally, a frequency of at least 17kHz was needed before line whistle was inaudible, whilst a frame rate in excess of 55Hz was desirable to reduce flicker. With the need to adequately display 25 rows of 80 characters, a resolution of at least 720 by 300 picture elements was considered necessary. This combination of resolution and higher scan rates pushed up monitor bandwidth; open-frame monochrome monitors meeting this specification sold in small quantities for over a hundred pounds.

Massive sales of home computers created a new, large market for tv line-rate monitors, particularly where parents wanted their television set back! The IBM PC emerged, it too driving a tv line-rate colour monitor, and went on to be sold in huge quantities. The price of both monochrome and colour low frequency monitors fell, and in turn became more attractive to other product designers. Futhermore, the IBM PC standard graphics offered a resolution at best of 640 by 200 pixels, with many of the business applications using the 320 by 200 mode. Suddenly lower resolution, lower frequency monitors were acceptable for business use, with many of the IBM PC look-alikes adopting the same standard. Despite this, there are still many business and c.a.d. machines which do use high frequency monitors, and IBM themselves may soon be setting new standards with the introduction of two new graphics cards.

Memory architecture. The architecture has not changed over the last three years. Four options exist:

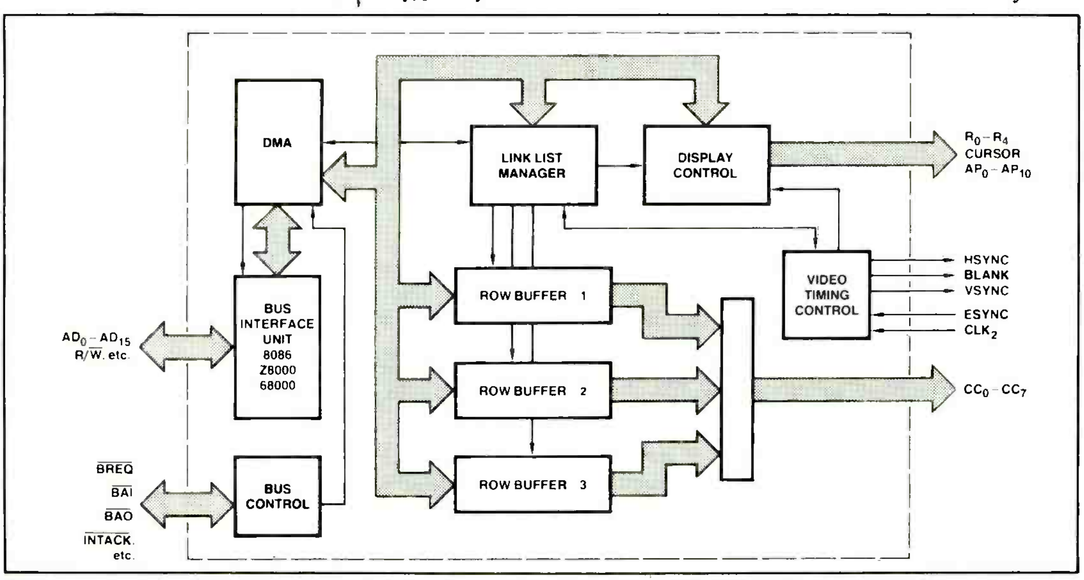
1. ideo ram, dual-ported between the system and the video controller.
2. Video ram dedicated to the video controller so that system access to the ram is via the controller.
3. Video ram residing inside the controller.

In these three cases, it is important that the ram can be accessed at any time, with minimal delay, and without affecting the picture.

4. Character information is stored in system ram and via d.m.a. into row buffers inside the video controller.

Low-end video controllers. There are some applications, such as cash dispensers or window advertising, where only a simple display is required. One of the first devices was the General Instruments AY-3-9025 (later 9035 and second-sourced by Plessey), designed as part of a viewdata chip set to display text and "chunky" graphics. Another is the Motorola 6847 which supports text and a number of colour graphics modes up to a maximum resolution of 256 by 192 elements. Unfortunately both devices still require external ram and logic (option 1). Fujitsu's MB88303 is a truly self-contained monochrome video controller that can connect directly onto an eight-bit multiplexed address and data bus to provide access to its internal ram (option 3). Nine rows, each of 20 characters may be displayed from an internal character set of 58 different rounded characters. The device can be synchronized to a television or video source, allowing text superposition. The single-chip microprocessor with built-in simple video controller must now be imminent: its introduction would help the development of many 'single-chip' products.

Mid-range controllers. The ubiquitous 6845, sourced from Hitachi and others as well as Motorola, is still as popular as it was in 1982. Pop the lid off any year-old business type computer and the chances are there will be a 6845 resident. Although it does little more than generate memory addresses and sync information (option 1) it still seems to be used in new designs in preference to more sophisticated and expensive controllers. One reason may be the adoption of the IBM PC as a de-facto standard. The normal graphics card basically supports four video formats: 80 by 25 and 40 by 25 colour text, 640 by 200 graphics and 320 by 200 colour graphics with a limited palette,



*'Introduction to v.d.us' by Colin Carson, October and December 1982, and by James Tully, January 1983.

achieved using more than 60 i.cs.

Manufacturers attempting to emulate this product, as several dozen have, may find it hard work to design equivalent graphics circuitry without using a 6845. Equally, the use of a more advanced controller might be regarded as over-the-top, and not cost-effective. There must be a possibility that a manufacturer will produce a video controller more suitable for this application. The 6845 still requires a number of logic or 'glue' chips to make it function: the trend is toward complete chip sets that require little or no glue. Mullard's 2670, 2674 and 2675 are one well-known set. The 2670 is a character generator, the 2674 the timing controller and 2675 or 2677 adds the video attributes.

Advanced video controllers. As with the mid-range controllers, there are so many different advanced controllers, that it is not feasible to detail them all. Most boast greater resolution that is normally required. The secret to choosing a controller is to obtain detailed specifications and decide which device best meets hardware, software and cost requirements. It is perhaps a shame that more manufacturers have not got together to produce similar or second-sourced devices; some components are so expensive that there must be a real risk they will be left on the shelf.

Intel's 82730 is an advanced text controller (option 4). It will support rows with up to 200 characters, and a total of 2048 scan lines. Its specification includes proportional spacing, subscript and superscripts, and smooth scrolling. The device is connected directly to the system bus with a second chip, the 82731, producing a serial data stream. The 82730 has two internal row buffers. Whilst one is being used to generate the display, the other is filled by d.m.a. This sophisticated device is controlled by blocks of data and pointers residing in system memory, and is ideal for high-performance word processors.

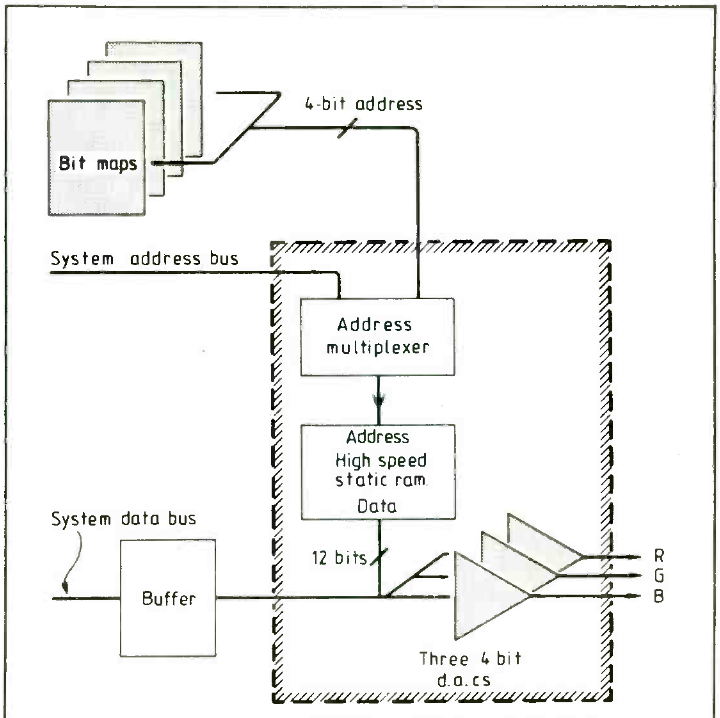
NEC's 7220 graphics display controller (option 2) supports a pixel map of 4 Mbits, or four planes each of 1024 by 1024 picture elements. The chip offers zooming, drawing of arcs, circles and rectangles, as well as limited text facilities.

AMD manufacture a range of integrated text and graphics chips including the 8052 text controller which is similar in principle to Intel's 82730, but has three internal row buffers to provide flicker-free smooth scrolling of split-screen displays (page 18).

Colour palettes comprise a look-up table and high-speed d-to-a converters. Consider a graphics system having four planes of display. Each element is defined by four bits, one in each plane. Those four bits could be used to drive R, G, B and I directly, alternatively they could form an address into a look-up table. The look-up table is no more than a small block of high-speed static ram. With four bits, the look-up table needs to be 16 addresses deep. The data outputs of the look-up table feed high-speed d-to-a converters. If three 4-bit converters are used, then the table must be 12 bits wide. Each of the 12-bit combinations will display one of 2^{12} colours, and the four planes allow simultaneous selection of any 16 of those 2^{12} colours. Until recently colour palettes were generally in hybrid form, but AMD have introduced the 8151 single-channel eight-bit palette, and Thomson the 9369 three-channel four-bit palette.

Thomson's other products — 9365/6/7 graphic display processors and the single-chip 9345 semi-graphic processor — will be joined shortly by a 16-bit controller. Last April, when Mostek and Thomson announced an exchange agreement for second-sourcing Motorola's 68000 products, Thomson said they would include a graphics controller. Though not yet finalized, the device (designated 68483) will be a 68-pin advanced graphics chip to interface with most 8 or 16bit processors with programmable video timing to allow its use in a wide range of terminal or computer designs.

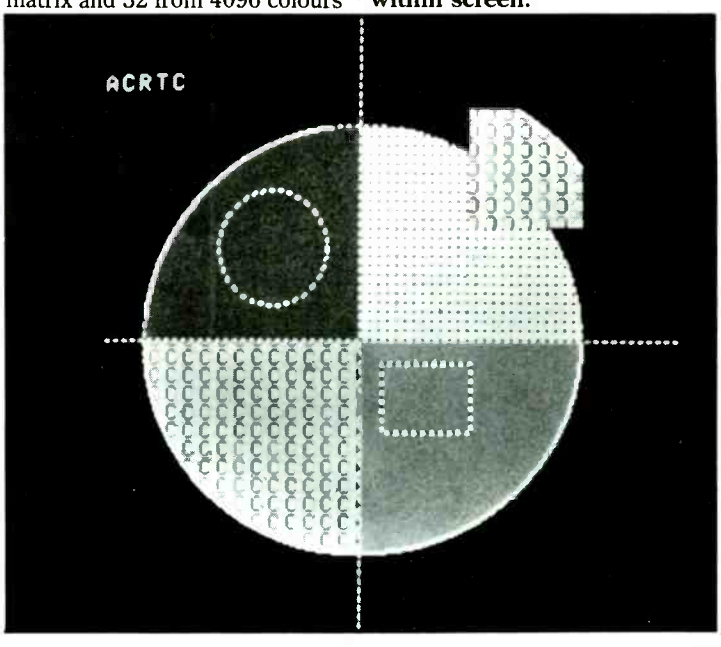
Some other recently introduced devices that we do not have space to describe in detail are Motorola's 'raster memory system', a two-chip 'virtual screen' graphics generator whose quality 'rests on the driving processor and its software rather than on RMS itself'... TI's AVDP, intended particularly for US videotex terminals and home computers, with 32-sprite control features and sound generator (type 9228)... National Semiconductor's 'terminal management processor' designed for test and measurement instrumentation (an application note describes a logic analyser) as well as terminals (NS455)... Xtar Electronics, 16bit 'graphics microprocessor' and video shift register that claims to draw polygon segments of 64 or more elements much faster than for 7220 systems (5ns/pel!)... NCR's 7300 colour graphics controller integrating as many as 100,000 transistors onto one chip... Hitachi's advanced controller HD63484, using a multiprocessor architecture to allow parallel processing of drawing, display and timing parameters, and with 38 high-level commands... Philips Eurom for level 3 videotex terminals with its 40 alphabet capability, 12 by 10 matrix and 32 from 4096 colours

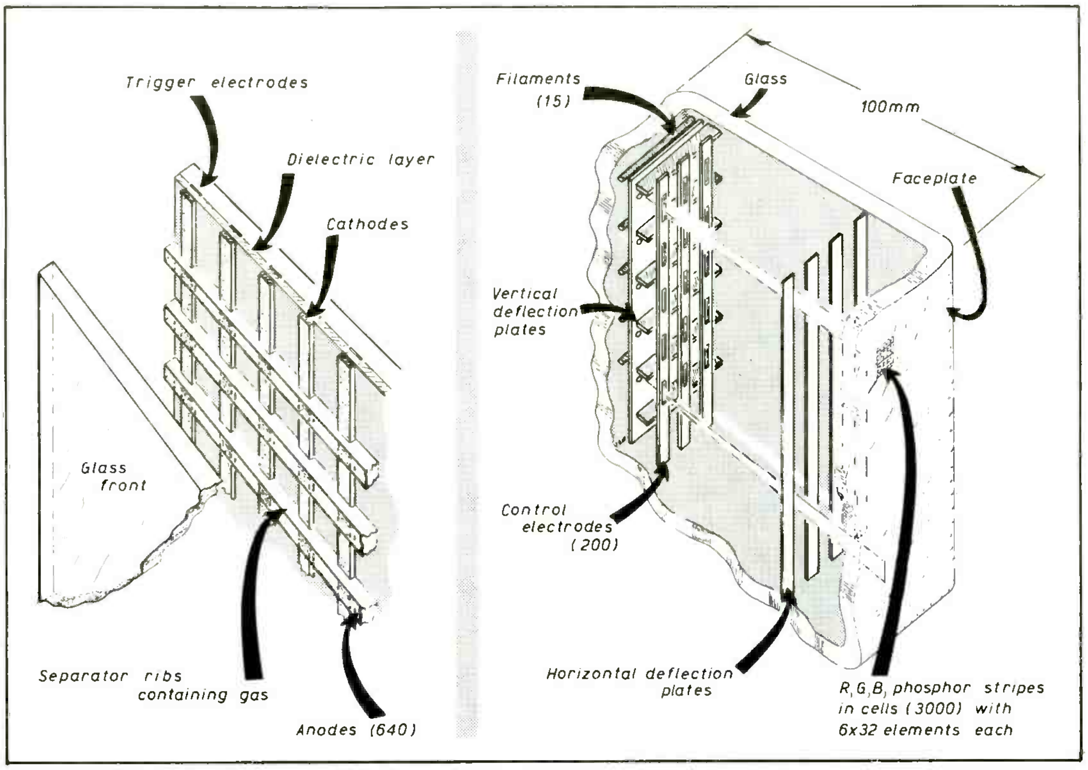


TYPICAL PALETTE GENERATOR

Colour palettes enhance low-end graphics applications in allowing economical display of up to 16 colours chosen from a universe of 4096 values (Thomson 9369) with a colour look-up table and three d-to-a converters.

Hitachi's HD63484 has a multiprocessor architecture that enables simultaneous processing of high-level commands, display functions and timing parameters. Picture shows target filled-in using pattern command, with window copied and moved within screen.





Dixy's prototype A4-size 640 by 800 plasma panel uses a trigger electrode beneath the cathode to 'keep alive' the discharge and reduce switching voltage. (left and far right). Constructions of Matsushita's vacuum flourescent display panel may be likened to an array of 3000 small colour cathode ray tubes, but without yoke, shadow mask and e.h.t. (middle diagram). Filament consumption is said to be only seven watts.

(type 5350)... And STC's CRT9007, a second-sourced Standard Microsystems' video processor and controller, with row-table-driven or sequential addressing modes... Almost all of which were introduced last year. Which must make 1984 the year of the c.r.t. controller. Hot news: Just announced is Inmos' colour palette (256 colours from 256k) containing three 6-bit converters — see page 87.

Flat panels

The number of flat panels appearing with a 640 by 200 resolution (á la IBM PC?) conjures up thoughts of portable IBM-compatible business computers. There are even some panels that are plug-in replacements for c.r.ts, using the syncs, data and an extra signal, the dot clock (pin 7 on the 9-way connector?

Because of low production cost and power consumption liquid crystal panels are expected to take the lion's share of the flat panel market. Japanese devices dominate, the largest from Densitron, Epson, Hitachi, Panasonic, Seiko, Sharp, Terenix, and Toshiba, though many of the 640 by 200-element units appear very similar and may well have common sources. But most of the liquid crystal's limitations — grey scale, temperature range, field of view, contrast ratio, response time, limited resolution — are still prevalent.

Despite some big names dropping out of the field over the years, developments continue in plasma panels. Engineers have left Sony, Zenith and most recently Burroughs when their plasma projects were terminated and set up their own companies — Dixy, Lucitron, Plasma Graphics — though usually when this happens the originating company takes a stake in the new venture. The prototype Dixy panel's are the d.c. kind in which a gas mixture is sandwiched between two glass plates in such a way that pockets of gas are isolated from one another — unlike the a.c. kind where there is no isolation — and located at the intersection or vertical and horizontal anodes and cathodes deposited on the glass plates. One of the difficulties with this kind of display is in switching the high voltage needed to break down the gas, necessitating some kind of 'keep alive' arrangement; and even then of keeping the trigger potential low enough to use low-cost transistors. Yoshifumi Amano, founder of Dixy, over-

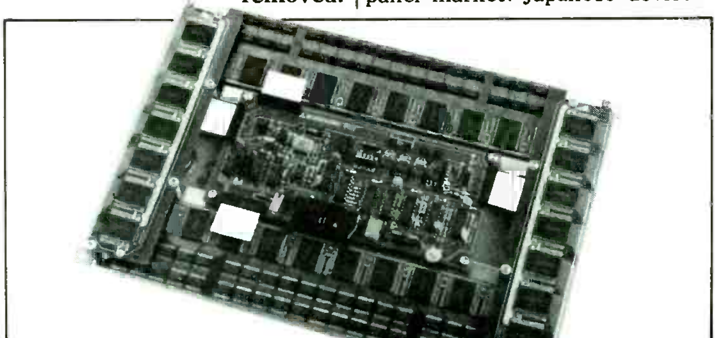
came the triggering problem with a capacitatively-coupled trigger electrode deposited on the rear glass plate, together with a dielectric layer situated *underneath* the cathode, using a thick-film printing process (illustrated above). The technique of positively charging the cathode using this structure not only reduces the initial discharge potential but also reduces anode-cathode switching voltage, making integrated-circuit driving possible.

In driving the 640 by 400 panel, data for the 640 lines of vertical electrodes are grouped into eight-bit packages and shifted onto the display by shift register in 80 right-to-left transfers per clock pulse. Data for all 640 lines are transferred simultaneously to latches and then to the anodes. The 400-line horizontal electrodes are sequentially driven from top to bottom and because critical flicker frequency is 60Hz the scan dwells on each cathode for 40μs or less. Luminances of this 0.3mm dot-spaced panel is 120 cd/m^2 pk with a viewing angle of 140° up/down and 45° left, 70° right, consuming 8 watts at 12, 65 and 175V. A prototype 640 by 800 A4 panel is being readied for trial production (see photo). (Craft Data Ltd of 92 Broad Street, Chesham, Bucks are importers for Dixy.)

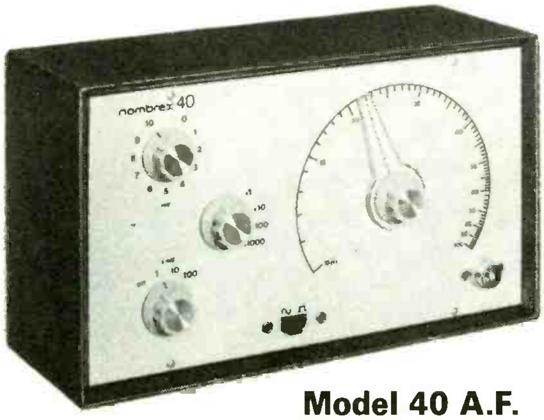
Another d.c. panel with a similarly small dot size (0.25mm with a pitch of 0.33mm) and a 400 by 640-dot array is sold by Densitron. Its construction appears to be similar to Dixy's and its method of driving, though there are differences of detail in performance and in drive electronics.

Densitron claim a luminance of 50cd/m^2, a contrast ratio of 10:1 and a 120° viewing angle, while the circuitry uses 5 and 200V supplies a double four-bit serial format, and a t.t.l.-level interface for operation from a c.r.t.

Densitron's 600 by 400 plasma display requires 5 and 200-volt supplies and can be driven from conventional c.r.t. controllers. This view of the display drive circuits has the front panel removed.



nombrex



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controller.

The vacuum flourescent panel — a kind of multiple cathode ray tube — has until recently been restricted to small sizes of display, though work in Japan is aimed at increasing the size to compete with the plasma — panel sizes. Earlier this year Matsushita announced construction of a prototype panel with a 25cm diagonal screen and a depth of 10cm. Called a 'matrix drive and deflection' scheme, the panel is the equivalent of 3000 electron guns — 200 horizontally and 15 vertically — that excite phosphors. Using sets of primary phosphors, this device clearly has colour potential; in fact each of the electron beams can excite two sets of red, green and blue phosphors horizontally by 32 steps vertical, to form images comprising 192,000 elements. The panel has a constrast ratio of 50 and a resolution of 270 lines (0.5mm element pitch).

It effectively removes the shadow mask from colour c.r.ts, the high e.h.t., and the bulk, whilst retaining its luminance. The electrode structure had to be optimized by computer simulation to create a beam fine enough. But the secret to its construction is the cementing technology, which is required to "evenly and alternately cement 0.1mm grid electrodes with insulating plates".

Signal processing and drive for the panel is digital, brightness being controlled by pulse duration modulation to give 64 grey scale steps, while colour reproduction is achieved by sequentially activating the phosphors.

Hacking the vdu

Almost everyone has experienced the radio interference given off by the clocked logic circuits of present-day domestic electronic equipment, first brought to public attention by a CAA ban on the use of calculators in commercial airliners. The UK has never really had regulations that parallel those of the FCC in controlling levels of product radiation, but a recent publication from British Standards Institution lays down limits for spurious signals from data processing and electronic office equipment in the absence of agreed international limits. The Standard, BS 6527:1984, specifies two 'protection' distances, one of 30m for offices and factories, and the other of 10m for homes, at which distances the field strength limits in the range 150kHz to 1GHz are 30dB(μV/m) below 230MHz and 37dB above. (The committee members that drafted this standard obviously live in detached houses.)

These figures of course were not designed to prevent *interception* by anyone intent on decoding the radiated signals. Last February, a Tomorrow's World programme showed how easy it is to eavesdrop on a v.d.u. terminal. A van contained equipment to recieve and decode signals radiated from a word processor within a nearby office block and demonstrated that usable information could be obtained from many buildings around London, including a well-known merchant bank. Not surpising, you might think, considering the power of surveillance techniques nowadays; but the tv programme brought to light just how cheaply it could be done, a fact that has not been widely appreciated hitherto.

Surveying the subsequent press coverage, we noticed that one journal thought that plasma panel displays are immune from screen eavesdropping because they do not radiate outside the visible spectrum: ". . . and so unlike c.r.ts cannot be remotely read." The fact is that the easiest way to get at the displayed information is to pick up *circuit* radiation and not screen radiation.

The video drive in monitors is rich in harmonics of the dot rate, usually around 15 to 20MHz. Jonathan Drori, assistant producer of the Tomorrow's World team, explained his finding to us that certain circuit elements e.g. p.c. loops can resonate at v.h.f. and radiate a strengthened harmonic of the video signal. The actual frequency may be unpredicatable if a cable loom or other wiring variable is involved, but a typical monitor will radiate at Band III — inviting the use of a v.h.f. tv receiver. Close up, you can't get rid of the signal, Drori says, (suggesting that the harmonics are spaced at less than 5.5MHz intervals) and he has had results over 300m and others have worked v.d.us at a kilometre and beyond.

Of course the sync pulses do not propagate anywhere near as effectively because of their lower frequency, but can be picked up by an inductive loop, or failing that, regenerated by sync pulses from a simple t.t.l. or c-mos digital oscillator inserted into the adapted tv set. The only other item needed in the eavesdropper's armoury is a directional aerial.

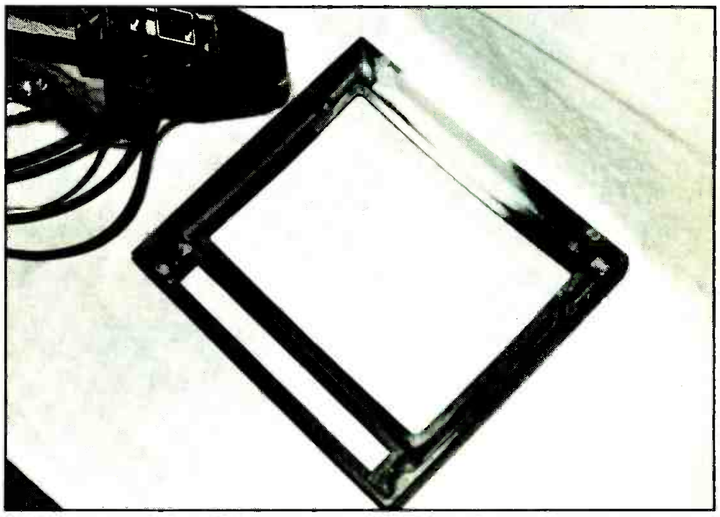
The significance of all this, Drori points out, it that far more installations are at risk than previously realised, and what's more, last year's Data Protection Act requires that "appropriate security measures shall be taken against unauthorized access to personal data"; company directors not taking such measures are liable to prosecution.

Now, Philips Business Systems are introducing a new range of terminals, initially for such security-conscious areas as banking, with features designed to "increase the difficulty of interception". This is achieved by using the higher scan rate of 70Hz and a high-resolution character box of 13 by 18, designed to put the terminals outside the norm of low-cost 'hacking' equipment, according to product manager John Williams.

Researchers at Philips, Apeldorn, have come up with the idea of randomizing the raster scan for a more secure approach, using a software key to the randomizing. Prototype chips have already been developed but while trials continue no timescale has been set for their introduction.

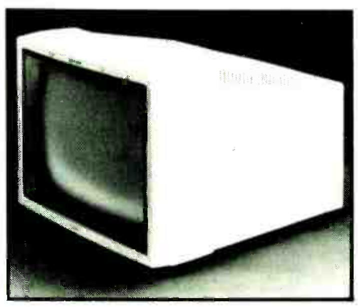
So lots of interest in e-m screening can be expected. One study has demonstrated dramatic reductions in field intensity by screening with copper foil after installation. With a cost of only £10 to £30, this is probably not as cost-effective as spraying at the manufacturing stage (see photo).

Acknowledgement. — Special thanks to Colin Carson and Jonathan Drori for valuable contributions.



Metal spraying at the assembly stage is probably the most cost-effective way of reducing radiation from video display housings from three viewpoints — possibly hazardous emissions, radio interference, and data security now that the Data Protection Act is in force. Picture shows Tafa electric arc spray gun being marketed by Mining and Chemical Products of Stone, Staffs.

Barco's latest range of computer graphics displays, available from Cameron Communications of Glasgow, is designed around Matsushita's overlapping-field-gun c.r.t. and is aimed at the CAD/CAM market, with 120MHz video amplifier and 64kHz scan frequency. A brief survey of monitors will appear in next month's issue.



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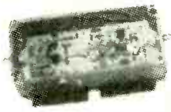

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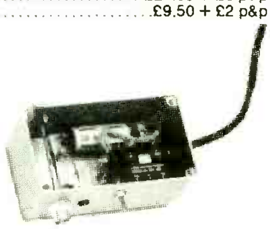

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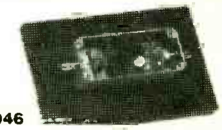

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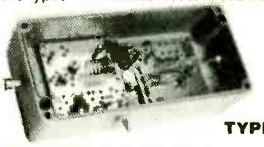

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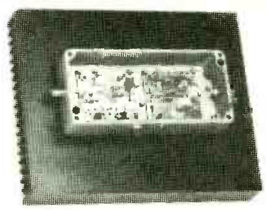

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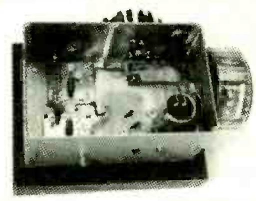

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Domestic tv to monitor

by J.A. Grubb M.I.E.E.

If you can't afford a colour monitor, here's how to avoid the bandwidth limitation and spectrum interleaving of the colour tv set.

Modern colour sets have most of their signal processing performed by a set of integrated circuits, one of which takes care of the colour decoding. This chip also has to cope with the demands of teletext, which is decoded by a different circuit but is still switched into the picture signal by the colour chip. This switching is performed electronically after the colour decoder but before the tube drive amplifiers. The TDA3561 and equivalents have data insertion inputs which require a one-volt input level and a switch pin which, when taken high, connects these inputs into the signal path. Synchronization can be effected by inserting a switch into the circuit at a suitable point to connect the computer sync. signal to the deflection unit in place of the sync. separator output. As a final refinement where the computer has a direct voltage output on the monitor connector. this can be used to control the switching automatically so that the tv set operates normally until the computer is switched on.

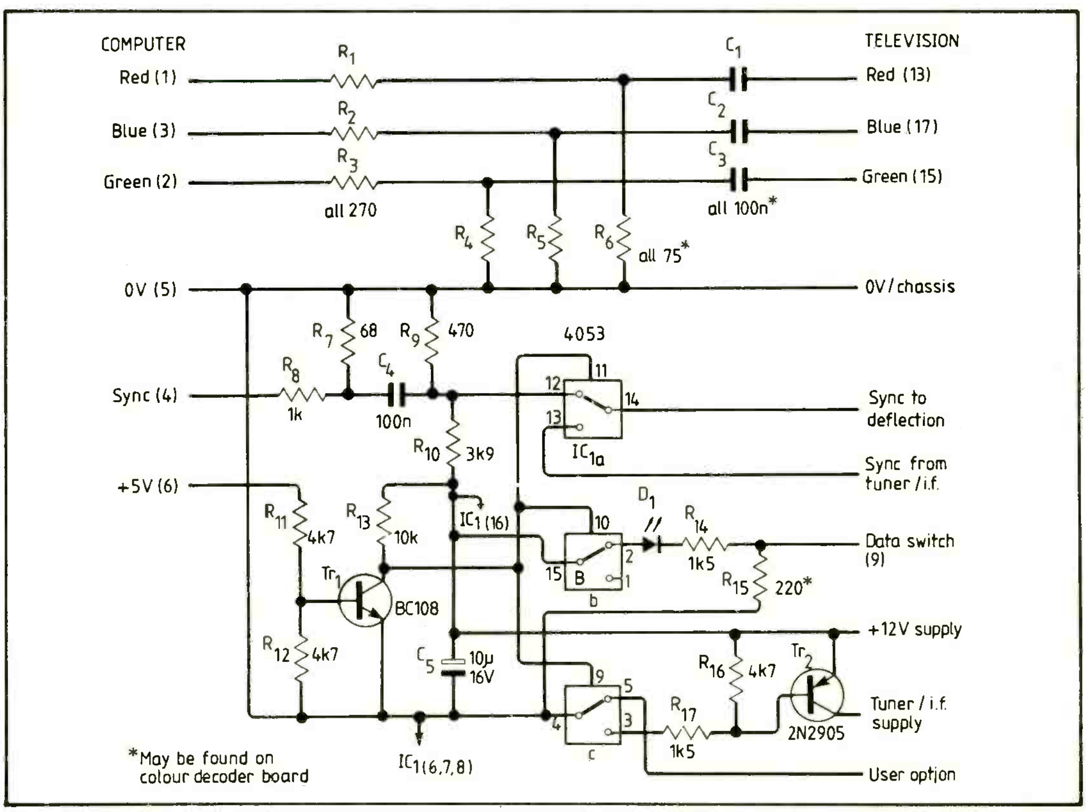
Most modern sets incorporate a switch-mode power supply which operates at a high frequency using a small ferrite-cored transformer. You may find (as I did) that this transformer is arranged so as to provide complete isolation from the mains. Note that there is a rectifier and other circuitry feeding the transformer primary from the mains, but there must be no connection between this and the tv signal circuits.

If the internal power supply does not provide isolation, there are two alternative strategies: put isolators in all the signal lines or use an isolating transformer in the mains supply. The first method can be implemented with four opto-isolators, which would be smaller than a transformer. However, they must be rated for 240V a.c. and high-speed operation. Such devices are expensive (over £5 each), and extra circuitry would be needed to interface the isolators to the tv circuits, and possibly to the computer as well. The use of a transformer in the supply line is simpler and probably cheaper. It means that the chassis can be solidly earthed, which makes for safer adjustment and gives scope for further modifications e.g. a feed for a hi-fi sound system. It is preferable from a safety point of view that the chassis should be earthed via a three-core mains lead rather than relying on the connection to the computer.

The colour and sync. signals from the computer are at t.t.l. levels, i.e. 0 to +5V. The PAL decoder chip TDA3561 requires inputs of 0 to about +1V for data and switching, while the TDA1950 horizontal deflection i.c. is a little more awkward: it requires a negative-going sync. pulse of 0.3V amplitude on a +1.3V baseline. Other deflection i.cs may require different voltages, which will be specified in the manufacturer's data sheet. As the deflection system has only one input, a switching circuit must be provided to switch this between tv tuner and the computer. The easiest and cheapest way to do this is to use a c-mos analogue switch type 4053, which contains three separate changeover switches.

A 12-15V supply must be derived from the television: the current required is minimal and should not present any problems. The three colour inputs are

Interface between computer and television receivers which use TDA 3561 single-chip PAL decoders or equivalents.



simply divided down to the correct level by resistor chains and a.c.-coupled to the i.c. inputs. Components marked with an asterisk may be present already, as they were in my set (a Grundig CUC120). Transistor Tr_1 is switched on by the +5V line from the computer and drives the i.c. control inputs. If your computer does not have a d.c. output, arrange a switch to connect R_{11} to the +12V supply in the tv. The network formed by R_7 to R_{10} and C_4 reduce the amplitude of the computer sync. pulses and shift the d.c. level. The resistor values should be changed if your tv deflection system requires different voltage levels. The feed from the tuner i.f. unit to the deflection system must be cut (in my case, there was a wire link to un-solder) and re-connected via IC_{1a} which provides the sync. switching function. Switch IC_{1b} is used to drive the switch input of the colour i.c. via the voltage divider R_{14} and R_{15}. The led indicates that the set is in monitor mode and may be mounted in a convenient position or replaced by a link if not required.

When the circuit was tested, patterning was visible in monitor mode which was traced to break-through from the normal tv signal. This was eliminated by switching off the d.c. supply to the tuner-i.f. unit by Tr_2, chosen to switch the required current with a low voltage drop to avoid upsetting the tuner-i.f. alignment. Substituters beware! Pin 5 of IC_1 is connected to 0V when in monitor mode and is available to the user for other functions. e.g. audio muting. It is brought out to a pin with provision for a diode.

The prototype was made on double-sided board with an earth plane on the component side. This is a common technique for high-frequency circuits: the top of the board is left un-etched apart from small areas around non-earthed component leads. These areas are easily cleared using a drill bit. Earthed leads are soldered to both sides of the board.

When the installation is completed and checked, switch on the tv without the computer connected. The set should behave normally, although the tuning may need slight adjustment to compensate for the voltage drop across Tr_2. Plug in the computer lead and switch on. The screen should now display the computer start-up message. If the picture is unstable, the sync. signal is probably incorrect: try changing the values of the sync. network R_7 to R_{10}. If your tv deflection circuit requires positive sync. pulses, these may be provided by changing over link 31 within the BBC Micro. You may find that optimum sharpness is obtained with the brightness control turned down a little.

by D.J. Dinning

RGB conversion for Philips G8 uses opto-isolators

The Philips G8 series of sets, like most of their marque, used a 'live' chassis, i.e. the chassis of the set was connected to one pole of the mains, making direct connection of the computer a potentially hazardous operation. Other approaches overcome this problem with the use of mains isolating transformers, but these items are both bulky and costly and, if housed within the receiver cabinet, their magnetic field may affect the convergence and purity of the picture. Additionally, unless a low-capacitance isolation transformer is used, transients can still be fed through from the mains and either damage the computer or corrupt data.

The interface uses high-speed optocouplers with 2.5kV isolation and low feed-through capacitance (0.6 pF) and is housed on a small p.c.b. fitted into the tv set, connection to the computer being via a six-core cable. The unit can be powered from the tv set itself or via a small (10VA) transformer. The unit features automatic changeover from 'off-air' to RGB drive when the computer is switched on, and was used with a BBC model B computer, but will work equally well with any computer that has RGB and sync. outputs.

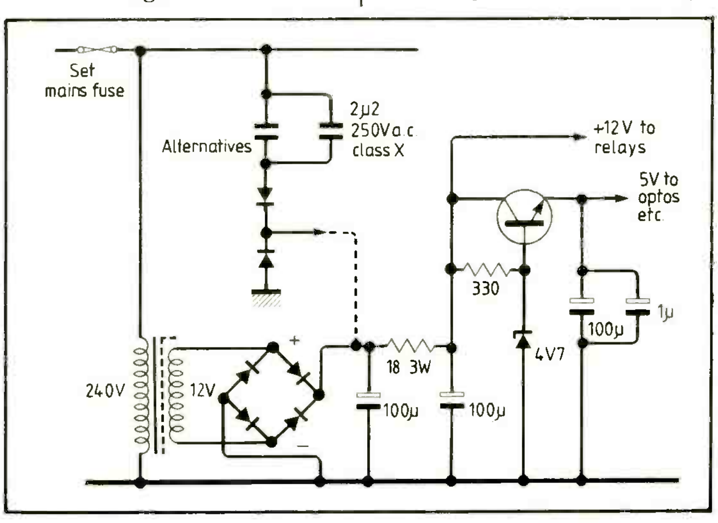
RGB outputs from three identical emitter followers are fed via a six-pin DIN plug and socket to multicore cable, whose length should not exceed about three metres. The signals are terminated in high-speed opto-isolators type 6N137 (RS 304-273) Fig. 1. Resistors 1 – 3 are the terminating resistors with C_{1-3} as speed-up capacitors. Leds (RS 586-475) balance the line in the reverse direction and provide a discharge path of C_{1-3}. These techniques are essential if a bandwidth of up to 10MHz is to be achieved. The optocouplers are capable of operating at up to 20MHz and require careful bypassing to avoid instability; $C_4 - C_6$ MUST be mounted across the chip, within 5mm of the pins. Components D_1, D_4, R_{10} form a modified version of the 'standard' t.t.l.-to-transistor interface, with C_7 as a speed-up capacitor.

The sync. circuit, Fig. 2, is fed from a gate in the computer via pin 4 on the RGB socket to a circuit similar to those used for the RGB drives. A level shifting circuit D_7, R_{23}, R_{26} feeds the output of the opto-gate to the sync. driver transistor, Tr_7. C_{12} and C_{13} are speed-up capacitors. The sync. drive required by the tv circuits is negative-going and referenced to about -2volts.

The negative emitter supply is obtained by rectifying the 6.3-volt tube heater supply with D_9 and regulating it with R_{27} and D_8.

The actual level is set by the 1k preset during the setting up procedure.

Fig.3. **Power circuit.**



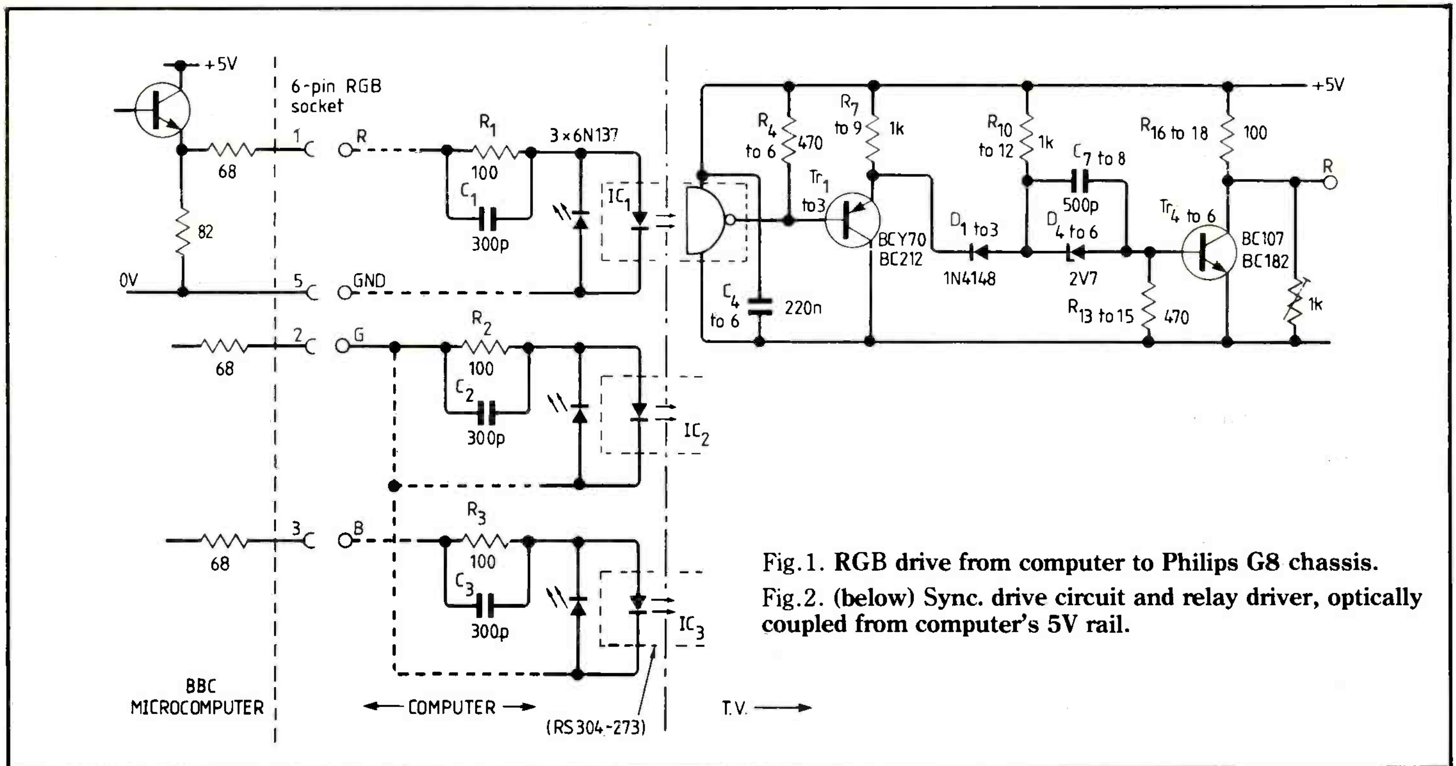


Fig.1. **RGB drive from computer to Philips G8 chassis.**

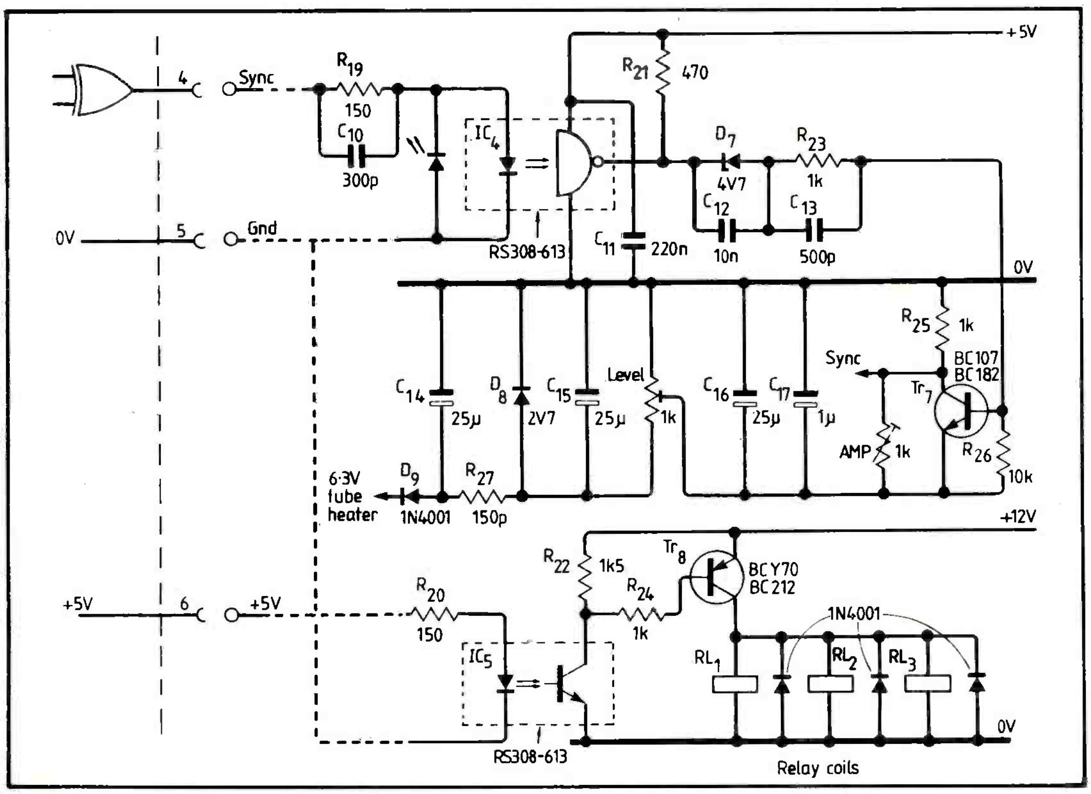
Fig.2. **(below) Sync. drive circuit and relay driver, optically coupled from computer's 5V rail.**

The interface can be left plugged into the computer if desired; the circuit then switches over automatically when the computer is 'powered up'. Opto-isolator, IC_5 is supplied from the computer 5V rail via pin 6 of the DIN plug. This causes Tr_8 to turn on and operate the changeover relays RL1 — RL3, small p.c.b.-mounting relays (RS348-655) or similar. These relays are mounted on the top of the delay line (RGB relays) and on top of the sound selectivity module (sync. relay), by means of double-sided adhesive pads.

The interface card draws about 130mA at 12 volts, without relay coil currents. This was thought to be too much of an additional burden for the receiver.

A small mains transformer can be used, but this should be mounted well away from the tube to prevent convergence problems; alternatively a capacitive 'dropper', using class X capacitors, can be used, as in Fig.3.

A transistor regulator is shown, but a chip regulator such as the 7805 could equally well be used. Smoothing electrolytic capacitors are paralleled with 1μF paper capacitors for h.f. bypassing. The negative supply is derived from the tube heater pin 14 (pin 1 is earthed).



The G8 was produced with several p.c.b. versions, early sets having separate tuner i.f. and chroma boards, later sets having one large board. Thus the mounting position and number of relays used is left to the constructor.

The RGB output transistor circuitry is fed from either the RGB driver, IC_{570}, or the interface unit, via the changeover relays, and the sync. signal is either taken from the sound selectivity module (off air) or from the interface unit and is fed via the changeover relay into IC_{001} pin 10.

Illustrations showing the location of the necessary track cuts together with associated circuit diagrams are available from the editorial office in return for an s.a.e.: mark envelopes 'G8'.)

With the unit checked out and connected to the tv sets, plug in the computer and switch on. Set the RGB pre-sets to max. resistance and adjust the 'level' preset for -2volts on the emitter of Tr_7 with respect to ground. Adjust the 'amplitude' preset until the picture just locks, then a further 10°. If the picture jumps in and out of lock, but slowly, increase the smoothing on the -2volt line, or adjust 'level' to give, say -2.5 volts. A colour bar pattern program* can be run on the micro and the RGB levels adjusted until the appropriate colours are just coming out of saturation.

* *Television*, January 1985, page 185.

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PC900	1.25
PCC84	0.40
PCC85	0.54
PCC88	0.70
PCC89	0.70
PCC189	0.70
PCC805	0.70
PCC806	0.80
PCE82	0.80
PCF80	0.85
PCF82	0.60
PCF84	0.65
PCF86	1.20
PCF87	0.40
PCF200	1.80
PCF201	1.80
PCF800	0.40
PCF801	1.35
PCF802	0.80
PCF805	1.25
PCF806	1.00
PCF808	1.25
PCH200	1.50
PCL82	0.85
PCL83	2.50
PCL84	0.75
PCL85	0.80
PCL86	0.85
PCL800	0.80
PCL805	0.90
PD500	3.50
PD510	3.65
PE1-100	69.00
PEN25	2.00
PEN40DD	2.50
PEN45	3.00
PEN45DD	3.00
PEN46	2.00
PEO6-40N	42.00
PFL200	0.95
PL21	2.50
PL36	0.95
PL38	1.50
PL81	0.72
PL81A	0.72
PL82	0.60
PL83	0.52
PL84	0.78
PL88	1.00
PL95	1.75
PL302	1.00
PL345	12.50
PL500	1.10
PL504	1.15
PL508	1.75
PL509	4.85
PL519	4.95
PL802	5.95
PL802T	3.50
PL820	2.95
PL5557	29.50
PY32	0.60
PY33	0.50
PY81	0.70
PY82	0.70
PY83	0.70
PY88	0.65
PY500A	1.95
PY800	0.79
PY801	0.79
QB3-300	54.95
QE03-10	4.95
QE08-200	145.00
QF40	65.00
QP25	1.00
QQE03-12	7.95
QQE03-20	35.00
QQV02-6	19.50
QQV03-10	5.50
QQV03-10 Mullard	15.00
QQV03-20	25.00
QQV03-20B	32.00
QQV06-40A	27.50
QQV07-50	63.50
QQZ03-20	42.50
QS75.20	1.50
QS75/40	3.00
QS92/10	5.00
QS95/10	4.85
QS108/45	4.00
QS150/15	6.95
QS150/30	1.15
QS150/45	7.00
QS1200	3.95

QS1202	3.95
QS1203	4.15
QS1205	3.95
QS1206	1.05
QS1207	0.90
QS1208	0.90
QS1209	3.15
QS1210	1.50
QS1211	1.50
QS1212	3.20
QS1213	5.00
QS1215	2.10
QS1218	5.00
QU37	9.50
QV03-12	4.95
QV05-25	1.75
QV06-20	29.50
QV08-100	145.00
QV2-250	45.00
QY3-125	65.00
QY4-250	70.00
QY4-400	76.00
R10	4.00
R16	12.00
R17	1.50
R18	2.50
R19	2.50
R20	1.20
R1169	55.00
RG1-125	4.95
RG1-240A	14.50
RG3-250A	3.50
RG3-1250A	35.00
RK2K25	62.50
RK-20A	12.00
RL16	1.50
RPL16	12.00
RPY13	2.50
RPY43	2.50
RPY82	2.50
RR3-250	15.00
RR3-1250	35.00
RS613	45.00
RS685	54.95
RS688	52.15
S6F17	5.95
S6F33	28.95
S11E12	38.00
S30/2K	12.00
S104/1K	10.00
S109/1K	15.00
S130	5.95
S130P	5.95
SC1/800	5.00
SC1/1100	6.00
SC1/1200	5.00
SC1/1300	6.00
SC1/2000	9.00
SD6000M	45.00
SP41	5.00
SP42	3.00
SP4B	4.95
SS501	35.00
ST11	1.50
STV280/40	11.95
STV280/80	19.95
SU42	4.95
TB2.5/300	85.00
TB2-300	45.00
TB3-2000	395.00
TBL-2-300	275.00
TD1-100A	25.00
TD03-10F	35.00
TD3-12	4.00
TDD4	5.50
TP25	1.50
TSP4	7.00
TT11	1.50
TT15	34.95
TT21	45.00
TT22	45.00
TT100	57.00
TTR-31MR	65.00
TY2-125A	85.00
TY4.400	85.00
TY8-600W	365.00
TYS2/250	375.00
U18-20	2.75
U19	11.95
U24	2.00
U25	0.90
U26	0.90
U37	9.00
U41	6.95
U50	2.00
U82	3.00
U191	0.70
U192	1.00
U193	0.65
U251	1.00
U801	0.75
UABC80	0.65
UAF42	1.00
UBF80	0.60
UBC41	2.95
UBC81	1.50
UBF89	0.60
UBL21	1.75
UC92	1.20
UCC84	0.70
UCC85	0.60
UCF80	1.00
UCH21	1.20
UCH41	2.50
UCH42	2.50
UCH81	0.65
UCL82	1.75
UF41	1.15
UF42	1.15
UF80	1.75
UF85	1.20
UF89	2.50
UL41	4.50
UL44	3.50

UL84	0.85
UU5	3.50
UU7	8.00
UU8	9.00
UY41	3.50
UY85	0.70
V235A/1K	250.00
V238A/1K	295.00
V240C/2K	225.00
V241C/1K	195.00
V2464A/2K	315.00
V339	3.50
V453	12.00
VLS631	10.95
VP4B	4.50
VP133	2.00
VR75/30	3.00
VR101	2.00
VR105/30	1.50
VR150/30	1.15
VT52	2.50
VU29	4.50
VU39	1.50
W21	4.50
W77	5.00
W729	1.00
W739	1.50
X24	4.50
X66/X65	4.95
X76M	1.95
XC24	1.50
XC25	0.50
XFW47	1.50
XFW50	1.50
XG2-6400	135.00
XG5-500	22.50
XL1-5V	1.50
XL628FT	7.50
XNP12	2.50
XR1-1600A	49.50
XR1-3200A	79.50
XR1-6400A	99.50
Y503	25.00
Y65	6.95
Y602	12.00
YD1100	75.00
YJ1060	265.00
YL1020	29.00
YL1070	195.00
YL1071	195.00
YL1290	65.00
Z77	1.20
Z302C	12.00
Z359	9.00
Z505S	15.00
Z520M	4.00
Z521M	8.00
Z700U	3.00
Z749	0.60
Z759	19.85
Z800U	3.00
Z803U	18.95
ZA1000	12.50
ZA1001	1.50
ZA1002	1.50
ZC1040	8.00
ZM1005	8.00
ZM1020	8.95
ZM1021	8.00
ZM1023	7.95
ZM1041	14.00
ZM1082	9.00
ZM1084	10.00
ZM1177	9.00
ZM1202	55.00
ZM1263	4.00
ZM1612	3.00
1A3	4.50
1AC6	1.20
1B3GT	1.95
1B22	10.00
1B24	14.95
1B35A	29.50
1BC2A	2.50
1C1	2.50
1C5GT	2.50
1D5	2.50
1FD1	2.50
1G3GT	2.50
1K3GT	2.50
1N2	4.50
1N5GT	2.50
1P28	25.00
1T4	0.70
1U5	1.00
1X2B	1.40
1Z2	8.95
2B7	1.50
2B22	69.50
2C21	1.00
2C39A	32.50
2C39BA	39.50
2C40	37.00
2C42	29.50
2C51	0.75
2C53	32.00
2CY5	1.50
2D21	1.50
2D21W	2.50
2E26	7.95
2J42	93.00
2K25	24.95
2K25 Raytheon	75.00
2K26	95.00
3A/107B	12.00
3A/108A	9.00
3A/109B	11.00
3A/110B	12.00
3A/141K	11.50
3A/147J	7.50
3A/167M	10.00
3A2	3.95
3A3A	3.95
3A4	1.10
3AL5	0.95

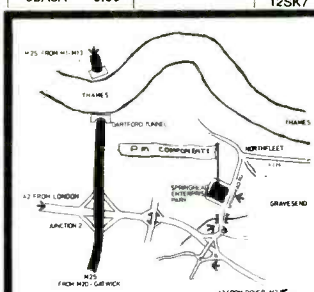
3AT2	3.35
3B2	3.00
3B4	7.00
3B7	4.50
3B24	10.00
3B26	24.00
3B28	12.00
3BZ6	1.50
3C4	1.00
3C23	19.00
3C45	24.00
3CB6	1.50
3CN3A	2.50
3CS6	0.95
3CX3	2.50
3CY5	1.50
3D6	4.50
3D21A	29.50
3D22	19.50
3E22	49.50
3EH7	1.95
3EJ7	1.95
3W4GT	2.50
4B551B	115.00
4-65A	59.00
4687A	9.50
4.125A	60.00
4-250A	65.00
4B32	35.00
4BQ7A	1.75
4BZ6	1.95
4C27	25.00
4C28	25.00
4CB6	1.95
4CX250B	49.00
4CX250BM EIMAC	75.00
4CX250K EIMAC	95.00
4CX125C EIMAC	125.00
4CX350A	95.00
4D26	75.00
4GS7	2.25
4GV7	2.25
4J52	75.00
4JC6A	2.95
4X150A	35.00
5A/102D	9.50
5A152M	9.00
5A163K	10.00
5A170K	6.25
5A-180M	9.00
5A-206K	10.00
5AMB	2.15
5ANB	1.20
5AR4	2.00
5AU4	1.50
5B8	2.50
5B.110M	10.00
5B-254M	14.50
5B-255M	19.50
5B-256M	9.00
5B-257M	9.00
5B-258M	14.50
5C22	125-00
5J180E	1895.00
5R4GB	3.50
5R4GY	3.50
5T4	5.95
5U4G	2.50
5U4GB	2.50
5V4G	1.25
5Y3GT	1.95
5Z4GT	0.85
6/30L2	0.70
6A/203K	9.00
6A7	4.95
6A8G	1.50
6AC7	2.00
6AF4A	2.50
6AF9	4.15
6AG5	1.50
6AG7	1.95
6AH6	2.50
6AJ4	2.00
6AJ7	2.00
6AK5	1.50
6AK6	2.50
6AL5	0.60
6AM4	3.25
6AM5	6.00
6AM6	1.50
6AN5	2.65
6AN8A	2.65
6AQ5	1.75
6AQ8	0.85
6AR5	5.95
6AR8	3.95
6AS5	1.50
6AS6	2.50
6AS7G	4.50
6AT6	0.75
6AT8	1.75
6AU4	2.00
6AU6	0.95
6AV6	0.75
6AW8A	2.50
6AZ8	5.95
6B7	2.80
6B8G	1.50
6BA6	0.95
6BA7	4.50
6BA8A	3.50

6BC8	1.00
6BD4	1.50
6BD6	2.50
6BE6	0.72
6BG6G	3.00
6BH6	1.95
6BH8	1.50
6BJ6	1.20
6BK4	4.00
6BK7A	1.95
6BL8	1.15
6BM8	0.58
6BN4	1.65
6BN6	1.65
6BN7	4.50
6BN8	3.95
6BQ5	0.75
6BQ7A	0.72
6BL7GTA	3.95
6BR5	0.70
6BR7	4.95
6BR8	2.15
6BR8A	2.15
6BS7	5.50
6BW4	1.50
6BW6	5.35
6BW7	1.50
6BW8	4.00
6BX6	0.48
6BX7GT	3.50
6BZ6	2.50
6BZ7	2.95
6C4	1.10
6C5	1.95
6C6	2.50
6C8G	1.50
6C11	2.50
6C18	2.50
6CA4	4.95
6CA7	3.50
6CB5	3.95
6CB6	1.95
6CD6GA	4.50
6CF6	1.50
6CG7	2.25
6CH6	6.95
6CL3	3.95
6CL6	3.25
6CL8A	1.50
6CM5	1.60
6CM7	2.95
6CS6	0.75
6CW4	6.50
6CY5	1.00
6D6	2.50
6DC6	2.35
6DJ8	0.95
6DK6	1.15
6DQ5	5.95
6DQ6B	2.50
6DT6A	1.50
6DW4	2.15
6EA4	4.95
6EA7	2.50
6EA8	2.50
6EB8	1.75
6EM5	2.50
6EM7	2.50
6EU7	1.95
6EU8	1.75
6EV7	2.95
6EW6	1.50
6EW7	4.50
6F1	2.00
6F5	4.95
6F6	2.50
6F6G	2.00
6F7	5.50
6F12	1.50
6F13	3.00
6F14	1.00
6F17	2.75
6F21	2.50
6F23	0.60
6F24	1.25
6F25	1.25
6F28	1.25
6F32	1.25
6F33	17.00
6FG5	1.95
6FQ7	2.95
6G6G	5.50
6GH8A	0.80
6GK5	1.50
6GK6	1.95
6GS7	2.15
6GV7	2.50
6GW6	2.50
6H1	9.50
6H3N	1.10
6H6	1.35
6H6GT	1.95
6HF8	0.95
6HS6	4.95
6J4	2.15
6J4WA	3.15
6J5	2.50
6J6	2.00
6JB6A	3.95
6JE6C	4.95

6JU8	2.50
6JS6C	4.95
6J7G	4.15
6K7G	2.00
6K8Y/G	3.00
6KD6	5.50
6KM8	2.50
6KT8	2.95
6L1	2.50
6L15	3.15
6L19	3.95
6L6GC	2.95
6L6GC(GE)	4.50
6L6GT	1.95
6LD20	1.15
6LF6	7.50
6LJ8	2.50
6LQ6	4.95
6N7	2.50
6N7GT	2.50
6P15	1.50
6P25	4.00
6P26	4.00
6P28	2.00
6Q7	1.20
6Q7GT	1.20
6R7G	3.15
6S4A	1.50
6SA7GT	1.35
6SC7	1.50
6SG7	1.35
6SH7	1.35
6SJ7GT	1.20
6SK7	1.35
6SK7GT	1.35
6SL7GT	0.85
6SN7GT	1.35
6SQ7	1.35
6SS7	1.95
6U4GT	1.75
6U8	1.15
6U8A	1.50
6V6GT	1.50
6X2N	1.00
6X4	1.50
6X5GT	1.00
6X5GTY	1.00
6X8A	2.25
7A6	4.50
7A7	2.00
7AD7	1.75
7B6	3.50
7B7	2.50
7C5	3.50
7C6	2.50
7E7	2.50
7H7	3.50
7AU7	1.50
7J7	5.50
7Y4	2.50
8B8	2.50
8B10	2.50
8BQ5	1.95
8FQ7	1.95
10D2	1.25
10DE7	2.50
10F1	0.75
10GK6	1.95
10P14	2.50
10P18	0.78
10LD12	0.65
11E3	55.00
12A6	3.95
12AD6	1.50
12AG8	1.50
12AL5	1.00
12AT6	0.95
12AT7	1.15
12AT7WA	2.50
12AU6	1.50
12AU7	0.65
12AV6	1.95
12AV7	2.50
12AX4GT	1.00
12AX7	0.65
12AX7WA	2.50
12AY7	3.95
12AZ7A	1.95
12B4A	4.50
12BA6	1.50
12BE6	1.95
12BH7A	2.50
12BL6	1.75
12BY7A	2.75
12CA5	1.95
12CX6	1.20
12DQ6B	3.50
12DW4A	3.50
12DW7	2.50
12E1	17.95
12E14	38.00
12GN7	3.95
12HG7	4.50
12HG7A	4.50
12J7GT	3.50
12K5	1.95
12K7GT	1.50
12K8	1.95
12SA7GT	1.95
12SG7	4.75
12SH7	1.95
12SK7	1.95

12SJ7	1.50
12SQ7GT	1.95
12SR7	2.50
12SQ7GT	1.50
13D3	3.20
13D7	3.20
13D9	3.20
13DE7	2.50
13DR7	2.95
13E1	145.00
13EM7	3.50
14S7	1.95
17DW4A	2.95
17EW8	0.95
17JZ8	4.50
18D3	6.00
19AU4GT	2.50
19G3	17.00
19H5	33.50
19Q6	9.00
20A2	10.50
20D1	0.70
20LF6	3.50
20L1	0.95
20P1	0.55
20P3	0.60
20P4	1.95
20P5	1.15
21LU8	2.50
24B1	39.50
25L6GT	1.75
25BQ6	1.75
29C1	19.50
29KQ6	6.50
30C17	0.40
30C18	1.48
30F5	0.95
30FL1	1.00
30FL2	1.35
30FL12	0.95
30FL13	1.10
30FL14	1.25
30L1	0.45
30L15	0.60
30L17	0.60
30P4MR	1.00
30P12	1.00
30P18	0.60
30P19	1.00
30PL1	2.50
30PL13	0.60
30PL14	1.75
31JS6C	5.50
33A/158M	19.50
35A5	4.50
35L6GT	2.00
35W4	0.70
35Z3	1.85
38HE7	4.50
40KD6	5.50
42	6.95
47	6.00
50A5	1.50
50C5	0.95
50CD6G	1.15
50EH5	1.50
50JY6	2.95
52KU	2.00
53CG	15.00
61SPT	4.50
75B1	3.50
75C1	2.50
83	8.50
84	3.00
85A1	6.50
85A2	1.50
90AV	10.00
90C1	2.70
90CG	13.50
90CV	12.50
91AG	9.00
92AG	19.50
92AV	12.50
95A1	6.50
108C1	1.50
150B2	6.95
150C2	1.50
150C4	2.15
155UG	25.00
185BT	1.50
211	33.50
274A	15.00
307	5.00
328A	15.00
388A	17.50
425A5	8.00
431U	4.50
705A	8.00
708A	8.00
715C	45.00
725A	275.00
803	14.95
805	39.00
807	1.95
810	45.00
811A	12.95
813	23.50
813USA	45.00
829B	14.50

833A	95.00
866A	4.50
872A	27.50
873	60.00
884	5.50
930	9.95
931A	13.95
954	1.00
955	1.00
958A	1.00
1299A	0.60
1619	2.50
1625	3.00
1626	3.00
2050W	4.50
2050	3.95
3545	4.00
404A	10.95
927	15.00
1927	25.00
4212E	250.00
4313C	4.00
4328D	9.00
5642	9.50
5651	2.50
5654	1.95
5663	1.95
5670	3.25
5672	4.50
5687	4.50
5692	3.50
5696	3.50
5704	3.50
5718	6.15
5725	2.50
5726	1.50
5727	1.95
5749	2.50
5750	1.85
5751	2.95
5763	4.95
5814A	3.25
5829WA	6.50
5636	5.50
5678	7.50
5840	3.50
5842	11.00
5847	10.95
5879	8.50
5886	13.95
5894	39.50
5899	4.50
5963	1.75
5965	2.25
6005	1.85
6012	16.00
6021	3.65
6057	2.50
6058	3.95
6059	3.75
6060	2.25
6062	4.50
6063	2.00
6064	3.25
6067	1.95
6072	4.20
6080	8.50
6080WA	9.50
6132	10.00
6136	2.50
6146B	9.95
6157	2.50
6158	3.20
6201	6.45
6205	6.95
6211	2.50
6267	2.25
6350	3.50
6360	4.50
6386	14.50
6545	8.50
6550A	10.95
6688	6.50
6870	11.50
6887	9.50
6883B	9.95
6973	5.95
7025	2.50
7027A	4.50
7032	2.00
7059	2.50
7167	3.95
7189	2.35
7193	7.50
7247	2.95
7360	13.50
7462	15.00
7475	5.00
7486	125.00
7527	85.00
7551	6.95
7558	9.45
7586	11.00
7587	29.50
7591A	4.95
7609	47.00
7733	5.50
7788	25.00
7868	3.95
8012	15.00



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CIRCLE 77 FOR FURTHER DETAILS.

by Rod Cooper

Recharging system for NiCd cells

Recharging sealed NiCd cells can be very unsatisfactory if it is done with d.c., at too low a temperature, at too high a rate, if it is prolonged, or if it is done with cells in series. Part 3 of this series of articles describes a practical method of recharging which not only avoids some of the pitfalls, but gives the best possible performance from NiCd cells, and is at the same time cost-effective, giving pay-back time of about two years.

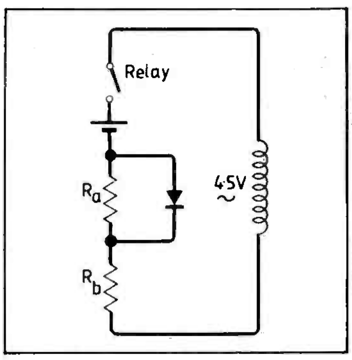


Fig. 1. **Simple circuit, based on electro-plating principles, but without precise current definition, can employ a.c. mains.**

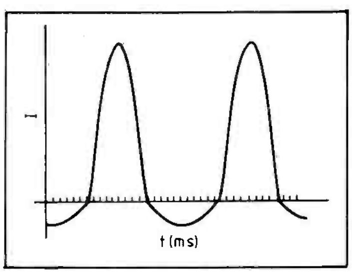


Fig. 2. **Typical current waveform in circuit of Fig. 1.**

In the recent two-part article on the failure modes of nickel-cadmium cells, mention was made of the damage done to cells by incorrect charging techniques. The recharging system (I call it this because it is more than just a battery charger) described here was devised to show that it is possible to recharge cells both efficiently and without premature failure or falling-off in performance. Moreover, in practical terms this system is far more pleasant to operate than simple conventional chargers since there are none of the irritating problems of having to ensure that cells are matched in capacity, are not over or under-charged, do not lose capacity on standing, or that the temperature is correct.

In this radical approach the NiCd cells are intended to remain in the charger until required. Once placed in the charger, the cell is taken care of until removed for use.

The design features are:

- cells are charged individually to reduce the effects of any disparity in capacity.
- dendrite-suppression charging circuit prevents premature failure due to dendrites forming between the plates.
- automatic turn-off prevents over-charging.
- automatic turn-on minimizes the effects of self-discharge.
- low-temperature cut-out prevents damage due to charging below 5°C.
- inherent NiCd fault-diagnosis capability.

These features are examined in turn as follows.

Cells charged individually

In the article on failure modes it was explained how charging a battery of cells could lead to more fault modes developing due to initial slight variations in the capacity of neighbouring cells. A common method of trying to even out the charge give to each cell in the battery is to thoroughly overcharge the whole battery in the hope that each cell is driven into the oxygen-recombination phase. The attendant long-term danger of this method is separator deterioration. Another factor which detracts from the method is the possible presence of cells in the battery that have dendrites. These cells may become "stuck" short of full charge regardless of how much the rest of the battery is overcharged, but the symptoms will usually go undetected, thus storing up trouble for the future. There seems to be no easy way round this problem if the cells are charged together as a battery.

In this new approach the cells are disassembled for charging and treated as individuals. Clearly this technique can only be used for equipment where separate cells are held in a battery compartment and cannot be used where batteries consist of cells spot-welded together. However, much commercial gear like radios, cassette players etc. employs numbers of separate cells in an accessible compartment, so it is expected that this recharging system will suit most applications, and in particular it is highly suitable for those using a single cells coupled to d.c.-d.c. converters like the Texas TL496 or Verkon V9-a to step up to 9V.

Indeed, in the case of single-cell d.c.-d.c. converter combinations it is obviously nonsense to connect such a cell in series with another for the recharging process.

There are therefore definite advantages in recharging each cell according to its needs. Firstly, it will not be persistently overcharged in the interests of charge-uniformity so it is unlikely to suffer separator degradation. Secondly each cell is assured of a full charge regardless of whether this takes longer to achieve in some cells than in others, and this is more likely to result in an even charge throughout the battery than any other method, the benefits of which have already been dealt with. Thirdly, with this method it is very easy to spot the cell that has gone wrong, which can then be removed from service instead of being left to cause trouble in the battery. This aspect is dealt with later.

Dendrite-supression charging circuit

Charging cells with d.c. can result in the formation of cadmium dendrites, leading to the early failure or falling-off in performance that was detailed in the earlier article. Dendrite formation is not exclusive to the charging of nickel-cadmium cells. It is a problem experienced in the electroplating industry when copper, zinc and silver are electroplated. These metals are the close neighbours of cadmium in the periodic table of the elements and share some common characteristics, such as dendrite formation. However, the electroplating industry has had a remedy for very many years in the form of periodic current reversal (p.c.r. for short). This technique consists of applying a short pulse of current in the opposite direction to the main plating current at regular intervals. The result is a smooth, hard, dendrite-free metal deposit quite unlike that produced by d.c. A magnified cross-section of p.c.r. deposit shows that it is not homogeneous but distinctly laminar in nature.

Now, the charging of a NiCd cell can be regarded as a special case of electroplating, and it should therefore be possible to eliminate dendrites by using a charging current based on p.c.r. When electroplating it is necessary to define accurately the forward and reverse currents to obtain satisfactory results, but when charging a NiCd cell the requirement is not so strict, the intention being not to produce a smooth hard deposit of cadmium but merely to supress dendrite formation. A simpler circuit should be possible, and in this design the a.c. mains is used to supply both forward and reverse currents and to define the timing. The circuit is shown in Fig. 1 and a typical current waveform in Fig. 2. Note that $R_a > R_b$. If a bank of, say, four cells were charged together using four of the circuits shown it would lead to unbalanced operation of the transformer, which would need to be up-rated to cope, so in this design the cells are charged in balanced pairs, as shown in Fig. 3. Although this detracts slightly from the concept simplicity, it does keep the transformer size (and cost) down. It was considered essential to have a basic charging circuit that was as simple as possible because the circuit is repeated many times, i.e. by as many cells as there are in the charger. The prototype, for example, held eight.

Note from Fig. 2 that the ratio of forward coulombs to reverse coulombs is approximately 5:1. With p.c.r. it is the coulomb ratio which is important, not just the current ratio.

It is not the first time that cells have been charged using p.c.r. In 1955 R. Hallows reported in *Wireless World* on a device name the Electrophoor which was designed to recharge ordinary zinc-carbon dry cells, and which used the mains to produce p.c.r. Hallows described the hard deposits of zinc in cells that had been recharged in the Electrophoor, and contrasted them with the soft and spongy (i.e. dendritic) deposit of zinc that he found in cells recharged using d.c., although at that time he did not know of the reasons for this phenomenon. The indications that p.c.r. does the same for cadmium are therefore strong.

It would be a fair deduction that using d.c. is probably the worst possible way of recharging NiCd cells, yet there are nevertheless plenty of published designs for NiCd chargers which go to the trouble of providing smoothing for the d.c. applied to the cells!

Periodic current reversal is intended as a preventive measure, not as a cure for dendrites which are already in place.

Automatic turn-off

Although the nominal charge rate is set at C/10, which a standard NiCd cell can tolerate within the limitations explained in part 2, this design incorporates a cut-out that stops the charging shortly after full charge has been reached. The cell does not therefore remain in the oxygen-recombination phase for long.

A cut-out is necessary, bearing in mind the design philosophy of leaving cells in the charger until required, in order to avoid the ill effects of normal overcharging (at C/10) for prolonged periods.

There is available a choice of detection methods for determining the end-of-charge point for NiCd cells, and for this design the temperature-rise method was chosen because it was the least expensive consistent with reliability; cost is important when many cells are being individually monitored. The circuit design is shown in Fig. 4 and consists of a simple i.c. comparator driven directly by the differential temperature sensor comprising Sensor 1 and Sensor 2. The operating point is set by R_{29}. Originally, the temperature-sensitive devices used were thermistors of the VA1066 type, but in the interests of cost-effectiveness these were substituted by a string of four forward-biased 1N4148 silicon diodes. These diodes are available at only 2p each, a worthwhile saving on the prototype charger, which housed eight cells.

The voltage drop across a forward-biased silicon diode decreases by about 2mV per 1 deg C rise in temperature. A string of four will thus give 8mV per deg C. The likely temperature rise in a D-cell at C/10 charge rate during the oxygen-recombination phasr is around 5°C, so this will produce a drop of 40mV, which is ample to drive a comparator directly. A CA3140 i.c., for example, will work happily with a 5mV differential in the circuit shown. The 1N4148 diode varies in its temperature characteristics from manufacturer to manufacturer and also between individual specimens from one source, but there is no need for close matching in this circuit, as the differences average out over

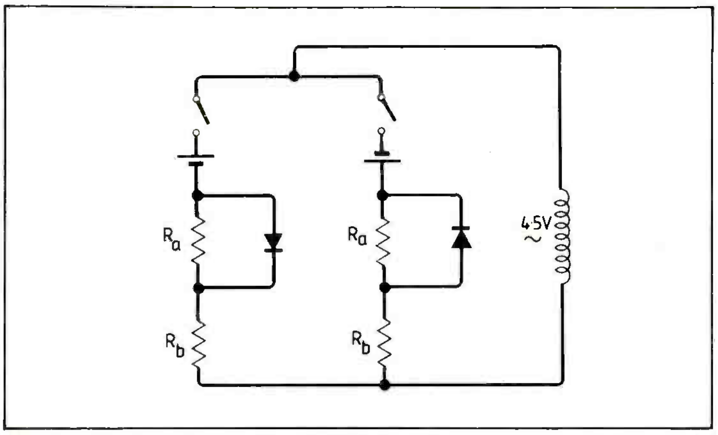


Fig. 3. **Charging cells in balanced pairs saves on transformer cost, halving its size.**

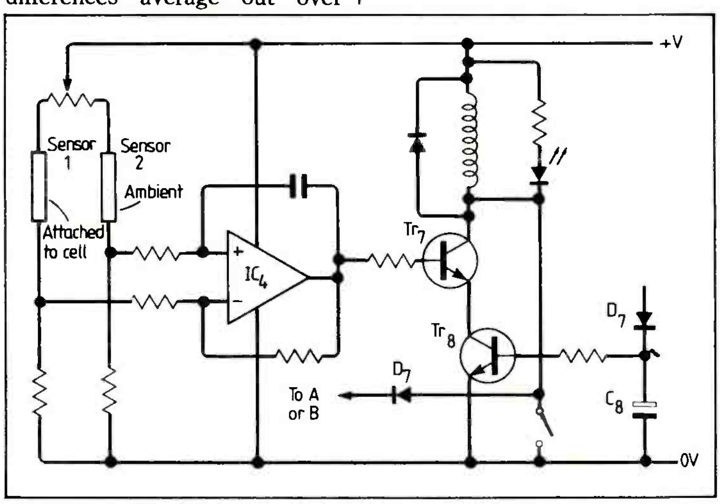


Fig. 4. **Sensor bridge and op-amp comparator determine temperature rise and therefore end-of-charge.**

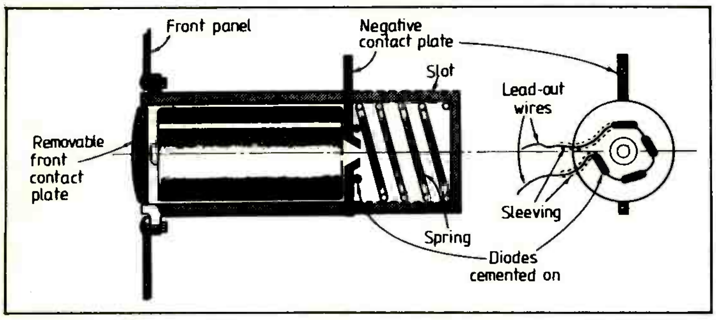


Fig. 5. **Cell holder from R S Components.**

eight diodes provided they are from the same source. The thermal coupling of Sensor 1 to the cell is important. Attachment direct to the cell, as described in other designs featuring thermal detection, is out of the question in this charger, where ease of use in putting cells into and taking them out of the cell holders is required. Of the other options available it was finally decided to fix Sensor 1 to the metal contact of the cell holder as it was easiest from the construction point of view. Of the single-cell holders on the market, only one has been found suitable for sensor attachment, this being distributed by RS Components. The RS reference numbers are given at the end of this article.

This range of holders has good thermal properties, an important point considering that in the case of a standard D cell only about half a watt of power is being dissipated over a surface area of some 23cm^2. The recommended holder has a tubular plastic body (Fig. 5) which tends to insulate the outside of the cell, which is beneficial for temperature-rise detection, and metal contact plates at eachend. The negative contact plate is large enough to attach the string of four diodes and has reasonable thermal contact with the end of the cell. This contact plate is spring loaded and slides in two slots cut in the body of the holder; the slots allow air at ambient temperature to circulate over the contact plate. This is an important point, because with such a small temperature rise to detect, some insulation from the surroundings is necessary, but it is also necessary to avoid over-insulation or a separate micro-climate will be set up inside the holder and the differential action will be upset.

A compromise is required and I have found by experiment that a $^1/_8$in thick plastic foam disc glued onto the back of the contact plate and covering the diodes strikes about the right balance between sensitive detection of the cell temperature rise and equilibrium with the ambient temperature. It is also necessary to insulate the metal spring from the contact plate by slipping a piece of plastic sleeving over it, otherwise it acts as a heat-sink.

There are some other interesting features to this type of cell holder. For example, being panel-mounted makes design and construction of the housing for the charger easier, from the point of view of cell access. When the front cap (F) is unscrewed, the cell is partly pushed out by the rear spring — no grappling with plastic side grips to get the cell out. Also, it is polarity-protected; if a cell is inserted the wrong way round, no contact is made.

The more familiar plastic open-frame cell holders are unsatisfactory from most aspects for this design and are not recommended.

Before leaving the subject of temperature, it is worth discussing the cells themselves. It is desirable to produce a sharp rise in temperature during normal overcharge, both in the interests of end-of-charge detection and in assisting the oxygen-recombination process, which works better at higher temperatures. In the last article it was suggested that the plastic sleeve usually found on NiCd cells was removed and possibly replaced with 50mm adhesive tape. This is a good idea because the covering will accentuate the temperature rise at the ends of the cell; this will not be the case if the cell is left bare.

Note that there is a time-lag between the onset of oxygen-recombination as denoted by a rise in internal pressure and the rise in temperature at the surface of the cell, but this is not long — about an hour or so for a D-cell — and may even help dendrite suppression (see article by K.C. Johnson, *WW*, Feb., 1977) The temperature rise for standard D-cells is around 5°C, but is appreciably less for smaller cells. With standard AA size cells the rise is so small that it is not sufficient for reliable operation of this design. In this case, fast charge AA cells should be used instead of standard cells even though their fast-charge capability may not actually be needed, and the charge rate increased to C/3 to produce a usable temperature rise. The extra cost in this size of cell is very small.

Regarding circuit operation, in the charging mode the output of IC_4 is high and Tr_7 is turned on. However, the relay RL2 cannot close until energised manually by closing push-button switch Sw_2 or automatically by a clamping pulse applied via D_7 from the auto turn-on circuit (see next section), and even then the relay cannot remain closed unless Tr_8 is also turned on. The function of Tr_8 is to prevent the relay from latching unless a cell is present in the cell holder. If the relay were to remain closed without a cell being present it would stay in this state because there would be no mechanism for turning it off. The Tr_8 circuit also ensures that the charging circuit is turned off if a cell is removed during charging.

The sequence of operation is therefore this; a pulse is applied to the relay as described; the a.c. line is connected to the NiCd cell and via D_9 charges C_8 and turns Tr_8 on, latching the relay RL2 when charging is completed, IC_4 clamps the base of Tr_7 to ground, turning it off and de-energising the relay. The a.c. is disconnected, C_8 discharges and Tr_8 turns off. As the cell cools down, IC_4 turns Tr_7 back on and the circuit is then ready for the next command pulse.

A command pulse applied before cooling-off has taken place cannot initiate more charging because Tr_7 will remain off until comparator IC_4 returns to the high state and this prevents prolonged overcharging whether intentional or not.

A relay was chosen for the switching element because it offers complete isolation of the NiCd cell when not being charged, and avoids the need to take into account leakage currents and "brown out" associated with semiconductors over long periods of use. Leakage is a significant factor bearing in mind the intention of leaving cells in the charger.

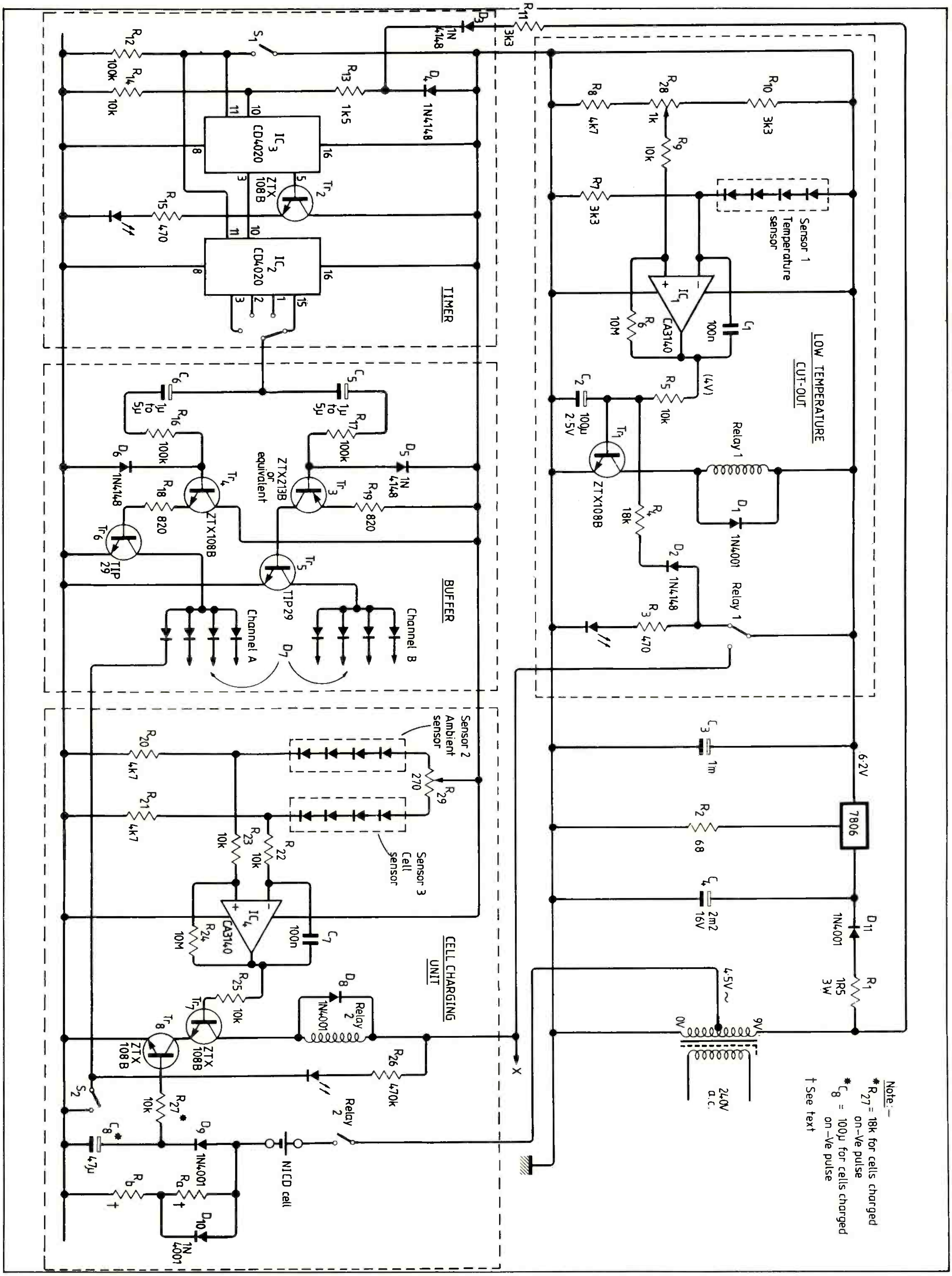
To set this circuit up, it is necessary to have a warm, freshly charged cell and a cell at room temperature, or alternatively a d.c. millivoltmeter. With the warm cell method, preset pot R_{29} is set to that relay RL2 just switches off when the warm cell is inserted in the holder. The cold cell is then inserted in its place, and it should be possible to reset the charger with S_2. This process has to be repeated to ensure reliable results, and because the thermal time-constants are lengthy — a couple of minutes for each check — this scheme can be can be tedious if there are many circuits to set up. A much quicker method is to set the differential voltage between Tr_1 and Tr_2 at about 20mV using a d.c. millivoltmeter. This makes sure that a warm cell will turn off the relay but at the same time will be reasonably immune to spurious temperature fluctuations. A suitable millivoltmeter can readily be contructed from a m.c. meter and a chopper amp like the ICL7650 — see *WW*, June 1983.

It is difficult to tell when a cell is in the warm, charged state without resorting to accurate temperature measurement, and as this is essential to the first method this practical tip may help, having the advantage of needing no equipment. The difference between a warm cell taken from a charger and a cold cell which has been standing at room temperature cannot be readily detected by holding them in the hand, but if they are held simultaneously to the face, the difference is instantly apparent, the face being suprisingly sensitive to temperature difference. A strange but useful tip! Note that there is virtually no temperature rise in a NiCd cell during charging until the oxygen-recombination is reached.

Automatic turn-on

One of the most annoying features of sintered cells is their ability to discharge themselves when left standing. This feature is inherent in the design and is not a failure mode, although it is a failing in practical terms. Typically a brand-new D-cell will discharge itself to about 60% of

Fig. 6. **Complete circuit diagram of cell recharger. Leds are standard 0.2in devices.**


TIMER
BUFFER
CELL CHARGING UNIT
LOW TEMPERATURE CUT-OUT
Channel A
Channel B
Sensor 1 Temperature sensor
Sensor 2 Ambient sensor
Sensor 3 Cell sensor
NICD cell
240V a.c.
Note:-
*R27 = 18k for cells charged on -Ve pulse
*C8 = 100µ for cells charged on -Ve pulse
† See text

capacity in only 40 days — a relatively short period when compared to the shelf life of other types of cell. This figure is for a temperature of 20°C, and the performance improves at lower temperatures but deteriorates at higher temperatures. The self-discharge phenomenon is due to the unstable nature of the active materials and, of course, is not irreversible — a recharge will restore the status quo.

To overcome this problem a timer has beenn added to the charger so that it turns itself on periodically to give the cells a topping-up charge. The time period selected can be 62, 31, $15\frac{1}{2}$ or $7\frac{3}{4}$ days depending on the user's requirements. I personally prefer $15\frac{1}{2}$ days, giving a guaranteed minimum state of charge of any cell taken from the charger of about 80%.

The timer itself is shown bottom left of Fig. 6 and consists of two CD4020 c-mos i.cs. connected in cascade. Each CD4020 is a 14-stage binary counter with stage 1 and then stages 4 to 14 brought out to buffered outputs, stage 14 providing a total frequency division of 16,384. If two devices are cascaded and the input fed with a 50Hz input, the output from stage 14 of the second i.c. will give a change of state every 31 days 1 hour and forty minutes. The signal input is not critical since the i.c. contains waveform-shaping circuitry at the input stage, so a mains-derived signal is a very attractive source, helping to keep the cost down.

The output to the cell charging circuit is buffered by transistors Tr_3 and Tr_5 for negative-going changes of state and by Tr_4 and Tr_6 for positive-going changes. By splitting the output like this, where one buffer responds only to negative changes and the other buffer to positive changes, the maximum timing period is effectively doubled. Each buffer feeds a bank of cells, so banks of cells will be turned on at alternate times. This system makes the best use of the equipment; it is clearly not efficient to have the charger idling for up to 62 days and then turning on to charge all the cells at once.

The buffers apply a sufficiently long pulse to the relay coil RL2 to charge C_8 and turn on Tr_8, locking the circuit on. A pulse length of 2 or 3 seconds is required to ensure reliable latching. A value for C_5 and C_6 of between 1 and 5 µF is generally satisfactory, but it is necessary to experiment with various values to achieve equal pulse lengths for both channel A and B, due to differences in H_{fe} of the transistors and their assymmetric configuration. Each charging circuit is isolated from the other by D_7 so individual cells can be charged if required by pressing pushbutton S_2, independently of the timer.

Switch S_1 is a momentary push-button type used for setting the start of the timing period and only needs to be pressed once when the charger is commissioned or if the charger is disconnected from the mains supply for any reason.

Transistor Tr_2 and the led form a flashing light indicator. On the first models I used an ordinary mains neon as the pilot light but found this to be very unsatisfactory because it did not show that anything was actually working and there was always a nagging doubt about whether or not the charger was going to switch itself on after the stipulated period. Sixty two days is a long time to have to wait to discover a simple fault!

This addition puts one's mind to rest as it shows that at least the secondary side of the transformer is working, that the a.c. signal is reaching the counters, that the first stage of the counters is working and that the stabilised line is on. The flash signal is taken from stage 5 of the first counter and has a duration of a third of a second.

Low-temperature cut-out

The dangers of charging below about 5°C are avoided by using a latching cut-out which switches the 6.2V power line away from the relay coils RL2, thus preventing them from turning on, and diverts it to a led warning light. The cut-out can only be reset by unplugging the unit and moving it somewhere warmer.

The circuit (top left of Fig. 6) is similar to that used for the end-of-charge detector, except that only one string of temperature-sensing diodes is used. The drop in temperature from 20°C to 5°C produces a voltage rise of 120mV across the diodes. The pre-set resistor is set so that the comparator switches high at 5°C, energising relay RL1 via Tr_1. latching is achieved via D_2.

The circuit can either be set up by putting the unit in an ordinary domestic refrigerator for an hour or so (these are usually about 4°C) and then setting R_{28} so that the relay RL1 closes.

NiCd fault-diagnosis capability

It is easy to spot a bad cell with individual charging. A cell that is suffering dendrite problems and has become stuck will stand out like a sore thumb in a bank of, say, four cells on charge, as the faulty cell will continue charging long after the others have turned themselves off.

Also, it is not difficult to sort out the cells that have "dried out" because their impedance will be higher than usual. Cells charged via the positive side of the a.c. charging circuit need an internal impedance of less than 25ohms to latch the relay, so a quick test by pushing switch S_2 will reveal faulty cells. Cells charged from the negative a.c. line need an impedance of less than 60ohms to latch.

This is not a very stringent test, but it is possible to improve it if required by modifying the base drive to Tr_8. A few diodes or even a zener in series with the base drive resistor will make it more difficult for Tr_8 to turn on with these high-impedance cells.

Practical construction details

A metal case is recommended for housing the unit as it gives good temperature equalisation with the surroundings. The cases I used had no vents but this did not present a problem since the temperature rise with bank of four D-cells on charge is not large.

During development, I found that transients introduced from the mains supply caused IC_1 and IC_4 to turn off and terminate charging before due time. A mains interference filter cured this. Other causes of erratic operation arise from placing the unit in a draught, near a heating source or in a place suffering from water condensation.

The mains transformer used for charging two banks of four D-cells was a 20VA type with two 4.5V secondaries rated at 2.2 amp each (RS 207-122). One 4.5V secondary was used to power the cell-charging circuits and the other was used in series to provide a nominal 9V from which the 6.2V stabilized line was derived. For other cells there are other transformers available from the RS range to suit.

Several methods were tried for attaching the four 1N4148 diodes which form Sensor 1 to the back of the cell contact plate. The easiest method consisted of cutting the diode leads to give an overall length of just over 1cm and then soldering the diodes together in a straight line. They can then be bent into the circular shape shown in Fig. 5. The diode body must be protected from stress damage when doing this by holding the lead at a point near the body with pliers. The contact plate must be removed from the holder for the next step. A small amount of Araldite is put on the plate where the diodes are to be fixed and the diodes held hard against the plate with small crocodile clips until the Araldite is set (heating to about 80°C hastens setting). The lead-out wires can then be soldered on. Some sleeving is recommended over the lead-out wires at the soldered connection to reduce the possibility of breakage due to flexing, as the contact plates moves 1 to 2 cm when cells are put in and out. The diodes can then be covered with a layer of Araldite for protection. Note that when the contact plate is returned to the holder, the raised part of the centre must face to the rear as shown in Fig. 5 otherwise thermal contact will be impaired. The lead-out wires are best led through an exit hole drilled in the rear of the holder.

It is a good idea to test the timer circuit before commissioning the charger. This can be done by omitting IC_3 for the time being and connecting C_5 and C_6 to terminal 3 of IC_2. The buffers Tr_3 to Tr_6 should then close a relay every 2 minutes 44 seconds, and the flashing should give 100 flashes every 64 seconds. The circuit should then be rearranged so that IC_2 is omitted and a jumper lead taken from terminal 10 of IC_2 to terminal 10 of IC_3, which is now in place. Capacitors C_5 and C_6 should be connected to terminal 3 of IC_3, and the RL2 relays should again close every 2 minutes 44 seconds. This assumes two banks of relays, one connected to point A and one to point B. If the timing sequences are not correct, the most probable fault is a damaged i.c.

The internal layout is not critical but the heat-evolving components such as R_b and the transformer should be kept away from the heat-sensitive components.

Printer buffer

by
Mike Catherwood

Mike Catherwood is Systems Engineering Manager for single-chip microcontroller products with Motorola.

Essentially a small microcomputer board with large memory, this printer buffer holds enough text for around twenty A4 pages and has serial and parallel ports. Its hardware was detailed in the May issue — this article discusses software, construction and operation.

Incoming data is stored sequentially in a type of data structure known as a circular queue or more commonly, circular buffer. It uses two address pointers, one for data input, the other for data output. The input address pointer points to the next free space in the buffer and the output pointer points to the last space vacated.

If the buffer overflows, the input pointer is reset to the first entry point and data continues to be accepted until the input pointer is equal to the output pointer, at which time the buffer is deemed full. In other words, all buffer space relinquished by the output pointer after removing data is available for immediate use. The buffer is considered empty when the output pointer plus one equals the input pointer, Fig.1.

Modular software

The software is interrupt driven and consists of six modules

— initialization
— parallel data in
— parallel data out
— serial data in
— serial data out
— d-ram refresh.

During initialization, a vector jump table is set up in scratch-pad ram for interrupt request, IRQ, and software interrupt, SWI, instructions. The jump address inserted depends on the operating mode. Interrupt vectors for IRQ and SWI point to the jump table and can therefore indirectly enter the appropriate handling routine without the need to poll the interrupt sources. A sign-on message is placed into the buffer by the initialization routine primarily to help with debugging, should it be necessary.

Interrupt handling software for parallel data input is entered following a positive edge on the host data-strobe signal, DS. Similarly, the data-output handler is entered following a positive edge on the printer acknowledge signal, ACK.

To get the ball rolling, the first printer data strobe (output) is forced by executing a software interrupt instruction, SWI. This instruction's entry in the vector jump table will have been set to point to the parallel output service routine during initialization. Although the SWI instruction is essentially intended for use by in-circuit emulators, for example in break-point generation, it is an elegant way to force an interrupt. Note that SWI is not maskable.

Further printer data-strobe pulses are generated automatically as the subsequent printer-acknowledge signal causes the data-output handler to be reentered. The next byte to be sent is then written into the p.i.a. and a further data-strobe pulse is generated by the on-board handshake logic.

Similarly, acknowledge pulses to the host are also generated automatically whenever the input p.i.a. port is read.

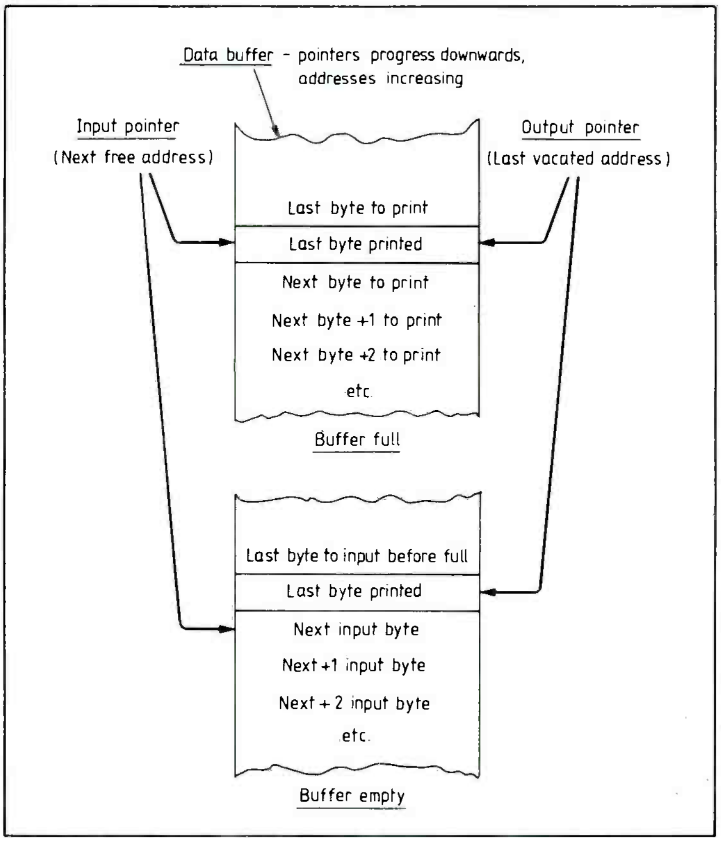
If the buffer becomes full, the BUSY line is asserted and the buffer-full led lights. Acknowledgement for the last character strobed is not sent until space has become available for the data. The BUSY line is cleared before sending this acknowledgement.

Serial data transfer is performed in a similar way to parallel data transfer apart from the handshaking and buffer status differences described in the May issue. Also, the serial-to-serial mode is unique in as much as the absence of a second serial interface precludes concurrent reception and transmission of characters.

Simple code

Much of the buffer software is straightforward, as can be seen from the sample listing. The two address pointers are BUFIN and BUFOUT. After checking that the buffer is not already full, the program reads the p.i.a., which causes an acknowledge strobe, and stores the acquired data. After being incremented, input pointer BUFIN is checked to

Fig. 1. **Circular queue principle, as applied in the printer buffer. All buffer space relinquished by the output pointer after removing data is available for immediate use.**



Specification

Two Centronics parallel ports and one serial
Modes
- **Parallel-to-parallel**
- **Parallel-to-serial**
- **Serial-to-serial**
- **Serial-to-parallel**

Serial RS232 port
- **Transmit/receive using XON/XOFF protocols**
- **300 or 9600 baud**
- **One start, one stop and eight data bits**

Parallel Centronics interfaces
- **Eight-bit parallel**
- **DS/ACK handshaking**
- **Busy and prime lines supported**

64K-byte circular buffer
6803 microprocessor/6821 p.i.a.
Abort and multiple copy functions
Error and busy indicators

ensure that it remains within the circular-buffer address range by calling subroutine LIMIT, as shown in the sample listing.

Buffer status byte FLAG is now tested to check whether or not the buffer was previously empty. If the buffer was previously empty then FLAG is cleared and, provided that the buffer is not operating in serial-to-serial mode, the program forces execution of the printer interface interrupt handler through an SWI instruction. This restarts the DS/ACK handshake after the buffer becomes empty.

Hidden benefits

A large part of the code is common to both serial and parallel communication. For example you will find that while the buffer is in parallel-to-serial mode, the parallel printer port is also active although the acknowledge handshake signal is disregarded. Consequently, parallel-to-serial and parallel-to-parallel transfers may be performed simultaneously provided that the parallel printer can receive characters at least as fast as the serial port is sending them to its printer.

Also worthy of a mention is the ability to change the baud setting between reception and transmission of serial data in serial-to-serial mode. This allows you to transfer a file to the buffer at 9600 baud, then leave the buffer to send it to the printer at the much slower rate of 300 baud.

Refreshing of the dynamic ram is carried out by software executing a string of no-operation instructions (NOP) every 2ms. This increments the address bus 128 times which ensures that every column is refreshed through a RAS-only refresh at least once in 2ms.

An output-compare feature on the MC6803 processor is used to generate the periodic 2ms interrupt. The on-chip timer is a free-running incrementing counter which has an associated output-compare register. When the content of this compare register is equal to that of the timer, an interrupt can occur and/or a port line state can be altered (P21).

In this system, during execution of each d-ram refresh module, the output-compare register is loaded with the value of the timer plus 2ms. Port P21 is set up to fall when this time elapses, pulling the non-maskable interrupt, NMI, low and causing the d-ram refresh handler to be reentered.

Interrupt priority of the normal output-compare function was considered too low for the d-ram refresh module. Using port P21 to activate NMI effectively moved this interrupt priority to the highest position, apart from RESET. Software execution overhead is about 12% for this technique, but that is of no real consequence in this application.

Components and construction

None of the components is critical, but note that the external-clock version of the processor, the MC6803E, is not suitable for this design. A regulated 5V supply capable of delivering 1A is needed; typical current requirement is around 450mA.

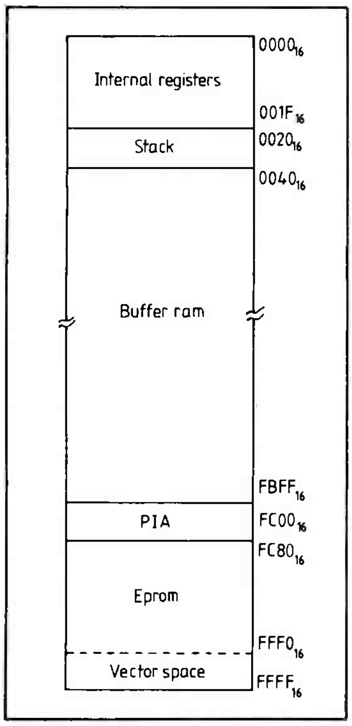
Although construction is straightforward, using a p.c.b. is recommended. High-quality i.c. sockets should be used for the processor, p.i.a., and ideally the d-ram. These few components should be inserted last. To avoid damage to the more expensive components in the kit, and wasting a lot of time tracing faults resulting from the damage, it is advisable to perform continuity, oscillator and supply-rail tests before inserting the processor, p.i.a. or memory devices. Note that on the p.c.b. the 2716 is the other way round in relation to the 6803 and 6821.

Should you decide not to use a p.c.b., remember to keep the 4MHz clock circuit compact and close to the processor. Be generous with supply decoupling, especially around the d-rams.

Finally, be concious that you are handling mos devices, so at least earth yourself and don't wear a Nylon shirt! To help with any debugging, a sign-on message is sent to the printer immediately after a reset, but not following abort/repeat operations.

There are four operating modes on the printer buffer, determined by the state of Mode 0 and Mode 1 switches $S_{3,4}$ immediately after power-up. These switches, shown on the circuit in the May issue, act as follows.

S_4	S_3	Operation
0	0	Serial-to-serial
0	1	Serial-to-parallel
1	0	Parallel-to-serial
1	1	Parallel-to-parallel



Memory map of the printer buffer, which will be of use if the hardware is to be used in other applications as a microcomputer board with serial and parallel i/o.

```
A                     ******************************************************************
A                     *
A                     *        IRQ1   -   PIA  INTERRUPT  HANDLER IRQA (HOST INTERFACE)
A                     *                   ENTERED DUE TO DATA STROBE +VE EDGE
A                     *
A                     *        ******   EMPTYTST - ENTRY POINT FROM SCIIN
A
A FE5B DE2A           IRQ1     LDX      BUFIN
A FE5D 9C26                    CPX      BUFOUT               CHECK IF FULL
A FE5F 260D                    BNE      NOTFUL
A
A FE61 9602                    LDAA     PORT1                SET BUFFER FULL LED + BUSY LINE
A FE63 8A10                    ORAA     £BFULL1
A FE65 9702                    STAA     PORT1
A FE67 862E                    LDAA     £%00101110           DISABLE IRQA
A FE69 B7FC01                  STAA     CONA
A FE6C 2015                    BRA      QUIT
A
A FE6E B6FC00         NOTFUL   LDAA     REGA                 GET DATA,GENERATE ACK -VE EDGE,CLEAR IRQA
A FE71 A700                    STAA     ,X                   STORE
A FE73 8D83                    BSR      LIMIT                CHECK POINTER
A FE75 DF2A                    STX      BUFIN                & STORE CORRECTED VALUE
A
A FE77 962E           EMPTYTST LDAA     FLAG                 IF PRINTER WAITING FOR NEXT DATA
A FE79 2708                    BEQ      QUIT                 TO BE SENT,
A FE7B 7F002E                  CLR      FLAG                 THEN CLEAR EMPTY FLAG (BIT7=0)
A FE7E 962F                    LDAA     MODE                 ENSURE NO SWI FOR S-S OPERATION TO PREVENT 1ST
A FE80 2701                    BEQ      QUIT                 CHAR SENT BEING TX IMMEDIATELY.
A
A FE82 3F                      SWI                           INITIATE A WRITE FOR ALL OTHER (DUAL PORT) MODES.
A
A FE83 3B             QUIT     RTI
A
```

Important section of the printer buffer software in assembly language.

Select the mode, connect the necessary cables and power up. The sign-on message should be printed. If not, refer to the Fault-finding section described later. Note that the mode switches are only read once, just after power up.

The abort/repeat key allows you to terminate printing of the current file or reprint the content of the buffer from the first address to the current output pointer, excluding the sign-on message. Momentary operation of the abort key terminates printing of the buffer content, however, for serial printers and printers without a PRIME line, any buffer inside the printer will have to empty before printing can cease.

Multiple copies

Keeping the abort/repeat key pressed for more than a second or so causes printing to abort, provided that it is not already completed, and resets the BUFIN pointer to the start of the user data. The error led lights to indicate this. Subsequent releasing of the key initiates printing of a further copy after a short delay. This may be performed *ad infinitum*.

Serial-to-serial transfer

For serial-to-serial operation, the following procedure must be followed. Set the Rx/Tx switch, S_1, to Rx, i.e., off. Connect the interface to the host and send the data file. If the file does not fill the buffer, then the XON/XOFF protocol will not need to be implemented in the host.

When the transfer is complete or the buffer-full led is lit, disconnect the host and connect the printer. Change the data rate if necessary and then ensure that the printer is selected and set S_1 to its Tx position. After a short delay, the file will be sent to the printer.

If the buffer-full led was lit, then it will be extinguished when 256 bytes of data have been transmitted. In this case, the rest of the file can be transmitted to the buffer by reconnecting the buffer to the host and changing S_1 back to Rx. Each time that this switch is changed to the Rx state, an XON character is transmitted, to which the host should respond by sending more data.

During the reception of serial data, the error led is used to indicate a communication error, i.e. a framing or overrun error, or a protocol failure. A communication error is for information only and will not inhibit buffer operation. However, the printer output may have some characters missing since data received incorrectly is not stored by the buffer ram.

A protocol failure can occur as follows. If the buffer ram becomes full, i.e. less than 64 bytes left, the buffer-full led lights and an XOFF character is sent to the host. However, if it is ignored and the host continues to send data, the error led is lit. Subsequent data sent to the buffer will be ignored until the buffer status changes to not full.

Fault finding

These hints should be useful if any debugging proves necessary. Using an oscilloscope, recheck the oscillator and switch off immediately if it is not running. You probably have a short-circuit somewhere around the microprocessor. If the clock is running, check that the E clock and AS are functioning properly. For this, refer to Fig. 3 on page 22 of the May issue.

Check that there is 'sensible' activity on the data and address buses. If not, check the mode-select circuit around P20-22, and the RESET line. Try pulling the RESET line low momentarily and examine the printer port for activity. Looking at the various chip-enable signals is also a good guide as to what is happening.

A negative-going pulse of about 34µs width and 2ms period should be present on pins four and nine of the microprocessor. The falling edge of this pulse is used to initiate the d-ram refresh interrupt module. Common causes of problems in designs like this are solder bridges and/or static damage to devices, so careful construction is essential.

Conclusion

This design is a typical example of an application which can benefit from using a microprocessor. Had this buffer been destined for volume production, then the manufacturer would have taken advantage of the internal rom available in the MC6801 to reduce overall cost and physical size with the bonus of increased reliability. Field trials using an eprom version of the processor, the MC68701, may have been performed before committing the code to a mask.

Even though a rom version is not available for the printer buffer, I hope that this project has given an insight into the features and capabilities of a typical single-chip processor, and provided a useful computer peripheral.

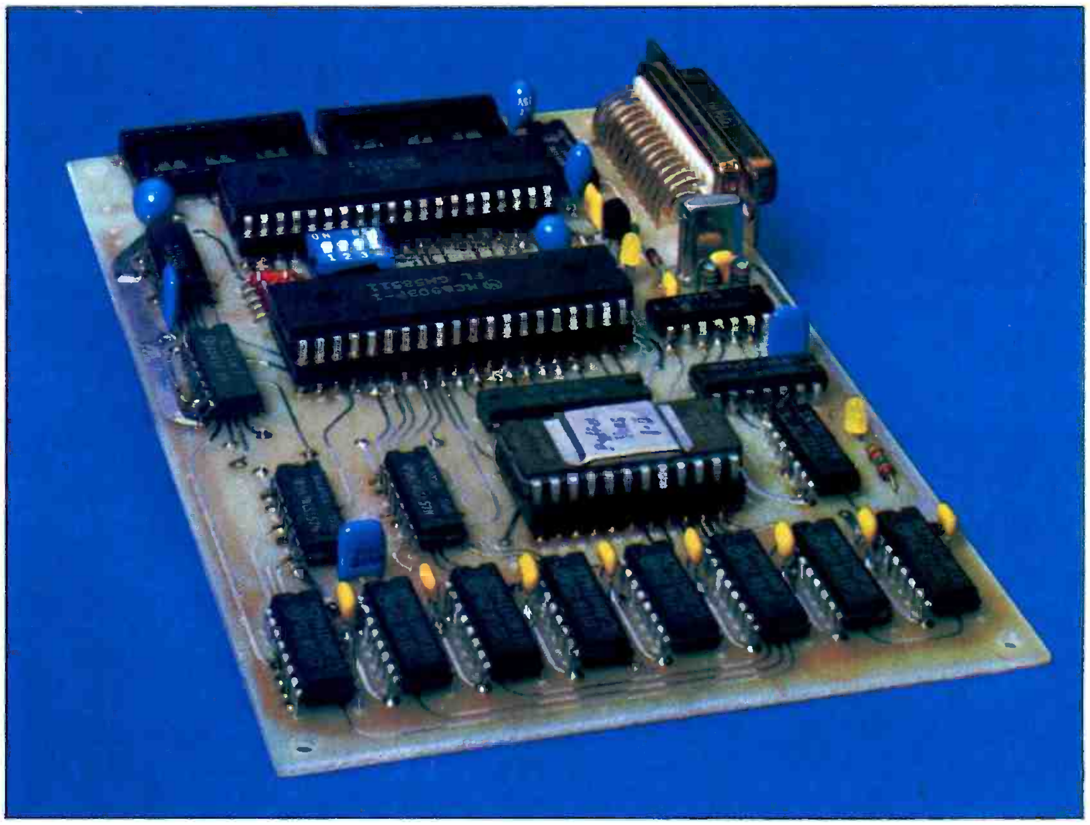
Kit and expandable p.c.b. under £100

Printer buffer kits, excluding p.c.b. and case but including D connector and programmed eprom are £70.74 each (postage and packing £1.50), excluding v.a.t., from Technomatic Ltd., 17 Burnley Road, London NW10 1ED.

Silk-screened plated-through p.c.bs for the buffer are £14 each including vat and UK postage or overseas postage from Combe Martin Electronics, King Street, Combe Martin, North Devon EX34 0AD. These Eurocard size boards include holes for tapping essential processor lines so that the hardware design may be used in other applications. Hexadecimal listings of the software can be obtained by sending an A4 sized s.a.e. to our editorial offices at Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS. If you require the assembly-language list, please include a cheque or postal order for £2 to cover part of the copying cost.

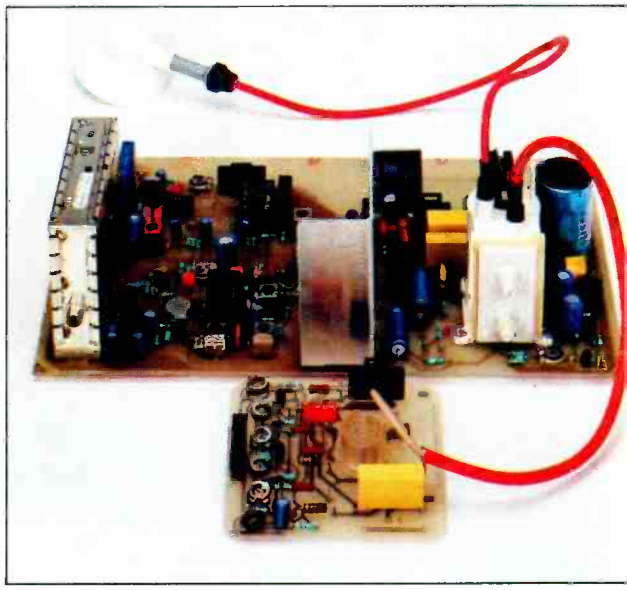
The eprom shown in the May issue printer-buffer circuit diagram is 250ns or faster.

The complete printer buffer, shown here, can be built for under £100.



Developments in tv components

High-performance i.cs and new circuit techniques promise better performance and extra features. Richard Lambley reports on a big range of new devices from Mullard.



Complete economy tv chassis.

Shed a tear for the glass delay-line: soon it may be as obsolete in colour tv sets as the top-cap pentode.

Almost two decades have passed since the start of regular colour broadcasts in Britain and in that time colour receiver design has changed radically. First came the all-solid-state chassis, then the integrated circuit and the pre-aligned picture tube with built-in deflection coils. Now one of the last familiar landmarks of the early sets is likely to disappear with the introduction by Mullard of a delay-line on a chip.

The conventional ultrasonic delay-line is the bulkiest component in present-day colour decoders and one of the most expensive. At one time it was considered so difficult to mass-produce that it almost prevented the Pal system from being adopted.

Mullard's replacement for it, now being prepared in sample quantities at Southampton, is an analogue charge-coupled delay-line in an 18-pin d.i.l. package. The TDA8450 incorporates all the delay lines and filters for a Pal colour decoder. With the addition of some integrated gyrator filters it can also improve performance of Secam decoders. It has no a-to-d or d-to-a converters, need not be shielded from interference from clock signals and it consumes little power.

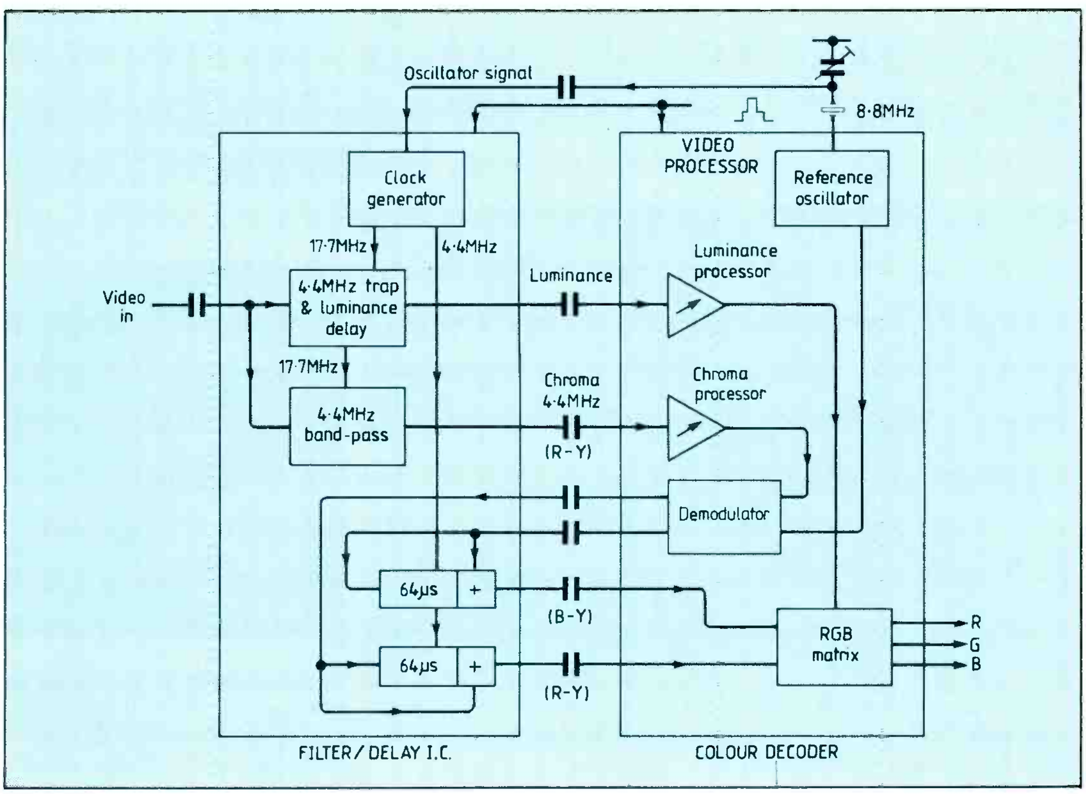
The new chip is one of a series of developments by Mullard aimed at keeping pace with changes in the market for tv sets.

In their view, with the advent of new video sources such as cable and satellite tv, video players and home computers, the market is demanding an increasing diversity of tv receivers. Although the demand for basic low-cost sets is certain to continue, today's top-of-the-market receiver chassis may soon give way to a 'features tv' — an expandable system built around a basic display unit to which the designer can add extras such as multi-standard colour decoding, synthesized tuning, video memory, high-performance sound and teletext, or interfaces for peripheral devices such as microcomputers and modems.

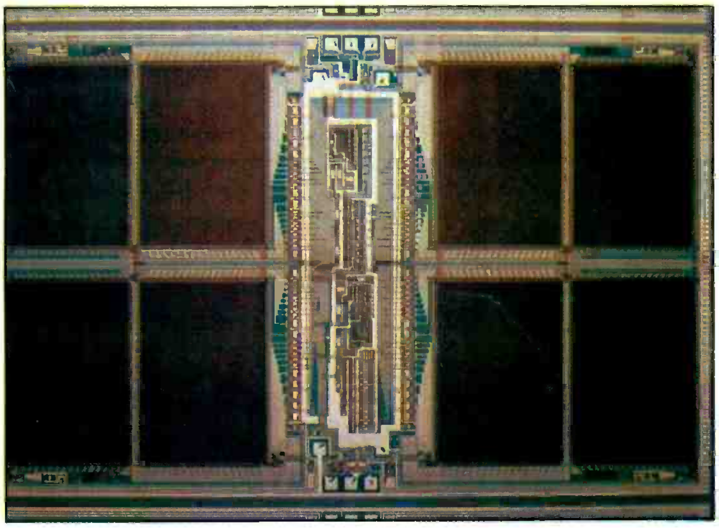
Besides providing the improved performance now demanded by set-makers (and by some of their customers) Mullard's new i.cs are intended to help hold manufacturing costs down; and not just through being shrunk on to ever-smaller pieces of silicon.

A typical modern colour tv has about 30 internal controls needing adjustment on the production line. The horizontal and vertical timebases, the vision i.f. and sound modules, the colour decoder and the picture geometry all take time to set up — and can account for up to a fifth of the total manufacturing time.

Many of these costly adjustments can be eliminated simply by integration on a larger scale.



A Pal decoder with integrated filters and analogue delay-lines. The delay-lines handle colour-difference information as baseband signals and not as 4.43MHz chrominance sidebands.



Digital c.c.d. memory i.c., 320K by 1 bit, for Mullard's 'features tv'. The eight 40K sections run at one-eighth of the input data rate; multiplexing and demultiplexing elements can be seen in the middle. A bank of seven such chips makes up a complete field memory (see diagrams opposite).

Others Mullard plan to deal with by basing the design of future sets on computer techniques.

Some headway has already been made in this direction by the introduction of digital tuning, which at little cost to the manufacturer has given the set buyer better pictures and improved reliability plus the possibility of remote control.

But with the new i.c. designs it will be possible to cut the number of adjustments to just seven. (This figure is for a receiver fitted with a stereo/dual sound option for the German market: for a British set the total will be lower still.)

In addition, the use of computer techniques brings the possibility of automatic alignment and quality monitoring — without recourse to devices such as automatic screwdrivers.

Automatic alignment

Automation in tv factories has so far been confined mainly to the automatic assembly of components on the p.c.b. Mullard propose to take it a stage further through the concept of a computer-controlled tv.

The idea behind this is an internal communications link within the set — the inter-i.c. bus or I^2C. This data bus acts as the set's spinal cord, linking the various analogue processing blocks and carrying control signals and data from one to another.

The bus saves some p.c.b. space by reducing the number of interconnections and the amount of wiring. But it does much more: it makes it possible to digitize most preset adjustments, transforming them into data values to be inserted on the production line

The Philips I^2C bus

The inter-i.c. bus (I^2C bus) is one of two bus structures designed by Philips to meet the growing need to interconnect electronic equipment.

In the hierarchy of computer networks I^2C is about as local as local can be. Intended for exchanging control signals and data between different integrated circuits within the same box, it has a bidirectional serial data format and a two-wire structure.

Maximum possible length of the bus depends on the drive capability of bus devices, which is about 400pF: in practice this means a limit of 4m. A bus can support more than one master device (a master is a device which can initiate a data transfer) and its protocols settle any contention between masters which start simultaneously.

Each unit on the bus has an open-drain or open-collector output to both the clock wire (SCL) and the data wire (SDA). A pull-up resistor connects each wire to the positive supply voltage, creating a wired-and arrangement. When a device pulls the line low it will override any 'high' outputs from the others. All devices have input buffers connected to their outputs and so can read the status of the bus. Signal levels are t.t.l. and cmos compatible.

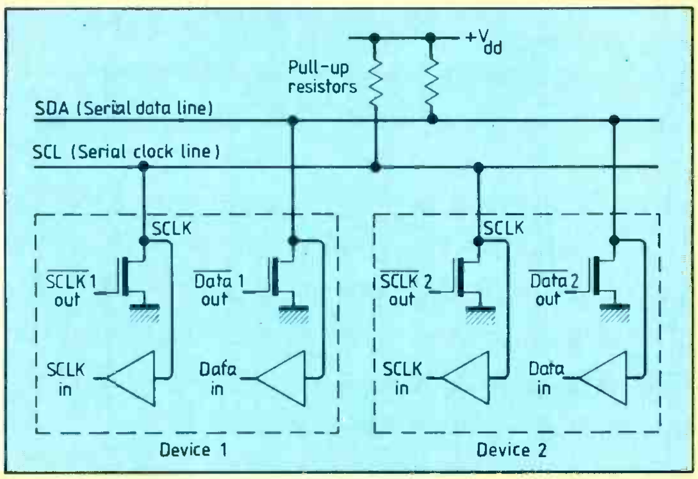
There is no fixed data rate, but speeds of up to 100kbit/s are possible. Data is sent in 8-bit bytes, each one answered by an acknowledgement from the receiving device, which pulls down the data wire during the ninth bit period.

Peripheral devices available for the bus include ram, non-volatile ram, l.c.d. drivers, a-to-d and I^2C-to-parallel converters as well as many dedicated tv i.cs. To drive the bus, Mullard offer two families of microcontrollers with serial i/o.

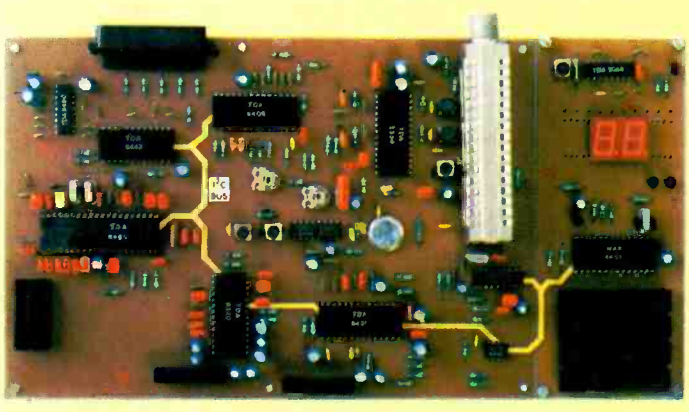
Philips' other bus structure, the digital data bus (or D^2B) is for linking physically separate items of equipment — home entertainment units for example. Thus a user might be able to command a video recorder, a tv and an audio system through a single remote control unit.

In contrast to the I^2C, where the designer must decide in advance what devices will be connected to the bus, the D^2B allows the set-up to be altered freely. It can handle up to 50 units spread over a distance of 150m.

The D^2 bus is essentially a single-wire system, but it is implemented in the form of a balanced pair to overcome possible noise problems on long wiring runs. Maximum data transfer rate is 8000 characters per second.



Open drain configuration of inter-i.c. bus circuits. The bus has a bidirectional two-wire structure; maximum possible length is about 4m. Multiple data rates are allowed.



Full-specification tv circuit: the course of the inter-i.c. bus is marked by yellow tape. In place of the familiar glass delay-line is the TDA8450 i.c. (top left), an analogue c.c.d. which embodies all the filters and delay lines needed in a Pal decoder.

and held in non-volatile memory. And it allows automatic analysis and fault testing of individual modules or complete receivers.

Mullard have shown one such set, an experimental one which has fully automatic control of picture geometry and colour balance. The equipment needed to adjust it consists of a microcomputer, a GPIB-compatible signal generator and a grid of light sensors.

The grid is fitted over the screen, and the equipment transmits sequence of video waveforms, making software adjustments to the tv set until the response detected by the sensors is the correct one. The white-point is programmed in by a similar procedure and the corresponding data is stored in the set's internal memory.

This test set-up is relatively low in cost: an important point, since a similar rig with editing software would be needed in the service technician's workshop. Receivers under scrutiny there could be switched into their service mode by a special infra-red command not available from the customer's remote control unit.

Why have Mullard not followed the all-digital trail blazed by ITT with their Digivision sets? "Analogue is very difficult to beat", replies Rob Green of Mullard. He points out that the tv signal arrives from the aerial in analogue form and must be presented as analogue signals to the picture tube and loudspeaker. Any digital processing in between is likely to introduce quality impairments and must be justified by other benefits.

Memory features

One area where digital processing can help is in the introduction of memory-based features. Adding a digital frame store to the basic set can provide the manufacturer with many new selling points.

A simple example might be the set which, at the touch of a button, could freeze the current screen to enable the viewer to copy down an address or a recipe. Another idea might be to offer a split-screen display, for the viewer who cannot decide which football match to watch.

But one most effective use of memory is in improving the apparent quality of sub-standard programme sources. Many home video recorders give noisy pictures; but if the incoming picture is recirculated through a digital field-store and the delayed signal combined with the direct signal in suitable proportions, the picture itself is reinforced while the noise (being random) tends to cancel out. The degree of mixing needs to be controlled dynamically, since with rapidly-changing pictures the result would otherwise be a blur. But an experimental system demonstrated by Mullard using programme material from a video disc showed a very worthwhile improvement in signal-to-noise ratio. It also gave a noticeable reduction in the cross-colour interference caused by poor separation of luminance and chrominance components.

BBC television engineers have used the same principle for some years to enhance their network pictures. But the new delay-line technology will offer the same facility to the home user, at a fraction of the price professionals have been paying.

In the teletext mode, the memory can store up to 250 pages, to which the user has immediate access. Mullard's demonstration system can recall any page within a second.

Teletext enhancements

The UK teletext system (now widely known as World System Teletext) is a hierarchy of five downwards-compatible standards. The present broadcast service is the basic Level 1 version.

The higher levels promise advanced features such as dynamically re-definable character sets, high resolution graphics, transmission of still colour photographs and so on.

But such developments are unlikely to render today's receivers obsolete yet, since they carry a heavy cost in transmission time and require capacity which might be used more effectively by Level 1 pages. Mullard have already announced a Level 3 decoder; nevertheless, they believe that the present Level 1 standard still has plenty of untapped potential.

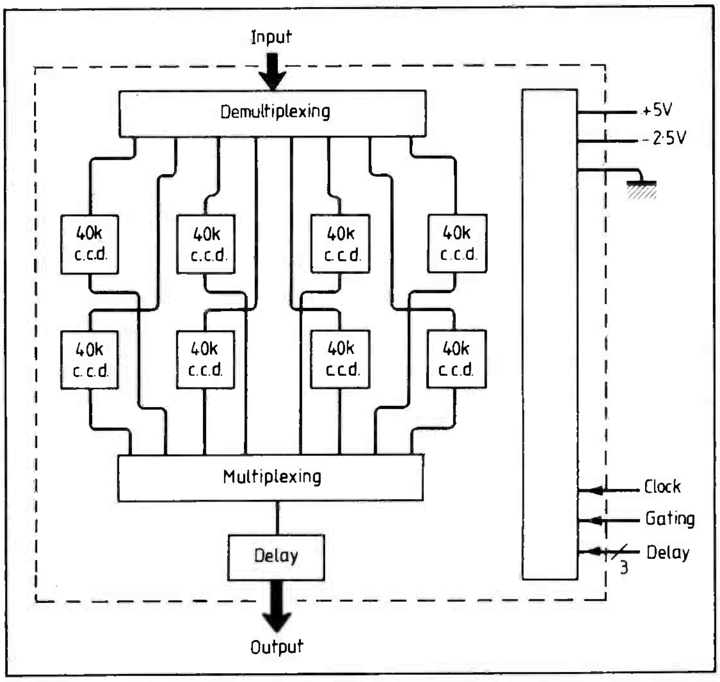
Sales of tv sets in Britain are running at about 2.4 million per year. But despite a steady fall in the price of teletext components — a teletext card adds only £60 or so to the retail price of a set — deliveries of teletext sets amount to only 700 000 per year. And the growth in teletext sales seems to have levelled out.

One explanation for this might be that a sizable proportion of viewing public prefers to avoid information in written form. It is certainly true, though, that many find the broadcast teletext services slow and awkward to use.

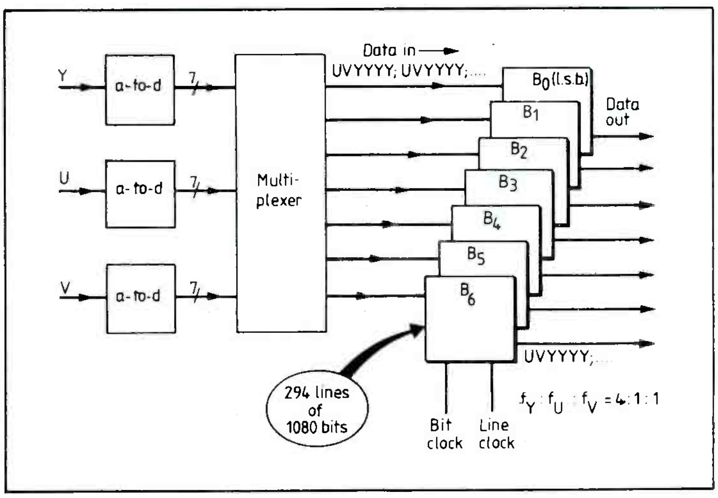
Page access time is the biggest problem: it can take up to 15s for a chosen page to appear and viewers undoubtedly find the delay frustrating. But another difficulty for users is in finding their way about within the teletext magazines: teletext lacks the tree structure of viewdata systems such as Prestel, where each page displays a choice of escape-routes to other pages.

To deal with this omission, Mullard have proposed a simple improvement which they are hoping the broadcasters will want to adopt.

The idea is to add to each teletext page an extra line which would provide such routing information. This line would carry up to four brief labels indicating pages the user might want next:



For the tv set with memory features: this 320K-bit delay-line chip is organized internally as eight parallel charge-coupled delay sections. Each runs at one-eighth of the data input frequency, reducing significantly both clock-rate and power dissipation.



The complete digital field memory consists of seven c.c.d. chips working in parallel. The baseband input signal (in YUV form) is scanned sequentially by a multiplexer: four samples of the luminance (Y) signal emerge for every pair of colour difference (U and V) samples.

'News headlines', 'Weather', 'TV' and 'Sport', for example. Each label would be colour-coded to match a corresponding button on the user's hand-held control unit — which through a single key-press would give immediate access to those pages.

This page-linking feature is made possible by 'ghost rows', spare lines in the existing teletext transmission format. Each line (or packet) of transmitted teletext data carries an address specifying the region of the screen where it is to be displayed — blank rows do not have to be transmitted. Up to 32 different addresses are possible, though the teletext page consists of only 24 lines. So eight spare row-addresses are available for other purposes.

Mullard suggest using packet 25 to carry the new page labels and packet 27 for the numbers of the corresponding pages. Then, when the user calls for, say, page 102, the decoder receives advance warning as that page comes in of pages he is likely to want next. And if the decoder has a multi-page teletext memory, it can grab those pages while the user is still reading page 102 and will have them ready for immediate display when one of the coloured buttons is pressed.

This automatic alignment system cuts out costly factory adjustments. A grid of light sensors over the screen responds to a sequence of test waveforms generated by a microcomputer system. The equipment handles picture-geometry and white-point adjustments and it programmes the appropriate control settings into the tv set's internal microcomputer.

Page linking is one of the features incorporated in the company's Euro-CCT decoder design, which is based on two new special-function chips plus an eight-page memory. Direct page selection in the normal way is still available. But the page number can now include 'don't care' digits, a feature which, among other things, can help overcome the problem of finding an index. For reasons which only the broadcasters understand, the four British teletext services have been unable to harmonize their choice of page for their basic indexes: to the bafflement of many viewers, these appear on pages 100, 200, 100 and 400 respectively. Yet with the new decoder, pressing -00 would find any of them — and the various sub-indexes too.

Other features of the Euro-CCT decoder include a mask-programmed character generator, which can display text in up to three different languages. The correct one is selected automatically by control bits in the page header. This might be attractive to the viewer when reception of foreign services by cable and satellite becomes more common.

Each character in the display is built up on a 12 dots by 10 grid, giving a major improvement in appearance over earlier 5 × 9 types.

Another detail of interest to potential cable subscribers is that the data acquisition period can be controlled in software: the cable operator can select either the normal field flyback period (lines 6 to 22) or the entire field, enabling him to offer high-capacity full-field teletext services.

Control of the decoder is via the inter-i.c. bus (I^2C).

Other features

Improved sync processing: the TDA2579 includes a circuit which measures the noise at the middle of the horizontal sync pulses and so can recognise whether the programme is coming from a tv transmitter or a home video recorder. Domestic v.c.rs have poor speed stability and can give jittery pictures: the new chip copes by altering automatically the time-constant of the horizontal phase detector. The same i.c. provides automatic selection of 50Hz or 60Hz field rate, eliminating the need for manual adjustment.

Better colour: the TDA4560, already fitted to some sets for the West German market, helps to eliminate picture defects at the boundaries between areas of different colour. The i.c. has a delay-line which it switches in and out to increase the slope of colour transients. To compensate for the resulting variations in chrominance delay, it includes a luminance delay-line constructed with gyrator cells.

Improved sound: the familiar intercarrier sound demodulator, which derives the sound from the video detector as an f.m. subcarrier on 5.5MHz or 6MHz, has several shortcomings. Its performance is inevitably compromised by the conflicting requirements of picture and sound; consequently defects such as intercarrier buzz can arise and the audio signal-to-noise ratio has to be sacrificed. An alternative approach, the quasi-split sound system (QSS), offers the promise of real hi-fi performance by providing separate i.f. channels for vision and sound. The intercarrier technique is still used in the sound channel, but the filters can now be optimized for it: abandoning intercarrier altogether, say Mullard, would cause problems in the tuner.

Multi-standard reception: in Europe languages often spread across frontiers even though tv transmission standards do not. And in many countries there is a brisk demand for multi-standard sets. Mullard offer a colour decoder i.c., TDA4555, which automatically selects the standard from Pal, Secam, NTSC-3.58MHz or NTSC-4.43MHz by sequentially scanning the input signal. Another i.c., TDA3568, is an high-performance NTSC decoder which uses comb filtering to separate the chrominance and luminance signals and to suppress the colour subcarrier. The luminance channel has a hi-peaker controlled by an external potentiometer.

In the sound department, Mullard have a three-chip processor which can handle all current European transmission standards, including the German dual-subcarrier stereo sound system. The sound i.f. chip TDA8401 also has a synchronous demodulator for the French a.m. sound standard.

Eprom programmer software for the BBC microcomputer

by Norman Sargent

On its own, John Adams' eprom programmer copies many different types of eprom but with software such as this for the BBC model B microcomputer, eproms can also be written from or read to a disc file with ease. Eprom data on disc can be manipulated in ram, which gives a lot more scope for experimentation.

The SC84 eprom programmer* and a BBC model B microcomputer form a versatile system for reading, writing and experimenting with most current eproms. Interfacing is easy; the programmer connects to the BBC microcomputer through the RS232/423 serial port.

This control software greatly simplifies driving of the eprom programmer by presenting two menus, one to select eprom type and the second to select the required function. These functions include reading from either programmer socket to disc, transferring data between memory and disc, programming from disc or master, erasure verifying and printing. Data check sums are displayed and drive-select and catalogue facilities are menu selectable.

Although the computer only accepts 2764 and 27128 eproms in its sideways rom sockets, the programming system will read, write and commit to file the larger 32 and 64Kbyte eproms accommodated in the programmer design. Microprocessors in the 8080 series with built-in eprom are allowed for and special flags and messages are included for user guidance.

* John Adams' eprom copier/programmer for 2716, 32, 64, 128, 256 and 512 eproms and 8741/42/48/49 single-chip microprocessors was described in the November, December 1984 and February 1985 issues.

Details of the adaptor for programming these microprocessors were given in the second article describing the programmer.

Data read from all eproms up to 16Kbyte can be transferred to memory for inspection and/or editing using memory manipulation routines in utility roms like Disk-Doctor or Toolstar, and re-saved to a disc file for programming when necessary. An MDUMP function is included in the command list to allow running of Toolstar's memory dump routine. This command can be changed to suit your needs.

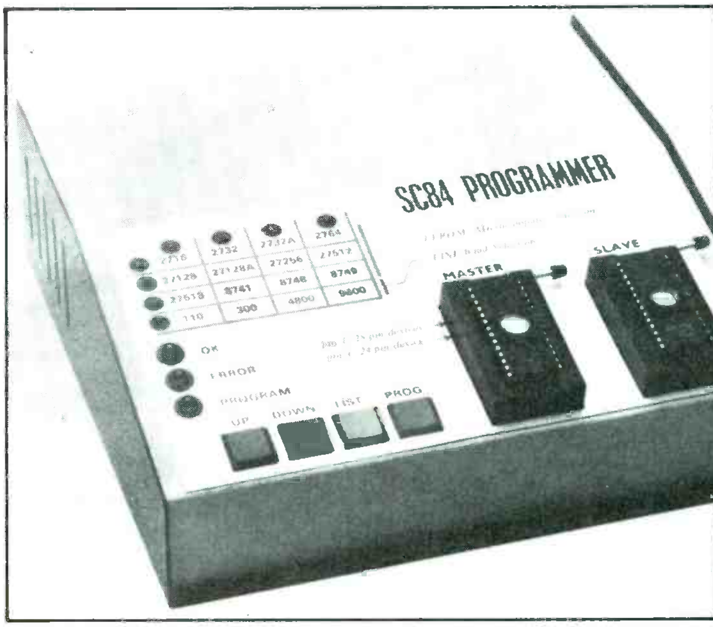
I have based my software on John Adams' original suggestions for computer control on page 51 of the December 1984 issue. Most of the program is written in Basic, with machine code calls to access the RS423 serial port and extract the eight-byte check-sum code sent back from the programmer. Using Basic is no real handicap, since the BBC microcomputer is very fast, and it has the advantage that the program can be easily modified.

Notorious GOTOs are used only inside procedures in conjunction with steering flags, and in the generally accepted ON GOTO used for menu selection, to help keep the coding compact. Character string (CHR$) colour control codes are set as variables for readability and again, to save memory.

Initially, the display prompts you to enter a letter to select an eprom from the 'Eprom list'; this selection remains in force during all subsequent command selections until the eprom list is reentered or the program is terminated. The top two thirds of the second menu display is dedicated to the 'Command list'. A selected command is highlighted during execution. The remaining display area consists of seven lines.

- Elapsed time in minutes and seconds (and adaptor message)
- Message line (including error address on error)
- Master sum check
- Slave sum check
- File name input and counter
- Counter limit
- 'New command' prompt

A typical time for programming a 2764 eprom from a master eprom with a data sumcheck of DCC7B and the programmer in stand-alone mode was 1min 35s. With computer control using an identical disc file, time taken was 2min 8s. As the programming cycle is data dependent, these figures are only a rough guide.



```
10 REM BBC Basic program to drive
20 REM   SC84 eprom programmer
30 REM 19-5-1985 * (C) NRWS G4XWK
40 REM
50 MODE7:HIMEM=&3AFF:CLOSE#0:N%=7
60 DIM code% 110:oscli=&FFF7
70 DIM epsave 20,fnm N%,drv 6
80 A$="ABCDEFGHIJKL":C$="USE WITH 40 pin ADAPTOR IN SLAVE SKT":D$="2":E$="NOT POSSIBLE"
90 PROCdrive_no(-1):sp$=STRING$(34," ")
100 r$=CHR$129:g$=CHR$130:y$=CHR$131
110 b$=CHR$132:c$=CHR$134:w$=CHR$135
120 f$=CHR$136:uf$=CHR$137:bg$=CHR$157
130 B$=y$+"Sumcheck being computed"
140 REM Disable cursor, auto-repeat
150 *FX4,1
160 *FX11,0
170 ON ERROR CLS:VDU7:REPORT:PRINT r$" Any key to continue":IFGET:RUN
180 REM 9600 baud; escape disabled
190 *FX7,7
200 *FX8,7
210 *FX200,1
220 *KEY10 OLD|MRUN|M
230 REM program start
240 VDU28,0,24,39,0:*FX202,32
250 PROCheading(c$+"E&WW EPROM PROGRAMMER")
260 PRINTTAB(14,4)"EPROM LIST"
270 RESTORE 500:FOR I%=65 TO 76:READ Z$,Z%:PRINTTAB(13)y$CHR$I%w$"-"c$Z$:NEXT
280 PRINTTAB(0,24)b$bg$c$"Select EPROM type :";:REPEAT Z$=GET$:UNTIL INSTR(A$,Z$)
290 IF Z$="L" PROCrestore:END
300 M%=0:RESTORE 500:FOR y%=1 TO ASCZ$-64:READ type$,M%:NEXT
310 b%=0:y%=y%-2:IF y%>8 y%=y%+1:IF y%>9 b%=-1
320 PROCmcode:PROCheading(type$)
330 VDU28,0,24,39,2:PRINTTAB(0,0)SPC117TAB(13,1)"COMMAND LIST"
340 RESTORE 510:PROCmenu
350 flag=0:PRINTz$;:PROCchngcol:PRINTTAB(7,z%+2)w$
360 ON z% GOTO240,370,380,390,400,410,420,430,440,450,460,470
370 PROCeprom_comp(2):GOTO330
380 PROCeprom_comp(3):GOTO330
390 PROCmem_disc:GOTO330
400 PROCdisc_mem:GOTO330
410 PROCcomp_slave:GOTO330
420 PROCmaster_slave:GOTO330
430 PROCsumcheck:GOTO330
440 PROClist:GOTO330
450 PROCdrive_no(0):GOTO330
460 PROCcat:GOTO330
470 PROCrestore:PRINTTAB(0,21)b$bg$c$"'ESCAPE' to edit"TAB(0,22)b$bg$c$"'BREAK' to exit";:VDU28,0,21,39,2
480 *MDUMP3B00
490 END
500 DATA2716,2047,2732,4095,2732A,4095,2764,8191,2764A,8191,27128,16383,27128A,16383,27256,32767,27512,65535,8741/8,1023,8742/9,2047,Basic,0
510 DATA Eprom select(and exit),Read master to disc,Read slave  to disc,Save memory to disc,Read disc to memory,Program slave from disc
520 DATA Program slave from master,Sumcheck/erase verify,List to printer from master,Data drive no.,*CAT   ..  ..  .,*MDUMP 3B00
530 :
540 DEF PROCrestore
550 CLS:*FX12
560 *FX4
570 *FX200
580 *DRIVE 0
590 ENDPROC
600 :
610 DEF PROCdrive_no(flag)
620 IF flag=-1 GOTO640
630 VDU28,0,24,39,18:CLS:PRINTTAB(0,2)y$"Data storage drive no (0/1/2/3):";:REPEAT D$=GET$:UNTIL INSTR("0123",D$)
640 $drv="DRIVE"+D$
650 X%=drv MOD256:Y%=drv DIV256:CALLoscli
660 CLS:ENDPROC
670 :
680 DEF PROCchngcol
690 FOR I%=3 TO 14:PRINTTAB(7,I%)CHR$133:NEXT:ENDPROC
700 :
710 DEF PROCheading(z$)
720 CLS:FOR I%=0 TO 1:PRINTr$bg$CHR$141c$SPC(16-LEN(z$)/2)z$:NEXT:ENDPROC
730 :
740 DEF PROCmenu
750 FOR I%=65 TO 76:READ Z$:PRINTTAB(3)y$CHR$I%;w$"-"c$Z$SPC(31-LENZ$):NEXT:PRINTTAB(23,12)"("D$")"
760 PRINTTAB(0,15)CHR$148STRING$(39,","):IF b%<0 PRINTTAB(3,16)C$
770 PRINTTAB(0,22)b$bg$c$"COMMAND:"y$;:REPEAT:z$=GET$
780    UNTIL INSTR(A$,z$):z%=ASCz$-64
790 ENDPROC
800 :
810 DEF PROCeprom_comp(t%)
820 VDU28,0,23,39,18:IF b%<0 AND t%=2:VDU7:PRINTTAB(13,1)r$E$:GOTO890 ELSE PROCskt(t%)
830  PROCinput("W"):IF Z=-1 THEN CLS:ENDPROC
840 VDU23,1,0;0;0;0;:PRINTTAB(20,4)SPC(19)TAB(25,4)w$"Count:"g$TAB(20,5)"(End count):"c$;M%
850 ?f1%=OPENOUT($fnm):PROCsetEP(y%,t%)
860 L%=0:FORI%=0 TOM%:CALLget1:PTR#?f1%=I%:BPUT#?f1%,?&7A:L%=L%+?&7A:PRINT TAB(33,4);I%:NEXT
870 PRINTTAB(23,3)"Sumcheck:"g$;~L%
880 CLOSE#0:VDU23,1,1;0;0;0;
890 PROCprompt:ENDPROC
900 :
910 DEF PROCdisc_mem
920 VDU28,0,24,39,18:PRINTTAB(0,6)b$bg$TAB(3,6)sp$;
930 IF M%>16383 VDU7:PRINT TAB(7,1)r$"NOT ENOUGH MEMORY-16K MAX":GOTO970
940 PROCinput("R"):IF Z=-1 CLS:ENDPROC
950 PROCdiscacs("LOAD ",$fnm,"")
960 PROCmemsmck
970 PROCprompt:ENDPROC
980 :
990 DEF PROCmem_disc
1000 VDU28,0,24,39,18:PRINTTAB(0,6)b$bg$TAB(3,6)sp$:
1010 IF M%>16383 VDU7:PRINTTAB(9,1)r$"WRONG EPROM SELECTED":GOTO 1040
1020 PROCinput("W"):IF Z=-1 CLS:ENDPROC
1030 PROCdiscacs("SAVE ",$fnm,"+"+STR$~(M%+1))
1040 PROCprompt:ENDPROC
1050 :
1060 DEF PROCdiscacs(z1$,z2$,b1$)
1070 $epsave=z1$+z2$+" 3B00"+b1$
1080 X%=epsave MOD256:Y%=epsave DIV256:CALLoscli
1090 ENDPROC
1100 :
1110 DEF PROCskt(a%)
1120 IF a%=2 PRINTTAB(1,1)y$"Insert "type$" into"w$"MASTER"y$"for reading":ENDPROC
1130 IF a%=3 PRINTTAB(2,1)y$"Insert "type$" into"w$"SLAVE"y$"for reading":ENDPROC
1140 IF a%=4 PRINTTAB(7,1)y$"Insert both "type$" eproms":ENDPROC
1150 IF a%=5 PRINTTAB(5,1)y$"Insert blank "type$" into"w$"SLAVE":ENDPROC
1160 :
1170 DEF PROCmaster_slave
1180 flag=-1:VDU28,0,24,39,18:IF b%<0 VDU7:PRINTTAB(13,1)r$E$:PROCprompt:ENDPROC ELSE PROCskt(4)
1190 PRINTTAB(0,6)b$bg$sp$TAB(3,6)y$"P"c$"to program :";:REPEAT:Z=GET:UNTIL Z=80 OR Z=13:IF Z=13 CLS:ENDPROC
1200 PRINTTAB(8,1)y$" PROGRAMMING RUNNING  ";:PROCsetEP(y%,4)
1210 PROCsumcheck:ENDPROC
1220 :
1230 DEF PROCcomp_slave
1240 flag=-1:VDU28,0,23,39,18:PROCskt(5)
1250 PROCinput("R"):IF Z=-1 CLS:ENDPROC
1260 PROCsetEP(y%,5):?f1%=OPENIN($fnm)
1270 VDU23,1,0;0;0;0;:PRINTTAB(25,4)w$"Count:"g$TAB(20,5)"(End count):"c$;M%
1280 FORI%=0TOM%:PTR#?f1%=I%:?&7A=BGET#?f1%:CALLsend1:PRINTTAB(33,4);I%:NEXT
1290 CLOSE#0:PROCtime
1300 VDU23,1,1;0;0;0;:PROCsumcheck
1310 ENDPROC
1320 :
1330 DEF PROCtime
1340 T=TIME DIV100:PRINTTAB(2,0)SPC37TAB(2,0)"Programming time:"y$;T DIV60;"min";T MOD60"sec":ENDPROC
1350 :
1360 DEF PROCsumcheck
1370 VDU28,0,23,39,18
1380 IF flag>=0 PROCsetEP(y%,1):PRINTTAB(7,1)B$;
1390 CALLsmchk:PRINTTAB(1,1)sp$
1400 chk1=?&70*256+?&71:IF chk1>0 chk1=chk1-1
1410 chk2=?&75*(2^16)+?&76*(2^8)+?&77
1420 chk3=?&72*(2^16)+?&73*(2^8)+?&74
1430 IF flag=0 AND chk2<>chk3 VDU7:PRINTTAB(3,1)f$r$"ERROR"uf$y$"- Sumchecks different"
1440 IF flag=-1 AND chk2<>chk3 VDU7:PRINTTAB(0,1)f$r$"ERROR"uf$w$"@ address:"y$"&";~chk1;TAB(30)"(";chk1;")"
1450 IF b%=0 AND flag=0 AND chk2=(M%+1)*255 PRINTTAB(0,1)sp$TAB(13,1)"ERASE VERIFIED":GOTO1490
1460 IF b%<0 AND flag=0 AND chk3=0 PRINTTAB(0,1)sp$TAB(13,1)"ERASE VERIFIED":GOTO1490
1470 PRINTTAB(3,2)"Master sumcheck:"g$"&";~chk2;TAB(27);"(";chk2;")"
1480 PRINTTAB(3,3)"Copy sumcheck  :"g$"&";~chk3;TAB(27);"(";chk3;")"
1490 IF flag=-1 PROCtime
1500 PROCprompt:ENDPROC
1510 :
1520 DEF PROCmemsmck
1530 PRINTTAB(7,1)B$;
1540 L%=0:FORI%=&3B00TOI%+M%:L%=L%+?I%:NEXT:PRINTTAB(20,4)w$"Sumcheck:"g$;~L%TAB(8,1)sp$:ENDPROC
1550 :
1560 DEF PROCprompt
1570 VDU28,0,24,39,18:PRINTTAB(0,6)b$bg$sp$TAB(3,6)y$"N"c$"for new command :";:REPEAT UNTIL GET=78
1580 CLS:ENDPROC
1590 :
1600 DEF PROClist
1610 VDU28,0,24,39,18,2,32,32,32,3:IF ADVAL(-4)<63:VDU7:PRINTTAB(8,2)f$r$"Put printer ON LINE"
1620 IFb%<0PROCskt(3) ELSE PROCskt(2)
1630 PRINTTAB(0,6)b$bg$sp$TAB(4,6)y$"P"c$"to print "y$"'BRK'"c$"to exit :";:REPEAT Z=GET:UNTIL Z=80 OR Z=69 OR Z=13:IF Z=13 GOTO1650
1640 IF Z=80 THENVDU2,21:PROCsetEP(y%,0):REPEAT CALLget1:VDU?&7A:UNTIL?&7A=0:VDU6,3
1650 CLS:ENDPROC
1660 :
1670 DEF PROCinput(rw$)
1680 Z=0:PRINTTAB(2,4)"Filename:"g$STRING$(N%,"*")
1690 VDU28,12,22,13+N%,22:INPUTTAB(12,4)Z$
1700 IF LENZ$>N% VDU28,0,24,39,18:GOTO1680
1710 VDU28,0,24,39,18
1720 IF LENZ$<1 Z=-1:ENDPROC
1730 PRINTTAB(11,4)SPC8TAB(11,4)c$Z$;
1740 $fnm=Z$:?f1%=OPENUP($fnm)
1750 IF rw$="W" AND ?f1%>0 VDU7:PRINTTAB(21,4)r$"OK to overwrite?";:REPEAT Z=GET:UNTIL Z=89 OR Z=78:VDUZ:IF Z=78 Z=-1
1760 IF rw$="R" AND ?f1%=0 VDU7:PRINTTAB(22,4)r$"Not on file";:PROCprompt:Z=-1
1770 CLOSE#0:ENDPROC
1780 :
1790 DEF PROCsetEP(y%,v%)
1800 Y%=166:CALLsend
1810 Y%=y%:CALLsend
1820 Y%=v%:CALLsend
1830 REM Clear buffers
1840 *FX15,0
1850 TIME=0:ENDPROC
1860 :
1870 DEF PROCcat
1880 CLS:*INFO *.*
1890 PROCprompt:ENDPROC
1900 :
1910 DEF PROCmcode
1920 osbyte=&FFF4:f1%=&79
1930 memloc%=&70:counter%=&78
1940 FOR S=0 TO 2 STEP 2:P%=code%
1950 [OPT S
1960        \ Sends control codes to EP
1970 .send LDA #&97  \ Write to RS423
1980 LDX #9          \ port transmit
1990 JSR osbyte      \ register.
2000 RTS
2010                 \
2020 .smchk LDA #8   \ Gets 8-byte sum
2030 STA counter%    \ sum check and
2040 .get            \ stores in page
2050 LDA #2          \ zero at &70-&77.
2060 LDX #1
2070 JSR osbyte      \ Enable RS423,
2080 .loop1 LDA #&91\ then
2090 LDX #1          \ loop until
2100 JSR osbyte      \ Y contains byte
2110 BCS loop1       \ from programmer:
2120 LDA counter%
2130 TAX                  \ store
2140 STY memloc%-1,X      \ sum check;
2150 DEC counter%
2160 CPX #1               \ finished?
2170 BNE get
2180 LDA #2
2190 LDX #2          \ Disable RS423.
```

Duplicated disc file names are reported to prevent accidental overwriting, and the program asks whether or not you want to overwrite the existing file. Displayed information and cross checking using information from the programmer led and error/end-of-command bleeps should result in problem-free eprom programming.

Connection of the serial lead is discussed in Richard Lambley's article on page 46 of the December 1984 issue of *E&WW* describing the multi-standard modem. Note that it is possible to enter the 5 pin DIN plug into the BBC computer incorrectly; the keyway slot in the metal skirt must face downwards.

Because of cost and availability, I was unable to confirm programming of 64Kbyte eproms, and single-chip microprocessors, but I cannot foresee any problems. I may write additional code for loading segments of 32 and 64Kbyte eproms into memory if demand is forthcoming. Code for committing Basic programs to eprom and sideways ram could also be considered.

This software for driving the SC84 eprom programmer is written in BBC Basic with embedded machine code. Data passes between intelligent programmer and computer through an RS232 serial link. If you send a disc and a £1.50 copying charge to Norman Sargent at 171 Monega Road, Forest Gate, London E7 8EP, he will copy this software for you.

```
2200 JSR osbyte
2210 RTS
2220                  \ Gets byte from
2230 .get1 LDA #2     \ programmer and
2240 LDX #1           \ stores in &7A.
2250 JSR osbyte       \ Enable serial,
2260 .loop2 LDA #&91\ loop until Y
2270 LDX #1           \ contains byte
2280 JSR osbyte       \ from programmer.
2290 BCS loop2
2300 STY &7A
2310 LDA #2
2320 LDX #2           \ Disable RS423.
2330 JSR osbyte
2340 RTS
2350                  \ Sends byte to
2360 .send1 LDA #&96\ programmer.
2370 LDX #8           \ Read serial con-
2380 JSR osbyte       \ trol register,
2390 TYA              \ loop until tx
2400 AND #&A          \ reg. is empty
2410 BEQ send1        \ (bits 1 and 3
2420 CMP #8           \ set).
2430 BEQ send1
2440 LDA &7A          \ Get byte from
2450 TAY              \ &7A and
2460 LDA #&97         \ write it to
2470 LDX #9           \ RS423 transmit
2480 JSR osbyte       \ register.
2490 RTS
2500 ]
2510 NEXT S
2520 ENDPROC
```

Creating diagrams on the BBC microcomputer

Without spending vast amounts of money, it is impossible to display all of a large detailed drawing developed on a microcomputer. In many draughting programs this problem is solved by building up a diagram in segments and stepping between them, but then drawing becomes difficult at the intersections.

The best compromise is to use the computer screen as a window to any area of the drawing, which is what Pineapple Software's Diagram program does, given a BBC model B microcomputer and disc drive*.

Although the drawing is seen as fixed rectangular segments as far as the computer is concerned, the user need not be aware of this while drawing. When the cursor meets the edge of an on-screen drawing segment, the segment moves over a little and the empty edge of the screen is filled immediately, to create the effect of a microfiche viewer. The number of segments used for a drawing may be changed at any time and is limited only by capacity of the disc; an empty 80-track disc holds up to 39 screen segments.

*Diagram accesses the disc catalogue and will not necessarily run with non-Acorn disc interfaces. It has been tried in single density with the Microware interface.

A second problem with computer drawing, that of accurately positioning the cursor to allow neat line joints, is overcome by building up the diagram using predetermined icons. These icons are defined using a special routine which is just as easy to use as the main drawing program. Even line drawing uses these predetermined elements so joints are always perfect.

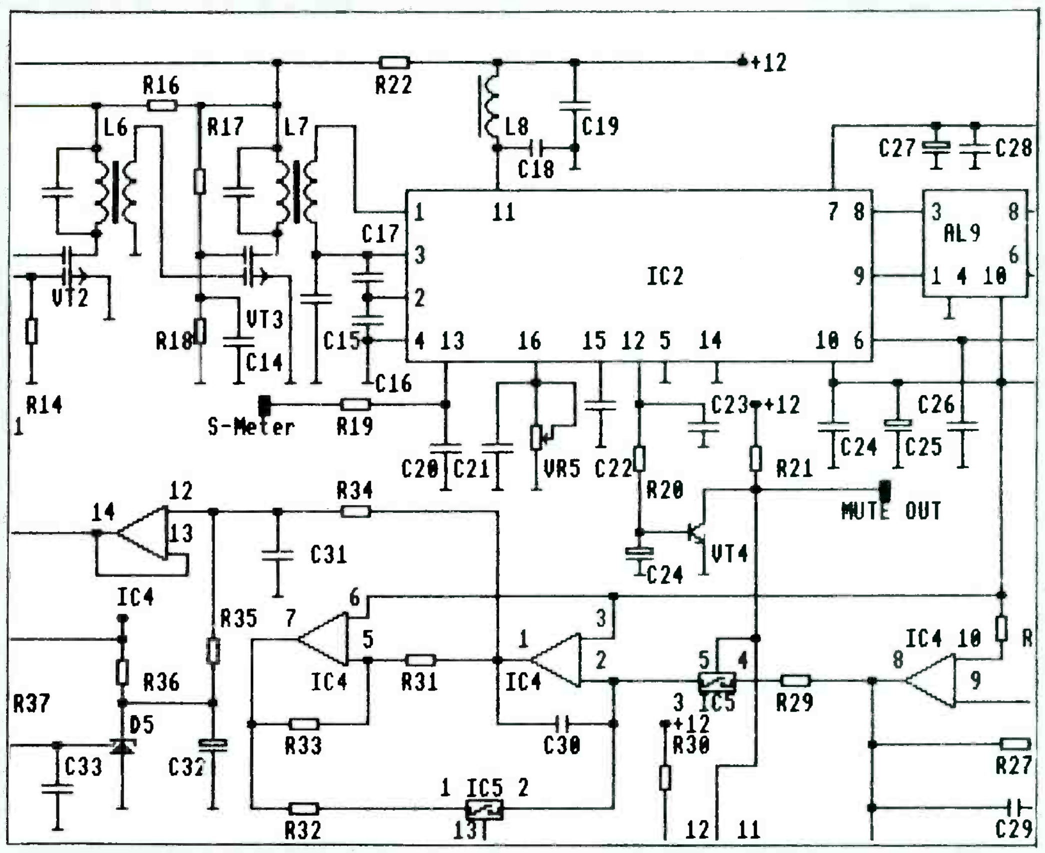
Each icon is built up of between one and twelve 8×8 matrixes, each the size of one character element in 80-column, 30-line mode. Screen resolution is therefore around 640 by 250 pixels (mode zero), but the cursor moves in steps of 1/80 of a screen horizontally or 1/30 vertically, so positioning is easy.

There is room for 128 basic 8×8 icons, excluding text of course, which may be positioned anywhere on the drawing. Text and icons may not be superimposed though. Once an icon is used on the drawing, it may not be redefined without affecting the drawing; all spaces used by the original icon are changed to represent the new icon.

Drawing is further simplified by using tabs and the program has an indexing feature which allows you to mark items which may later be located on screen by simply typing in the index reference. All attributes associated with the diagram are stored on the diagram's disc file, including the current screen background and foreground colours.

Various printing modes are possible and the hard-copy section of the program is written with modification in mind so screen limitations need not be passed on to the printer. One of the two sample drawings is three screens wide by two high and it is still legible when printed in full across an A4 sheet.

The penalty for this ease of drawing is that all fine details must be predefined. To illustrate, the smallest rectangle that can be drawn using line-drawing mode is the size of a character matrix on an 80-column screen. The end product is a reliable piece of software which, with a little practice, actually allows circuit diagrams and schematics to be produced faster than can be drawn by hand, especially if one reuses predefined characters. This cannot be said of all similar products, although some of them are more suited to engineering drawing. The £28.75 package consists of a disc with two sets of programs, one for use in sideways ram and the other for main memory, and documentation. The authors are currently working on plotter-driving routines.



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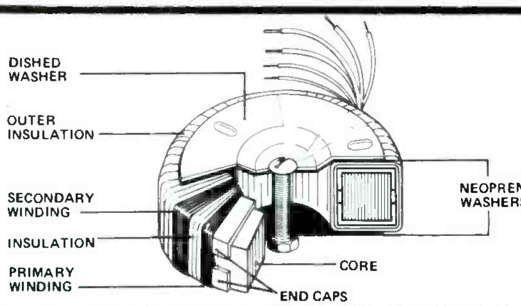

15 VA
62 x 34mm 0.35Kg
Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1 25
0x011	9+9	0.83
0x012	12+12	0.63
0x013	15+15	0 50
0x014	18+18	0 42
0x015	22+22	0.34
0x016	25+25	0 30
0x017	30+30	0 25

(encased in ABS plastic)

30 VA
70 x 30mm 0.45Kg
Regulation 18%

1x010	6+6	2.50
1x011	9+9	1 66
1x012	12+12	1.25
1x013	15+15	1 00
1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
1x017	30+30	0.50

50 VA
80 x 35mm 0.9Kg
Regulation 13%

2x010	6+6	4.16
2x011	9+9	2 77
2x012	12+12	2.08
2x013	15+15	1.66
2x014	18+18	1 38
2x015	22+22	1 13
2x016	25+25	1.00
2x017	30+30	0.83
2x028	110	0 45
2x029	220	0 22
2x030	240	0 20

80 VA
90 x 30mm 1Kg
Regulation 12%

3x010	6+6	6 64
3x011	9+9	4 44
3x012	12+12	3.33
3x013	15+15	2 66
3x014	18+18	2 22
3x015	22+22	1.81
3x016	25+25	1.60
3x017	30+30	1 33
3x028	110	0 72
3x029	220	0 36
3x030	240	0.33

120 VA
90 x 40mm 1.2Kg
Regulation 11%

4x010	6+6	10.00
4x011	9+9	6.66
4x012	12+12	5.00
4x013	15+15	4.00
4x014	18+18	3.33
4x015	22+22	2.72
4x016	25+25	2 40
4x017	30+30	2.00
4x018	35+35	1 71
4x028	110	1 09
4x029	220	0.54
4x030	240	0.50

160 VA
110 x 40mm 1.8Kg
Regulation 8%

5x011	9+9	8.89
5x012	12+12	6.66
5x013	15+15	5.33
5x014	18+18	4 44
5x015	22+22	3.63
5x016	25+25	3 20
5x017	30+30	2.66
5x018	35+35	2.28
5x026	40+40	2 00
5x028	110	1.45
5x029	220	0 72
5x030	240	0.66

225 VA
110 x 45mm 2.2Kg
Regulation 7%

6x012	12+12	9.38
6x013	15+15	7.50
6x014	18+18	6 25
6x015	22+22	5.11
6x016	25+25	4 50
6x017	30+30	3.75
6x018	35+35	3 21
6x026	40+40	2 81
6x025	45+45	2.50
6x033	50+50	2.25
6x028	110	2.04
6x029	220	1.02
6x030	240	0 93

300 VA
110 x 50mm 2.6Kg
Regulation 6%

7x013	15+15	10.00
7x014	18+18	8 33
7x015	22+22	6 82
7x016	25+25	6 00
7x017	30+30	5.00
7x018	35+35	4.28
7x026	40+40	3 75
7x025	45+45	3 33
7x033	50+50	3.00
7x028	110	2 72
7x029	220	1.36
7x030	240	1 25

500 VA
140 x 60mm 4Kg
Regulation 4%

8x016	25+25	10.00
8x017	30+30	8.33
8x018	35+35	7 14
8x026	40+40	6 25
8x025	45+45	5.55
8x033	50+50	5 00
8x042	55+55	4.54
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9x028	110	5.68
9x029	220	2 84
9x030	240	2.60

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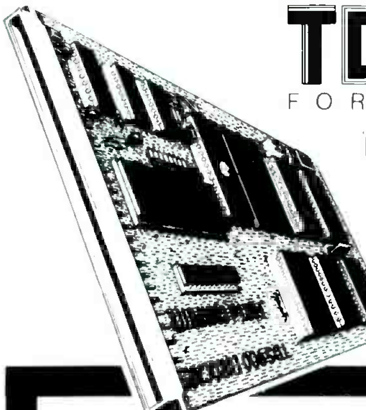

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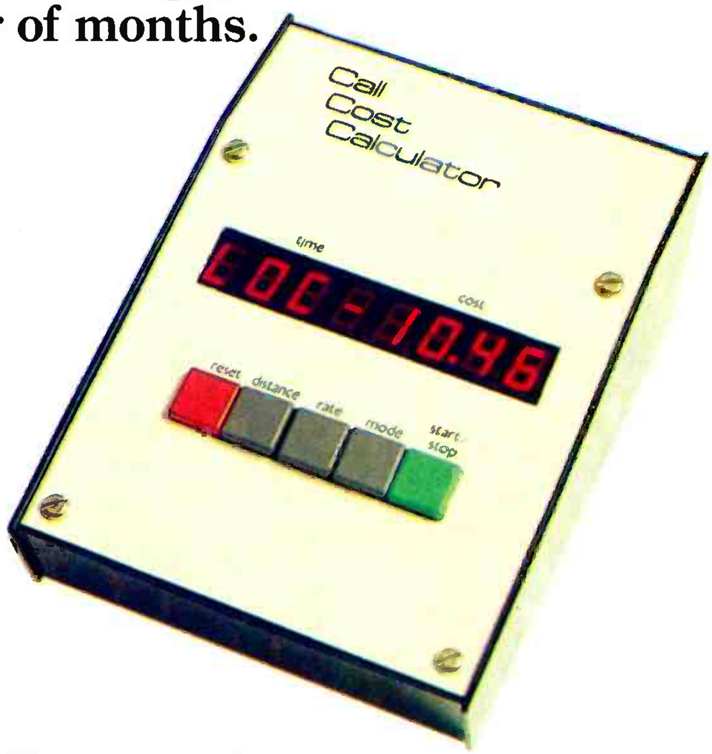
by S.A. Cameron

Stephen Cameron, who is 23, is reading for a B.Sc. in electrical and electronic engineering at Brunel University, Uxbridge. An industry-sponsored student, he has worked for the past four years on broadcast equipment, radio and line development and computing systems.

He qualified as an instructor in Cadet Force signals while at the Duke of York's Royal Military School, Dover. Spare-time interests include music, tennis and writing poetry. He is publicity manager of the Brunel University Industrial Society.

Call cost calculator

Control your telephone bills with this full-feature Z80-based design, which can save its cost in a matter of months.



This call cost calculator is a very effective aid to saving money whilst making private telephone calls. It is suitable for use in any country and can cost any chargeable service on the telephone system. In price (about £70) it compares favourably to the few commercially-made instruments on the market; in performance it far outstrips them.

There are two basic types of instrument for calculating call charges: automatic devices which count charging pulses sent by the exchange at the end of each call unit and manual devices which rely on the user to enter the details of each call correctly.

Automatic devices have the drawback that British Telecom levies an additional rental for sending the charging pulses and makes a connection charge for the instrument itself. So the extra costs may wipe out some of the potential saving. Furthermore, some such instruments do no more than count pulse units and are not even automatic, since they require the user to start the pulse detection facility.

Manual instruments need no BABT approval because they have no connection to the line. However, when call tariffs are changed, reprogramming is necessary. One system on the market uses a 'credit card' which slots into the machine. When charges are revised, a new card is available to the user at extra cost. Others are just specialized stop-watches.

In this design, call charges are stored in a battery-backed cmos memory which the user can re-program without incurring any replacement costs.

The unit will cost not only direct-dialled calls but operator-controlled calls too. It takes account of normal and lower charges and can include the cost of any special services offered by the operator. This facility is unique to this instrument: on automatic machines it is not available since operator-connected calls are charged separately and by-pass the exchange's costing mechanism.

Furthermore, some units neglect certain types of inland calls: those to Ireland and over low-cost routes. This unit provides for these and in addition will cost any international call at any charge rate, whether dialled direct or connected by the operator.

```
Distances:

Local (LOL)
Under 35 miles (U35)
Over 35 miles (O35)
Over 35 miles, low-cost routes (L35)
Channel Islands (L.15)
Irish Republic, Isle of Man, calls to
    cellular radio subscribers (IrE)
International charge band A (CbA)
International charge band B (Cbb)
International charge band C (CbC)
International charge band D (Cbd)
International charge band E (CbE)
International charge band F (CbF)
International charge band G (CbG)
```

```
Rates:

Cheap/economy (CHP)
Standard (Std)
Peak (PEA)
```

```
Modes:

Direct-dialled (dr)
Operator-controlled,
      lower charge (OL)
Operator-controlled,
     normal charge (On)
```

```
Special services:

None selected (nU)
Advice of duration
      and charge (Adu)
Fixed time call (F d)
Credit-card call (CrCd)
Personal call ((PErS)
```

Fig. 1. **A variety of factors can affect the cost of a telephone call and this design takes account of all of them.**

Software

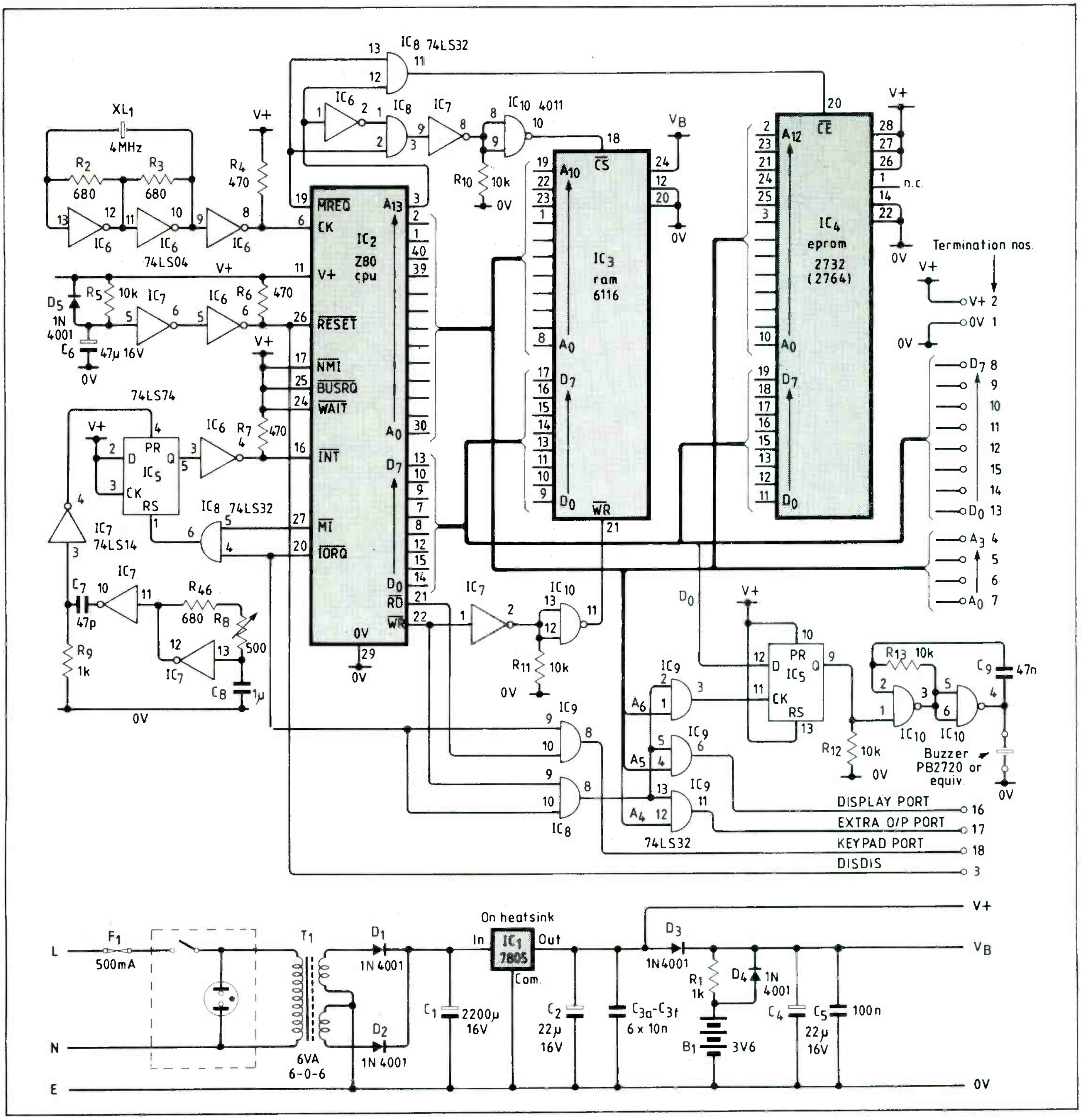
To cost a telephone call, the cost of and duration of each unit must be known.

Charging systems differ from country to country, but one factor is normally fixed while the other varies. For example, British Telecom at present charge a fixed unit cost of 5.41p, but the time bought for that sum ranges from eight minutes to 3.1 seconds. With calls connected by the operator, the unit time is fixed at 60s, while the unit cost varies from 2.33p to 179.4p.

The format I have chosen for storing all this information (Fig.3) is such that the software can handle any country's charging scheme. Twelve bytes are allocated for each call-type combination: three bytes for the unit cost, three bytes for the duration of the initial unit, plus three bytes each for the unit cost and unit time of any subsequent call units.

These numbers are stored in b.c.d. form, which means that the maximum unit cost is 9999.99 pence and the maximum unit time 59 minutes 59.99 seconds. The unit cost is stored in floating-point form for convenience when handling currencies with small base units such as the Italian lira.

Resolution of the software



counters is 10ms, but as British Telecom (like the PTT authorities in other countries) specify their timings down to 50ms, the counters are set to increment in 0.05s steps. The cost can be set to the nearest hundredth of a penny, which is adequate for dealing with awkward v.a.t.-inclusive charges.

Operating system

The system memory map is shown in Fig.2. There is a small fixed text data area carrying mostly the messages for the display; its contents can be altered to suit the user.

Hardware configuration information and indicators used by the system are stored in eprom, from which they are transferred to ram on starting up (if the ram has not previously been battery-backed). The eprom bootstrap loader saves time when the system is first commissioned, but can be disabled to avoid over-writing on subsequent power-ups any changes written into ram.

The operating system includes an interrupt service routine which updates the timers and the display. The top eight bytes of ram form the display interface between the interrupt routine and the main program. When the latter writes to any one of these bytes, the interrupt routine will output that byte to the corresponding position in the display. This method of communicating between two software modules is known as a virtual interface.

For the processor I selected the Z80 because of its compre-

Circuit diagram of the processor board. The design uses easily available, low-cost components throughout. The display board diagram will appear in the next article.

The call cost calculator's five unique facilities:

- it simultaneously displays the elapsed time and cost of a call as it progresses
- it gives warning when a new charge unit is about to begin
- it can display the unit cost, unit time or special service cost during the call
- it keeps a running total of cost and (for dialled calls) call units with full editing facilities
- it holds call tariffs in a battery-backed memory, which can be updated readily by the user

Component sources

A kit of parts including the box but excluding p.c.bs and eprom is obtainable at the special price of £38.25 (add £1 for inland postage; v.a.t. is payable on the total) from T. Powell Electronic Components), 16 Paddington Green, London W2 1LG.

Software in eprom can be supplied by the author at £8.50 including postage. The listing is available separately at £3. The address to write to is 7 Donnington Court, Worthy Road, Winchester, Hampshire SO23 7BJ.

A set of two printed circuit boards, silk-screened and double-sided with plated-through holes is available from Combe Martin Electronics, King Street, Combe Martin, Devon EX34 0AD. The price is £23 inclusive for customers inland or abroad.

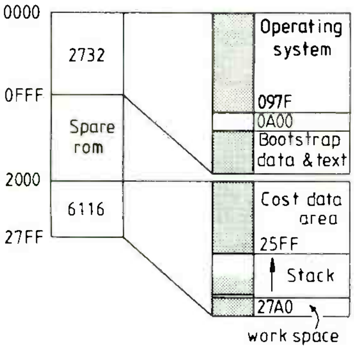


Fig. 2. **Memory map of the system. With different software, the board could be used as a general-purpose i/o controller for applications such as driving central heating systems.**

Fig. 3. **Whatever the combination of charging factors (see Fig. 1) the instrument stores the charging information in twelve bytes using the format shown here.**

1	pounds	unit cost	initial unit
2	pence		
3	hundredths of pence		
4	minutes	unit time	
5	seconds		
6	hundredths of seconds		
7	pounds	unit cost	subsequent units
8	pence		
9	hundredths of pence		
10	minutes	unit time	
11	seconds		
12	hundredths of seconds		

hensive instruction set, its low cost and the wide range of industrial and commercial development aids available for it.

The c.p.u. runs at 4MHz, which is fast enough to service the multi-task interrupt routines which handle the display driver and keypad without adversely affecting the main program. An additional function of the c.p.u. is to emulate a real-time clock derived from software counters and an interrupt generator, the frequency of which is governed by the multiplexing frequency of the display (at least 800Hz) and the time taken to update the software counters.

The interrupt generator, a single Schmitt inverter running at 1KHz, forces timing and display actions from the c.p.u. In timing these intervals, there is no need for high accuracy: any error of less than 0.5% is acceptable. An external interrupt latch is set by a positive-edge discriminator with a pulse width of 50ns, or shorter then the interrupt response tme of the c.p.u. (at least 3.5 T states). On the interrupt acknowledge cycle, when $\overline{M1}$ and $\overline{IORQ}$ are both active, the latch is reset and the interrupt serviced. I have avoided using the edge-triggered interrupt $\overline{NMI}$ since it could not have been disabled while the software down-counters were being refreshed.

A7	A6	A5	A4	A3	A2	A1	A0	
X	0	1	1	X	X	X	X	Write to piezo latch
X	1	0	1	0	D	D	D	Clear display digit DDD
X	1	0	1	1	D	D	D	Write data to display digit DDD
X	1	1	0	X	X	X	X	Write data to extra output port

DDD - Binary no.
X — Dont care

Fig. 4. **Output port address table**

In the memory map of the system, the first 8K of address space is assigned to rom and the remainder to ram. The chip-select inputs of the memory devices are decoded from $\overline{MREQ}$ and A13 to give this 8K block addressing. At the input of the cmos gate which drives the $\overline{CS}$ terminal of the ram, a pull-down resistor ensures that the address and data buses are isolated when mains power is absent. A similar arrangement protects the $\overline{W}$/R pin. The device's $\overline{OE}$ pin is permanently enabled, since its function can be controlled indirectly through the $\overline{CE}$ decoder.

A bit-mapped port decoder using or-gates addresses the instrument's peripheral functions.

The piezo-sounder circuit is made up of two gates and a D-type latch. Writing logic 1 to the latch sounds the buzzer, a logic 0 silences it. This makes full control possible through an interrupt-based software monostable.

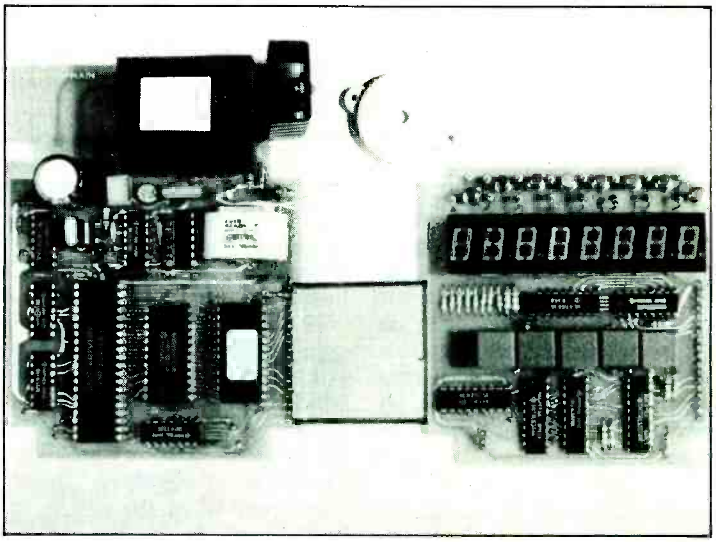
On the display board three octal latches interface the data bus to the outside world. One drives the display with the help of an LS259 addressable latch, which points to the active digit.

The display devices are 0.4 in. common-anode leds with right-hand decimal points. The software can also be made to drive displays with left-hand decimal points; the p.c.b. will accept either type.

Debounce, auto-repeat and multiple key discrimination for the keypad are provided by software. The keypad can be changed to a matrix type by use of the extra output and input port — up to 40 keys can be interpreted. The software can already support this mode and so allows easy expansion or reprogramming of the system. Connection to a serial printer and an auto-dialler would also be possible.

The same hardware could be used to implement a general i/o controller, in a security system or central heating installation for example.

In the next article, Stephen Cameron will describe construction and programming of the instrument.



A short length of ribbon cable links the two boards, which fold together and fit neatly into a standard plastics box.

A.c. mains power controller

by J.L. Linsley Hood

A simple circuit to stabilize the power into a resistive load by means of a triac control element. Intended for use with a photographic enlarger, it can be used for other purposes in which the 'notched' output waveform is no detriment.

The control of the illumination of an enlarger, particularly with reference to the voltage applied to, and the consequent colour temperature of the enlarger lamp bulb, is a matter of some concern to photographers using colour printing papers, especially if the local a.c. mains supply is subject to voltage fluctuations, either short- or medium-term.

This arises particularly between the time at which a test strip is printed, to determine correct filtration and colour balance, and the subsequent printing of an enlargement. Any variation of mains supply voltage between these two events can lead to unwanted errors in the characteristics of the final print.

A.c. mains voltage controllers have been available for many years, and while they can give a reasonably sinusoidal output waveform, when based on a saturable reactor system, the price paid for this is the considerable weight, bulk and cost of the unit.

An alternative approach is to use a triac power controller, whereby the effective output power is regulated by varying the time of switch-on of the triac at the beginning of each half-cycle, as shown in Figs 1 and 2. Such a system is light in weight, does not dissipate much energy as heat, and is entirely satisfactory as a control method for lamp bulbs or heaters where the actual waveform is not particularly important. It does, however, have the snag that the switching waveform of the triac generates a certain amount of electrical interference, so the unit should be electrically screened, and also fitted with output/input 'snubber' networks (R_8/C_5 in Fig.4).

A simplification of the construction of the triac control element is given by the use of one of the proprietary 3-terminal power-control i.cs, of the type shown in Fig. 3, in which the switching phase-angle can be controlled, simply, by a variable resistance between pins 1 and 2 of the i.c.

In the final circuit of the instrument, shown in Fig.4, this variable control resistance was replaced by a photo-conductive cell, PC_1, so that the output of the control amplifier could be isolated from the a.c. power circuit by the use of a led-photocell link.

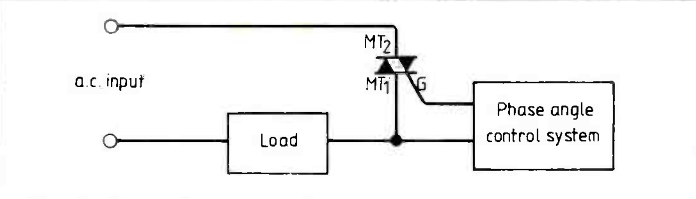


Fig. 1. **Basic triac control system**

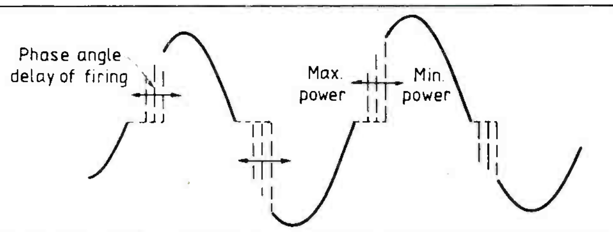
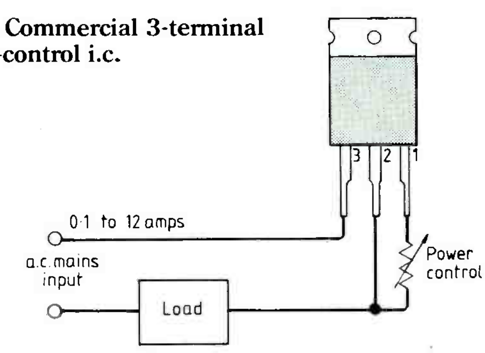


Fig. 2. **Operation of triac controller. 'Notched' waveform can be a disadvantage in some applications.**

Fig. 3. **Commercial 3-terminal power-control i.c.**



The method of regulation is based on the use of a small filament lamp bulb, whose brightness is determined by the effective input voltage/current waveform applied to the primary of the input power transformer, Tr_1, across the secondary of which the bulb is connected. This is useful since it mimics the action of the larger power bulb for which this unit is intended to act as a brightness control, and also because a lamp bulb acts as a reasonably satisfactory and inexpensive 'true r.m.s.' converter.

The input transformer, a 12V/3VA unit, is also used to provide a 15V d.c. supply for an op-amp, IC_2, for which a stable 5V d.c. reference is generated by an i.c. voltage regulator, IC_3.

A supplementary d.c. power supply, having a fast response time (D_3/D_4, C_4), provides a suitable energizing voltage for a voltage divider chain, consisting of the photoconductive cell R_{11}, and the variable resistor R_{10}. This provides an output voltage which can be compared with the very stable voltage reference derived from IC_3, and used, when amplified, to power the light-emitting diode D_5, which, in turn, controls the power regulator i.c.

Because the 'dark' resistance of R_9 must be fairly high in order not to turn on the i.c. when not required, a fairly high sensitivity photoconductive cell was employed (an NSL-382 cadmium-selenide unit). Also, for the servo control loop to be stable, it is essential that the time delay elements within the feedback loop shall have as fast a response as practicable, and this is helped by the choice of cadmium selenide devices for R_9 and R_{11}.

This leaves the lamp bulb, LP_1, as the main slow-response component, but the system is stable, as a second-order control loop, with the component values shown, provided that the reservoir capacitor, C_4, is not made too large.

Because R_{11} is a fairly low-resistance unit, mounted in close

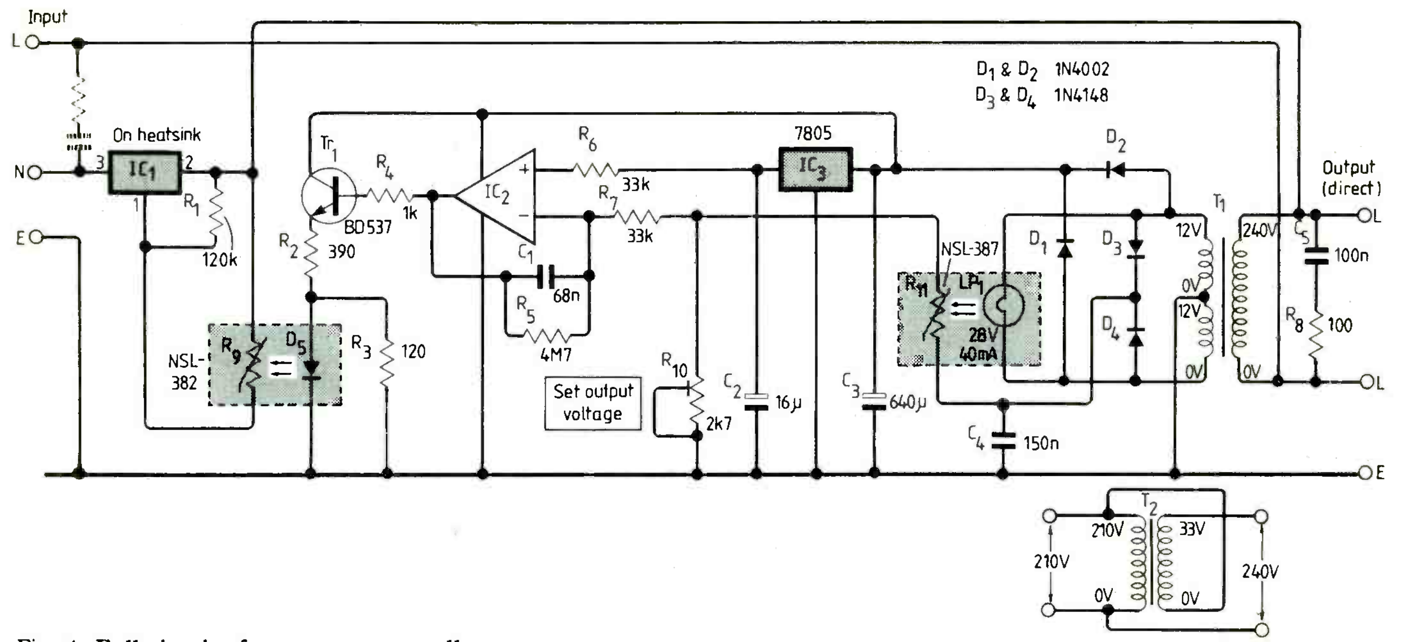
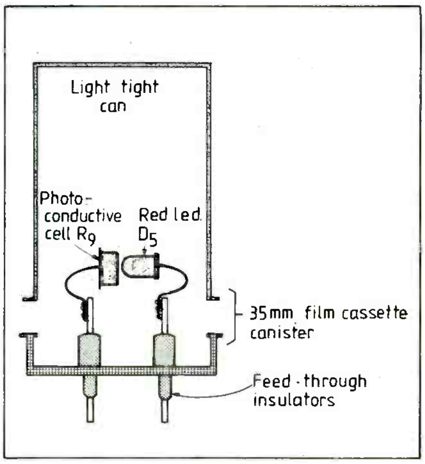


Fig. 4. **Full circuit of a.c. power controller**

Fig. 5. **Housing for led/photocell opto-coupler, made from 35mm cassette container. Conventional led/phototransistor opto-coupler would not be usable here.**



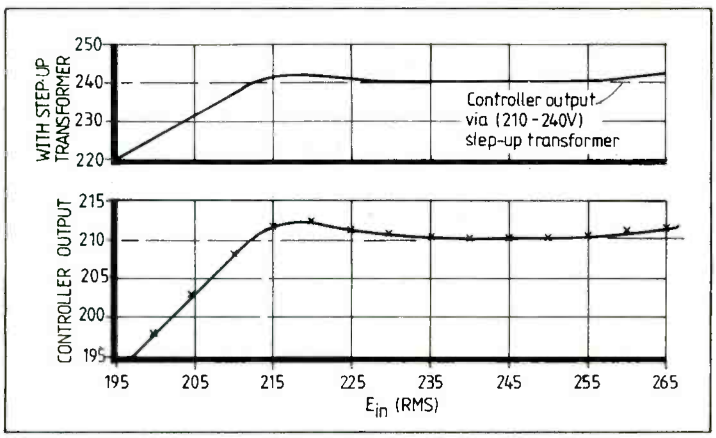


Fig. 6. **Performance of power controller, with output set to 210V at an input of 240V.**

proximity to the lamp bulb, LP_1, the problem of stray light isn't a particularly serious one in this instance, though it is prudent to ensure that there is little ambient light present at this point in that it will affect the output 'control voltage' setting.

However, much greater care is essential in respect of R_9/D_5, and the light-proof housing used for this is shown in Fig.5. After some experimentation with the prototype, the construction adopted was based on a light-tight container used for 35mm film cassettes, into the cap of which four lead-through insulators were fitted. The led and photocell could then be soldered on to the internal pins. The whole unit would then be adequately light-tight when the can was fitted on to the cap.

The preset potentiometer, R_{10}, mounted on the printed circuit board, is used to control the power output of the regulator unit. The actual output voltage setting chosen will depend on the anticipated range of input voltage variation, bearing in mind that there will be a minimum of 10-12 volts drop across the control device for proper operation.

So, if it is thought that the possible input voltage range may lie between 225V and 255V r.m.s., an output setting of, say, 210V would be appropriate.

The performance of the control unit, with the output voltage measured by a true r.m.s. reading a.c. voltmeter, is shown in Fig.6, with a 100V lamp bulb as a load.

Method of operation

A small resistor, R_1, connected across the regulator i.c. control pins, ensures that there is some power transmitted through this i.c. on start-up, and that the amplifier i.c., IC_2, and the voltage regulator i.c., IC_3, are powered. Because the illumination of LP_1 will be low, at switch on, the resistance of R_{11} will be high, and the d.c. voltage present at the inverting input of IC_2 will be lower than that at the non-inverting input, derived from IC_3.

The output of IC_2 will then be, initially, close to the potential of the internal d.c. supply line, and D_5 will be illuminated. This causes the conductivity of R_9 to decrease, which increases the output voltage from the controller, and consequently the voltage applied across LP_1.

This reduces the resistance of R_{11}, which lowers the illumination of R_9, until a stable output voltage is reached, which will depend on the setting of R_{10}.

The unit requires an output load, preferably resistive such as a small power lamp bulb, for correct operation, in that transformer T_1 and its snubber network are not sufficient as a load for IC_1. The output voltage from the control unit can be transformed up, say to 240V r.m.s. equivalent, for use with a nominal 240V lamp bulb, or down to some lower voltage, as the case may be, though some caution should be exercised in rating such transformers, in that the 'notched' waveform will somewhat increase the internal transformer power losses, and this should be taken into account.

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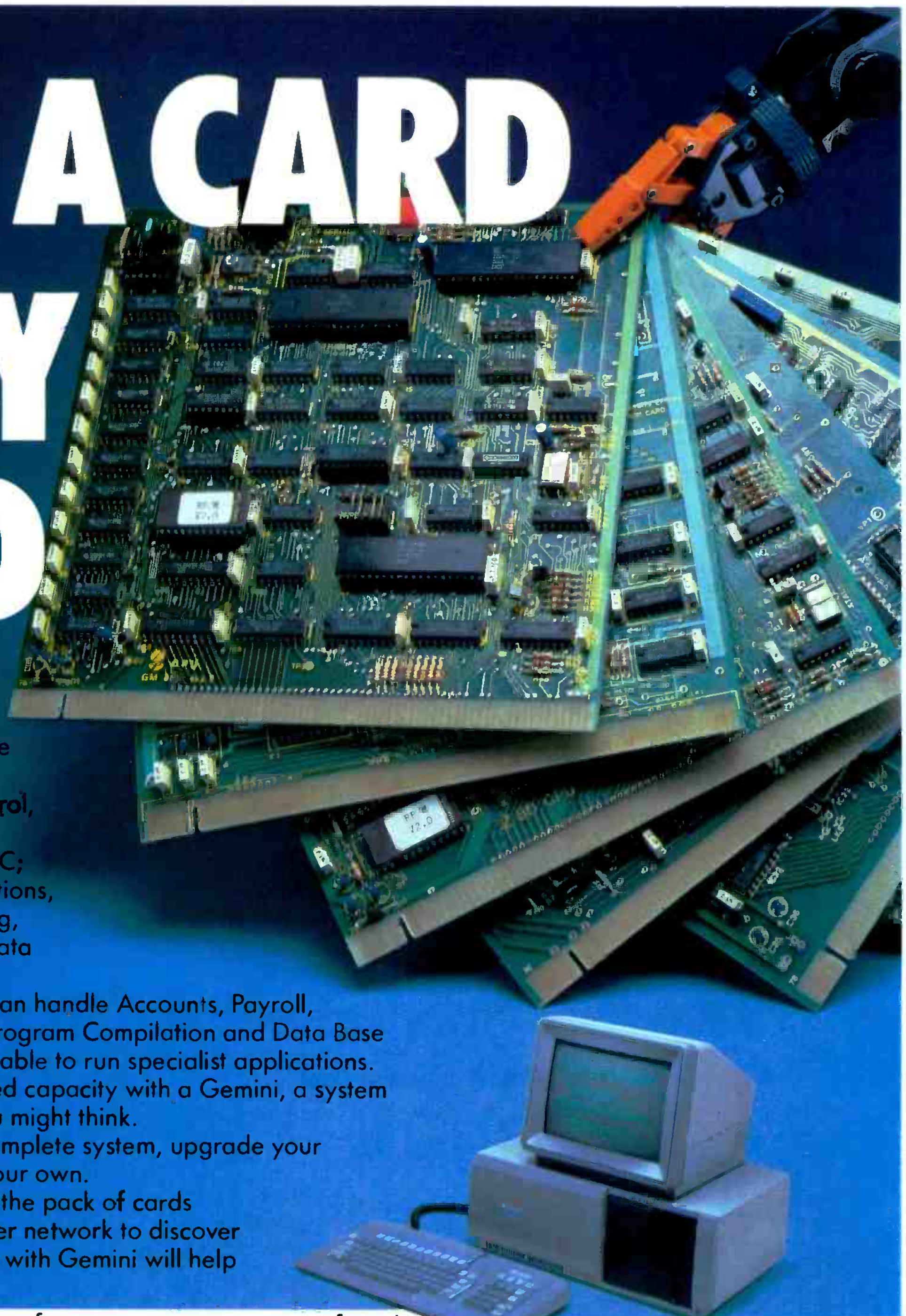

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MULTIBOARD COMPUTERS

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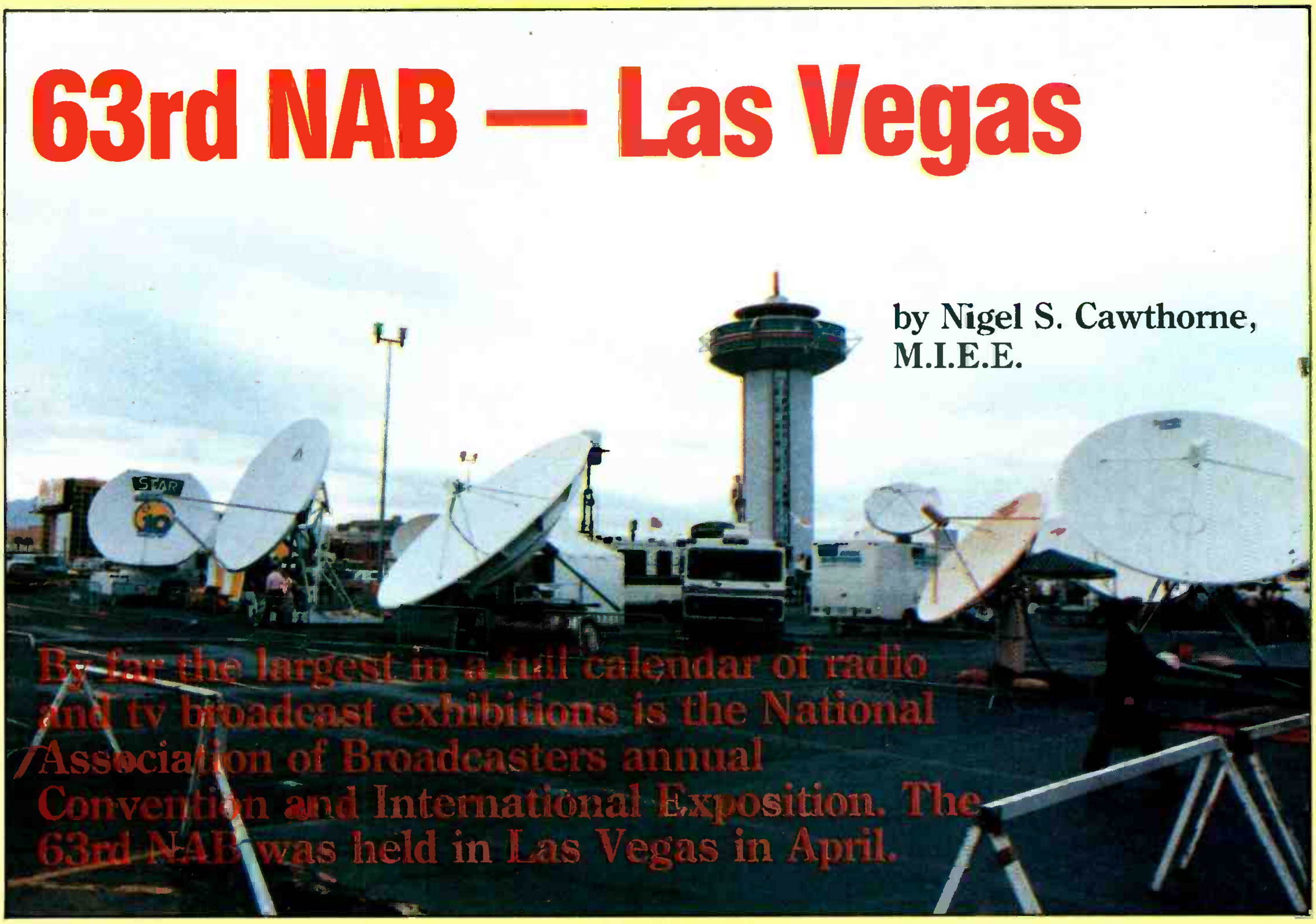
CIRCLE 66 FOR FURTHER DETAILS.

63rd NAB — Las Vegas

by Nigel S. Cawthorne, M.I.E.E.

By far the largest in a full calendar of radio and tv broadcast exhibitions is the National Association of Broadcasters annual Convention and International Exposition. The 63rd NAB was held in Las Vegas in April.



As satellites play an ever more important role in broadcasting, broadcast exhibition is complete without a large outside satellite terminal park. Outside satellite equipment exhibitors sat in temperatures approaching 100°F during this year's NAB in Las Vegas.

North American radio and tv broadcasting is big business. The maximization of advertising revenues and the minimization of operating costs are the major consideration of broadcasting managers in the USA. Ratings are all important. The higher your audience rating the more you can charge for advertising air-time.

Understanding that business profit is the driving force behind broadcasting in the US, makes it easier to follow the development or lack of development of some of the new techniques of broadcasting in the US.

Stereo-sound tv

Stereo-sound tv has been slow to catch on in the US. A US standard for Multichannel Television Sound (MTS) was approved by the FCC in March 1984. Since then only about 25 tv stations across the US are regularly transmitting with stereo sound, although this figure is expected to increase as viewers become more aware of stereo-sound tv.

The US system, which is referred to by the initials of the Broadcast Television Systems Committee (BTSC), provides two additional sound channels as well as the stereo programme channel. A stereo a.m.-d.s.b. suppressed-carrier subchannel is centred on a frequency corresponding to twice the horizontal line frequency ($2f_H$) within the audio baseband. This carries the (L-R) information in a similar way to stereo radio transmissions.

A monaural f.m. channel is centred at $5f_H$ further along the audio baseband. This second audio programme channel (s.a.p.) can be used for bilingual programming. In parts of the US with large second language populations, the s.a.p. facility will be attractive to both programme producers and advertisers. By the use of the second language channel, advertisers will be able to reach audiences that up until now have not taken too much notice of their advertisements, because of language difficulties. The s.a.p. can also be used for transmitting the original sound track of a foreign film, the dubbed sound-track of which is being transmitted on the main audio channel.

The third channel provided within the audio baseband of the US stereo-sound tv system is called the Pro channel. This 3.4kHz wide channel can be used for data or voice: talk-back facilities would be one possible use for this relatively narrow-band communications facility.

The total base-bandwidth required for the multiplexed stereo sound signal in the BTSC system is about 120kHz. One of the main technical topics of discussion among television transmitter engineers at NAB was the question of stereo-sound operation and how existing equipments may have to be modified in order to access this new market. The increased audio bandwidth required imposes constraints on the transmitter driver stages. Also, in transmitter configurations which combine the sound and vision signals at the output of the transmitters before feeding the combined signal into the antenna, some modifications to the combiner may also be necessary.

Typical sound-vision combiners use a single resonator for the "sound notch". Because the multiplexed stereo audio requires more bandwidth at r.f. as well as at baseband, the sound notch has to be widened, by the addition of a further sound-notch filter.

A major part of the technical discussion programme was given over to lectures on how to modify transmitting equipment, both at the low-level signal-processing stages as well as at the output combiner, to handle the demands of stereo-sound tv programming.

Tv stations that are using stereo-sound transmission currently make most use of the facility for their own in-house productions and outside broadcasts. Much of the bought-in material used by tv stations is not recorded in stereo.

Viewers in the US are being encouraged to trade-in their

NAB, the World's largest radio and tv broadcast exhibition, held this year in Las Vegas attracted 40,000 visitors from all sectors of the broadcast industry.

existing tv sets for stereo receivers. The familiar chicken and egg situation arises: tv viewers in the US will not be easily tempted to trade-in their existing perfectly functioning tv receiver for a new one until there is adequate programming available to make it worth their while. On the other hand, the businessmen running broadcast stations will not be too excited about investing in new equipment to convert their stations for stereo sound unless there is a ready audience. However, by next year's NAB, stereo-sound tv in the US is likely to be more common than it is today, only one year after the FCC approved a common standard.

U.h.f. tv under pressure

Whereas in the UK it is now some months since the last of the v.h.f. tv transmitters were finally turned off, liberating in excess of 70MHz of prime spectrum for other users, including predominately land mobile radio, in the US tv broadcast spectrum things are quite different. For US tv broadcasters the v.h.f. bands are still the major programme carriers. Rather than expanding services in the u.h.f. band, US broad-casters are under attack from other users, particularly the land mobile services for more access to u.h.f. channels. US tv broad-casters have already lost access to the highest u.h.f. tv channels of 70 to 83 (807-890). These higher tv channels have been taken over by different types of mobile services, including the US cellular networks, which currently operate in the ranges 825-845MHz and 870-890MHz. Other parts of this spectrum at 800MHz are used for both conventional and trunked land mobile services in the US. There is also a provisional allocation at 821-825MHz and 866-870MHz for a future land mobile satellite service. US broadcasters have lost some u.h.f. tv channels for ever. It doesn't stop there.

U.h.f. tv broadcasters are now facing up to the idea of having to share u.h.f. frequencies with land mobile services on other u.h.f. tv channels. The FCC are proposing that certain u.h.f. tv channels be used by land mobile radio services in the US in cities distant from tv broadcasters using the same channel. The mobile radio industry in the US is a powerful lobby and they have been successful in squeezing broadcasters out of some of their exclusive allocations as well as encroaching on other broadcast channels. During a u.h.f. conference session at NAB, u.h.f. broadcasters were told by FCC Commissioner Rivera that "the land mobile community (in the US) are well organised and they smell blood and are being agressive (in their attack on u.h.f. tv frequencies)". "Broadcasters", concluded Rivera "must make their views known".

The take-over of some u.h.f. broadcast frequencies in the US by land mobile services is the exact opposite of the situation in the UK where the u.h.f. tv channels are still the exclusive reserve of tv broadcasters, but where land mobile services have taken over or will eventually take over most of what until recently were Broadcast tv Bands I and III.

Transistors move to high-power

Two of the last remaining bastions of the thermionic valve are in the front ends of e.m.p. proof receivers and in the back end of high power broadcast transmitters. Everywhere else the ever more powerful and robust transistor is taking over.

The Nautel Ampfet 50kW medium-wave broadcast transmitter being shown at NAB was an example of the transistor's ever continuing advance into the area of high-power transmitters. By using 48 power blocks, each consisting of a solid-state 1.25kW amplifier, this Canadian designed nominally 50kW a.m. transmitter is able to operate with 55kW of output power at 125% positive modulation. Old-time broadcast transmitter engineers, brought up perhaps in the days of bright emitter valves were noticeably shaking at the idea of using about 200 transistors in parallel to produce 50kW of a.m. on the medium wave! How far away now is the solid-state megawatt broadcast transmitter?

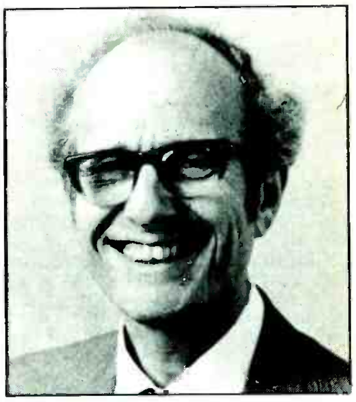
The output stages of high-power u.h.f. television transmitters are unlikely to go solid-state for many years. In the meantime klystron designers and u.h.f. tv transmitter manufacturers continue to strive to increase the d.c.-to-r.f. efficiency of transmitter output stages.

A new record in klystron efficiency was being claimed at NAB by US transmitter manufacturers Comark. Using an "S" series Comark 60kW u.h.f. transmitter fitted with a Marconi B7500 drive, an Amperex YK1265 klystron and a high energy CTM-20 pulser, klystron beam efficiencies in excess of 77% had been measured during tests made at the Columbus Ohio tv station WTTE. Cost-conscious tv transmitter station operators are always striving to reduce their energy costs. Increasing beam efficiency of the klystron amplifier can lead to significant reductions in operating costs. The Chief Engineer of WTTE was being quoted at NAB as saying that if the equipment used for the tests were permanently installed at his station, then he would expect "a 25-33% reduction in the power bill for the transmitter plant."

NAB 1986

Next year's NAB will be held in Dallas. Before then radio and tv broadcasters have both Montreux in Switzerland and Inter-BEE in Tokyo to attend, but for broadcasters on the transmission side of the business, there is only one exhibition and that is NAB!

Sampled-data servos – a new analysis



by D.M. Taub, M.Sc., Ph.D.

June's article explained how to calculate open and closed-loop gains as functions of frequency. This section, presented in two parts, extends the working of part 4 to give the response as a function of time. The first part, below, shows how to calculate the various sampled-data signals in the loop, while the second part, next month, shows how to calculate the continuous signals.

The servo system in Fig. 21 (June) receives a sequence of input samples at U, and produces a sequence of output samples at Y. To compute the relationship between the two, we have to obtain an expression for the closed-loop gain, H_{UY}, as a function of z — the expression will have the same form as the expression for $H_{VX}(z)$ on page 35 of the June issue — and then write down the corresponding recurrence formula to give an expression analogous to the one at the top of the same column. The first step is to develop an expression for $H_{XY}(z)$. This can be multiplied by $H_{VX}(z)$ to give the open-loop gain $H_{VY}(z)$, which is then used in the expression

$$H_{UY}(z) = \frac{H_{VY}(z)}{1 + H_{VY}(z)}$$

This is the same as expression 4.5 except that the gains are expressed as functions of z instead of jω.

Term $H_{XY}(z)$ will be expressed, like $H_{VX}(z)$ in part 4, as the ratio of two polynomials. There is a relationship between this function and $H_{XD}(s)$, the gain through the continuous-signal part of the loop, which gives us a straightforward way of finding the denominator polynomial. H_{XY} is already known in terms of real frequency (June issue, page 35), and so the problem reduces to that of finding a numerator polynomial which, taken in conjunction with this denominator polynomial, gives us the correct form of $H_{XY}(j\omega)$. How this is done is explained on page 60.

Relationship between $H_{XY}(s)$ and $H_{XD}(s)$

Assume a unit impulse applied at X, — Fig. 21. This produces a response d(t) at D, whose Laplace transform represents the gain between X and D in terms of s [ref.5, section 7.2.3]. Thus

$$H_{XD}(s) = \int_0^\infty d(t)\, e^{-st}\, dt \qquad \ldots 5.1$$

The response at Y, y(t), is the result of multiplying d(t) by the sampling waveform (equation 2.3). This gives

$$y(t) = d(t) \sum_{m=-\infty}^{\infty} e^{jm\omega_s t}$$

and taking its Laplace transform,

$$H_{XY}(s) = \int_0^\infty d(t) \left[\sum_{m=-\infty}^{\infty} e^{jm\omega_s t} \right] e^{-st}\, dt$$

The significance of this expression is made clear by expanding it in the following way:

$$H_{XY}(s) = \ldots + \int_0^\infty d(t)\, e^{-j\omega_s t} e^{-st}\, dt + \int_0^\infty d(t)\, e^{-st}\, dt + \int_0^\infty d(t)\, e^{j\omega_s t} e^{-st}\, dt + \ldots$$

$$H_{XY}(s) = \ldots + \int_0^\infty d(t)\, e^{-(s+j\omega_s)t}\, dt + \int_0^\infty d(t)\, e^{-st}\, dt + \int_0^\infty d(t)\, e^{-(s-j\omega_s)t}\, dt + \ldots$$

The middle term in this expression is seen to be $H_{XD}(s)$ from (5.1). The term immediately preceding it represents H_{XD} at $s + j\omega_s$, i.e. when the real part, σ, of s is unchanged but the imaginary part jω is increased to $j(\omega + \omega_s)$. This is written $H_{XD}(s + j\omega_s)$. Similarly, the last term shown represents H_{XD} at $s - j\omega_s$, i.e. $H_{XD}(s - j\omega_s)$. The terms preceding the ones shown represent $H_{XD}(s + j2\omega_s)$, $H_{XD}(s + j3\omega_s)$, and so on, while those following represent $H_{XD}(s - j2\omega_s)$, $H_{XD}(s - j3\omega_s)$ etc. Stated formally,

$$H_{XY}(s) = \sum_{m=-\infty}^{\infty} H_{XD}(s + jm\omega_s)\,. \qquad \ldots 5.2$$

The meaning of this expression is that if we draw a line on the s-plane parallel to the jω axis, Fig. 27, and take an infinite series of points along it, $\ldots P_{-1}$, P_0, P_1, ... pitched $j\omega_s$ apart, the value of H_{XY} at every one of them is the sum of H_{XD} at all of them. This is a generalisation of what was found earlier (June, page 35): the only difference is that there, the real part of s was zero.

Fig. 27. **s-plane diagram illustrating the relationship between H_{XY} and H_{XD} as function of s.**

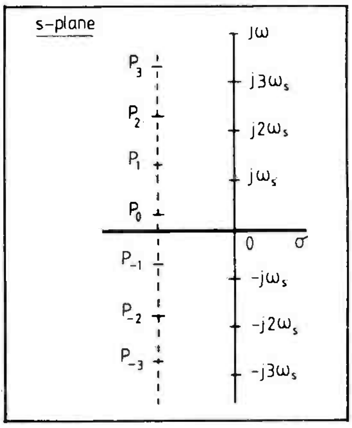


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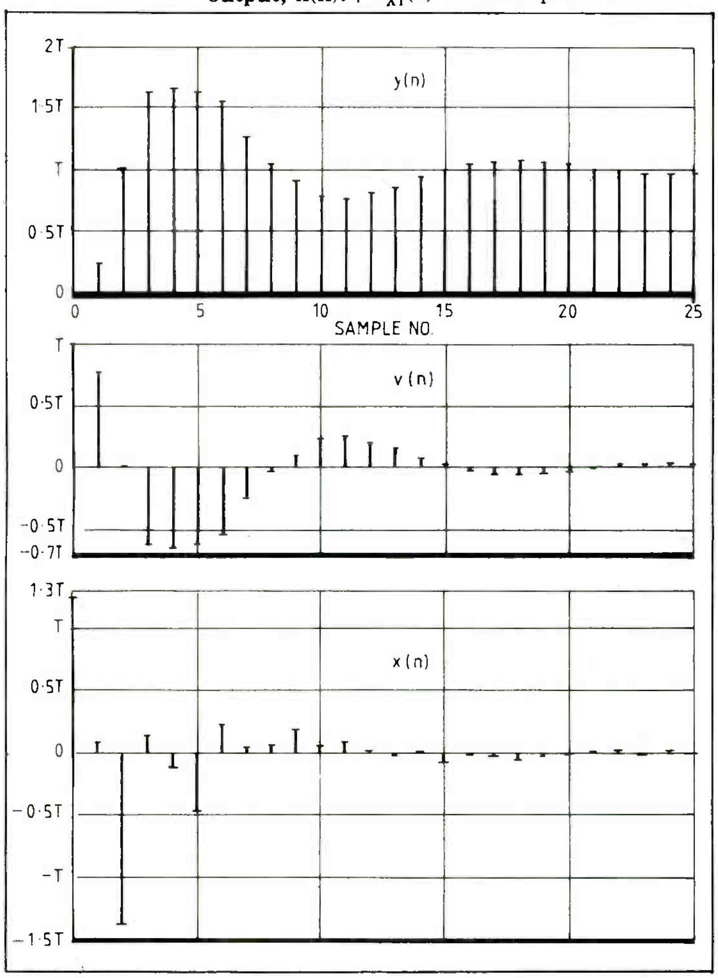
Fig. 28. **Sampled-data signals in response to a step-function input. Top: plant output, y(n), middle: error signal, v(n), bottom: compensator output, x(n).**



Denominator polynomial of $H_{XY}(z)$

The expression for $H_{XD}(s)$ will generally be the ratio of two polynomials in s, analoguously with the $H_{VX}(z)$ expression mentioned earlier, or in terms of their factors, i.e.

$$H_{XD}(s) = K_{XD}\,\frac{(s-\lambda_1)(s-\lambda_2)\ldots}{(s-\mu_1)(s-\mu_2)\ldots}$$

λ_1, λ_2 etc are the roots of the numerator polynomial, ie the values of s at which H_{XD} is zero, and μ_1, μ_2 etc are the roots of the denominator polyomial, the values of s at which H_{XD} becomes infinite. They are known respectively as the zeros and poles of H_{XD}.

Referring to Fig. 27, suppose that one of the points shown, say P_1, represents a pole of H_{XD}, i.e. a point where H_{XD} is infinite. Then from the argument given above, H_{XY} will be infinite at all of them; in other words, all of them will be poles of H_{XY}. This infinite set of poles maps into a single pole in the z-plane through the equation $z = e^{Ts}$.

Thus for each pole of $H_{XD}(s)$ there will be a corresponding pole of $H_{XY}(z)$. If these poles are at ψ_1, $\psi_2 \ldots \psi_m$ the denominator of $H_{XY}(z)$ can be expressed as

$$(z-\psi_1)(z-\psi_2)\ldots(z-\psi_m)$$

and these factors multipled together to give the denominator polynomial

$$z^m + \xi_{m-1}z^{m-1} + \ldots + \xi_1 z + \xi_0 . \qquad \ldots 5.3$$

Generally speaking, the number of poles needed to represent the gain of the plant and any continuous-signal compensation is finite, but the number needed for an exact representation of the time delay and hold-circuit is infinite (see equations 3.1 and 4.1)*. The poles associated with the time delay and hold circuit will be ignored for the moment, and the necessary correction introduced later.

Numerator polynomial of $H_{XY}(z)$

The numerator polynomial of $H_{XY}(z)$ cannot be of higher order than the denominator polynomial, otherwise the function would be unrealisable (see ref.5, section 9.4.2). It could conceivably be lower, but no generality is lost by assuming the order of the two polynomials to be the same. If in fact the numerator polynomial turns out to be of lower order, the computation described in this section will cause the coefficients of the superfluous higher powers of z to be zero. $H_{XY}(z)$ can therefore be expressed as

$$H_{XY}(z) = \frac{\nu_m z^m + \nu_{m-1}z^{m-1} + \ldots + \nu_1 z + \nu_0}{z^m + \xi_{m-1}z^{m-1} + \ldots + \xi_1 z + \xi_0} \qquad \ldots 5.4$$

Writing the denominator in a more compact form, and cross-multiplying,

$$H_{XY}(z)\sum_{k=0}^{m}\xi_k z^k = \nu_m z^m + \nu_{m-1}z^{m-1} + \ldots + \nu_0$$

At real frequencies z reduces to $e^{jT\omega}$ giving

$$H_{XY}(j\omega)\sum_{k=0}^{m}\xi_k e^{jkT\omega} = \nu_m e^{jmT\omega} +$$

$$+ \nu_{m-1}e^{j(m-1)T\omega} + \ldots + \nu_0$$

We already have the means of finding values for ξ_k and $H_{XY}(j\omega)$; therefore we can choose m + 1 values of ω, ω_0 to ω_m, and compute m + 1 corresponding values for the left-hand side of this equation. Calling these values L_0 to L_m, now write the following set of equations:

$$L_0 = e^{jmT\omega_0}\,\nu_m + e^{j(m-1)T\omega_0}\,\nu_{m-1} + \ldots + \nu_0$$

$$L_1 = e^{jmT\omega_1}\,\nu_m + e^{j(m-1)T\omega_1}\,\nu_{m-1} + \ldots + \nu_0$$

$$L_m = e^{jmT\omega_m}\,\nu_m + e^{j(m-1)T\omega_m}\,\nu_{m-1} + \ldots + \nu_0$$

* There is a way of representing the zero-order hold and first-order hold with $\alpha = 1$ exactly (ref. 6, section 3.5), but it adds complication and gives no advantage in practice.

This is a straightforward set of linear simultaneous equations in which ν_0 to ν_m are the unknowns and the exponential terms are the coefficients. They can be solved by any of the standard methods e.g. determinants or matrices. In matrix notation they become

$$\begin{bmatrix} L_0 \\ L_1 \\ \vdots \\ L_m \end{bmatrix} = \begin{bmatrix} e^{jmT\omega_0} & e^{j(m-1)T\omega_0} & \ldots & 1 \\ e^{jmT\omega_1} & e^{j(m-1)T\omega_1} & \ldots & 1 \\ \cdot & \cdot & \cdot & \cdot \\ e^{jmT\omega_m} & e^{j(m-1)T\omega_m} & \ldots & 1 \end{bmatrix} \cdot \begin{bmatrix} \nu_m \\ \nu_{m-1} \\ \vdots \\ \nu_0 \end{bmatrix}$$

or, more compactly,

$$\mathbf{L} = \mathbf{E} \times \nu .$$

The solution is found by inverting the matrix of exponential terms **E** and forming its product with the column vector **L** (see, for example, ref. 7 section 1.11):

$$\nu = \mathbf{E}^{-1} \times \mathbf{L} .$$

Increasing the accuracy

At the end of the denominator polynomial section it was suggested that the poles associated with the time delay and hold circuits should be left out of the calculation for the time being. This means that equation 5.4 will not give H_{XY} exactly, except at the m+1 chosen frequencies. The way to increase the accuracy is to increase the order of the polynomials in (5.4). The procedure is as follows.

(a) The denominator polynomial is found as described, (see heading)
(b) The numerator coefficients ν_0 to ν_m are found as described (see heading).
(c) A pole is added at the origin of the z-plane. This is done by multiplying the denominator polynomial (5.3) by z, so that it is now one order higher than before, viz:

$$z^{m+1} + \xi_{m-1}z^m + \ldots + \xi_0 z .$$

(d) The procedure described above is repeated, giving a new set of coefficients for the numerator polynomial. The new numerator polynomial, also one order higher than before, can be written

$$\nu'_{m+1}z^{m+1} + \nu'_m z^m + \ldots + \nu'_1 z + \nu'_0 .$$

Now if the earlier numerator polynomial had been exact, then coefficients ν'_{m+1}, ν'_m, $\ldots \nu'_1$ will turn out to be exactly equal to ν_m, $\nu_{m-1}, \ldots \nu_0$ respectively, and

v'_0 will be zero. This is equivalent to saying that the effect of adding the extra pole at the z-plane origin has been to add an extra zero in the same position, the two cancelling one another. Therefore, having found the new numerator coefficients, they are compared with the old ones as described above. If the comparison shows the difference to be insignificant, the last pole added, and its cancelling zero, are removed by dividing the numerator and denominator by z, and the procedure is terminated. If not, steps (c) and (d) are repeated.

In the cases studied so far it was found that at most one pole and zero had to be added to give good accuracy.

Sample-time response

Having found H_{XY} in terms of z, we are now in a position to find the sample-time response at various points in the loop, V, X and Y (Fig. 21), for any sequence of input samples at U.

The open-loop gain is

$$H_{VY}(z) = H_{VX}(z) \, . \, H_{XY}(z) \qquad \ldots 5.5$$

and, from the first expression in this article the closed-loop gain is

$$H_{UY}(z) = \frac{H_{VX}(z) \, . \, H_{XY}(z)}{1 + H_{VX}(z) \, . \, H_{XY}(z)}$$

Expressing the right-hand side of this equation in terms of the relevant numerator and denominator polynomials obtained from (5.4)and the expression for $H_{VX}(z)$

$$\frac{\left[\sum_k \beta_k z^k\right]\left[\sum_k \nu_k z^k\right]}{\left[\sum_k \gamma_k z^k\right]\left[\sum_k \xi_k z^k\right] + \left[\sum_k \beta_k z^k\right]\left[\sum_k \nu_k z^k\right]} \qquad \ldots 5.6$$

The gain between U and V, is

$$H_{UV}(z) = \frac{H_{UY}(z)}{H_{VY}(z)} = \frac{1}{1 + H_{VX}(z) \, . \, H_{XY}(z)}$$

and in terms of the polynomials $H_{UV}(z) =$

$$\frac{\left[\sum_k \gamma_k z^k\right]\left[\sum_k \xi_k z^k\right]}{\left[\sum_k \gamma_k z^k\right]\left[\sum_k \xi_k z^k\right] + \left[\sum_k \beta_k z^k\right]\left[\sum_k \nu_k z^k\right]} \qquad \ldots 5.7$$

The gain between U and X is

$$H_{UX}(z) = H_{UV}(z) \, . \, H_{VX}(z)$$

which, in terms of the polynomials, becomes $H_{UX}(z) =$

$$\frac{\left[\sum_k \beta_k z^k\right]\left[\sum_k \xi_k z^k\right]}{\left[\sum_k \gamma_k z^k\right]\left[\sum_k \xi_k z^k\right] + \left[\sum_k \beta_k z^k\right]\left[\sum_k \nu_k z^k\right]} \qquad \ldots 5.8$$

All these expressions for the various gains can be arranged as the ratio of two polynomials, and we take $H_{UY}(z)$ as being typical. Expressed in this way

$$H_{UY}(z) = \frac{Y(z)}{U(z)} = \frac{\zeta_M z^M + \zeta_{M-1} z^{M-1} + \ldots + \zeta_0}{z^M + \eta_{M-1} z^{M-1} + \ldots + \eta_0}$$

and dividing numerator and denominator by z^M,

$$\frac{Y(z)}{U(z)} = \frac{\zeta_M + \zeta_{M-1} z^{-1} + \ldots + \zeta_0 z^{-M}}{1 + \eta_{M-1} z^{-1} + \ldots + \eta_0 z^{-M}}$$

The relationship between the sample values at U and Y is found by writing down the recurrence formula that corresponds to this expression, i.e. by carrying out the reverse of the process used on page 35, June issue. This gives

$$y(n) = \zeta_M v(n) + \zeta_{M-1} v(n-1) + \ldots + \zeta_0 v(n-M)$$
$$-\left[\eta_{M-1} y(n-1) + \ldots + \eta_0 y(n-M)\right].$$

The sample values at V and X can be found in a corresponding manner.

Example

The procedure explained in the preceding sections has been applied to the system used in the example on page 36, June issue. The coefficients of the polynomials in the expressions for $H_{XY}(z)$, $H_{UV}(z)$, $H_{UY}(z)$ and $H_{UX}(z)$ were found to be as follows. They are given in order of decreasing powers of z, the last one being the constant term in each case. Note from equations 5.6, 5.7 and 5.8 that $H_{UY}(z)$, $H_{UV}(z)$ and $H_{UX}(z)$ all have the same denominator.

$H_{XY}(z)$ numerator:
8.479×10^{-7} 0.1836 0.6489 0.7117 0.3565 0.003985
$H_{XY}(z)$ denominator:
1 −0.7656 −0.7079 −0.2875 0.7609 0
$H_{UV}(z)$ numerator:
1 −0.03119 −1.559 −1.555 1.035 1.669 0.3937 −0.5964 −0.3473 −0.008918 0
$H_{UY}(z)$ numerator:
1.067×10^{-6} 0.231 0.822 0.6015 −0.646 −1.12 −0.2673 0.3838 0.2018 0.002257
$H_{UX}(z)$ numerator:
1.258 −0.9319 −2.625 0.891 2.753 0.1069 −1.693 −0.1896 0.431 0
$H_{UV}(z)$, $H_{UY}(z)$ and $H_{UX}(z)$ denominator:
1 0.1998 −0.7372 −0.9533 0.3892 0.5484 0.1265 −0.2126 −0.1456 −0.006661

The sample values at V, X and Y, denoted by v(n), x(n) and y(n) respectively, have been computed for an input at U consisting of a sampled step function in which each of the samples is of weight T; this corresponds to a unit step function input at R (April). The results, plotted in Fig. 28, show that not until sample no.14 does the output settle to within 10% of the input. The programs used for these computations are given in ref 9.

Stability criterion

At the beginning of the sample-time response section an expression was given for the open-loop gain as a function of z, i.e. $H_{VY}(z)$ (equation 5.5). Using this, apply the Nyquist stability criterion to check that the loop is stable.

The procedure is to follow a path in the z-plane that encloses the whole area falling outside the unit circle, steering just clear of any points lying on the unit circle itself. The path to be followed is shown in Fig. 29(a) by ABCDEFGHA. At every point along this path there will be a corresponding value of magnitude and phase for $H_{VY}(z)$; around the unit circle itself these will correspond to $H_{VY}(j\omega)$ (page 36, June). The magnitude is plotted against phase on polar co-ordinates to give the familiar Nyquist diagram (ref, 1, chapter 11). This takes the form of a closed contour, and the criterion for stability is that the net number of clockwise encirclements of the point (−1, 0) must not exceed 0.

A Nyquist plot for the system used in the examples is sketched in Fig. 29(b), points A′, B′ etc representing H_{VY} at A, B etc respectively. The contour traced out is seen to make one clockwise and one anticlockwise encirclement of (−1,0), confirming that the system is stable. The stability margins can be read from the diagram as an alternative to the Bode plot in Fig. 25.

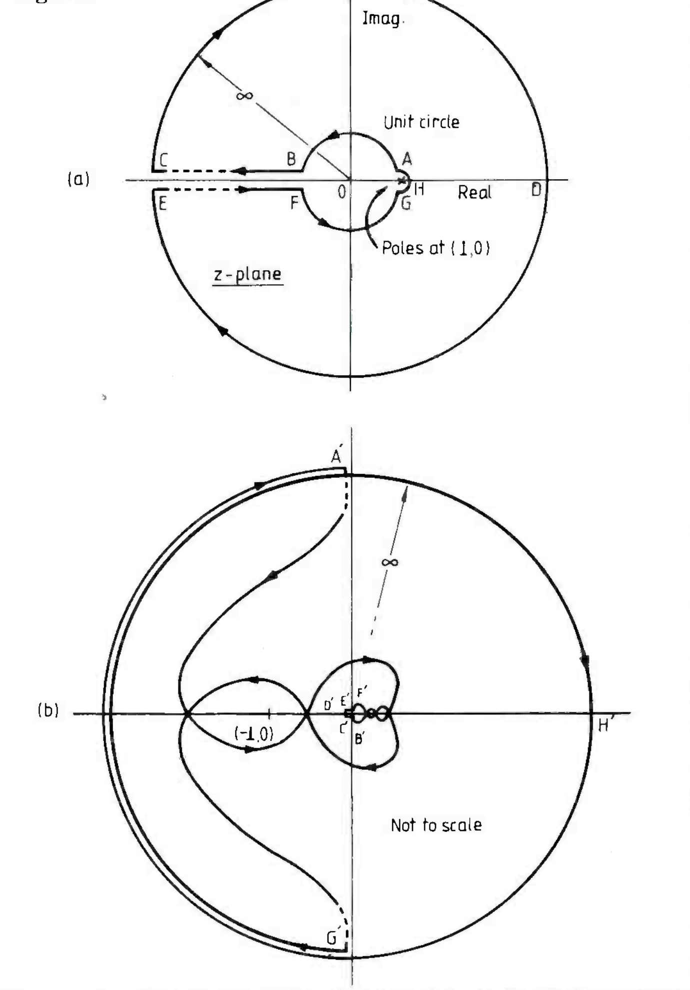
To be continued.

Appendix

Relationship between $H_{XY}(s)$ and $H_{XD}(s)$:

$$H_{XY}(s) = \frac{1}{T}\sum_{m=-\infty}^{\infty} H_{XD}(s + jm\omega_s) \qquad \ldots U\,5.2$$

Fig. 29.



Social electronics for youth

by K.L. Smith, Ph.D.

University of Kent at Canterbury

Ken Smith describes his work with young people. Facilities are there, components need not be expensive — where are the teachers?

In the recent past, *Wireless World* has carried commentary about the social implications of technology and electronics in particular. There is one aspect of this debate upon which I can make a few observations from a fairly wide experience that could very well have a practical outcome.

This aspect is appropriate from the point of view of individuals and 'human-scale' values relating to technology. Such a view would, of course, link with that offered by the late Fritz Schumacher[1]. I realise that underlying these comments is the old question, "Where are we going, what do we want to achieve?" Therefore with a general view across most of technology, but from an unusual starting point, I ask the question: why is "grass roots" technical activity in voluntary youth work at a negligible level? All the evidence I have is that once it was much more likely to be seen, at least within certain social classes. It now seems that hardly any engineers or scientists in Britain take up voluntary 'hands-on' work with girls and boys. The prevailing attitude in technology and engineering is remarkably conservative (with a little c. . .).

But science, especially physics and chemistry, was once radical, as ecology is now. And radical activity is activity for change — especially with youth. Even if engineers as a breed tend to be 'uptight', as we used to say[2], yet there are hardly any scientists either that enter the rural or inner-city Youth Clubs offering science-technology activities. The occasional talk might be given perhaps, or "High-tech" careers may get a mention — even if it shows careers most youth probably *won't* attain in the meagre job situation. . .

Small, but high-status projects occasionally surface and the odd lecturer or research boss sits on a committee 'advising' about the purchase of a dozen micros for some municipal youth centre or another. Or someone may appear on a tv channel talking about what ought to be done. The youth themselves end up becoming labelled as a noisy, disorganized rabble — "Can't you keep those kids out of here, they might damage the computers. . .". Is this the 'sanitary' theory of projects?

There is another tendency, which appears to be the growth of social engineering and systematization of everything. If the work is not professional and does not fit the youth into some kind of peg-in-a-hole trade — or if it does not possess the right image and help induce consumption of the products — and unquestioning conformity, then it is labelled useless. Or worse, it might tend to radicalize the youth, and we don't appear to want that.

Many young people are critical of such things (except certain pyivileged ones) when they discover the manipulation. They (the failures) get enough of that in the schools. Mind you, this ethos of what has been called "closetted oppression" (or in schooling circles, the 'hidden curriculum'), is often discussed, but little is done about it. Its continuance wears down most of the young people in the end and many become docile consumers. Yet we do have, to a considerable extent, a violent State and society, lots of fiddling, unfeeling and anti-social behaviour. The economic system being what it is there is even a lot of vested interest profit in illogical uses — some would say misuses — of resources. There are of course, many other generous actions with a silver lining, but I ask again, where are the engineers contributing this good-will and gift of their time and moral values through their subject?

Considering these observations, we might look at a few things that could be developed concerning the Technological Society, which would involve many of our youth in new activities. But first a few more observations: visits to four youth clubs showed one or two games going on; a blaring disco, a coffee bar, general (unabating) guffawing, yelling, horseplay — bashing and spitting. One had a pottery kiln, some painting, enamelling, etc: excellent. But most had very little practical activity to offer. Whenever I mentioned electronics as a possible activity, a silence fell on the proceedings nearly everywhere.

Where in these clubs is the

photographic lab.
model engineering-metalwork shop
carpentry shop
physics-chemistry lab.
electronics club
radio shack

Even, nowadays

"computer arcade". . . (sic)
astronomy observatory
biology and ecology group
motor mechanics workshop
boat-building yard
building construction going on. . .

etc.

I tried to arouse the interest of one person via a local radio club (with a membership of about 60) to help one evening per week in something for youth from the above list — but there were no takers at all. Is this apathy also a kind of decadence?

I have not exaggerated — there appears to be few youth clubs in Britain with any of the activities I have listed. I believe much more occurs in Japan and, although patchy, in the USA. Thousands of youth in our country at the present time never meet an expert 'skills model' to emul-

Fig.1. **Nicky, aged nine, enjoying the construction of his 555 timer switching project on the benches built by the boys of an earlier generation.**

ate. Young teenagers in my group shock me every time they say, "You are the only person that's ever bothered about us, — we've never had anyone to talk to about all these technical things before." In other words, they've had no mature friend from the technically literate middle class to lead them in projects.

I am not talking about paid, full-time professionals who service a sub-group of young people (the selected few, mainly middle class) as clients, but spontaneous networking which is not socially engineered. The lack of this freedom is rather sad. The point is an important one, as even in voluntary — or what the Youth Service calls part-time — leadership, systematic professional-like training towards some kind of standardized norms and assumptions, are imposed. In some respects we should be critical of this developments[3]).

The Thanet electronics club

Exerting a little effort, this situation can be overcome. With very little in the way of resources, other than a tiny room (with thanks to the Centre Management Committee in Margate), a small subscription and scrap electronic junk, very good results have been achieved.

The development of this electronics group for youth links back to a much earlier pilot project called the Roding Boys' Society, which was set up in Wanstead, Essex, back in the 1960s. A few years ago, Mr Stevens, then Youth and Community Officer for Kent County Council, visited me at the University and I mentioned this early work. He asked me for a short contribution to a group of Youth Leaders at a weekend training course in Broadstairs. One Centre Leader, Tony Kearney, was fired with enthusiasm after hearing the lecture, and invited me to try to form a club in a small store room at the Quarter Deck, Margate. The result has been a successful group for a few years now. This is a pattern that could very well be repeated elsewhere. To this end, you might offer a short talk to a Youth Workers' Conference in your locality.

Many projects, from low-frequency multivibrators and switching circuits, to sensitive short-wave radios, stabilized power supplies and similar devices are continually produced by a flow of young members: each project can be made for a couple of pounds or so. A useful standard assembly system has been evolved with very good educational results indeed. Experiments in play-rehearsing small-business experiences, both via the usual hierarchical "other ownership" capitalist models, and through co-operative methods of production, have been much enjoyed.

Visits to the Model Engineering Exhibition and Science Museum are highlights. I have found it is important to socialize like this — the club must be a social group as well as technical. Going cycling on Youth Hostel tours is also a good experience for the young people and is very educational. The last holiday on which I took them was around the Isle of Wight, which enabled us to visit the excellent Wireless Museum at Arreton Manor.

Recently, a number of members requested and then organized a "study group" for mathematics and physics to "O" Level. The youth are all "non-selective"(!) young people — but enjoyed their maths (differential calculus included!) enormously. One member entered for the GCE "O" Level Electronics exam and his project, a sound and light operated counter/timer, gained 47 marks out of a possible 50.

The group is registered as Volunteers for the Talking Book for the Blind repair scheme. The whole activities programme is regularly exhibited — usually with an "Alternative Technology" special club project — at large local fairs and events (e.g. QUEXPO, Birchington). Of course, all this kind of activity is ideal for the Duke of Edinburgh's Award Scheme.

Springing from this electronics club experience has been the offshoot consisting of a programme of lectures for children at the University of Kent. This work, organized by a local commmittee, is known as the Canterbury Young Technologists scheme. It is much more middle-class in flavour, attracting young people from prep. schools, etc. and professors' children. In this, inspiring and useful work has also been achieved, with great fun for all concerned.

Regarding the Thanet Club work, it is not universally cheered on. There are sometimes a few inhibited reactions from one or two professionals — I wonder why? But I would like publicly to thank many of my colleagues at UKC who have helped with optimistic interest and in little practical ways, who are not like this.

Spreading the work

The work of processing and engineering people into state-determined slots already figures prominently and, in spite of squeals to the contrary, mobilizes enormous private and public wealth. So I am *not* discussing that system, which often seems to claim to be the only valid one when powerful knowledge is involved.

But if you are interested in alternatives, then it is important to see that professionals involved (engineers, scientists, teachers) must act in a *voluntary capacity* and suspend the expectation of normal "fees"-level income recommended by their professional associations. But the essential thing to remember is that the given time is nevertheless worth a considerable, even if unstated, value. This means that a difficult theoretical question arises. Would such contributions amount to self-exploitation by the volunteer who carries such marketable knowledge? Would more entrenched interests take the 'profit', and laugh all the way to the (ideological) bank?

Be that as it may, it remains essential for society to provide the minimum facilities, even in so-called economically difficult times. A room and small capitation grants are important from the statutory bodies and from private sources[4]. The volunteer offering the valuable skills and time cannot even start without these. The apparent difficulty many statutory services experience in providing the basic requirements probably helps to account for the dearth of competent leaders in technical activities working with youth. Technology as an activity *is* sufficiently out of the tradition to end up different in quality than most youth work (certainly true at the present time, but many authors claim Britain never has been pro-technology as a cultural or popular activity — ever), hence the prejudice, as well as the trend for large numbers of people to be "deskilled" by the ethos of the modern State.

Young people who find, for example, *Tomorrow's World* not as interesting as one might expect, say to me that there is nothing they can see relevant to their hobbies and so on. In other words, everything is so professional — and middle-class. I can see their point. But I admit a sizeable problem. Busy engineers and scientists find it nearly impossible to generate anything for television, say, without media-people advice. Unfortunately media people are usually non-technical and have a discouraging "whizz-bang-wow" attitude to material, as well as a lot of status-mindedness. It is a problem, and a response from that quarter is needed.

The youth respect *real* skill and knowledge, but are unimpressed by ego-trippers — those qualified people who wear their status on their sleeve. The young people are incisive, genuine and spontaneous. Their respect for your Ph.D lasts no longer than the time you try to cover up the fact that you can't solder, but claim you can — or show you are a status-bore. (Huh! he's just like a teacher after all); probably the worst epithet you will receive and they will vote with their feet.

But if you get your bottom on a bike seat and take them on a YHA tour, visiting an Engineerium, or wireless station, or technical museum en route, then you *are* a bit of a hero.

The youth require *results* — and fast. They certainly are more demanding than most rather inhibited research students I have known. Because of the direct nature of this kind of work, the peculiar dehumanization ethos that is creeping across a vast area of our social/professional life, is, perhaps somewhat offset. And the lie is put to the belief that technology and its implementation is the path to human happiness. It certainly isn't to many, but democratizing it certainly can be; to us at least.

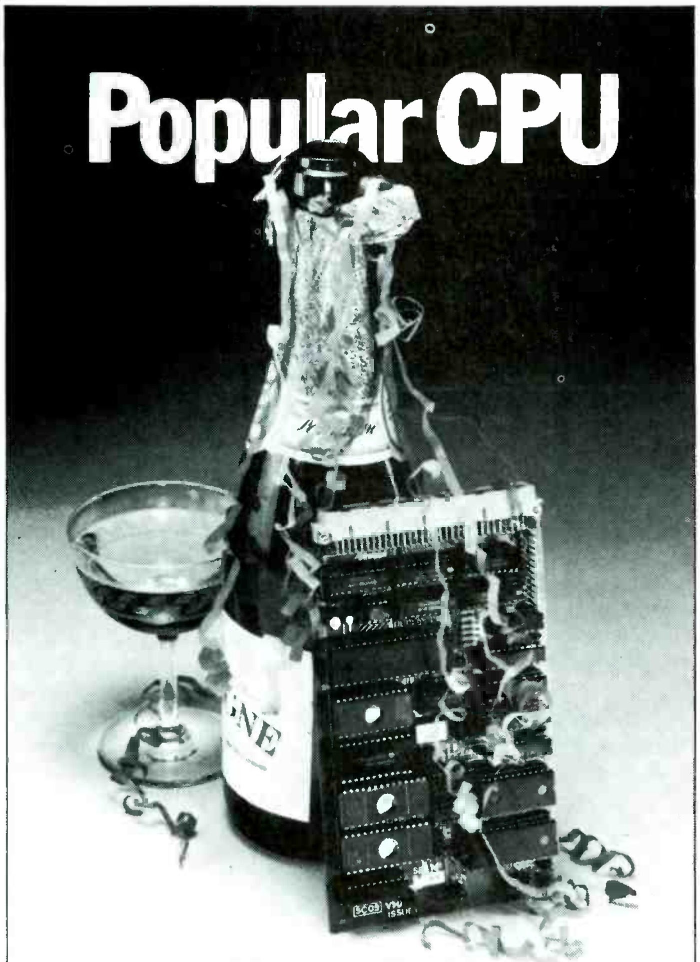
REFERENCES

1. See "Small is Beautiful"... Economics as if People Mattered E.F. Schumacher. ABACUS 1974."

2. "Contrary Imaginations" Liam Hudson. Penguin 1972.
Liam Hudson show the "convergent personality" likely to be shown in people who take up engineering, Law etc. They like things and systems more than people — who they tend to find messy. A salutory read for most engineers...

3. "Disabling Professions" Ivan Illich *et al.* Marion Boyars 1977.
Much in "professionalism" might be oppressive, so argue these authors. Such a view is like 'swearing at the altar', but I have found some evidence for some of this — even in our own profession. A healthy bit of scepticism and some democratic accountability regarding professional pomposity would do a power of good.

4. I would like to record thanks to those Companies and individuals who have helped us with gifts of equipment etc. I can especially mention Messrs Avo of Dover and Sendz Components of Southend-on-Sea.



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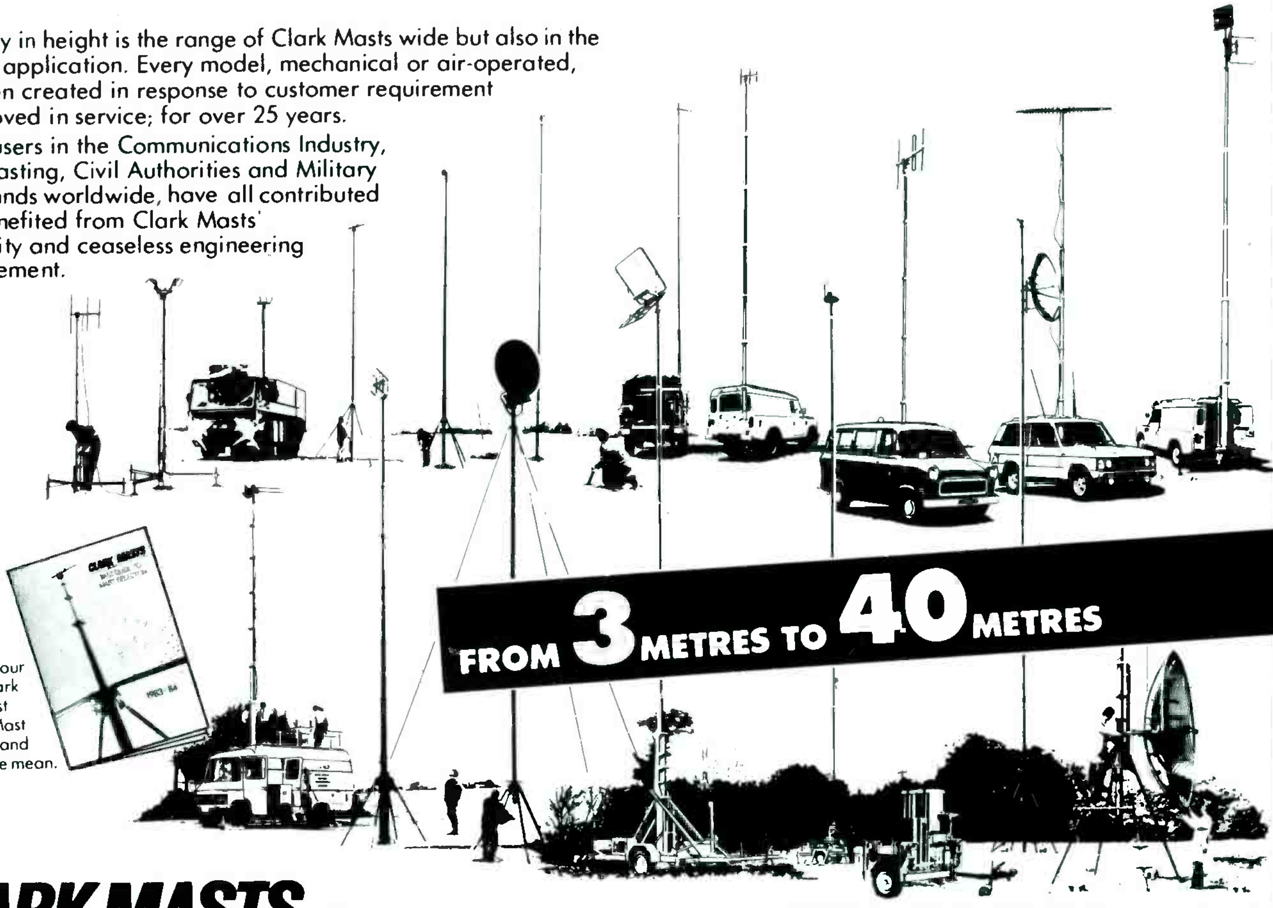

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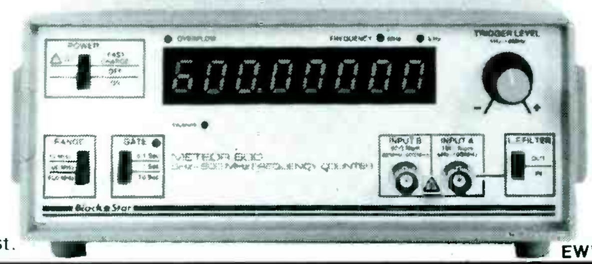

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Battery-saving relay switch

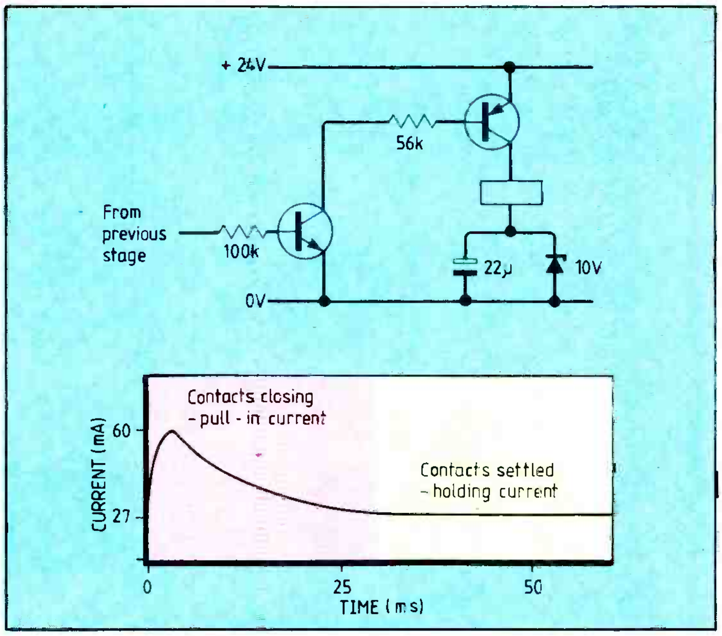
During a period of testing, the need arose for a multi-channel coaxial relay with remote control through optical fibre. Battery power was essential and the relay had to perform well at above 500MHz*. The relay chosen had a 330Ω coil, 27mA holding current and 20 and 9V minimum hold and drop voltages respectively.

Current requirement during the first 50ms after energizing the coil is shown in the graph. Using a 24V supply, the relay draws 73mA. After 30ms, the current could safely be reduced to 36mA without any effect on the relay but with a 50% saving in battery drain, which is what this circuit does.

Initially, the capacitor is uncharged and both transistors are off. When the input goes high, both transistors conduct; this puts around 22V across the relay coil and its contacts switch. Current flowing through the coil causes the capacitor to charge which gradually reduces voltage over the coil. After 50ms, the zener diode conducts (10V) and holds the current at 36mA.

Derek Walton
Preston
Lancashire

* Mr Walton tells us that the relay chosen — an SR-4MIN-D — actually works up to 18GHz and is from RLC Electronics, Mount Kisco, New York. Ed.



Accurate digital measurement of remote transducers

A remote resistive transducer can be accurately measured using a Wheatstone bridge, provided that a three-wire connection is made to compensate for lead resistance as illustrated. For precise lead resistance compensation, R_1 must equal R_2.

Accurate measurement of such a transducer using a microcomputer-controlled analogue-to-digital converter or d.v.m. chip is a different matter though. My solution to this problem is shown in the second diagram.

The op-amp and Darlington transistor automatically balance the bridge so that

$$(R_x+R_l)/R_1=(R_t+R_l)/R_2.$$

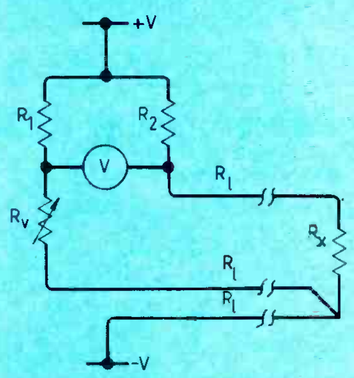
Resistor $R_1=R_2$, $R_l/R_1=R_l/R_2$ and $R_x/R_1=R_t/R_2$. The a-to-d converter measures the value of R_t/R_2 and hence indicates the value of R_x/R_1.

Accuracy limitations are introduced by the op-amp offset voltage and the small amount of current injected into the Darlington transistor base. Using the 7650 chopper-stabilized op-amp, maximum offset voltage is less than 1µV. With a bridge supply of about 5V, and R_x having a minimum value of $R_1/10$, error introduced by the offset voltage will be less than 3 p.p.m. Current gain of the Darlington transistor is about 10 000 so the error introduced will be of the order of 1 in 10 000 (R_1/R_x).

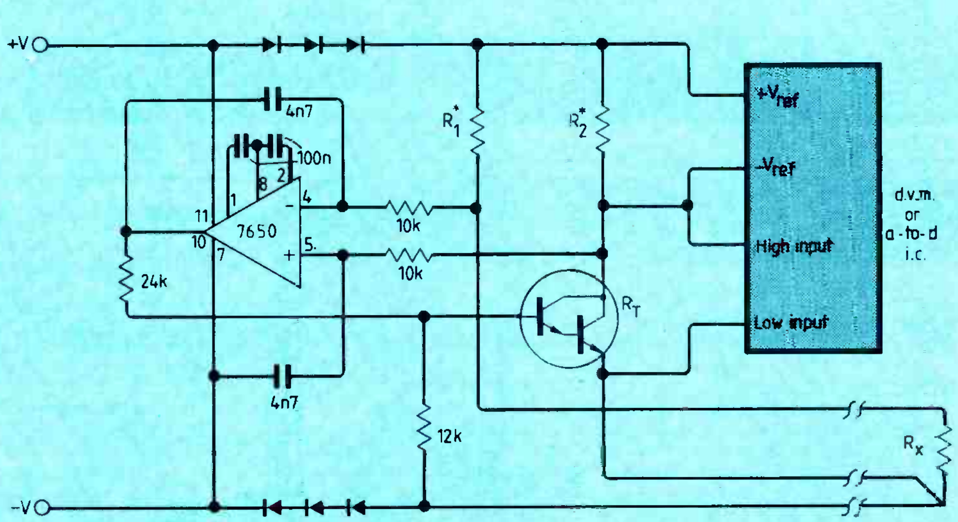
Measurement accuracy thus depends on the accuracy and stability of R_1 and R_2 and resolution of the a-to-d converter. Unless the resistors are more accurate than 0.01% and the converter can resolve to better than 1 part in 10 000, op-amp offset or Darlington-transistor base current will not have any real effect on measurement accuracy.

With 0.01% accuracy resistors and, for example a 4½-digit d.v.m. i.c., R_x can be measured to an accuracy of 1/10 000 of R_1.

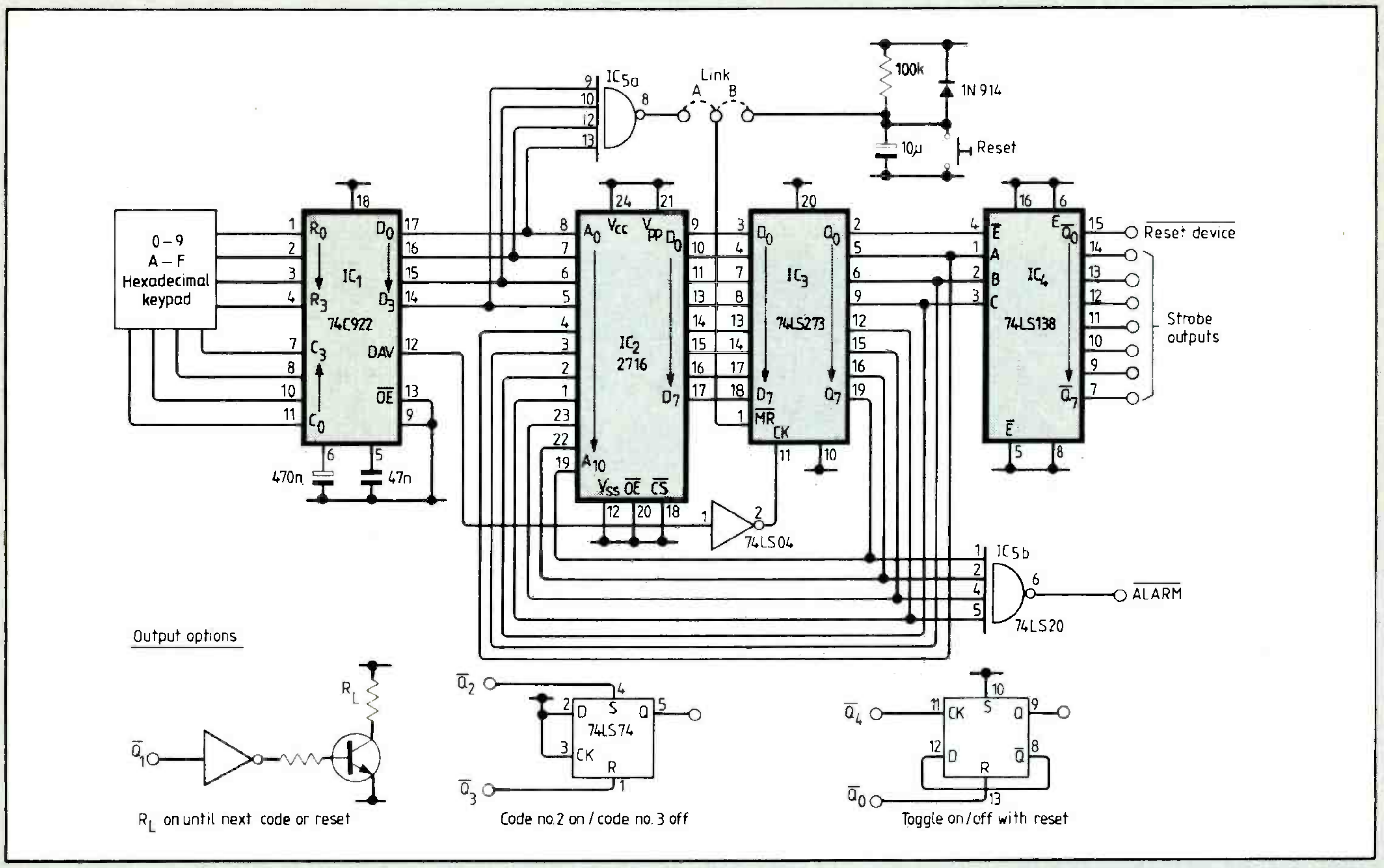
A.J. Ewins
North Harrow
Middlesex



R_1 must equal R_2 to compensate for lead resistances, R_l
At balance, $R_v = R_x$



* Accurate, matched resistors
d.v.m. (or other a-to-d device) indicates value R_T/R_2 which is equal to R_x/R_1



Versatile combination lock

Many limitations of the usual electronic combination lock are overcome by this relatively simple design in which codes are programmable and can vary in length. Up to seven devices can be independently controlled from the same keypad. Several output options are given for use in different applications.

Expressions shown below, for calculating addresses and data, could easily be incorporated into a computer program for programming an eprom with any desired combination and device-select code.

Resetting of the circuit is carried out either by pressing F on the keypad (link A made) or on power up (link B). This resets bistable device IC_3 and output $\overline{Q}_0$ of the decoder IC_4 goes low. The decoder reset output can be used to reset switches, alarms, etc.

On pressing the first key in the sequence (C_0), code for the key is presented as an address. Data for that location is clocked into IC_3 on the falling edge of DAV from IC_1 on releasing the key. This data forms part of the address that will be combined with the next key press.

The process continues unless an incorrect key is pressed, in which case an unprogrammed eprom location is accessed and decoding by IC_{5b} causes an alarm signal. When the final key code is reached, output Q_0 of IC_3 goes low, enabling the LS138 decoder and allowing the appropriate device to be switched. The system is now ready to receive the next code.

In these expressions, d is the device code, i.e. decoder output Q_d is enabled at code end, N+1 is the number of digits in the code ($2 \leqslant N < 14$), n is the key press counter and C_n is the n^{th} element in the code. Desired code is C_0, C_1, C_2. . . C_n.

For n is zero and values of r from zero to seven, the address is C_0+16r and data is $1+2d+16$. This is required to ensure restarting at the correct place after a previous code has been entered. For values of n from zero to N−1, the address is $C_n+16d+128n$ and data is $1+2d+16(n+1)$. For n=N, the address is $C_N+16d+128N$ and data is 2d.

Codes with the same initial few digits can be accommodated by making d zero for the common digits.

P.M. Glover
N. Humberside

Measuring rupture current

When instant rupture current needs to be determined while supply voltage and load resistance are unknown or are too remote to be measured, this hold circuit may be of use. It works for a.c. or d.c. supplies.

A resistance of known value, R_k, is inserted in the line. If current is very high, a portion of the bus bar may be used for R_k provided that its resistance can be accurately measured. For a current of around 10A, a 5W resistor of 500mΩ is used.

At the moment that the current ruptures the fuse, the diode doesn't conduct. Charge representing the current is held by the capacitor for quite some time as the op-amp has a fet input. Output voltage of the op-amp can now be measured at leisure.

The relationship between rupture current and output is given by

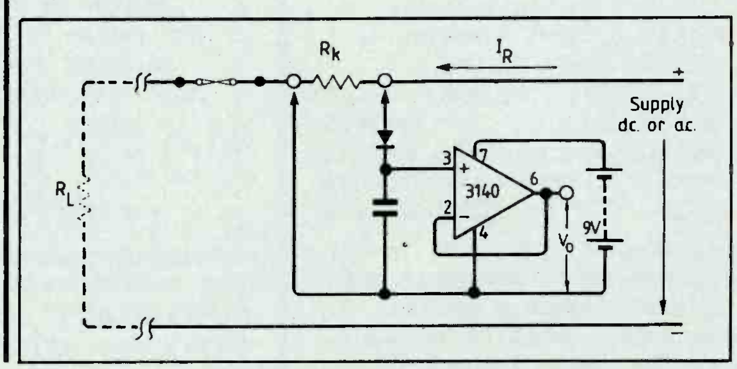
$$I_R=(V_o+0.6)/R_k$$

for d.c. and

$$I_R=(V_o+0.6)/0.45R_k$$

for a.c., assuming negligible offset voltage. Note that once the fuse has blown, the common line of the test jig is not connected to the return line of the unknown supply.

T.S. Doraiswamy
Shikrewadi
India



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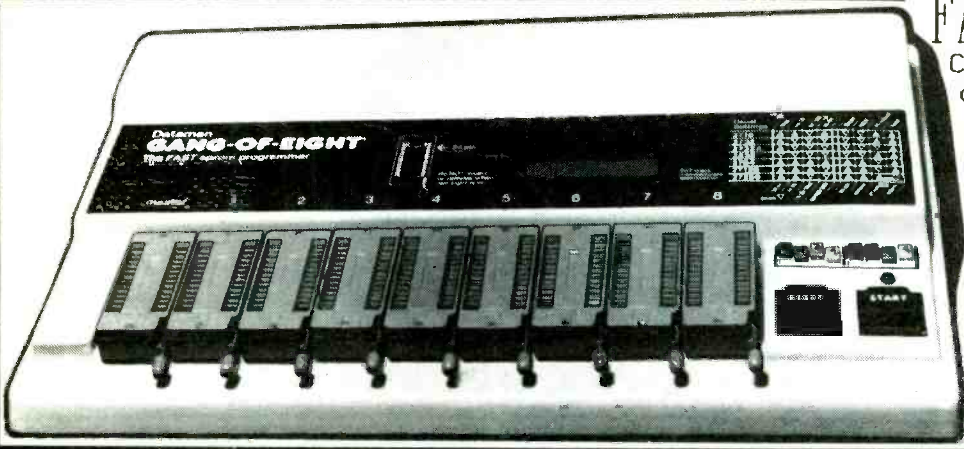

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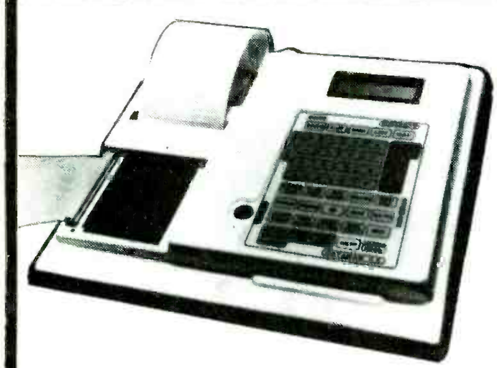

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Big-system automation and telemetry

by R.E. Young, B.Sc.(Eng.), F.I.E.E., M.R.Ae.S.

Using public utilities as examples, R.E. Young continues his series on British innovation with a discussion of the philosophy of big-system automation, with an eye to telemetry and crisis control.

In 1984, details were published of the new national control centre of the British Central Electricity Generating Board in advance of full trials in the Spring of 1985 and final commissioning in 1988[1].

This account, centred on "... a new information (monitoring) system for use by the Board's system control engineers", is of particular interest in this instance because of the R & D and associated aspects shown to be involved. Thus the evolution of the system has been the responsibility of a CEGB research team with technico-economic targets in view. One of these main targets was to provide 'more efficient monitoring of the network' with the dual objectives of achieving more economic power generation and transmission, and of improving 'security'.

One example of the possibilities offered is that the manual calculation of consumer demand, especially for immediate load forecasting, will be computer assisted and will be in terms of continuously updated information from the monitoring system.

Inevitably the question will be asked "Why manual calculation in this day and age?"

From work on comparable big systems, it is safe to assume that the CEGB engineers — with full user experience being brought in — are doing everything possible to ensure the soundness of the information needed to set up the extremely complex software which will be required for the final scheme.

As planned, the national control centre will receive comprehensive operational data from the whole of the Grid network through six regional control centres, will analyse this measurement data, 'separate-out the factors', and then issue instructions (optimized every 5 minutes) for system loading back to the individual centres on the continuously updated basis noted earlier. In addition to carrying out these multiple supervisory control functions, the national control centre will also cover 'fine tuning' of power output which will be effected largely by virtue of the near-instantaneous response of the CEGB's Dinorwig pumped-storage station to sudden power demands (stated as 1800 MW available within 10 seconds).

Also, of special relevance in this connection, it is proposed to employ the overall monitoring system to determine whether Dinorwig would provide the most economic means of controlling Grid frequency, a technical possibility which was a feature of its original design concept.

From this brief summary it will be apparent that even to cover these *interacting* control functions purely on a routine basis demands an extremely large assembly of software. Therefore, to attempt not only to forecast demand a day ahead but also to warn the operator of potential problems make it imperative to determine trends accurately as part of 'separating-out the factors'. This situation is paralleled in building-up the engineering details of a large automation scheme where a number of interests are involved; or with any R & D project, working with experimental data coming from a number of sources when it is not really known whether these are interacting or independent, as part of the initial — and over-riding — task of finding the 'unknowns'.

These last considerations are almost certainly the key to "Why manual calculation?". Phrased equally colloquially, the answer to this original question is "Leave it in the computer and you lose (never find) trends and variations from the expected". In more conventional terms this means that the CEGB engineers themselves would appear to be providing the flexibility needed for dealing with such widely varying experimental data, a flexibility which cannot be approached by ordinary computer programming.

This does not mean that the Board's policy is directed away from full computer working; on the contrary, certain elements of these remarkably far-reaching proposals for computer-based working have already been brought to the stage of field testing and evaluation. Fully engineered terminals with touch-sensitive screens and self-explanatory keys have been installed at two of the regional control centres, so that full continuity will be maintained over the whole project, from initial planning to final operational use.

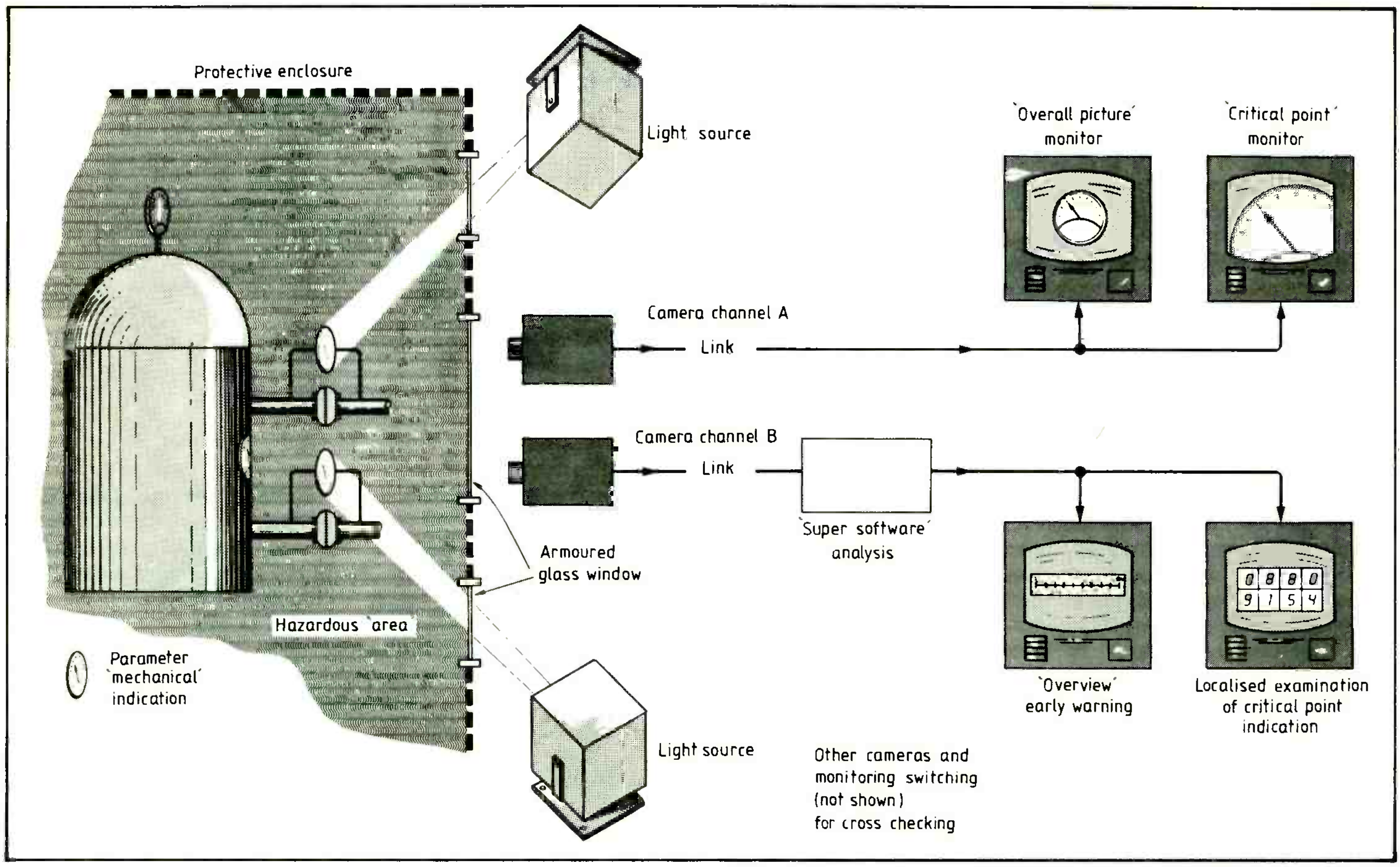
The pivotal years from 1960 and the innovative lead-up

In the introductory article of this series, it was noted that the first issue of *Industrial Electronics*, in October 1962, not only showed that 'the Chip' was well understood in Britain at that time; but also marked the firm establishment of 'Big-System' control in the UK by then, with a mainframe process-control type computer as the cover picture.

Within the year, the first International Telemetering Conference was being held in London (September 1963); and from the report in *Wireless World*[2] it will be seen that while the intensive development characteristic of aerospace telemetry could be expected to continue indefinitely, public utility systems had already been produced which were mature when they were brought into use. It will be realised that the implications of the word 'mature' are considerable. The early part of the Conference had, in fact, been largely devoted to the question of "Has telemetry reached maturity?"; and it was in his paper "Thirty Years of 'Grid' Telemetering"[3]) that P.F. Gunning made the point that over those years (1932-1963), CEGB equipment gave the performance demanded of it and did not have to be replaced by new systems until fresh operational requirements arose. Again, the implications of this last statement are considerable. Apart from anything else, it indicates that development was not carried out in a vacuum — system engineering and the operational side were closely interlocked throughout, something which is evident in the 1984 CEGB approach as outlined at the beginning of this article.

The overall continuity that this represents is, of course, vital, particularly with work carried out on such a scale, not least in helping to establish a climate of confidence. Further evidence of the existence of this climate of confidence, certainly over the period up to 1963, can be deduced from Gunning's paper, with his record of achievement with equipment (usually electro-mechanical in nature) which was, in principle, the same as the 'electronic' equivalents such as analogue-digital convertors which followed them much later.

Before giving a brief list of these precursors, it may help in establishing background to recall the reactions of delegates, particularly from overseas, when visiting the Conference exhibition where these original pieces of equipment were being demonstrated. Almost invariably, the ensuing remarks were ones of astonishment finishing with "It (modern digital technology) is all



C.c.t.v. and super-software used to provide independently checked early warning and detection of mechanical malfunction.

there already, and has been there for some time."

Given in date order, salient developments are outlined below: **1932-1935** 'on-demand' operation, the equivalent of digital 'address-reply' (interrogation) working introduced, and employing various forms of electro-mechanical analogue-digital converters. **1935-1945** pulse-duration modulation and frequency-modulation techniques adopted, together with pulse-count methods, in 1937. **1945-1952** multiplexing with simple coded pulse-trains brought into service at the beginning of this period with address decoding for eight measurement channels. Techniques included 'cup-and-bucket' data (signal) handling with high-gain amplifier/cathode follower feedback; while on the system side, a close approach to real-time working was achieved with standard teleprinter-code multiplexing for the cup-and-bucket equipment. This, incidentally, was an all-electronic system; and, although it was largely superseded in 1952, was reported as still being in service in 1963.

Now it will be appreciated that there are a number of reasons, such as the depth of the factual information which can be quoted, which make this CEGB work uniquely suitable for this article. Seen purely as a multi-aspect R & D project, its scale is perhaps best illustrated by the statement made in 1963 that at the end of 30 years of development (from 1933), the CEGB control complex had become the biggest and most comprehensive of its kind in world.

At this point, however, it is necessary to bring in telemetry as an overall concept[4] with two divisions aerospace and supervisory, where in the latter the telemetering function is combined with that of remote control within the one supervisory system. Even in 1963, however, control in the CEGB case was exercised by supervisory engineers largely by passing instructions to the remote stations by telephone. As will be shown in the last section, in connection with crisis control there are times when human intervention in control becomes (literally) vital; and the facility of direct intervention becomes equally vital. Consequently it may be assumed that provision for intervention will always be a feature of supervisory schemes, although direct communication may not necessarily always be by (speech) control line[5].

However, by the end of the 1950s, full development design was being carried out on supervisory systems offering what was, in effect, computer-based automation; and embodying the solid-state equipment and digital techniques which have since become virtually standard for this work. Thus 1960 saw the beginning of a new era in supervisory remote control where a multiplicity of functions — both for telemetering and for control — were handled by the one set of master station equipment using the same 'address/reply' format for the two groups of (digital) signals.

Typical of such telemetry complexes installed in the UK in the early 1960s was the Strathfarrar hydroelectric scheme[6], which incorporated two major automation techniques in its extremely comprehensive operational facilities. The first of these was for the remote monitoring and control of four unattended generating stations, together with two compensation stations and an area switching centre. This North of Scotland Hydro-Electric Board network, with a total capacity of 102 MW, also demanded 'hydraulic' monitoring. By this means, water storage and flow down the river system, effectively from one generating station to the next, could be controlled as part of the energy management of the complex, seen overall.

The other technique — of

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local-loop operation — is of particular interest in the automation context. In this instance, two virtually self-contained control functions were covered, with master-station supervisory monitoring, viz. 'machine loading' and 'start-up' in each of the unattended stations.

Another example of these original big-systems is afforded by the UK National Methane Grid Control Scheme[7,8]. Designed to distribute imported methane gas from the tanker terminal in the Thames Estuary to eight Area Boards, this pipeline 'Grid' was made relatively simple in operating as a free-flow system. This meant that after initial pressurization at the dispatching end, no additional pump boosting was needed along the line; and, with no intermediate compressor stages, the requirement for remote control as such was made relatively small. Specific remote control was, in fact, restricted to four gas-flow valves, which, in conjunction with automatic shut-off valves, gave all the real-time control facilities required.

From the system point of view, it is of interest that the development of a leak resulted in the local automatic valve moving to shut-off as determined by rate of pressure drop across it; while with the movement giving a 'transducer' indication of this condition at the master station, action could be taken to isolate the faulty section of the line by closing the adjacent upstream remote control valve. Measurement of gas flow was made in terms of corrected volume relative to standard (atmospheric) pressure and temperature (16° C). Of special interest here is the fact that this correction was effected by an instrument computer local to the primary measuring unit, a practice which was still being followed in comparable oil-well supervisory control systems some ten years after its establishment in the first half of the 1960s.

Crisis control — the two basic requirements

To borrow from another world, it is a 'crashing glimpse of the obvious' to state that as the size of modern industrial complexes has increased, so the risk of a large-scale disaster has grown with it. Such near-catastrophic accidents — fortunately small in number — have been experienced in many industrialized countries of the world, with a range extending from chemical processing to nuclear power generation as exemplified by Three Mile Island[9].

However, it was not until this last incident had occurred that the international public became fully aware of the threats posed to safety by high-risk centrally-controlled complexes when a completely unforeseen failure develops. Three Mile Island had a special significance for nuclear safety; but it had an equal significance in regard to the picture it gave of crisis control under operational conditions[10] as deduced from the excellent, detailed, reporting given to it by the US authorities.

The importance of this reporting and of the analysis that lies behind it cannot be stressed too highly. The incident at Three Mile Island took place in 1979, and international action followed almost immediately in the examination of safety precautions and in re-drafting standards. In this general connection, it is worthy ot note that somewhat earlier — in 1974 — Flixborough in the north of England was the scene of an explosion type of accident which, among its consequences, included serious loss of life. In this instance, a 40 tonne cloud of cyclohexane vapour escaped from a broken pipe to form "a highly flammable bubble" which exploded to "flatten" the Flixborough chemical factory. It has been indicated that this incident weighed heavily in the production of recommendations by the (UK) Health and Safety Commission aimed at the prevention of such destructive accidents. In turn it should be added that the Health and Safety Executive maintains a service in which quarterly statements are issued of incidents which have occurred at UK nuclear installations and have been reported to the Nuclear Installations Inspectorate.

As stated earlier, these accidents — often becoming utterly catastrophic in their 'aftermath' effects — have been small in number; and it says much for the various national agencies concerned that this number has been kept so low, particularly bearing in mind the spread of the technologies, both nuclear and non-nuclear, encountered. Thus, citing the article in the *Nuclear Engineer* on crisis control[9], the statistics are that with Flixborough being the first accident if its kind in Britain during a 40 year period, at least 24 accidents had reached comparable levels in other countries over the same period.

Clearly, and as discussed in that article, a wide-ranging approach to control-system design has to be adopted if every kind of emergency, however unlikely, is to be covered.

In terms of crisis control, this approach has two main phases. The first is, in effect, an extension of conventional supervisory control system design[5,8], where full account is taken of potential sources of trouble, and which, initially at least, comprise known hazards, such as the risk of explosion in coal mines or at oil well-heads. With sufficient engineering resources available, it is possible to extend this process by taking advantage of experience in analogous fields and take precautions in design to cover the fault conditions which can be envisaged.

However, although these 'total-system' design procedures have to be undertaken in order to provide the foundation for any crisis-control scheme, the design approach has to take on an entirely new character; and it is for this second phase that completely fresh concepts and techniques have to be introduced. This stems from the very nature and purpose of crisis control: to deal with the emergency conditions of an incident which is completely unforeseen.

Because of their unpredictability, 'incident' failures threatening the whole operation of the plant must be countered by human intervention, i.e. an operator must take over-riding control. Thus it becomes evident that if an incident of this magnitude is to be contained and brought under control, several pre-requisites have to be fulfilled: the maximum possible early warning must be given of 'onset'; operational information (essentially measurement data) must have complete integrity; this information must be presented to the control engineer in such a way that it is assimilated almost subconsciously, so that delay and error, particularly ambiguity, are kept to an absolute minimum.

It should be added that, as an ideal, wrong information should be detected and its source located.

Requirements

Now, these pre-requisites represent a formidable total; but it can be stated that if they are brought under two 'requirement' headings, it is possible to arrive at a general picture of the present position with the suggestions that have been put forward and the way development should go.

These headings are derived in terms of a 'fully developed crisis'[10]: the control staff are being given wrong information *somewhere*, and, as a rider, they have no possible means of finding out where; the control staff are completely out of contact with the plant under their control because of the misleading and unsuccessful way in which control information is presented to them.

Integrity of data

This requirement is essentially one of failure of equipment (principally transducers) or of an element in the main installation which results in the indication coming, say, from a transducer being totally erroneous. There is no need to stress the dangers of relying on a reading which is utterly wrong. The extreme case develops when, for example, a transducer indicates mechanical movement that has not actually taken place because of a break in an actuator shaft with the (position) transducer being on the drive side of the break. Such a failure apparently occurred in practice[9] with the break of the operating shaft of a vital control valve.

There are various ways of reducing these risks[5,9], one being to make the transducer, in effect, part of the operating mechanism itself. As quoted earlier in this article, this was done with the automatic shut-off valves of the UK Methane Grid where, mechanically, valve and transducer actuation were one and the same.

Another method of improving integrity is covered by the general principle of the Independent Check where, in its basic form the measurement indication of one instrumentation chain is checked by an entirely separate chain. This principle can be applied to comparison of accuracy as well as to detection of the break type of indication fault; and it will be appreciated that the former can be just as dangerous a failure as the complete break.

Various approaches can be adopted to apply this principle, ranging from suitable positioning of adjacent transducers, to c.c.t.v. telemetering[8]. This last system is of interest on several counts. The first is in the context of transducer fundamental design where television 'transfer' obviates certain 'hyper-interface' problems; and also ensures that once the data has been 'encoded' (in pictorial form), no further degradation in its accuracy can take place through the system.

At the other end of the scale, it is suggested that c.c.t.v. could be used in conjunction with 'super-software' to provide computer-based facilities including early warning and the possibility of detecting physical (mechanical) changes, for example 'breaks' both visually and more indirectly by computer[5].

Transfer of information

Two distinct, but closely interlinked, areas come into this requirement. The first, the presentation of information, is largely a matter of system design in the full sense of the word; while the second is perhaps best described as being concerned with analysis/interpretation of incoming information and the implementation of the conclusions as a control action.

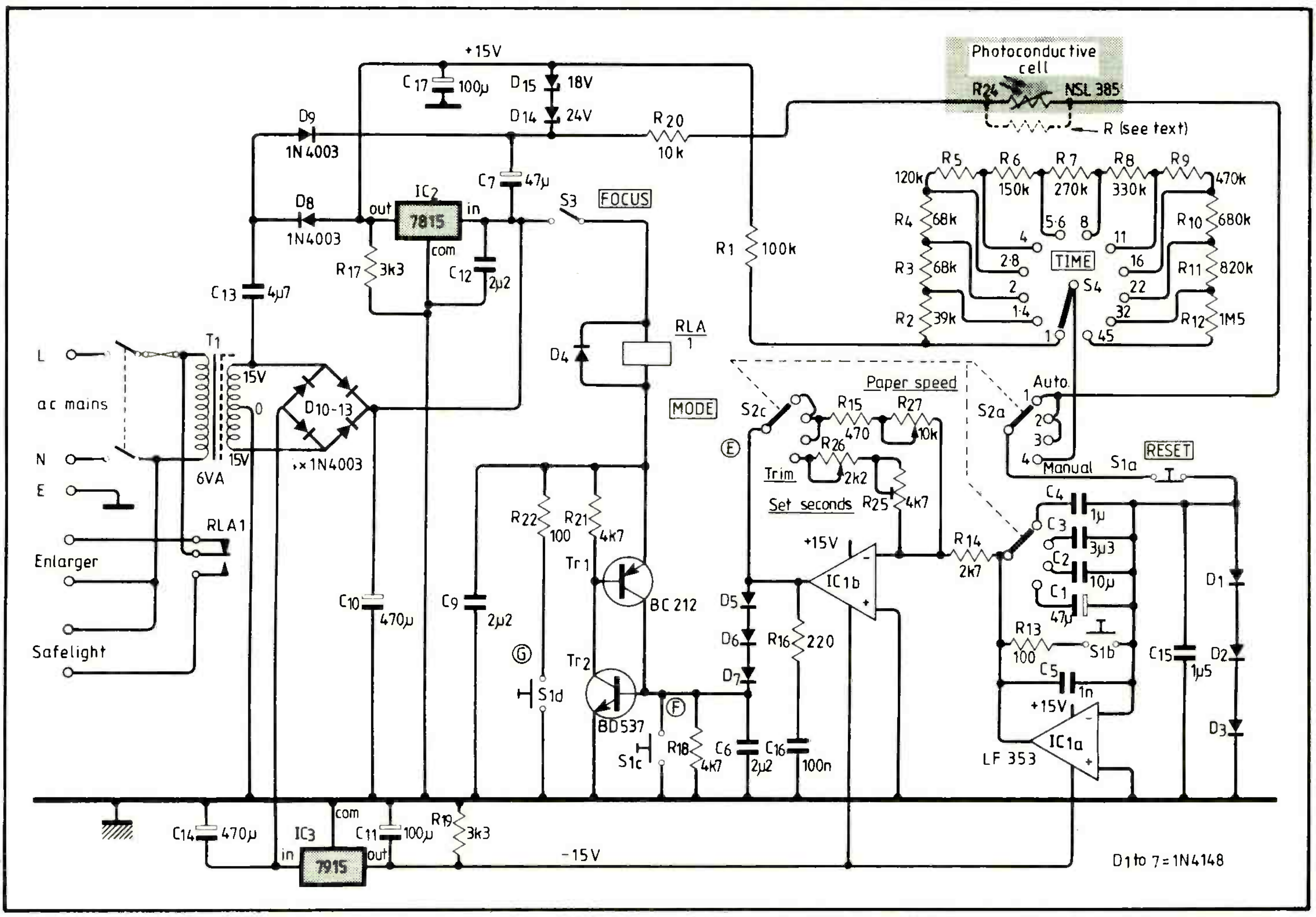
The underlying principle which enters into both of these areas is that of 'data marshalling'. Defined as the 'separation, streaming and systematic presentation' of masses of data, this concept helps to reduce the intangibility which is inseparable from the complex design considerations associated with crisis control and its entirely new technological approach. This applies particularly to the actual control aspect where, from the overall design point of view, some understanding of the mode of thinking of the engineer and of his general behaviour under stress is of paramount importance. This aspect has been discussed in the *Wireless World* article already quoted[10] and forms one of the main elements in the penultimate article of this series that on Human Communications. It will be realised that data marshalling is required in this mode of thinking, both for the appreciation of the incoming multi-channel information, and for the selection (as a decision) ofthe correct action to take, and its implementation.

It is sometimes found useful for system design, especially for full crisis control, and to consider the man-machine interface which exists between the operating engineer and the plant under his control. Two-way transfer of information takes place at this interface; and it is worth noting that under full crisis conditions, the outward transfer will usually involve 'voice command' being employed to its maximum capacity. It is also worth noting that transfer in each direction should be as smooth as possible, i.e. distortion and obstruction should be eliminated. One practical example of this is the change from spread-panel display to individual control console layout. This introduces a form of data marshalling which helps to smooth the flow of information in the transfer across to the control engineer, and also assists in the other direction by facilitating actual operation.

Finally, in relation to engineering R & D, it can be said that in the circumstances of a full crisis, the control engineer is engaged in an R & D project, with all its implications and difficulties, which has to be brought to a successful conclusion, not within months, but as nearly as possible instantaneously, certainly in a matter of minutes.

Automatic englarger timer

Regrettably, one or two errors appeared in Mr Linsley Hood's timer circuit in the May issue. In Fig.3. on page 46, the diodes D_1 to D_3, D_5 to D_7 were reversed. The input and output of stabilizer IC_2 were reversed and a 100 μF, 16V electrolytic should be connected between +15V and 0V. The diagram is reproduced here in corrected form. Apologies for the mistakes.



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OC28 2.00
OC29 2.00
OC35 1.50
OC36 1.50
OC41 0.90
OC42 0.90
OC43 1.50
OC44 0.85
OC45 0.65
OC71 0.55
OC72 1.00
OC73 1.00
OC74 0.70
OC75 0.65
OC76 1.00
OC77 1.00
OC81 0.65
OC81Z 1.20
OC82 0.90
OC83 1.00
OC84 0.80
OC122 2.75
OC123 2.00
OC139 3.00
OC140 4.00
OC141 4.25
OC170 4.50
OC171 4.50
OC200 1.50
OC201 3.75
OC202 2.75
OC203 3.00
OC204 3.00

OC205 2.75
OC206 2.75
OC207 2.50
OCP71 2.00
ORP12 1.00
R2008B 2.00
R2009 2.25
R2010B 2.00
T1C44 0.27
T1C226D 1.20
T1L209 0.16
T1P29A 0.43
T1P30A 0.45
T1P31A 0.33
T1P32A 0.36
T1P33A 0.54
T1P34A 0.67
T1P41A 0.44
T1P42A 0.42
T1P2955 0.70
T1P3055 0.56
ZS140 0.25
ZS170 0.21
ZS178 0.54
ZS271 0.23
ZS278 0.57
ZTX107 0.12
ZTX108 0.12
ZTX109 0.13
ZTX300 0.13
ZTX301 0.14
ZTX302 0.18
ZTX303 0.18
ZTX304 0.20
ZTX311 0.13
ZTX314 0.25
ZTX500 0.14
ZTX501 0.14
ZTX502 0.18
ZTX503 0.19

ZTX504 0.21
ZTX531 0.24
ZTX550 0.25
1N914 0.05
1N916 0.09
1N4001 0.06
1N4002 0.06
1N4003 0.06
1N4004 0.07
1N4005 0.09
1N4006 0.11
1N4007 0.12
1N4009 0.07
1N4148 0.04
1N5400 0.13
1N5401 0.13
1S44 0.04
1S920 0.08
1S921 0.09
2G301 1.00
2G302 1.00
2G306 1.00
2N404 1.30
2N696 0.32
2N697 0.32
2N698 0.32
2N705 1.25
2N706 0.25
2N708 0.25
2N930 0.25
2N1131 0.30
2N1132 0.30
2N1302 1.20
2N1303 0.80
2N1304 1.20
2N1305 1.00
2N1306 1.50
2N1307 1.10
2N1308 1.75
2N1309 1.20
2N1613 0.32

2N1671 5.00
2N1893 0.32
2N2147 4.00
2N2148 3.75
2N2218 0.32
2N2219 0.32
2N2220 0.20
2N2221 0.20
2N2222 0.20
2N2223 4.25
2N2368 0.25
2N2369A 0.25
2N2484 0.25
2N2646 0.50
2N2904 0.32
2N2905 0.32
2N2906 0.21
2N2907 0.21
2N2924 0.26
2N2925 0.22
2N2926 0.15
2N3053 0.26
2N3054 0.55
2N3055 0.65
2N3440 0.70
2N3441 0.85
2N3442 1.25
2N3614 2.20
2N3702 0.11
2N3703 0.11
2N3704 0.11
2N3705 0.11
2N3706 0.11
2N3707 0.11
2N3708 0.10
2N3709 0.11
2N3710 0.10
2N3711 0.10
2N3771 1.40
2N3772 1.60
2N3773 1.80

2N3819 0.30
2N3820 0.39
2N3823 0.60
2N3866 1.00
2N3904 0.17
2N3905 0.17
2N3906 0.17
2N4058 0.20
2N4059 0.20
2N4060 0.16
2N4061 0.16
2N4062 0.16
2N4124 0.16
2N4126 0.16
2N4286 0.15
2N4288 0.18
2N4289 0.18
2N4400 0.11
2N4401 0.11
2N4402 0.11
2N5457 0.32
2N5458 0.32
2N5459 0.32
2S017 10.00
2S019 12.00
2S024 35.00
2S025 35.00
2S026 35.00
2S103 1.50
2S302 3.50
2S303 1.50
2S322 3.50
2S324 3.50
2S701 3.50
2S745A 0.95
2S746A 0.95
CV Devices
Large stocks
Prices on application

VALVES

A1834 9.00
A2087 13.50
A2134 17.50
A2293 16.00
A2426 27.50
A2521 25.00
A2900 15.00
A3343 45.00
AZ31 2.75
AZ41 2.60
BK448 114.90
BK484 155.35
BS90 58.00
BS810 60.00
BT5 58.95
BT17 151.00
BT19 44.05
BT29 349.15
BT69 354.80
BT95 129.90
CBL31 4.00
CL33 4.00
CY31 3.00
C1K 20.00
C3A 22.00
C3JA 22.00
DA41 25.00
DA42 18.70
DAF91 1.75
DAF96 1.75
DET22 35.00
DET24 49.00
DF91 1.75
DF96 1.75
DK91 1.75
DK92 2.00
DK96 1.75
DL92 2.00
DL94 1.75
DL96 1.75
DLS10 14.00
DLS15 12.50
DLS16 12.50
DLS19 12.50
DM70 2.00
DM71 2.00
DM160 4.75
DY87 1.50
DY802 1.50
E55L 45.00
E80CC 15.00
E80CF 11.27
E80F 14.19
E80L 13.73
E81CC 8.00
E81L 13.27
E810F 35.48
E82CC 8.10
E83CC 8.40
E86C 8.25
E88C 8.25
E88CC 8.42
E90CC 9.47
E90F 9.90
E91H 6.25
E92CC 8.75
E99F 9.10

E130L 18.50
E180CC 10.50
E180F 10.20
E182CC 13.25
E186F 11.50
E188CC 8.91
E280F 22.51
E283CC 12.00
E288CC 17.50
EA52 125.00
EA76 2.50
EABC80 1.25
EAC91 3.50
EAF42 2.50
EAF801 2.00
EB41 4.00
EB91 1.50
EBC33 2.50
EBC41 2.50
EBC81 1.50
EBC90 1.25
EBF80 1.50
EBF83 1.75
EBF89 1.50
EBL31 10.00
EC90 1.25
EC91 8.00
EC92 1.75
EC157 410.00
ECC33 4.50
ECC35 4.50
ECC40 5.50
ECC81 1.75
ECC82 1.75
ECC83 1.75
ECC84 1.75
ECC85 1.75
ECC86 2.50
ECC88 3.50
ECC89 2.00
ECC91 8.93
ECC189 2.10
ECC807 1.75
ECC808 3.00
ECF80 1.50
ECF82 1.50
ECF86 2.50
ECH35 3.00
ECH42 3.50
ECH81 3.00
ECH83 2.50
ECH84 2.50
ECL80 1.50
ECL81 1.50
ECL82 1.50
ECL83 3.00
ECL84 1.50
ECL85 1.50
ECL86 1.75
EF37A 5.50
EF39 2.75
EF40 5.00
EF41 3.50
EF42 4.50
EF50 2.50
EF54 5.00
EF55 3.50
EF80 1.75
EF83 4.00
EF85 1.7

EF86 3.50
EF89 2.50
EF91 2.95
EF92 6.37
EF93 1.50
EF94 2.50
EF95 5.99
EF98 2.00
EF183 2.00
EF184 2.00
EF804S 12.00
EF805S 15.00
EH90 1.75
EK90 1.50
EL32 2.50
EL33 4.00
EL34MUI 4.00
EL36 2.50
EL41 2.80
EL42 2.50
EL81 5.25
EL83 6.00
EL84 2.25
EL86 2.75
EL90 2.25
EL91 9.69
EL95 2.00
EL156 30.00
EL360 8.50
EL500/504 3.00
EL509 10.00
EL821 13.00
EL822 13.97
ELL80 19.00
EM34 8.00
EM80 2.50
EM81 2.50
EM84 2.00
EM85 2.75
EM87 2.50
EN32 17.46
EN91 6.50
EN92 6.96
EY51 2.75
EY81 2.50
EY83 2.50
EY84 9.24
EY86 1.75
EY88 1.75
EY500A 3.00
EY802 1.75
EZ35 1.75
EZ40 2.50
EZ41 2.50
EZ80 1.50
EZ81 1.50
EZ90 2.00
FW4-500 3.50
FW4-800 3.50
G1.371K 35.00
G551K 12.00
G180.2M 17.50
G240.2D 12.00
G400.1K 17.50
GN4 9.00
GN4A 9.00
GS16 16.00
GT1C 25.00
GU50 20.00
GU51 20.00

GXU1 15.35
GXU2 30.00
GXU3 25.40
GXU4 44.50
GXU50 20.00
GY501 3.00
GZ32 4.00
GZ33 4.75
GZ34 4.00
GZ37 4.75
KT61 5.00
KT66 15.00
KT77 Gold Lion 12.00
KT88 Gold Lion 20.00
KTW61 2.50
KTW62 2.50
KTW63 2.50
M8079 12.34
M8080 8.25
M8081 9.82
M8082 9.69
M8083 8.58
M8091 10.43
M8096 6.80
M8097 8.10
M8098 8.15
M8099 8.00
M8100 9.52
M8136 10.23
M8137 10.23
M8140 6.00
M8141 6.50
M8142 8.75
M8144 7.50
M8149 6.50
M8161 9.35
M8162 10.40
M8163 8.25
M8190 5.00
M8195 10.85
M8196 7.50
M8204 7.05
M8212 11.37
M8223 6.00
M8224 6.30
M8225 4.50
M8248 14.03
MD2901 115.00
MU14 2.50
MX119 55.00
MX123 76.00
MX145 56.70
MX151 17.25
MX152 131.25
MX161 152.25
MX163 20.25
MX164 25.52
MX166 147.00
MX168 50.00
N78 15.00
OA2 3.25
OA3 2.50
OA4 6.00
OB2 4.35
OB3 2.50
OC2 4.35
OC3 2.50

OD3 2.50
OZ4 3.50
PC86 2.50
PC88 2.50
PC95 1.75
PC97 1.75
PC900 1.75
PCC84 1.50
PCC85 1.50
PCC88 2.00
PCC89 1.75
PCC189 2.50
PCC805 1.60
PCC806 1.60
PCE82 2.00
PCF80 2.00
PCF82 1.50
PCF86 2.50
PCF87 2.00
PCF200 3.25
PCF201 3.25
PCF801 2.50
PCF802 2.50
PCF805 1.70
PCF806 1.70
PCF808 1.70
PCL82 2.00
PCL83 3.00
PCL84 2.00
PCL85 2.50
PCL86 2.50
PCL805/85 2.50
PD500 6.00
PE06-40N 45.00
PFL200 2.50
PL36 2.50
PL81 1.75
PL81A 2.00
PL82 1.50
PL83 2.50
PL84 2.00
PL504/5 2.50
PL508 2.50
PL509 6.00
PL519 6.00
PL801 1.50
PL802 6.00
PY33 2.50
PY81 1.50
PY82 1.50
PY83 1.25
PY88 2.00
PY500A 4.00
PY800 1.50
PY801 1.50
QF451 82.50
QQV02-6 31.80
QQV03-10 23.50
QQV03-20A 48.38
QQV06-40A 75.00
QQV07-50 69.74
QQZ06-40A 62.20
QU37 12.50
QV03-12 6.80
QV04-7 3.50
QV08-100 171.20

QY3-65 63.24
QY3-125 68.64
QY4-250 70.14
QY4-400 76.20
QY5-500 190.00
QY5-3000A 450.00
QZ06-20 32.70
R10 6.00
R17 3.00
R18 3.00
R19 9.24
R20 2.50
RG3-250 32.68
RG3-250A 32.68
RG3-1250 59.50
RG4-1250 61.60
RG4-3000 99.45
RR3-250 40.00
RR3-1250 45.75
S11E12 65.00
S130 6.00
S130P 6.00
STV280-40 14.00
STV280-80 21.00
SU41 5.00
SU42 10.00
TD03-10 35.00
TD03-10F 35.00
TT15 50.00
TT21 30.00
TT22 37.50
TT100 60.00
TY2-125 65.00
TY4-400 80.00
TY4-500 105.00
TY5-500 214.00
TY6-800 210.00
TY6-5000A 490.00
TY6-5000B 395.00
TY6-5000W 425.00
TY7-6000A 525.00
TY7-6000W 525.00
TZ40 25.00
U18-20 3.50
U19 13.75
U25 2.50
U26 2.50
U37 12.00
UABC80 1.25
UAF42 2.50
UB41 3.00
UBC41 2.25
UBF89 1.50
UCC84 1.75
UCC85 1.85
UCF80 2.00
UCH42 2.50
UCH81 2.50
UCL82 1.75
UCL83 2.75

UF41 2.00
UF42 2.10
UF80 1.75
UF85 1.75
UF89 2.00
UL41 5.00
UL84 1.95
UM80 2.00
UY41 2.25
UY85 2.25
VLS631 15.00
XG1-2500 55.00
XG2-6400 141.90
XG5-500 30.00
XG2-6400 162.00
XR1-1600A 53.75
XR1-3200 81.97
XR1-3200A
XR1-6400 165.00
YD1120 395.00
YD1240 490.00
Z803U 25.00
Z759 25.00
ZM1000 8.00
ZM1001 8.00
ZM1020 9.00
ZM1021 9.00
ZM1022 9.00
ZM1023 9.00
ZM1040 19.36
ZM1041 16.66
ZM1042 17.77
1B3GT 3.00
1B24 25.00
1B35A 48.00
1B63 64.00
1R5 1.75
1S5 1.75
1T4 1.75
2AS15 11.50
2C39A 60.00
2C43 70.00
2D21 3.25
2E26 8.25
2J42 98.00
2J55 £245.00
2J70A 383.00
2J70B 336.00
2K25 125.00
3400Z 115.00
3500Z 100.00
3A5 3.00
3B24 11.00
3B28 15.35
3B29 20.05
3B240M 17.50
3B241M 17.50
3C23 25.00
3C45 24.50
3CX100A5 47.00
3E29 45.00
3S4 2.00
3V4 1.75
465A 60.00
4-125A 60.00

4-250A 80.00
4-400A 87.00
4B32 20.00
4C35 120.00
4CX250B 58.00
4CX350A 105.00
4X150A 60.00
4X150D 56.00
5B254M 35.00
5B255M 35.00
5C22 160.00
5J180E 1650.00
5R4GY 3.50
5U4G 3.00
5U4GB 2.50
5V4G 2.50
5Y3GT 2.50
5Z3 4.00
5Z4G 2.50
5Z4GT 2.50
6-30L2 1.75
6AB4 1.75
6AB7 3.00
6AC7 3.00
6AF4A 4.25
6AG7 3.00
6AH6 5.00
6AK5 5.99
6AK6 2.50
6AL5 1.50
6AM4 4.00
6AM5 9.69
6AM6 6.02
6AN5 4.75
6AN8A 3.50
6AQ5 2.25
6AS6 8.66
6AS7G 8.75
6AT6 1.25
6AU5GT 5.00
6AU6 2.50
6AV5GA 4.50
6AV6 1.50
6AX5GT 3.00
6B7 3.25
6B8 3.25
6BA6 1.50
6BA7 5.00
6BA8A 4.00
6BC4 4.00
6BE6 1.50
6BH6 2.50
6BJ6 2.25
6BK4 4.50
6BL6 85.00
6BL7GT 4.50
6BM6 115.00
6BN6 2.00
6BQ7A 3.50
6BR7 6.00
6BR8A 3.50
6BS7 6.00
6BW6 6.00
6BW7 1.50
6BX7GT 5.00
6BZ6 2.75
6C4 1.25
6CB6A 2.50
6CD6GA 5.00

6CG7 2.50
6CH6 13.00
6CL6 3.75
6CW4 8.00
6D2 1.50
6DK6 3.00
6DQ6B 4.75
6EA8 3.00
6EB8 2.50
6EW6 2.25
6F6 3.00
6F23 1.60
6F28 1.60
6F33 33.50
6H1 14.00
6H2N 2.75
6H3N 2.75
6H6 3.00
6J4 5.50
6J6 8.93
6J7 4.75
6JE6 7.50
6K4N 2.50
6K6GT 2.75
6K7 3.00
6K8 3.00
6KD6 7.00
6L6G 3.00
6L6GA 3.00
6L6GC 4.75
6L6GT 3.00
6L7 2.50
6N2P 2.50
6N3P 2.50
6N7 3.00
6P25 4.00
6Q7 3.75
6R7 3.25
6RHH8/6KN8 10.00
6SA7 3.00
6SC7 2.75
6SF7 2.50
6SH7 3.00
6SJ7 3.25
6SK7 3.50
6SK7GT 3.00
6SN7GT 3.00
6SQ7 3.40
6SR7 4.00
6SS7 2.75
6U5G 3.50
6U8A 2.25
6V6GT 2.25
6X4 2.00
6X5GT 1.75
7B7 2.50
7C5 4.00
7C6 2.50
7H7 4.00
7R7 4.25
7S7 3.50
7Y4 2.25
7Z4 2.00
11E3 55.00
12AH8 5.00
12AT6 1.50
12AT7 1.75
12AU6 2.50

12AU7 1.75
12AV6 2.50
12AV7 3.50
12AX7 1.75
12AY7A 4.00
12B4A 3.50
12BA6 2.50
12BE6 2.50
12BH7 2.75
12BY7 3.00
12E1 20.00
12E1ITT 28.00
12E14 65.00
13E1 170.00
19H4 27.50
19H5 47.50
24B9 67.25
30C15 2.00
30C17 2.00
30C18 2.00
30F5 1.60
30FL1/2 1.38
30FL12 1.80
30FL14 2.00
30L1 1.50
30L15 2.00
30L17 2.00
30P4 2.50
30P19 2.50
30PL1 3.00
30PL14 1.80
30PL15 1.80
35W4 1.00
50C5 1.50
75B1 6.05
75C1 4.50
85A1 7.50
85A2 6.45
90AG 20.00
90AV 20.00
90C1 6.00
90CG 14.54
90CV 15.45
92AG 20.00
92AV 20.00
95A1 8.45
150B2 6.50
150B3 8.35
150C2 3.25
150C4 6.00
211 35.00
723AB 125.00
803 25.00
805 45.00
807 3.75
811A 18.33
812A 35.00
813 valve 65.00
833A 193.16
866A 20.03
872A 20.00
922 6.00
931A 18.50
1624 4.00
1625 3.50
2050 7.50
4212E 300.00
4212H 300.00
5544 81.97

5545 165.00
5551A 114.90
5552A 155.35
5642 9.00
5654 3.00
5651 4.45
5670 4.50
5675 28.00
5687 6.00
5696 4.50
5718 7.50
5725 5.50
5726 11.37
5727 7.05
5749 2.50
5751 4.00
5763 4.50
5814A 4.00
5840 4.00
5842 12.00
5876A 31.50
5879 5.00
5886 17.50
5963 2.50
5965 3.50
6005 2.25
6021 4.50
6057 10.23
6058 12.34
6059 6.00
6061 6.00
6063 3.75
6064 8.58
6067 10.23
6072 6.00
6080 14.00
6097A 235.00
6097B 200.00
6146A 8.25
6146B 12.00
6159B 19.00
6189 9.50
6201 11.40
6442 20.00
6550 8.00
6883B 8.25
6973 4.00
7025 3.00
7027A 8.00
7551 6.25
7586 15.00
7587 23.00
7609 56.00
7868 6.00
7895 12.00
8005 110.49
8068 14.00
8122 100.00
8136 2.50
8417 6.00
18042 11.53
18045 10.49
Tested
Ex-Equipment
4CX250B 6.50
CV Devices
Large stocks
Prices on application

BASES

B7G Unskirted 0.40
B7G Skirted 0.50
B9A Unskirted 0.40
B9A Skirted 0.50
B9D 0.55
Int Octal 0.40
Loctal 0.55
Nuvistor base 2.00
Valve screening cans all sizes 0.40

CRTs

2AP1 8.50
2BP1 9.00
3BP1 12.00
3DP1 5.00
3EG1 10.00
3FP7 6.00
3GP1 6.00
3JP1 8.00
3JP2 8.00
3JP7 10.00
3KP1 15.00
3RP1 35.00
3WP1 20.00

5ADP1 55.00
5CP1 10.00
5CP1A 40.00
5FP15A 15.00
5UP7 25.00
DG7-5 63.32
DG7-31 58.07
DG7-32 58.07
DG7-36 65.00
DH3-91 56.83
DH7-11 113.12
VCR97 12.00
VCR138 12.00
VCR138A 12.50
VCR139A 8.00

VCR517B 10.00
VCR517C 10.00

CRT sockets
Prices on application

I/C sockets
Texas
low profile
8 pin 10p
14 pin 10p
16 pin 10p

INTEGRATED CIRCUITS

7400 0.16
7401 0.17
7402 0.17
7403 0.17
7404 0.18
7405 0.18
7406 0.43
7407 0.43
7408 0.20
7409 0.20
7410 0.17
7412 0.29
7413 0.32
7416 0.32
7417 0.32
7420 0.18
7422 0.20

7423 0.33
7425 0.30
7427 0.30
7428 0.43
7430 0.17
7432 0.30
7433 0.40
7437 0.32
7438 0.32
7440 0.32
7441 0.90
7442 0.72
7447AN 1.17
7450 0.18
7451 0.18
7453 0.18
7454 0.18

7460 0.18
7470 0.38
7472 0.33
7473 0.38
7474 0.38
7475 0.54
7476 0.42
7480 0.56
7482 0.75
7483 1.00
7484 1.05
7486 0.39
7490 0.60
7491 0.82
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7493 0.60
7494 0.82

7495 0.73
7496 0.82
7497 3.15
74100 1.54
74107 0.45
74109 0.73
74110 0.51
74111 0.71
74116 1.85
74118 1.00
74119 1.54
74120 0.83
74121 0.43
74122 0.62
74123 1.18
74125 0.58
74126 0.58
74128 0.63
74132 0.72

74136 0.51
74141 0.89
74142 2.30
74143 2.60
74144 2.60
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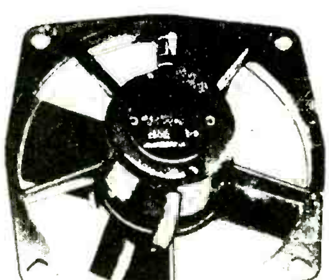

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CIRCLE 96 FOR FURTHER DETAILS.

Ptarmigan at last

Ptarmigan, the secure tactical communications system linking static and mobile battlefield units in a digital cellular-type network, is now fully operational with British service units in West Germany. As a "second generation" tactical command, control and information system it is claimed to be in advance of anything previously fielded by NATO services. Although greedy of radio spectrum, Ptarmigan is designed to "degrade gracefully" if the network sustains damage.

But, for those with long memories, Ptarmigan might better be named Phoenix, having risen from the ashes of the Hobart plan of the early 1960s, and the aborted Project Mallard proposed later as a joint American, Australian, Canadian, British plan for tactical communications. Hobard led to the Clansman single-channel radios, but its elaborate digital switching and trunking system was temporarily put aside in favour of Bruin as a secure area system.

Ptarmigan comprises a fully transportable, distributed trunk network containing switching nodes via which brigade, division and corps subscribers have dialled access, much as outlined in the Defence White Paper of 1963. Anyone with access to the radio switching nodes, and this includes single-channel radio access from vehicle and packsets, can be connected to the line and radio multichannel trunking system. The act of lifting the handset automatically transmits a "calling line identity" to a 12-channel central. The system depends on the Plessey System 250 stored-program processor for switching, routing, signalling, multiplexing, interfacing and supervisory functions, with four-wire 16Kb/s time division multiplexed channels. The original Ptarmigan concept has been enhanced to provide a packet switched network, using the X.25 protocol, for the Wavell automatic data processing system.

As foreseen in the Hobart Plan the whole battlefield area is provided with a high-capacity and flexible communications grid in which static and mobile users can be brought into contact via the lorry-mounted digital switching nodes. It has been 22 years in the making, but has been warmly welcomed by the Royal Signals — though, as noted below, not everyone is convinced that the necessary software expertise to keep it going is available.

Software crisis

The Spring 1985 issue of *The Journal of the Royal Signals Institution* follows a description of the Ptarmigan system, perhaps coincidentally, with a warning by Colonel A.J. Sammes of a "crisis in software support". He foresees the possibility of entire area networks failing at critical moments due to lack of skilled software support. In particular he is concerned that software errors or deficiencies cannot readily be put right in the field without skilled personnel and full access to all the original documents, plans, notes, charts, schedules, magnetic tapes and discs, as well as to the stored program itself.

Unlike hardware maintenance and modification, a change to software requires all the facilities and information used by the software designers to be available to the maintainers and enhancers: "A level of specialized expertise and equipment is now needed that we cannot reasonably expect to find deployed in the field. . . finding a permanent solution to a critical error may take weeks of effort and is more difficult and more error-prone than the original development of the software."

Col. Sammes sees the need for the creation of far more software and hardware support, including quick-reaction teams, in-house and contract software maintenance staff, software integrity and security teams. MoD have recently established a new Directorate of Communications and Information Systems (Army) one of whose tasks is to consider the need for an integrated support organization for CIS. But if it took Hobart 22 years to come finally to fruition, how long will it take to provide the sort of support needed to prevent Ptarmigan and similar systems from failing when they are most needed? I recall the story of an American "European" switching centrre in Paris which, due to an unsuspected software error, shut itself down for 24 hours during a crisis.

High and wide

It often seems that the only point on which members of international and national television standards committees can all agree is to disagree. The current attempts to establish an entirely new "world standard" for high-definition television are still making only slow progress, despite the impact made by demonstrations of the Japanese 1125-line, 60Hz, 5:3 aspect-ratio system, using very high-cost projection displays.

Having seen not only that system but also more recently the new wide-screen enhanced C-MAC pictures demonstrated by IBA, I am far from convinced that there is any need to create at this stage an entirely new plus-1000 line standard for broadcasting, although justifiable for electronic cinematography. With digital processing in receivers, the basic 625-line 50Hz system (and according to RCA even the 525-line 60Hz standard) can produce extremely impressive pictures using progressive (sequential) scanning for the display. Keeping the luminance and chrominance components separate, as with the MAC systems, also noticeably cleans up pictures and helps give an illusion of higher definition even without digital processing.

As someone who in the past has often complained of the flicker on 50Hz interlaced systems, it comes as something of a revelation to discover how much of this is in fact 25Hz interline flicker and how little large-area flicker remains with 50Hz progressive systems.

RCA engineers are also drawing attention to the effect of the mechanical jitter on film displayed in the cinema and argue that even well-maintained modern cinema projectors provide dynamic picture resolution of not much more than 750 lines, a resolution that can be achieved with digital processing from both 525- and 625-line pictures.

ICAP 85

A more application-orientated approach than at some of the earlier International Conferences on Antennas and Propagation is reflected in the 130 or so papers delivered at the IEE/URSI ICAP 85, which attracted almost 300 delegates to the University of Warwick during April.

Nevertheless, with some 130 papers and up to three simultaneous sessions, and a conference book (IEE Conference Publication No 248) running to 584 double-column pages, it would be surprising if all delegates came away with any clear idea of what was and was not truly significant.

Much of ICAP 85 was concerned with microwave and millimetric propagation, rain attenuation and rain scatter; electronic steering of antenna arrays, including the possible use of adaptive antennas on satellites; h.f. over-the-horizon and sea-state radar, seemingly now attracting increasing attention in the UK; direction-finding and null-steering for electronic counter-counter measures; a clutch of BBC papers on h.f., v.h.f. and microwave antenna and coverage-prediction techniques for broadcast applications; satellite antennas and propagation; broadband antennas for frequency-hopping and surveillance; millimetric radio telescopes; u.h.f. propagation for mobile cellular radio; anomalous v.h.f. and u.h.f. propagation including ducting. Many of the papers reflected university research including a number funded with a view to new defence systems.

A joint BBC/Royal Military College of Science (which was 'privatized' in 1984 as part of the Cranfield Institute of Technology) paper on a cost-constrained 'flat-plate' antenna for the reception of 12GHz d.b.s. television underlined the advantages of having a steerable 'flat' antenna that could be affixed to the side of a building. But it seemed less than certain that the proposed antennas, constructed from a microstrip comb-line sandwich structure and using lightweight foam material, will prove as practical as the conventional parabolic dish reflector, at least until further progress has been made. A problem appears to be the inevitable loss of gain when the antenna is mounted so that considerable steering is needed, reducing the effective aperture.

With papers from Canada, China, Germany, Sweden, South Africa, Israel, Belgium, USA, Japan, India, U.S.S.R., Italy, France, Denmark, Holland, Taiwan, Poland, Spain, ICAP 85 retained its international flavour.

Aerostats

About ten years ago there was considerable interest in the idea of using load-carrying balloons, called aerostats, bearing aloft v.h.f. television transmitters to provide wide-area coverage from a single site. A Westinghouse subsidiary (TCOM) announced orders to supply such systems in the Caribbean, Iran and Nigeria. The BBC looked in some detail at the use of such a system for v.h.f. when 405-line transmissions ended. The schemes seem to have come to nothing, though I believe one was implemented in the Caribbean. Earlier, u.h.f. television broadcasting from aircraft was used operationally for an educational service in the USA and also by the Americans in Vietnam.

The 20,000ft balloon sky-hook, much cheaper than d.b.s., appeared an attractive system (though possibly not to airline pilots) and I have never understood why it apparently never caught on, or what the practical, financial or technical problems proved to be. From just two aerostats you could cover the UK nationwide. It was therefore interesting to note that Westinghouse are currently demonstrating an L-band surveillance radar (AN/TPS-63) to the Saudi Air Force, lifted by a 365,000 cubic-foot aerostat, as a supplement to early-warning aircraft.

Holiday rigs

"Have rig — will travel" is a concept that is growing apace among both h.f. and v.h.f. enthusiasts. During the summer months many amateurs can be heard operating from unfamiliar locations, particularly those that have a rare prefix or even an unusual "square" designation. Monaco, Liechtenstein, Luxembourg, Andorra, Aland Islands suddenly become centres of amateur radio activity.

With rare prefixes it is easy to get answers to CQ calls even if your signals are relatively weak, but rather more of a problem exists for visitors to countries having considerable indigenous radio activity.

Compact, self-contained h.f. or v.h.f. transceivers are readily transportable. On v.h.f. it is also relatively easy to devise an antenna array that dismantles and fits into a portable carrying case. At a pinch even a foil quad loop stuck on a window pane can be reasonably effective.

For h.f. the problem is more tricky, although a throw-out random length of wire can be surprisiingly effective provided the traveller has brought along a flexible antenna tuning unit. Increasingly popular are mobile-type whip antennas mounted on a balcony, using monopoles but also occasionally end-fed loaded dipoles. But I was surprised recently to contact on 7MHz an Austrian amateur putting out a remarkably good signal from a hotel in Germany from a rod antenna only about a metre in length. Admittedly his transmitter was about 100 watts. It has always seemed to me that while there is a lot of interest in very-low-power operation (under 5 watts) with good antennas, more could be done to improve the efficiency of miniature, easily portable, h.f. antennas regardless of the transmitter power.

Microwave danger?

Questions surrounding health hazards posed by non-ionizing microwave radiation never seem to go away. Recent claims from Poland that military personnel exposed to relatively low levels of microwave radiation are from three to seven times more likely to suffer from certain forms of cancer compared with those not so exposed have again highlighted the continued reluctance by British authorities to act on the 1982 recommendations of the National Radiological Protection Board to lower the safety limits of v.h.f. and microwave radiation. Moreover the Polish findings appear to put in question even the proposed NRPB limit of 0.4W/kg of body weight (current British safety standard is 1W/kg).

Safety limits not only affect people working near to radar and radio transmitters and industrial r.f. generators but also microwave leakage from damaged or inadequate microwave-oven doors. The Polish investigations suggest that exposure increases the risk of cancer of the lymphatic system and blood forming organs and also, to a lesser extent, thyroid, stomach and skin cancers.

British safety standards have always been based on the premise that the only proven hazard of non-ionizing radiation is the heat generated by absorption, with particular reference to eyes.

Diamond jubilees

This recent 60th anniversary of the formation of the International Amateur Radio Union in which the American Radio Relay League were prime movers in Paris in May 1925 is only one of several "diamond jubilees" in the amateur radio field this year. It was in February 1925 that a change of ownership of *The Wireless World*, previously carrying the official notices of the Radio Society of Great Britain, led first to *Experimental Wireless* becoming the official journal in its stead, and then quickly to the launch in July 1925 of the *T & R Bulletin* by the more active Transmitter & Relay Section of the RSGB. This was the first British publication devoted entirely to amateur radio, surviving 720 monthly issues later as *Radio Communication.*

It was also in 1925 that Gerald Marcuse, G2NM, began a series of telephony broadcasts to New Zealand that quickly led to his pioneering, in advance of the BBC, and with Post Office permission, the first regular h.f. broadcasting from the UK intended for reception by listeners in all parts of the then widespread British Empire. He used a 1.5kW transmitter on 32.5 metres and a 100ft high antenna at his home in Caterham, Surrey, later setting up a studio and control panel in the nearby home of Percy Valentine.

Here and there

The RSGB and City & Guilds of London Institute have been invited by the DTI to tender for taking over responsibility for the Amateur Radio Morse Test. British Telecom, who inherited the running of the morse test from the Post Office, is expected to relinquish this responsibility in 1986.

DTI are to introduce a new form of abbreviated licence certificate with full licence conditions to be available separately in book form.

About 70 British special-call stations were licensed for operation for use over the "40th anniversary of VE Day" period using for the first time the prefix "GV".

Rajiv Gandhi who became Prime Minister of India following the assassination of his mother, Mrs Indira Gandhi, last October has held and used on h.f. and v.h.f. the amateur callsign VU2RG since January 1975. In that year he built his own h.f. s.s.b./c.w. transceiver (which he used until 1982) and a two-element quad antenna. His wife, Mrs Sonia Gandhi, has held and used the callsign VU2SON also since 1975 and his teenage son and daughter are reported to be studying to take the examination.

In brief

The British Amateur Teleprinter Group is holding a rally at Sandown Park, Esher, Surrey on Sunday, August 25. The Group is also offering to provide local clubs with speakers on r.t.t.y., Amtor and "packet radio" (Ian Wade, G3NRW, 7 Daubeney Close, Harlington, Dunstable (daytime telephone 0582 429141)... As an entry in a 40th anniversary "suitcase radio" event organized by the G-QRP Club, S. Garner, G3WSL has built a miniature 7MHz transceiver inside a standard, battery-powered bicycle lamp — which still functions as a lamp. Using four transistors plus an MD108 double-balanced mixer as the active devices, his rig comprises a two-stage one-watt crystal-controlled transmitter and associated fixed-channel direct-conversion receiver... Pat Hawker, G3VA.

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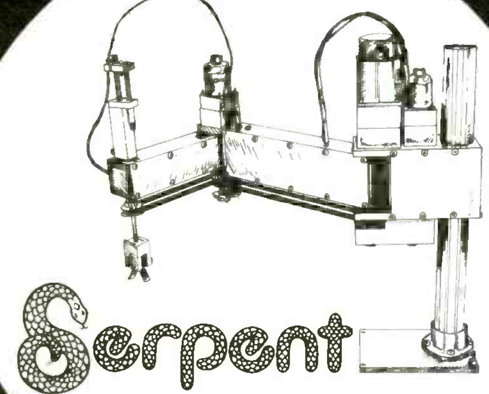

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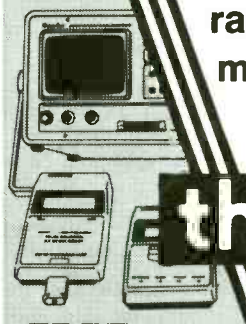

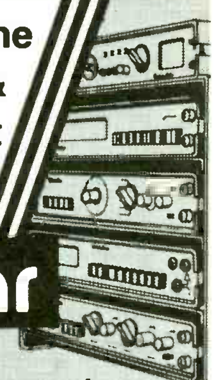

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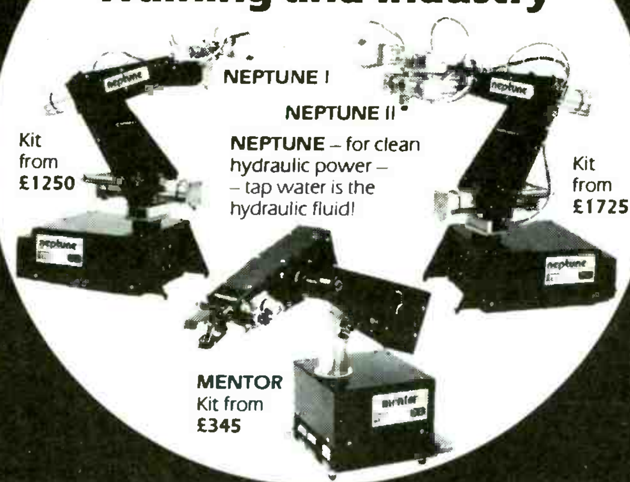

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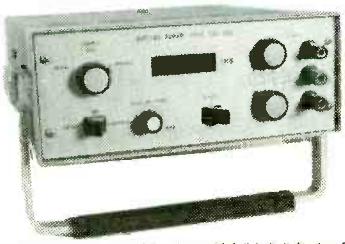

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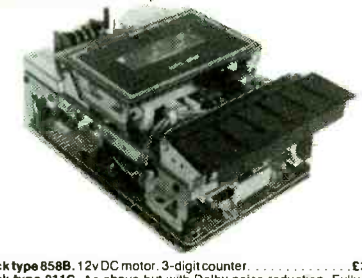

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VALVE DISC PREAMPLIFIER

I read with interest the article by Richard Brice on a valve disc pre-amplifier. I agree with his basic assumptions and design philosophy but he has made some errors of calculation.

The 10nF capacitor in conjunction with R_1 (1MΩ) will not produce the 7950µs IEC bass roll-off. The Thevenin impedence seen by the 10nF capacitor is more of the order of 18MΩ due to the bootstrapping effect of the cathode follower. There is no need to change this — the IEC roll-off may be implemented elsewhere. His equalization is, unfortunately, incorrect. He has assumed that the equalization network sees only the 250kΩ series resistor, (where do you get 250kΩ resistors)? In fact, it sees the Thévenin equivalent circuit which is the 250kΩ resistor in parallel with the 1MΩ resistor. An easy mistake — I did the same for months in blissful ignorance.

If we re-calculate the values of components in the equalization network we can also add the IEC roll-off. This has the added advantage that we can replace the 1µF electrolytic capacitor with a better-quality component such as a polycarbonate. See diagram 1.

The only other changes I would make are of detail, the 1µF capacitor feeding the 250kΩ potentiometer could be replaced by a 0.22µF polycarbonate. The 1µF capacitor following could be replaced by a 10nF as used in the earlier stage.

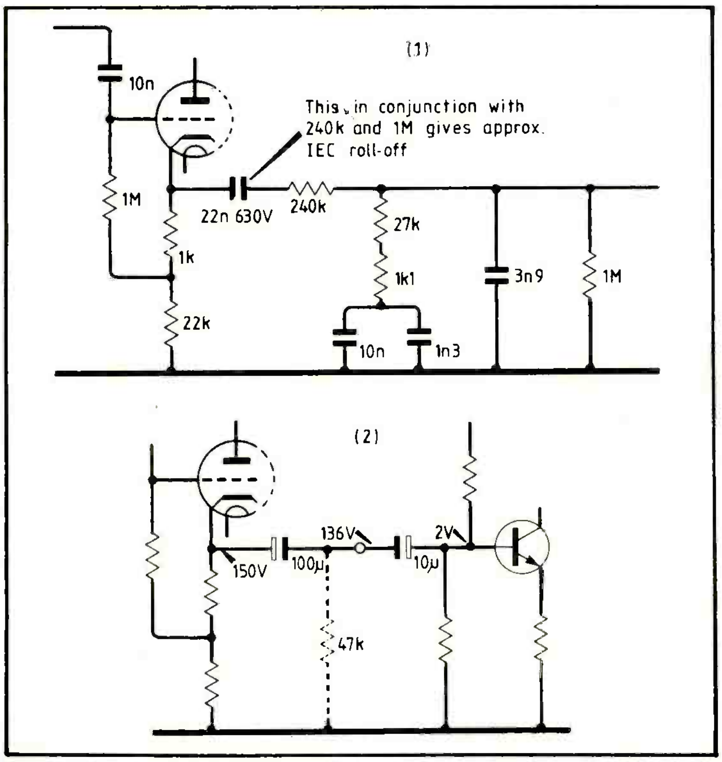
The 100µF output coupling capacitor must surely be a bulky and suspect component; is it really necessary? The output stage should not be loaded by less then 10kΩ, so if we accept that as the minimum input impedance of the power amplifier, we find that 4.7µF would be an adequate value. It may be possible to use a non-polarised component here, but it would be expensive.

A word of warning, some transistor power amplifiers have coupling capacitors on their inputs with the laudable aim of preventing damage due to d.c. being applied at the input. Valve equipment always has an output capacitor to protect the following stage. Therefore connecting a valve pre-amplifier to a transistor amplifier should be safe. Occasionally this is not so; diagram 2 shows why.

The capacitors charge to equal values of charge: by applying Q = CV, we find that the small input capacitor of the amplifier has a large reverse voltage across it. It will fail quickly.

The solution is to add a resistor, shown dotted, or to remove one of the capacitors.

M. Jones
Shirley Warren
Southampton



RELATIVELY BORING?

Is it not possible to stem the flow of letters and articles on relativity, energy transfer and the other recondite subjects that appear to have taken over the pages of *Wireless World*? I realise that these are important, but why do they have to take up space in this particular magazine, which is supposed to be for engineers?

One could not object to the occasional page or two of exotica, but the continuous welter of statement and counter-statement, argument and bad-tempered knocking is becoming boring. It does seem a pity that all these, no doubt very clever people can't iron out their differences in some less public and less space-consuming place and then present us, once and for all, with the outcome.

Surely, Einstein, Maxwell, Michelson and Morley, Catt, Jones and all the rest are either right or they are wrong. Please try to find the most respected scientific figure in the world and get him to say which. Then, maybe, we can all get back to something useful.

H. Morgan
Tonbridge
Kent

Who would Mr Morgan suggest? — Ed.

LOGIC SYMBOLS

I can sympathise with the views expressed by Mr Hayward (Feedback, May 1985) regarding the new logic symbols. As an amateur enthusiast, I certainly hope the amateur magazines do not adopt this standard for their circuit diagrams, but the style used at the moment does not escape criticism either. Many magazines (not *Wireless World*) use unidentified blocks for complex i.cs and provide a legend elsewhere on the diagram (IC_1 is 74LS193, IC_2 is. . .) which makes it quite difficult to understand at a glance.

With my other hat on, as a professional engineer, I do not think Mr Hayward has the right attitude. He may well, as most of us do, operate his own personal or in-house standard for logic diagrams with complete self consistency, and very successfully too. The trouble is that the standard used is probably different from the way anyone else does it. As such the new BS will unite. I must confess though, that I dread to think how a Z80 or 6502, or for that matter a 68020, will be represented in the new scheme.

One point that Mr Hayward seems to have missed, is that it doesn't matter a jot which logic representation is used. The designer (of a complicated circuit typical of industry) invariably understands his design, while no one else does without considerable effort. If nothing else, then the BS provides the mechanism for fully documented top down design, and can lead the observer gently into the intimate details of a fiendish design.

I wish to close by taking (a minor) issue with the BS. The qualifiers used to designate the function of a combinatorial box seem based on mathematical principles, eg Or "≥1", XOr "=1", and presumably a three-input, majority-voting circuit would be "≥2". Why then is the And function given by the non-mathematical symbol "&"? Surely, a two-input And gate ought to be "=2", a three-input one "=3", etc. While I admit the use of the ampersand means that you don't have to count the inputs, I contest that this concession to the old standards breaks the symmetry of the new.

Ken Wood
Ipswich
Suffolk

While I have a certain sympathy with Mr Hayward and his views about the new logic symbols I may have them presented to me and have no option but to learn them and use them. What I should really like to know is what are the policies of the major manufacturers with regard to this standard.

Mr Kampel's statement, in his first article, that: 'France, Germany, Netherlands, Japan, the UK and USA and many more now intend to bring their own national standards fully or broadly in line. . .' implies, to me, that manufacturers are all set to follow suit. This is not at all sure. We are all aware of the impact that BS 3939: Section 21 (published in 1977) had — very little, and Section 21 was very similar to IEC Publication 117-15 which was certainly not a home-grown standard.

I am aware that publications for the armed services written to the Joint Services Publications (JSP) standads require symbols to be drawn to BS 3939 but I think I am right in suggesting that the use is selective. How many publications contractors make full use of, for example, the common control block notation?

The Texas TTL Data Book 5th Edition 1982 has as a supplement: 'Explanation of the New Logic Symbols'. The introduction mentions that work first began in the mid 1960s. IEEE/ANSI Standard Y32.14-1973 proposed the introduction of rectangular symbols for gates. I cannot remember ever having seen a 'square gate' on an American circuit diagram. A brief 'phone call to Texas suggested that they were not aware of any impending changes and a similar position seems to be current amongst a number of other manufacturers to whom I spoke.

The First Quarter 1985 issue of the *Journal of the Society for Technical Communication states:* 'IEEE Std 91-84 Graphic Symbols for Logic Diagrams. Dated 9th July 1984. This standard has been accepted by the Department of Defense for logic symbols.' Does this mean that manufacturers in the USA will now be obliged to change? If they do then very soon we shall all have to comply.

One need look no further, however, then page 23 of the May issue of this journal to see some very old-fashioned symbols; even I draw the line at 'wiggly resistors'!

My concern is with technical publications and training and I have to deal with equipment and handbooks from different sources and prepare material for use by students from many different countries. It is important that both the technical author and the lecturer be aware of impending change. Mr Kampel, in his interesting articles, has forewarned me but need I pay any real attention if this latest attempt at standardisation is largely to be ignored as was BS 3939?

L.P. Best, F.I.S.T.C.
Aldershot
Hampshire

FUNDAMENTALS OF ENERGY TRANSFER

P.L. Taylor (Letters, June 1985) is unfair to me, probably because he has not read much of my writings. The whole thrust of "The Catt Anomaly" (*WW* Sept 1984, p.48) is that the conventional theory (which I call Theory N) contains logical inconsistency when it tries to explain the TEM wave, because electrons are involved. I base the case for my own theory, Theory C (*WW* Dec 1982 and Oct 1984) on the point Taylor is making. Does he really expect me to defend the conventional theory, which I habitually attack, for his benefit?

N.C. Hawkes (Letters, June 1985) misunderstood my February letter. He discusses the force between charged conductors and the force between conductors carrying current, whereas I am discussing the force between two conductors between which a TEM wave is travelling. I only mentioned charged conductors and current-carrying conductors in passing, in order to prove that the force between conductors between which a TEM wave is travelling is zero. Having established that the force is zero, I then proceeded to superpose two TEM waves. Hawkes has put the cart before the horse and turned them round and upside down.

I congratulate C.B.V. Francksen (*WW* May 85) on the first two and last three paragraphs of his letter.

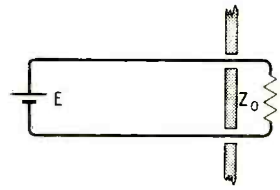
My own position is that "modern physics", as the Establishment developments in our field during this century are termed, is a collage of layer upon layer of muddle, misconception and confusion. We do not just have a problem of one or two errors in the structure. The whole is riddled with error, and a false philosophy of science has developed to buttress it. When it collapses, the effect will be devastating. I do not believe we shall save much fundamental theory from the mess of the twentieth century.

What we *can* do is try to get more study going on the politics, the sociology and the self-seeking contained within the science of this century, so as to learn the lessons we shall need in order to stop a similar mess from engulfing the science of the twenty-first century. We musy learn why apparently clever men succumb to such a welter of arrant nonsense; what part of their action stems from self-interest; what part from lack of mental agility and what part from the very narrow education that scientists are subjected to.

Ivor Catt
St Albans
Hertforshire

It is quite easy by pejorative writing to attack, as D.H. Potter does in *WW* April, 1985, Ivor Catt and myself. If will need somewhat more skill and persistence to attack the ideas put forward. Mr Potter says in his letter that I assume the lines initially quiescent, but I am not aware of having said that, any more than I am of unwinding reels to infinity. I simply assumed, as the SI definition of the ampere requires, that a current of 1 A is established in the conductors. How that current is set up is of no concern, since the measurement is done *after* the current is established. There was a slight error in the diagrams reproduced in *WW* that may have caused some confusion although the text was reasonably complete without the diagrams. I will give a numerical example that will, I hope, illustrate my point.

It has been long established, and I take no issue with it, that if we have a transmission line passing through a partition, no measurement that is done at the sending end can determine whether the line beyond the parition extends to infinity or is terminated in its characteristic impedance. A practical man of course would have doubts and put his head round the partition to see. The diagram shows such a line terminated in Z_0. Force may be measured on a metre length on the left hand side of the partition and the results will apply to the infinite line.



Consider a line that is not too different from that of the SI definition. The conductors could be 4mm diameter spaced 1m. It is easy to calculate that $Z_0 = 745\Omega$ and the capacitance per metre is 4.747 pF. Thus the value of E necessary to establish a current of 1 A is 745 V and that p.d. produces a charge per metre of 3.36 nC. The force between two such charges at a distance of 1 m is 2×10^{-7} N, which is the same as the magnetic force between the conductors when carrying 1 A, and in the opposite sense so that the net force is zero. Ivor Catt reaches the same conclusion, but by a different method.

I had not intended to enter into a prolonged discussion on this matter for I have taken it up before in *Physics Education*, a journal of the Institute of Physics. The issues concerned are Nov 1981, Mar 1982, Nov 1982, May 1983 and July 1983. Indeed if Mr Potter cares to consult the July 1983 issue of *Physics Education* he will find Professor R.G. Chambers stating my case rather more strongly than I did myself.

The question not unnaturally rises, if the ampere is always realised with an Ayrton-Jones balance, then why not define it in terms of that apparatus? It is as easy to specify circular conductors as straight ones, and clearly the manufacturing tolerances are as good in one case as the other.

One point on which I do agree with Mr Potter is the slovenly use of the term *impedance of free space*. The word *impedance* is a bad choice and *impedivity* or *specific impedance* would be better for it is an impedance measured in a specified way. What is referred to is a superficial resistivity of 377Ω/square. Space card is paper loaded with conducting particles such that if we cut a square from it with arbitrary length of side, the resistance between two opposite edges is 377Ω. Any air-spaced transmission line passing through snugly fitting holes in the space card will have all its energy absorbed by the card and there will be no reflections.

I have said snugly fitting holes since I feel that the card should make good electrical contact with the conductors. However that may not be necessary. Heaviside, Poynting, and Ivor Catt all believe that transmission line energy is carried by the dielectric and only guided by the conductors. Space card may offer a way of testing that hypothesis. If the conductors are varnished where they pass through the card so that there is no electrical contact, it should make no difference if the energy is indeed only guided by the conductors, but all the difference if the conductors carry the energy. I do not have the facilities to test for reflection in the varnished and unvarnished cases, but if anyone does I would be glad to know the result.

Chris Parton
Uddingston
Glasgow

May I offer a few thoughts on that part of Chris Parton's letter (*E&WW*, Dec. 1984, p66) relating to the NPL defination of the ampere involving infinitely long parallel conductors? It seems to me that electric current is defined simply by the differential equation

$$i = dq/dt \qquad (1)$$

When the unit of charge is the coulomb (a physical quantity) and the unit of time is the second (a physical quantity) we obtain the unit of current called the ampere (a mathematical concept).

The NPL definition of the ampere seems at first sight to involve forethoughts that the ampere has to be subsequently realised by a physical system because of its practical utility and that the definition is "superior" to the c.g.s. "circle of wire" definition. When we try to define it apart from Eq. (1), we always run into difficulties over concepts such as "conductors of infinite length" and so on which are not allowed in real life physical systems. The c.g.s. "circle of wire" difinition also involves difficulties: Does a unit pole exist? How does the current enter and leave the coil? What is meant by force? etc.

What the NPL is doing is defining the ampere in an "absolute type" of way. The term "absolute" was introduced by Gauss, meaning independent of the size of any particular instrument, or the value of gravity at any particular place, or of any other arbitrary quantities than the three standards of length, mass and time. But with concepts such as electric current I do not see how the difficulties I have mentioned can be avoided. Mechanical quantities can be defined in Gauss's absolute way but it is better, I think, to refer to "the NPL definition of the ampere" and to realize that it is an "absolute type" of concept from which any practicality has been removed. When the NPL has to realise the ampere practically then, of course, all thoughts of infinite conductors, unit poles, etc. vanish from their minds and they turn to the realities of forces and torques on mutually magnetically coupled coils, masses and levers.

May I draw readers' attention to part of a comment[1] by Dr A.T. Starr (whom I knew at Callender's Research Laboratories in 1939 and for whom I have the utmost respect)? "The development of electromagnetism adopted in this chapter is regarded with disfavour by many teachers of the subject and international committees. A few words in defence of the method will therefore be given. . . we are told that the idea of a magnetic pole is very deluding and that we are likely to find ourselves 'floundering in a world of make-believe'. This need not alarm us, as anything abstract is 'make-believe' and may be indulged in, provided it is self-consistent and useful. . . the fact that a north pole is asociated with an equal south pole is not sufficient to make the idea of a single pole useless or misleading, just as the fact that every action is associated with an equal and opposite reaction does not prevent the idea of force from being useful." The whole of this reference is very worth-while reading.

In conclusion, I feel that the 'wisdom of our forefathers' was in the c.g.s. definition and that the NPL has erred in adopting the infinitely long wire definition. Chris Parton isto be congratulated on explaining the absurdity of introducing infinity into any 'absolute type' of definition. May I gently remind him, however, that parallel infiinite wires never occurred originally in any c.g.s. definition?

Philip John Drake
Whickham
Newcastle-on-Tyne

Reference

A.T. Starr "Electric circuits and wave filters". (Pitman. 2ND Ed. 1944, pp.63-65).

CORRESPONDENCE, PROBLEM OR PARADOX?

In computer vision, we are led to believe that by finding corresponding objects in stereo images we can extract 3D information. In the correspondence technique, an object is found in one image and its *corresponding* object is found in the other stereo image; then using triangulation we find the range of the object. The method seems obvious but has never been implemented in practice because the rules for working out which objects correspond has never been found and hence we get the 'correspondence problem'.

However, presented now is proof that the correspondence problem was never a problem but an insoluble paradox. To start off, we say that our overall objective is not solving the correspondence problem but general object recognition with no 'a priori' knowledge of the scene. On examining the image we may find several objects but we cannot decipher the size of the objects because a small object will have the same size when imaged as a similar but large object further away. To resolve this we take a second and stereo image with the intent of finding the *same* object in both images and use triangulation to calculate object distance. In practice, finding the same object in both images is difficult and hence we get the correspondence problem. In truth, however, finding the *same* object in both images is impossible because to find the *same* object in both images we must *recognise each object* and to do that we *must* know how far each object is away from the camera! That is, we must know how far each object is before we can try to find the corresponding object.

We clearly have a paradox. We need stereo images to range objects. To solve the correspondence problem we need to know in advance how far each object is away from the camera. To find out how far each object is away from the camera, we need stereo images. . . ad infinitum. Hence we conclude that the correspondence problem is not a problem but an insoluble paradox.

J. Michael
London N.4.

Letters

Letters for publication are always welcome, but the shorter and pithier, the better. I try not to edit original letters, but sometimes they are far too long, and therefore cut, and the writers upset. Please keep your letters short.

CORRECTIONS

Fast camera interface

In the timing circuit of this design for interfacing a video camera to a microcomputer, (June issue) the v.c.o. timing capacitor is 5pF. We apologize for this ommission.

Helical antennas for 435MHz

This reference list was accidentally ommitted from James Miller's article in the June issue.

References

1. Kraus, J.D. Antennas, Chap.7, McGraw-Hill, 1950.
2. King, H.E. and Wong, J.L. Characteristics of 1 to 8 wavelength uniform helical antennas, *IEEE Trans. Ant. & Prop.* vol. AP-28 No.2, March, 1980.
3. Tilson W.V., On evaluating the performance of communications antennas, *IEEE Communications Magazine* September, 1981.

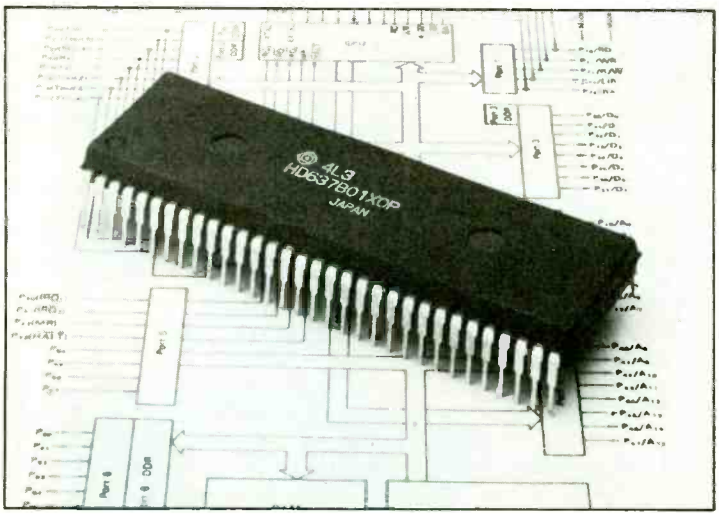
British Electronics Week

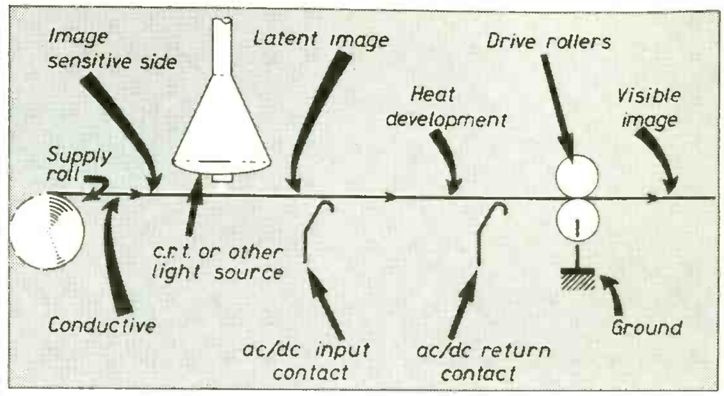
Two halls at London's Olympia were used to house a combination of the All Electronics Show, The Electronic Product Design Show and the Fibre Optics Exhibition. Despite its title, this great extravaganza lasted only three days, and with over 800 exhibitors it was found to be impossible to cover everything. We offer here details of some of the products which particularly attracted our attention.

Programme-once-only micro

Zero turn-around is the title invented by Hitachi for their processor which has on-chip prom that is not erasable, so that is programmed once and the operating system is retained from then on. This gives the equivalent of a masked device without the cost and the delay time usual for such devices.

The ZTAT principle is to be extended from the present 63701 to other processors. Hitachi were also proudly displaying their HM65265 pseudo-static ram which, they claim, offers the best of the static and dynamic memories combined together, i.e. high speed and low power. Hitachi Electronic Components (UK) Ltd., 221 Station Road, Harrow, Middlesex HA1 2XL. EWW208





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Designed for use in medical imaging such as ultrasonic scanning and fluoroscopy, the Imager is self contained and may be used in aseptic environments. The system has been used to print electron microscope images. Other applications include facsimile printing of satellite or laser images, computer printing and graphics hard copy, and instrumentation logging. Different papers and films are available for various applications and others including u-v sensitive film and colour images are in course of development. 3M United Kingdom plc, PO Box 1, Bracknell, Berks RG12 1JU. EWW204

Development system with Concurrent CP/M-86

The STE bus standard is used in the ARC88 computer system. The 80188-based computer runs Concurrent CP/M-86 and provides facilities for the development of 80188 software for use in real-time target application or as an expandable system for general-purpose laboratory computing. The minimum configuration consists of two boards, a floppy disc controller and the processor with its twin d.m.a. channels, three counter-timers and interrupt vectoring priority. It also has 256Kbytes of dynamic ram, two programmable serial i.o. channels, STE bus clock, reset and arbiter circuit. The disc controller supports either 3 or 3.5in drives with up to 1.6Mbytes total capacity.

Eight card slots are left free for expansion and the user may choose from a wide variety of modules, including an eprom programmer, v.d.u. drivers, a real-time clock with up to 48K extra memory, and a range of industrial cards such as a-to-d and d-to-a converters. Concurrent CP/M-86 is a multi-tasking, multi-user system that is event driven and holds all current programs in memory for fast response. The system comes with an integral power supply large enough to handle fully populated racks. Prices start at under £3000. Arcom Control Systems Ltd., Unit 8, Clifton Road, Cambridge CB1 4WH. EWW206

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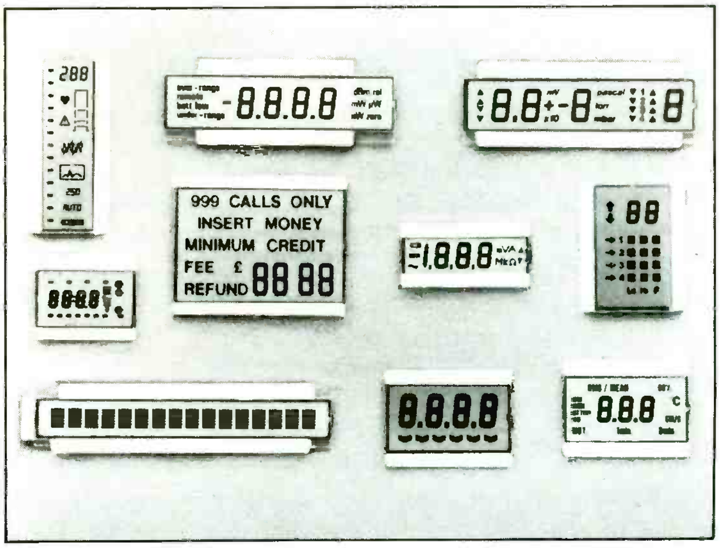
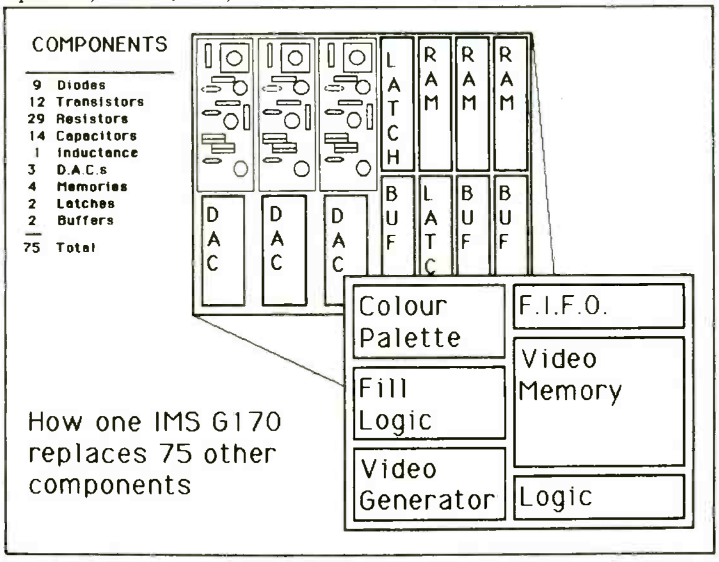


Graphics colour controller

Combining the functions of a colour palette and video memory, the IMS 170 from Inmos is capable of generating 256K different colours, of which any 256 may be displayed on a screen at one time. The 28-pin chip incorporates a colour look-up table, three (RGB) 6-bit d-to-a converters, video memory and microprocessor interface. Colour change is enabled by a pixel word mask which allows colours to be altered in one clock cycle. With a pixel rate of up to 50MHz, very fast graphics and animation may be achieved. The integrated circuit was on demonstration at the Show but details are not yet final. Inmos Ltd., Whitefriars, Lewins Mead, Bristol BS1 2NP. EWW201



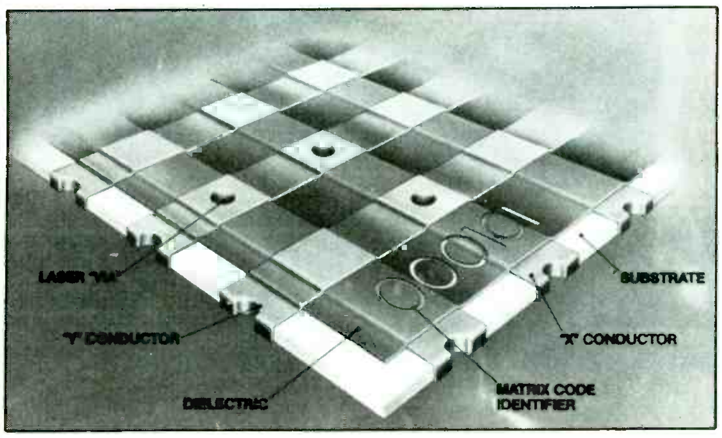
How one IMS G170 replaces 75 other components

Coded key

A thick film matrix is used to store a number, which can be used for identification and in security systems. The idea is not new; pins and a matrix of copper tracks on a p.c.b. have previously provided such coding. The new system, 'Pre-programmed Memory' from Welwyn, has miniaturized this onto a 16-by-16 matrix on a ceramic substrate, the device being 10mm square.

A layer of tracks 0.25mm wide and the same distance apart are printed onto the substrate in the 'x' direction. These are coated with a thick film dielectric material. A laser is used to punch neat holes in the dielectric so that when the 'y' conductors are printed on top, they make contact with the x layer through the holes. The laser can also print the code onto the device so that it may be visually identified. The manufacturing system is highly automated with automatic testing. The matrix may be incorporated into a thick-film circuit or mounted on a p.c.b., using surface-mounting techniques. Dynamic addressing of the matrix enables the retrieval of the code in bit serial form and provides a much greater range of codes than when using simple static coding.

Applications include the identification of animals in a herd, objects on a production line, electronic locks and identification tags for personal use. Welwyn Microelectronics, Bedlington, Northumberland NE22 7AA. EWW203



Power back-up

A range of uninterruptible power supplies is to be marketed by A.F. Bulgin, following the signing, at the Show, of an agreement between them and Power Equipment Ltd. The Power Bank range, rated at 120, 250 and 500VA, offers no-break performance and can maintain power for 15 to 20 minutes at full load. Output frequency and voltage are stabilized and the units also act as a buffer against spikes, surges and dropouts in the mains supply. They are fully protected against overload. The u.p.s. range complements Bulgin's growing range of power products which includes switch-mode power supplies. A.F. Bulgin & Co. plc, Bypass Road, Barking, Essex IG11 0AZ. EWW202

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A sophisticated computing and logging DMM
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CIRCLE 36 FOR FURTHER DETAILS.

Add 8 channels to your 'scope
New Thurlby OM358 multiplexer £169 + vat

The Thurlby OM358 gives any oscilloscope an 8 channel display. Observing many waveforms simultaneously can be essential when analysing sophisticated equipment. Application areas include microprocessor based products, data transmission systems, A to D converters, frequency synthesizers etc.
The OM358 is ideal for digital equipment (it can often solve problems that would otherwise need a fast logic analyser) but, unlike dedicated logic test instruments, it is equally suited to analogue waveforms.
The OM358 has a bandwidth of 35MHz and 3% calibration accuracy. Each input has an impedance of 1MΩ - 20pF and accepts signals up to ±6V. An 8 channel, 4 channel, or single channel display can be selected with triggering from any channel. *Colour data sheet with full specifications available.*

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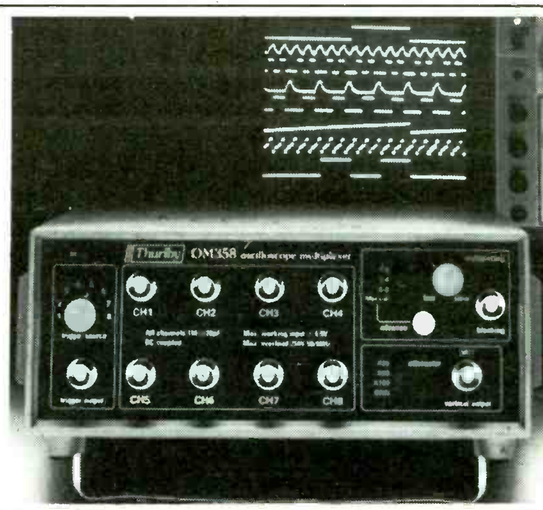
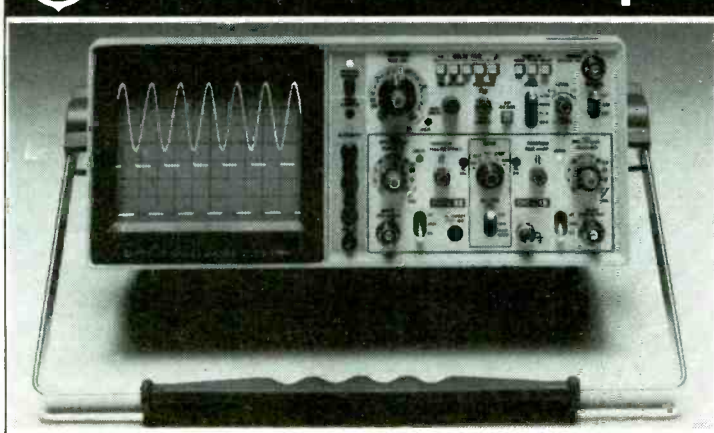
OM358 with two BNC cables £197.80
(inc P & P and VAT)



CIRCLE 37 FOR FURTHER DETAILS.

Hitachi Oscilloscopes
performance, reliability, value and immediate delivery!



Hitachi Oscilloscopes provide the quality and performance that you'd expect from such a famous name, with a newly-extended 14 model range that represents the best value for money available anywhere.

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V-223	20MHz Sweep Delay (illustrated)	V-1050	100MHz Quad Trace
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V-209	20MHz Mini-Portable	V-1100	100MHz DMM/Counter
V-422	40MHz Dual Trace	V-134	10MHz Tube Storage
V-423	40MHz Sweep Delay	VC-6015	10MHz Digital Storage
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For colour brochure giving specifications and prices ring **(0480) 63570**
Thurlby-Reltech, 46 High Street, Solihull, W.Midlands, B91 3TB.

CIRCLE 38 FOR FURTHER DETAILS.

CIRCLE 13 FOR FURTHER DETAILS.

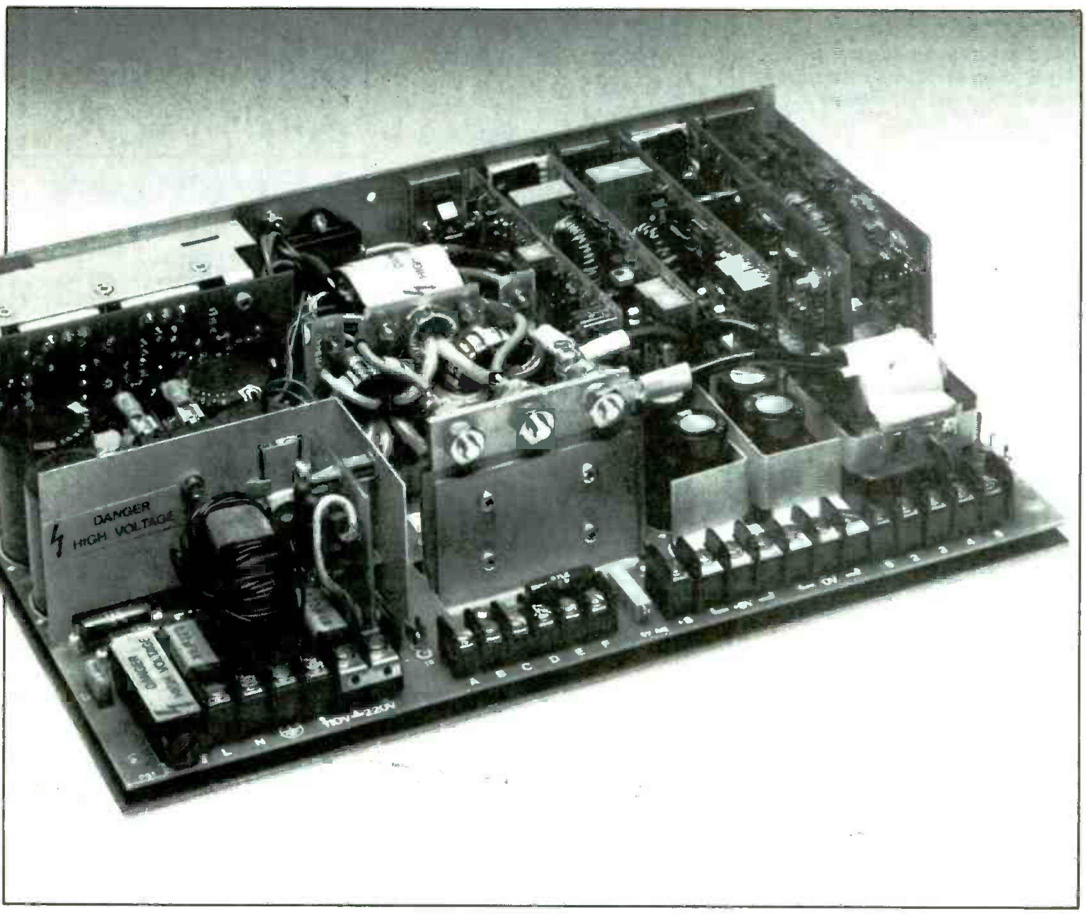
CIRCLE 89 FOR FURTHER DETAILS.

Oscilloscopes and logic analysers

A number of new instruments from Gould were launched at the All Electronics/ECIF show. Pride of place goes to the 1425 oscilloscope which can function as a conventional real-time oscilloscope but can also be used as a digital storage instrument. It incorporates a high degree of 'intelligence' combined with features such as repetitive sampling for storage to 20MHz, automatic measurement for voltage, time and frequency as well as RS232/423 interfaces for use with personal computers. The interface also allows stored waveforms to be copied out on a digital plotter; different traces can be plotted in different colours and scaling parameters and graticule lines can be printed automatically. An analogue output can be used to provide low-cost printouts through a potentiometric pen recorder.

An optional addition to the oscilloscope is the 125 waveform processor. This is a small keypad unit that allows waveforms to be stored, recalled for comparison or analysis, magnified, attenuated, transferred between channels, manipulated arithmetically, averaged, filtered, shifted or compared with datum points indicated by cursors on the screen. The oscilloscope can store reference waveforms for comparative testing. The oscilloscope costs £2090.

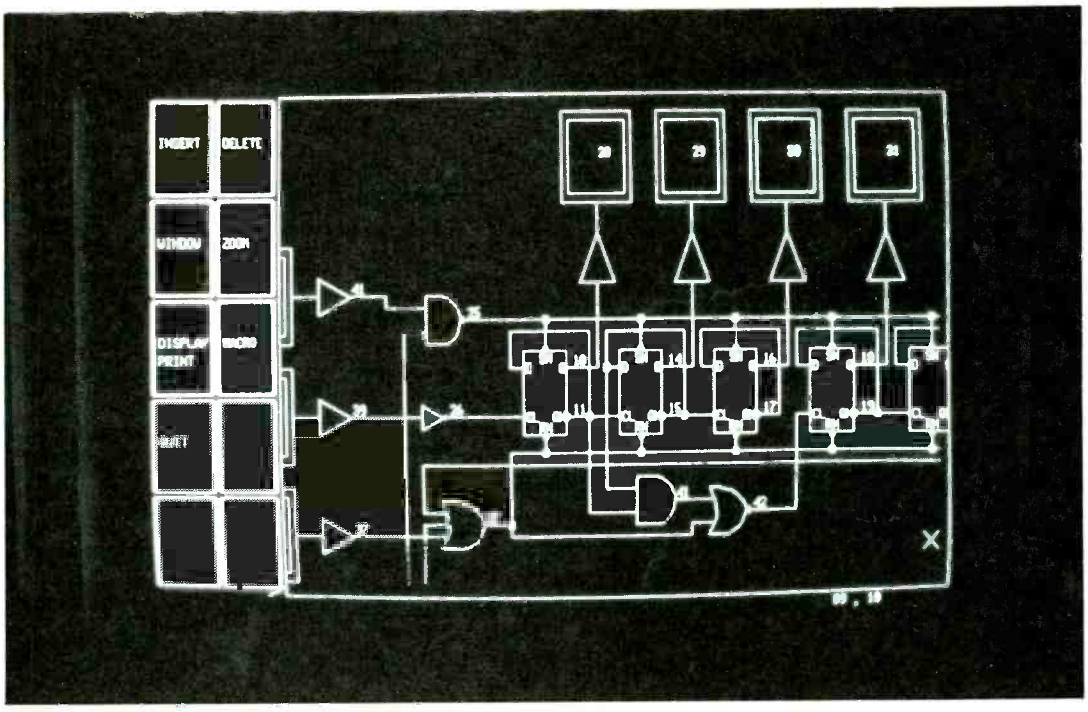
Also featured was the K205 logic analyser with many enhancements over previous models. It now has a user-defineable disassembler and a number of processor analysis packages for the disassembly of all the popular 8 and 16-bit microprocessors. The analyser can test up to 48 channels at 100MHz bandwidth and combines these with circuit analysis and variable triggering. It may be used for the analysis and trouble shooting on the very fast bit-slice processors, e.c.l. circuits, gate arrays, and discrete logic systems. Gould Electronics Ltd., Instrument Systems, Roebuck Road, Hainault, Ilford, Essex IG6 3UE. EWW210



New power supplies

Following a management buy-out by Advance Power Supplies from their former masters, Gould, Advance were celebrating by launching a number of new products at the Show. They were particularly proud of higher power versions of existing ranges. For example, the Hiflex modular multi-output system has a 1kW version with a redesigned, fan-cooled input module. It is suitable for powering digital systems. Also featured were several new variants in the Powerflex P-350 system, an open frame unit with plug-in cards to give up to five separate outputs; fixed or variable 5V, 10 to 15V, and 24V. The 350W unit now includes a signals board which can give a mains-failure alarm signal and remote shut-down. Advance Power Supplies Ltd, Raynham Road, Bishop's Stortford, Herts CM23 5PF. EWW 214.

I.c. design made easy



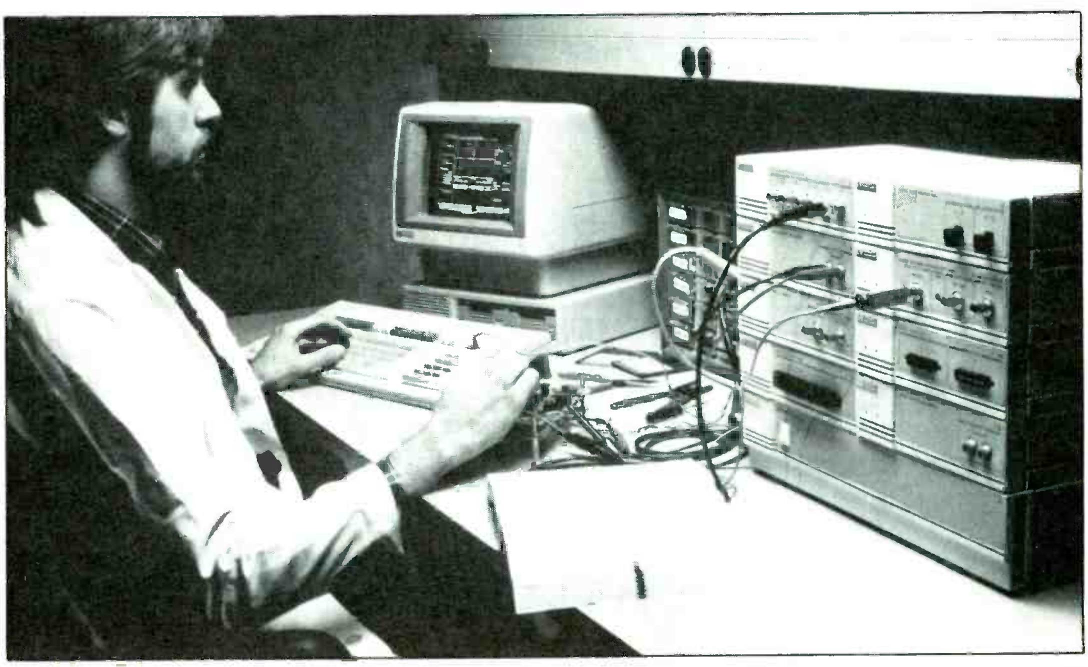
A program for running on the IBM PC, Sceptre II/M, may be used to develop i.cs using the AMI 3-micron single and double metal cell libraries. A recent enhancement also allows it to be used for gate array design, allowing schematic entry, functional simulation and net list generation. As AMI, a USA/Austrian joint company with a design and marketing centre in Swindon, are keen to offer their services as silicon manufacturers, they are offering the software and licences at knock-down prices. Sceptre also runs on a Sirius.

AMI have also been working on the Mentor Graphics work-station and have come up with an adaption which allows the design of large-scale gate arrays ranging from 1000 to 4000 gates. System users can have complete control over all stages in the design process, including physical layout and interconnection. The design tasks can be automatic or interactive and it is possible to place manually and route sections of a circuit, or macros, where automatic placement might not put them in quite the right place. The logical operation of the circuit can be simulated and examined at specific nodes. Timing analysis, together with voltage, capacitance and temperature figures are all provided automatically and the circuit may be altered to change these parameters where they may be critical. The process up to the point of submitting masks to the manufacturer may be carried out entirely by the customer or, at any stage in the design, may be passed over to AMI for completion.

This is all part of the service which AMI can provide from complete design of a circuit to the manufacture of the silicon circuits. They claim that they can make a rom from a programmed eprom within two weeks. Specializing in custom circuits, they also manufacture some standard products, especially telecommunications i.cs. and are currently reducing their circuit geometry from three microns to two and eventually less. AMI Microsystems Ltd, Prospect Place, Swindon, Wilts SN1 3JZ. EWW 211.

Instrumentation on a PC

A number of hardware modules and a software package to link them all together constitute a complete instrumentation package for the IBM Personal computer. The Hewlett-Packard instruments include a 50MHz digital storage oscilloscope, a 4.5-digit multimeter, a 100MHz counter/timer, a relay multiplexer, 5MHz function genertor, 12-bit digital-to-analogue converter, 16-bit digital input output module and an 8-channel relay actuator. The modules are powered independently from an isolated power supply. Up to eight units may be connected to a PC bus and each PC can cope with two bus lines. The units fit together rather like a stacked hi-fi system. All the instruments use the computer screen for readout and simulate the discrete versions of the instruments. The software is menu-driven and offers easy control through a mouse on any of the IBM personal computers or by touching the screen when combined with H-P's own 150 or 160 personal computer. Hewlett-Packard have devised a new bus protocol for the system, PCIB, which includes both analogue and digital components. This interconnection bus is lower cost than IEE-488 although the system as a whole can also communicate over the IEE-488 bus. Hewlett-Packard Ltd, Miller House, The Ring, Bracknell, Berks RG12 1XN. EWW 213.



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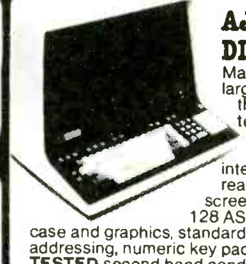
Anderson Jacobson AJ510 VIDEO DISPLAY TERMINAL



Made by one of the USA's largest peripheral manufacturers the AJ510 Professional VDU terminal has too many features to include in space available – just a few are: internal Z80 cpu control, very readable 15" non glare green screen, 24 lines by 80 characters, 128 ASCII character set with lower case and graphics, standard RS232 interface, Cursor addressing, numeric key pad etc. Supplied in good **TESTED** second hand condition with full manual **£225.00** + carr £10.00. Data sheet on request.

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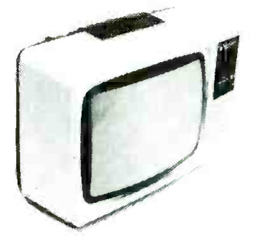

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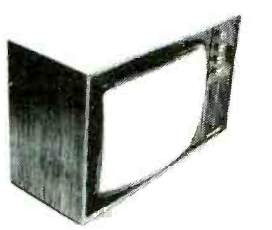

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(2603)

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required to assist in the construction and maintenance of electronic equipment associated with research and teaching of biological studies (under the supervision of the Electronics Engineer).
Must be capable of working from circuit diagrams and sketches.
Applicants should hold ONC or equivalent qualification and have 3-5 years relevant experience (including training period). Further education possible. Salary will be Grade 3 £5,399 – £6,325 p.a. (under review).
Applications stating age, qualifications and full experience, together with the names and addresses of two referees should be addressed to Mr. S. Stainthorpe, Department of Phisiology, Medical and Dental Building, University of Leeds, Leeds LS2 9NQ.

(2623)

TECHNICIAN ENGINEERS

COMMUNICATIONS AND ELECTRONICS

A Planned Career in Technology in the Cotswolds

Salaries up to £11,445

- **VACANCIES** at both **TECHNICIAN ENGINEER** and **ENGINEERING TECHNICIAN** level.
- **CHALLENGING WORK** in the development and support of highly sophisticated communications and computer systems.
- **OPPORTUNITIES** for gaining experience in a wide variety of technical roles.
- **EXTENSIVE ENGINEERING FACILITIES**
- **CAREER PLANNING** aided by regular assessments of performance.
- **ADVANCEMENT** opportunities on the basis of proven ability.
- **OVERSEAS** service (voluntary).
- **FLEXIBLE** working hours with up to six weeks leave.
- **RELOCATION EXPENSES** in most cases.

Applicants for the higher grade of **TECHNICIAN ENGINEER** should normally possess a BTEC Higher National Certificate/Diploma in electronics or other relevant subject; or a City and Guilds Full Technological Certificate, or an equivalent qualification. An aggregate of at least 8 years relevant training and experience is required. Registration as a Technician Engineer (T.Eng) would be an advantage.

Salary Scale: £9,113 – £11,445

Applicants with BTEC ONC or equivalent and at least 4 years relevant training and experience are eligible for posts at the **ENGINEERING TECHNICIAN** level for which a structured training programme is provided.

Salary Scale: £6,599 – £9,135

INTERESTED? Then for either post send for full details and application form to the address below, quoting Ref: T/6523/85

2599

GCHQ
THE RECRUITMENT OFFICE, GCHQ, ROOM A/1108
OAKLEY, PRIORS ROAD, CHELTENHAM, GLOS GL52 5AJ
OR TELEPHONE (0242) 32912/3

NOTTINGHAM HEALTH AUTHORITY

MEDICAL PHYSICS/ELECTRONIC TECHNICIAN GRADE III

Hearing Services Centre
General Hospital
Nottingham

The Hearing Services Centre is a friendly department of 19 staff. It has links with the Medical Physics Department also at the General Hospital, and the Institute of Hearing Research, Clinical Outstation.

The successful applicant will be based at the General Hospital but will be expected to undertake peripatetic work in schools in Nottinghamshire. They will be concerned with development, repair and maintenance of a wide range of Audiological and Hearing Aid equipment for both Health and Education.

A car would be desirable.

Applications are invited for the post from candidates with 'B' TEC in Electronics Engineering ('H' TEC of equivalent) and at least 3 years' related experience).

The Salary Scale is £6,408-8,283.

For further details contact

Mr. G. Armstrong-Bednall
Senior Chief Technician
Hearing Services Centre
General Hospital
Nottingham

Tel: Nottingham 476161 ext 437

For Job Description and Application Form contact

Personnel Department
General Hospital
Nottingham

Tel: Nottingham 476161 ext 489

Closing date: 3rd July 1985

(2608)

ELECTRONICS RESEARCH AT THE OPEN UNIVERSITY

Applications are invited from candidates with a good degree or equivalent qualification in an appropriate subject to study for a full-time research degree in the Electronics Discipline at The Open University.

Research projects are available in a range of subjects including: Telecommunications (Digital Systems, LAN's, Conference TV, Satellite TV), Man-Machine Interface, Robotics, Computer Vision and Graphics, Ultrasonics and Acoustics, Computer Design, Microprocessor Systems, Instrumentation, Signal Processing and Filters, and Computer-Aided-Design, Learning and Manufacture.

The Electronics Discipline has good laboratory facilities and many industrial contacts, and is based in the OU campus in the new city of Milton Keynes. Suitably qualified candidates may be eligible for an SERC studentship.

For further particulars and application forms send a POSTCARD to the Higher Degrees Office, The Open University, P.O. Box 49, Milton Keynes, MK7 6AD or telephone Milton Keynes 0908 653361 or 653806. Please quote reference TE/4 Applications should be submitted as soon as possible.

(2607)

College of Technology,
Yarmouk University, Jordan.

Faculty and technical staff positions in EE Technology available Sep 85 and Feb 86. Relevant educational qualifications and demonstrated teaching/industrial abilities required. Areas of interest include, but are not restricted to Power & Machines, Communications, Electronics, Computers, Controls, Instrumentation, and Manufacturing. Responsibilities include teaching and advisory duties in a quality undergraduate EE Technology program, as well as assisting in the overall development of the College. Rank and Salary commensurate with qualifications and experience. An excellent benefits package. Positions open until filled. Letters of application, detailed resumes, copies of official transcripts, and at least three professional letters of reference should be sent to Faculty Affairs Division, Yarmouk University, Irbid, Jordan.

(2574)

Opportunities in Broadcast Engineering

SONY BROADCAST LTD is well established as one of the world leaders in the professional broadcast television industry, with branches throughout Europe, the Middle East and Africa. Our wide range of sophisticated products includes Cameras, VTRs/VCRs, Camcorders, Editors and the new High Definition Video System. Applications are now invited from experienced engineers for the following career opportunities located at our international headquarters in North Hampshire.

Senior Base Service Engineer

Reporting to the Head of Base Service, the successful candidate will be expected to lead and contribute to a team of engineers and technicians engaged in the service and repair of our range of products. In addition to an electronics qualification, applicants should have a significant track record in the broadcast industry. Previous supervisory experience would be an advantage.

Senior Engineer – Customer Acceptance

The successful candidate will be responsible for the technical support of complex video products, such as Betacam and the new Sony studio camera.
Key activities will include the optimisation of performance, and the conducting of customer acceptance tests for both new and established products. A minimum of 3 years broadcast experience and the ability to effectively maintain the customer interface is essential.

QA Support Engineer

To provide engineering support to the inspection and customer acceptance activities. Responsibilities will be varied and will include: conducting customer acceptance tests to recognised performance standards, preparation of test procedures, the maintenance of test facilities (including ATE) and the resolving of technical problems encountered by the QA inspectorate. Previous engineering experience with broadcast equipment is essential.

QA Technician

The successful candidate will assist in the provision of technical support to the QA and customer acceptance functions. Duties will include product alignment, the maintenance and construction of test facilities, and the control of fixed assets, repair and recalibration schedules. Applicants should possess a formal electronics qualifications – a minimum of Higher TEC (or equivalent). Previous experience would be an advantage.

Full product training will be provided for all the above positions and generous relocation assistance offered where appropriate. In addition, we offer attractive salaries and first class conditions of employment, including Free Private Medical Cover and Company Pension/Life Assurance Scheme.

If you are interested please contact David Parry, Personnel Officer.

SONY® Broadcast

Sony Broadcast Ltd.
Belgrave House
Basing View, Basingstoke
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United Kingdom
Telephone (0256) 55 0 11

2602

Telecommunications Technicians

The posts available are varied, but broadly they fall into 2 groups at,

HANSLOPE PARK (MILTON KEYNES) and CENTRAL LONDON

for installations, maintenance and other work associated with HF communications equipment, VHF, UHF and microwave links and associated test equipment; teleprinters, telephone subscribers' apparatus, PMBXs, PAXs, PABXs and ancillary equipment including that using analogue and digital techniques and voice frequency telegraph.

Applicants should have at least 4 years' relevant experience, and must hold one of the following qualifications:

* ★ ONC in Engineering (with pass in Electrical Engineering 'A')
* ★ BTEC/SCOTEC certificate in relevant discipline
* ★ City and Guilds Telecommunications Technicians Certificate Part II (Course No 271) or Part I plus Maths 'B', Telecommunications Principles 'B' and one other subject
* ★ a pass in the Council of Engineering Institutions Part I examination
* ★ an equivalent or higher relevant qualification

Ex-Service personnel who have had suitable technical traning, and with at least 3 years ' in an approved senior technical capacity will also be considered.

Salary: £6512 — £9009; London £1300 more, starting salary may be above minimum for those with additional relevant experience. Promotion prospects are good. Relocation assistance may be available.

For an application form write to:

Foreign & Commonwealth Office, Hanslope Park, Hanslope, Milton Keynes, MK19 7BH, or telephone Milton Keynes (0908) 510444 Ext 232. Please quote reference TT/02/85.

Closing date for applications 31 July 1985.

FOREIGN AND COMMONWEALTH OFFICE

(2617)

Analogue Engineer

Berks Commercial Company c£17,000

Our client a major privately owned group of companies, due to continued expansion, are seeking a top calibre analogue engineer to become involved with their successful product development programme based around tape and cartridge systems for commercial markets.

Involvement will cover the design testing and releasing to production products and product sub assemblies. Ideally you should have experience in the following:

- Several years design experience
- Design of Servos motor/tacho systems
- Low level signal amplifiers and data recovery circuits
- Digital ability in TTL, CMOS, Pals, and Mpus (preferably Motorola).

In return you will receive all the benefits expected from joining an expanding and commercially aware company (excellent salary, superior working conditions, the use of the latest "kit", genuine career prospects) and many other advantages associated with working for a company operating at the very forefront of technology.

For further information please telephone Stephen Salt, or write enclosing a full CV.

2605

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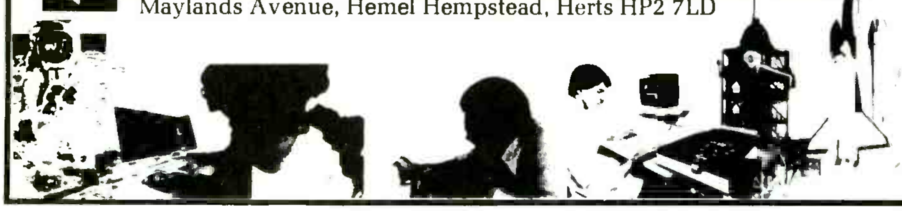

NAME .... (Mr/Miss/Mrs)

ADDRESS ....

....

POST CODE ....

TEL NO: ....

QUALIFICATIONS AGE ....

☐ NONE ☐ CG/HNC ☐ DEGREE ☐ OTHER

SALARY

☐ 0-£6000 ☐ £6-10000 ☐ £10-15000 ☐ £15000+

JOB WW2

(2618)

COMMUNICATIONS MAINTENANCE SUPERVISOR

TELEVISION OUTSIDE BROADCASTS

Salary: £11,907 – £14,542 p.a.
Depending on experience and qualifications

Responsibility for supervising the Communications Test Area which specialises in maintaining all the Sound and Vision Radio Links and line testing equipment associated with Television Outside Broadcasts. This involves a high level of diagnostic skill, both for system and unit maintenance and the ability to manage support staff. Development work and liaison with other BBC Engineering Departments and outside organisations is also included.

Applicants should have a proven ability to supervise a modern technical area, understanding of maintenance techniques and hold a HNC, B.TEC Higher Diploma or degree in Electronic Engineering or equivalent.

For further information and an application form write to or telephone, quoting ref. 85.E.4026/WW: **J.W. Boden, BBC Television Outside Broadcasts, Kendal Avenue, Westfields Road, Acton, London W3 ORP. 01-992 5344 Extension 272.**

BBC

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SOUTH OF SCOTLAND ELECTRICITY BOARD

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TORNESS POWER STATIONS (AGR)

IN ELECTRICAL, INSTRUMENT AND COMPUTER MAINTENANCE

SECOND/THIRD ENGINEERS

SALARY (Currently under review):-
SECOND ENGINEER £10575/£14031
THIRD ENGINEER £8086/£11882
(plus £325 responsibility per Grade)

Torness Nuclear Power Station is currently under construction near Dunbar, East Lothian, approximately 30 miles South East of Edinburgh.

Successful candidates will assist in all aspects of maintenance in one or more of the following areas, viz:- large high voltage electrical plant, light current control systems, conventional instrumentation systems, computers and associated peripherals. Initially work will be concentrated on important activities associated with the establishment of the Section and may include some involvement in plant commissioning. Applicants should preferrably have a HNC or equivalent qualification.

Applications quoting reference no. 67/G188/85, should be submitted on the standard form obtainable from and returnable to the Station Manager, Torness Power Station, Dunbar, East Lothian, EH42 1QS (Tel. No. 0368 63500) not later than 20 July, 1985. (2619)

Bloomsbury Health Authority
Department of Medical Physics and Bioengineering
University College Hospital, London.

EQUIPMENT MANAGEMENT TECHNICIAN (MPT IV)

Ref RT28

To work for the Department's Electromedical Equipment Unit. The Unit is involved in the provision of an equipment management service for the Bloomsbury District. The task is to keep a wide range of patient connected equipment. Serviced, cleaned, calibrated and ready for immediate use. Duties include visits to wards to service equipment. Some knowledge of electronics and a practical aptitude are essential.

Appointment, according to qualifications and experience.

MEDICAL PHYSICS TECHNICIAN IV

Ref RT35

£6,087-£8,188 pa inc London Weighting

Further details available from Mr R. Blackwell, on **01 636 5152**.

For application forms and job descriptions please contact the Personnel Department, on **01 387 2374** (24 hour service) quoting the appropriate reference number.

Closing date

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(2601)

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(1935)

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(291)

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(2595)

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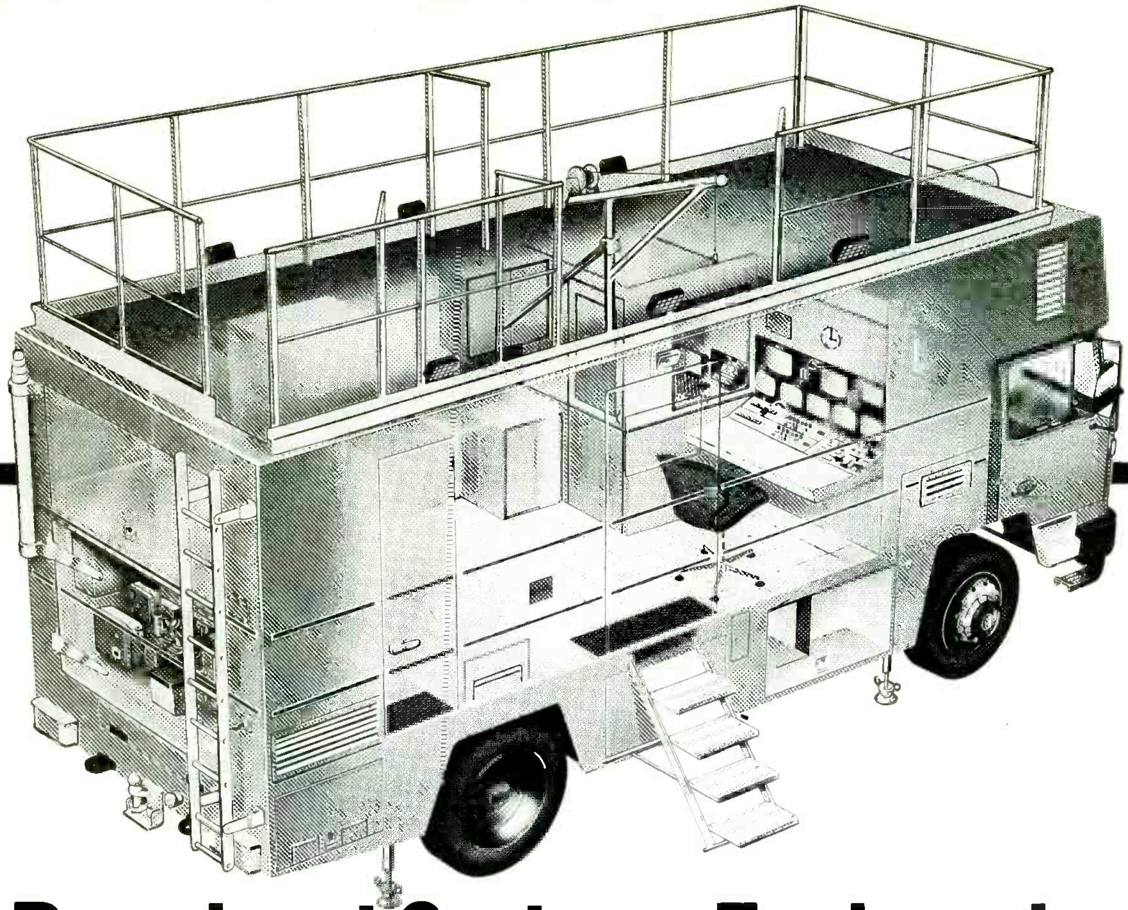
(2593)

Appointments



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RADIO OFFICERS

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Salaries start at £4,762 at age 19 to £5,755 at age 25 and over during training and then £6,399 at 19 to £8,510 at 25 and over as a Radio Officer. Increments then follow annually to £11,741 inclusive of shift and weekend working allowances.

For full details and application form phone 0242 32912/3 or write to: GCHQ The Recruitment Office A/1108 Priors Road CHELTENHAM Glos GL52 5AJ (2806)

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(2598)

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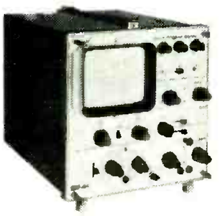
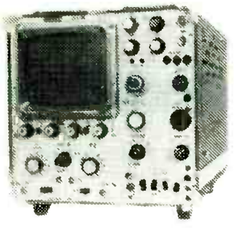


Portable Battery or Mains Oscilloscope. SE Laboratories 111 Oscilloscope — Solid State — General purpose — Bandwidth DC to 18/20MC/S at 20MV/CM — Dual Channel — Rise time 19NS — Calibrated Sweep — Calibrator — Display 10CMS×8CMS — Power AC — 95 Volts to 100-190 Volts to 260 or 24 Volt DC battery — Size. W.25.5.CM — H25.5CCMS — 56CMS Deep — WT11.4KGS — Carrying handle — Tested in fair condition with operating instructions £120.00.



Latest Bulk Government Release — Cossor Oscilloscope CDU150 (CT531/3) £150 only. Solid state general purpose bandwidth DC to 35MHz at 5MV/CM — Dual Channel — High brighlness display (8×10cm) Full delayed time base with gated mode — Risetime 10NS — Illuminated graticule — Beam finder — Calibrator 1KHz squarewave — Power 100 — 120V.200V — 250 volts AC — Size W 26CM — 41CM deep — WT 12.5 K.G. carrying handle — colour blue — protection cover front containing polarized viewer and camera adaptor plate — probe (1) — Mains lead. Tested in Fair condition with operating instructions — £150.00.

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	TF995A/3	AM/FM SIGNAL GENERATOR 220MHz	£175

(2610)

FOR SALE

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2) Tecktronixs 1485 multi standard vectorscope £2950.
3) Versatec VS10 Electro static printer-plotter £3950.
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6) Clarke Hess digital ESR metre P.O.A.
7) Dec LA 36 KSR Printer £100.
8) Facit tape punch model 5070 £100.
9) HP 8746 BS Parom Test Set £1250.

Tel: Cambridge (0223) 68990 (2609)

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